DRAUGHTSMAN MECHANICAL

NSQF LEVEL - 4

1st Year

TRADE PRACTICAL

SECTOR: CAPITAL GOODS & MANUFACTURING

(As per revised syllabus July 2022 - 1200 Hrs)

© NIMI NOT TO BE REPUBLISHED

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : **Capital Goods and Manufacturing**

Duration : **2 - Years**

Trades : **Draughtsman Mechanical - 1st Year - Trade Practical - NSQF LEVEL - 4 (Revised 2022)**

Developed & Published by

National Instructional Media Institute
Post Box No.3142
Guindy, Chennai - 600 032
INDIA
Email: chennai-nimi@nic.in
Website: www.nimi.gov.in

Copyright © 2022 National Instructional Media Institute, Chennai

First Edition : October 2022 Copies : 500

Rs.405/-

© NIMI NOT TO BE REPUBLISHED

All rights reserved.

No part of this publication can be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording or any information storage and retrieval system, without permission in writing from the National Instructional Media Institute, Chennai.

FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Media Development Committee members of various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Draughtsman Mechanical 1st Year Trade Practical NSQF Level- 4 (Revised 2022) in Capital Goods and Manufacturing Sector under Yearly Pattern.** The NSQF Level - 4 (Revised 2022) Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

Addl. Secretary / Director General of Training
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001

© NIMI NOT TO BE REPUBLISHED

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Directorate General of Training, Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of Federal Republic of Germany. The prime objective of this Institute is to develop and provide instructional materials for various trades as per the prescribed syllabus under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

Chennai - 600 032 **EXECUTIVE DIRECTOR**

© NIMI NOT TO BE REPUBLISHED

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisation to bring out this IMP **(Trade Practical)** for the trade of **Draughtsman Mechanical** under the **Capital Goods and Manufacturing** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Shri.Johnson George	-	Senior Instructor, Govt ITI, Dhanuvanchapuram, Kerala.
Shri. V. Dhanasekaran	-	ADT(Retd), MDC Member, NIMI, Guindy Chennai - 32.

NIMI CO-ORDINATORS

Shri. Nirmalya Nath	-	Deputy Director NIMI - Chennai - 32.
Shri. V. Gopalakrishnan	-	Manager NIMI - Chennai -32.

NIMI records its appreciation of the Data Entry, CAD, DTP Operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks, the invaluable efforts rendered by all other staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

© NIMI NOT TO BE REPUBLISHED

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intented to be used in workshop . It consists of a series of practical exercises to be completed by the trainees during the course of the **Draughtsman Mechanical** trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 4 (Revised 2022)

The manual is divided into Ten modules.

Module 1	Importance of trade training and Safety
Module 2	Basic Engineering drawing - Types of curves - Methods of dimensioning - Types of scales
Module 3	Projection - Freehand sketching of different part of machines
Module 4	Sectional views
Module 5	Development of surfaces and interpreteration of solids in orthographic projection
Module 6	Isometric projection from orthographic views (viceversa) oblique projection from orthographic views
Module 7	Specification of different types of fasteners and locking devices as per SP 46 2003
Module 8	Allied trade
Module 9	Tolreances - Machining symbol - surface finishing symbols - Geometrical tolerances - sectional view
Module10	Computer Operation

The skill training in the shop floor is planned through a series of practical exercises centred around some practical project. However, there are few instances where the individual exercise does not form a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the course of the **Draughtsman Mechanical** Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The Trade theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indicating about the corresponding practical exercise are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not the purpose of self learning and should be considered as supplementary to class room instruction.

© NIMI NOT TO BE REPUBLISHED

CONTENTS

© NIMI NOT TO BE REPUBLISHED

© NIMI NOT TO BE REPUBLISHED

NOT TO BE REPUBLISHED © NIMI

NOT TO BE REPUBLISHED © NIMI

LEARNING OUTCOME

On completion of this book you shall be able to

S.No.	Learning Outcome	Ref. Ex.No.
1	Construct different Geometrical figures using drawing Instruments following safety precautions.	1.1.01 - 1.3.22
2	Draw orthographic Projections giving proper dimensioning with title block using appropriate line type and scale.	1.3.23 - 1.4.28
3	Construct free hand sketches of simple machine parts with correct proportions.	1.5.29
4	Construct plain scale, comparative scale, diagonal scale and vernier scale	1.5.30
5	Draw Sectional views of orthographic projections.	1.5.31 - 1.6.33
6	Develop surface and interpenetration of solid in orthographic projection.	1.6.34 - 1.6.38
7	Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views.	1.6.39 - 1.7.47
8	Draw and indicate the specification of different types of fasteners, welds and locking devices as per SP-46:2003	1.7.48 - 1.8.62
9	Acquire basic knowledge on tools and equipments and their application in Allied trades viz. Fitter, Turner, Machinist, Sheet Metal Worker, Welder, Foundry man, Electrician and Maintenance Motor Vehicles.	1.8.63 - 1.8.72
10	Construct different types of gears, couplings and bearings with tolerance dimension and indicating surface finish symbol.	1.8.73 - 1.9.81
11	Perform computer application and create 2D objects on CAD drawing space using commands from ribbon, menu bar, toolbars and by typing in command prompt.	1.9.82 - 1.10.89

© NIMI NOT TO BE REPUBLISHED

SYLLABUS

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
Professional Skill 120Hrs; Professional Knowledge 26Hrs	Construct different Geometrical figures using drawing Instruments following safety precautions. (CSC/NO402)	1 Importance of trade training, List of tools & Machinery used in the trade. (02 hrs) 2 Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). (05 hrs) 3 First Aid Method and basic training. (03 hrs) 4 Safe disposal of waste materials like cotton waste, metal chips/burrs etc. (02 hrs) 5 Hazard identification and avoidance. (02 hrs) 6 Safety signs for Danger, Warning, caution & personal safety message. (02 hrs) 7 Preventive measures for electrical accidents & steps to be taken in such accidents. (05 hrs) 8 Use of Fire extinguishers. (07 hrs)	Importance of safety and general precautions observed in the industry/shop floor. All necessary guidance to be provided to the newcomers to become familiar with the working of Industrial Training Institute system including stores procedures. Soft Skills: its importance and Job area after completion of training. Introduction of First aid. Operation of electrical mains. Introduction of PPEs. Introduction to 5S concept & its application. Response to emergencies e.g. power failure, fire, and system failure.(04 hrs.)
		Perform assignment using drawing instruments: 9 Draw straight lines of a given length. (01hr) 10 Draw perpendicular, inclined (given angle) and parallel lines. Draw triangles with given sides and angles. (03hrs) 11 Construct regular polygons (up to 8 sides) on equal base. (04hrs) 12 Draw inscribed and circumscribed circles of triangle, pentagon and hexagon. (04hrs) 13 Draw a parallelogram with a given length included angle. (02hrs) 14 Draw an angle bi-sector and a line bi-sector. (08hrs) 15 Divide a line into given equal divisions. (06hrs)	Nomenclature, description and use of drawing instruments & various equipments used in drawing office. Their care and maintenance.(04 hrs.) Lay out and designation of a drawing sheet as per Sp -46 : 2003 Recommended scale of engineering drawing as per Sp -46 : 2003 Types of Lines and their application. Folding of prints for filing Cabinets or binding as per SP: 46-2003. (06 hrs.)
		16 Layout a A3 drawing sheet as per Sp -46 : 2003 with margin and name plate. (05hrs) 17 Draw a sample title block providing details as: (i) Title of the drawing (ii) Sheet number (iii)Scale (iv)Symbol, denoting the method of projection (v) Revision with sign (vi) Name of the firm (vii) Initials of staff drawn, checked and approved. (05hrs)	

NOT TO BE REPUBLISHED © NIMI

		18 Draw different types of lines & write their uses in drawing. (05hrs) 19 Label a drawing views showing most of the types of line.(13hrs)	
		20 Write Block letters & numerals in single & double stroke of ratio 7:4 and 5:4 in drawing sheet. (18hrs)	Type of lettering proportion and spacing of letters and words.(06 hrs.)
		21 Construction of ellipse, parabola & hyperbola in different methods. (10120hrs) 22 Construction of involutes, cycloid curves, helix & spiral. 08hrs)	Definition of ellipse, parabola, hyperbola,different methods of their construction. Definition & method of drawing involutes cycloid curves, helix & spiral.(06 hrs.)
Professional Skill 60 Hrs; Professional Knowledge 15Hrs	Draw orthographic Projections giving proper dimensioning with title block using appropriate line type and scale. (CSC/NO402)	23 Construct object drawing with dimensioning in different alignment as per SP-46. (03hrs) 24 Create dimensions in previous assignments. (15hrs)	Terminology - feature, functional feature, functional dimension, datum dimension, principles. Units of dimensioning, System of dimensioning, Method of dimensioning & common features. (04 hrs.)
		25 Draw orthographic projection of points and lines. (08 hrs) 26 Draw projection of plane figures (lamina). (12 hrs)	Methods of obtaining orthographic view. Position of the object, selection of the views, three views of drawing. Planes and their normal projections.(04 hrs.)
		27 Draw orthographic projection of solids- prisms, cylinders, cones, pyramids. (10 hrs) 28 Draw orthographic projection of cut section/ frustums of solids- prism, cylinders, cones, pyramids. (12hrs)	Orthographic projection. First angle and third angle projection. Principal of orthographic projection. Projection of solids like prism, cones, pyramids and their frustums. (05 hrs.)
Professional Skill 15Hrs; Professional Knowledge 06Hrs	Construct free hand sketches of simple machine parts with correct proportions. (CSC/NO402)	29 Free hand sketch (in proper proportion) of tool post of a Lathe, Bench Vice, Cutting Tools, Bolts, Stud & Nut, gland, Pipe Flange, Hand Wheel, Crane hook, Steel bracket. (15hrs)	Methods of free hand sketching for machine parts.(06 hrs.)
Professional Skill 15Hrs; Professional Knowledge 06Hrs	Construct plain scale, comparative scale, diagonal scale and vernier scale(CSC/NO402)	30 Draw plain scales, diagonal scales, comparative scales, venire scale & scale of chords. (15hrs)	Knowledge of different types of scales, scale of cords, their appropriate uses, Principle of R.F, diagonal &vernier. (06 hrs.)
Professional Skill 30Hrs; Professional Knowledge 12Hrs	Draw Sectional views of orthographic projections. (CSC/NO402)	31 Sketch Conventional sings and symbols. (05hrs) 32 Sketch different types of section lines and abbreviations for different materials as per SP-46:2003. (05hrs) 33 Draw Orthographic drawing of solids (viz., cube, prisms, cone and pyramids) finding out the true shape surfaces cut by oblique planes. (20hrs)	Knowledge of solid section. Types of sectional views & their uses. Cutting plane and its representation. Parts not shown in section. Conventional signs, symbols, abbreviations & hatching for different materials. Solution of problems to find out the true shape of surfaces when solids are cut by different cutting planes.(12 hrs.)
Professional Skill 82Hrs; Professional Knowledge 20Hrs	Develop surface and interpenetration of solid in orthographic projection. (CSC/NO402)	34 Construct the development of surface of cylinder, prisms, Cone, pyramids and their frustum. (18hrs) 35 Draw development of an oblique cone with elliptical base. (05hrs) 36 Draw the development of a 3-pieces pipe elbow, a pipe hole through it, a bucket and a funnel. (13hrs)	Definition of development, its need in industry & different method of developing the surfaces. Development of surfaces bounded by plane of revolution intersecting each other. Development of an oblique cone with elliptical base etc. Calculation of de-

© NIMI NOT TO BE REPUBLISHED

			veloped lengths of geometrical solids.(10 hrs.)
		37 Construct orthographic projection of interpenetrating solids (cylinder, cones, prism & pyramid) of axes right angle to each other and axes inclined to each other. (26hrs) 38 Generate the curves of intersection of cylinder penetrating through a sphere, cone and a cylinder. (20hrs)	Definition of Intersection & interpenetration curves. Common method to find out the curve of interpenetration. Solution of problems on interpenetration of prism, cones, & pyramids with their axes intersecting at an angle. Intersection of cylinder.(10 hrs.)
Professional Skill 82 Hrs; Professional Knowledge 20Hrs	Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views. (CSC/NO402)	39 Construct the isometric view of Polygons and circular lamina. (08 hrs) 40 Draw isometric view of solid geometrical figures from orthographic views with dimension. (08 hrs) 41 Draw isometric views of truncated cone and pyramid. (08hrs)	Principle of isometric projection and Isometric drawing. Methods of isometric projection and dimensioning. Isometric scale. Difference between Isometric drawing & Isometric projection. (04 hrs.)
		42 Construct orthographic views from isometric drawing of solid blocks with holes, grooves, notches, dovetail cut, square cut, round cut, stepped, etc. (10hrs) 43 Construct orthographic views of hanger, bracket & support (08 hrs) 44 Draw isometric view of V-block, Angle plate, sliding block. (10 hrs) 45 Draw isometric drawing of a simple Journal Bearing. (08 hrs.)	Principles of making orthographic views from isometric drawing. Selection of views for construction of orthographic drawings for clear description of the object. (10 hrs.)
		46 Draw oblique projection of circular lamina in receding axis at 30° & 45°. (05hrs) 47 Draw oblique projection of levers and hollow blocks. (17 hrs)	Principle and types of oblique projection. Advantage of oblique projection over isometric. Projection. (06 hrs.)
Professional Skill 130 Hrs; Professional Knowledge 30Hrs	Draw and indicate the specification of different types of fasteners, welds and locking devices as per SP-46:2003 (CSC/NO402)	48 Draw Screw threads with SP-46:2003 conventions. (08hrs) 49 Draw different types of bolts, studs, nuts and washers as per SP-46:2003 conventions. (08hrs) 50 Draw different locking arrangement of nuts, machine screws, caps screw set screw as per convention. (08hrs) 51 Draw a half sectional view of a coupler nut. (04hrs) 52 Draw four different types of foundation bolt. (16hrs)	Screw threads, terms nomenclature, types of screw thread, proportion and their uses, threads as per SP-46:2003 conventions. Types of bolts, nuts and studs, and their proportion, uses. Different types of locking devices. Different types of machine screws, cap screws, set screws as per specification. Different types of foundation bolts and their uses.(10 hrs.)
		53 Draw fillet weld and butt weld joint specifying the basic term of the joint. (05hrs) 54 Draw a weld joint representing the position and dimensioning of the weld with conventional symbols on the drawing. (06hrs) 55 Draw section of welded steel structural column & bracket fabricated by plate. (10hrs)	Description of Welded Joints and their representation (Actual and Symbolic) Indication of Welding Symbol on drawing as per SP-46. (04 hrs.) Different types of keys (Heavy duty and Light duty) cotters, splined shaft, pins and circlips. Calculation of sizes and proportions of keys. (06 hrs.)

NOT TO BE REPUBLISHED © NIMI

		56 Draw a half-sectional view of Cotter joint with socket and spigot ends. (12hrs) 57 Draw different types of Keys, splined shaft, circlips and pins as per convention. (08 hrs)	
		58 Draw the different types of pipe fittings. (06 hrs) 59 Draw pipe joints: flanged joint, welded joint, threaded joint, socket and spigot joint.(18hrs)	Pipe Joints: selection of materials as per carrying fluid and conditions. Description of different pipe joints fitted on pipe. Expansion joint, loop and other pipe fittings. (04 hrs.)
		60 Draw rolled steel sections as per IS specification. (05hrs) 61 Draw the different types of rivet heads indicating the dimensions related to diameter of the rivet as per convention. (08hrs) 62 Draw riveted joints of lap and butt with covers in chain and zig-zag orientation. (08hrs)	Types of rivets, their size proportions and uses. Types of riveted joints, terms and proportions of riveted joints. Conventional representation. Relation between rivet size and thickness of plates and calculation for arrangement of rivets position. Causes of failure of riveted joint efficiency of riveted joints. (06 hrs.)
Professional Skill 130Hrs; Professional Knowledge 30Hrs	Acquire basic knowledge on tools and equipments and their application in Allied trades viz. Fitter, Turner, Machinist, Sheet Metal Worker, Welder, Foundry man, Electrician and Maintenance Motor Vehicles. (CSC/NO402)	Allied Trade- Fitting 63 Use of different types of fitters hand tools. (06hrs) 64 Work on MS plate by filing, hack sawing, check dimensions, mark the plate, punch centre mark, cut a v-notch by chisel, drill a hole on the center mark. (16hrs)	Description and application of simple measuring tools. Description of vices, hammers, cold chisel, files, drills, etc.-proper method of using them. Method of using precision measuring instrument. Maintaining sequence of operation in fitting shop and safety precaution. (04 hrs.)
		Allied Trade Turning 65 Cut a round bar in power saw, centering and facing the bar, perform the turning, grooving, stepped and taper operation on the bar. (20hrs)	Safety precaution for lathes. Description of parts of Lathe & its accessories. Method of using precision measuring instrument such as inside & outside micrometers, depth gauges, verniercallipers, dial indicators, slip gauges, sine bars, universal bevel protractor, etc. (04 hrs.)
		Allied Trade Machinist: 66 Use of jigs and fixtures Simple operations on milling machine such as plain-milling and key way cutting. (10 hrs) 67 Mark out on castings and forgings work piece, set up and perform operation of shaping, slotting and planning machines. (10 hrs)	Brief Description of milling, shaping, slotting and planning machines. Quick return mechanism of these machines. Maintaining sequence of operation in machine shop and safety precaution. (06 hrs.)
		68 Allied Trade: Sheet Metal Use of hand tools such as planishing,hammers stakes, mallet, bricks prick punch etc. Mark and cut a sheet to make a container. (20hrs)	Brief description of common equipment required for sheet metal work. Different types of joints used in sheet metal work. (04 hrs.)
		Allied Trade: Welding 69 Use of hand tools used in gas and in electric arc welding	Maintaining sequence of operation in machine shop and safety precaution. Brief description of the hand tools used gas & arc welding. Different types of

NOT TO BE REPUBLISHED © NIMI

		Weld an object according to drawing. (12 hrs) 70 Foudryman/Moulder Different types of mould, cores and core dressing, use of moulding tools. (12 hrs) Allied Trade: Electrician 71 Prepare a simple wiring for residential room. Identify the electrical equipment and measuring instruments.(12hrs) Allied Trade: MMV- IC Engine 72 Identify different parts of IC Engines (Both spark ignition & compression ignition-2 stroke & 4 stroke engines). (12hrs)	welded joints and necessary preparation required for these. Safety precautions, Hand tools used for molding. The description, use and care of hand tools.(06 hrs.) Safety precaution maintained in electrician shop. A.C & D.C Motors Generators of common types and their uses and brief description of common equipment necessary for sheet metal work. Electrical units and quantities. Laws of electricity. Simple examples of calculation of current voltage, resistance in series and parallel connection (D.C.Circuit). Brief description of internal combustion engines, such as cylinder block piston, carburettor spark plug, camshaft, crank shaft, injector fuel pump etc. (06 hrs.)
Professional Skill 120Hrs; Professional Knowledge 26Hrs	Construct different types of gears, couplings and bearings with tolerance dimension and indicating surface finish symbol. (CSC/NO402)	73 Draw the diagram illustrating basic size deviations and tolerances. (03hrs) 74 Draw symbols for machining and surface finishes (grades and micron values) (03hrs) 75 Draw the system of indication of geometrical tolerances of form and position as per standard: Straightness, flatness, circularity, cylindricity, parallelism, perpendicularity, angularity, concentricity, coaxiality, symmetry, radial run-out, axial run-out. (10hrs) 76 Construct a machine part indicating geometrical tolerance. (08hrs)	Limits, fit, tolerance. Toleranced dimensioning, geometrical tolerance. Indications of symbols for machining and surface finishes on drawing(grades and micron values) Production of interchangeable parts, geometrical tolerance. Familiarization with IS: 919, IS:2709.(06 hrs.)
		Construct the sectional view of: 77 Muff coupling, (06hrs) 78 Flanged coupling, (10hrs) 79 Friction grip coupling. (10hrs) 80 Pin type flexible coupling, (10hrs) 81 Universal coupling. (10hrs) (conventional method)	Couplings, necessity of coupling, classification of couplings. Uses and proportion of different types of couplings. Materials used for couplings. (10 hrs.)
		Draw detailed and assembly drawing of: 82 Simple bearing (03hrs) 83 Foot step bearing. (03hrs) 84 Plummer block. (08hrs) 85 Self-aligning bearing (swivel bearing). (08hrs) 86 Construct tooth profile of a spur gear above 30 teeth. (10hrs) 87 Draw two spur gears in mesh (08hrs) 88 Draw two bevel gears in mesh (10hrs)	Knowledge of bearing to reduce friction, types of bearing, frictional and anti-frictional bearings. Material used for frictional bearings. Properties of frictional bearing (sliding bearing) materials. Parts of anti-frictional bearings (ball, roller, thrust ball, needle & taper roller). Materials and proportion of parts. Difference between frictional and anti-frictional bearings. Advantages of anti-frictional bearings. (05hrs.) Gears and gear drives- uses, types, nomenclature and tooth profiles. (05 hrs.)

Professional Skill 56Hrs; Professional Knowledge 15Hrs	Perform computer application and create 2D objects on CAD drawing space using commands from ribbon,menu bar,tool bars and by typing in command prompt.	89 Perform computer application (05hrs) i) create new folder, ii) add subfolders, iii) create application files, iv) change appearance of windows, v) search for files, vi) sort files, vii) copy files, viii) create shortcut folder, ix) create shortcut icon in desktop and taskbar x) move files to and from removable disk/ flash drive. xi) install a printer from driver software in operatingsystem. Create, save and print a document, worksheet and pdf (portable document format) files.(10hrs)	Introduction to computer, Windows operating system, file management system. Computer hardware and software specification. Knowledge of installation of application software.(04 hrs.)

© NIMI NOT TO BE REPUBLISHED

© NIMI
NOT TO BE REPUBLISHED

Importance of training - List of tools and machinery used in trade

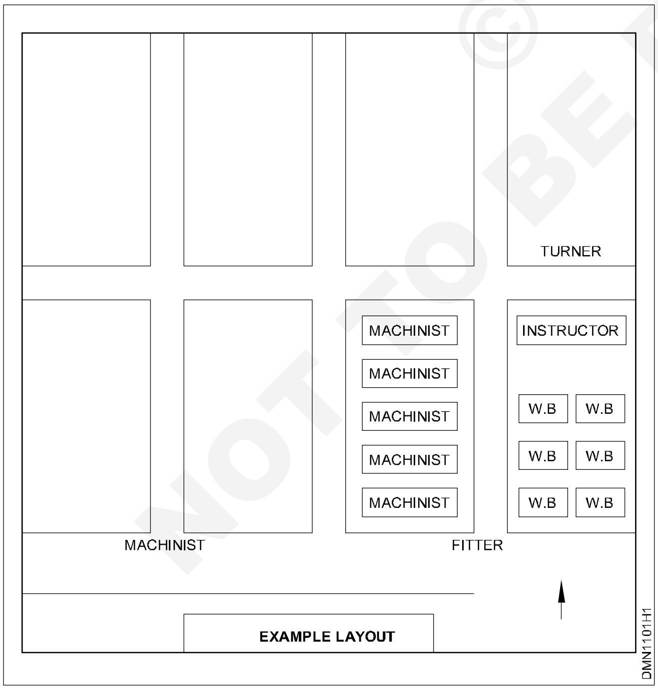
Objective: At the end of this exercise you shall be able to
- **over view about the trade.**

- Draughtsman mechanical trade is basically differ from other trade
- Practicals are conducted in the classroom instead of conducting in shop floor.
- Trainees has been taught basic knowledge of geometrical construction, projections, development of solids and sectional views.
- A trainee in this trade has to under go, Allied training in various trades.
- The trades are fitting - turning - machinist - sheet metal - welding - foundry - Electrician - MMV - IC.
- Being a draughts man mechanical he plays an important role in the capital goods and manufacturing.
- He prepares working drawings and even in CAD with required limits-fits and tolerances.
- Hence the trade of D'man mechanical is a vital trade in I.T.I
- It has more job opportunity and even for self-employment
- The following are the tools and equipment used by a draughtsman mechanical in the course of training.

Visit to various section of the ITI

Objectives: At the end of this exercise you shall be able to
- **identify the ITI staffs their designation and their names**
- **list the trades available at your ITI**
- **mention the location of your ITI with respect to railway station/ bus stand and any land mark**
- **record the telephone numbers of ITI office, hospital, police station and fire station**
- **draw the layout of your section.**

Exercise 1: Visit various section of ITI and acquaint with the staff members



Instructor will lead the new recruits to various section of ITI.

- During the visit collect information like the designation of staff member, their name.
- Identify the sections in the ITI and list the trades in which training is given.
- Identify the location of ITI with respect to railway station and bus stand and list of bus route numbers which ply near the ITI.
- Collect the telephone numbers of ITI office, nearest hospital, nearest police station and the nearest fire station.

Exercise 2: Draw the layout of your section of ITI

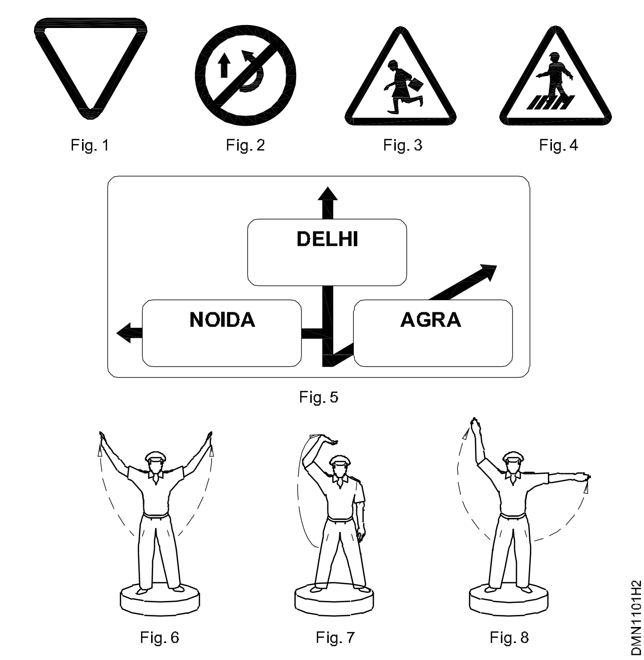
- Draw the plan of your section to a suitable scale in a separate sheet of paper (A4 size).
- Take the length and the breadth measurements of machine foundations, work benches, panels, wiring cubicles, doors, windows, furniture etc.
- Draw the layout of the machines work benches panels and furniture etc. The section plan should be same scale as in step1 as per the actual placement of the machine foundation, panels, furniture work benches etc.

Exercise 3: Road safety signal / Traffic signals

Instructor will explain all the road safety sign and traffic police signals

- Read the sign given and mention their kinds and the meaning in the table1.

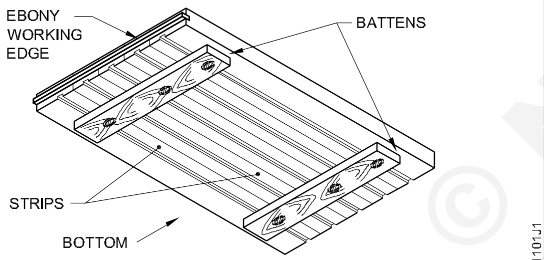
© NIMI NOT TO BE REPUBLISHED



Get it checked by the instructor.

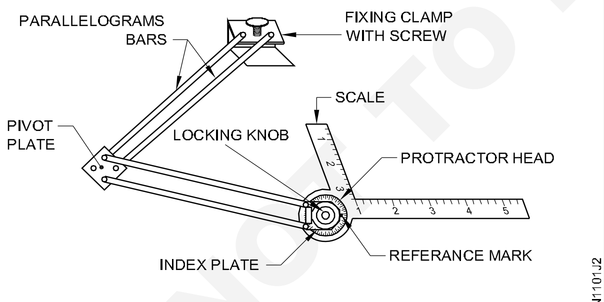
Exercise 4: Drawing equipment and instruments in Table 2

Fig 1



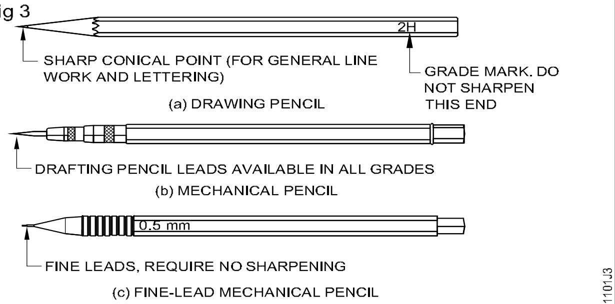
DRAWING BOARD

Fig 2



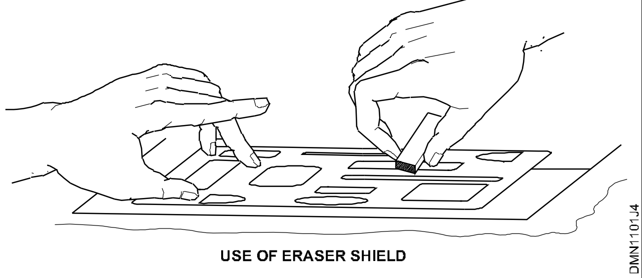
PARTS

Fig 3



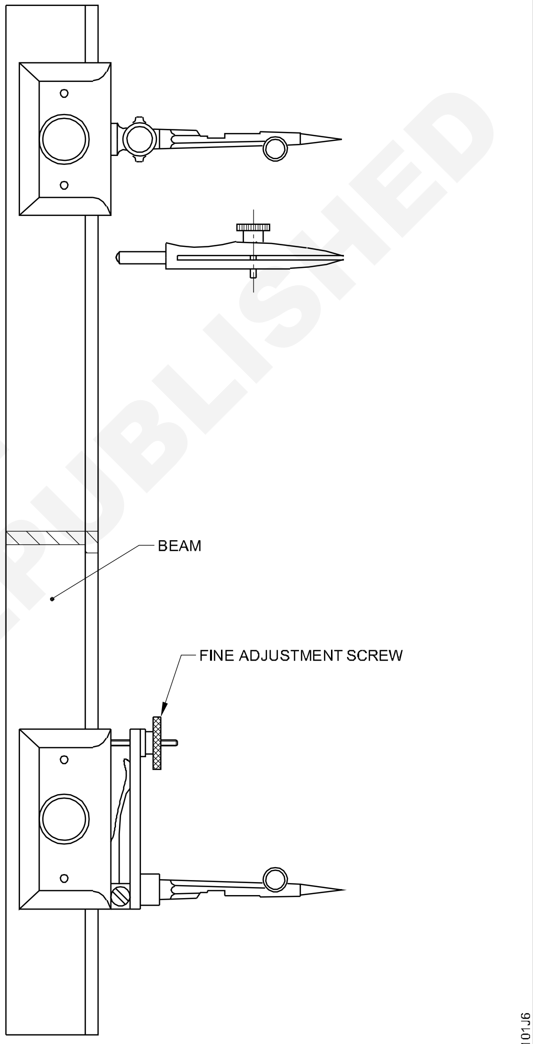
DRAWING PENCILS

Fig 4



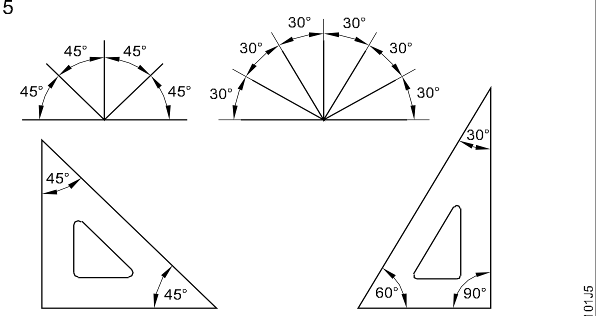
USE OF ERASER SHIELD

Fig 6



BEAM COMPASS

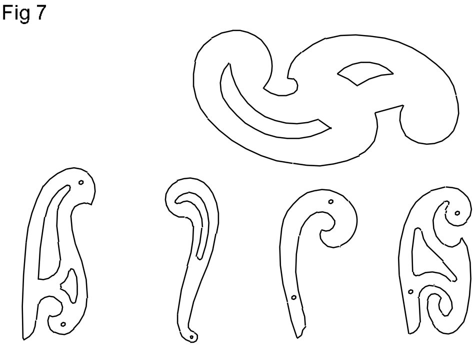
Fig 5



(a) 45° SET SQUARE **(b) 30° - 60° SET SQUARE**

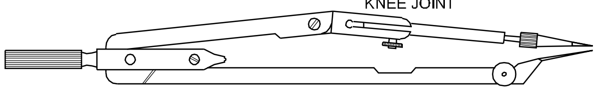
© NIMI NOT TO BE REPUBLISHED

Fig 7



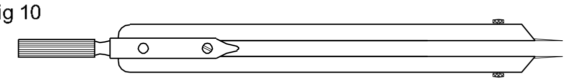
FRENCH CURVES

Fig 9



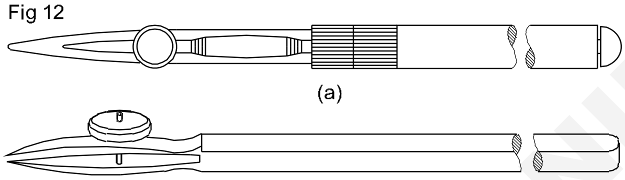
LARGE COMPASS

Fig 10



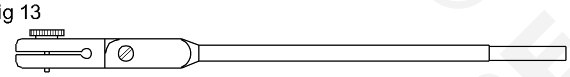
DIVIDER

Fig 12



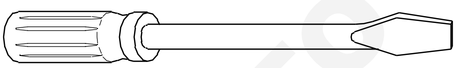
RULING PENS

Fig 13



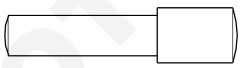
LENGTHENING BAR

Fig 14



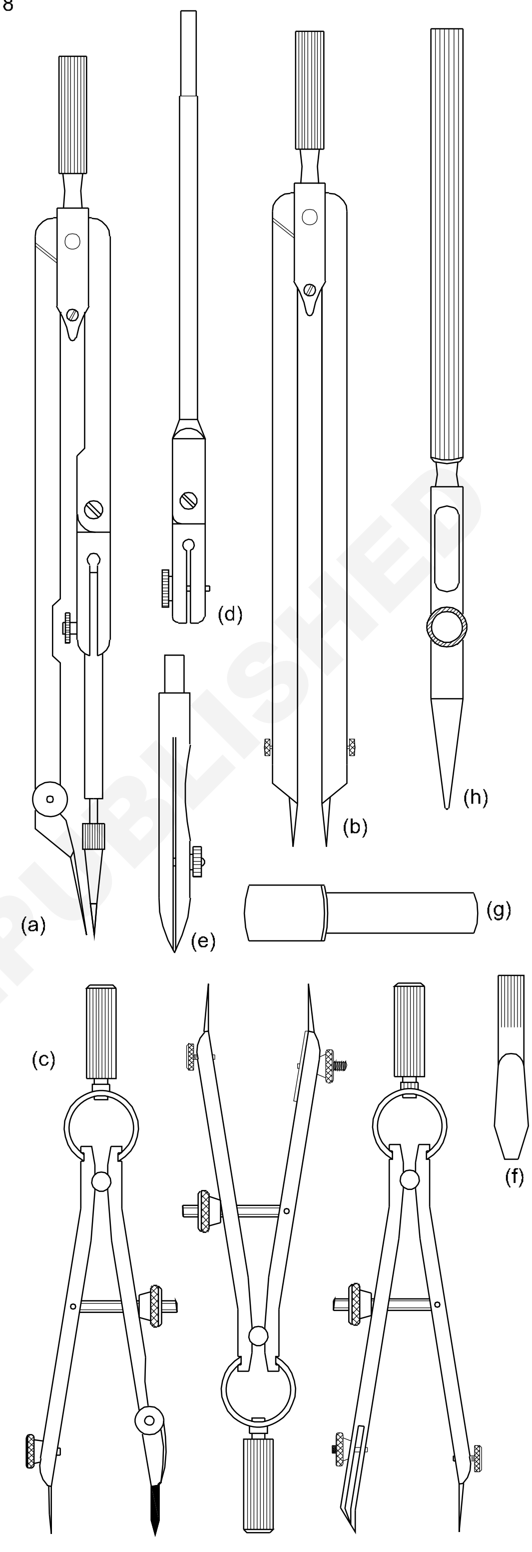
SCREW DRIVER

Fig 15



LEAD CASE

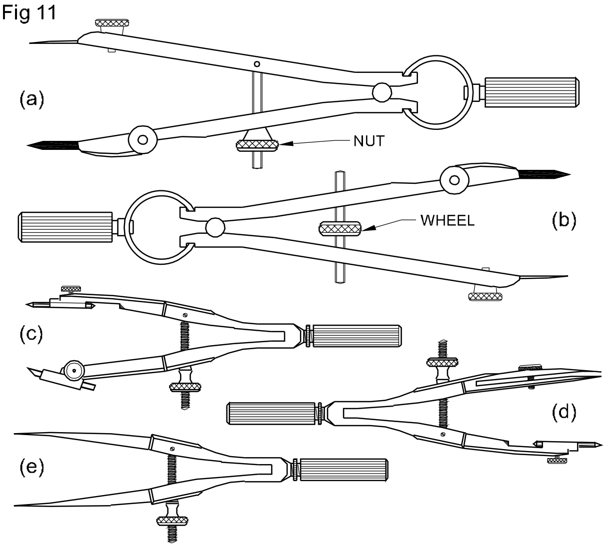
Fig 8



DRAWING INSTRUMENTS

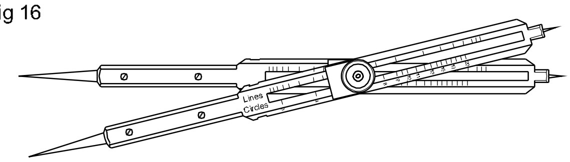
© NIMI NOT TO BE REPUBLISHED

Fig 11



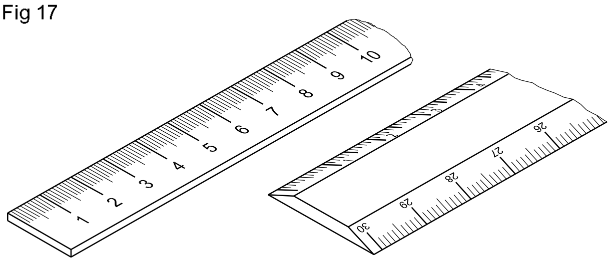
BOW - INSTRUMENTS

Fig 16



PROPORTIONAL DIVIDERS

Fig 17



STEEL RULE WOODEN SCALE

Note : Instructor should ask the trainees to prepare appropriate table for each topic and fill the details. Guide the trainees to prepare the table.

© NIMI NOT TO BE REPUBLISHED

Safety - Use of personal protection equipment (PPE) and japanese 5s concept

Objectives: At the end of this exercise you shall be able to
- **identify the places/machinery/equipments are to be cleaned**
- **collect the cleaning materials/devices required on cleaning**
- **clean the machines/equipment and devices installed in your section.**

Requirements

Tools / Equipments

- Portable vacuum cleaner/blower - 1 No.

Materials

- Emery sheet 'O' grade - 1 No.
- Dusting cloth - as reqd.
- Dust bin - 3 Nos (labeled)

Exercise 1: Practice on cleanliness

Switch-off all the machinery and equipment before starting the cleaning. Use mask or cover the mouth and nose.

Instructor has to brief the Japanese 5S concept to the trainees before starting the work.

IS.Sort
IIS.Set in order
IIIS.Shine
IVS.Standardise
VS.Sustabin

$\left.\begin{array}{l}\\ \\ \\ \\ \end{array}\right\}$ **5S concept**

1 Identify the areas/equipment machine have to be cleaned.

2 Keep the movable items at one place and group it.

3 Clean the dust carefully without damaging any part/ connection of the machine / equipment, by using clothes.

4 Use wet dusting cloth to shine the areas to be cleaned/ wired.

5 Remove the rust in any of the parts of equipment or devices by using emery sheet.

Do not remove any lubricants applied to the machine for its function while wiping/cleaning.

Wear the PPE set to avoid accidents

6 Use vacuum cleaner to suck the dust from the places where brush or cloth cannot be reached.

7 Collect the waste materials found in the lab and put it in the dustbin specified for it, as shown in Fig 1.

Dusting and cleaning can be arranged in groups of trainees under the supervision of instructor.

8 Clean the places where water or oil spill over the floor and dusting particles.

Note down any abnormal things you noticed in particular while doing cleaning and report to the instructor to take action to correct it.

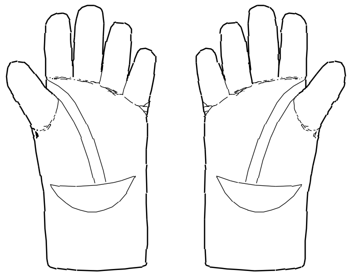
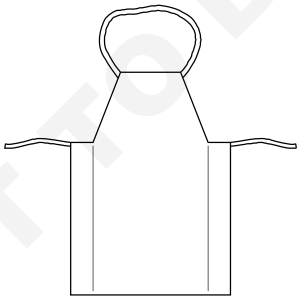
9 Put back all the materials and equipment used for cleaning.

10 Inspect in the presence of instructor and ensure that all the machines are working after cleaning.

11 Discuss with instructor anything you noticed in particular and prepare a report if required to the instructor.

Assign the cleaning work in batch wise daily into the trainees by the instructor in an arranged manner. Dispose the waste as and when required through stores.

© NIMI NOT TO BE REPUBLISHED

Sl. No.	Sketches	Name of PPE	Type of protection	Uses
1	Fig 1  DMN1102H1			
2	Fig 2  DMN1102H2			
3	Fig 3  DMN1102H3			

12 Get it checked by your instructor.

Fig 1

© NIMI NOT TO BE REPUBLISHED

Importance of housekeeping & good shop floor practice

Objectives: At the end of this exercise you shall be able to
- **follow the activities performed for better up keeping of working environment**
- **follow the good shop floor practices.**

Exercise 1: Housekeeping

The following activities to be performed for better up keep of working environment.

1 **Cleaning of shop floor:** Keep clean and free from accumulation of dirt and refuse daily.

2 **Cleaning of machines:** Reduce accidents to keep machines cleaned well.

3 **Prevention of leakage and spillage:** Use splash guards in machines and collecting tray.

4 **Disposal of scrap:** Empty scrap, wastage, SWAB from repective containers regularly.

5 **Tool storage:** Use special racks, holders for respective tools.

6 **Storage spaces:** Identify storage areas for respective items. Do not park material in aisle.

7 **Piling methods:** Do not overload platform, floor and keep material at safe height.

8 **Material handling:** Use forklifts, conveyors and hoist.

Good shop floor practices

- Good shop floor practices are motivating action plans for improvement of the manufacturing process.
- All workers are communicated with daily target on manufacturing activities.
- Informative charts are used to post production, quality standards.
- Manufactured parts are inspected to ensure adherence to quality standards.
- Production processes are planned by engineering to minimize product variation.
- 5S Methods are used to organize the shop floor and production lines.
- Workers are trained on plant safety practices in accordance with OSH standards.
- Workers are trained on "root cause" analysis for determining the causes of non - conformances.
- A written preventive maintenance plan for upkeep of plant machinery & equipment.
- Management meets with plant employees regularly to get input on process improvements.
- Process improvement teams are employed to implement "best practices".

© NIMI NOT TO BE REPUBLISHED

Use of personal protective equipment (Occupational Safety)

Objectives: At the end of this exercise you shall be able to
- **read and interpret the different types of Personal Protective Equipment (PPE) from the chart (or) real PPE**
- **identify and name the PPEs for the corresponding type of protection and write their uses.**

Requirements

Tools / Equipments

- Chart showing different types of PPEs - 1 No.
- Real PPEs (available in section) - as reqd.

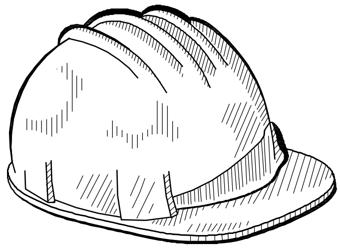
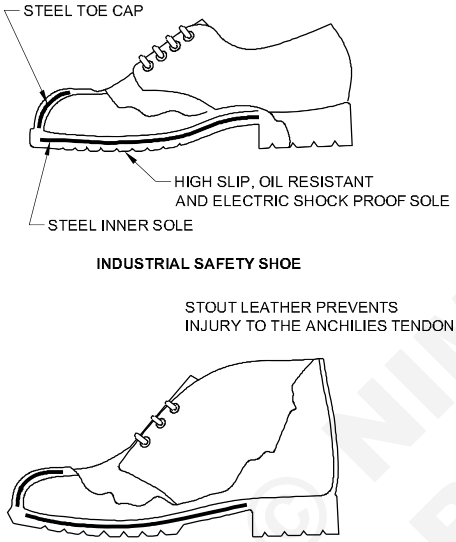
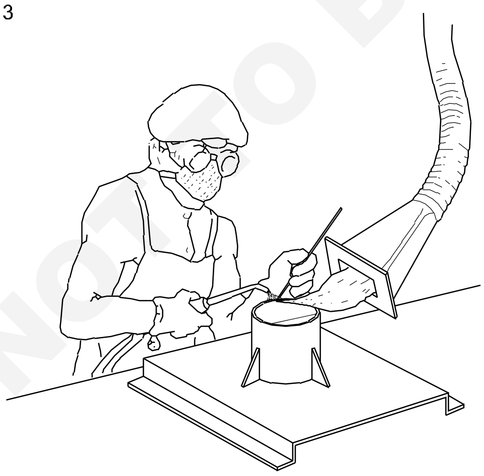
Excercise 1: Identifying and name the PPEs - fill in to table 1

Instructor may arrange the available different types of PPEs in the table (or) provide the chart showing the PPEs. Explain the types of PPEs and their uses for corresponding hazards.

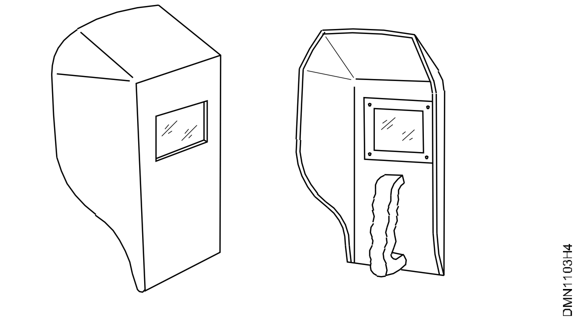
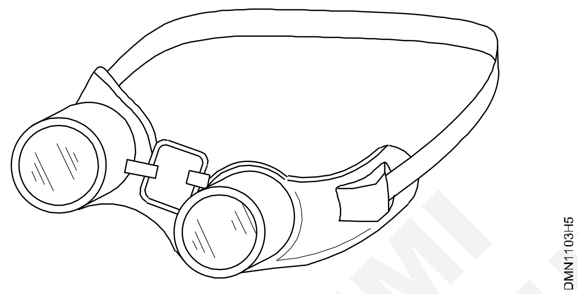
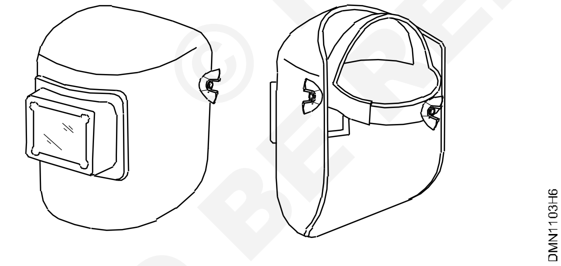
1 Identify the type of PPEs and write their names to the corresponding PPE, by referring from chart (or) read PPEs in Table 1.

2 Write their type of protection and uses in the blank space provided against each PPE in Table 1.

Table 1

Sl. No.	Sketches	Name of PPE	Type of protection	Uses
1	Fig 1 			
2	Fig 2 			
3	Fig 3 			

NOT TO BE REPUBLISHED © NIMI

Sl. No.	Sketches	Name of PPE	Type of protection	Uses
4	Fig 4 			
5	Fig 5 			
6	Fig 6 			

© NIMI NOT TO BE REPUBLISHED

First aid method and basic training

Objective: At the end of this exercise you shall be able to
- **prepare the victim for elementary first aid.**

Requirements

Equipment/Materials

- No. of Persons (Instructor can divide the trainees in suitable No. of groups.) - 20 Nos.
- Control panel arrangement - 1 No.
- Motor - 1 No.
- Rubber mat - 1 No.
- Wooden stick - 1 No.
- 2 persons for demonstration purpose

PROCEDURE

Assumption - For easy manageability, Instructor may arrange the trainees in group and ask each group to perform one method of resuscitation.

TASK 1: **Prepare the victim before giving first aid treatment**

1 Loosen the tight clothing which may interfere with the victim's breathing. (Fig 1)

Fig 1

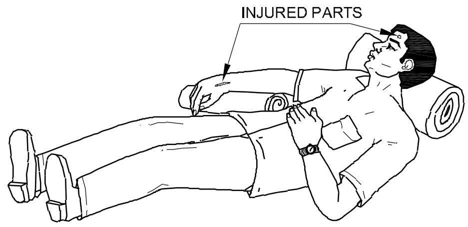
2 Remove any foreign materials or false teeth from his mouth and keep the victim's mouth open. (Fig 2)

3 Bring the victim safely to the level ground, taking necessary safety measures. (Fig 3)

Do not waste too much time in loosening the clothes or trying to open the tightly closed mouth.

Fig 2

Fig 3



4 Avoid violent operations to prevent injury to the internal parts of the victim.

— — — — — — —

TASK 2: **Prepare the victim to receive artificial respiration**

1 If breathing has stopped, apply immediate artificial respiration.

2 Send word for professional assistance. (If no other person is available, you stay with the victim and render help as best as you can)

3 Look for visible injury in the body and decide on the suitable method of artificial respiration.

4 Have you observed ? (In this case you are told by the instructor)

5 In the case of injury/burns to chest and/or belly follow the mouth to mouth method.

6 In case the mouth is closed tightly, use Schafer's or Holgen–Nelson method.

7 In the case of burn and injury in the back, follow Nelson's method.

8 Arrange the victim in the correct position for giving artificial respiration.

© NIMI NOT TO BE REPUBLISHED

All action should be taken immediately.

Delay even by a few seconds may be dangerous.

Exercise extreme care to prevent injury to internal organs.

9 Place the mock victim in the recovery position.

10 Cover the victim with coat, sacks or improvise your own method. It helps to keep the victim's body warm.

11 Proceed to perform the suitable artificial respiration method.

— — — — — — —

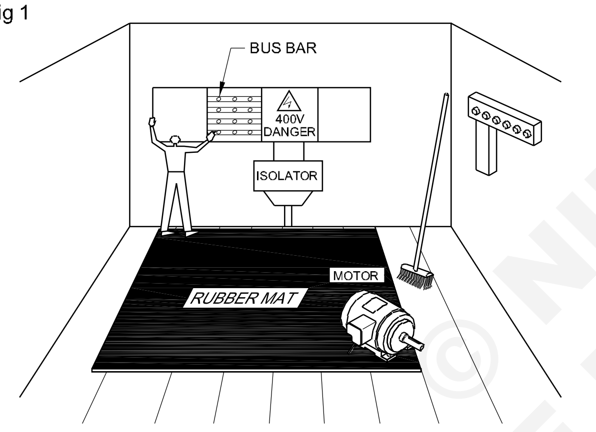
Rescue a person and practice artificial respiration

Objectives: At the end of this exercise you shall be able to
- **disconnect the victim from electric shock**
- **resuscitate the victim by**
  - **nelson's arm - Lift back method**
  - **schafer's method**
  - **mouth to mouth method**
  - **mouth to nose method.**

PROCEDURE

TASK 1 : **Disconnecting a person (mock victim) from a live supply (simulated). (Fig 1)**

Fig 1



1 Observe the person (mock victim) receiving an electric shock. Interpret the situation quickly.

2 Remove the victim safety from the `live` equipment by disconnecting the supply or using one of the items of insulating material.

Do not run to switch off the supply that is far away.

Do not touch the victim with bare hands until the circuit is made dead or the victim is moved away from the equipment.

Push or pull the victim from the point of contact of the live equipment, without causing serious injury to the victim.

3 Move the victim physically to a nearby place.

4 Check for the victim's natural breathing and consciousness.

5 Take steps to apply respiratory resuscitation if the victim is unconscious and not breathing.

— — — — — — —

TASK 2 : **Resuscitate the victim by Nelson's arm - Lift back pressure method**

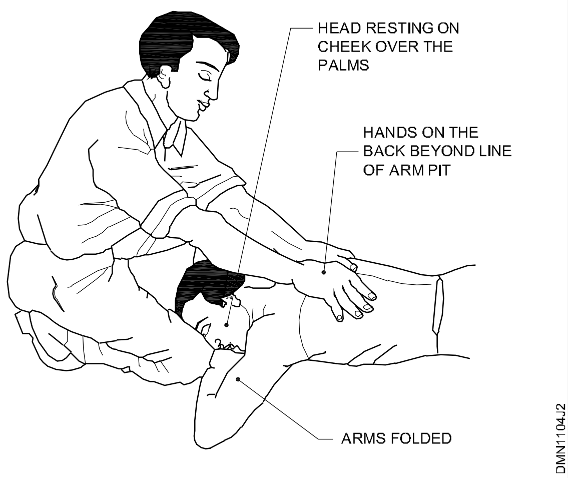
Nelson's arm-lift back pressure method must not be used in case there are injuries to the chest and belly.

1 Place the victim prone (that is face down) with his arms folded with the palms one over the other and the head resting on his cheek over the palms.

2 Kneel on one or both knees near the victim's hand.

3 Place your hands on the victim's back beyond the line of the armpits, with your fingers spread outwards and downwards, thumbs just touching each other as in Fig 2.

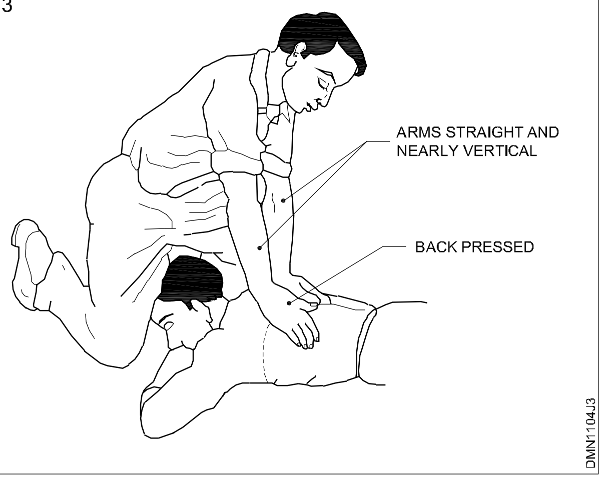
Fig 2



© NIMI NOT TO BE REPUBLISHED

4 Gently rock forward keeping your arms straight until they are nearly vertical, and steadily pressing the victim's back as shown in Fig 3 to force the air out of the victim's lungs.

Fig 3



5 Synchronize the above movement of rocking backwards with your hands sliding downwards along the victim's arms, and grasp his upper arm just above the elbows as shown in Fig 4. Continue to rock backwards.

Fig 4

6 As you rock back, gently raise and pull the victim's arms towards you as shown in Fig 5 until you feel tension in his shoulders. To complete the cycle, lower the victim's arms and move your hands up to the initial position.

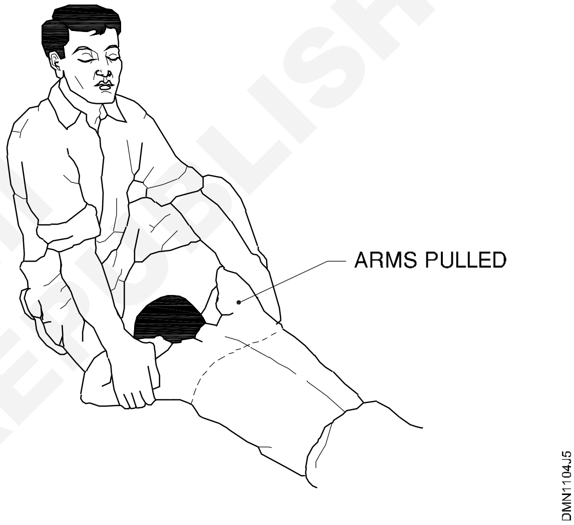
7 Continue artificial respiration till the victim begins to breathe naturally. Please note, in some cases, it may take hours.

8 When the victim revives, keep the victim warm with a blanket, wrapped up with hot water bottles or warm bricks; stimulate circulation by stroking the insides of the arms and legs towards the heart.

9 Keep him in the lying down position and do not let him exert himself.

Do not give him any stimulant until he is fully conscious.

Fig 5



© NIMI NOT TO BE REPUBLISHED

TASK 3 : **Resuscitate the victim by Schafer's method**

Do not use this method in case of injuries to victim on the chest and belly.

1 Lay the victim on his belly, one arm extended direct forward, the other arm bent at the elbow and with the face turned sideward and resting on the hand or forearm as shown in Fig 6.

2 Kneel astride the victim, so that his thighs are between your knees and with your fingers and thumbs positioned as in Fig 6.

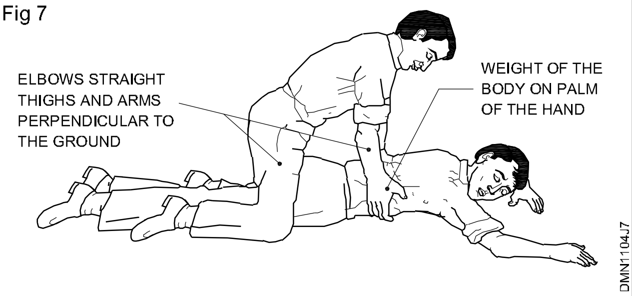
3 With the arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the lower ribs of the victim to force the air out of the victim's lungs as shown in Fig 7.

Fig 6

4 Now swing backward immediately removing all the pressure from the victim's body as shown in Fig 8, thereby, allowing the lungs to fill with air.

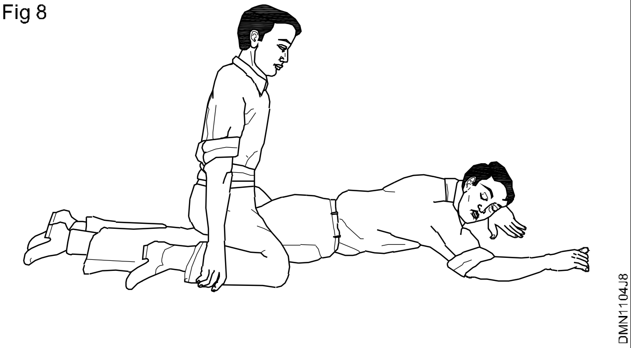
5 After two seconds, swing forward again and repeat the cycle twelve to fifteen times a minute.

Fig 7



6 Continue artificial respiration till the victim begins to breathe naturally.

Fig 8

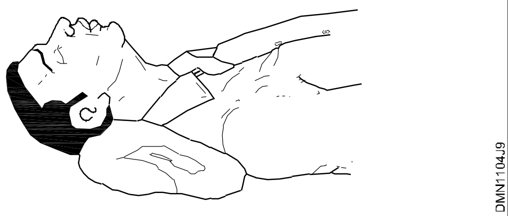


— — — — — — —

TASK 4 : **Resuscitate the victim by mouth-to-mouth method**

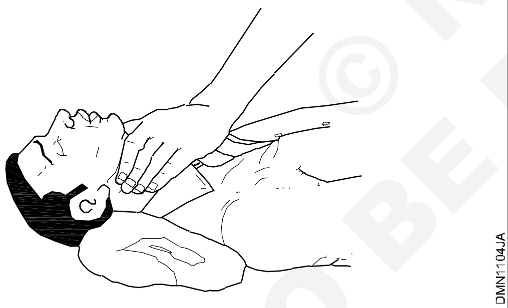
1 Lay the victim flat on his back and place a roll of clothing under his shoulders to ensure that his head is thrown well back. (Fig 9)

Fig 9



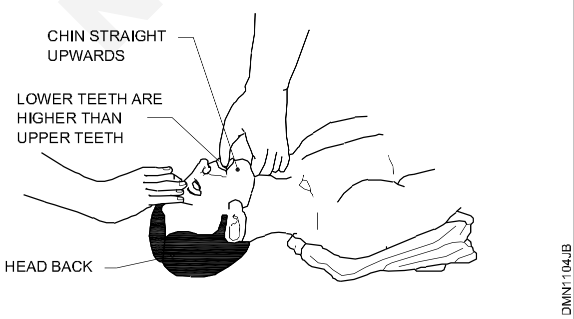
2 Tilt the victim's head back so that the chin points straight upward. (Fig 10)

Fig 10



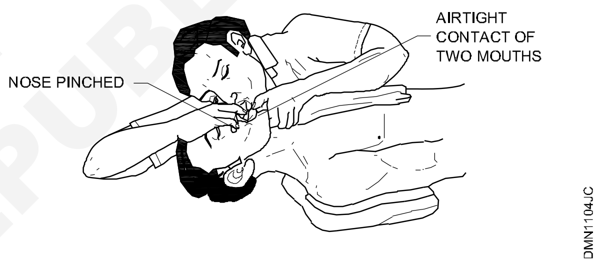
3 Grasp the victim's jaw as shown in Fig 11, and raise it upward until the lower teeth are higher than the upper teeth; or place fingers on both sides of the jaw near the ear lobes and pull upward. Maintain the jaw position throughout the artificial respiration to prevent the tongue from blocking the air passage.

Fig 11



4 Take a deep breath and place your mouth over the victim's mouth as shown in Fig 12 making airtight contact. Pinch the victim's nose shut with the thumb and forefinger. If you dislike direct contact, place a porous cloth between your mouth and the victim's. For an infant, place your mouth over his mouth and nose. (Fig 12)

Fig 12



5 Blow into the victim's mouth (gently in the case of an infant) until his chest rises. Remove your mouth and release the hold on the nose, to let him exhale, turning your head to hear the rushing out of air. The first 8 to 10 breathings should be as rapid as the victim responds, thereafter the rate should be slowed to about 12 times a minute (20 times for an infant).

If air cannot be blown in, check the position of the victim's head and jaw and recheck the mouth for obstructions, then try again more forcefully. If the chest still does not rise, turn the victim's face down and strike his back sharply to dislodge obstructions.

Sometimes air enters the victim's stomach as evidenced by a swelling stomach. Expel the air by gently pressing the stomach during the exhalation period.

— — — — — — —

© NIMI NOT TO BE REPUBLISHED

TASK 5 : **Resuscitate the victim by Mouth-to-Nose method**

Use this method when the victim's mouth will not open, or has a blockage you cannot clear.

1 Use the fingers of one hand to keep the victim's lips firmly shut, seal your lips around the victim's nostrils and breathe into him. Check to see if the victim's chest is rising and falling. (Fig 13)

2 Repeat this exercise at the rate of 10 - 15 times per minute till the victim responds.

3 Continue this exercise till the arrival of the doctor.

Fig 13

— — — — — — — —

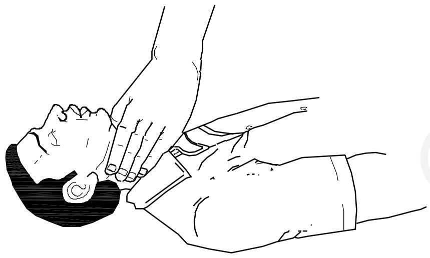
TASK 6 : **Resuscitate a victim who is under cardiac arrest**

In cases where the heart has stopped beating, you must act immediately.

1 Check quickly whether the victim is under cardiac arrest.

Cardiac arrest could be ascertained by the absence of the cardiac pulse in the neck (Fig 14), blue colour around lips and widely dilated pupil of the eyes.

Fig 14



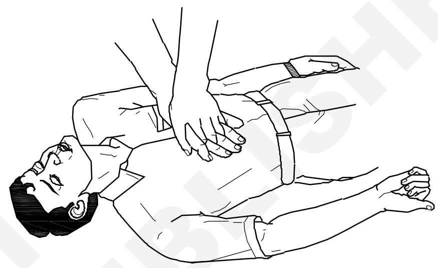
2 Lay the victim on his back on a firm surface.

3 Kneel alongside facing the chest and locate the lower part of the breastbone. (Fig 15)

Fig 15

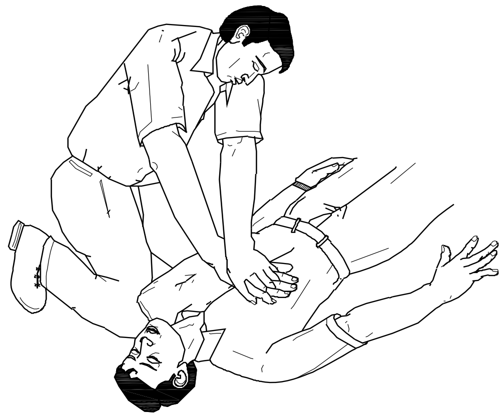
4 Place the palm of one hand on the center of the lower part of the breastbone, keeping your fingers off the ribs. Cover the palm with your other hand and lock your fingers together as shown in Fig 16.

Fig 16



5 Keeping your arms straight, press sharply down on the lower part of the breastbone; then release the pressure. (Fig 17)

Fig 17



6 Repeat step 5, fifteen times at the rate of at least once per second.

7 Check the cardiac pulse. (Fig 18)

8 Move back to the victim's mouth to give two breaths (mouth-to-mouth resuscitation). (Fig 19)

9 Continue with another 15 compressions of the heart followed by a further two breaths of mouth-to-mouth resuscitation, and so on, check the pulse at frequent intervals.

© NIMI NOT TO BE REPUBLISHED

Fig 18

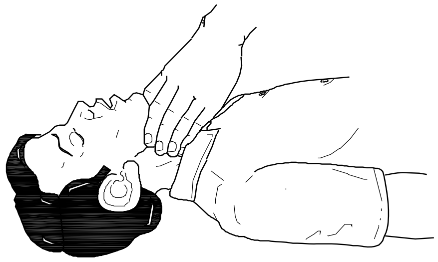


Fig 19

10 As soon as the heartbeat returns, stop the compressions immediately but continue with mouth-to-mouth resuscitation until natural breathing is fully restored.

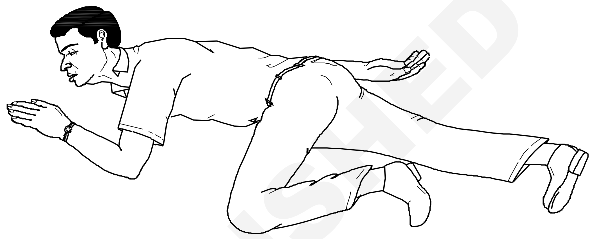
11 Place the victim in the recovery position as shown in Fig 20. Keep him warm and get medical help quickly.

Other steps

1 Send for a doctor immediately.

2 Keep the victim warm with a blanket, wrapped up with hot water bottles or warm bricks; stimulate circulation by stroking the insides of the arms and legs towards the heart.

Fig 20



© NIMI NOT TO BE REPUBLISHED

Disposal of waste materials

Objectives: At the end of this exercise you shall be able to
- **identify the waste material in different category**
- **segregate and arrange the waste materials in it's corresponding bins**
- **dispose non saleable and saleable material separately and maintain record.**

Requirements

Materials

- Shovel -1 No.
- Plastic/Metal bins - 4 Nos
- Trolley with wheels - 3 Nos
- Brush and gloves - 1 Pair

PROCEDURE

TASK 1: **Disposal of waste materials from the workshop**

1 Collect all the waste materials in workshop.

2 Identify and segregate the different waste like cotton waste. metal chips, all chemical waste and electrical waste etc. (Fig 1) separately and label them.

3 Segregate saleable, non saleable, organic and inorganic materials also.

4 Record the segregated waste material and fill the Table 1.

Fig 1

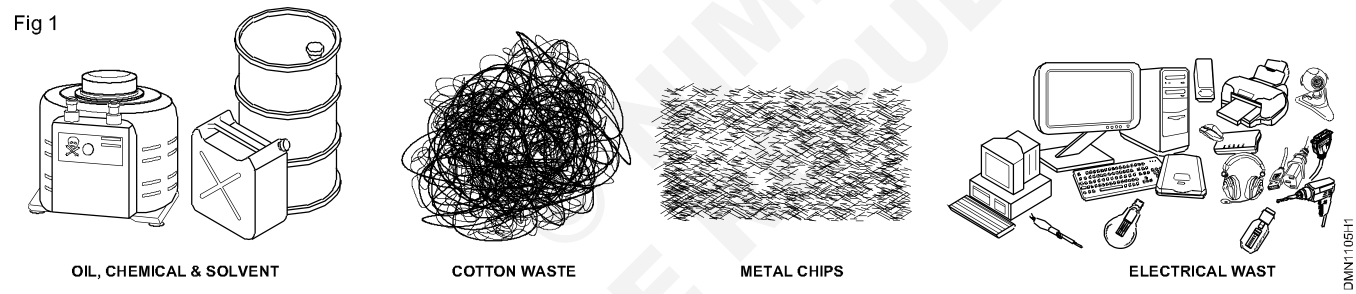


Table 1

Sl.No.	Name of the waste material	Quantity	Saleable or non Saleable
1			
2			
3			
4			
5			
6			

5 Arrange at least 3 trollies with wheel for disposal and stick the lable an each trolly as "Cotton Waste", "Metal chips" and "others" (Fig 2)

6 Put the cotton waste in cotton trolley and similarly put the metal chips waste and others in corresponding trolleys.

7 Keep another 4 bins to collect saleable scarp. non saleable scrap, organic waste and in-organic waste and label them. (Fig 3)

© NIMI NOT TO BE REPUBLISHED

Fig 2

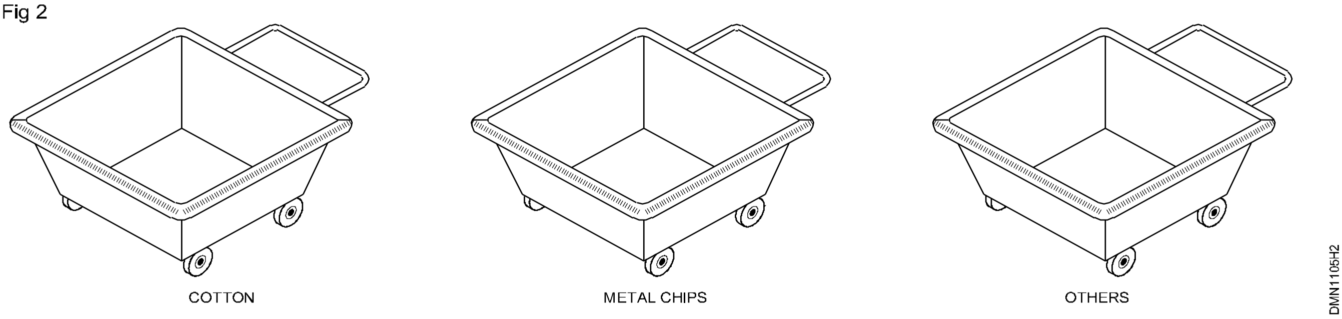


Fig 3

— — — — — — — —

Separate the cotton waste and dispose it

Objective: This shall help you to

- **separate and dispose the cotton waste.**

TASK 1: **Segregating the waste material**

1 Collect the chips by hand shovel with help of brush.

2 Clean the floor if oil is spill.

> **Do not handle the chip by bare hand there may be different metal chips. So separate the chip according to metal.**

3 Separate the cotton waste material and store in the bin provided to store the waste cotton material.

4 Store the each category similarly of metal chip in separate bins.

> **Each bin have respective label.**

5 Collect all the saleable material metal and non - metal separately and keep it's respective bins.

6 Collect all the non - saleable materials like cotton waste, paper waste, wooden pieces etc. and keep it's respective bin.

7 Check the non - saleable material work (organic) and send it for disposal by burning after getting approval.

8 Check the saleable material and segregate like Aluminium, Copper, Iron, Screws, nuts and other items separately and send to stores for disposal by auction (or) as per recommended procedure with approval.

© NIMI NOT TO BE REPUBLISHED

Hazards identification (symbolic) and avidance

Objectives: At the end of this exercise you shall be able to
- **identify the safety symbols from the chart and their basic category**
- **write their meaning and description and the place of use**
- **identify the road safety sign with traffic signal from the chart**
- **read and interpret the different types of occupational hazards from the chart.**

Requirements

Materials

- Basic safety signs chart -1 No.
- Road safety signs and traffic signal chart - 1 No.
- Occupational hazards chart - 1 No.

PROCEDURE

Exercise 1: Identify the safety symbols and interpret their meaning and color with shape

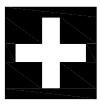
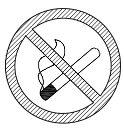
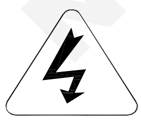
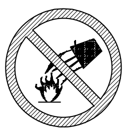
> **Instructor may provide various safety signs chart for basic categories and road safety with traffic signals. Then explain their categories meaning and color. Ask the trainees to identify the sign and record in table 1.**

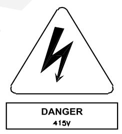
1 Identify the basic category of each sign from the chart.

2 Write the categories name of the each sign meaning description and the place of use of that safety sign in Table 1.

© NIMI NOT TO BE REPUBLISHED

Table 1

No.	Safety signs	Name of the basic category and sign	Place of use
1	 HOSPITAL		
2	 NO SMOKING		
3	 WEAR HAND PROTECTION		
4	 RISK OF ELECTRIC SHOCK		
5	 DO NOT EXTINGUISH WITH WATER		

No.	Safety signs	Name of the basic category and sign	Place of use
6			
7			
8			
9			
10			
11			
12			
13			

— — — — — — — — —

Exercise 2 : **Identify the road safety sign and traffic signals**

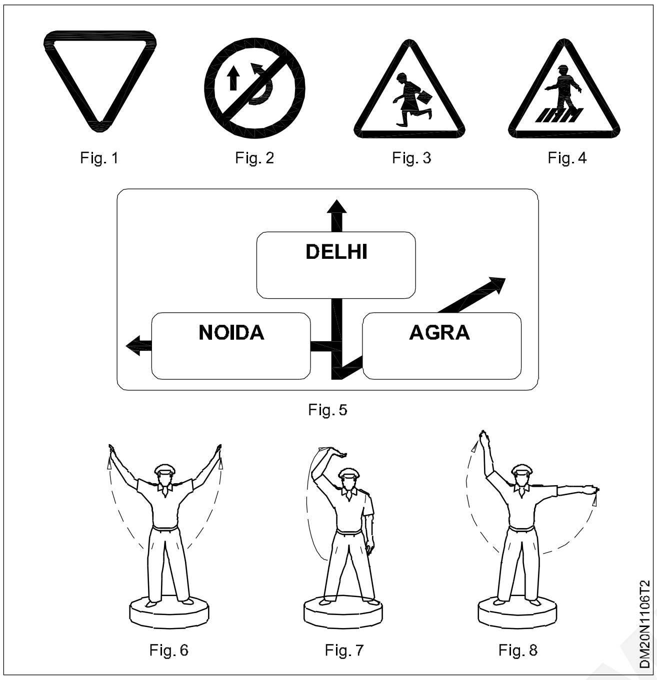
Instructor will explain all the road safety sign and traffic police signals.

1 Read the sign given and mention their kinds and the meaning in the table 2.

2 Get it checked by the instructor.

© NIMI NOT TO BE REPUBLISHED

Table 2

No.	Safety signs	Name of the basic category and sign	Place of use
			

— — — — — — — —

Exercise 3: Read and interpret the different types of personal protective devices from the chart

Instructor may brief the various types of occupational hazards and their causes.

1 Identify the occupational hazard to the corresponding situation with a potential harm given in table 3.

2 Fill up and get it checked by your instructor.

Table 3

Sl.No.	Source or potential harm	Type of occupational hazards
1	Noise	
2	Explosive	
3	Virus	
4	Sickness	
5	Smoking	
6	Non control device	
7	No earthing	
8	Poor housekeeping	

— — — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Preventive measure for electrical accidents and steps to be taken in such accidents

Objectives: At the end of this exercise you shall be able to
- **practice and follow the preventive safety rules to avoid electrical accident**
- **perform the immediate steps to save the electric shocked victim.**

Requirements

Equipment/Machines
- Fire extinguishers CO_2 - 1 No.

Materials
- Heavy insulated screw driver 200 mm - 1 No.
- Electrical safety chart (or) display - 1 No.
- Gloves - 1 No.
- Rubber mat - 1 No.
- Wooden stool - 1 No.
- Ladder - 1 No.
- Safety belt - 1 No.

PROCEDURE

TASK 1: **Practice and follow the preventive safety rules to avoid electrical accident**

1 Do not work on live circuits. If unavailable use rubber gloves or rubber mats, etc.

2 Do not touch bare conductors.

3 Stand on a wooden stool or an insulated ladder while repairing live electrical circuits/appliances or replacing fused bulbs.

4 Stand on rubber mats while working, operating switch panels, control gears, etc.

5 Use safety belts always, while working on poles or high rise points.

6 Use wooden or PVC insulated handle screw drivers when working on electrical circuits.

7 Replace (or) remove fuses only after switching off the circuit switches.

8 Open the main switch and make the circuit dead.

9 Do not stretch your hands on any moving part of rotating machine and around moving shafts.

10 Use always earth connection for all electrical appliances along with 3-pin sockets and plugs.

11 Do not connect earthing to the water pipe lines.

12 Do not use water on electrical equipment.

13 Discharge static voltage in HV lines/equipment and capacitors before working on them.

14 Keep the workshop floor clean and tools in good condition.

— — — — — — —

© NIMI NOT TO BE REPUBLISHED

TASK 2: **Perform the immediate steps to be taken to solve the shocked victim**

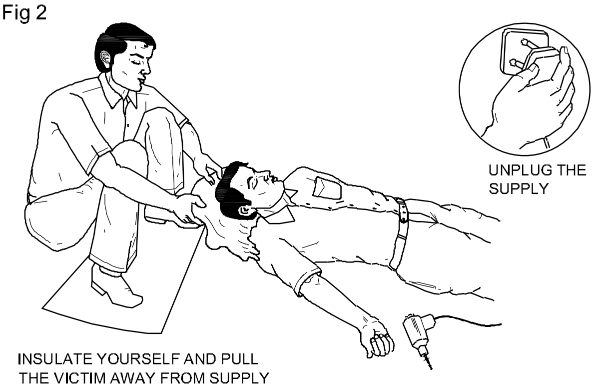
1 Proceed with treatment at once without panic emotion.

2 Break the contact either by switching off the power or removing the plug or wrenching the cable free.

3 Remove the victim from contact with the live conductor by using dry non-conducting materials such as wooden bar. (Fig 1 & 2)

Fig 1

Fig 2



Avoid direct contact with the victim. Wrap your hands in dry material if rubber gloves are not available. If you remain un-insulated, do not touch the victim with your bare hands.

4 Keep the patient warm and at mental rest.

Ensure of good air circulation and comfort. Call for help to shift the patient to safer place. If the victim is alone action to be taken to prevent him from falling.

5 Loosen the clothing about the neck chest and waist and place in recovery position. If the victim is unconscious.

6 Keep the victim warm and comfortable. (Fig 3)

Fig 3

7 Send the person to call doctor, in case of electric burns.

If the victim gets electrical burns due to shock, burns are very painful and dangerous. If a large area of the body is burnt give no treatment. But do the first aid as given below.

8 Cover the burnt area with running pure water.

9 Clean the burnt area by using clean cloth/cotton.

10 Send a person to call the doctor immediately.

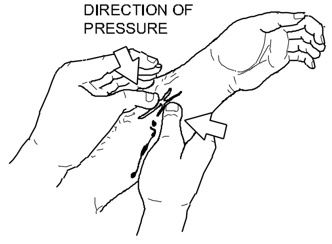
In case of severe bleeding

11 Lay the patient lie down and rest.

12 Raise the injured part above the level of the body. (If possible)

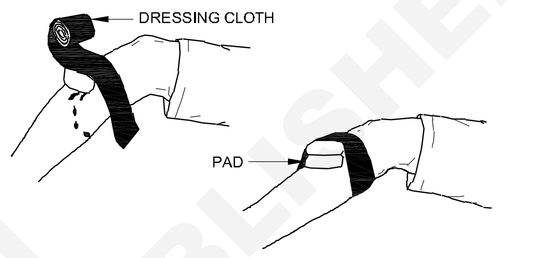
13 Apply pressure on the wound as long as necessary to stop the bleeding. (Fig 4)

Fig 4



14 Apply a clean pad and bandage firmly, if it is large wound. (Fig 5)

Fig 5



If bleeding is severe apply more than one dressing.

14 Proceed to perform the right methods of artificial respiration.

— — — — — — —

© NIMI NOT TO BE REPUBLISHED

Practice safe methods of fire fighting in case of electrical fire

Objectives: At the end of this exercise you shall be able to
- **demonstrate the ability of fire-fighting for electrical fire**
  - **as a member of the fire-fighting team**
  - **as a leader of the group.**

TASK 1: **General procedure to be adopted in the event of electrical fire**

1 Raise an alarm. Follow the method written below for giving an alarm signals when fire breaks out.

- by raising your voice and shouting Fire! Fire! to call the attention of others
- running towards fire alarm/bell to actuate it
- other means
- switch off the control main switch (if possible)

2 On receipt of the alarm signal:

- stop working
- turn off all machinery and power
- switch off fans/air circulators/exhaust fans. (Better switch off the sub-main)

3 If you are not involved in fighting the fire:

- leave calmly using the emergency exit.
- evacuate the premises
- assemble at a safe place along with the others
- check, if anyone has gone to inform about the fire break to the concerned authority
- close the doors and windows, but do not lock or bolt

As a member of the fire-fighting team

4 If you are involved in fire fighting:

- take instructions for an organised way of fighting the fire.

If taking instructions:

- follow the instructions, and obey, if you can do so safely; do not risk getting trapped.
- do not initiate your own idea.

As a leader of the group

If giving instructions:

- select co_2 fire extinguisher
- send for sufficient assistance and inform the fire brigade

- locate locally available suitable means to put out the fire
- judge the magnitude of the fire, ensure emergency exit paths are clear of obstructions and then attempt to evacuate (Remove explosive materials, substances that can serve as a ready fuel for fire within the vicinity of the fire break)
- fight out the fire with assistance to put it out, by naming the person responsible for each activity.

5 Report the fire accident and the measures taken to put out the fire, to the authorities concerned.

Reporting all fires however small helps in the investigation of the cause of the fire. It helps to prevent the same kind of accident occurring again.

© NIMI NOT TO BE REPUBLISHED

Use of fire extinguishers

Objectives: At the end of this exercise you shall be able to
- **select the fire extinguisher according to the type of fire**
- **operate the fire extinguisher**
- **extinguish the fire.**

Requirements

Equipment/Machines

- Fire extinguishers CO_2 - 1 No.
- Scissor 100mm - 1 No.
- Cell phone - 1 No.

PROCEDURE

TASK 1: **General Procedure in case of fire**

1 Alert people surrounding by shouting fire, fire, fire when observe fire (Fig 1a & b).

2 Inform fire service or arrange to inform immediately (Fig 1c).

3 Open emergency exist and ask them to go away (Fig 1d).

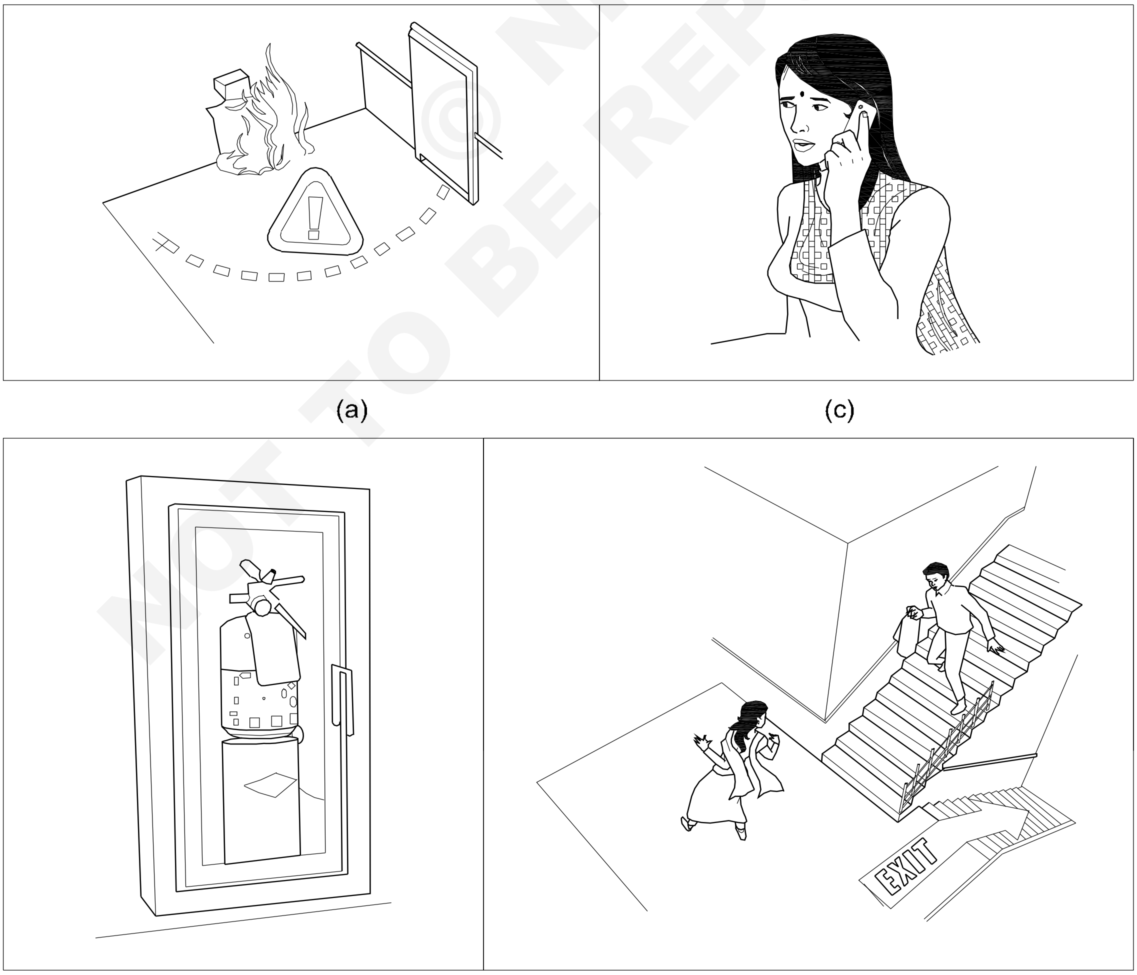
4 Put "Off" electrical power supply.

Do not allow people to go nearer to the fire.

5 Analyze and identify the type of fire. Refer Table1.

6 Assume the fire is D type (Electrical fire).

Fig 1

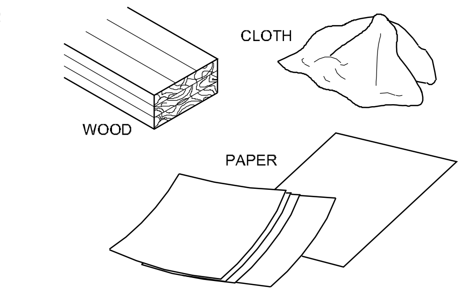
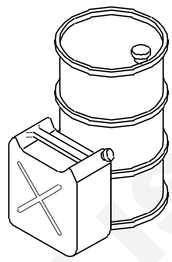
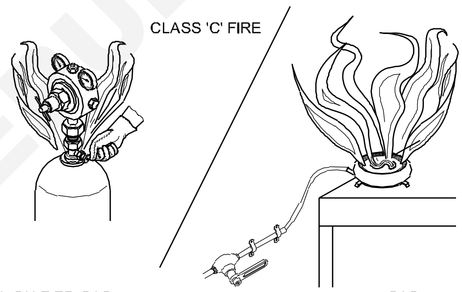


(a) (c)

(b) (d)

NOT TO BE REPUBLISHED © NIMI

Table 1

Class 'A': Wood, paper, cloth, solid material	Fig 2 
Class 'B': Oil based fire (grease, gasoline,oil) & liquefiable solids	Fig 3 
Class 'C' Gas and liquefied gases	Fig 4 
Class 'D' Metals and electrical equipment	Fig 5 

© NIMI NOT TO BE REPUBLISHED

7 Select CO_2 (carbon dioxide) fire extinguisher.

8 Locate and pick up CO_2 fire extinguisher. Check for its expiry date.

9 Break the seal. (Fig 6)

10 Pull the safety pin from the handle (Fig 7) (Pin located at the top of the fire extinguisher) (Fig 7)

11 Aim the extinguisher nozzle or hose at the base of the fire (this will remove the source of fuel fire) (Fig 8)

Keep your self low

12 Squeeze the handle lever slowly to discharge the agent (Fig 8)

13 Sweep side to side approximately 15 cm over the fuel fire until the fire is put off. (Fig 9)

Fig 6

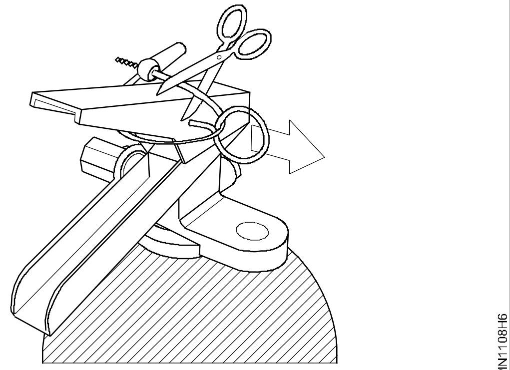


Fig 7

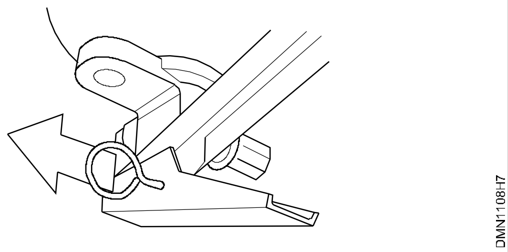


Fig 8

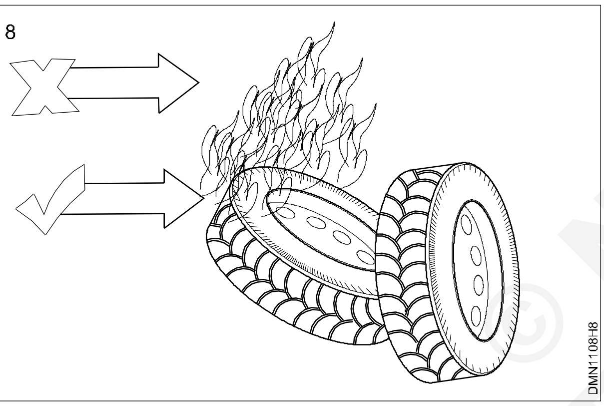
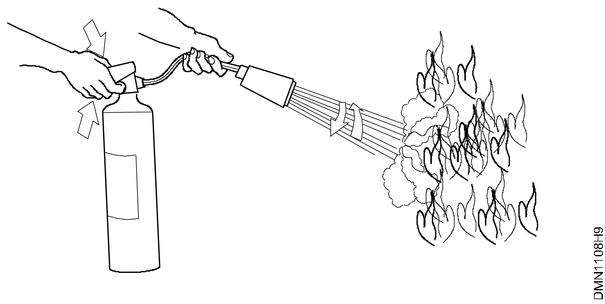


Fig 9



Fire extinguishers are manufactured for use from the distance.

Caution

- While putting off fire, the fire may flare up.
- Do not be panic so long as it put off promptly
- If the fire doesn't respond well after you have used up the fire extinguisher move away your self away from the fire point.
- Do not attempt to put out a fire where it is emitting toxic smoke, leave it to the professionals.
- Remember that your life is more important than property. So don't place yourself or others at risk.

In order to remember the simple operation of fire extinguisher

Remember

P.A.S.S. This will help to use fire extinguisher

P for pull

A for aim

S for squeeze

S for sweep

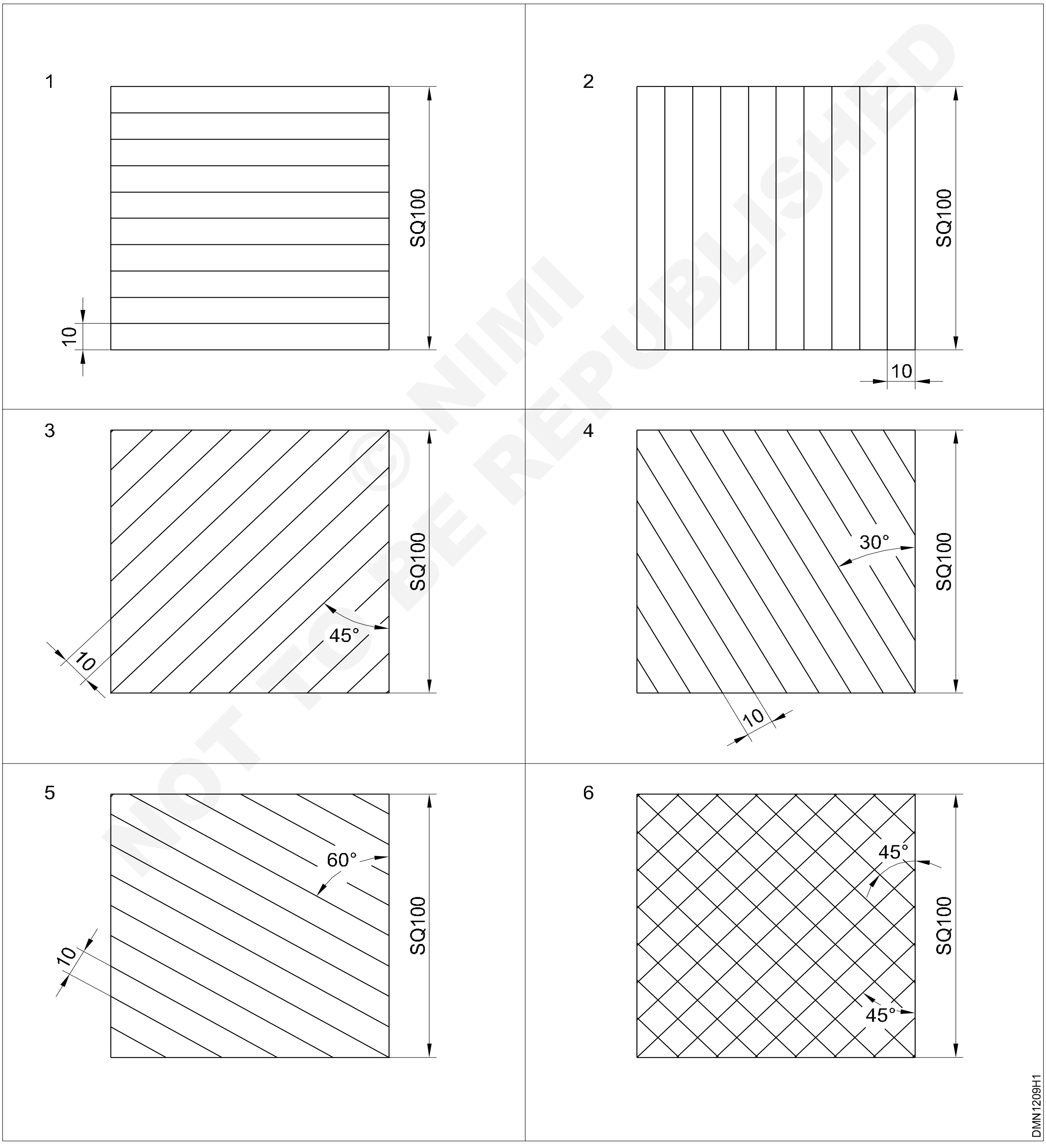
— — — — — — — —

Perform assignment using drawing instruments

Objectives: At the end of this exercise you shall be able to
- **draw figures involving horizontal, vertical and inclined lines**
- **independently using mini drafter, setsquares, scale, divider and protractor.**

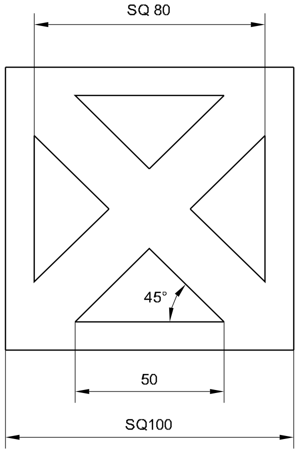
PROCEDURE

TASK 1: **Draw the following patterns and components using straight lines**

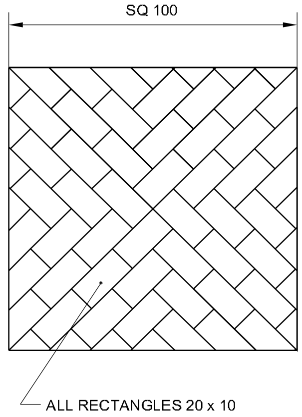


© NIMI NOT TO BE REPUBLISHED

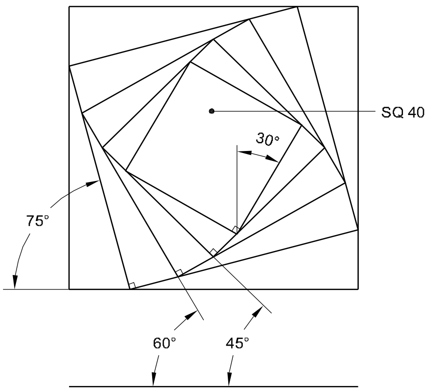
7



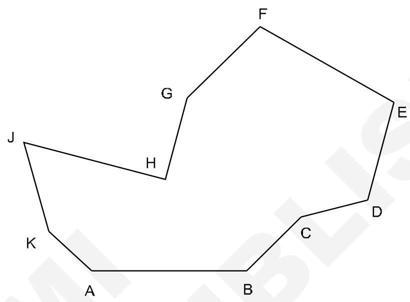
8



9



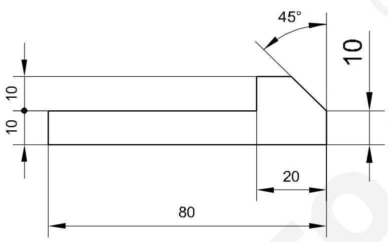
10



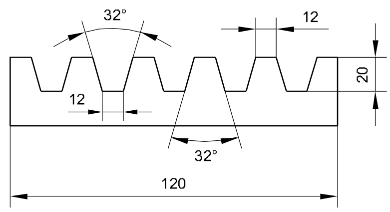
AB = 90	FG = 60
BC = 45	GH = 50
CD = 40	HJ = 85
DE = 60	JK = 55
EF = 90	KA = ?

∠B = 135°	∠G = 150°
∠C = 150°	∠H = 75°
∠D = 120°	∠J = 60°
∠E = 105°	∠K = ?°
∠F = 135°	∠A = ?°

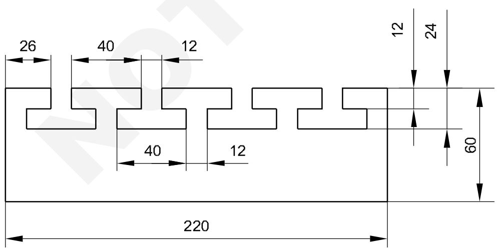
11



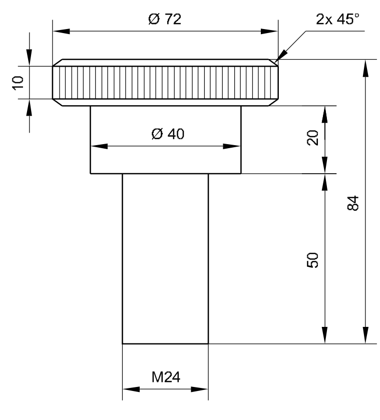
12



13



14



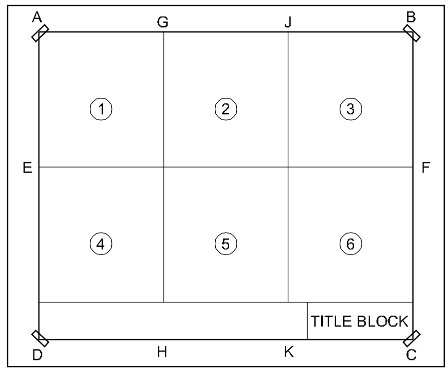
DMN1209H2

© NIMI NOT TO BE REPUBLISHED

TASK 2: **Layout of drawing sheets**

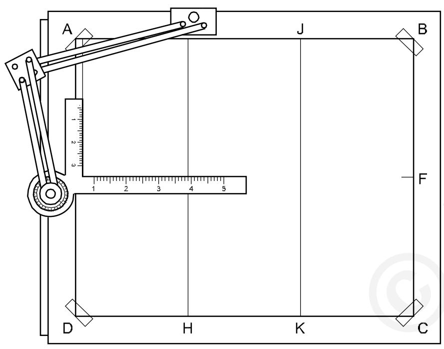
- Layout lines as shown in Fig 1 on an A2 drawing sheet.
- Fix the Minidrafter.

Fig 1



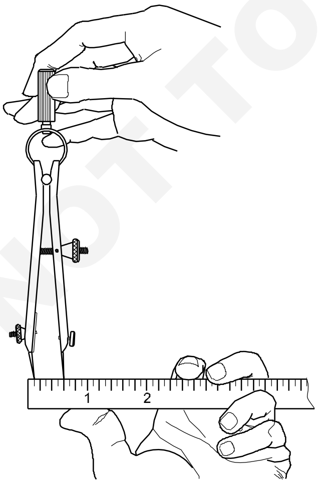
- Draw a horizontal line 100 mm long left to right. (15 mm from AE)
- Draw a vertical line 100 mm long from the left end of the drawing paper as shown in Fig 2.

Fig 2



- Mark of points on the vertical line at 10mm intervals using divider. (Fig 3)

Fig 3



TASK 3: **Horizontal lines**

- Adjust the mini drafter protector to 0°. (Reference mark) & lock using locking knob.
- Hold the pencil approximately at 60° with the paper.
- Draw the horizontal lines from left to right from reference mark giving 10mm gap between them.(Fig 4 &5)

Fig 4

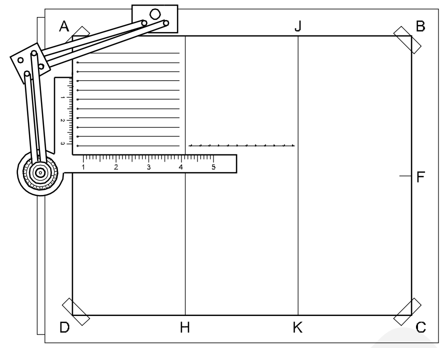
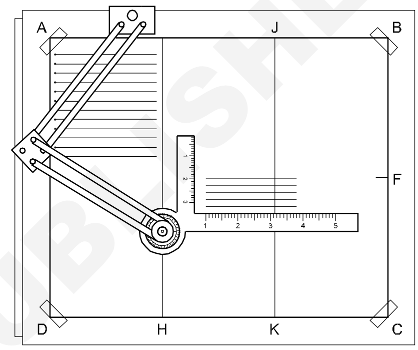


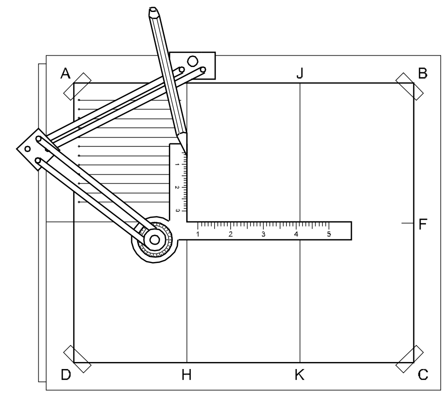
Fig 5



Exercise 4: Vertical lines

- Adjust the Minidrafter protractor head to 0° (Reference mark) & lock using locking knob.
- Hold the pencil approximately at 60° with the paper.
- Draw the horizontal lines from top to bottom from reference mark giving 10mm gap between them. (Figs 6 & 7)

Fig 6



© NIMI NOT TO BE REPUBLISHED

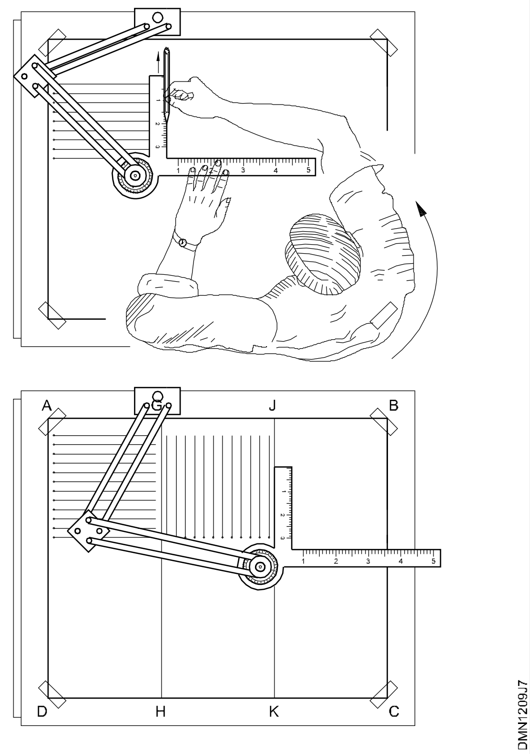


Fig 7

Exercise 5: Inclined lines

For drawing 45^0 lines.

- Adjust the protector head to 45° from reference mark & lock the using locking knob.
- Draw the 45^0. inclined line from reference mark to approximate length. (Figs 8 & 9)

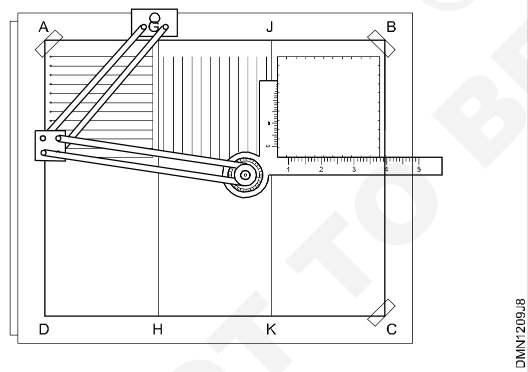


Fig 8

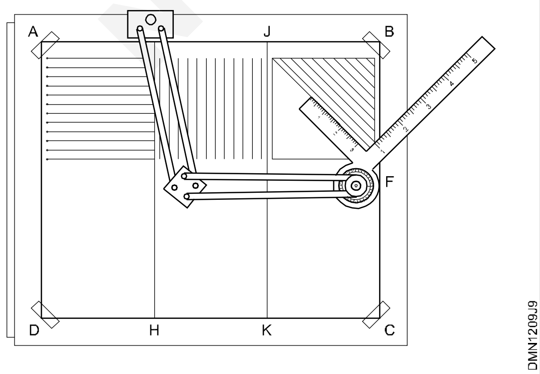


Fig 9

- 30° or/and 60° inclined lines can be drawn using Minidrafter. (Fig 10)

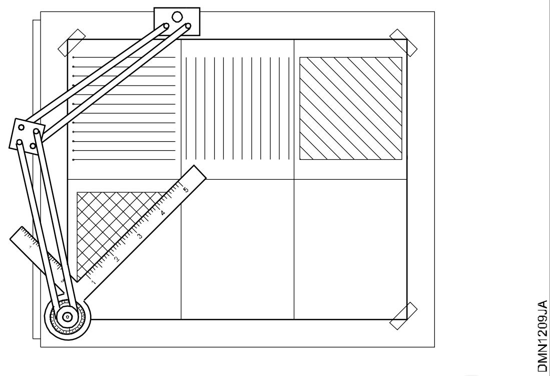


Fig 10

- Draw 30° inclined lines in block 5. (Fig 11)

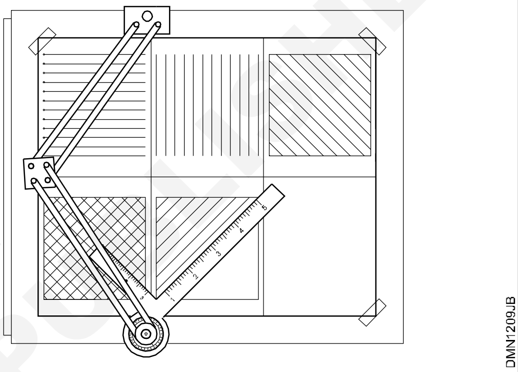


Fig 11

- In the block 6, draw 60° inclined lines. (Fig 12)

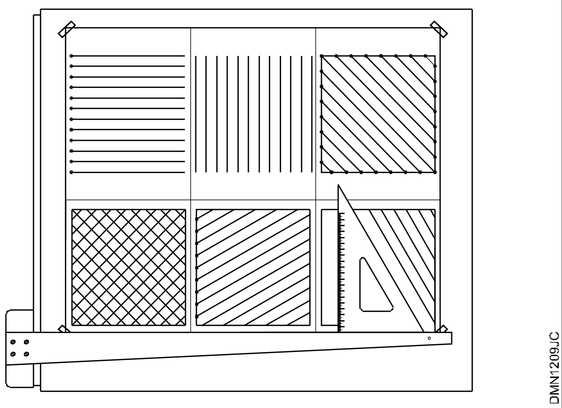


Fig 12

© NIMI NOT TO BE REPUBLISHED

Drawing parallel lines using set squares

Objective: This shall help you to

- **draw parallel lines to a given line through a given point.**

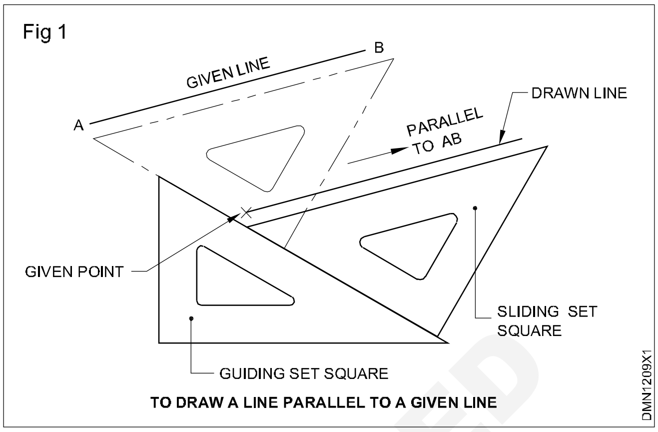
Place any one edge of the setsquare to coincide with the given line.

Place the other setsquare (guiding setsquare) with one of its edges butting the first square as shown in Fig 1.

While holding the guiding setsquare firmly, slide the first setsquare (sliding setsquare) till edge touches the given point.

Draw the line along the edge of the sliding setsquare through the given point.

Be sure that the guiding setsquare does not move from its initial position.



TO DRAW A LINE PARALLEL TO A GIVEN LINE

— — — — — — — — — — — —

Draw straight lines of given length

Objective: This shall help you to

- **draw a perpendicular to a given line through the given point.**

Method 1 (Fig 1a)

Place one of the perpendicular edges of the setsquare (sliding setsquare) such that in coincides with the given line.

Place the longer edge of the other setsquare (guiding setsquare) against the hypotenuse of the sliding setsquare.

Slide the sliding setsquare till the other edge forming right angle touches the given point.

Through the given point, draw the required perpendicular line along the edge of the sliding setsquare.

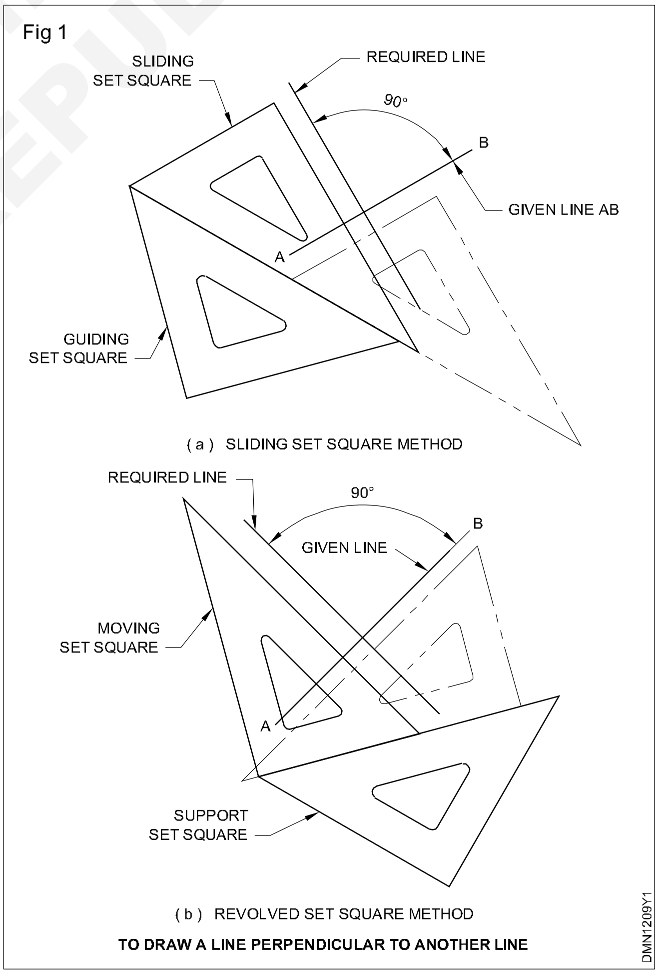
Method 2 (Fig 1b)

Place the hypotenuse of one setsquare to coincide with the given line.

Place the other setsquare (moving setsquare) with one of its edges butting against one of the perpendicular edges of the moving setsquare as shown in figure.

Holding the supporting setsquare firmly, revolve the moving setsquare and place it on the supporting setsquare such that the hypotenuse of the setsquare passes through the given point.

Draw the required perpendicular line as shown in Fig 1b.



TO DRAW A LINE PERPENDICULAR TO ANOTHER LINE

© NIMI NOT TO BE REPUBLISHED

Drawing perpendiculars lines, inclined lines (given angle) - parallel lines

Objectives: At the end of this exercise you shall be able to
- **draw horizontal and vertical lines of given length with given interval**
- **draw inclined lines at given angle.**

PROCEDURE

Exercise 1: Draw six horizontal parallel lines of 50mm long with 10 mm intervals. (Fig.1)

- Draw a vertical line AB 50 mm long, using setsquare on left side.

Fig 1

- Mark points on the vertical line AB with 10 mm intervals. Butt a setsquare on the line AB.
- Using another setsquare, draw parallel lines through the points marked.

Use sharpened conical point pencil

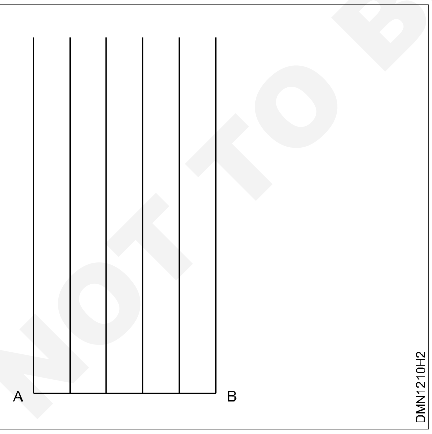
Keep the pencil slightly inclined towards the direction of the movement.

While drawing rotate the pencil to keep the constant thickness

Maintain uniform pressure on the lead of the pencil

Exercise 2: Draw six vertical parallel lines of 50mm length with 10mm intervals. (Fig 2)

Fig 2

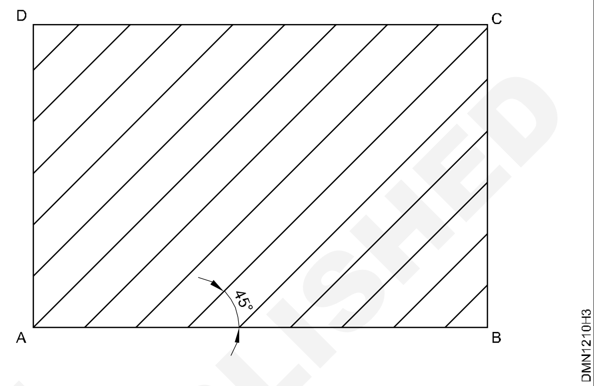


- Draw a horizontal line AB 50 mm long.
- Mark the points with 10 mm intervals.
- Butt a setsquare on the line AB.
- Using another setsquare draw vertical parallel lines from left to right.

Draw the vertical lines from bottom to top.

Exercise 3: Draw 45° inclined lines. (Fig 3)

Fig 3



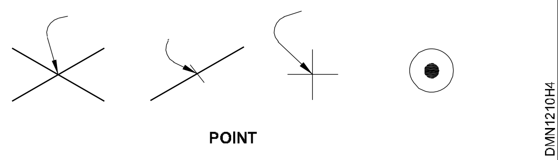
- Draw a horizontal line AB 60 mm long.
- Butt a setsquare on the line AB, draw vertical lines from the points A and B using another setsquare.
- Set off AD and BC equals to 40 mm and complete the box.
- On lines AB and DC mark 10 mm points.
- Butting the 60° setsquare on the line AB, using 45° setsquare draw inclined parallel lines through the marked points.

Draw lines from bottom to top.

Types of lines and angles

A point represents a location in space, having no width or height. It is represented by drawing intersection of lines or a dot. (Fig 4)

Fig 4

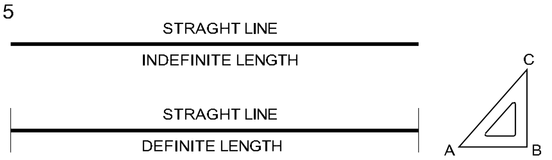


Line is the path of a point when it moves. It has no thickness and are of two types:

– Straight line
– Curved line

Straight line: It is the path of a point when it is moving in a particular direction. It has only length and no width. (Fig.5) Also a straight line is the shortest distance between two points. Straight line, depending on its orientation are classified as Horizontal, Vertical and Inclined or Oblique line.

Fig 5

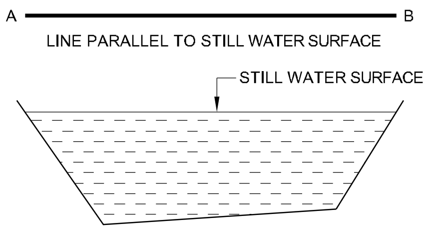


STRAIGHT LINE

DMN1210H5

Horizontal line (Fig 6**:** Horizontal lines are those which are parallel to a horizontal plane. Example of horizontal plane is the surface of a still water. (Fig 6)

Fig 6

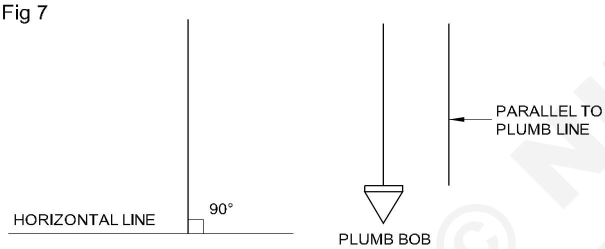


HORIZONTAL LINE

DMN1210H6

Vertical line (Fig 7a)**:** Lines which are perpendicular to horizontal lines are called vertical lines. It can be treated as a line along the plumb line of the plumb bob or parallel to a plumb line. (Fig 7b)

Fig 7



(a) (b)

VERTICAL LINE

DMN1210H7

Inclined line or Oblique line: A straight line which is neither horizontal nor vertical is called an inclined line. (Fig 8)

Fig 8

INCLINED OR OBLIQUE LINE

DMN1210H8

Curved line: It is the path of a point which always changes its direction. Examples of curved lines are shown in Fig 9.

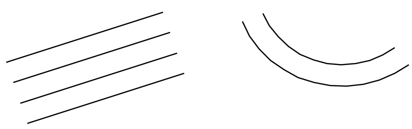
Fig 9

CURVED LINES

DMN1210H9

Parallel lines: They are the lines with same distance between them. They may be straight lines or curved lines. Parallel lines do not meet when extended. (Fig 10)

Fig 10

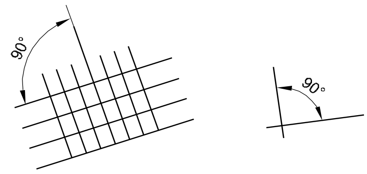


PARALLEL LINES

DMN1210HA

Perpendicular lines: When two lines meet at 90°, the two lines are said to be perpendicular to each other. One of this lines is called as reference line. (Fig 11)

Fig 11



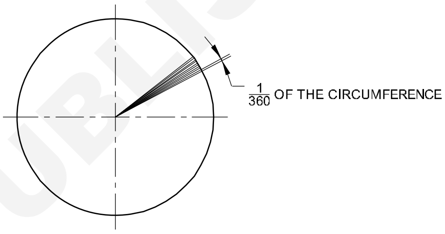
PERPENDICULAR LINES

DMN1210HB

Angles: Angle is the inclination between two straight lines meeting at a point or meet when extended. AB and BC are two straight lines meeting at B. The inclination between them is called an angle. The angle is expressed in degrees or radians.

Concept of a degree: When the circumference of a circle is divided into 360 equal parts and radial lines are drawn through these points, the inclination between the two adjacent radial lines is defined as one degree. Thus a circle is said to contain 360°. (Fig 12)

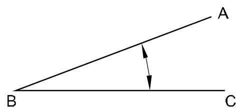
Fig 12



DMN1210HC

Acute angle: If an angle which is less than 90° is called an acute angle. (Fig 13)

Fig 13

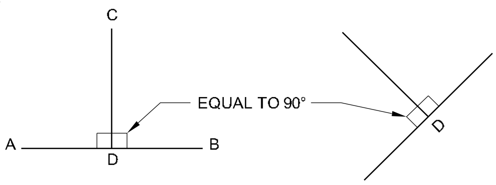


ACUTE ANGLE

DMN1210HD

Right angle: Angle between a reference line and a perpendicular line is called right angle. (Fig 14)

Fig 14

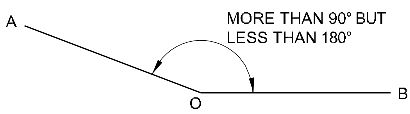


RIGHT ANGLE

DMN1210HE

Obtuse angle: This refer to an angle between 90° to 180°. (Fig 15)

Fig 15



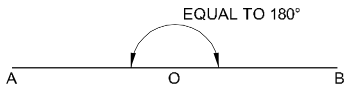
OBTUSE ANGLE

DMN1210HF

Straight angle: This refers to an angle of 180°. This is also called as the angle of a straight line. (Fig 16)

© NIMI NOT TO BE REPUBLISHED

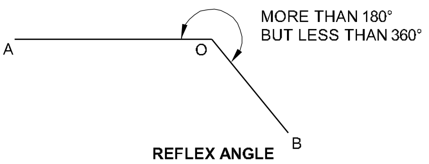
Fig 16



STRAIGHT ANGLE

Reflex angle: It is the angle which is more than 180°. (Fig 17)

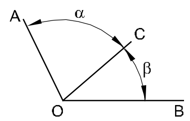
Fig 17



REFLEX ANGLE

Adjacent angles: These are the angles lying on either side of a line. (Fig 18)

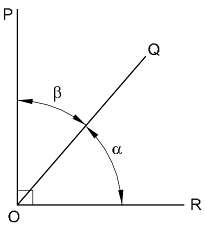
Fig 18



ADJACENT ANGLES

Complementary angles: When the sum of the two angles is equal to 90°, angle POQ + angle QOR = 90° angle POQ and angle QOR are complementary angles to each other. (Fig 19)

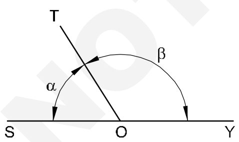
Fig 19



COMPLEMENTARY ANGLES

Supplementary angle: When the sum of the two adjacent angles is equal to 180°, example angle SOT + angle TOY = 180°, angle SOT and angle TOY are supplementary angles to each other. (Fig 20)

Fig 20



SUPPLEMENTARY ANGLES

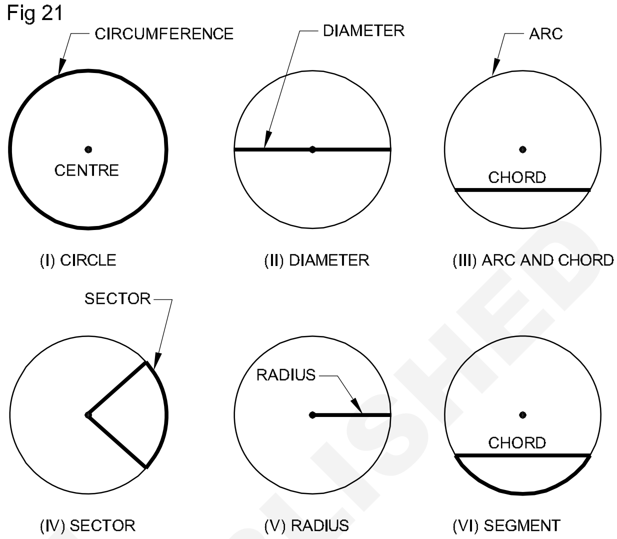
Circle

A moving point, which remains at equal distance from a fixed point called centre forms a circle. (Fig 21)

Some definitions

1. Chord — A line formed by joining two points on the circumference of a circle, is called chord. (Fig 21 iii)

Fig 21



CIRCLE

2. Centre — A point in the middle of a circle is called centre. A circle is drawn by placing pin leg of a compass at the centre point. (Fig 21i)
3. Diameter — A line formed by joining two points on the circle and passing through the centre point of the circle is called diameter. (Fig 21ii)
4. Radius — Any line from the centre of the circle and meeting any point on the circumference of 'the circle, is called radius. (Fig 21v)
5. Segment — A line passing through any point on the circumference of a circle is called tangent.(Fig 21vi)
6. Sector - it is a part a circle bounded by two radis (plural of radius) meeting at an angle and an arc.

© NIMI NOT TO BE REPUBLISHED

Drawing triangles of different types and a parallelogram with a given length and angle

Objectives: At the end of this exercise you shall be able to
- **construct scalene triangles**
- **construct right angled triangles**
- **construct isosceles triangles**
- **construct equilateral triangles**
- **construct quadrilateral and parallelograms.**

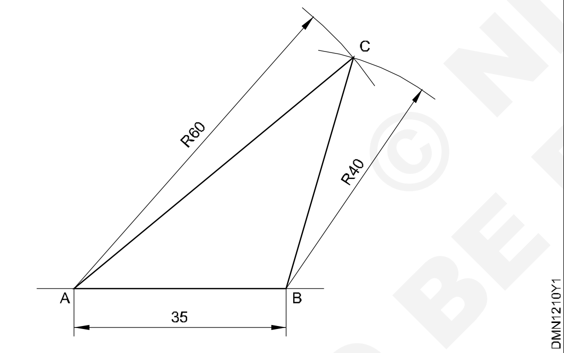
1 Scalene triangle: AB = 35 mm; BC = 60 mm & CA = 40 mm

- Draw base AB = 35
- 'A' as centre draw an arc of radius 60.
- 'B' as centre draw an arc of 40 cutting the previous arc at 'C'.
- Join CA and CB

AB = 35, BC = 40 and AC = 60

ABC is the required triangle. (Fig 1)

Fig 1

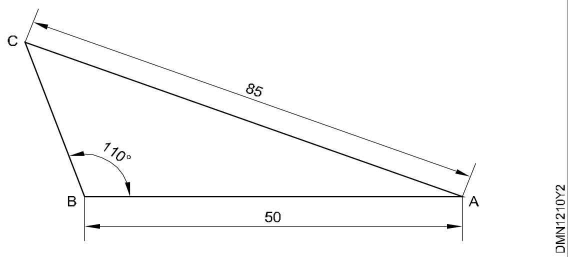


2 Scalene triangle: AB = 50mm; AC = 85 mm & $\angle ABC = 110^{o}$

- Draw AB = 50 mm
- Set an angle 110° at B
- 'A' as centre and with radius AC = 85 mm, draw an arc cutting line at C. Join CB and CA.

ABC is the required triangle. (Fig 2)

Fig 2

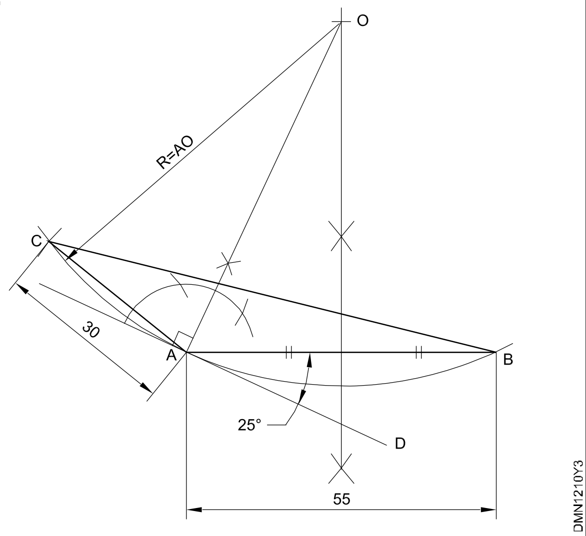


3 Scalene triangle: AB = 55 mm; AC = 30 mm & $\angle BCA = 25^{o}$

- Draw base AB (55 mm) and perpendicular from its mid-point.
- Set/draw the given angle 25° such that angle BAD = 25° (Angle C)
- Erect perpendicular to AD at A.
- Extend both perpendiculars to meet at '0'.
- AO as radius and '0' as centre, draw a circle or an arc.
- Side AC (30 mm) as radius and A as centre, draw an arc cutting the previous arc at C.
- Join CA and CB.

ABC is the required triangle. (Fig 3)

Fig 3



4 Right angled triangle: AB = 100 mm; AC = 40 mm

- Draw a straight line AB of given length 100 mm (hypotenuse).
- Bisect AB and mark centre of AB as `0'.
- AO or OB as radius, draw a semi-circle on AB.
- With centre either A or B draw an arc of radius equal to the side (40 mm) cutting the semi-circle at C.
- Mark the point C and join it to A and B.

ABC is the required right angled triangle. (Fig 4)

© NIMI NOT TO BE REPUBLISHED

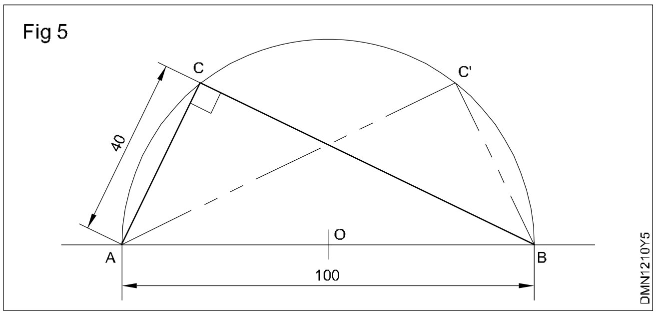


Fig 5

5 Isosceles triangle: AB = AC = 50 mm & $\angle BAC = 36^{o}$

- Draw the side AB equal to 50 mm. A as centre, draw an arc of radius AB.
- Draw a line AC at 36° to BA.
- Join BC to form the triangle ABC. (Fig 6)

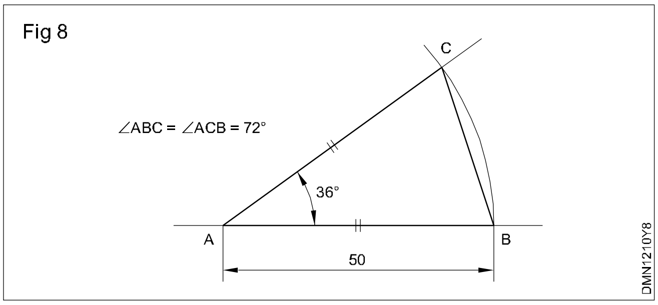


Fig 8

6 Isosceles triangle (Fig 6)**:** Altitude = 40 mm & $\angle BCA = \angle BAC = 65^{o}$

- Draw any line X'Y' and erect a perpendicular DB of height 40 mm at a convenient point D.
- Draw a parallel line XY to X'Y' through B.
- Draw A'B at 65° to XY and extend to meet at A on line X'Y'.
- Erect another point C on line X'Y' same way as in the previous step and complete the triangle ABC.

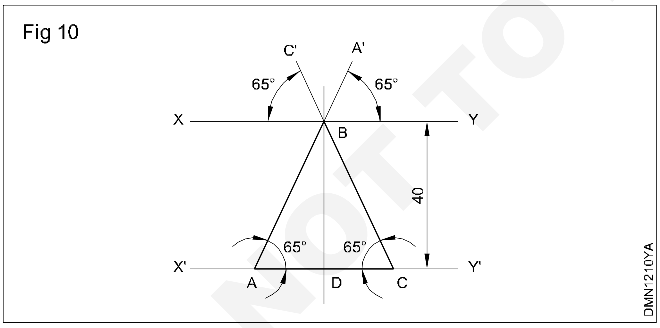


Fig 10

7 Equilateral triangle (Fig 7): AB = BC = CA = 45 mm

- Draw a line and mark AB 45 mm the side of triangle.
- With radius AB and centre A and B, draw arcs cutting at C.
- Join CA and CB.

ABC is a required triangle.

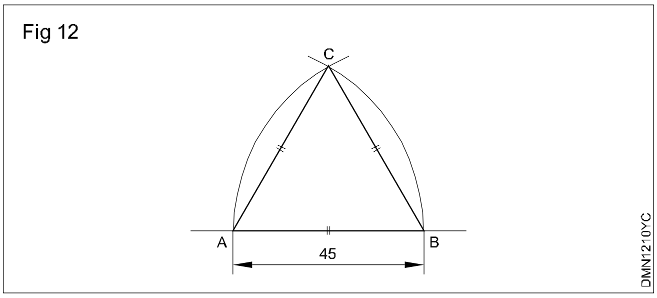


Fig 12

8 Scalene triangle (Fig 8): AB + BC + CA = 255 mm AB:BC:CA = 3:6:4

- Draw a line DE equal to 255 and divide it into 13 equal parts. (sum of the ratio of sides)
- Mark the points B and C at 3rd and 9th divisions.
- B as centre, BD as radius, draw an arc.
- Similarly C as centre, CE as radius, draw another arc.
- Both arcs meet at A.
- Join AB and AC and complete the triangle.

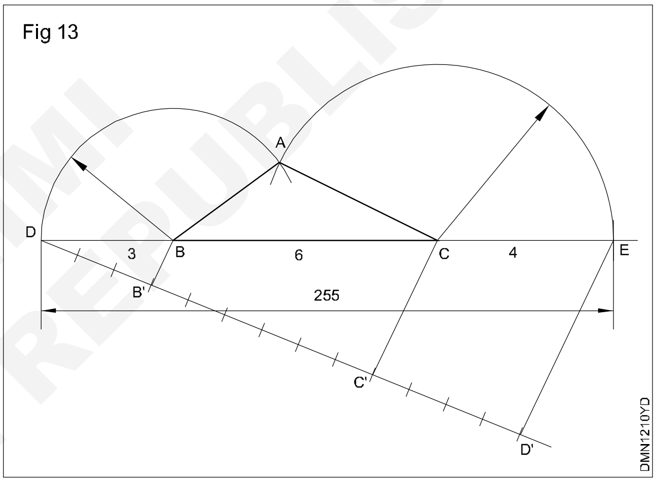


Fig 13

Problems for further practice

Exercise

1 Construct a right angled triangle of hypotenuse 125 mm and one side 75 mm. Measure the other side.

2 Construct a right angled isosceles triangle of side(s) 80 mm. Find hypotenuse.

3 Construct a right angled triangle of adjacent sides 90 mm and 60 mm. Measure the hypotenuse.

4 Construct a right angled triangle of sides 75 mm and 48 mm.

5 Construct a right angled triangle whose hypotenuse is 100 mm and the sides are equal.

6 Construct a right angled triangle of hypotenuse 75 mm and one angle is 30°.

7 Construct an isosceles triangle of sides 80 mm and the angle between them is 50°.

8 Construct an isosceles triangle of one side 70 mm and the other sides are 90 mm each.

NOT TO BE REPUBLISHED © NIMI

9 Construct an isosceles triangle of base angles 55° and the altitude 90 mm.

10 Construct an isosceles triangle of base angles 75° and altitude is 110 mm.

11 Construct an isosceles triangle of perimeter 150 mm and altitude 65 mm.

12 Construct an isosceles triangle of perimeter 120 mm and altitude 40 mm.

13 Construct a equilateral triangle of side 100 mm using protractor.

14 Construct an equilateral triangle of side 90 mm using compass.

15 Construct an equilateral triangle of perimeter of 240 mm.

16 Construct a triangle of adjacent sides 80 mm and 55 mm and angle between them is 55°.

17 Construct a triangle of sides 90, 75 & 60 mm. Measure the angle opposite to them.

18 Construct a triangle of one side 80 mm and the adjacent angles are 75° and 45°. Measure the other sides.

19 Construct a triangle of side 100 mm and the adjacent angles to it are 125° and 30°. Measure the other sides.

20 construct a triangle of base 75 mm, one side is 40 mm and vertical angle 35°.

21 Construct a triangle of sides 90 mm, 60 mm and the vertical angle 55°.

Construction of quadrilateral

Objective: At the end of this exercise you shall be able to
- **construct square, rectangle, parallelogram, rhombus, trapezium and quadrilateral from the given conditions and data.**

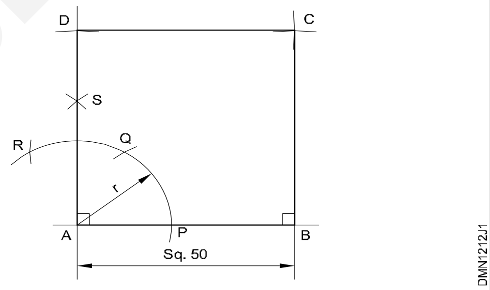
PROCEDURE

Exercise 9 (Fig 9)

A square of side 50 mm by erecting perpendicular

- Draw a line AB 50 mm long.
- 'A' as centre, draw an arc of convenient radius 'r' touching the line AB at 'P' as shown in Fig 9.
- 'P' as centre and radius 'r' draw another arc cutting the earlier drawn arc at `Q'.
- 'Q' as centre and radius 'r', draw another arc 'R'.
- Bisect QR at S and extend.
- Mark 50 mm on AS extended line. AD = 50 mm.
- From points B and D, draw parallels to AD and AB and complete the square ABCD.

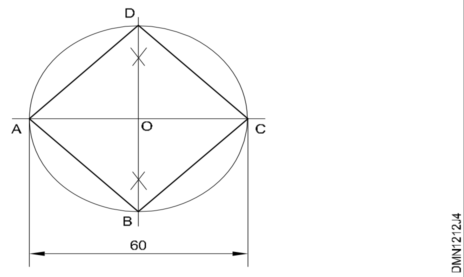
Fig 9



Exercise 10: Square having diagonal 60 mm (Fig 10)

- Draw horizontal and vertical centre lines intersecting at '0'.
- '0' as centre, draw a circle of radius 30 mm passing through centre lines at A,B,C and D.
- Join points A-B, B-C, C-D and D-A. ABCD is the required square, whose diagonal is 60 mm.

Fig 10

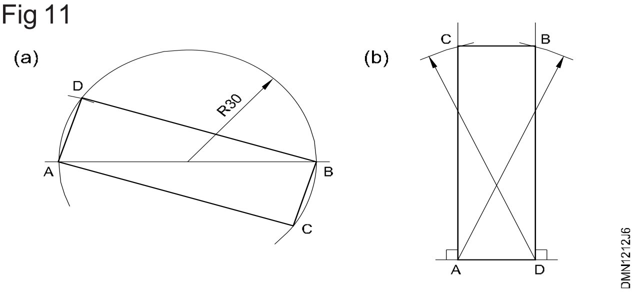


Exercise 11 : (Fig 11)

Rectangle - Diagonal - 60 mm, one side 18 mm

- Draw a line AB 60 mm.
- Draw a circle with AB as its diameter.
- 'A' as centre, draw an arc of R18, cutting the circle at D.
- Join AD and BD.

Fig 11



- Draw AC parallel to DB.
- Join BC and complete the rectangle.

© NIMI NOT TO BE REPUBLISHED

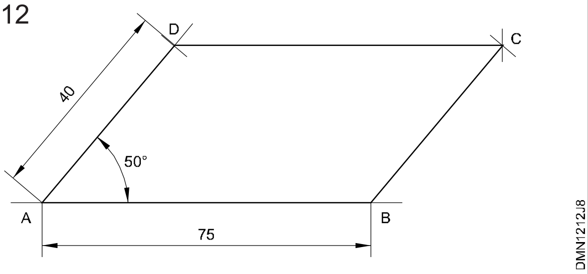
Exercise 12: **Parallelogram** (Fig 12)

Sides = 75 mm and 40 mm

Angle between them: 50°

- Draw line AB 75 mm long.
- Draw line AD equal to 40 mm to 50° angle to AB.
- D as centre, draw an arc of radius equal to AB.
- 'B' as centre, draw an arc of radius equal at AD, upwards such that they meet at a point 'C'.
- ABCD is the required parallelogram.

Fig 12



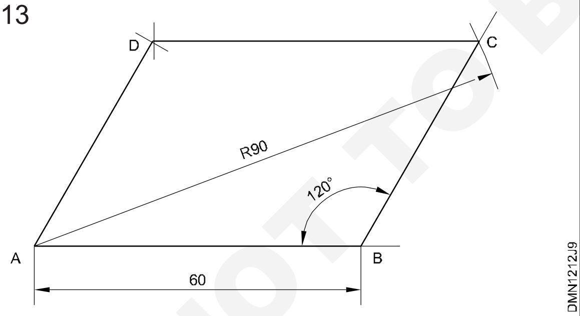
Exercise 13 : Parallelogram (Fig 13)

Parallelogram - Side AB = 60 mm

Diagonal AC = 90 mm $\angle ABC = 120°$

- Draw a line AB = 60 mm.
- Draw a line from B at angle of 120° to AB.
- 'A' as centre with radius 90 mm, draw an arc cutting 120° line from B at C.
- `C' as centre, radius = AB, draw an arc.
- Similarly `A' as centre and BC as radius, draw another arc, both arcs meet at `D'.
- Join AD and DC.

Fig 13



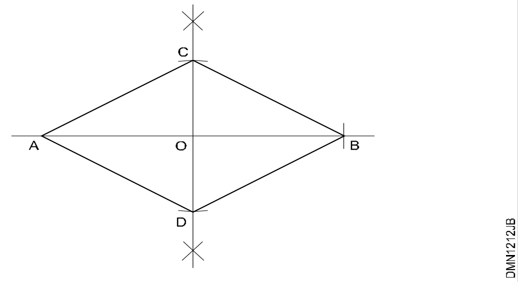
ABCD is the required parallelogram.

Exercise 14 : Rhombus (Fig 14)

Diagonals AB = 80 mm
CD = 50 mm

- Draw a line AB equal to 80 mm
- Draw perpendicular bisector of AB, passing through 0.
- mark OC = OD = 25 mm.
- Join the points AC, CB, BD and DA to complete the rhombus.

Fig 14



Exercise 15 : Trapezium (Fig 15)

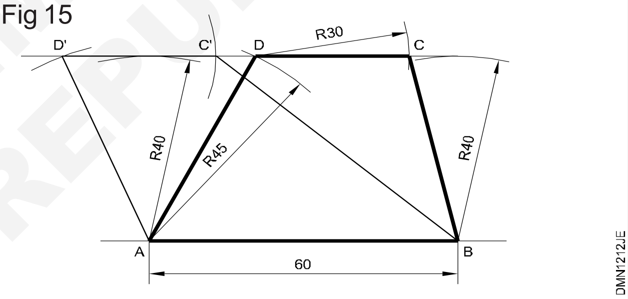
Parallel sides AB = 60 mm; CD = 30 mm

Distance between parallel sides = 40 mm

Side DA = 45 mm.

- Draw the base AB equal to 60 mm.
- With radius 40 mm, draw arcs from A and B.
- Draw a tangential line (Parallel to AB)
- Draw an arc with radius 45 mm and A as centre, cutting the line at two places D and D'.
- From D or D' mark length of 30 mm towards right side, mark it as C or C'.
- Join B and C or C'.
- Join A and D or D'.

Fig 15



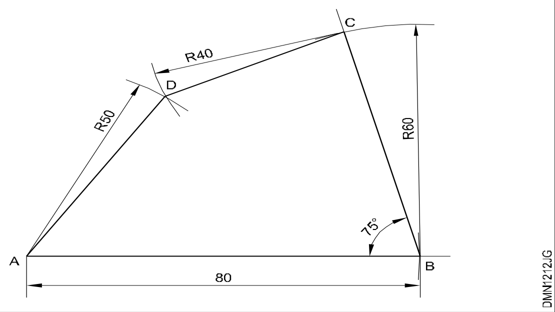
ABCD/ABC'D' is the trapezium.

Exercise 16 : Quadrilateral (Fig 16)

Sides AB = 80 mm; BC = 60 mm; CD = 40 mm; DA = 50 mm and $\angle ABC = 75°$

- Draw line AB equal to 80 mm.
- Draw line BC equal to 60 mm at an angle of 75°.
- C as centre and radius 40 mm, draw an arc.
- A as centre and radius 50 mm, draw another arc intersecting the previous at D.
- Join CD and AD to form the required quadrilateral.

Fig 16



© NIMI NOT TO BE REPUBLISHED

Construct regular polygons (up to eight sides) one equal base

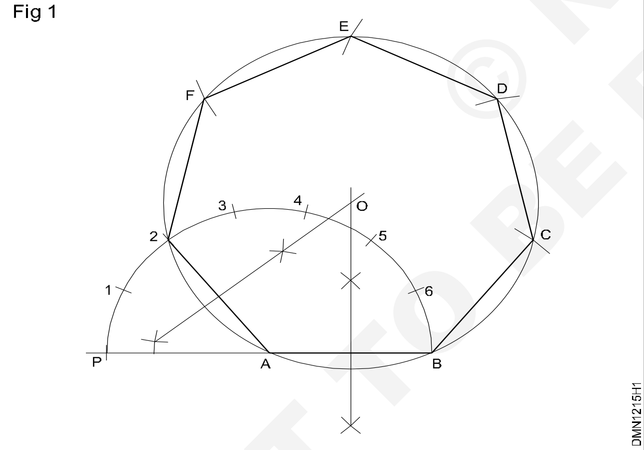
Objective: At the end of this exercise you shall be able to
- **construct a regular polygon from given data by different methods.**

PROCEDURE

Exercise 1: Regular heptagon of side 30 mm Semi-circular method - Type A (Fig 1)

- Draw a line AB equal to 30 mm.
- Extend BA to a convenient length.
- A as centre and radius AB describe a semi-circle.
- Divide the semi-circle into seven equal parts (number of sides) using divider.
- Number the points as 1,2,3,4,5,6 starting from P.
- Draw the perpendicular bisectors from 2A and AB intersecting at 0.
- 0 as centre and OA or OB as radius describe a circle.
- Mark the points C,D,E,F and 2 on the circle such that BC = CD = DE = EF = F2 = AB.
- Join the line BC, CD, DE, EF and F2.
- ABCDEF2 is required heptagon.

Fig 1

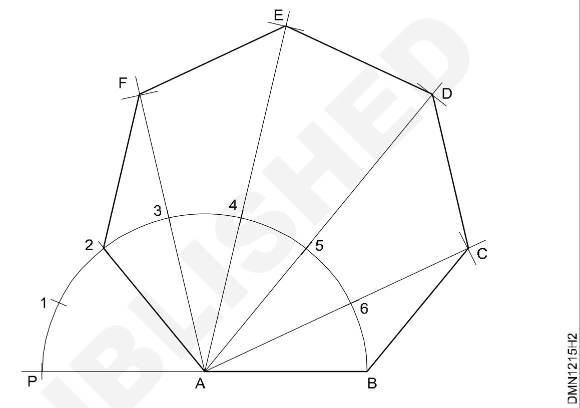


Exercise 2: Semi-circle method - Type B (Fig 2)

Follow the procedure of TYPE A upto dividing the semi-circle into number of equal parts.

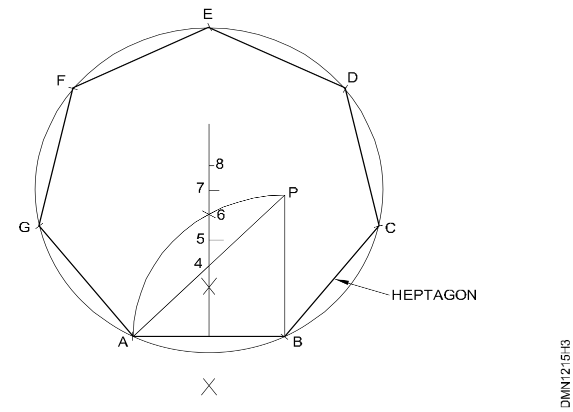
- Join A2
- Join A3, A4, A5 and A6 and extend to a convenient length.
- With centre B and radius AB draw an arc cutting A6 extended line at C.
- C as centre and same radius, draw an arc cutting the line A5 at D.
- Locate the points E & F in the same manner.
- Join BC, CD, DE, EF and F2.
- ABCDEF2 is the required heptagon.

Fig 2



Exercise 3: Perpendicular bisector method - Type A (Fig 3)

Fig 3



- Draw a line AB equal to 30 mm.
- At B, draw a line BP perpendicular AB and equal to AB.
- Join AP
- B as centre BA as radius, draw an arc AP.
- Bisect AB and draw the bisector cutting the line AP and the arc AP at 4 & 6 respectively.
- Mark 5 the mid point of 4-6.
- Set off 6-7, 7-8, 8-9, 9-10 equals to 4-5.
- 7 as centre, 7A as radius, draw a circle on AB.
- On the circumference set off BC, CD, DE, EF, FG equals to AB.
- Join BC, CD, DE, EF, FG and GA.
- ABCDEFG is the required heptagon.

© NIMI NOT TO BE REPUBLISHED

Exercise 4:Perpendicular bisector method - Type B (Fig 4a)

- Draw a semi-circle on line AB, the side of the polygon (in this case it is heptagon)
- Describe an arc with B as centre and AB as radius.

Fig 4a

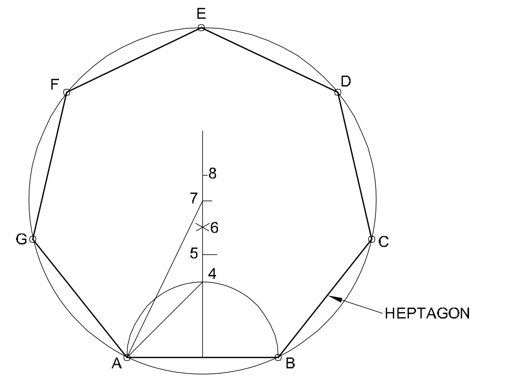
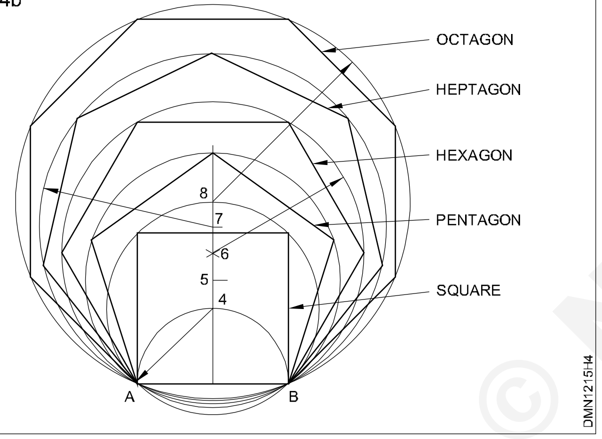


Fig 4b



- Draw a perpendicular bisector of AB.
- Perpendicular line cut the semi-circle at point 4 and the arc at point 6. (AB as radius, B as centre)
- Mark point 5 at the mid-point of 4 and 6.

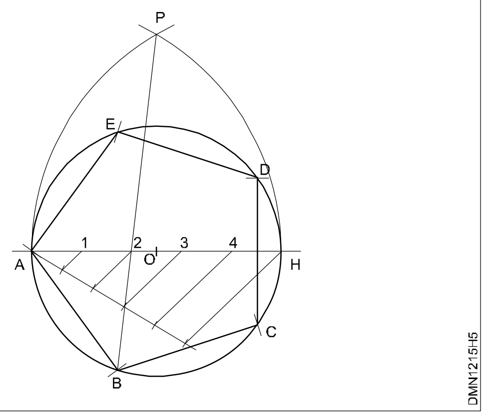
Follow the procedure of and complete the heptogon.

In this method also any regular polygon of different sides can be constructed. (Fig 4b)

Exercise 5: Pentagon inside a circle of diameter 80mm (Fig 5)

- Draw the line AH equals to 80 mm. (Diameter of circle)
- `O' as centre OA as radius describe a circle.
- Divide AH into 5 equal parts (as many equal parts as the sides).
- A and H as centres, AB as radius describe arcs intersecting at P.
- Join P2 and extend it to meet the circle at B.
- Set off BC, CD, DE, EF equals to AB on the circle.
- Join the points
- ABCDEF is the required pentagon.

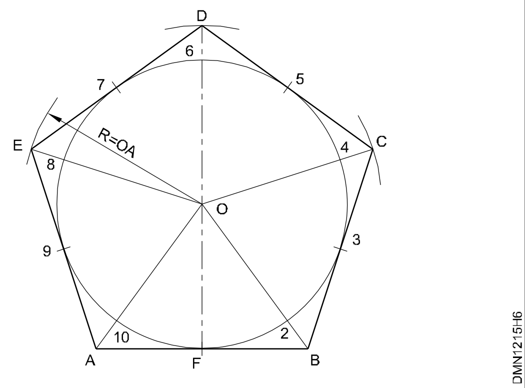
Fig 5



Exercise 6: Pentagon outside a circle of diameter 80mm (Fig 6)

- O as centre and OF as radius describe a circle of dia 80 mm.
- Draw the line DF vertically beyond the top of the circle.
- Divide the circle into 10 equal parts. (Twice as many equal parts as the number of sides)
- Points 1,3,5,7 and 9 are the tangent points of the pentagon.
- Join 02, 04, 06, 08, 010 and extend to a convenient length.
- Draw a tangent to the circle through point 1 (F).
- The tangent cuts the lines 0-2 and 0-10 lines at A & B.
- In same manner draw tangents on points 3,5,7,9 & locate C,D & E.
- Join BC, CD, DE, EA
- ABCDE is the required pentagon.

Fig 6



Exercise 7: Three circle method (Fig 7) **Pentagon of 38mm side**

- Draw the line AB equal to side of polygon 38 mm.
- Draw two circles of radius equal and AB, with centre A and B, cutting at two points F and G.
- Join G and F extend upwards.
- AB as radius, G as centre, draw a circle passing through A and B cutting both the circles at H and J, and also cutting the line FG at K.

© NIMI NOT TO BE REPUBLISHED

Draw Inscribed and circumscribed circles of traingle pentagon and hexagon

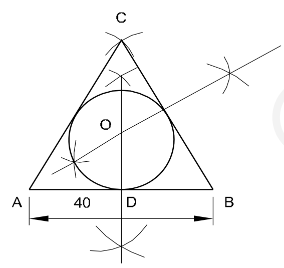
Objectives: At the end of this exercise you shall be able to
- **inscribing a circle in a equilateral triangle**
- **inscribing a circle in a scalene triangle**
- **circumscribing a circle about a equilateral triangle**
- **circumscribing a circle about a scalene triangle**
- **inscribing a circle in a regular pentagon**
- **circumscribing a circle about a regular pentagon**
- **circumscribing a circle about a regular hexagon.**

PROCEDURE

Exercise 1: Inscribe a circle in a equilateral triangle of given side 40mm (Fig.1)

- Construct the equilateral triangle A B C of side 40mm.
- Bisect the side A B & BC and the bisectors intersect at 0,
- Draw perpendicular from the point 0 to any one side (OD)
- With 0 as centre OD as radius inscribe a circle in the triangle and the sides are tangential to the circle.

Fig 1

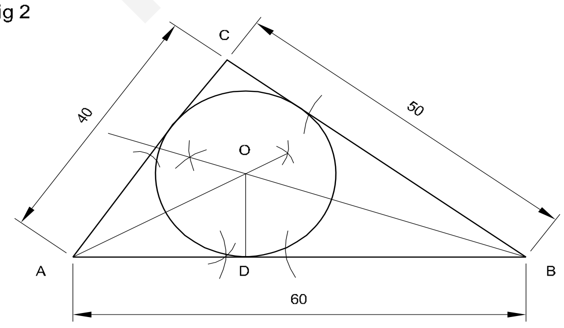


DMN1213H1

Exercise 2: Inscribing a circle in a scalene triangle of ABC give that AB = 60mm, BC = 50mm, CA = 40mm. (Fig.2)

- Construct the triangle ABC such that AB = 60, BC = 50, CA=40
- Bisect any two angles of the triangle ie ∠CAB & ∠ABC and let the bisectors intersect at O.
- O as centre OD as radius inscribe a circle in the ∆ABC

Fig 2

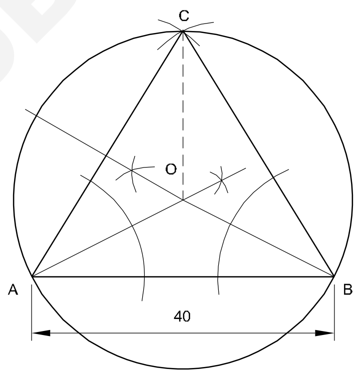


DMN1213H2

Exercise 3: Circumscribing a circle about a equilateral triangle. ABC of side 40mm (Fig 3).

- Construct the equilateral triangle ABC of side 40mm.
- Bisect any two angles of the triangle ABC ie ∠A & ∠B and the bisector of the angle intersect each other at 'O'
- 'O' as centre OA, or OC or OB as radius describe a circle about the triangle.

Fig 3

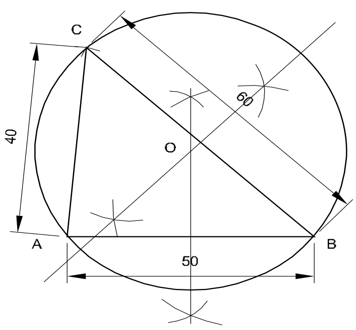


DMN1213H3

Exercise 4: Circumscribing a circle about a triangle ABC of AB = 50, BC = 60, CA = 40 (Fig 4)

- Construct the scalene triangle ABC of scale AB = 50, BC, 60, CA 40.
- Bisect any two sides of the triangle ABC ie AB & BC.
- Let the bisectors intersect each other at 'O'.
- 'O' as centre OA, OB or OC as radius describe a circle about the triangle ABC.

Fig 4



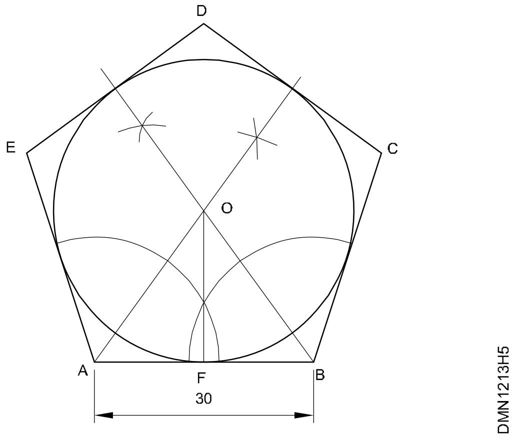
DMN1213H4

© NIMI NOT TO BE REPUBLISHED

Exercise 5: Inscribe a circle in a given pentagon of side 30mm (Fig 5)

- Construct the pentagon of side equals to 30mm.
- Bisect any two interior angle of the pentagon
- Let the bisector intersect at 'O'.
- From O draw a perpendicular any side of the pentagon (say to AB)
- Meets at F.
- O as centre OF as radius inscribe a circle inside the pentagon.

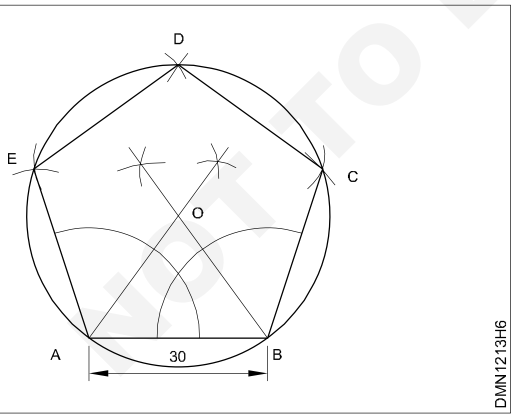
Fig 5



Exercise 6: Circumscribe a circle about a given pentagon of side 30mm (Fig 6)

- Construct a pentagon of ABCDE of side equals to 30mm
- Bisect any two interior angles of the pentagon.
- Let the bisector intersect at 'O'.
- With 'O' as centre and OA, OB, OC, OD or OE as readius describe a circle about the pentagon.

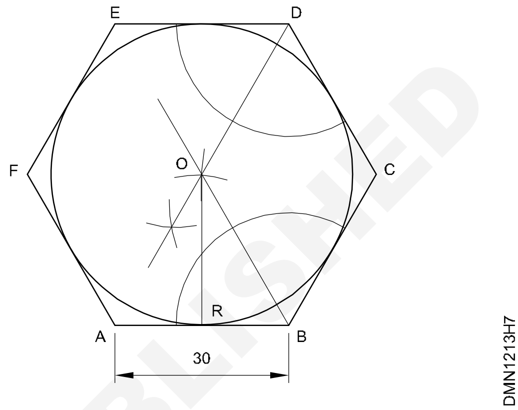
Fig 6



Exercise 7: Inscribe a circle is a given hexagon of side 30mm (Fig 7)

- Construct a hexagon ABCDEF of side 30mm.
- Bisect any interior angle of the hexagon.
- Let the bisector intersect at O.
- From the point 'O' draw a perpendicular to any side of hexagon (ie to AB)
- 'O' as centre and OR as radius inscribe a circle in the given hexagon.

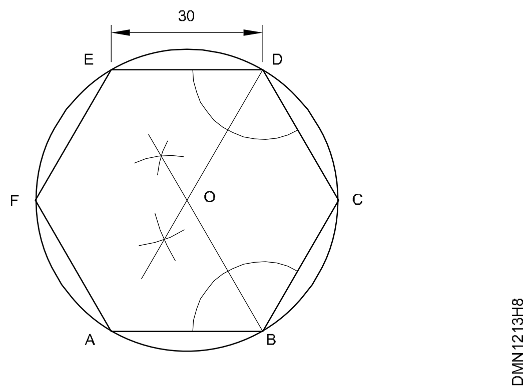
Fig 7



Exercise 8: Circumscribe a circle about a given hexagon of side 30mm (Fig 8)

- Construct the given hexagon ABCDEF of side 30mm.
- Bisect any two interior angles of the hexagon.
- Let the bisector intersect each other at O.
- 'O' as centre OA as radius (or any corner points) as radius circumscribe a circle about the hexagon.

Fig 8



© NIMI NOT TO BE REPUBLISHED

Draw an angle of bisector and a line bisector and divide a line into any number of equal parts

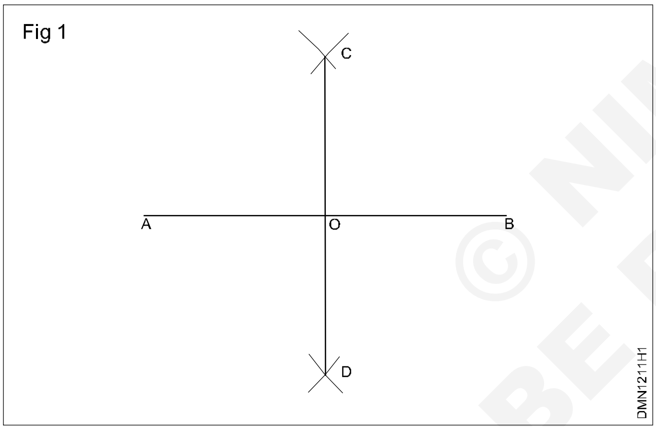
Objectives: At the end of this exercise you shall be able to
- **bisect a given angle**
- **trisect a given right angle**
- **bisect a given line**
- **divide a line into any number of equal parts.**

PROCEDURE

Exercise 1: Bisect a given straight line (Fig 1)

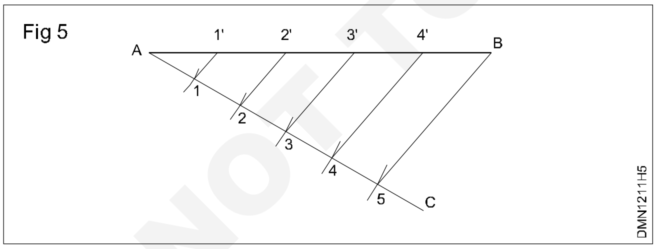
- Draw a line AB of 70 mm long
- With A and B as centres, more than half of AB as radius describe arcs an either side of line AB.
- Let the arcs intersect at C & D
- Join CD, Bisecting the line AB at 'O'
- CD is the bisector of the line AB and AO = OB.

Fig 1



Exercise 2: Divide a line into any number of equal parts (say 2). Fig 2

Fig 5



- Draw a line AB to a convenient length (say 65 mm).
- At `A' draw a line AC to a required length, forming an angle BAC. (Always it is better to form an acute angle)
- Set off 5 equal arcs on the line AC meeting at 1,2,3,4 & 5. (As many equal parts as required)
- Join 5 & B.
- From the points 4,3,2 & 1 draw lines parallel to 5-B meeting the line AB at 4', 3', 2' & 1'.
- Now the line AB is divided into 5 equal parts.

Exercise 2 : Bisect a given angle. (Fig 3)

- Construct an angle BAC (say 30°).
- `A' as centre to a convenient radius draw an arc to cut line AC at `E' and AB at `D'.
- Bisect the arc DE at `O'.
- Join AO.
- AO is the bisector of the angle BAC.
- Now $\angle OAB = \angle OAC$.

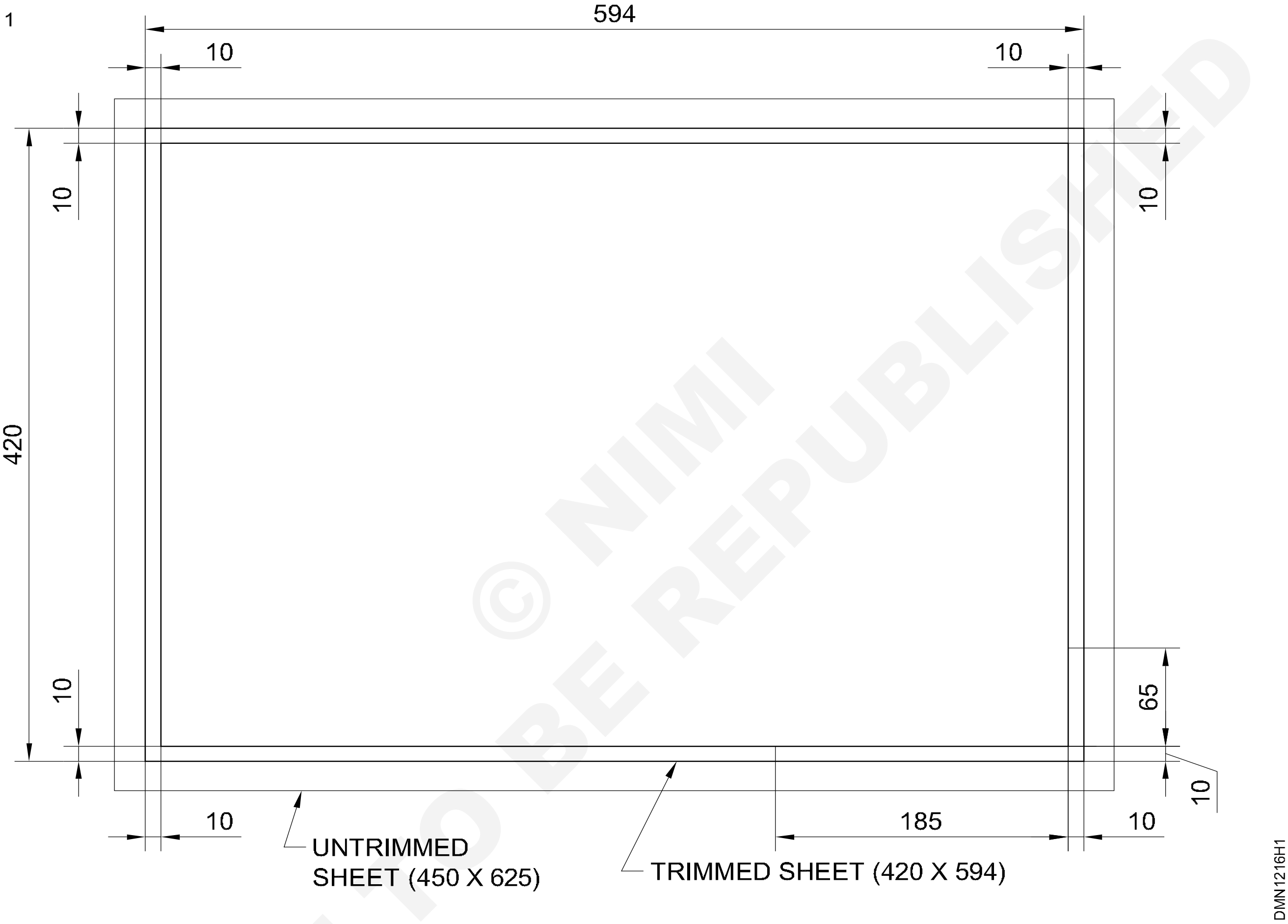
© NIMI NOT TO BE REPUBLISHED

Layout of A3 drawing sheet as per SP 46-2003 and title block with all informations details and folding of sheets

Objectives: At the end of this exercise you shall be able to
- **set and fix drawing paper on the drawing board**
- **draw margins and title block frame.**

PROCEDURE

Fig 1



Exercise 1: Prepare the layout as shown below on A2 size paper (Fig. 1)

- Place the drawing paper centrally on the drawing board.
- the drawing board and align the top edge of the drawing sheet.
- Hold the drawing sheet by hand in the same position and fix the sheet in this position with drawing cellulose tape. (Fig 1)
- Set off the margin distance using scale..
- Draw four border lines as shown above
- Mark and draw the title block.

© NIMI NOT TO BE REPUBLISHED

Draw the title block providing details

Objectives: At the end of this exercise you shall be able to
- **layout the drawing sheet**
- **draw the title block as per I.S.**

Exercise 1: Draw this title block in position. In the remaining area of paper print the following (Fig 1)

1 All dimensions are in mm

2 Ask if in doubt.

3 Six holes diameter 8 mm equally spaced 60 mm pitch circle diameter.

4 This drawing confirms to IS:9609-1983.

5 Bureau of Indian Standards (BIS) is our national standard.

6 General deviations as per IS:2012;(medium)

7 All thick lines-0.5 mm.

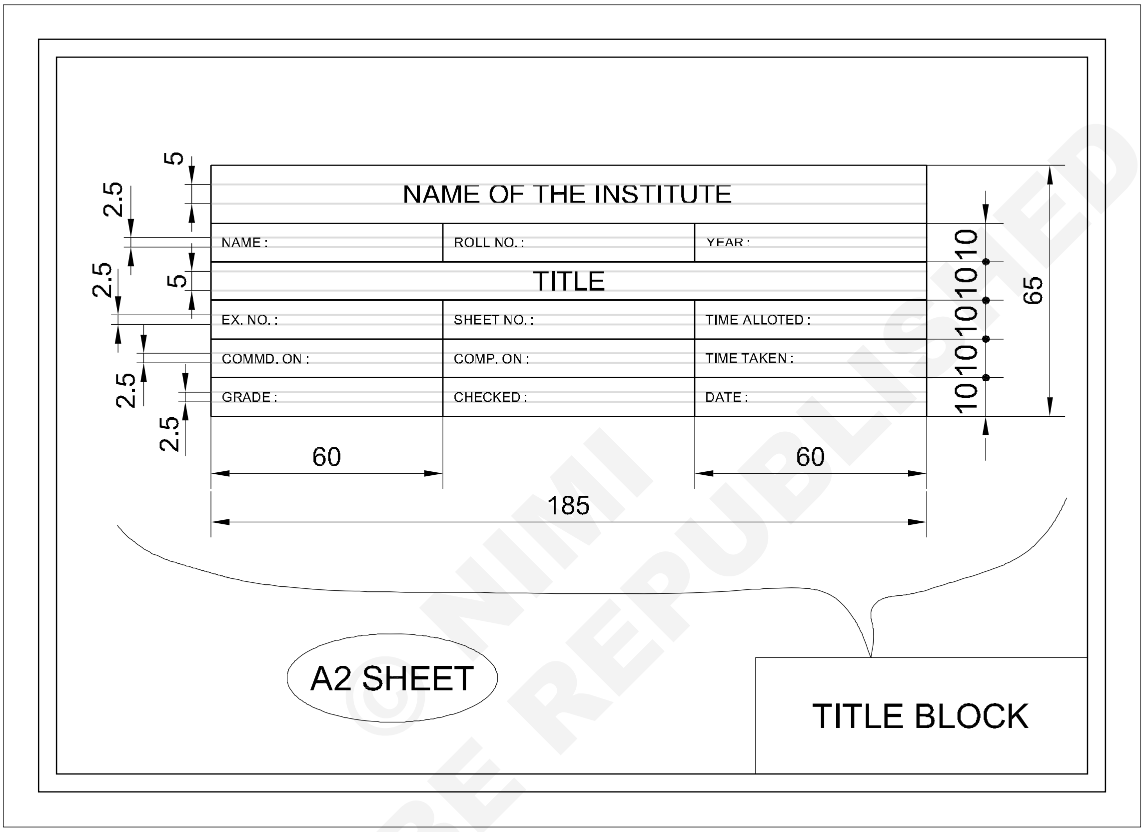
8 Chamfer to bottom of thread.

9 Rough will the surface marked ‘X’.

10 Punch roll number and part number.

- Calculate the width of the each letter.
- Draw the guidelines for the required size:
- Mark the width and spacing for each letter.
- Draw vertical guidelines.
- Print the letter free hand, using HB pencil.
- Draw the subsequent squares with the same

Fig 2



Folding of drawing sheets

Objective: At the end of this exercise you shall be able to
- **method of folding at drawing sheets.**

Scope

This section covers two methods of folding of drawing sheets.

The first method is intended for drawing sheets to be filed or bound, while the second method is intended for sheets to be kept individually in filing cabinet

Basic Principles

The basic principles in each of the above methods are to ensure that

a) all large prints of sizes higher than A4 are folded to A4 sizes:

b) The title blocks of all the folded sheets appear in topmost position; and

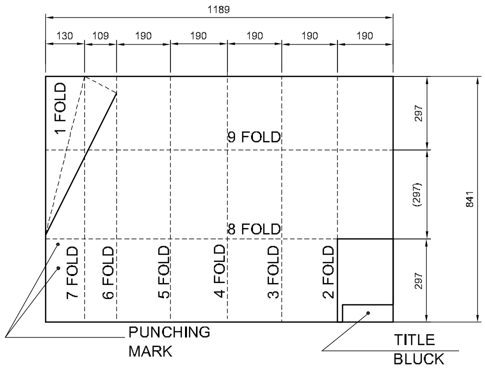
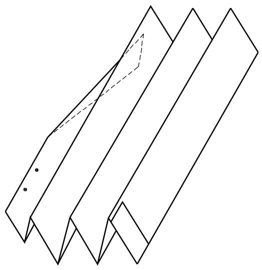
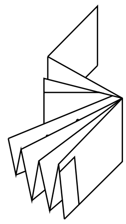
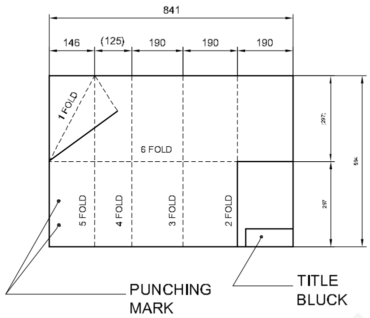
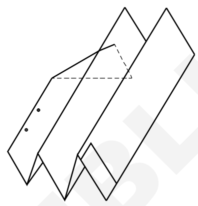
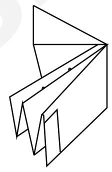
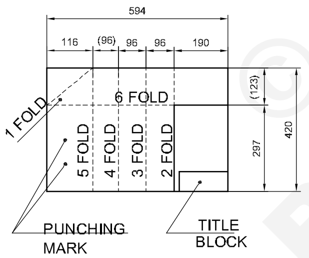
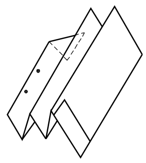
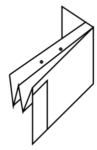
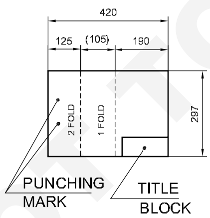
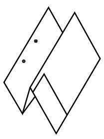
c) The bottom right corner shall be outermost visible section and shall have a width not less than 190mm.

Depending on the method of folding adopted, suitable folding marks are to be introduced in the tracing sheets as guide

Method of Folding of Drawing sheets

The methods recommended for folding are indicated in Exercise (Fig.1) and Exercise (Fig.2).

Fig 1

SHEET DESIGNATION	FOLDING DIAGRAM	LENGTHWISE FOLDING	CROSS WISE FOLDING
AO 841x1189			
A1 594x841			
A2 420x594			
A3 297x420			—

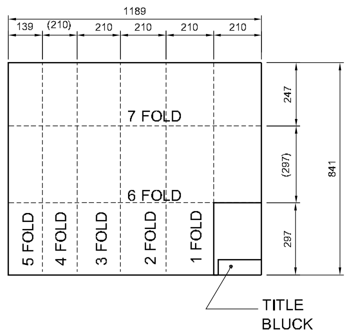
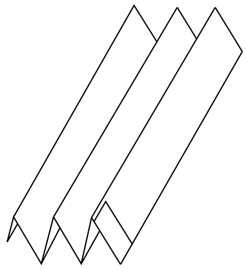
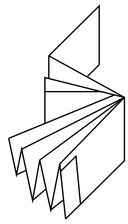
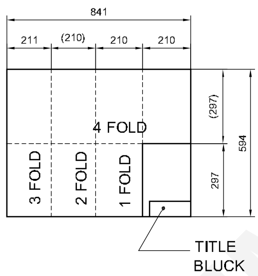
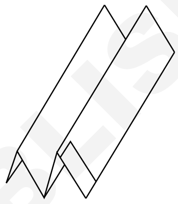
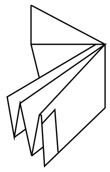
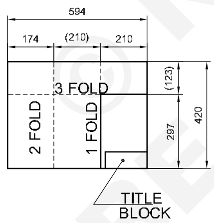
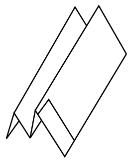
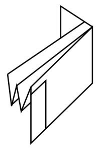
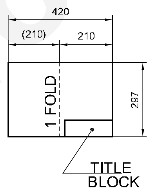
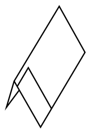
ALL DIMENSIONIN MILLIMETRES

FOLDING OF SHEETS FOR FILING OR BINDING

DMN1218H1

© NIMI NOT TO BE REPUBLISHED

Fig 2

SHEET DESIGNATION	FOLDING DIAGRAM	LENGTHWISE FOLDING	CROSS WISE FOLDING
AO 841x1189			
A1 594x841			
A2 420x594			
A3 297x420			—

ALL DIMENSIONIN MILLIMETRES

FOLDING OF SHEETS FOR STORING IN FILING OR BINDING

DM1507J2

NOT TO BE REPUBLISHED © NIMI

Capital Goods & Manufacturing — Exercise 1.2.16
Draughtsman Mechanical - Basic Engineering Drawing - Types of curves - Methods of dimensioning - Types of scales

Draw different types of lines and write their uses - show most of the lines in drawing view

Objectives: At the end of this exercise you shall be able to
- **draw the different types of lines**
- **draw the views of an object and indicate the application of lines.**

PROCEDURE

Exercise 1: Prepare the Table 1

Drawings are made up of different types of lines. Just as language with alphabets and grammar

Lines of different thickness and features are used for specific use.

Technical drawings are drawn with different types of lines. By proper choice and application of lines product features can be correctly defined in a drawing. Different types of lines recommended for specific applications are given in Table 1.

Table 1

Line	Description	General applications See figure and other relevant figure
A	Continuous thick	A1 Visible outlines A2 Visible edges
B	Continuous thin (straight or curved)	B1 Imaginary lines of intersection B2 Dimension lines B3 projection lines or extension line B4 Leader lines B5 Hatching B6 Outlines of revolved sections in place B7 Short centre lines B8 Thread line B9 Diagonal line
C	Continuous thin free hand	C1 Limits of partial or interrupted views & sections, if the limit is not a chain thin
D	Continous thin (Straight) with zig-zags	D1 Line (See figures)
E	Dashed thick	E1 Hidden outlines E2 Hidden edges
F	Dashed thin	F1 Hidden outlines F2 Hidden edges
G	Chain thin	G1 Centre lines G2 Lines of symmetry G3 Trajectories
H	Chain thin, thick at ends & changes of direction	H1 Cutting planes
J	Chain thick	J1 Indication of lines or surfaces to which a special requirement applies
K	Chain thin double-dashed	K1 Outlines of adjacent parts K2 Alternative and extreme positions of movable parts

© NIMI NOT TO BE REPUBLISHED

K		K3 Centroidal lines K4 Initial outlines prior to forming K5 Parts situated in front of the cutting plane

1 This type of line is suited for production of drawings by machines.
2 Although two alternatives are available, it is recommended that on any one drawing. Only one type of line be used.

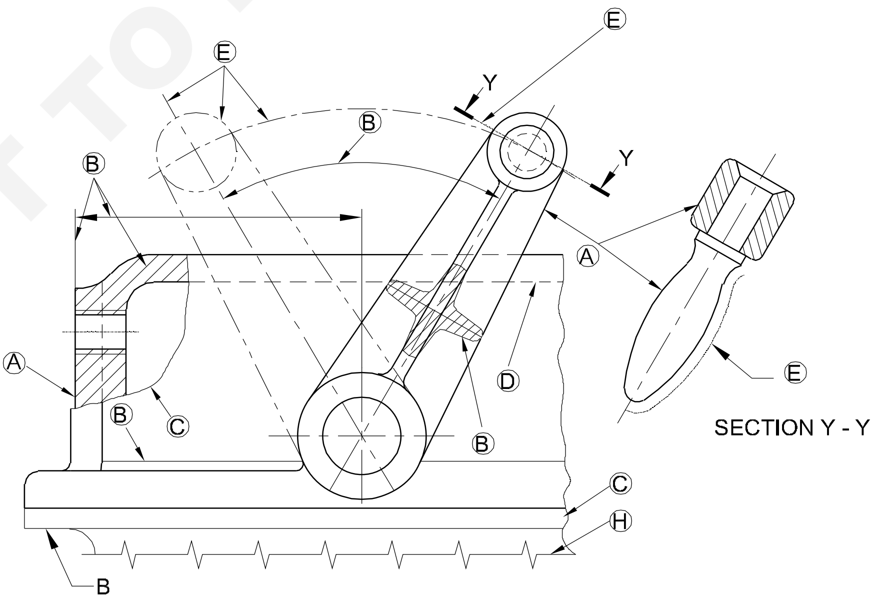
Exercise 2: Reproduce the type of line, illustration application of drawing. (Table 2)

Table 2

Type of Line	Illustration	Application
A Continuous thick	A	Visible outlines
B Continuous thin	B	Dimension lines, leader lines, external lines, construction lines, outlines, adjacent parts, hatching and revolve section.
C Continuous thin-way	C	Irregular boundary and edges
D Short dashes medium	D	Hidden outlines and edges
E Long chain thin	E	Central lines, locus lines, extreme positions of the moveable parts, parts situated in front of the cutting plane and pitch circles.
F Long chain thick at ends and thin elsewhere	F	Cutting plane lines
G Long chain thick	G	To indicates surfaces which are receive additional treatment
H Ruled lines and short Zig zag thin	H	Long break lines

Application of lines

Fig 1



EXAMPLES FOR THE USE OF VARIOUS TYPES OF LINES

© NIMI NOT TO BE REPUBLISHED

Draw block letters of numerals in single stroke and double stroke of ratio 7:4 and 5:4

Objective: At the end of this exercise you shall be able to
- **print letters and numerals of given size in different styles by free hand.**

PROCEDURE

Exercise 1: Reproduce single stroke vertical gothic and double stroke vertical gothic letters and double stroke italic gothic letter

Production

Lettering, in engineering drawing, is an important part of drawing. Lettering enhances the clarity of drawing.

Lettering

The method of writing letters A, B, C, D and numerals 1, 2, 3, 4 etc., titles, notes, scale etc. on drawing is called Lettering.

Types of lettering

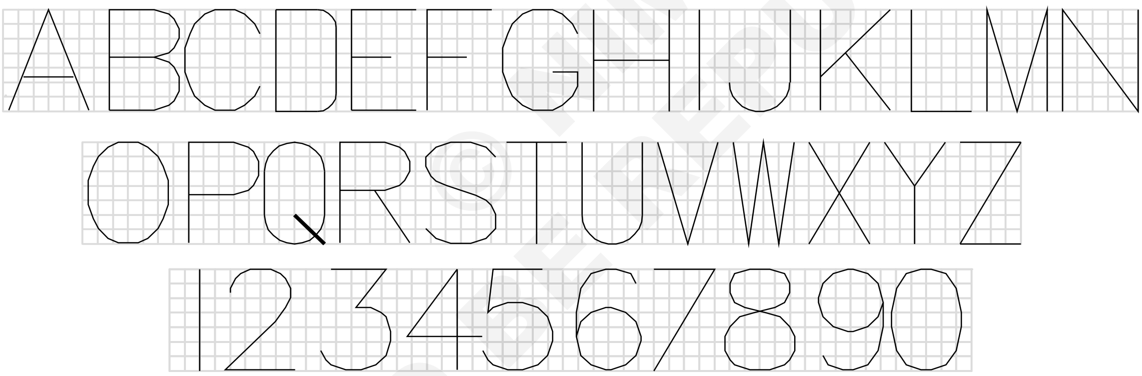
1 Gothic Lettering

2 Free Hand Lettering

3 Roman Lettering

1. **Gothic Lettering** — Single stroke letters of equal thickness and width are called Gothic letters. Gothic letters may be single stroke and double stroke letters. These letters can be written on a scale of 7:4 or 5:4. Letters inclined at 15° to vertical axis are italic gothic letters. All these types of letters are shown in figure below.

Fig 1



SINGLE STROKE VERTICAL GOTHIC LETTERING

DOUBLE STROKE VERTICAL GOTHIC LETTERING

INCLINED LINES

DMN1220H1

© NIMI NOT TO BE REPUBLISHED

Exercise 2: Reproduce the roman lettering as given below Fig.2

Fig 2

ROMAN LETTERING

DMN1220H2

Fig 3

DOUBLE STROKE ITALIC GOTHIC LETTERING

DMN1220H3

© NIMI NOT TO BE REPUBLISHED

Exercise 3: Reproduce the given style of letters as given below (Fig.4)

Fig 4

ABCDEFGHIJKLMN

OPQRSTUVWXYZ

1234567890

DOUBLE STROKE ITALIC FREE HAND CAPITAL LETTERING AND NUMERAL

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

1 2 3 4 5 6 7 8 9 0

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

1 2 3 4 5 6 7 8 9 0

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

1 2 3 4 5 6 7 8 9 0

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

1 2 3 4 5 6 7 8 9 0

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

1 2 3 4 5 6 7 8 9 0

DIFFERENT SIZES OF FREE HAND SKITCH

a b c d e f g h i j k l m n o p q r s t u v w x y z

1 2 3 4 5 6 7 8 9 0

LOWER CASE FREE HAND

DMN1220H4

© NIMI NOT TO BE REPUBLISHED

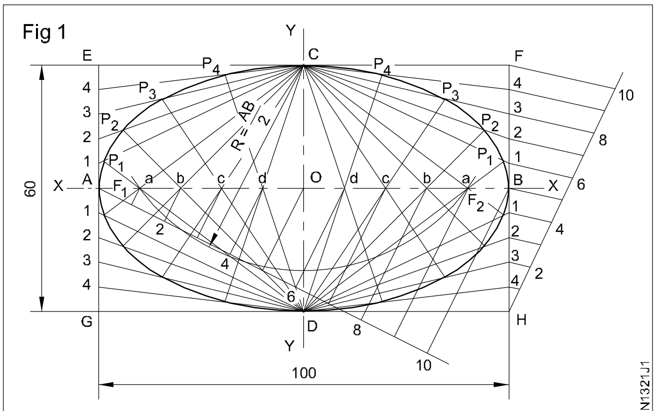
Construction of ellipse - parabola - hyperbola in different methods

Objective: At the end of this exercise you shall be able to
- **construct ellipse using different methods.**

PROCEDURE

Exercise 1: Rectangle/Oblong method (Fig 1)

Fig 1



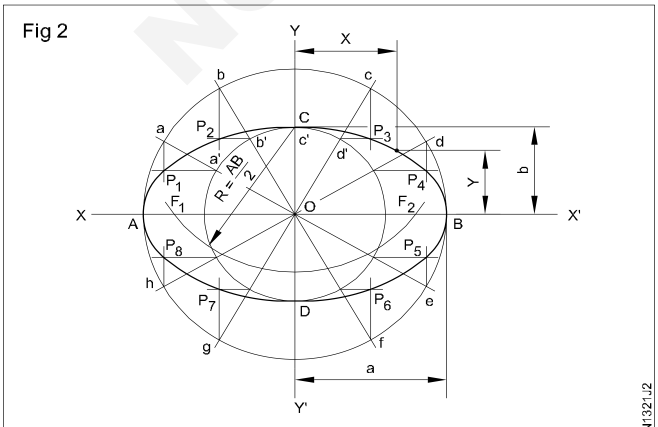
RECTANGLE/OBLONG METHOD

Construct an ellipse of major axis 100 mm and minor axis 60 mm.

- Draw a rectangle EFGH of sides 100 mm and 60 mm.
- Draw the major axis AB and minor axis CD and mark the intersection as `0'.
- Divide AO and OB into 5 equal parts each and name them as shown.
- Divide AE, AG, BF and BH into 5 equal parts and number them as shown.
- Draw lines and form C1, C2, C3, C4, D1, D2, D3, D4.
- Draw lines such as Ca, Cb, Da, Db etc to meet the corresponding lines drawn from C and D at points P_1, P_2 etc.
- Join A,$P_1$$P_2$ etc. with a smooth curve and form the ellipse.

Exercise 2: Concentric circle method (Fig 2)

Fig 2



CONCENTRIC CIRCLE METHOD

Major axis = 100 mm
Minor axis = 60 mm

- Draw the major axis AB (100 mm) and minor axis CD (60 mm), bisecting at right angle at 0.
- '0' as centre OA and OC as radius, draw two concentric circles.
- Draw a number of radial lines through '0' say 4 cutting the two circles.
- Mark the points on the outer circle as a,b,c.
- Similarly mark the intersecting points on inner circle as a',b',c'.
- From points such as a,b,c... draw lines parallel to minor axis.
- From points such as a', b'.... draw lines parallel to the major axis to intersect with the corresponding vertical lines at points P_1, P_2.... etc.
- Join all these points with a smooth curve using "french curve" and form the ellipse.
- To find the 'Foci' - with half the major axis (a) as radius and with 'C' on the minor axis as centre, draw an arc cutting the major axis, at two points, mark them as F_1, F_2, the focus points of the ellipse.

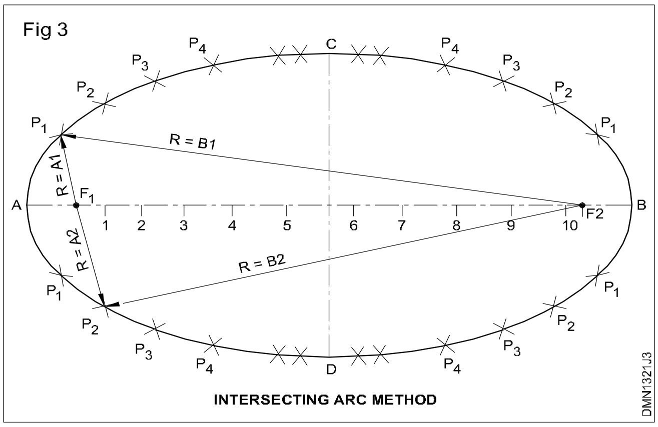
Check

Mark any point P on the curve and measure its distances from X axis and Y axis.

You will observe that $\frac{X^2}{a^2}+\frac{Y^2}{b^2}=1$
where a = 50 mm and b = 30 mm.

Exercise 3: Intersecting arc method (Fig 3)

Fig 3



INTERSECTING ARC METHOD

© NIMI NOT TO BE REPUBLISHED

Constructing parabolic curves by different methods

Objective: At the end of this exercise you shall be able to
- **constructing parabolic curves by different methods.**

Exercise 1: A parabola from the given focus is at 50 mm from the directrix (Fig 1)

Construct a Parabola from a given focus is at 50 mm from the directrix.

Construct a parabola given the base and axis.

Rectangle method

Tangent method

Parallelogram method

Offset method

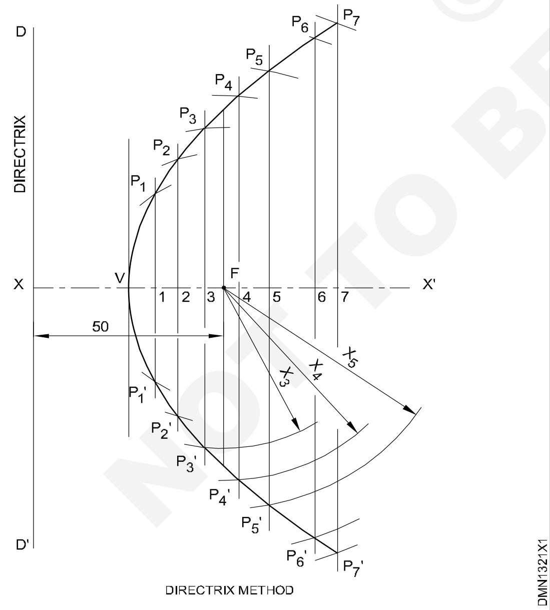
Construct Parabolic curves from the two given points.

– Points forming right angle, obtuse angle and acute angle.

Procedure

- Draw a vertical line D-D^1 the directrix.
- Draw horizontal line XX^1, the axis through any point X on the directrix.
- Mark the focus 'F' on XX^1 = 50 mm from X (on the directrix).
- Mark the midpoint of XF, as V.
- Mark a number of points from V towards right side on the axis as 1,2,3,4.....

Fig 1

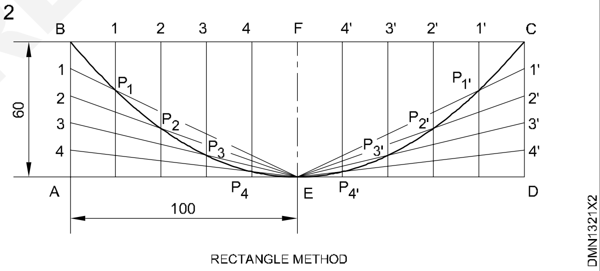


- Draw vertical lines through these points as shown, forming double ordinates.
- Point 'F' as centre, X-1 as radius, draw arcs on the co-ordinates (vertical lines) passing through 1, mark points P^1 & P_1^1.
- X-2 as radius, F as centre, draw arcs on the 2nd ordinate, mark P^2 & P_2^1.
- Similarly get point P_3, P_4.... P_3^1, P_4^1 etc. on the axis as above.
- Join all the points with a smooth curve, using french curve and form the parabola curve.

Exercise 2: Parabola, given the base and axis of a rectangle; base 200 mm axis 60 mm - Rectangle method (Fig 2)

- Draw a rectangle ABCD of sides 200 mm & 60 mm.
- Mark centre points of AD and BC, as E and F, join EF.
- Divide AB & CD and into any number of equal parts say 5. Also divide AE and ED into the same number of equal parts and number them as shown.
- From point E on AD, draw lines to the divisions on AB & CD.
- From the points on AED, draw parallel lines to EF.
- Mark the intersecting points P_1, P_2, P_3, P_4 on either side of axis.
- Form the parabola by joining the points BEC and intersecting with a smooth curve, passing through P_1, P_2.

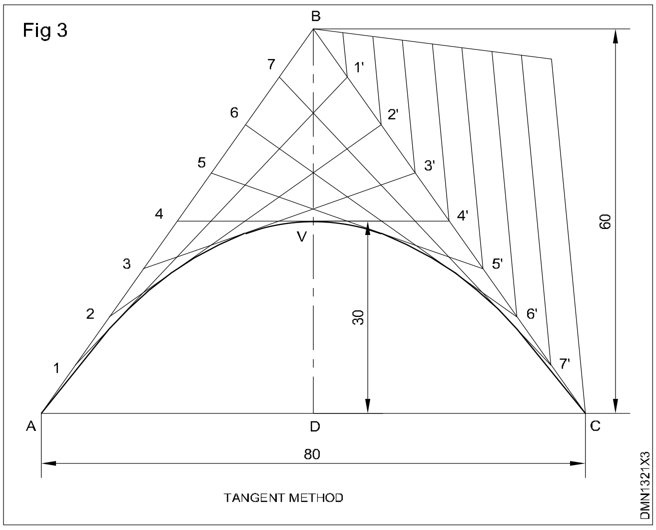
Fig 2



Exercise 3: Parabolic curve with base as 80 mm and axis 30 mm (Tangent method) (Fig 3)

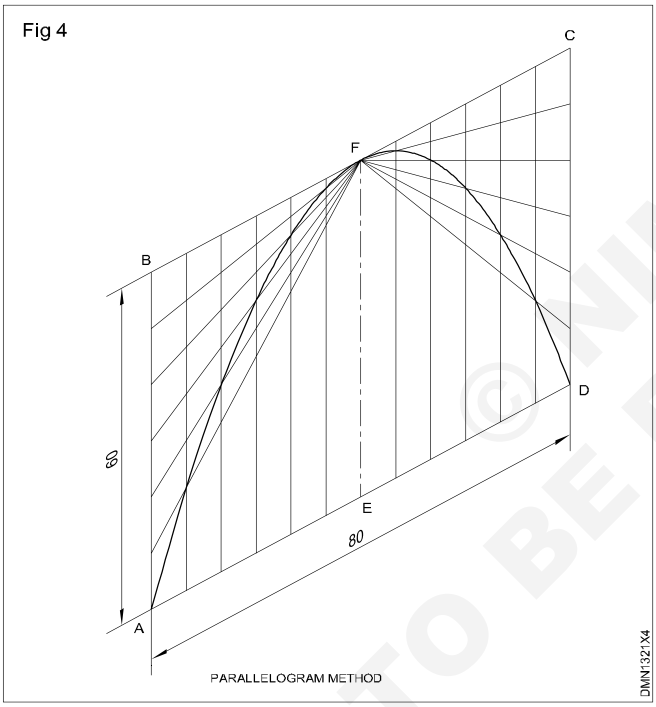
- Draw an isosceles triangle of base 80 mm and altitude 60 mm (double the abscissa).
- Join BD and mark mid point V, the vertex.
- Divide AB and BC into same number of equal parts using divider/other methods.
- Mark the points on AB as 1,2,3 etc in ascending order..
- Similarly mark 1', 2', 3' etc on CB but in descending order.
- Draw lines 1-1', 2-2'..... 7-7'.
- Join the points with A, V and C with a smooth curve. AC is tangential to line 1'1', 2 2' etc and form the required parabola.

© NIMI NOT TO BE REPUBLISHED



Exercise 4: Parabolic curve of sides 80 and 60 making 60°/120° - Parallelogram method (Fig 4)

Procedure is similar to the previous exercise



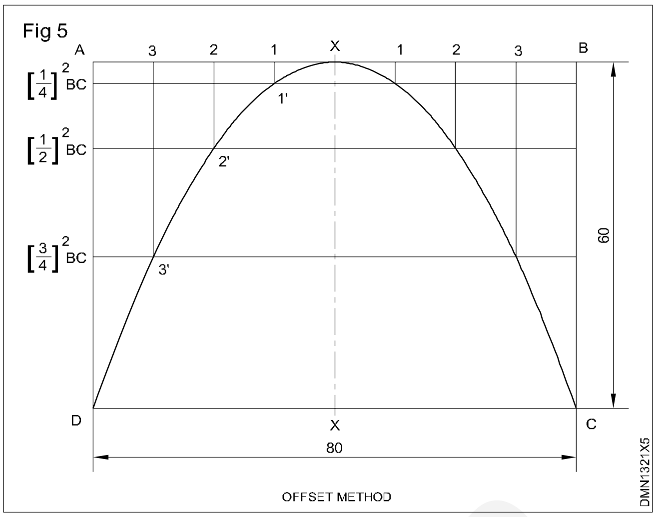
Exercise 5: Draw a parabola given double ordinate 80 mm and abscissa 60 mm 'offset method' (Fig 5)

- Draw the rectangle ABCD and draw XX through the midpoint of AB and CD.
- Divide AX and XB into same number of equal parts say 4 and mark them as 1,2,3 as shown.
- From the points 1,2 & 3, draw parallels (offset) to XX.
- On these offsets mark off distances as below:

  1-1' equal to $(1/4)^2$ of BC = 1/16 x 60 = 3.75 mm

  2-2' equal to $(2/4)^2$ of BC = 1/4 x 60 = 15 mm

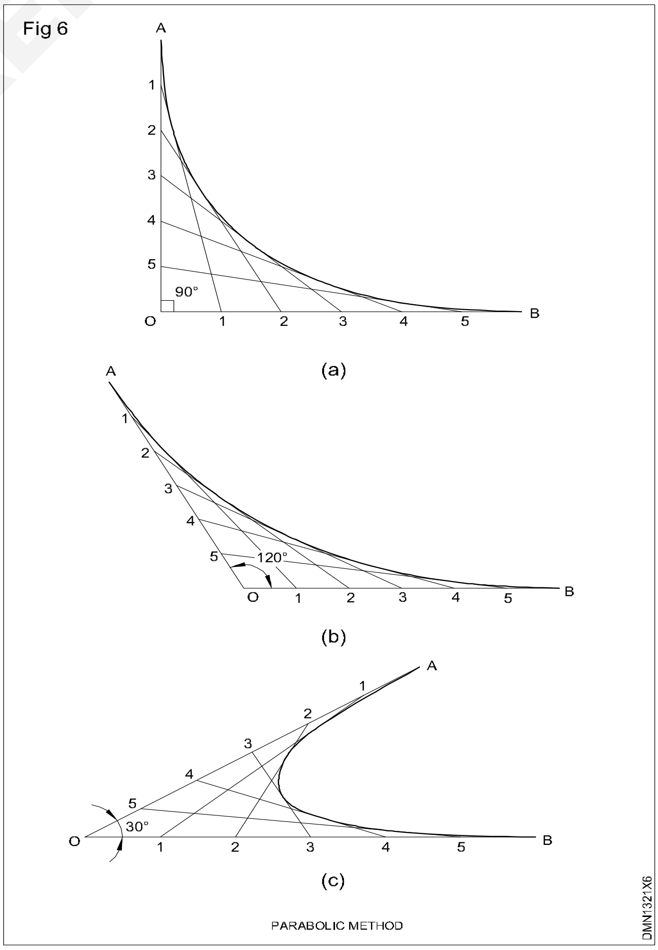
  3-3' equal to $(3/4)^2$ of BC = 9/16 x 60 = 33.75 mm
- Join D-X-C through parts 3', 2', 1' etc with a smooth curve and form the parabola.



Exercise 6: Parabolic curves joining two points A & B as shown (Fig 6)

Let the points A and B are in different positions as shown.

- Assume any point O.
- Join points A & B to O by straight lines.
- Divide AO and BO into same number of equal parts and number them as shown.
- Join the corresponding points i.e 1-1, 2-2.....5-5.
- Draw a smooth curve, tangential to line 1-1, 2-2, 3-3, 4-4, 5-5 etc and form this.
- Check the curve and draw thick parabola curve.



© NIMI NOT TO BE REPUBLISHED

Constructing hyperbolic curves by different methods

Objective: At the end of this exercise you shall be able to
- **construct hyperbola curve using the various conditions given.**

Exercise 1: Given the eccentricity and the distance of focus from the directrix (Fig 1)

Given the eccentricity and the distance of focus from directrix.

Given the double ordinates obscissa and distance

between vertices (transverse axis)

Given the transverse axis and the distance between focii.

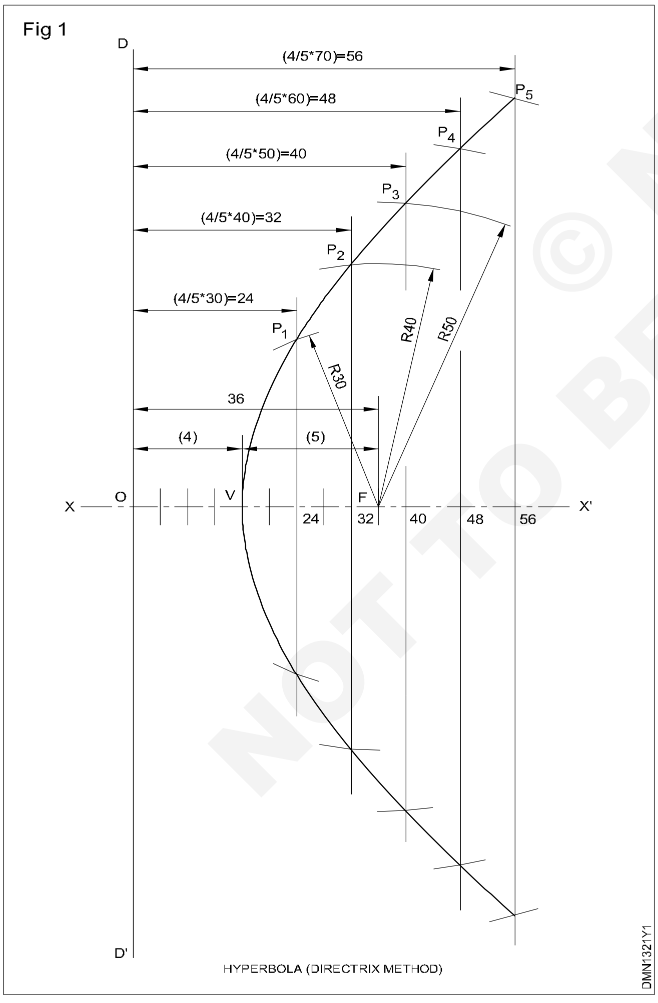
Rectangular hyperbola given point on the curve.

Hyperbola passing through a given point located between

the two asymptotes making any angle other than 90°

- Draw the locus of a point which moves so that its distance from a fixed point (Focus) and a line (directrix) bears a constant ratio of 5/4 (i.e eccentricity). Assume the focus at a distance of 36 mm from the directrix.
- Draw a directrix DD^1 and perpendicular XX^1 to it at 0.
- Mark F on XX^1 at a distance of 36 mm from 0.

Fig 1



HYPERBOLA (DIRECTRIX METHOD)

- Divide 'OF' into nine equal parts and mark 4th division as 'V'.
- Prepare a table as shown below such that the ratio of the value in each column is 4:5

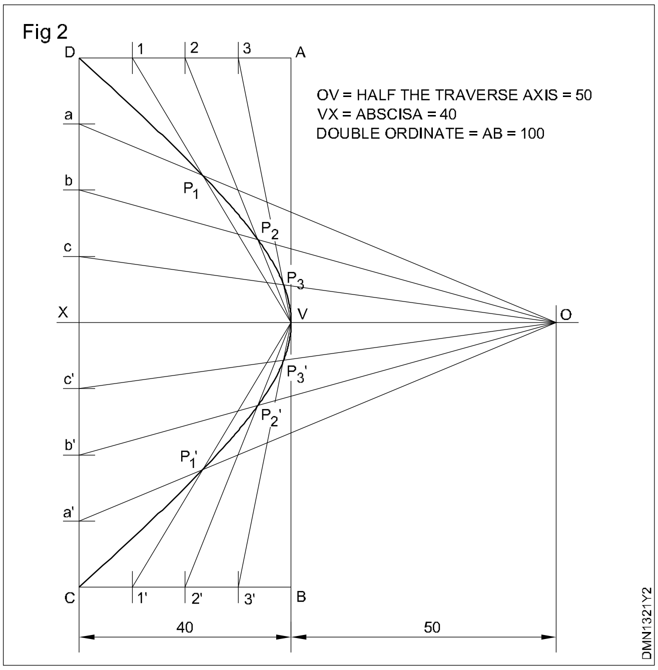
From directrix	24	32	40	48	56
From focus	30	40	50	60	70

- Draw parallels to directrix at distances 24,32 etc.
- F as centre and radius equal to 30, 40 etc. draw arcs to intersect the corresponding lines drawn in the previous step.
- Mark the intersecting points as P_1, P_2...etc.
- Complete the hyperbola by a smooth curve passing through these points.

Exercise 2: Given the double ordinate, abscissa and distance between vertices (traverse axis) (Fig 2)

- Draw a hyperbola with double ordinate 100 mm and abscissa 40 mm (rectangle method) and the transverse axis 100 mm.
- Draw the rectangle ABCD 100 x 40 mm.
- Mark the mid points V, X on AB and CD.
- Join VX and extend it outside to '0' 50 mm 100/2 from V.
- Divide AD and BC into 4 equal parts. Mark them as $1,2,3,1^1,2^1,3^1$.
- Join these points to V by straight lines.
- Divide DX;XC into 4 equal parts, each mark them as a,b,c,c^1,b^1,a^1.
- Join '0' to these points by straight lines.
- Mark the intersecting points as P_1,P_2 etc as shown.
- Join V-D with a smooth curve through P_1,P_2,P_3 etc.

Fig 2

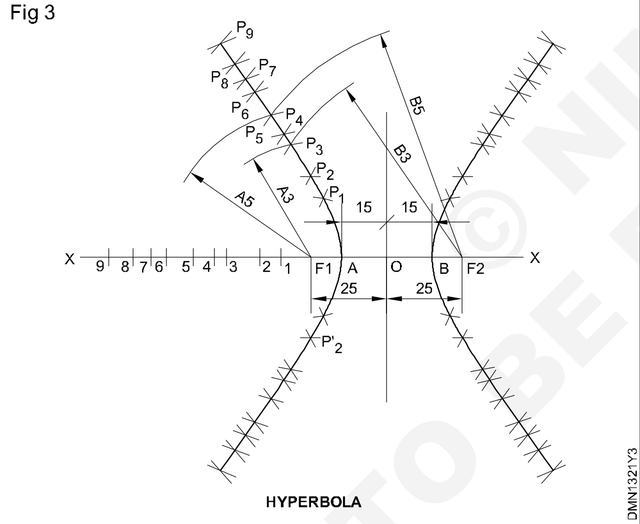


Exercise 3: Given the transverse axis and the distance between focus (Fig 3)

Draw a hyperbolic curve with transverse axis 30 mm and focus 50 mm apart.

- Draw the axis XX' and mark a point '0'.
- Mark OA = OB = 15 mm.
- Mark OF1 = OF2 = 25 mm.
- Mark any number of points on AX as 1,2,3,4....9
- Distance A-1 as radius, with centre F_1 and F_2, draw arcs on either side of XX'.
- Distance B -1 as radius, with centre F1 and F2. Draw arcs to intersect the previous arcs at P_1. (four places)
- A-2 as radius, F1 and F2 as centres, draw arcs on either side of XX'.
- Similarly B-2 as radius, F1 and F2 as centres draw arcs to get the point P2. (four places)
- Repeat as above and mark points P_3, P_4....P9 on four positions on either sides of XX'.
- Join the points in an order forming a pair of hyperbola curves.

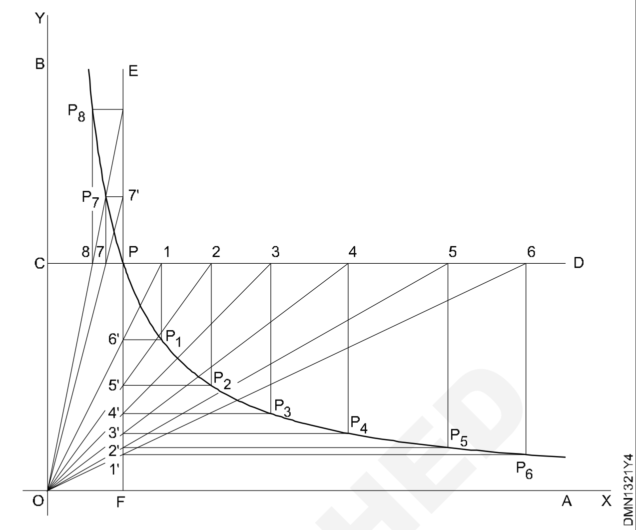
Fig 3



Exercise 4: Rectangular hyperbola given point on the curve (Fig 4)

- Draw a rectangular hyperbola given a symptotes as OX and OY are at right angles and a point P on the curve is 30 mm and 10 mm from OX and OY respectively.
- Draw the symptotes OA and OB at right angles to each other and locate the given point P. (10 mm from OX and 30 mm from OY)
- Draw the lines CD and EF passing through P and parallel to OA and OB respectively.
- Locate number of points 1,2,3 etc. (not necessarily equidistant) along the line CD.

Fig 4



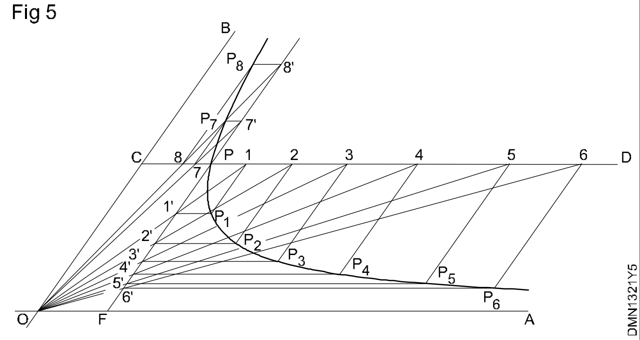
- Join 1,2,3 etc to O and extend if necessary till these lines meet the line EF at points 1', 2', 3' etc.
- Draw lines through 1,2,3 etc. parallel to EF and through 1', 2', 3' etc. parallel to CD to intersect at P_1, P_2, P_3 etc.

  A smooth curve passing through P_1, P_2, P_3 etc. is the required rectangular hyperbola.

Rectangular hyperbola is a graphical representation of Boyle's law, PV = constant. This curve also finds application in the design of water channels.

A hyperbola passing through any given point located between the two asymptotes making any angle other than 90° may also be constructed as shown in Fig 5.

Fig 5



© NIMI NOT TO BE REPUBLISHED

Construction of involutes - cycloid curves - helix and spiral

Objectives: At the end of this exercise you shall be able to
- **construct the following geometrical curves (involutes) under the given condition/data**
  - **involute of circle by radial line and concentric circle method**
  - **involute of plane figures such as square and heptagon.**

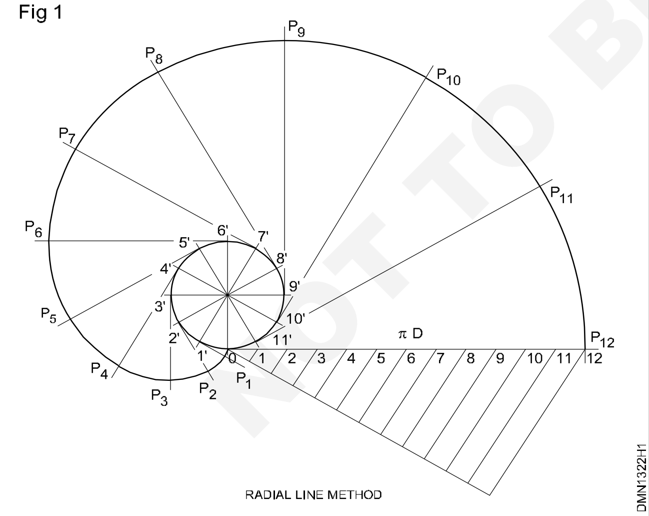
Draw an involute of a circle of diameter 40 mm.	Draw involutes of (regular plane figures)
Radial line method	Square of side 40 mm
Concentric method	Heptagon of side 40 mm

PROCEDURE

Exercise 1: Construct an involute of a circle of diameter 40 mm Radial line method (Fig 1)

- Draw a circle of diameter 40 mm.
- Divide the circle into a number of (say 12) equal parts and number than as 1', 2', 3'......12'.
- Draw a tangent through any of the points 1' , 2' etc and set a length equal to π D (graphically) on it, preferable draw the tangent from the point `O'.
- Divide the circumference (D) into equal parts as was done for circles and number them as 1,2,3....12.
- Draw tangents from points 1'2'3' etc and mark their lengths respectively equal to 01, 02, 03....011 etc and get points such as P_1,P_2...P_{12} smoothly and form the involute of circle.
- Follow the first four steps of the Radial line method.

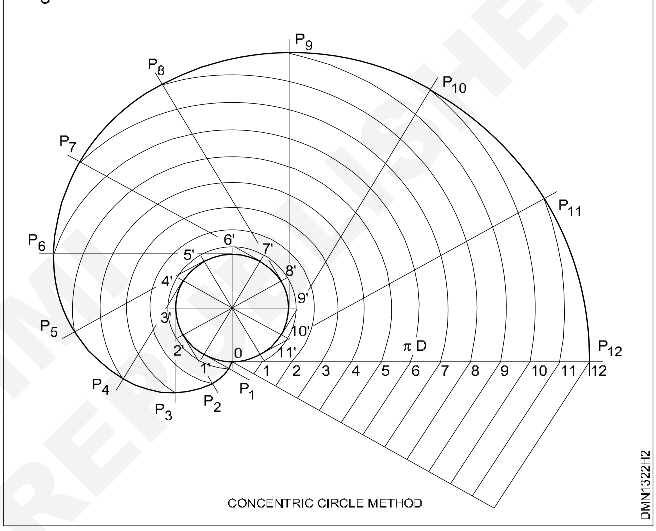
Fig 1



Exercise 2: Concentric circle method (Fig 2)

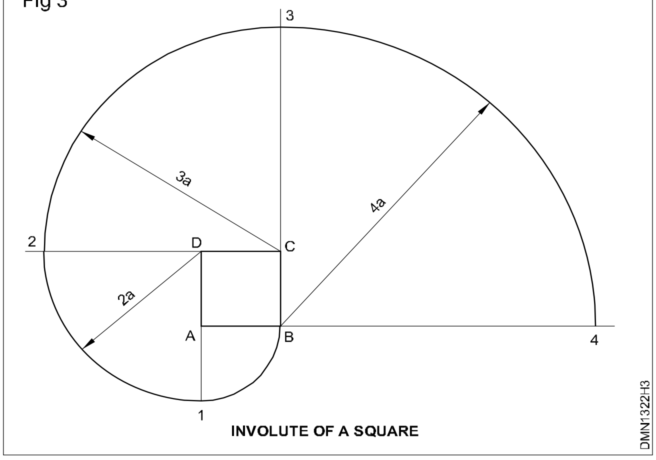
- Draw the concentric arcs, from the centre of the circle through the divisions 1,2,3.... etc to cut the tangential lines drawn from 1',2',3' etc at points P_1,P_2,P_3 etc.
- Join points P_1, P_2, P_3 by a smooth curve and form the involute of the circle.

Fig 2



Exercise 3: Construct an involute of square of side 40mm (Fig 3)

Fig 3

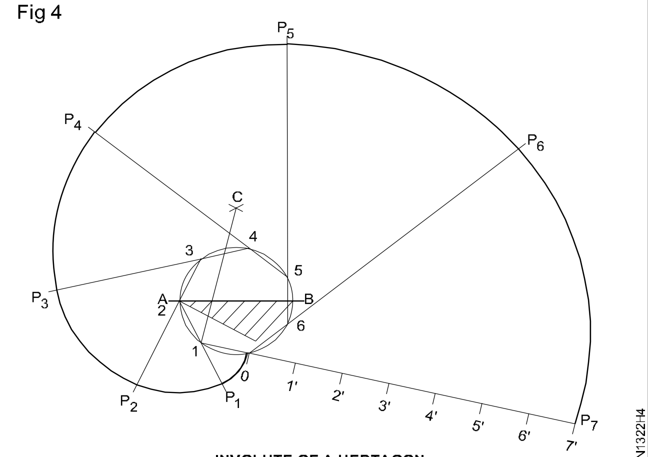


- Draw a square ABCD and extend the sides.
- 'A' as centre and radius 40 mm, draw the quadrant B.
- 'D' as centre and radius D-1, draw a second quadrant 1-2.
- 'C' as centre and radius C-2, draw a third quadrant 2-3.
- 'B' as centre and radius B-3 and draw forth quadrant 3-4.
- Now the curve 1-2-3-4 is the involute of the square.

© NIMI NOT TO BE REPUBLISHED

Exercise 4: Construct an involute of a heptagon (Polygon) in a circle of diameter 60mm (Fig 4)

Fig 4



INVOLUTE OF A HEPTAGON

Constructing cycloidal curves, Helix and spiral by different methods

Objective: At the end of this exercise you shall be able to

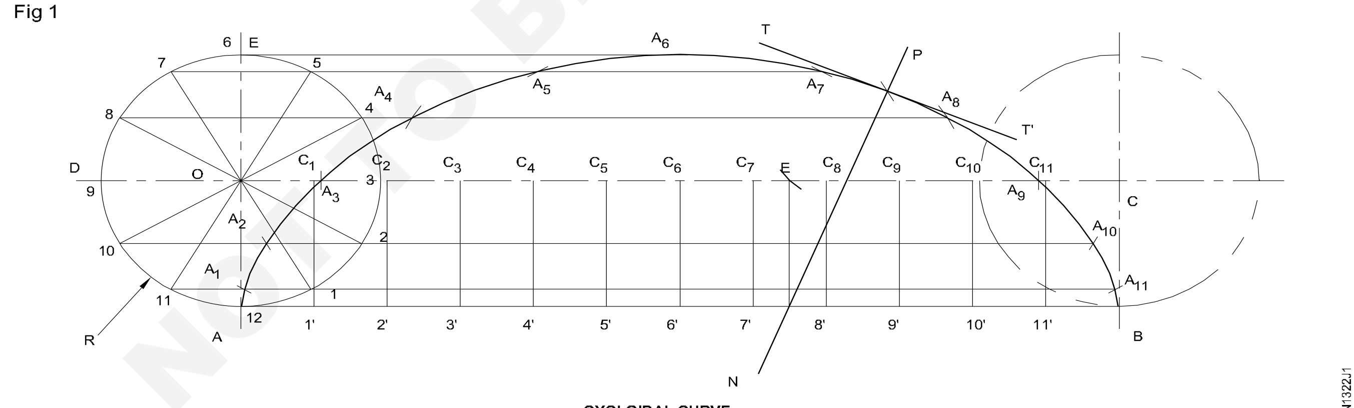
- **construct given radius/diameter of generating/directing circles.**

Exercise 1: The cycloid of a point on a rolling/generating circle of dia 60 mm along a straight line (Fig 1)

- Draw the generating circle of diameter 60 mm with centre '0'.
- Locate the initial position of the point A anywhere on the circumference of the circle.
- Draw a line AB tangential and equal to the circumference of the circle.
- Divide the line AB and the circle to the same number of equal parts (say 12) and number them as shown in figure.
- Draw the line OC parallel and equal to AB.
- Erect perpendiculars at $1^1, 2^1$.... etc to meet the line OC at $C_1 C_2$....etc.
- Through the points 1,2,3 etc draw lines parallel to AB.
- C_1 as centre and radius 30 mm, draw an arc intersecting the horizontal line 11-A_{11} at A_1.
- C_2 as centre and same radius (R30 mm) draw an arc intersecting the horizontal line 10-A_{10} at A_2. Similarly locate points A_3, A_4...A_{12} etc with centres C_3, C_4....etc.
- Join A, A_1, A_2....A_{11}, B with a smooth and complete the required cycloid.

© NIMI NOT TO BE REPUBLISHED

Fig 1



CYCLOIDAL CURVE

Exercise 2: A circle of radius 20 mm rolls outside slipping on another circle of radius 60 mm. Draw the path of a point, on the rolling circle, the Epi cycloid (Fig 2)

As the generating circle rolls once on the directing circle, it subtends an angle on the periphery of the directing circle.

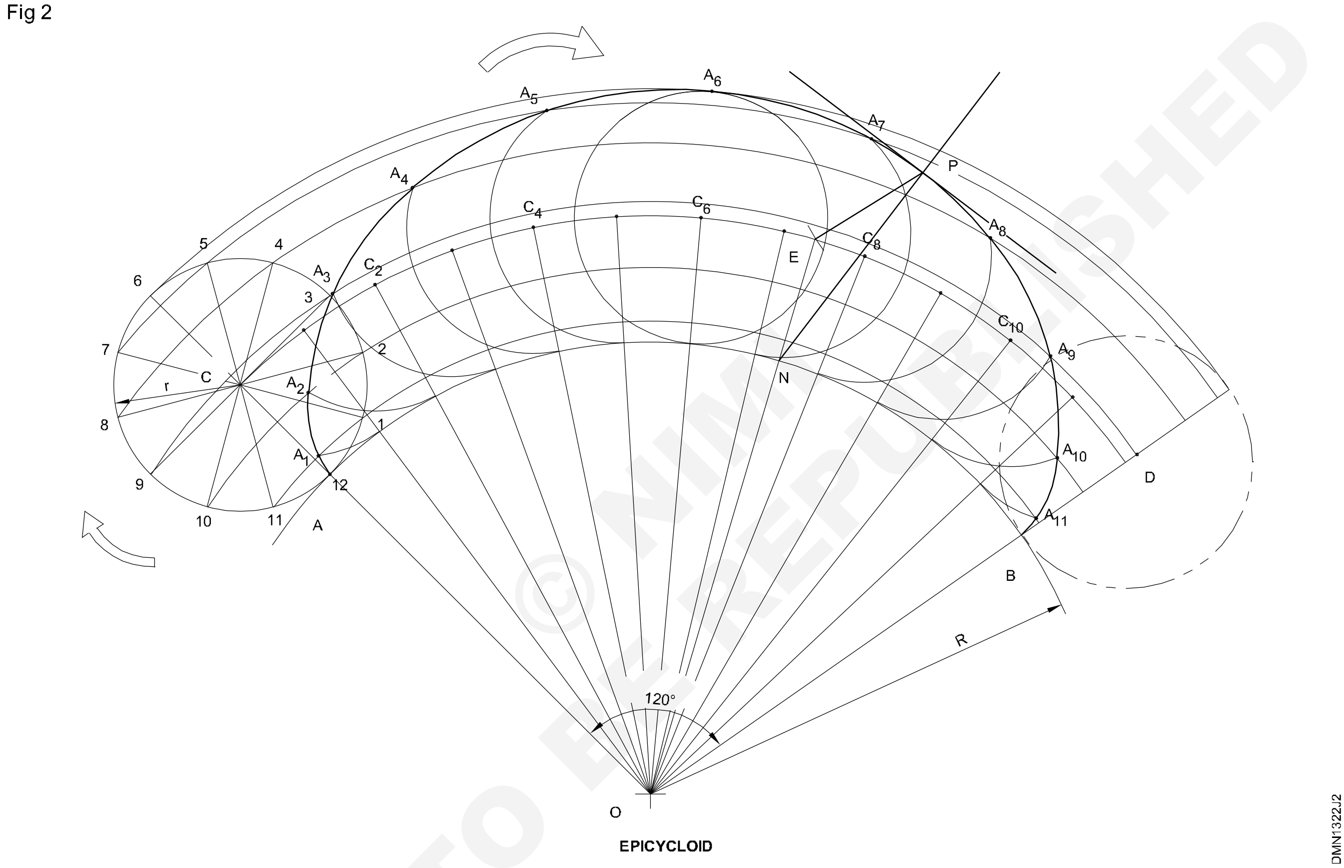
The value of this angle is = $\frac{r}{R} \times 360^\circ$

where r and R are the radii of generating and directing circles (20 mm and 60 mm) respectively.

Angle substandard = $\frac{20}{60} \times 360^\circ = 120^\circ$

- Draw an angle AOB equal to 120° and extend the sides.
- Point '0' as centre, draw the arc AB of radius 60 mm.
- Divide the angle AOB into 12 equal parts and draw lines from 0 as shown.
- On OA extended, with centre A and radius 20, draw an arc to cut the line OA extended at C.
- C as centre, draw a circle of r 20.
- Divide the rolling circle (C) into 12 equal parts 1,2,3....12 as shown.
- Point '0' as centre 0-1 as radius, draw an arc on to the angle AOB as shown.
- Repeat the same and draw arcs through points 2,3,4 & 5 with centre `O'.
- Mark the intersecting points of radial lines drawn from 'O' and drawn through C as C_1,C_2,C_3...etc.
- With radius r and centres C_1,C_2,C_3 etc. draw arcs on the respective radial lines to get points such as A_1, A_2, A_3 etc.
- Join points A_1, A_2, A_3 etc with smooth curve to form the required epicycloid.

Fig 2



© NIMI NOT TO BE REPUBLISHED

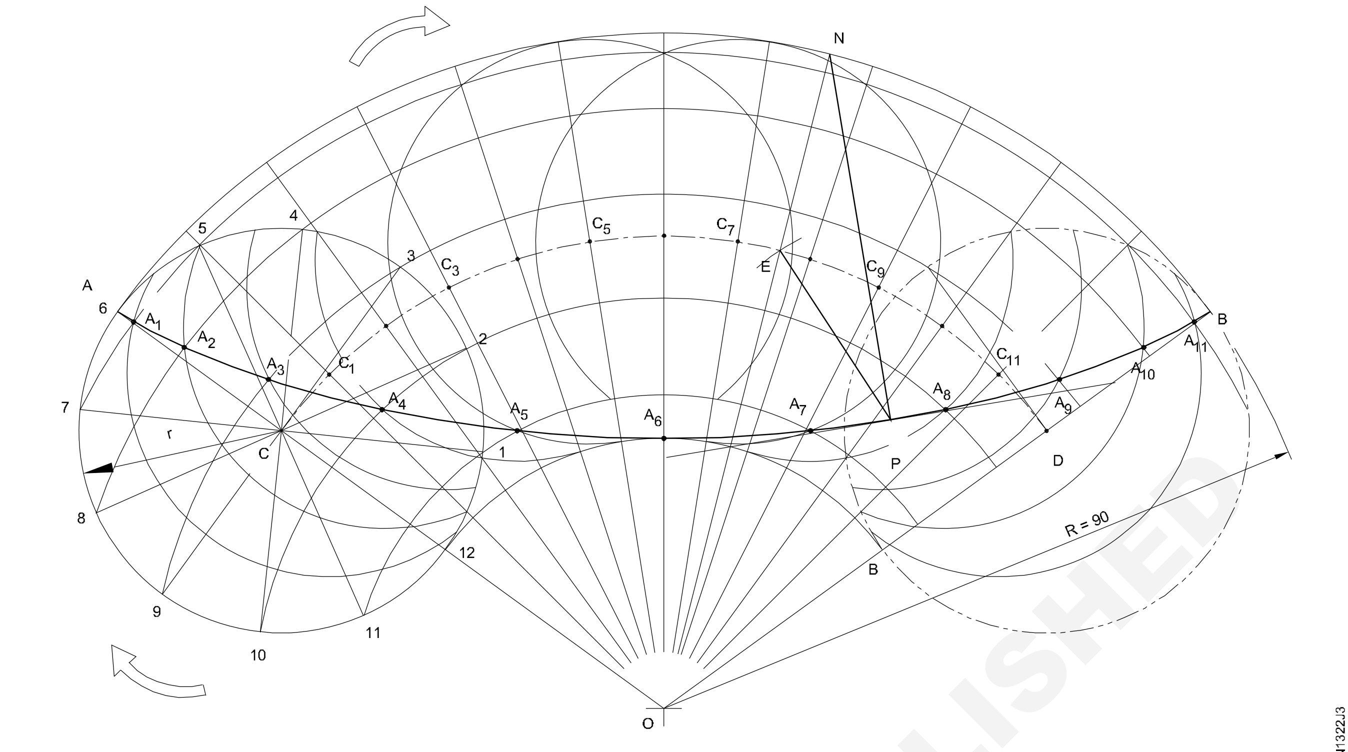
Exercise 3: A circle of diameter 80 mm rolls inside a circle of R90. Draw the resulting hypocycloid (Fig 3)

As in the previous exercise the angle subtended by the rolling circle

$$= \frac{r}{R} \times 360^\circ = \frac{40\,mm}{90\,mm} \times 360^\circ = 160^\circ$$

- Draw an angle AOB equal to 160° and extend the sides.
- Point '0' as centre, draw the arc AB of radius 90 mm.
- Divide the angle AOB into 12 equal parts, and draw lines from 0 as shown.
- On OA with centre A and radius r 40, draw an arc to cut the line CA at C.
- C as centre, draw a circle of r 40.
- Divide the rolling circle into 12 equal parts 1,2,3...12 as shown.
- Point '0' as centre 0-1 as radius draw an arc on to the angle AOB as shown.
- Repeat the same and draw arcs through points 2,3,4 etc with centre `O'.
- Mark the points intersecting points of radial lines drawn from '0' and the arc drawn through 'C' as C_1, C_2, C_3....etc.
- With radius r and centres C_1, C_2, C_3 etc., draw arcs on the respective radial lines to get points such as A_1, A_2, A_3 etc.
- Join A, A_1, A_2....A_{12}, B by a smooth curve and complete the required hypocycloid.

Fig 3

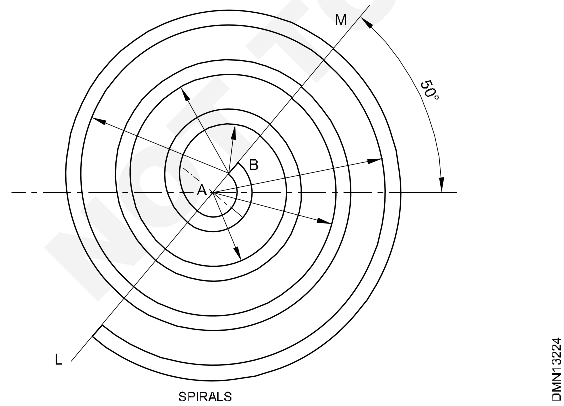


HYPOCYCLOID

Exercise 4: Draw four spirals on a line (Fig 4)

- Draw a line LM at an angle of 50° to the horizontal.
- Mark the points A and B (AB = 10mm)
- 'A' as centre, draw concentric semi-circles of radii 10 mm and 17 mm on the right side of the line LM.
- 'B' as centre, draw two concentric semi-circles/arcs in continuation to the previous arcs on left side of the line LM.
- Repeat the procedure with centres A and B and complete the pattern.

Fig 4



SPIRALS

Exercise 5: Draw the cam as per dimensions given (Fig.5)

- Draw a vertical line and mark the points C_1C_2 such that C_1C_2 = 84 mm.
- C_1 as centre, draw an arc of radius 56 mm (100-44) and C_2 as centre, draw another arc of radius 78 mm (100-22). Both arcs cut at C_3.
- Similarly obtain a point C_4 by drawing two arcs of radii 84 mm (44 + 40) and 62 mm (22 + 40) from points C_1 and C_2.
- Draw a circle of radius 44 mm with C_1 as centre and draw a circle or radius 22 mm with C_2 as centre.
- Produce C_1C_2 and get points A and B.
- C_3 as centre and radius BC_3 (100 mm) draw an arc.
- C_4 as centre and radius 40 mm draw an arc.
- Draw a circle of R10 with centre C_2.
- Rub off the unwanted lines and complete the pattern.
- Draw a polygon (heptagon) and mark the corners 0,1,2,.....6 etc.
- Extend each side of the polygon (heptagon) as shown.
- '1' as centre and 1-O as radius, draw an arc OP_1
- '2' as centre and 2-P_1 as radius, draw an arc P_1P_2
- Proceed in the similar way and draw arcs P_3 P_4 P_5 P_6 & P_7
- Now the curve `O' $P_1P_2P_3....P_7$ is the required involute.

© NIMI NOT TO BE REPUBLISHED

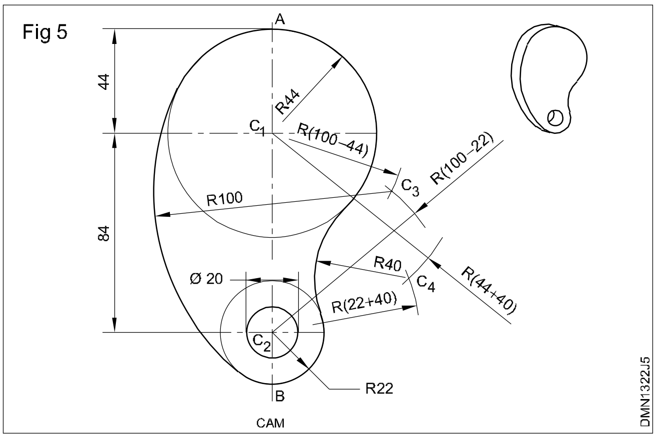


Fig 5

Exercise 6: Archimedean spiral of one convolution of radius 80 mm and starting from pole (Fig 6)

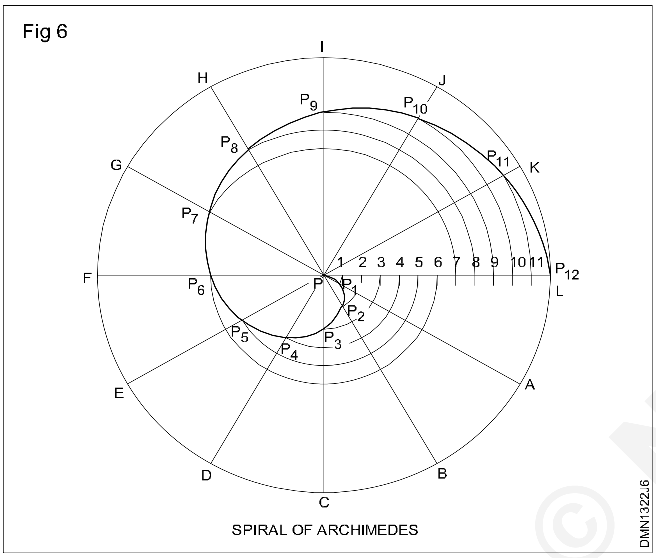


Fig 6

- Any point 'P' as centre, draw a circle of given radius 80 mm.
- Divide the circle into a number of equal (12) parts, number it as ABC, divide the radius into the same number of 12 equal parts and number them as 1,2,3.....12.
- Draw arc of radius P-1 on radial line PA. Mark the interaction as P_1.
- Draw arc of radius P-2 on radius line PB and mark the interaction as P_2.
- Draw arc of radius P-3 on radius line PC and mark the interaction as P_3.
- Similarly draw arcs on all the radial lines and mark points P_4 to P_{12}.
- Join the points P, P1, P2......P12 by a smooth curve and form spiral of the archimedes.

Exercise 7: **Construct an Archimedean spiral of $1\frac{1}{2}$ convolution, smallest radius r = 20 mm, largest radius R = 60 mm** (Fig 7)

- Any convenient point `O' as centre, draw a circle of radius 60 mm and draw the radius OH.
- Set of OQ equal to 20 mm.
- Divide the circle into 12 equal parts (i.e 30˚) and mark them as 1',2'.....12'.
- Divide the line QH into 18 equal parts and number them as 1,2,3.....18.
- 'O' as centre, draw arcs passing through points 1,2.... 18 to intersect the corresponding radial lines at P_1, P_2..... etc.
- Join the points P1 to P18 by a smooth curve and form the required spiral.

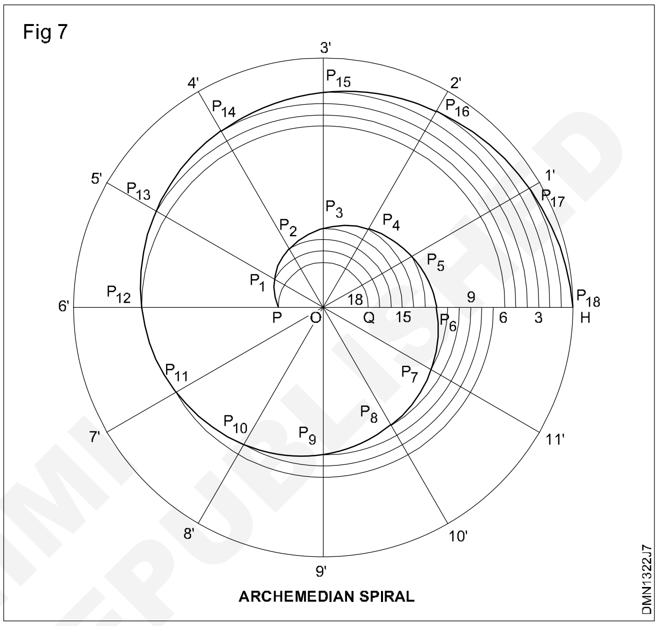


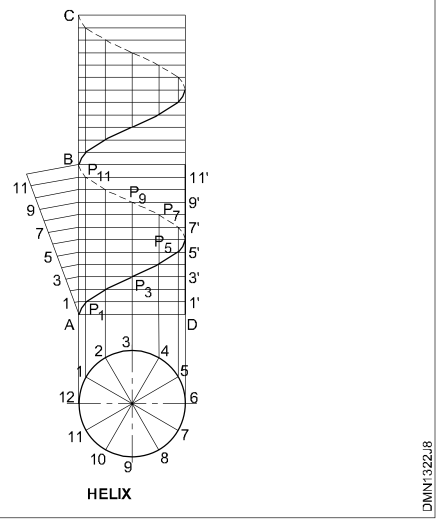
Fig 7

Exercise 8: **Construct a helix for two revolutions of a point on a cylinder dia 40 and pitch of helix 30 mm** (Fig.8)

- Draw a circle of diameter 40 mm, divide it into 12 equal parts and number them as 1,2.....12.
- Draw vertical projectors of sufficient length (more than 60 mm) from points 1,2.....12, such that the points 1 and 11, 2 and 10, 3 and etc lie on same vertical line.
- Mark the points A,B and C such that AB = BC = lead = 30 mm.
- Divide AB into the same number (12) of equal parts as there are similar divisions in the circle.
- Draw horizontal lines from 0, 1',2'..... etc to intersect with the projections from 1,2,3 etc at points P_1, P_2, P_3......P_{12}.
- Join the points P_1, P_2 etc with a smooth curve and form helix.
- Repeat the above procedure in portion BC and complete the helix for two leads.

© NIMI NOT TO BE REPUBLISHED

Fig 8

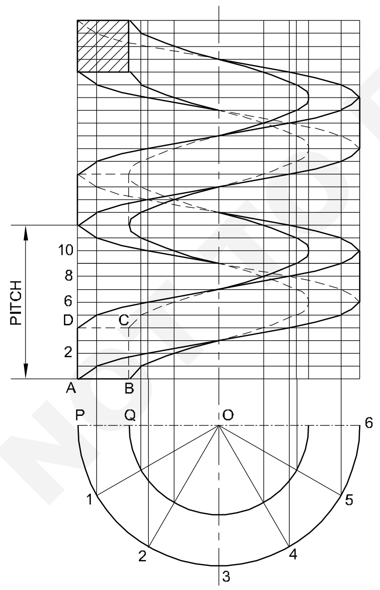


HELIX

Exercise 9: **Construct a helical spring of 10 mm square. Cross-section has an outside dia of 60 mm and pitch 30mm. Draw two pitches of the spring (Fig.9)**

- To draw the spring with one pitch we have to draw four helixes.
- Helixes starting from A is to be drawn using procedure of the previous exercise with outside diameter 60 mm. For helix 'D' reproduce same thing at distance 10 mm above helix A (thickness of spring 10 mm).
- Follow the above said procedure complete two helixes B&C with inside diameter 40 mm.
- Repeat four more curves and complete the two pitches of the spring.

Fig 9



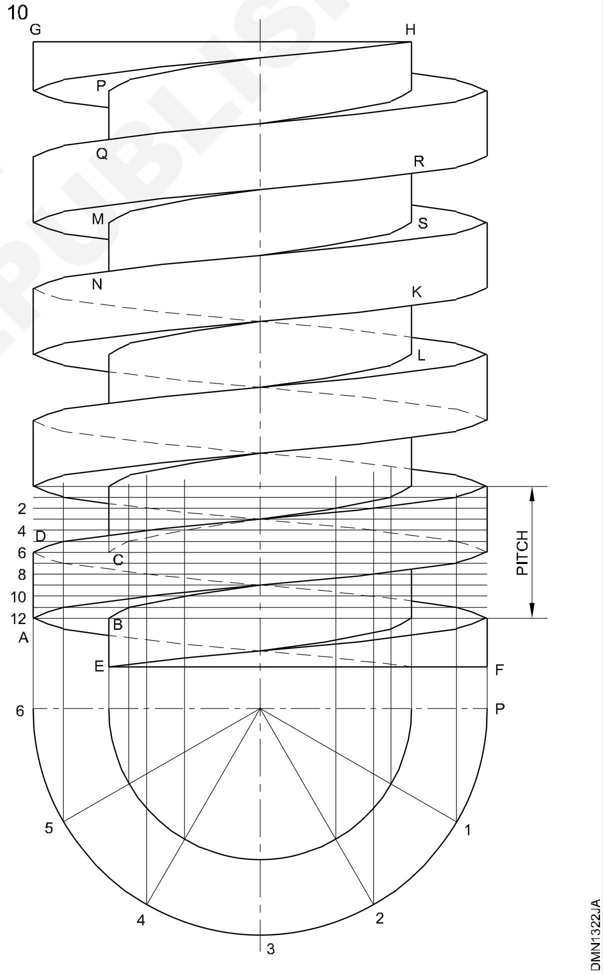
HELICAL SPRING

Exercise 10: **On a cylindrical rod of dia 80 a square helical groove of depth 12 mm is cut forming square thread. Assuming the pitch equal to 24 mm, draw 2 complete turns of the thread. Find the helix angle. Assume width/thickness of thread = depth of thread** (Fig 10)

Outside dia	=	80 mm
Depth of thread	=	12 mm
Pitch of thread	=	24 mm

- Starting from ABCD, draw four helixes using the method followed in the previous exercises and complete 5 pitches by drawing parallel helical curves.
- Draw vertical lines such as PQ, RS, MN etc to represent the core of the all five pitches.
- Draw parallel lines EF and GH at any convenient distance.
- Rub of the invisible portions of the helixes and complete the square thread.

Fig 10



© NIMI NOT TO BE REPUBLISHED

Objects drawing with dimensions of different alignment as per SP-46-2003

Objectives: At the end of this exercise you shall be able to
- **place dimensions in the drawings by aligned system and unidirectional system of dimensioning**
- **give dimensions to the given drawings by following dimensioning principles and as per BIS.**

Procedure

Exercise - 1

To the given drawing of the profiled sheet metal. (Fig 1) Place the dimensions in aligned system.

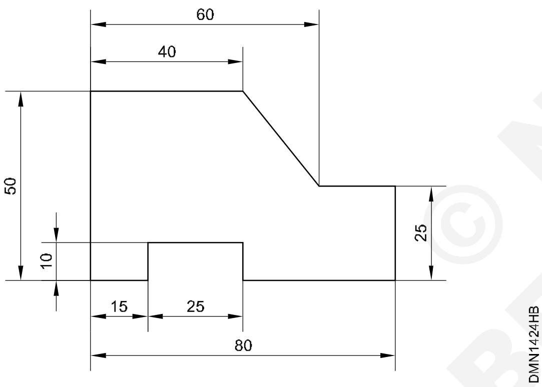
Draw the drawing of the sheet metal to 1.1 scale.

Draw the extension lines in continuation of outlines.

Draw the dimension lines. (Fig 1)

Place the dimension value near the middle and above the dimension line to be read from **"bottom and right hand side"** of the drawing.

Fig 1



Note: Draw the dimension line terminations as per IS:11669-1986.

- Draw the arrow heads with short lines forming borbs at any convenient angle between 15° to 90°.
- Maintain the uniformity of line thickness.
- Dimension lines are not to be broken.

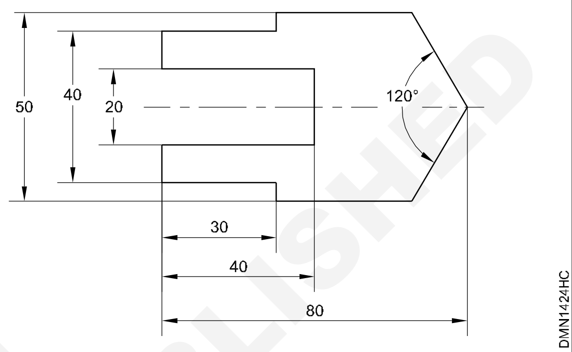
Exercise - 2

To the given drawing of the profiled sheet metal shown in Fig 2. Place the dimensions in unidirectional system.

- Place the horizontal dimensions above and middle of the dimension line without break.
- Break the dimension in the middle of all non-horizontal dimension lines. (Fig 2)

Note: Follow the general principles of dimensioning and show the dimensions as per standard.

Fig 2



Exercise - 3

Draw the four cover plates shown in (Fig 3a,b,c &d) and dimension according to standards.

- Fig 3 & 4 dimensions are placed taking the left and bottom edge as reference lines.
- Fig 5 & 6 centre lines are taken as reference lines for placing the dimensions.

Fig 3

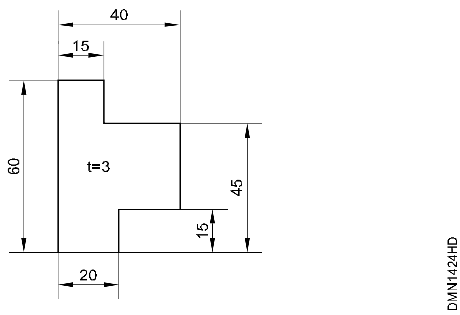
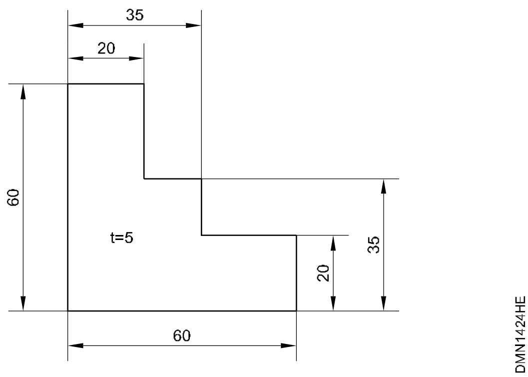


Fig 4



© NIMI NOT TO BE REPUBLISHED

Fig 5

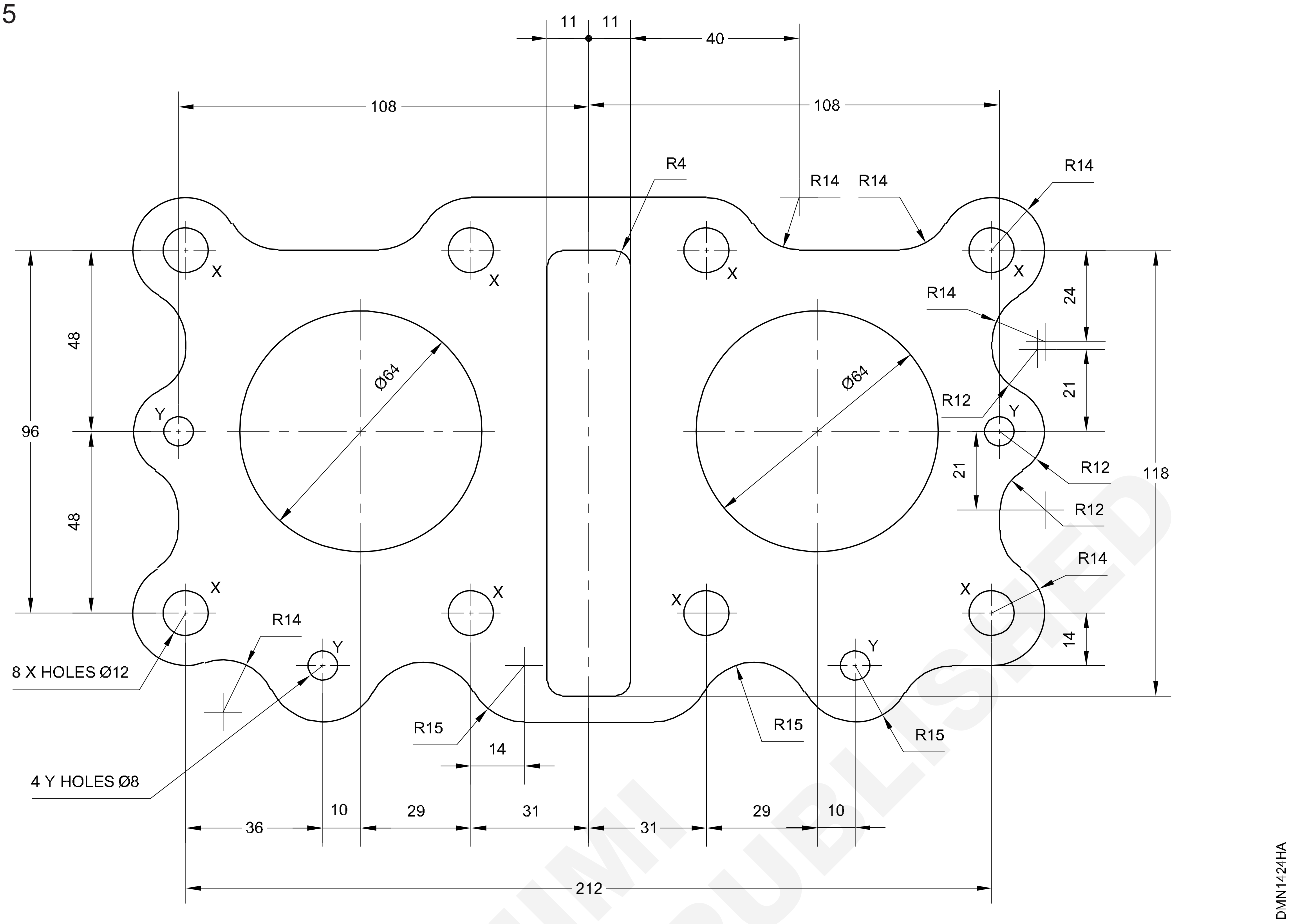


Fig 6

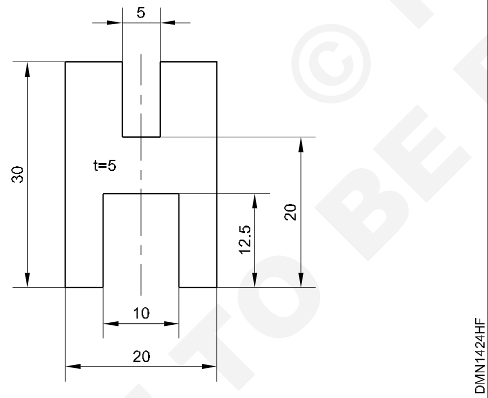


Fig 7

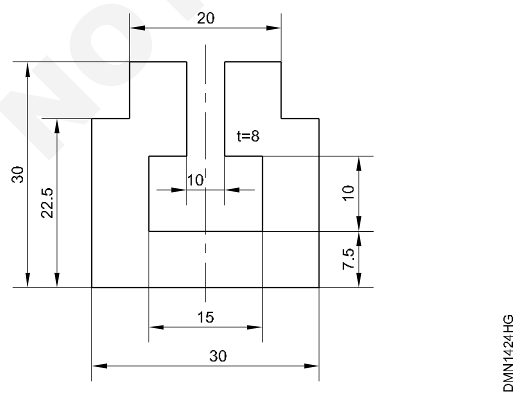
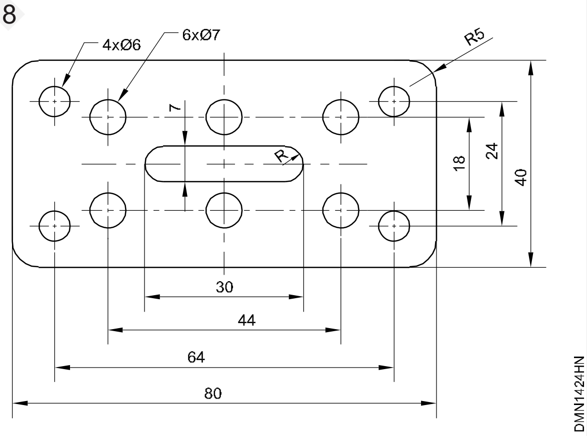


Fig 8



© NIMI NOT TO BE REPUBLISHED

- Follow the same procedure adopted in previous exercises.
- Centre lines are taken as reference line for the placing the dimensions

Exercise - 6

Draw the special can shown in Fig 8 and place the dimensions.

- Adopt the principles of dimensioning arcs, curves and fillets.
- Centre lines are taken as reference line for giving dimensions. (Fig 9)

Exercise - 5

Draw the board and seal of a three phase motor shown in Fig 7 .

Fig 9

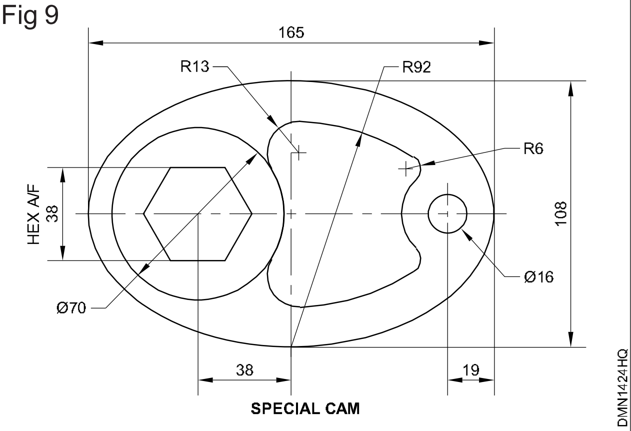
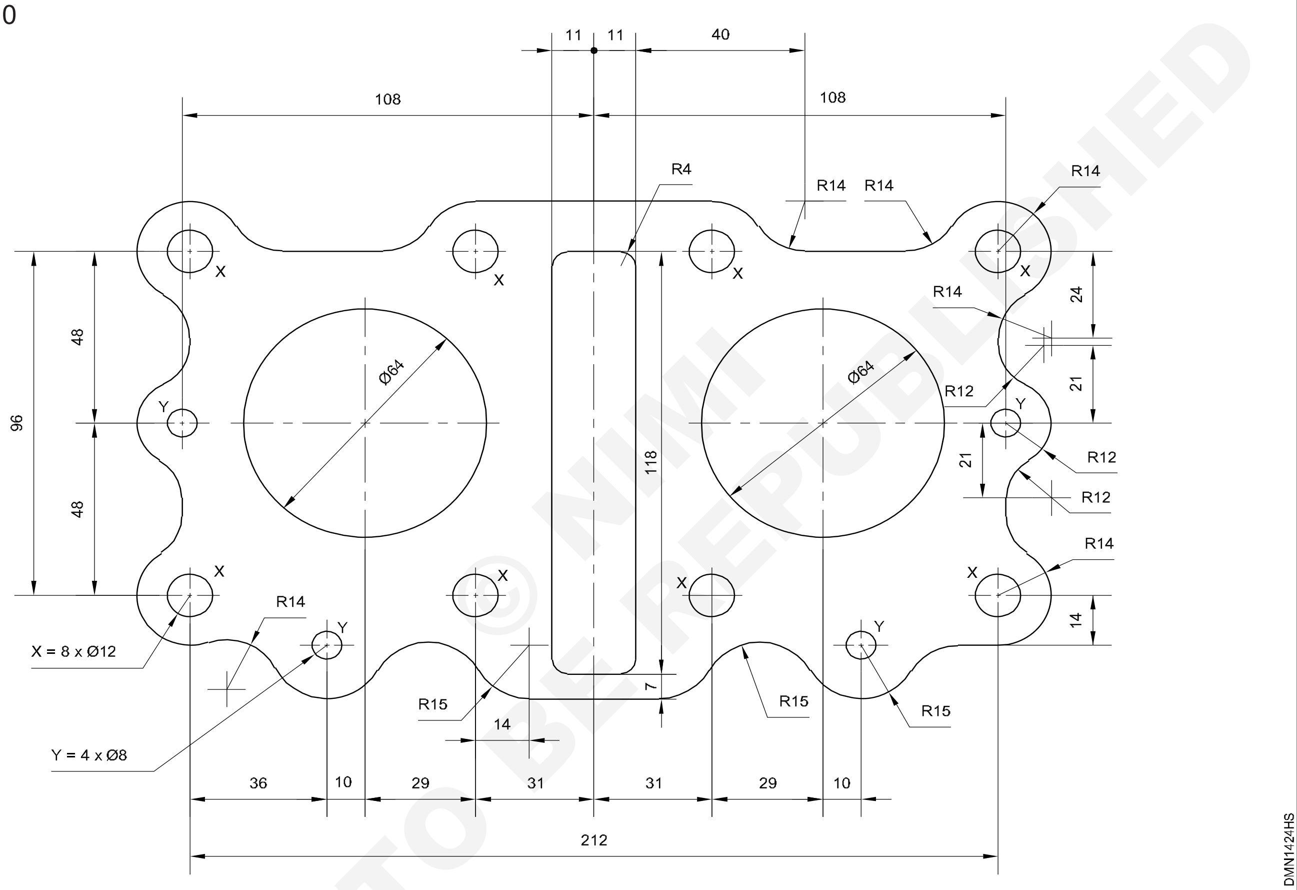

165
R13
R92
R6
HEX A/F
38
108
Ø16
Ø70
38
19
SPECIAL CAM
DMN1424HQ

Fig 10


11
11
40
108
108
R4
R14
R14
R14
R14
24
21
R12
R12
R12
21
96
48
48
Ø64
Ø64
118
R14
R14
X = 8 x Ø12
Y = 4 x Ø8
R15
R15
R15
7
14
14
36
10
29
31
31
29
10
212
DMN1424HS

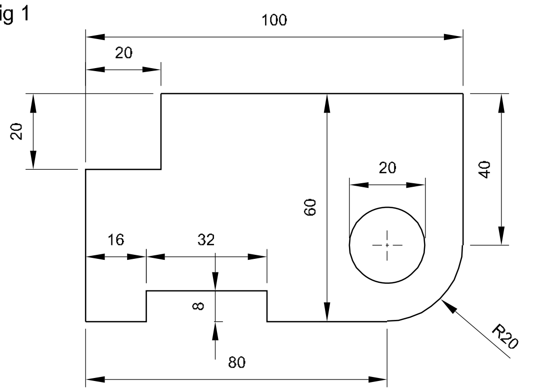
Application of Dimensioning Technique

Objective: At the end of this exercise you shall be able to
- **draw the drawings by correcting the mixtures and drawing in both systems.**

Exercise: Reproduce the given drawings (Figures 1 to 10) & dimensioning them both its aligned system and unidirectional system.

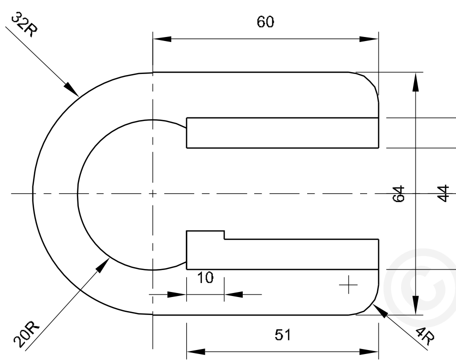
Note: Read the related theory related to dimensioning technic and draw the given figures 1 to 10 as per instructor.

Fig 1



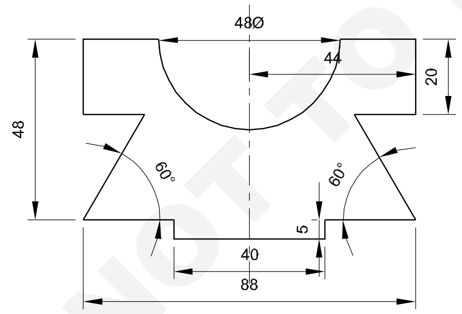
AN ANGLE PLATE (WRONG DIMENSIONING)

Fig 2



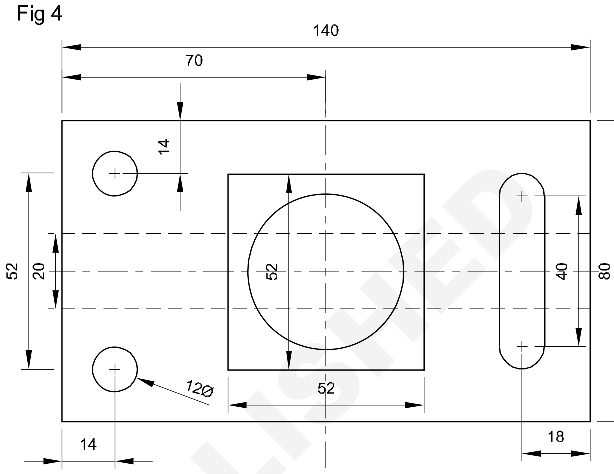
GO-NO-GO GAUGE (WRONG DIMENSIONING)

Fig 3



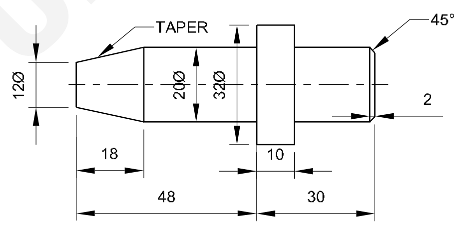
A TEMPLATE (WRONG DIMENSIONING)

Fig 4



A MACHINE PART (WRONG DIMENSIONING)

Fig 5



A MACHINE PART (WRONG DIMENSIONING)

Fig 6

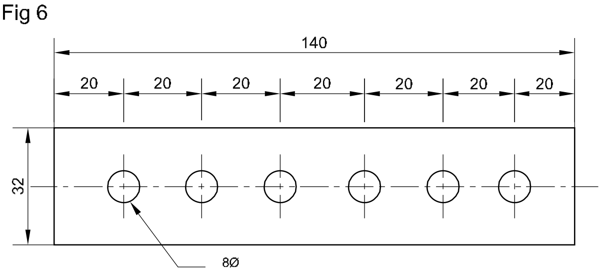
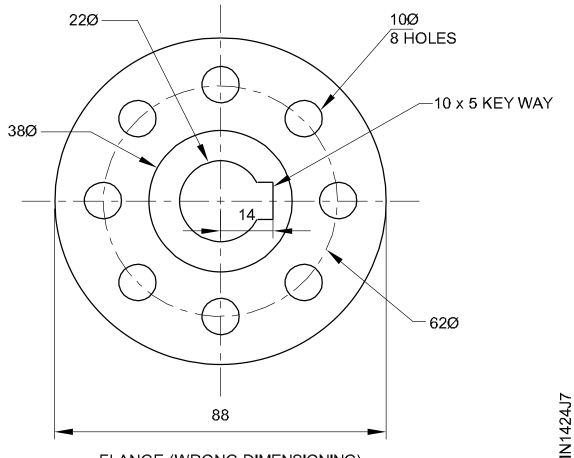


PLATE WITH HOLES (WRONG DIMENSIONING)

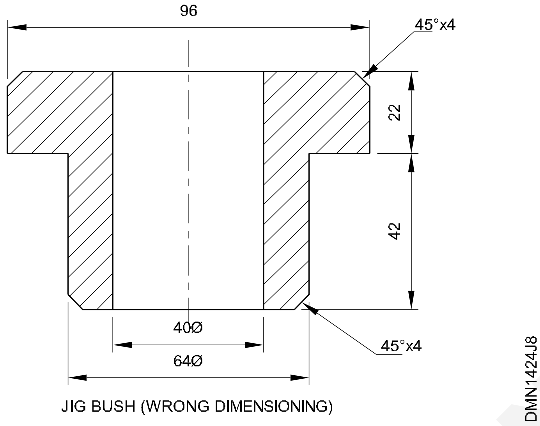
NOT TO BE REPUBLISHED © NIMI

Fig 7



FLANGE (WRONG DIMENSIONING)

Fig 8



JIG BUSH (WRONG DIMENSIONING)

Fig 9

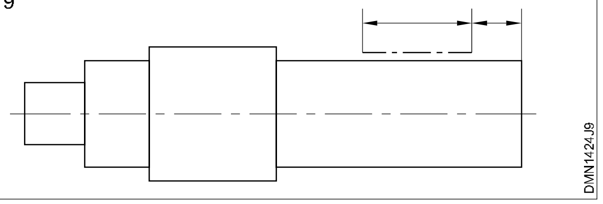
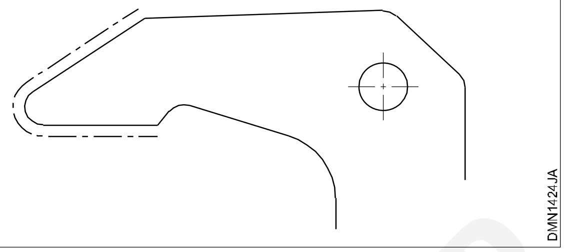


Fig 10



© NIMI NOT TO BE REPUBLISHED

Draw plain scale - Diagonal scale - comparative scale - vernier scale

Objectives: At the end of this exercise you shall be able to
- **construct the plain scale, diagonal scale and comparative scale**
- **vernier scale and scale of chords.**

Scales: It is difficult to draw the components to their actual sizes, because they may be too large to be accommodated on the drawing sheet or too small to draw and cannot be effectively used in the shop floor. For example, think of making the drawing of a motor car. It is too long and wide to be drawn on the drawing sheet to its original size. Similarly small component like wheel of a wrist watch or its needle (hands) if drawn to its original size will not be legible enough for use in the shop floor.

So depending on the situation drawings are drawn smaller or larger than the actual sizes. When we say that the drawings are smaller or larger, we mean that a given length in the drawing will be smaller or larger than the corresponding length in the object.

The ratio of the length in the drawing to its corresponding length of an object, when both the lengths are in the same unit, it is called the **Representative Fraction** (RF).

$$RF = \frac{\text{Size of the component in the Drawing}}{\text{Actual size of the component}}$$

1 Construct a plain scale of RF $\frac{1}{20}$ to measure up to 10 cm (min) and mark a distance of 1.2 metres on the scale.

2 Construct a scale of RF $\frac{1}{6000}$ and using this scale, draw a rectangle of perimeter 2400 m and the sides are in the ratio of 3:4.

3 Construct a plain scale of RF $\frac{1}{40}$ to measure metres and decimetres and mark a distance of 3.7m.

4 Construct a comparative scale to convert °C to °F

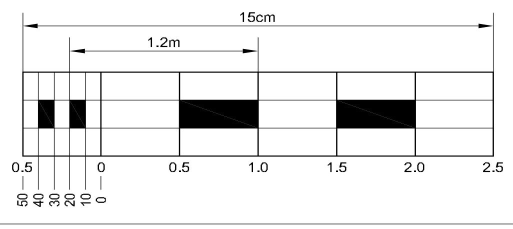
5 Construct a scale of chord and mark angle 35° using the same.

PROCEDURE

Exercise 1: Construct a plain scale of RF 1/20 to read 1.2 m and minimum distance of 10 cm (Fig 1)

- Take a length as 15 cm.
  15 cm x 20 = 300 cm (15 cm will represent 3 m)
- Draw a rectangle of 15 cm x 1.5 cm to represent the length and width of scale.
- Divide the length (15 cm) into 6 equal parts. Each part representing 0.5 m or 50 cm.
- Mark the parts as 0.5; 0; 0.5; 1.0; 1.5 etc.
- Divide the first part into five equal divisions (each of the division is 1 dm or 10 cm) and mark them as shown.
- Divide the width of the scale into 3 parts.
- Fill and number the alternate blocks (middle) as shown.
- Mark 1.2 m on the scale.

Fig 1



Exercise 2: Construct a rectangle whose perimeter is 2400 m and its sides are in the ratio of 3:4. Using scale of RF 1/6000 (Fig 2)

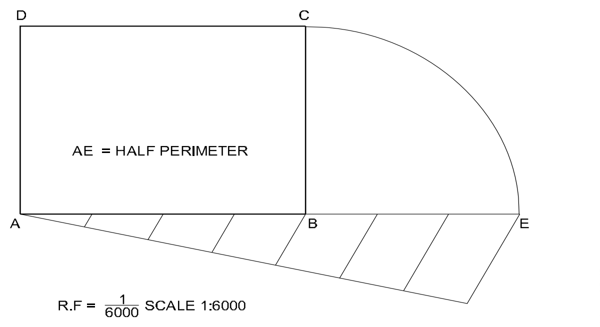
- Calculate the length of the scale to represent half the perimeter:1200 m

  Length of the scale = RF x length to be measured

  $\frac{1}{6000}$ x 1200 m x 100 = 20 cm.

- Draw a line AE 20 cm long represent half the perimeter.
- Divide AE into 7 equal parts. (3:4); 3+4 = 7)
- Mark AB equals to 4 units.

Fig 2



© NIMI NOT TO BE REPUBLISHED

- Draw perpendiculars at A and B.
- Mark D and C on the perpendiculars to a length of BE.
- Join DC and complete the rectangle ABCD.

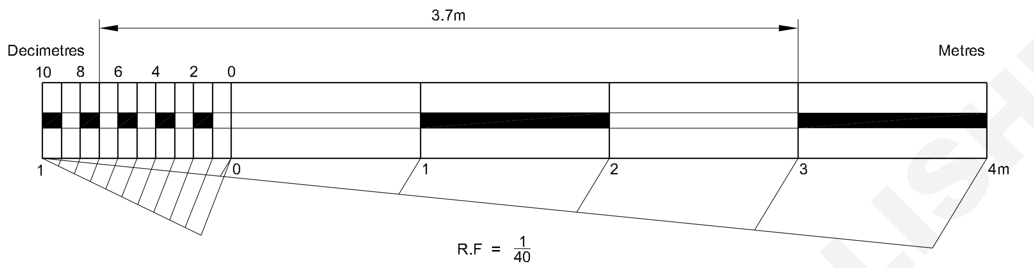
Exercise 3: Construct a plain scale to show metres and decimetres long enough to measure upto 5 m. RF = 1/40. Mark a length of 3.7 m on it (Fig 3)

RF = 1/40
Maximum length to measure = 5 m
Length of the scale required = RF x L

$$= \frac{1}{40} \times 5\,\text{m} \times 100 = 12.5\,\text{cm}$$

- Draw a rectangle of 12.5 cm x 1.5 cm.
- Divide the length into 5 equal parts each representing one metre.
- Mark them as shown.
- Divide the first division into 10 equal parts each representing 1 decimetre and mark them as shown.
- Mark the distance 3.7 as shown in Fig 3.

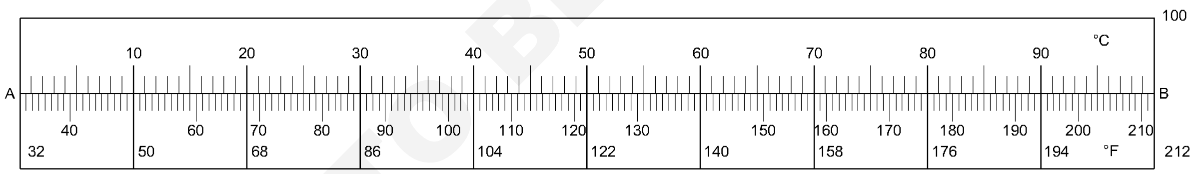
Fig 3



Exercise 4: Construct a comparative scale to convert Fahrenheit (°F) into Celsius °C and vice-versa (Fig 4)

- Draw a line AB of 15 cm long. (Top part will read °C and bottom part will read °F)
- Divide the line into 10 equal divisions.
- Top side mark 0,10,20....100 for °C scale (100 divisions) and on bottom side, mark 32, 50, 68.... 212 for °F scale 180 divisions as shown.
- On °C side divide one division into 10 equal parts. (Now each small division represents 1°C)
- On °F side, divide each division into 18 equal parts. (Now each small division represents 1°F)
- Mark other numbers and complete drawing the scale.

Fig 4



COMPARATIVE SCALE

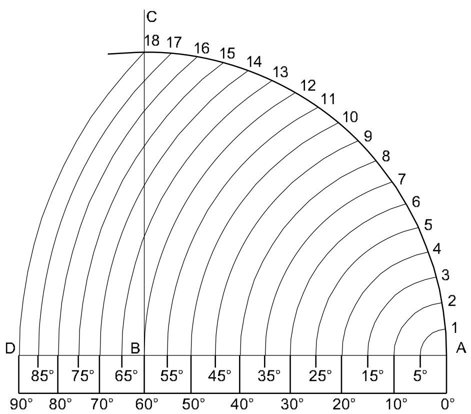
Exercise 5: Construct a scale of chord and draw an angle 35° (Fig 5 & 6)

- Draw a quadrant ABC and extend the line AB.
- 'A' as centre AC as radius, draw the arc CD. (Now AD represents the chord of arc CD)
- Divide the arc AC into 18 equal parts, so that each division will represent 5°.
- 'A' as centre, draw arcs with radii A_1', A_2'....A_{18}' to intersect line DA and mark them 5°, 10°.....90° as shown in Fig 5.

To draw the angle of 35°

- Draw a line PQ equal to AB.

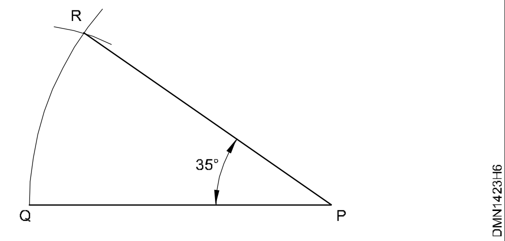
Fig 5



SCALE OF CHORDS

© NIMI NOT TO BE REPUBLISHED

Fig 6



- 'P' as centre PQ as radius, draw arc.
- Set the compass to A-35° and 'Q' as centre, draw an arc to intersect the previous arc at R.
- Join PR by a straight line and now angle RPQ = 35°

6 Construct a diagonal scale of RF = $\frac{1}{25}$, showing metre, decimeter and centimeter to measure upto 4 m. Mark a length of 2.69 m, 1.09 m and 0.08 m..

7 Construct direct vernier scale to read centimeters and to measure upto 4 metres having an RF = $\frac{1}{25}$. Mark distances 0.21 m; 2.74 m & 3.72 m.

8 Construct retrograde vernier scale to read centimeters and to measure upto 4 metres having an RF = $\frac{1}{25}$. Mark distances 0.21 m, 2.74 m & 3.89 m.

Exercise 6: Construct a diagonal scale for 4m length and show the lengths 2.69m, 1.09m and 0.08m. (RF=1/25) (Fig.7)

- Length of scale required = RF x length to be measured

$$= \frac{1}{25} \text{ x 4 m x 100 = 16 cm.}$$

- Draw a rectangle ABCD of 16 cm x 4 cm.
- Divide the rectangle ABCD into 4 equal parts and mark them EF, GH & IJ and each division represents one metre.
- Divide the line AB into ten equal parts and mark them $1_1, 2_1, 3_1 .....10_1$.
- Draw vertical lines from points 1, 2...... etc.
- Divide the BF into 10 equal parts and mark them as 1'2'3' etc and each division representing 10 cm (1 dm).
- Draw diagonals on all ten small rectangles in the 1st (lower) block ABFE and complete the diagonal scale.
- Metres are read on EF or line parallel to it i.e GH, IJ & DC. Decimetres are read on the division of line AE and centrimetres are read on points where the diagonals intersect with the vertical parallel lines drawn through the divisions of line AB.
- Mark 2.69 in using the diagonal scale. (Fig 7)

  2.00 m on metre division

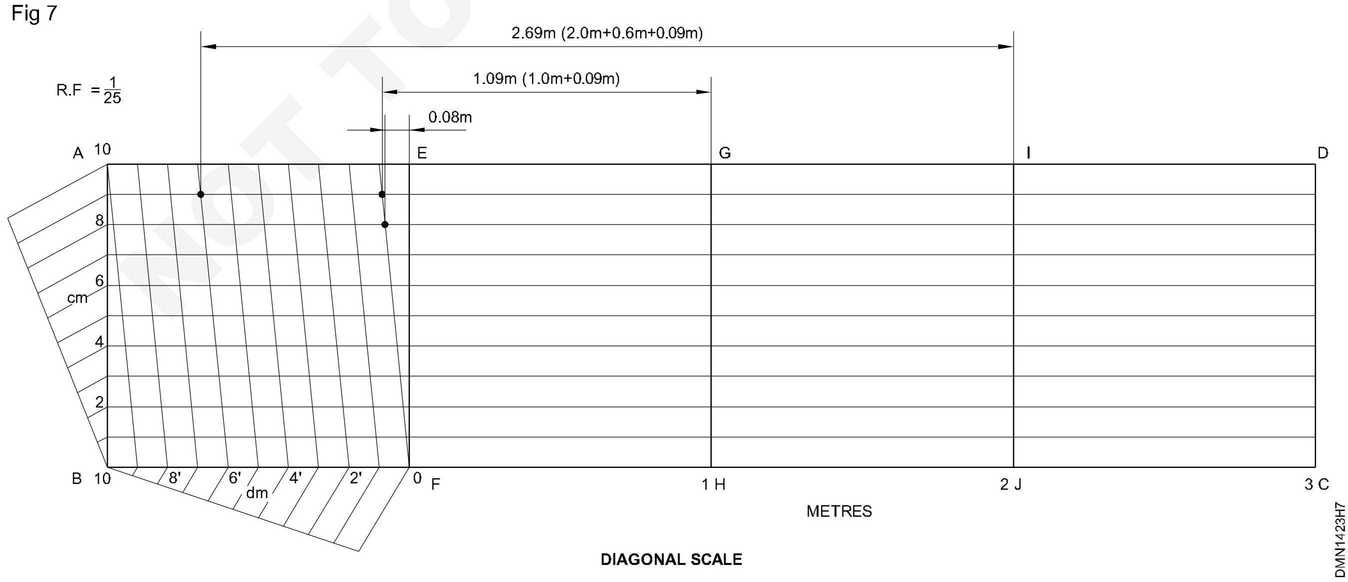
  0.60 m on decimetre division

  0.09 in the diagonal cm division

  1.09 m and 0.08 m are also marked in the figure 1 in the same way.

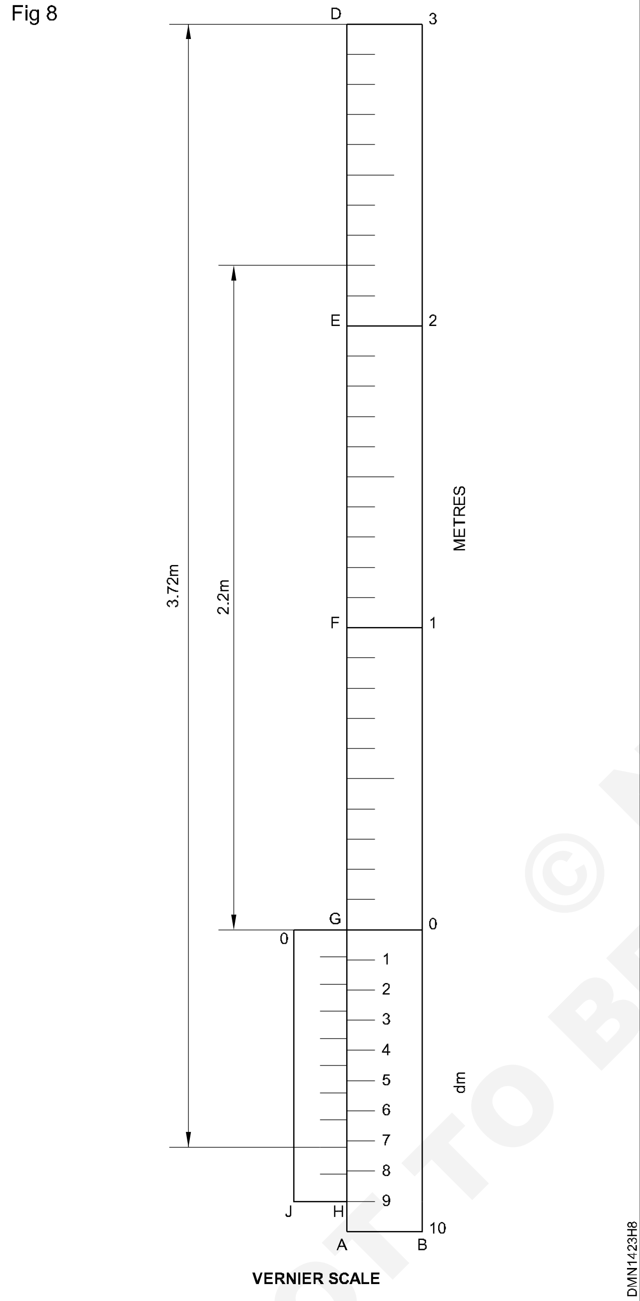
NOT TO BE REPUBLISHED © NIMI

Fig 7



Exercise 7: **(Figs 8) Construct a direct vernier scale of RF = $\frac{1}{25}$ to read centimetres for 4 m and 3.72 m, 2.74m and 0.21m**

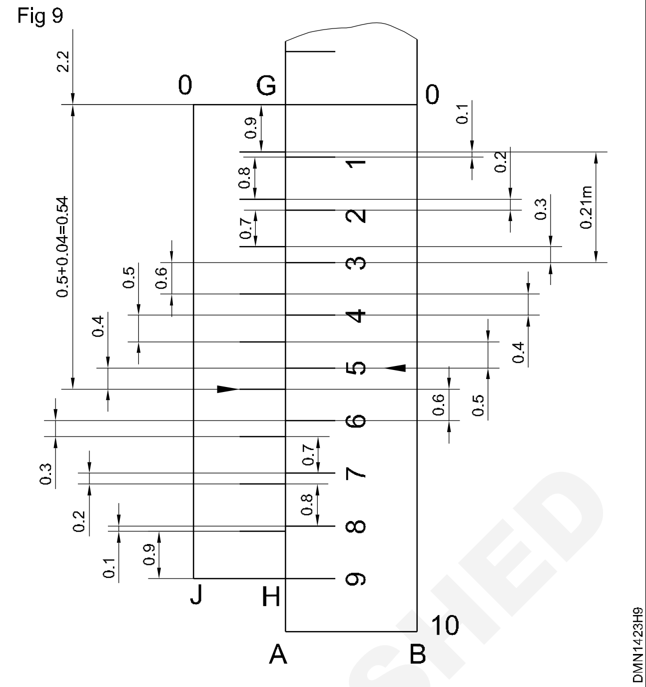
Fig 8



- Draw a rectangle ABCD (16 cm x 1 cm) representing main scale.
- Divide the main scale into 4 length of each part equal and representing 1 metre.

  Divide each line AG, GF, FE & ED into 10 equal divisions and each division is called one main scale division. (1 dm)
- Add another rectangle GO, J, H as secondary scale (vernier) to a length of 9 MSD (9 dm).
- Divide GH into 10 equal division on secondary (vernier scale) side and complete the vernier scale.

Fig 9



To show the reading 0.21 m (Fig 8 & 9)

0.21 m = 0.2 m + 0.01 m

0.2 m = Two full decimetre

0.01 m = difference between 1st MSD and 1st VSD (secondary)

Lowest main scale block and vernier side portion of Fig 8 is shown with more detail in Fig 9.

- To mark the reading 2.74 m refer the figures 8 & 9.

  Follow the marking made on G to D line in figure 8 for 2.2 m

  On the main scale OB 5 MSD marking made on G to D line in figure 3 for 0.5 m (1 MSD = 0.1 m)

  Refer VSD from left to right in Fig 3 for 0.04 m

  Required reading 2.74 m

To mark the reading 3.72 m

For reading 3.72 m follow the procedure given for earlier readings. (Fig 8 & 9)

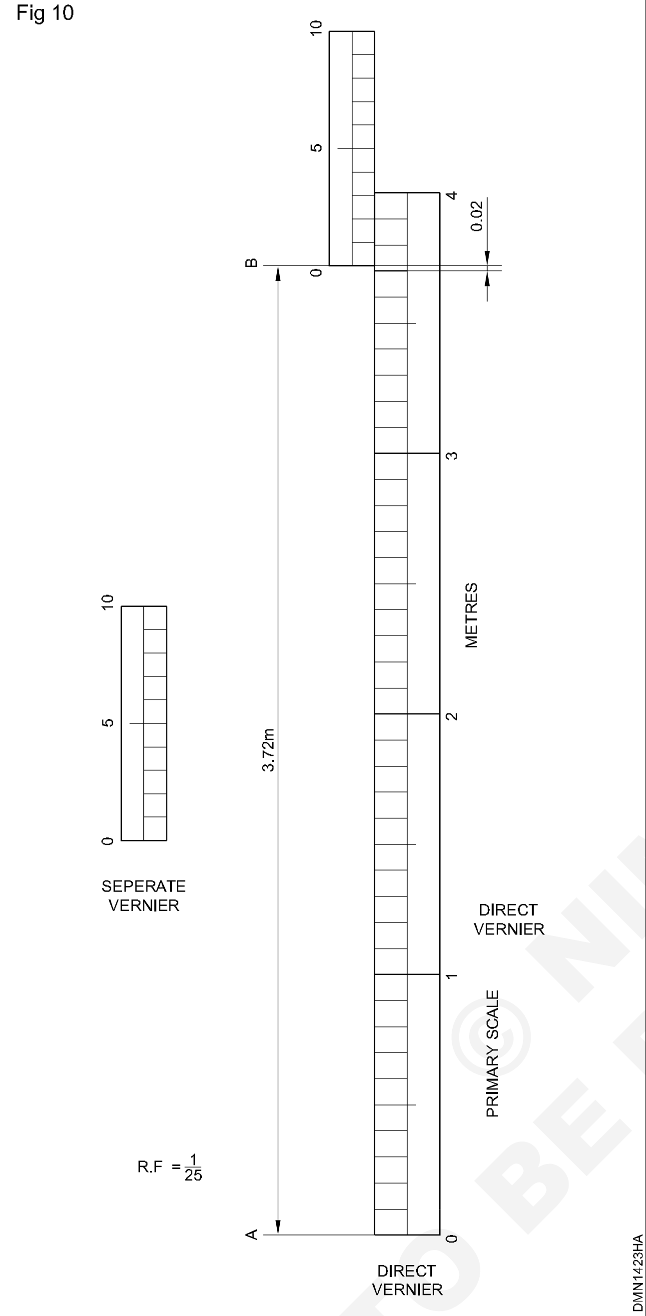
or

Follow the method and procedure given below. (Fig 10)

- Draw the main scale in the form of a rectangle (16 cm x 1 cm) with metre and decimetre divisions.
- Construct the secondary scale (vernier) separately, taking 9 main divisions and dividing it into 10 equal parts.
- To mark 3.72 m, position secondary (vernier) scale along the main scale to the right of 3.7 m and the second division of the secondary (vernier) scale coincides with 3.9 m mark.

© NIMI NOT TO BE REPUBLISHED

Fig 10



Exercise 8: Construct a retrograde vernier scale (Fig 11)

RF = $\frac{1}{25}$; Least count:1 cm; Maximum length: 4 m Length of scale: $\frac{1}{25}$ x 4 m x 100 = 16 cm

- Construct the main scale (instead 3 metres, draw to 4 metres)
- Extend the left end of the main scale temporarily by one division.
- Draw the secondary (vernier) scale of 11 MSD length as shown.
- Divide the secondary (vernier) scale into 10 equal divisions each representing 1.1 dm or 0.11 mm and complete the retrograde vernier scale.

To mark the reading, refer Figure 11.

(i) 0.21 metres = 1.1 + 0.1 = 0.21

– With reference to zero on the vernier scale, one division on the right hand side and 1 division on the left side.

– Draw extension lines and mark the reading.

(ii) 2.74 metres = 2.3 + 0.44 = 2.74

– Mark 4th division on the vernier scale represents 0.44 from `O' and mark 2.3 m on the main scale.

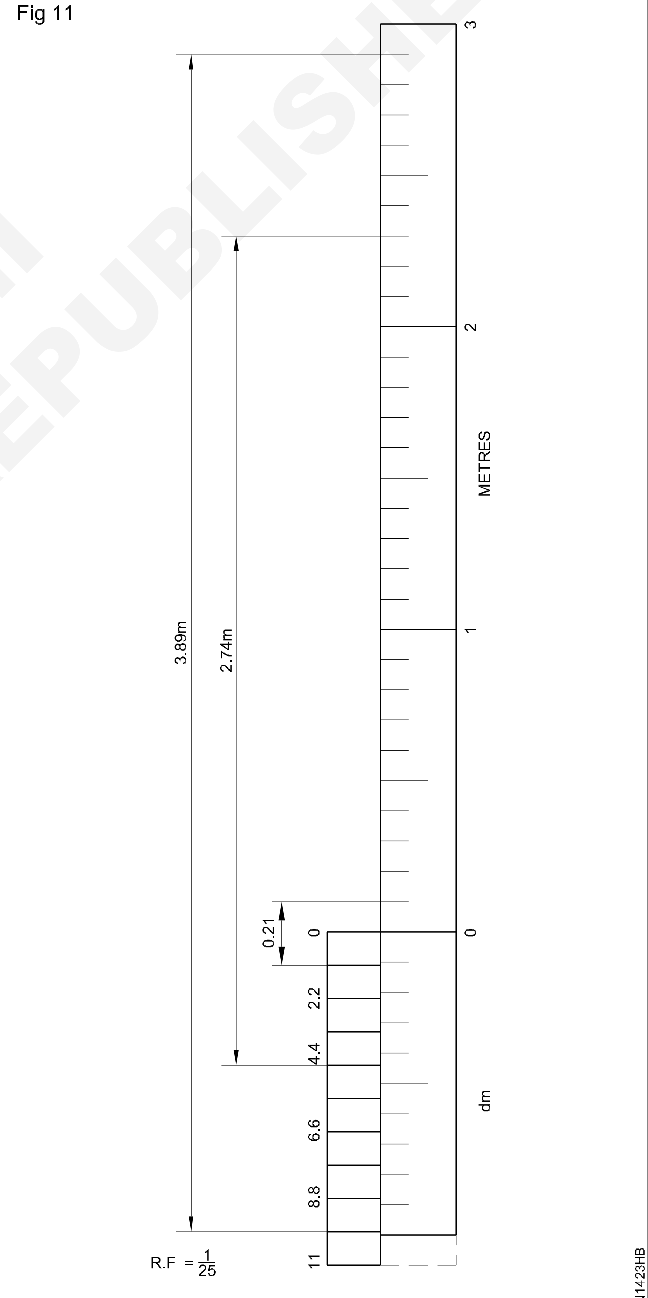
– Draw extension lines and mark the reading.

(iii) 3.89 metres = 2.9 + 0.99

– Mark the 9th division on the vernier scale represents 0.99 m from `O' and mark 2.9 m on the main scale.

– Draw extension lines and mark the reading.

Fig 11



VERNIER SCALE - RETROGRADE

© NIMI NOT TO BE REPUBLISHED

Capital Goods & Manufacturing — Exercise 1.3.22
Draughtsman Mechanical - Projection - Freehand sketching of different parts of machines

Orthographic projection of points and lines

Objectives: At the end of this exercise you shall be able to
- **draw the projection of a point for the given positions in the four quadrants**
- **draw the projection of lines in first angle and 3rd angle for the given positions.**

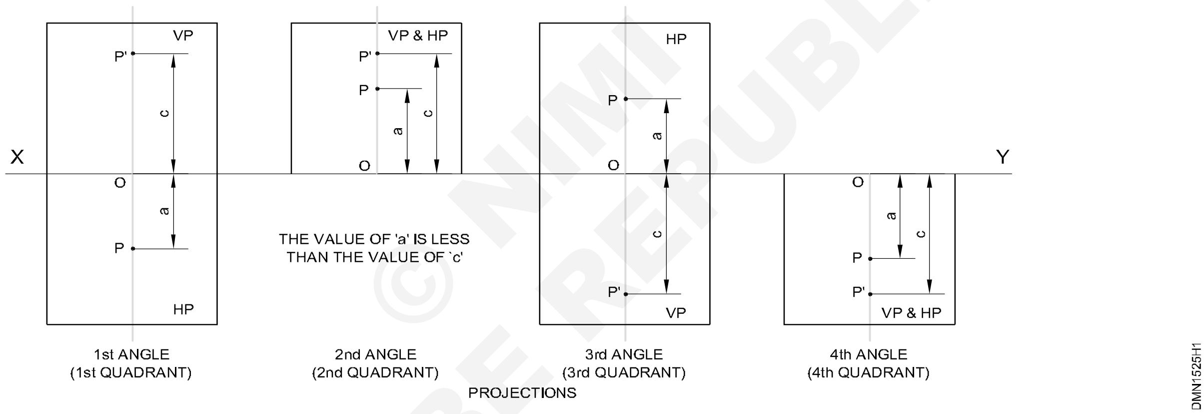
PROCEDURE

Exercise 1: (Fig.1): Draw the plan and elevation of the point 'P' given its distance 'a' and 'c' from the both the plane of projection when the point is lying in first, second, third and fourth quadrants. Refer the table 1 for the values 'a' and 'c' and draw the projections for the points in 1st, 2nd, 3rd and 4th angle.

Table 1

Points/ Distance Angle	1st	2nd	3rd	4th
a in front of VP	20	25	25	20
c above HP	40	30	30	35

Fig 1



Example 1

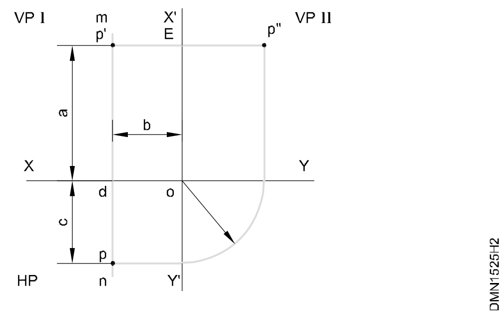
- Draw the plan and elevation of the point 'p' given its distance as a & c from both planes of projection, when the point is lying in first, second, third and fourth quadrants. Refer the table for the values a & c.

Points/ Distance	1st	2nd	3rd	4th
Distance from VPI a	30	35	40	40
Distance from VPII b	20	40	30	20
Distance above HP c	25	30	35	15

- Draw the XY line.
- Represent the HP & VP for each quadrant as shown in Fig 1.
- Draw vertical line perpendicular to intersect/ meet XY at '0'.
- Mark the points P and P' in all four quadrants such that OP = a & OP' = c.
- Now the points P & P' are the plan and elevation as required.
- Adopt the same procedure for points 2nd angle, 3rd angle and 4th angle. (Fig 1)

Draw the plan and elevation of a point given its distance as a, b and c from VP II and HP respectively, when the point is kept in first quadrant. Refer for the values of a, b and c (Fig 2)

Fig 2



© NIMI NOT TO BE REPUBLISHED

- Draw xy and x' y' intersecting each other at 'o' and mark the plane VP I, VP II and HP
- Draw a vertical lines 'xy' at a distance of b as shows in figure
- Mark the point p such that d' is equal to 'a' as shows
- The point p' shows highlighted will be the elevation
- Mark p shows that dp is equal to 'c' as section in figure. now the point p will be the plan.
- Draw a projector through p' parallel xy cutting x' y' at e
- Mark the point p'' such that EP'' is equal to c
- Now the point p'' will be the side elevation on VP II
- Adopt the procedure for the points A, B, C & D and draw the projection.

Exercise 3: Draw the projections of a line on VPI, VPII and HP given its positions as in the table below

Ex.No.	Line	Length of line	Distance from HP	Distance from VPI	Distance from VPII	Line inclined to HP	Line inclined to VPI
1	ab	40	30	40	20	Parallel	Parallel (Fig 3)
2	cd	45	Nearest end point of line 20 above HP	35	15	90° perpendicular	Parallel (Fig 4)
3	pq	55	25	Farthest end point of line 75 in front of VP	20	Parallel	90° (Fig 5) perpendicular
4	rs*	50	Nearest end point of line 15 above HP	40	60mm to the point nearest to HP	30°	Parallel (Fig 6)
5	mn	60	28	Nearest end point of line 15 from VP	33 mm to the nearest end point of the line	Parallel	55° (Fig 7)
6	kl*x	70	Nearest end point of line 20 above HP	Nearest end point of line 25 in front	35mm to the point nearest to VPII	Either 40°	or 50° (Fig 8)
7	gh***	70	-do-	Nearest end point of line 25 from VP	80 mm to the point nearest to VPII	40°	50° (Fig 9)

* Angle is measured positive in the anti-clockwise direction.

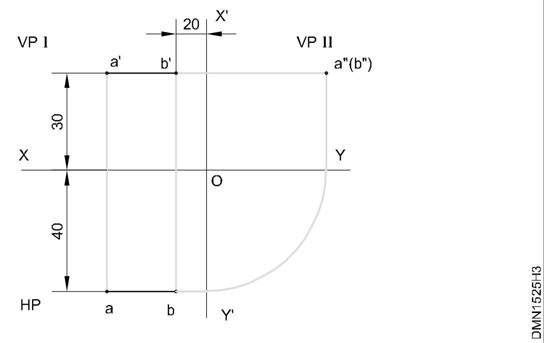
** Line KL is parallel to VPII

*** Line GH is not parallel to VPII

Ex 3-1

- Draw lines XY and X'Y'.
- Draw a line ab (plan) at a distance of 40 mm below XY and point 'b' 20 mm away from X'Y'.
- Draw a line a'b' 30 mm which will be the elevation above XY and point b' is 20 mm away from X'Y'.
- Draw the projectors from ab and a'b'. Projectors meet at a point a" (b") - the side elevation. (Fig 3)

Fig 3



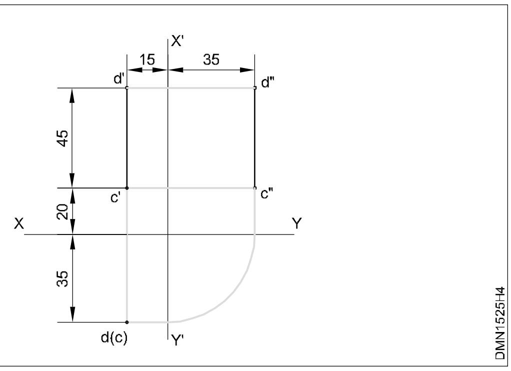
© NIMI NOT TO BE REPUBLISHED

Ex 3.2

- Draw the lines XYand X'Y'.
- Mark the point d (c) - Plan 35 mm below XY and 15 mm to the left of X'Y'.
- Project the point d (c) upwards and mark point c' 20 mm above XY line.
- Mark point d' 45 mm above point c'.
- Join points c'd' (length of the line). Now line c'd' is the elevation.
- Project c'd' to the right and draw the side elevation c"d" 35 mm away from the X'Y' line. (Fig 4)

For the previous step 35 mm may be taken from a scale or transfered from plan d (c) by construction as shown in Fig 4.

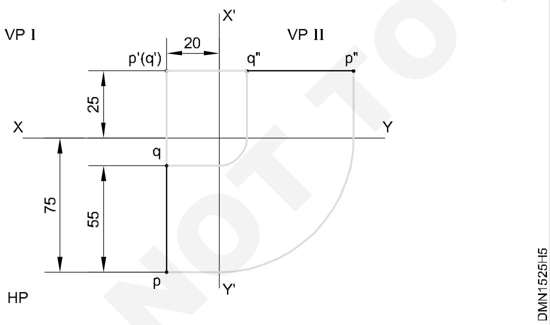
Fig 4



Ex 3.3

- Draw the lines XY and X'Y'.
- Draw pq (plan) of length 55 mm such that it is 20 mm away from X'Y' and point P is 75 mm below the XY line.
- Project pq vertically upwards and mark p' (elevation) ON it and 25 mm above the XY line.
- The side elevation p" q" is drawn by projecting p' to the right and transfering the distance pq as shown. (Fig 5)

Fig 5

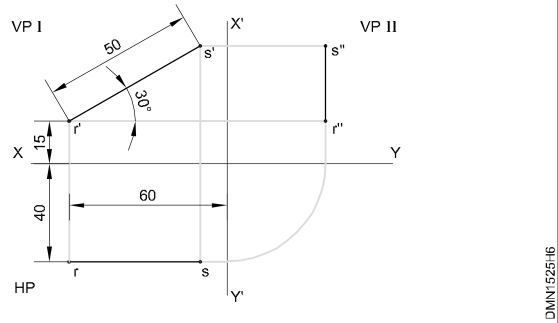


Exercise 3.4 (Fig 6)

In this problem, elevation on r's' will be of actual length (50 mm) at 30° to XY. Plan and side elevation will be shorter than actual length.

- Draw the elevation r's' at an angle 30° and of 50 mm long, with the point r' 15 mm above XY line and 60 mm to the left of X'Y'.
- Project r's' downwards and draw rs the plan at a distance 40 mm below the XY line.
- Draw the projectors from r's' and rs as shown and draw the r"s" - the side elevation. (Fig 6)

Fig 6

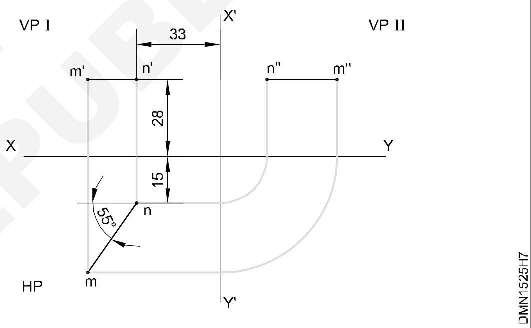


Exercise 3.5 (Fig 7)

Since the line is parallel to HP, projection on HP will be of true length and it will be at an angle of 55° to XY line.

- Draw the line mn (plan) such that it makes an angle of 55° to XY line and is of 60 mm in length. (Fig 7)
- Draw the elevation m' n' and side elevation m" n" as given in the earlier exercise.

Fig 7

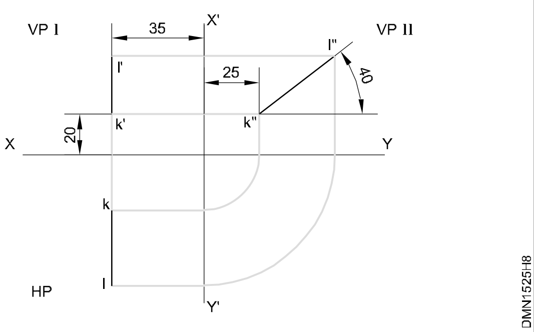


Exercise 3.6 (Fig 8)

Since the line is parallel to VPII, projection of VPII will be of true length and it will be at an angle of 40° as the inclination of the line to HP is 40°.

- Draw k"l" to length of 70 mm, inclined 40° to XY with point k" is 20 mm above XY and 25 mm away from X'Y'.
- Draw k'l' (elevation) 35 mm away from X'Y' by projecting points k" and l".
- Draw plan kl by drawing projectors from side elevation and elevation. (Fig 8)

Fig 8



© NIMI NOT TO BE REPUBLISHED

In this example projection of the line in all the three plane will be shorter in length than the actual length.

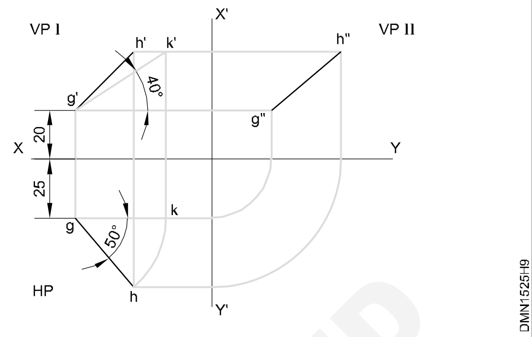
Ex 3.7

- Draw the line gk and g' k', the plan and elevation of the line if it was parallel to VP and inclined 40° to HP.
- Draw a line gh at an angle of 50° to gk and of same length as gk. Now gh will be the plan when the line makes 50° to VP.

The projected length of a line, when projected to one principle plane to which it is inclined will be of same length, no matter what angle it makes with the other principle plane.

- Get the point h' by drawing horizontal projectors through k' and vertical projector through 'h'.
- Join g' h' and this will be the required elevation on VPI.
- Get points g" h" by drawing projectors from plan and elevation.
- Join g" h", the side elevation. (Fig 9)

Fig 9



© NIMI NOT TO BE REPUBLISHED

Capital goods & Manufacturing — Exercise 1.3.23
Draughtsman Mechanical - Projection - Freehand sketching of different parts of machines

Projection of plane figures

Objectives: At the end of this exercise you shall be able to
- **draw the projection of surfaces, when they are parallel to one plane, but perpendicular to the other plane**
- **draw the projection of surfaces when they are inclined to one plane, but perpendicular to the other plane**
- **draw the projection of surfaces when they are perpendicular to both the planes**
- **draw the projection of surfaces when they are inclined to both the planes.**

Exercise 1: Draw the projections (elevation, plan and side view) of the plane figures shown below having their position defined as under:

– Surface parallel to VP

– Surface perpendicular to HP

– One of its edges parallel to HP

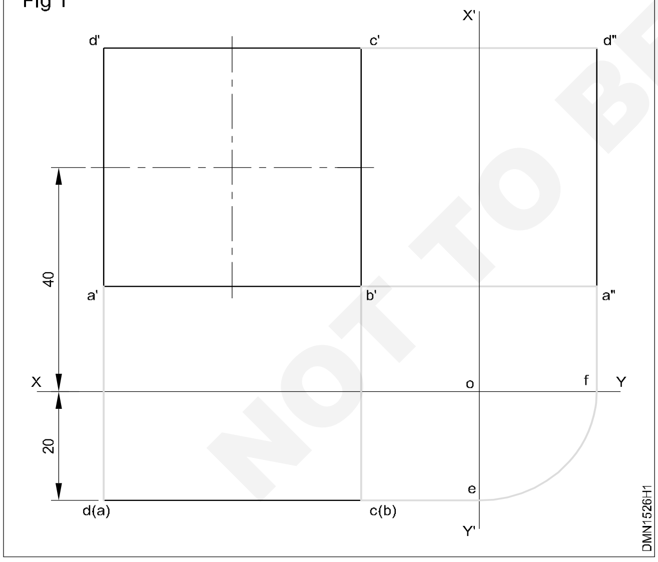
– Centre point 40 mm above HP and 20 mm in front of VP.

Square of 60 mm side (Fig 1)

Draw the projections (elevation, plan and side view) of the square having its position.

- Draw the xy line.
- Draw the square with its centre 40 mm above the xy line and one edge parallel to xy line.
- Mark the corners of the figure a', b', c' & d'. This will be the elevation of the square.

Fig 1



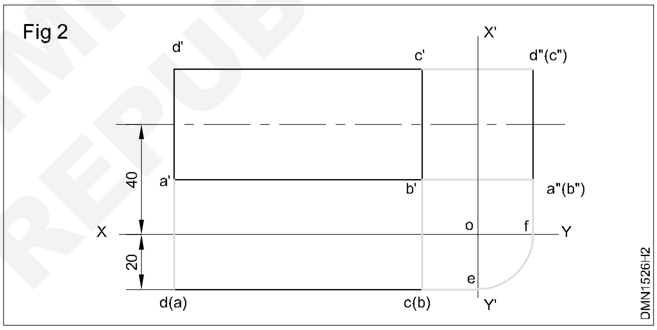
- Draw the vertical projectors from a'b' downward beyond the xy line.
- Draw a horizontal line dc at a distance of 20 mm below the xy line. Line dc will be the plan.
- Draw a X'Y' line at a convenient distance from b'c', intersecting the xy line at `0'.
- Project the plan to the X,Y, line meeting at e.
- By arc method transfer Oe to xy and mark the point `f'.
- Project `f' upwards.
- Project b' and c' to meet the the projected line from `f' at a" and d" respectively. Now the line a"d" is the side view.

Rectangle of 40 mm x 80 mm (Fig 2)

Draw the projections (elevation, plan and side view of a rectangle having the position.

- Follow the construction shown in Fig 2 and draw the views.

Fig 2

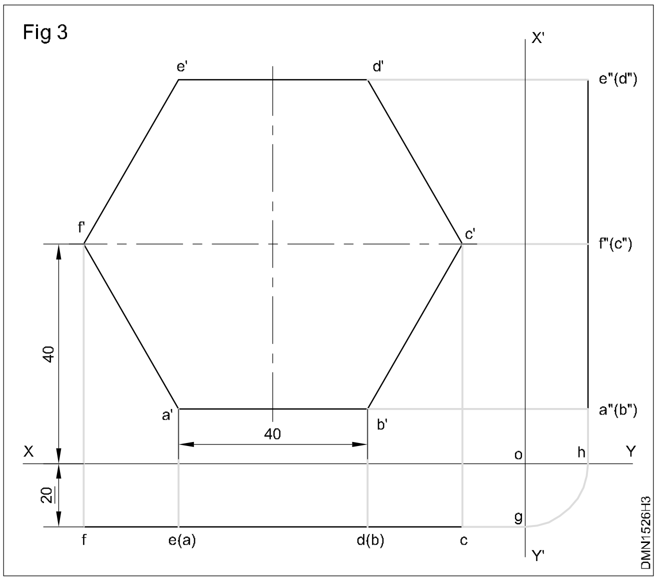


Hexagon of side 40 mm (Fig 3)

Draw the projection (elevation, plan and side view) of the hexagon having the position.

- Follow the construction and draw the views.

Fig 3



© NIMI NOT TO BE REPUBLISHED

Circle of diameter 60 mm (Fig 4)

Draw the projections (elevation, plan and side view) of circle having the position.

- Follow the construction shown in Fig 4 and draw the views.

Exercise 2: Draw the projection (elevation, plan and side view) of the plane figures shown below having their position defined as under:

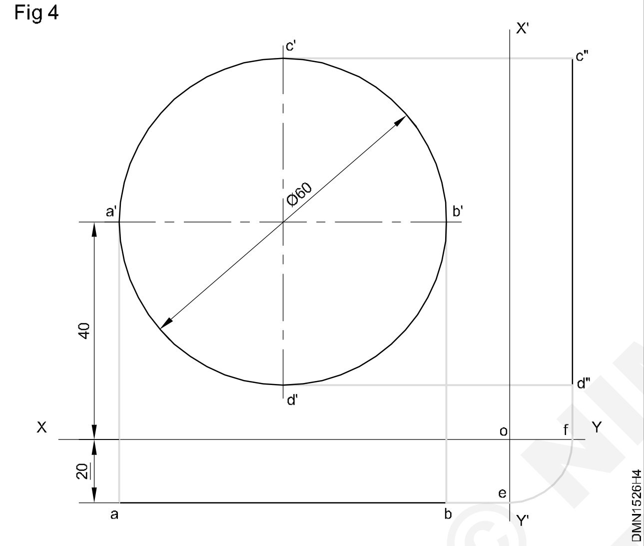
– Surface parallel to HP

– Surface perpendicular to VP

– One of its edges parallel to VP

– Centre point 20 mm above HP and 40 mm in front of VP.

Fig 4

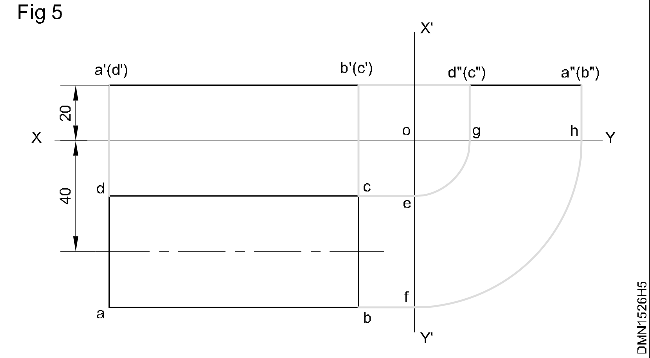


Rectangle 40 mm x 80 mm) (Fig 5)

Draw the projection (elevation, plan and side view) of the rectangle having the position defined.

- Longer side parallel to xy.
- Draw the xy line.
- Draw the rectangle with its centre 40 mm below xy line and its longer side parallel to xy. Mark the corners as a,b,c & d and join them.
- Figure a,b,c,d will be the plan.
- Draw the vertical projectors from d and c upwards beyond xy line.
- Draw a horizontal line a'b' at a distance of 20 mm above xy line.
- Now the line a'b' will be the elevation.
- Draw a vertical line x'y' line at a convenient distance from b'.
- Project c and b, meeting x'y' line at ef.
- By arc method transfer the point e & f to xy line and mark g & h respectively.
- Project the points g & h upward beyond xy line.

Fig 5



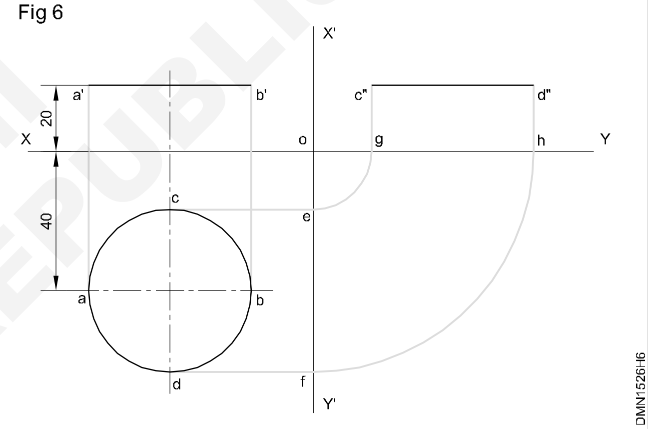
- Project a horizontal projectors from the point b' intersecting the vertical projectors, projected from g & h at d" & a" respectively.
- Now the line d"a" is the side view.

Circle of diameter 60 mm (Fig 6)

Draw the projection (elevation, plan and side view) of the circle having its position defined as under: (Fig 6)

- Follow the construction and draw the views.

Fig 6

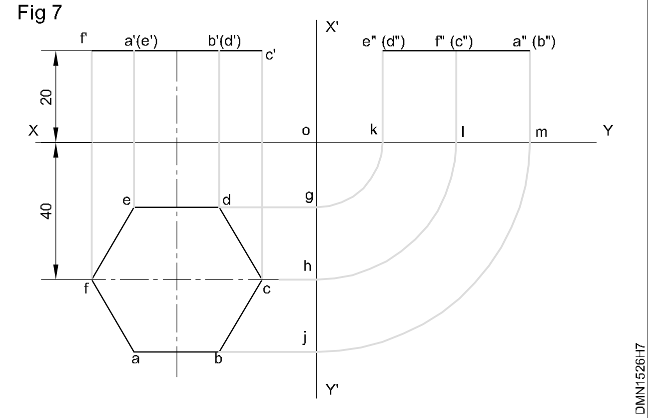


Hexagon of side 30 mm (Fig 7)

Draw the projection (elevation, plan and side view) of the hexagon having the position.

- Follow the construction and draw the views.

Fig 7



Ellipse of major dia 50 mm and minor dia 30 mm

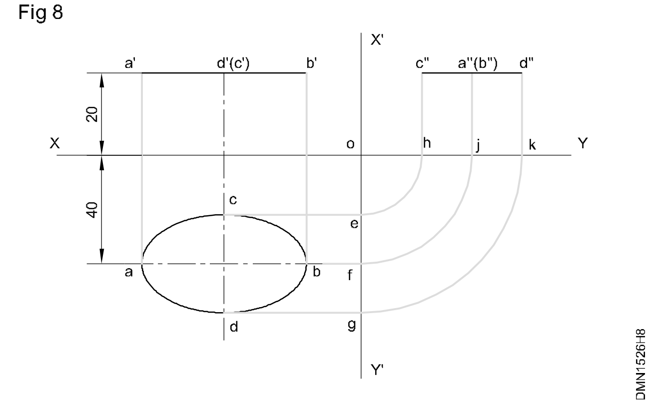
Draw the projection (elevation, plan and side view) of the ellipse having its position.

© NIMI NOT TO BE REPUBLISHED

Procedure is similar to the previous exercises.

- Follow the construction shown in Fig 8 and draw the views.

Fig 8



Exercise 3: Draw the projection (elevation, plan and side view) of the plane figures given below having their position defined as under:

– Surface inclined to HP at an given angle

– Surface perpendicular to VP

– One of the edges perpendicular to VP.
Axis/Major axis perpendicular to VP

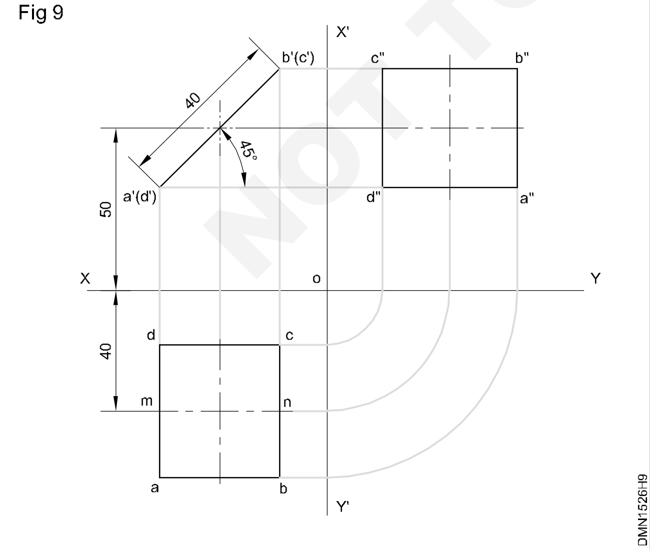
– Centre point is 50 mm above HP and 40 mm in front of VP.

Square of 40 mm side (Fig 9)

Draw the projection (elevation, plan and side view) of the square having its position.

- Draw xy, X',Y' axis.
- Draw a'b' equal to the side of the square (40) at 45° and its centre point 50 mm above xy.
- Now a'b' is the elevation.
- Project a'b' downwards beyond xy line.
- Draw centre line mn at a distance of 40 mm below xy.

Fig 9



- Mark points a,b,c & d at a distance of 20 mm above and below and project a'b' down and complete the rectangle a,b,c,d and this will be the plan.
- Draw the projectors from elevation and plan.

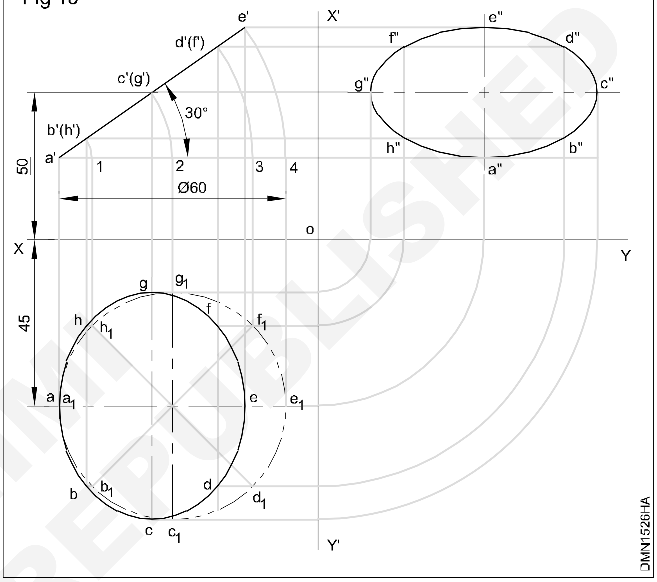
In this exercise we have started with the elevation as the true length of the side will be available in the elevation.

The plan and side view are rectangles one side is equal to 40 mm and another side is fore-shortened and complete the side view d",a", b" & c" as shown in Fig 9.

Circle of diameter 60 mm (Fig 10)

Draw the projection (elevation, plan and side view) of the circle having its position defined as under

Fig 10



- Draw xy, X','Y', axis.
- Draw a line a'e' equal to the diameter of the circle 60 mm at 30° and its centre point 50 mm above xy. Now a'e' is the front elevation.
- Project a' down to distance of 45 mm below xy line and draw a line ae^1 parallel to xy 60 mm long.
- Consider ae' as the diameter and draw a circle.
- Divide the circumference of the circle into 8 equal parts and mark them as a_1,b_1,c_1,d_1,e_1,f_1,g_1 and h_1.
- Draw a horizontal line from the point a' on the front elevation. ie parallel to xy line.
- Project the points $e_1 d_1 (f_1) c_1 (g_1) b_1 (h_1) a_1$ to the horizontal line drawn from a' in the elevation and mark the points 1,2,3 & 4.

  With a' as centre and the marked points 1,2,3 & 4 as radii draw arcs to cut the line a' at b'(h') c'(g') a'(f') & e'.
- Project e' of elevation down and e1 horizontal. Mark the junction as e.
- Similarly project the other three points of elevation and the points of the circle. Mark the points b,c,d,f,g and h.
- Join a,b,c,d,e,f,g,h with a smooth ellipse. Now this is the plan.

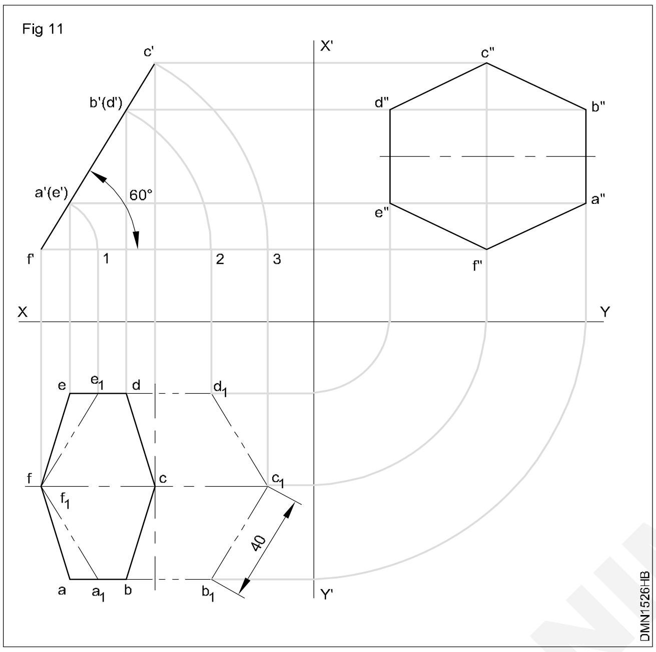
© NIMI NOT TO BE REPUBLISHED

- Project the points of the plan and the elevation and mark points a",b",c",d",e",f",g",h".
- Complete the side view by joining the points with an ellipse.

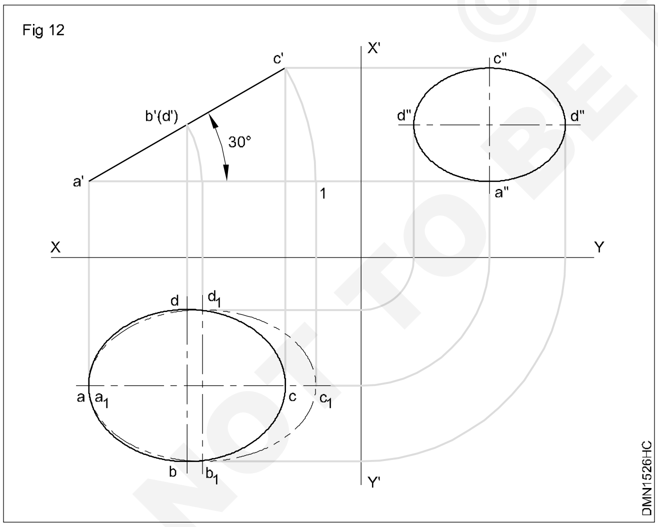
Hexagon of side 40 mm (Fig 11)

Draw the projection (elevation, plan and side view) of the hexagon having its position.

Follow the procedure of the hexagon. Inclination of the hexagon as done as previous exercise to HP is 60°.



Ellipse of major dia 50 mm and minor dia 30 mm (Fig.12)



Ex 4.4

Draw the projection (elevation, plan and side view) of the plane figures given below having their position defined as under

– Inclined to HP at an given angle

– Surface perpendicular to VP

– One of the edges perpendicular to VP.

Axis/Major axis perpendicular to VP

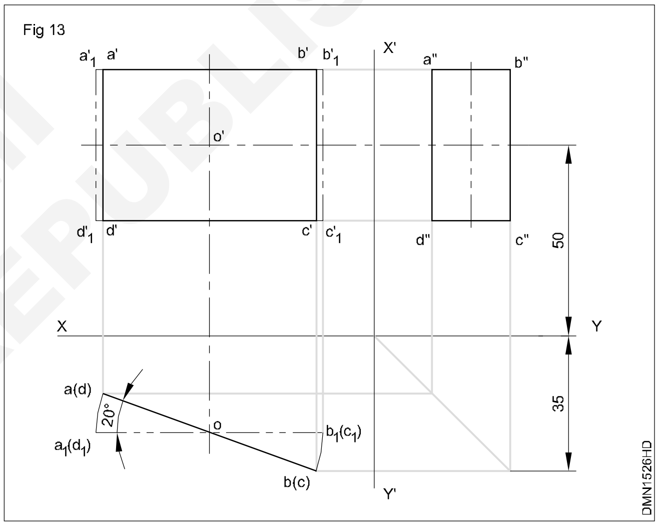
– Centre point is 50 mm above HP and 40 mm in front of VP.

Rectangle of 60 mm x 40 mm) (Fig 13)

Draw the projection (plan, elevation and side view) of a rectangle given its position.

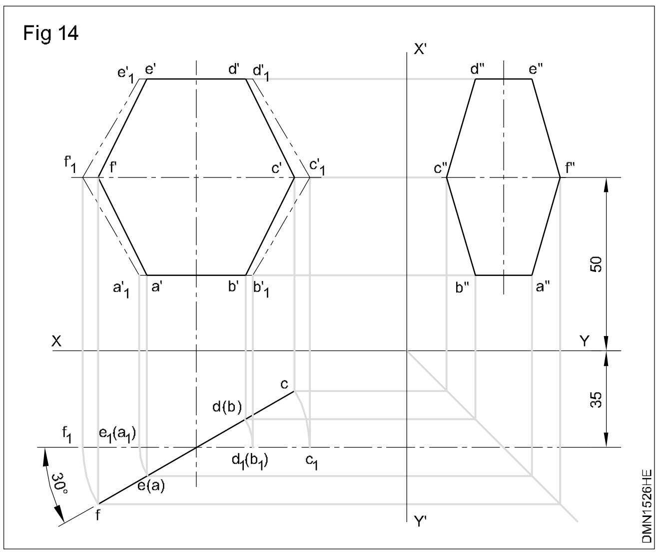
Surface perpendicular to HP, standing on its longer edge and also rotated about the vertical centre line to an angle. (say 20°)

- Since the surface is perpendicular to HP and inclined to VP the true length of the rectangle will be shown in the plan.
- Draw xy and X,'Y,' lines.
- Draw the plan and elevation as if the rectangle is parallel to VP and perpendicular to HP.
- Mark the centre point `0' and draw the plan ab in the rotated position. (i.e. 20°)
- Project the point a & b and complete the elevation a'b'c'd'.
- Complete the side view a"b"c"d" by drawing the projectors from plan and elevation.



Hexagon of side 30 mm (Fig 14)

Draw the plan, elevation and side view of an hexagon given its position.



© NIMI NOT TO BE REPUBLISHED

Surface standing on one edge and perpendicular to HP and rotated through 30° about the vertical centre line.

- Same as the previous exercise except the surface is an hexagon.

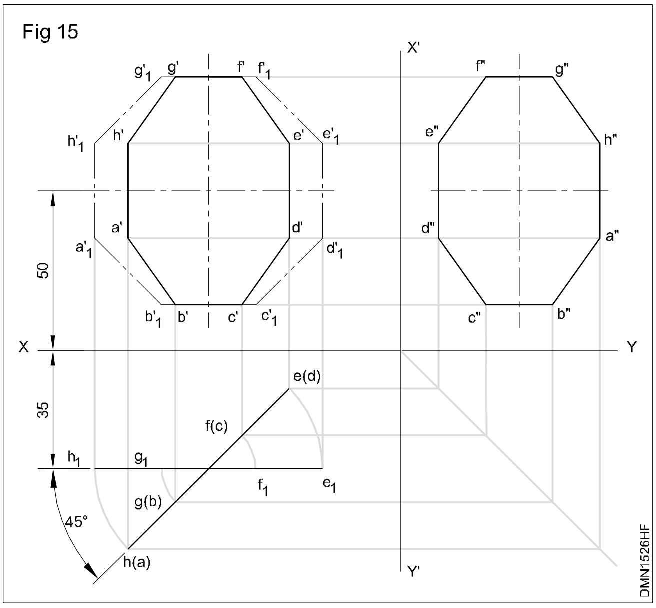


Fig 15

Octagon of side 30 mm (Fig 15)

Draw the plan, elevation and side views of an octagon given its position under.

Surface standing on one edge and perpendicular to HP and rotated through 45° about the vertical centre line.

Exercise is same as the previous exercise.

Annulus of OD 40 mm x ID 20 mm (Fig 16)

Draw the projection (plan, elevation, side view) of an annulus (surface standing on one edge and perpendicular to HP and rotated through 60° about the vertical centre line) as given its portion.

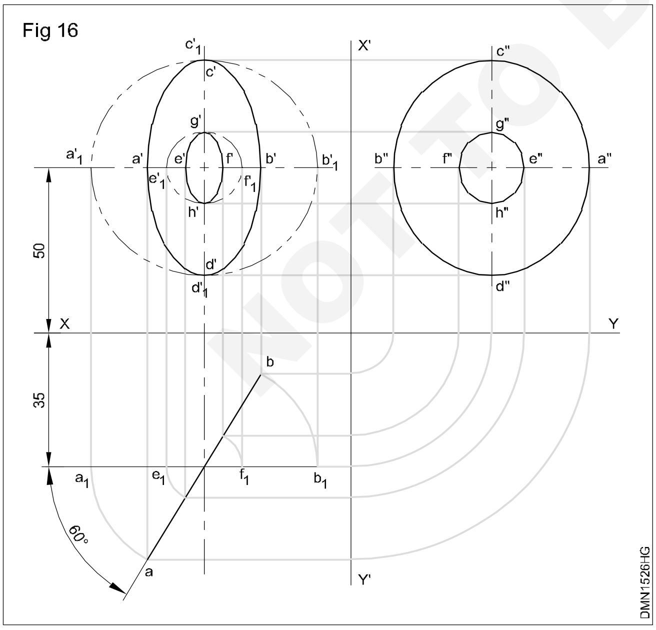


Fig 16

- This exercise is same as the previous exercises except that the surface is circular.
- Follow the procedure as in Fig 16 and complete the views.

Exercise 5: Draw the projection (elevation, plan and side view) of the plane figures given below having their position as defined as under:

– Surface perpendicular to HP

– Surface perpendicular to VP

– One of its edge/axis 40° to the HP

– Centre point 45 mm above HP and 40 mm in front of VP.

Square of side 40 mm (Fig 17)

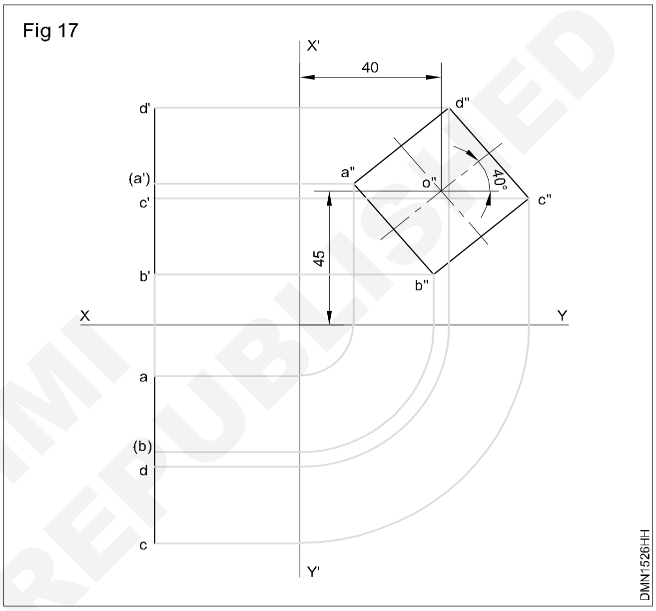


Fig 17

Draw the plan, elevation and side view of a square given its position.

- Surface is perpendicular to both HP and VP.
- One of its edges is 40° to HP. Centre point is 45 mm above Hp 40 mm in front of VP.
- According to the conditions listed above, true shape of the square can be seen only in side view. Draw the side view first.
- Draw xy line and draw parallel line 45 mm above xy.
- Mark point 0" the centre point of the square.
- Draw a line 40° with xy passing through the point 0".
- Mark of 20 mm both sides of point 0" and draw perpendiculars to 40° line from the points marked.
- Draw two lines parallel to 40° line at distances of 20 mm both sides.
- These lines cut the earlier lines at points a",b",c",d".
- a"b"c"d" is the side view.
- Draw X,'Y,' line 40 mm from the centre point of the square.

NOT TO BE REPUBLISHED © NIMI

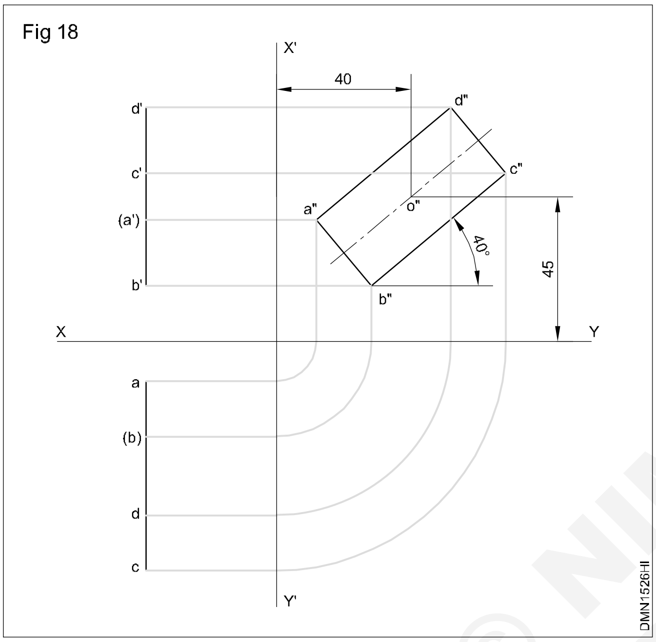
- Project the side view and draw plan and front view.

Rectangle of 60 mm x 20 mm (Fig 18)

Draw the plan, elevation and side view of a rectangle as given its position.

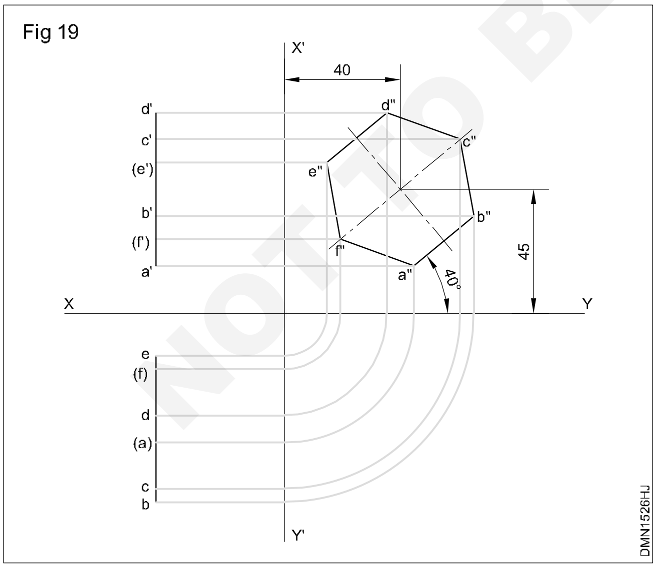
- One of its edges tilted 40° to HP.
- Surface is perpendicular to both HP and VP
- Centre point is 45 mm above HP and 40 mm in front of VP.

Follow the procedure of previous exercise and complete the views.



Hexagon of side 45 mm (Fig 19)

Draw the plan, elevation and side view of a regular hexagon as given its position.

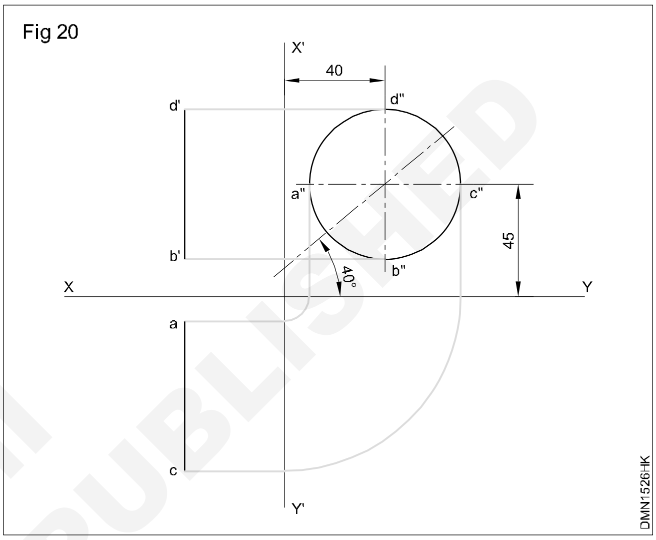


- One of its edges inclined at an angle of 40° to HP.
- Surface is perpendicular to both HP and VP. Centre point is 45 mm above HP and 40 mm in front of VP.
- Construct the hexagon with its edge a"b" at angle of 40° with HP.
- Hexagon a"b"c"d"e"f" is the side view.
- Project side view follow the procedure of previous exercise and complete the views.

Circle of diameter 60 mm (Fig 20)

Draw the plan, elevation and side view of circle as given its position.

- Draw the circle of diameter 60 with the axis inclined 40° with HP.
- Circle drawn will be the side view.
- Project the side view to complete the other views.



Exercise 6: Draw the projection (elevation, plan and side view) of the plane figures given below having their position defined as under:

– Surface inclined to HP

– Surface inclined to VP

– One of its diagonal/axis is parallel to HP

– One of its diagonal/axis is parallel to HP

– One of its edge is on HP.

Square of side 60 mm (Fig 21)

Draw the plan, elevation and side view of a square given its position as below

- Corner \`a' is on HP diagonal. ac makes 30° to HP and the diagonal bd makes 45° to VP, but parallel to HP.

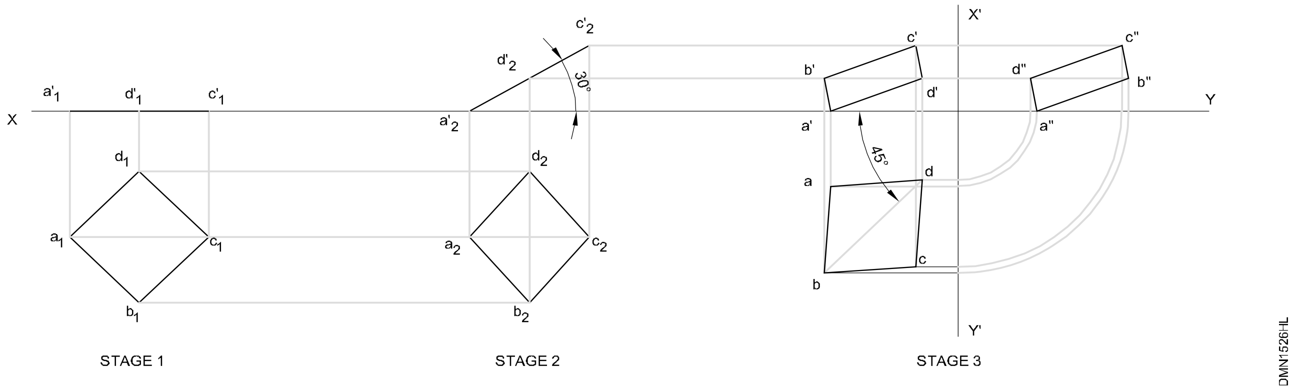
This is a case when the surface is inclined to both VP and HP. As the diagonal BD is parallel to HP its projection on HP will have its true length.

The procedure has three stages.

- In the first stage, draw a plan a_1, b_1, c_1, d_1 assuming the diagonal ac is parallel to HP and the diagonal bd is perpendicular to VP. Plan is a true square.
- In the second stage, assume corner a_2 (A) of the square is on HP and the diagonal ac makes 30° to HP and diagonal b_2d_2 is parallel to HP.
- Draw the line $a'_2b'_2c'_2$ the elevation of the second stage.

© NIMI NOT TO BE REPUBLISHED

Fig 21



- Draw the plan a_2, b_2, c_2 d_2 by projecting from the first stage plan and the second stage elevation. The diagonal b_2d_2 will be of true length and the diagonal a_2c_2 will be fore-shortened. In the third stage the diagonal b_2d_2 is to be tilted to an angle of 45° to VP and parallel HP.
- Even though the diagonal bd makes 45° to VP, the plan will be same as that of the plan of second stage, but rotated through 45°.
- Draw the plan abcd as shown in Fig $a_2b_2c_2d_2$ making bd at 45° to xy line.
- Draw an elevation a'b'c'd' by projecting second stage elevation (a_2'b_2'c_2') and the plan abcd.
- Finally draw the side view a"b"c"d" by projecting from final plan and elevation.

Rectangle 25 mm x 60 mm (Fig 22)

Draw the plan, elevation and side view of a rectangle given its positions.

The diagonal AC inclined at 30° to HP and the diagonal BD inclined at 45° to VP.

Stage 1: One surface parallel to HP and pair of sides inclined to VP. Draw a plan.

Stage 2: Rectangle standing on its corner A and inclined to HP. Draw the plan and elevation.

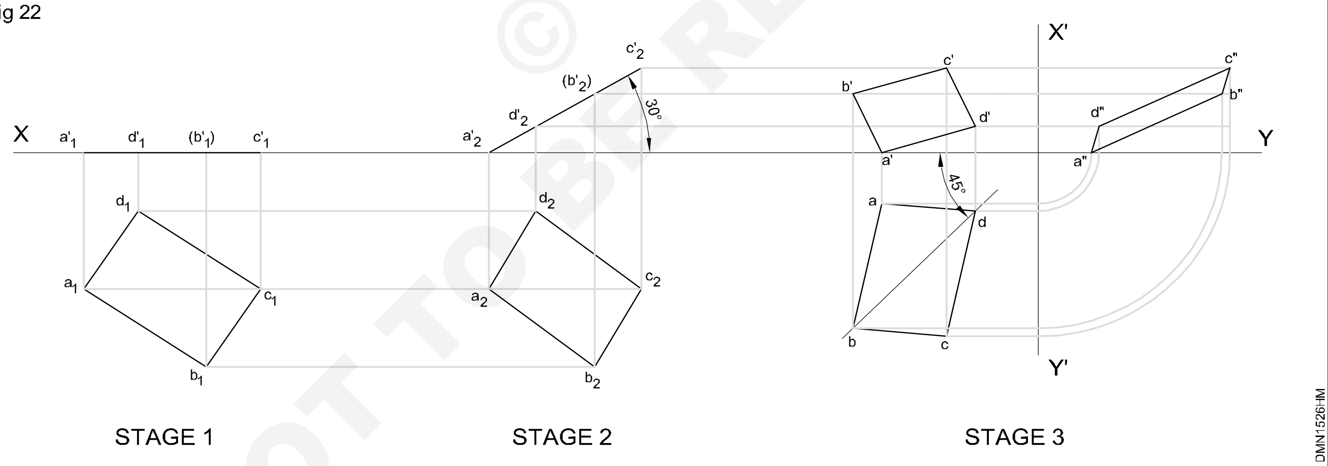
Stage 3: Stage diagonal bd is turned to 45° with VP. Same plan at the stage 2 turned and placed as the plan of the final stage.

Project the plan of the final stage and the stage 2 elevation and draw the final front view.

Project final plan and elevation and draw the final side view.

Hexagon of side 45 mm (Fig 23)

Fig 22



Draw the plan, elevation and side view a regular hexagon as given its position.

One of its sides is in the HP and inclined 50° to VP with the surface making an angle of 40° with the HP.

This example is similar to the case of surface inclined to all the three planes viz HP, VP and AVP and hence all three views will be the fore-shortened hexagon.

Procedure for this exercise is similar to the procedure in the previous exercise and the construction is shown in Fig.

- The construction has three stages.

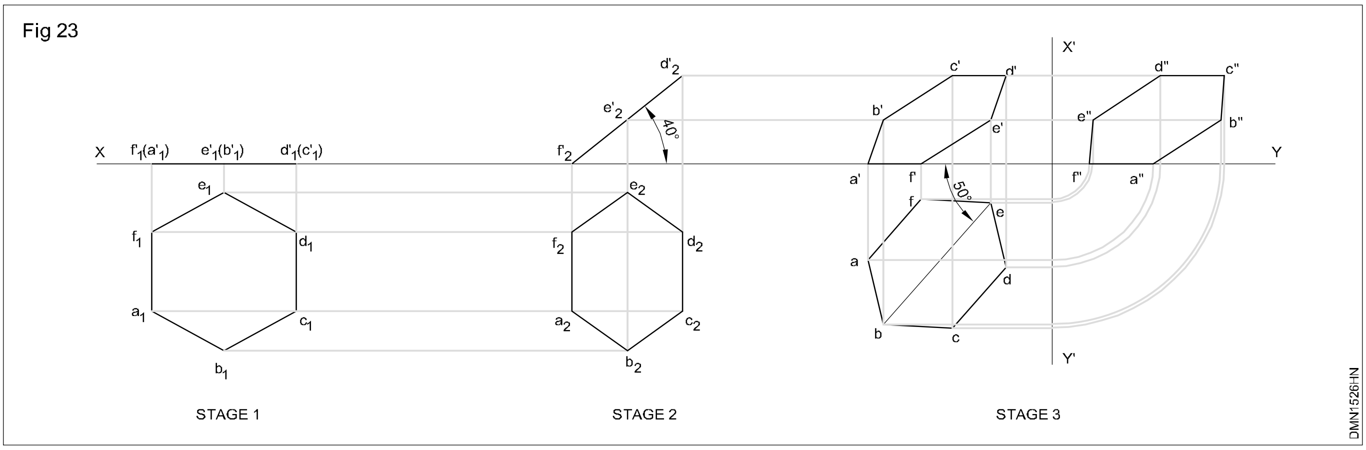
Stage 1: In this stage one draw the plan and elevation as if the hexagon parallel to HP and one edge is perpendicular to VP.

Stage 2: In this second stage draw the plan and elevation as if the surface makes 40° with HP.

Stage 3: To draw this plan in the second stage projectors are drawn from the plan of the first stage.

- In the third and final stage the surface is rotated so that one of its sides makes an angle of 50° to VP.
- To draw the final views of plan and elevation, first reproduce the plan of the second stage but with one side is inclined to an angle of 50° to xy.

© NIMI NOT TO BE REPUBLISHED



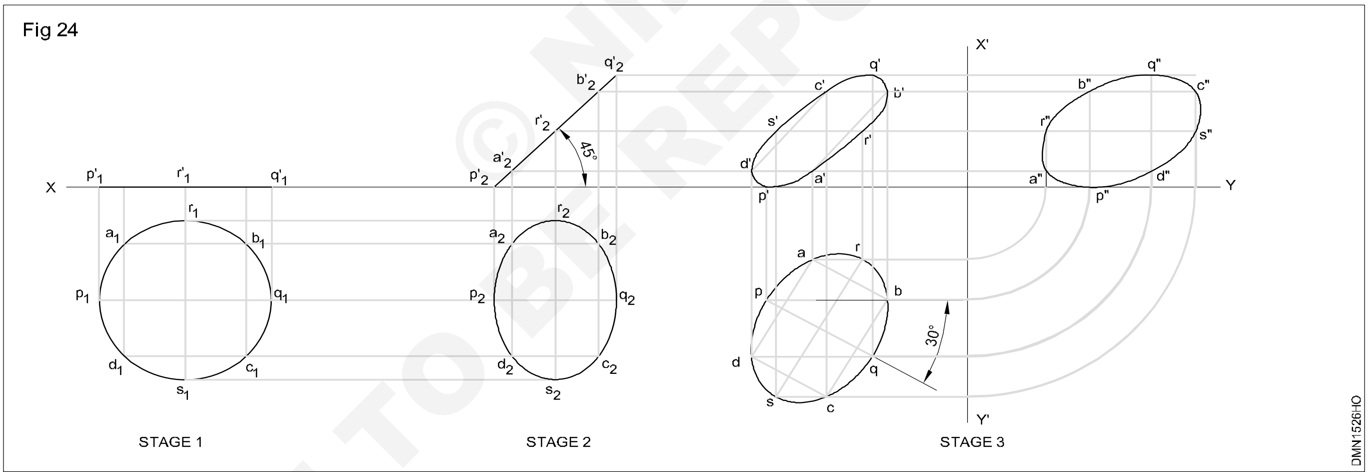
- Horizontal projectors are drawn from a'b'c' and vertical projectors from the plan abcdef to complete the elevation a'b'c'd'e'f' as shown.
- Complete the side view by drawing projectors from plan and elevation as shown. Trainees are advised to use cardboard to cut figures to help visualization.

Circle of diameter 60 mm (Fig 24)

Draw the plan, elevation and side view of (Lamina) a circle, when a point on the circumference is resting on HP and the surface is making 45° to the HP and the top view of the diameter PQ is at an angle of 30° with VP.

From the position described above it is clear that the circle is inclined to VP, HP and AVP. Therefore the plan, elevation, side view will be fore-shortened circles or rather elliptical.

- The solution to this exercise is done in 3 stages.
- Draw the plan and elevation when the circle is lying on HP with the diameter PQ parallel to VP.
- Second stage using views in first stage, draw plan and elevation when the surface makes 45° to HP and the diameter PQ is still parallel to VP.
- Final and third stage using the second stage, draw plan, elevation and side view when the diameter PQ makes 30° to VP.



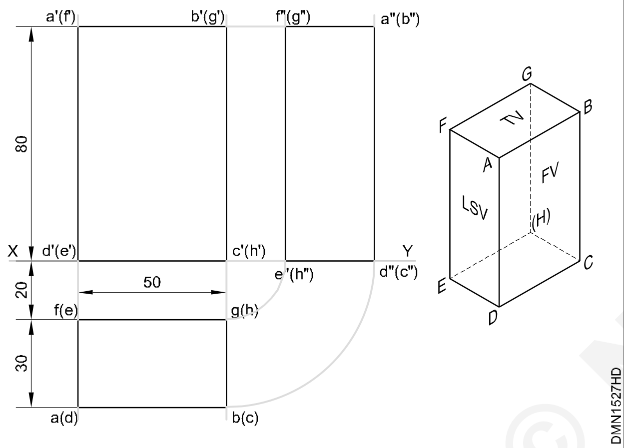
© NIMI NOT TO BE REPUBLISHED

Orthographic projection of solids Orthographic views of Prism, Cylinder, Pyramids, Cone, Frustum of cone

Objectives: At the end of this exercise you shall be able to
- **draw orthographic views of prism and cylinder in the given positions**
- **draw the orthographic views of cone and pyramids in the given positions**
- **draw the projections of frustum of cone and pyramids in the given positions**
- **draw the projection of spheres in the given position.**

Exercise 1: Draw the plan, elevation and side view of a rectangular prism of size base 50x30 and height 80mm given its position as below. (Fig 1)

Fig 1



- The base 50 x 30 is resting on HP.
- The vertical face 80 x 50 nearest to VP is 20 mm in front of it.

> **In this problem the face of prism are parallel to the planes of projection. Therefore the plan, elevation and side view will be rectangles.**

- The prism is shown pictorially in the figure and its eight corners are marked as abcd-efgh.
- Draw the plan (50 x 30) 20 mm below XY line.
- Project from plan and draw elevation (80 x 50)
- Draw the side view by drawing projection from elevation and plan. (Fig 1)

Exercise 2: Draw the plan, elevation and side view of an hexagonal prism whose side is 25 mm and length 60 mm given its position as below: (Fig 2)

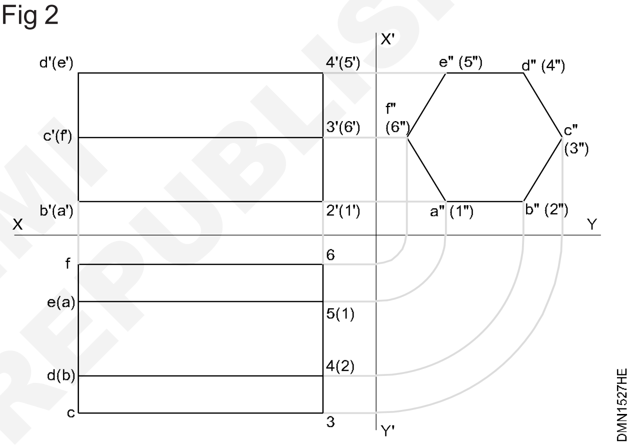
– One of its lateral surfaces lying on HP

– The axis is parallel to vertical plane.

From the position described above, it is clear that the hexagonal face of the prism is parallel to AVP. Therefore the end view is a true hexagon and hence this view should be drawn first.

- Draw the end view (Hexagonal of side 25mm) with one side OM HP (Fig 2)
- Draw horizontal projectors from side view and complete the elevation. (In the elevation two lateral faces are visible, but they are fore-shortened)

Fig 2



- Draw projectors from elevation and side view and complete the plan.

  (Three lateral faces are visible, of which one is of true shape and the other two are fore-shortened)

Exercise 3: Draw the plan, elevation and side view of a pentagonal prism of side 30 mm and length 70 mm given its position as below

- One of its lateral surfaces rests on HP
- The axis makes 30° with HP.

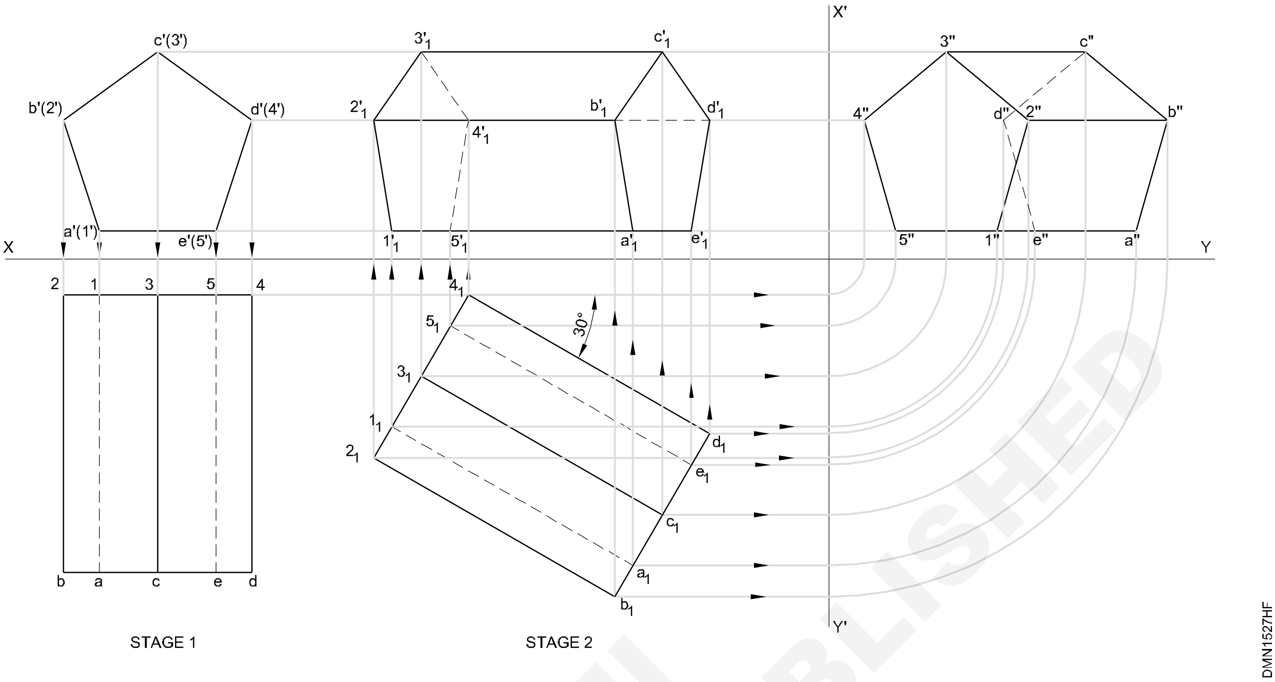
In this exercise none of the three views required will confirm to the true shape. Therefore the final views cannot be drawn straight away. The views have to be arrived at by first drawing some views using given data. Therefore we first draw plan and elevation as if it is lying on HP and axis perpendicular to VP.

- As stated above, start by drawing the elevation (Pentagon of side 30 mm) and mark corners as a',b',c',d', and e'. (Fig 3)
- Draw the plan projecting from the above elevation.
- Reproduce this plan with the axis making 30° with XY line as shown in figure. This is required plan.

© NIMI NOT TO BE REPUBLISHED

- Draw the horizontal projectors from the elevation of first stage and vertical projectors from plan of second stage and complete the required elevation as shown.
- Complete the side view by drawing horizontal projectors from the elevation and by transfering the distances from plan of the second stage.

Fig 3



Exercise 4: Draw the plan, elevation and end view of an Octagonal prism of side 20 mm and length 60 mm given its position as under (Fig 4)

- Resting on one edge of Octagon face on HP
- Octogonal face making an angle of 30° with HP
- One of its lateral face inclined at 45° to VP.

As in previous problem this problem also has to be done in three stages, because none of the required views can be drawn directly. Instead the required views are to be developed in three stages.

- Draw the plan and elevation assuming that the prism stands on HP with one of its lateral face parallel to VP. (Fig 4)
- Draw plan and elevation with the face making an angle of 30° with HP (tilt the elevation of the first stage to get the second stage elevation. Project from first stage plan and second stage elevation for second stage plan)
- To get the required plan, reproduce the second stage plan, but draw it at an angle of 45° to XY line.
- Draw the vertical projectors from final stage plan and horizontal projectors from second stage elevation and complete the required elevation.
- Draw projectors from final stage plan and elevation to get the required side view.

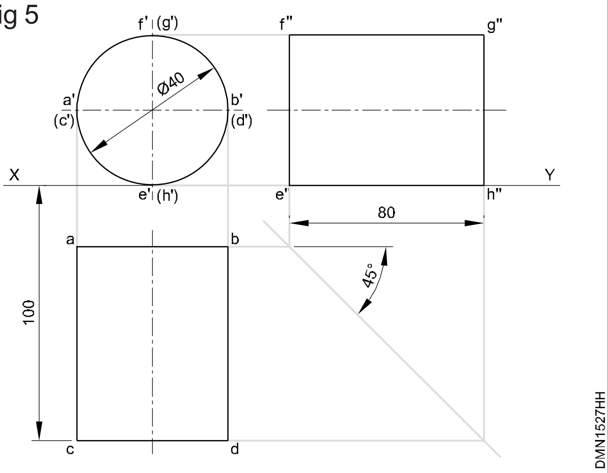
Exercise 5: Draw the plan, elevation and side view of a cylinder of diameter 40 mm and length 80 mm given its position as below:

- Cylinder resting on the HP with its axis perpendicular to VP.
- Face farthest from VP is 100 mm away from VP.

In this problem the circular faces are parallel to VP. Therefore the elevation is a circle resting on XY line. Plan an end views are rectangles of size 80 mm x 40 mm.

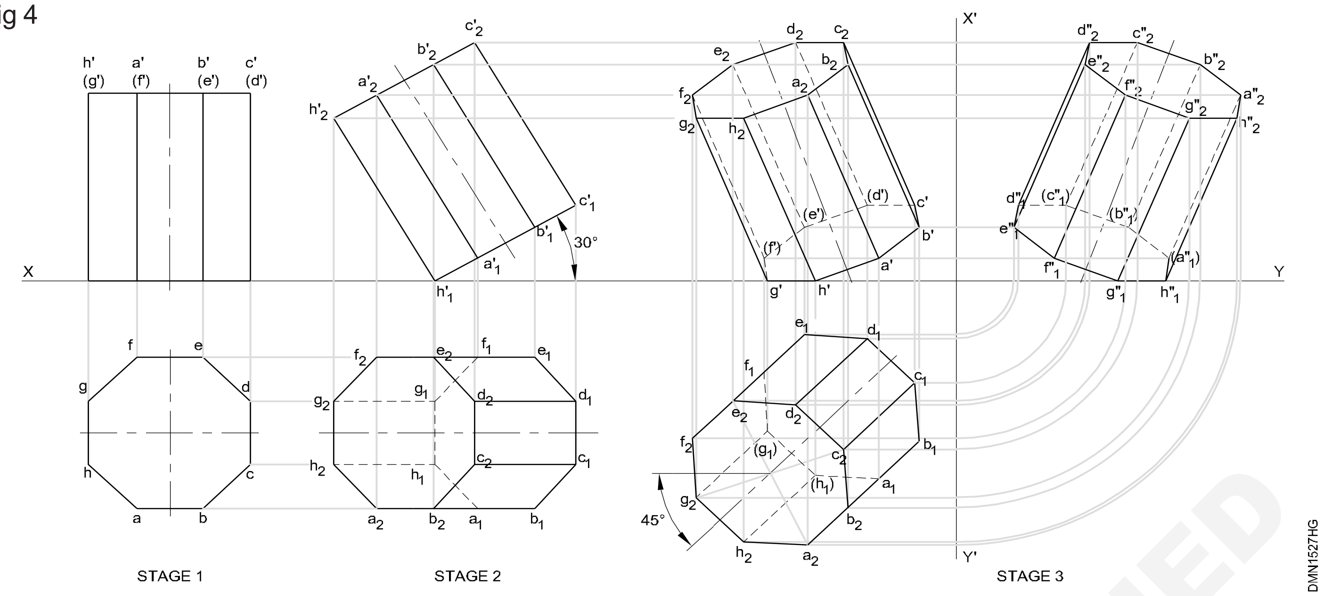
- Draw the circle of diameter 40 mm touching XY line. (Fig 5)
- Draw the plan projecting it from the elevation.
- Draw the end view by drawing projection on it, from the plan and elevation.

Fig 5



© NIMI NOT TO BE REPUBLISHED

Fig 4



Exercise 6: Draw the plan, elevation and side view of a cylinder whose base diameter is 35 mm and length of axis 50 mm and its position is as given below:

- Its base in point contact with HP
- Axis making an angle of 30° with HP.
- Cylinder rotated about the contact point on HP such that the axis of the cylinder in the plan will be perpendicular to XY line.

The position given above suggest that the axis is parallel to AVP. Therefore the side view will be a rectangle 50 x 35 with the axis inclined 30° to XY line. Also plan and elevation a distorted cylinder with the axis perpendicular to XY line.

- Similar to the previous examples the construction in this exercise also has to be made in three stages. (Fig 6)

– Draw plan and elevation as if the cylinder is resting on its base on HP. (Fig 6 Stage I)

– Divide the circle (plan) into number of equal parts and draw projectors upwards. Mark the points as per conventions.

– Reproduce the elevation of stage I its axis inclined to 30° with HP.

– Draw the stage 2 plan by drawing projectors from the elevation of stage 2 and plan of stage 1.

– Draw the plan of final position which is same as in plan in stage II but the axis in perpendicular to XY.

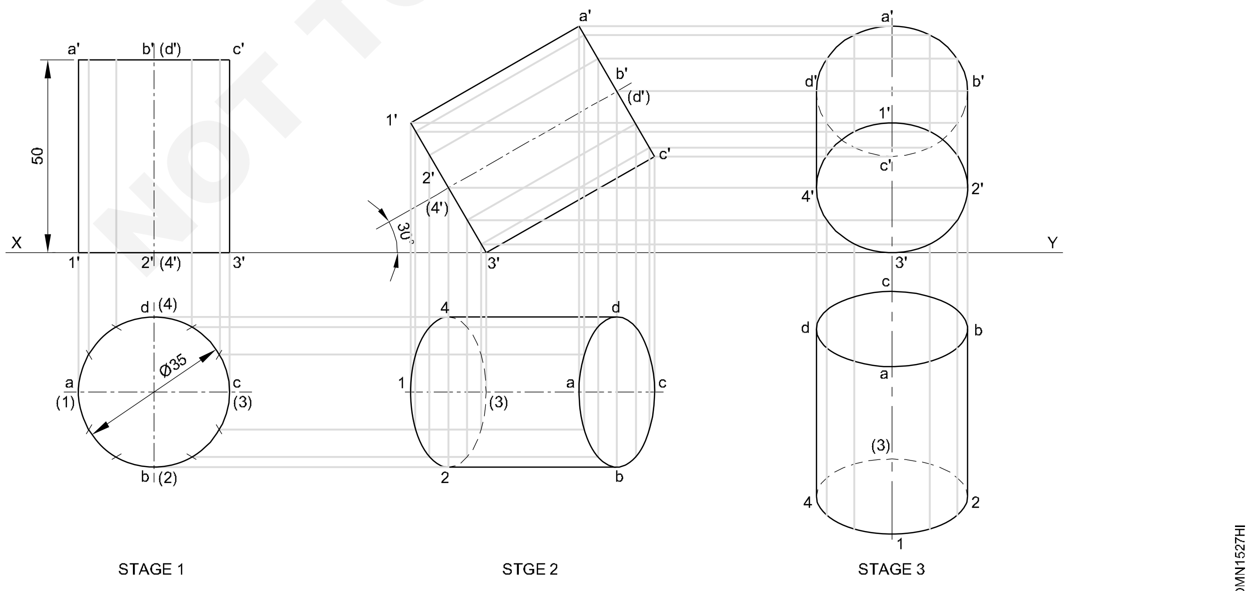
– Draw the projectors from elevation of stage 2, but the axis is perpendicular to XY.

– Draw the projectors from elevation of stage 2 and plan of final position complete the elevation of the final position.

As stated in the note above, the required side view of the final position will be the same as the elevation of stage 3.

© NIMI NOT TO BE REPUBLISHED

Fig 6



Exercise 7: Draw the Orthographic views of a regular hexagonal pyramid of side 30 mm and height 75 mm given its position as below:

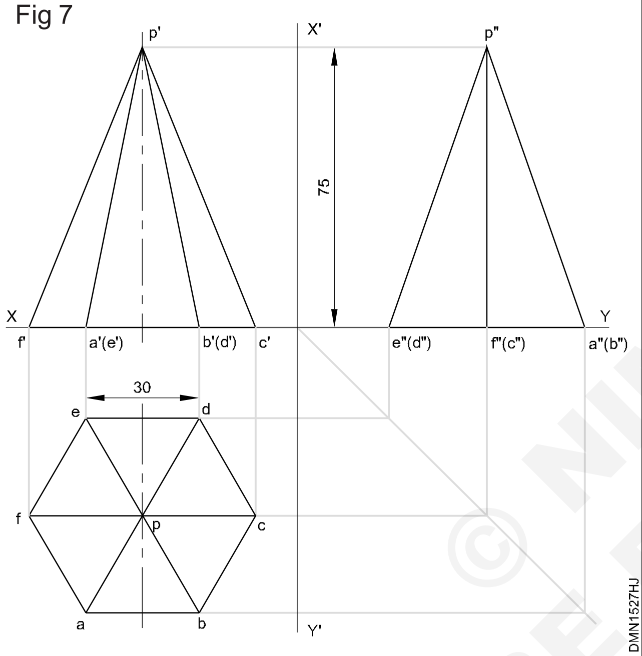
- Standing vertically with its base on HP with one side of the hexagonal base parallel to VP.

The pyramid has 6 triangular faces and one hexagonal base. The plan will show the true shape of the base and other six triangular faces are foreshortened.

In this elevation, three triangular faces are seen and all of them are fore-shortened.

- Mark the centre of hexagon (Point P) and draw lines from P to the six corners of the hexagon. Now this is the required plan. (Fig 7)

Fig 7



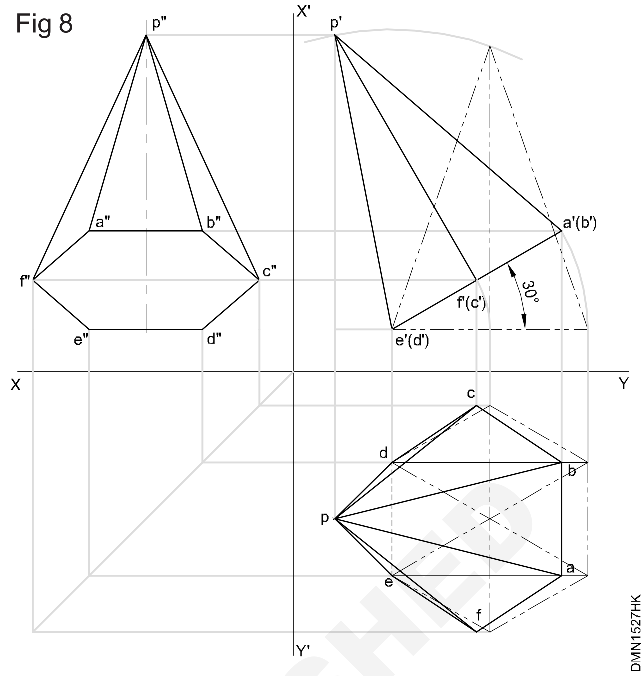
- Project this P from plan upwards and mark P' at a distance of 75 mm from XY line.
- Mark the points f', a'b'c' etc... on XY line by projecting the corresponding points from plan.
- Join the P' with f',a',b',c' etc and complete the required elevation.
- Draw projectors from elevation and plan to complete the required side view.

Exercise 8: A hexagonal pyramid of side 30 mm and height 60 mm is resting with its base on HP. Draw its projections when one of the base edges is at right angle to VP and the base makes 30° with the HP.

This is similar to the previous example with the only difference that is base makes 30° to HP. Therefore elevation will be same as in the previous exercise, but tilted to 30°.

- Draw the front view and top view of the pyramid as in the previous example. (Fig 8)
- Draw the required elevation by tilting the elevation of stage I to 30°.

Fig 8



- Draw the vertical projectors from the elevation and horizontal projectors from IST stage plan and complete the required plan.
- Draw the required end view by drawing projectors from elevation and plan.

Exercise 9: Draw the projections of a cone of base diameter 60 mm and height 80 mm when its position is as under

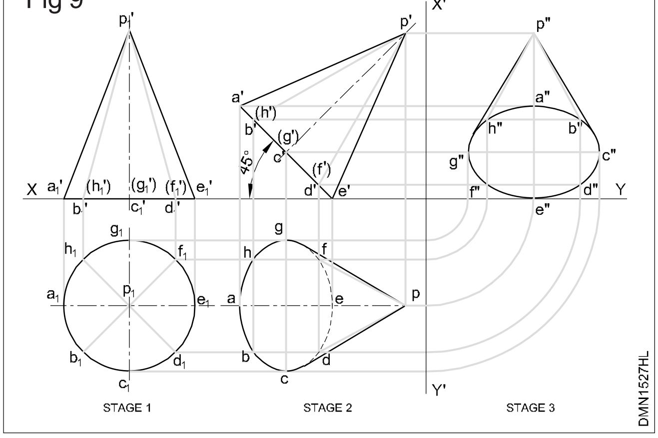
- Its circular base touching HP and making an angle of 45° with HP.
- Axis parallel to VP.

The elevation of a cone, which is standing vertical is a triangle. The base of the cone will be elliptical in both the plan and side view.

- Draw the plan and elevation of cone as if it is standing vertically on HP. (Stage 1) (Fig 9)
- Divide the circumference of the plan into number of equal parts. (say 8) and mark them. From these points draw projectors to XY line and mark the intersection is a',b' (h') c' etc.
- Draw the required elevation, same as in stage 1, but with the axis 45° to XY line and mark the points as a'b'(h') c'(g') etc.
- Draw the ellipse through the intersection of the corresponding points of the vertical and horizontal projectors and complete the required plan.
- From the final plan and elevation, draw projectors and complete the required end view.

© NIMI NOT TO BE REPUBLISHED

Fig 9



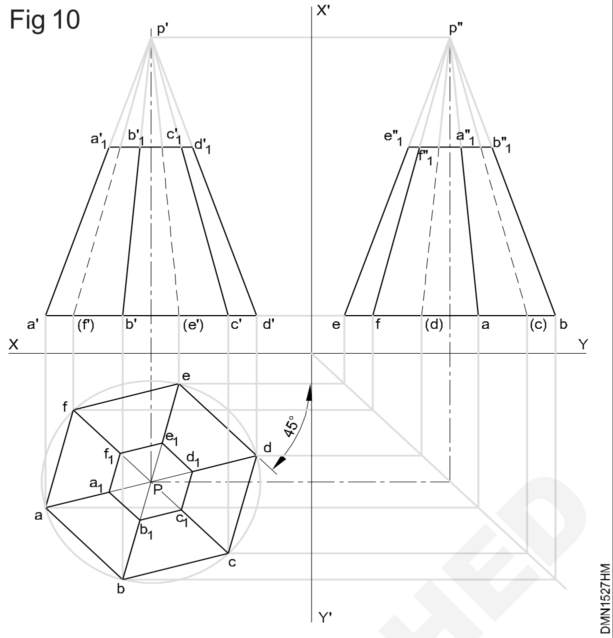
Exercise 10: Draw the three views of the frustum of an hexagonal pyramid of side of base hexagon 30 mm, apex angle 40° and height of frustum 50 mm given its position below

- Base of pyramid is parallel to HP and 10 mm above it.
- Its axis is vertical.
- One of the base edges makes 45° with VP.

Plan of this pyramid consists of two hexagons having common centre and lines connecting the corresponding corners of the inner and outer hexagons to form the slant faces of the frustum.

- The required views are shown in Fig 10.
- The procedure is self-explanatory.

Fig 10



Exercise 11: Draw the plan, elevation and side view of the hollow frustum of a cone whose diameter of base and top are 50 mm and 30 mm respectively and height 40 mm, given its position as under:

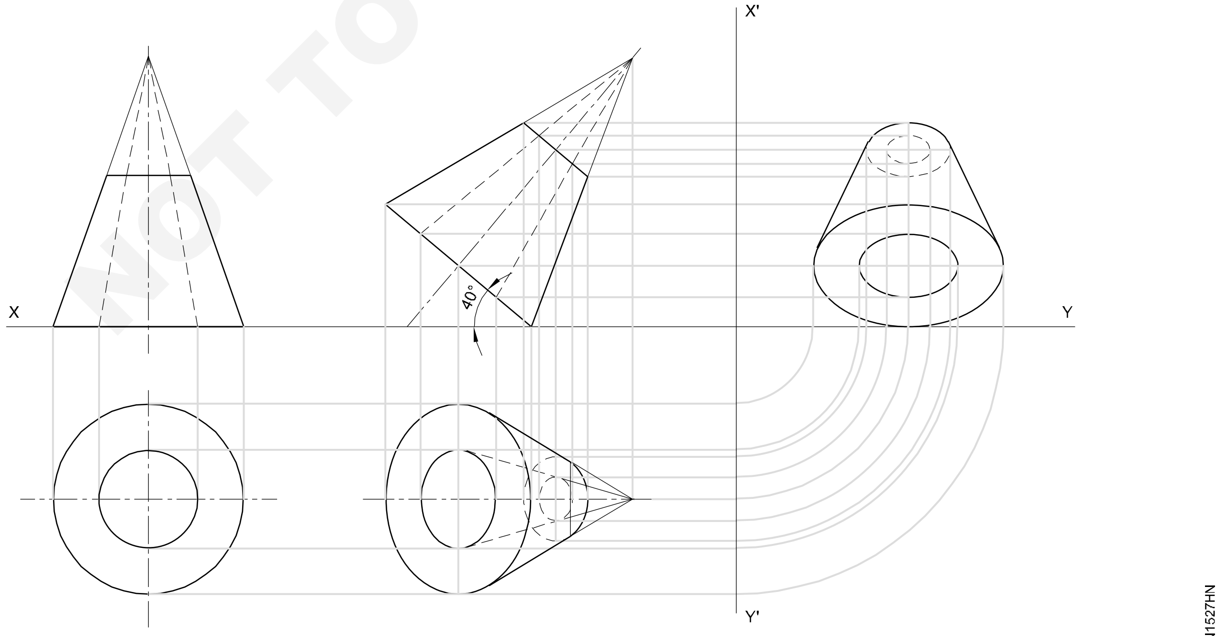
- Base touching HP
- Axis parallel to VP and inclined 40° to AVP.

Axis parallel to VP and inclined 40° to AVP implies that is base is inclined 40° to HP.

- Draw the plan and elevation when the base is on HP and axis vertical.
- Draw required elevation with the base making 40° to XY line.
- Draw required top view by drawing the final elevation and first stage plan.
- Complete the side view as shown in Fig 11.

© NIMI NOT TO BE REPUBLISHED

Fig 11



Exercise 12: Draw plan, elevation and side view of one sphere of 40 mm diameter and three spheres of 25 mm diameter each given their position as below

- Three spheres of diameter 25 mm kept touching each other, their centres forming a triangle.
- The 40 mm diameter sphere is resting on the above three spheres of 25mm diameter.

  The 40 mm diameter sphere will be sitting on three points of the three 25mm diameter spheres and its centres coincides with the triangle formed by three 25mm diameter spheres.
- Draw the top view of the three spheres of diameter 25mm touching each other. (Fig 12)
- Join the centres of the spheres, forming a triangle abc.
- Draw bisectors of $\angle$bac and $\angle$acb and mark the intersecting point `e'.
- Draw circles of diameter 40 mm with centre `e'.
- Draw arcs with radius equals to ec meeting the horizontal line drawn through `e' to meet at a' and c'.

To get the height of the sphere diameter 40 mm in the elevation note the following:

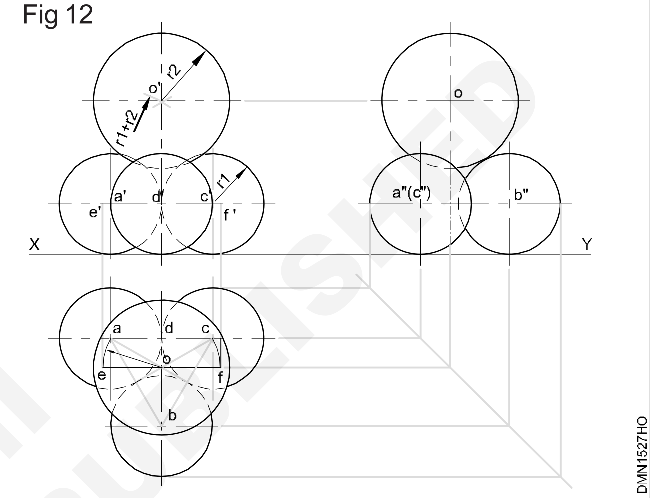
Join the centres of the spheres of diameter 25 with the centre of diameter 40 mm we get a triangular pyramid. The centre point of this base of pyramid the centre point of the sphere of diameter 40mm and the corner of the base will form right angled triangle whose hypotenuse is equal to $r_1 + r_2$. The other two sides are distance ae in the plan and the required height of the centre point of diameter 40 mm sphere.

- Draw arcs of radius (32.5) with centres a' and c' to intersect at O'.
- Draw a circle of diameter 40mm with centre O' and this complete the elevation.

To draw end view

- Draw horizontal projectors from centre O and a'.
- Draw horizontal projections on to 45° and then vertically to the end view.
- Mark the corresponding intersecting points and draw the sphere.

Fig 12



NOT TO BE REPUBLISHED © NIMI

Draw the freehand lathe tool post - bench vice - cutting tools - bolt - nut & steel - gear - pipe flanges hand wheel - cranehook - steel bracket

Objectives: At the end of this exercise you shall be able to
- **sketch the isometric views for different objects**
  - **plain paper**
  - **isometric lines paper**
- **sketch the oblique views of objects**
- **sketch the orthographic views of the objects.**

PROCEDURE

Exercise 1: To draw horizontal thick and thin lines. (Fig.1)

Lengthy lines can be drawn with the forearm motion and short lines are drawn with the wrist motion.

Keep uniform pressure while sketching.

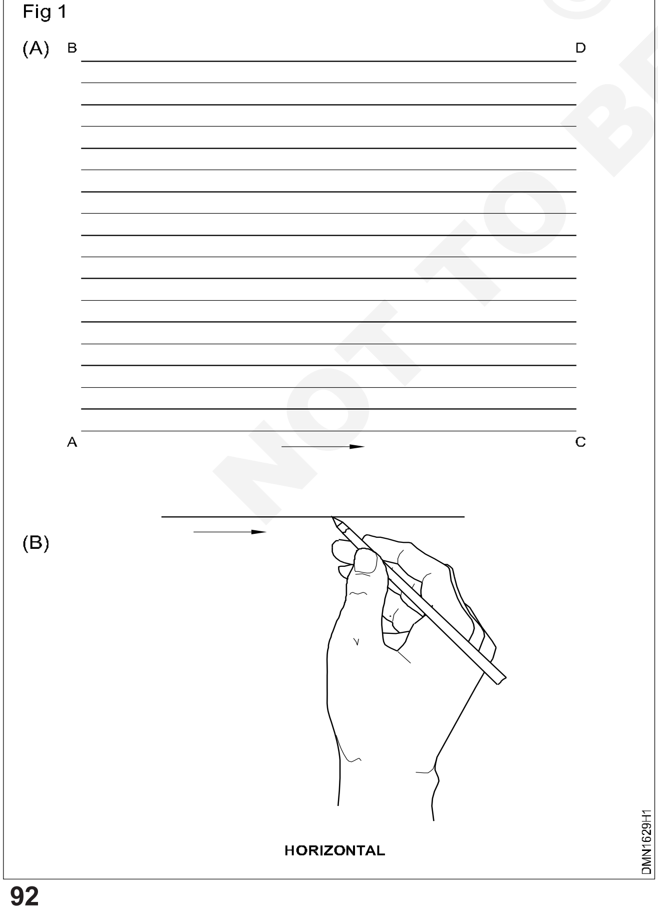
Horizontal lines are drawn from left to right. (Fig.1B)

While sketching straight lines between two points keep your eyes on the point to which the line is to go rather than the point of pencil.

Avoid of drawing whole length of line in one single stroke.

Prevent using eraser often.

Fig 1

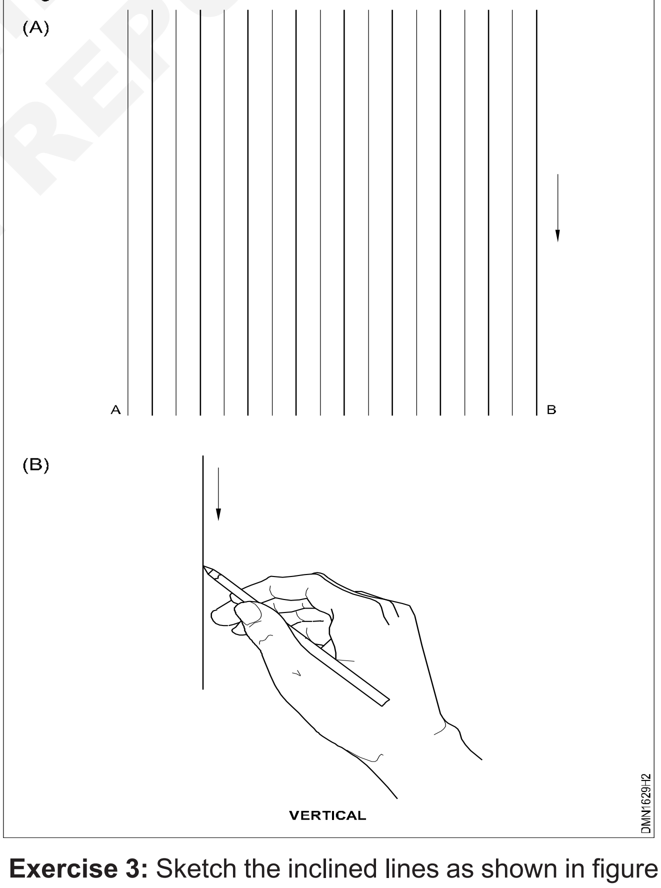


Exercise 2: To draw vertical lines in thick and thin. (Fig.2)

- Sketch two horizontal thin guide lines AB & CD.
- Mark points on the horizontal lines AB & CD, 5 mm intervals.
- Sketch the line in free hand between the two points with thick and thin alternatively.

Vertical lines are drawn from top to bottom. (Fig 2B)

Fig 2



Exercise 3: Sketch the inclined lines as shown in figure with thick and thin lines. (Fig 3)

- Sketch two axis AB & CD.
- On the horizontal and vertical axis AB and CD, mark points with 5 mm intervals.

© NIMI NOT TO BE REPUBLISHED

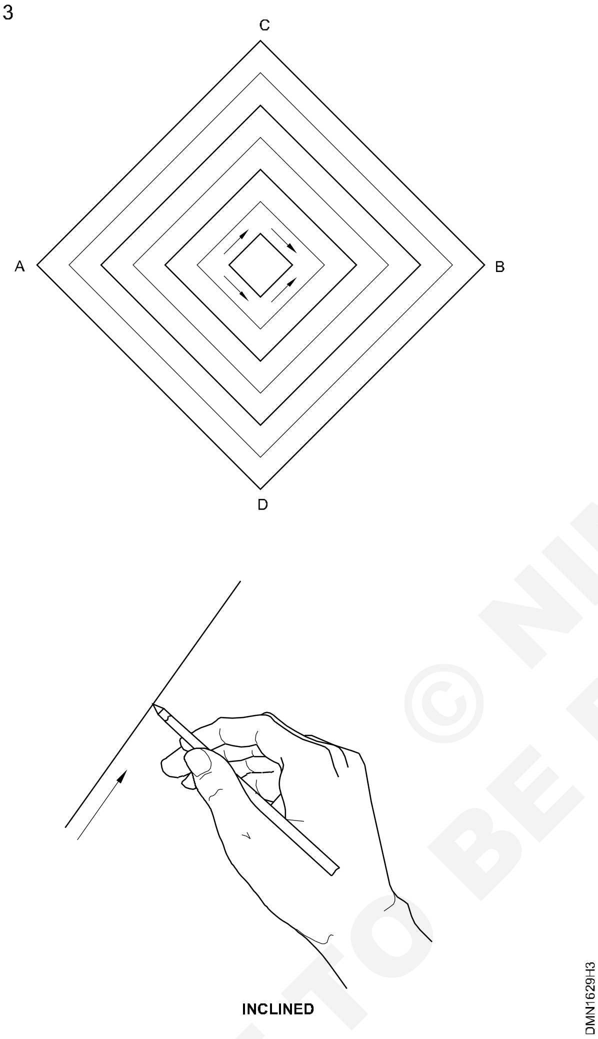
- Draw thick and thin lines in the direction as shown in the figure alternatively.

Inclined lines running upward are drawn left to right i.e bottom to top. (Fig 3B)
The pencil point need not to be too sharp.
Hold the pencil freely and not close to the point.
It is better that the pencil can be hold 30 mm away from the tip of the pencil lead.

Fig 3

(A)

(B)

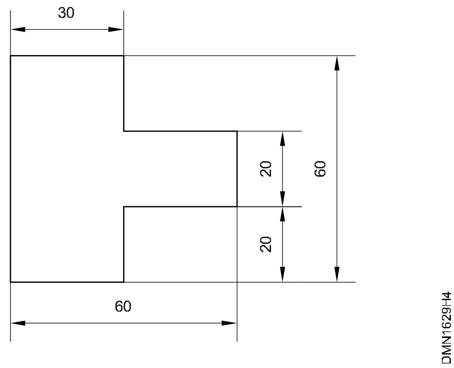


Exercise 4: Sketch the given plane figure as shown (Fig.4)

- Draw the horizontal straight line in free hand and mark off 60 mm approximately.
- Draw a vertical straight line of 60 mm long from the base.
- Draw horizontal & vertical parallel lines and form a square box of 30 mm sides.
- Darken the lines of the surfaces in figure using thick line.
- Erase the unwanted lines and complete the plane figure.

Do not place any dimensions in the figure.

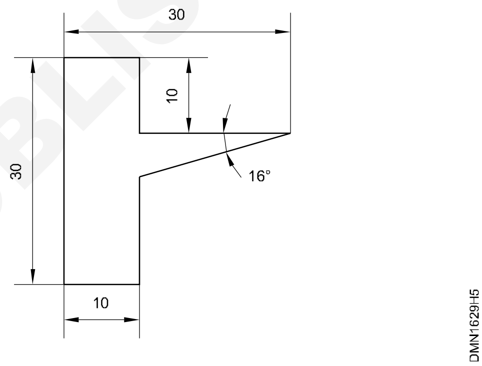
Fig 4



Exercise 5: Sketch the plane figure as shown. (Fig 5)

- Sketch a square box of 30 mm side in thin lines.
- Mark off the dimensions as shown in figure approximately.
- Thick the required lines.
- Erase the unwanted lines and complete the figure.

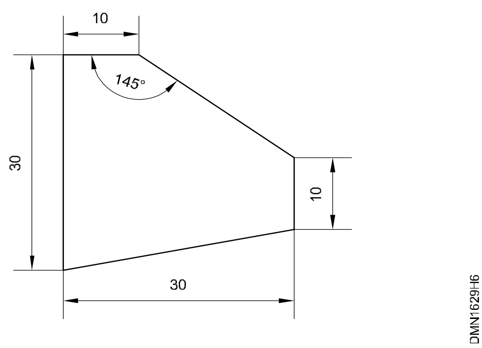
Fig 5



Exercise 6: **Sketch the plane figure as given. (Fig 6)**

- Form a square box of 30 mm side in thin lines.
- Set of the dimensions and angle as shown in figure.
- Draw the lines and remove the unwanted lines.
- Complete the figure.

Fig 6



Exercise 7: Sketch a square box of given diameter, mark the mid points and join the mid points of horizontal and vertical sides. (Fig 7A)

- Join the corners (diagonals) of the square box and mark the radius of the given diameter. (Fig 7B)
- Join all the 8 points by a smooth curve and complete the circle. (Fig 7C)

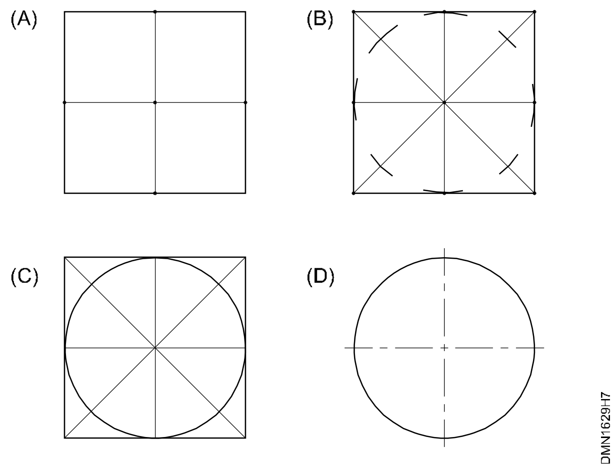
© NIMI NOT TO BE REPUBLISHED

- Erase the unwanted lines and darken the curve. (Fig 7D)

  Side of the square = Diameter of the circle

  Radius of circle = Half of the square side.

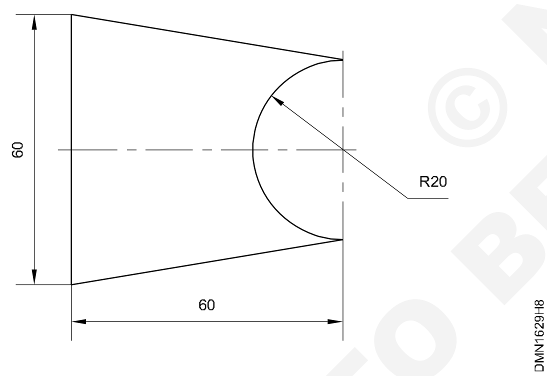
Fig 7



Exercise 8: Sketch the template as shown in figure. (Fig.8)

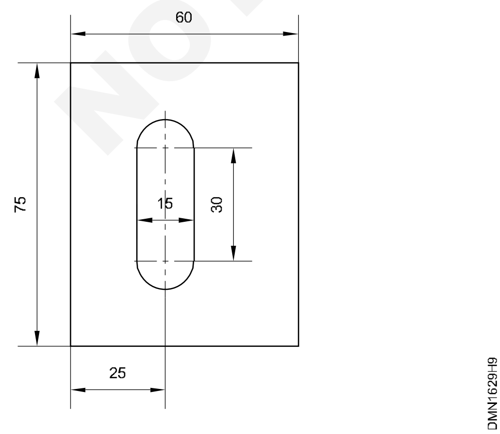
- Sketch a square box of 40 mm side.
- Sketch the semi-circle on right side of the square as shown in figure.
- Darken the lines as in figure and complete the shape of the template.

Fig 8



Exercise 9: Sketch a rectangular box of 75mm x 60mm as shown in figure 9

Fig 9

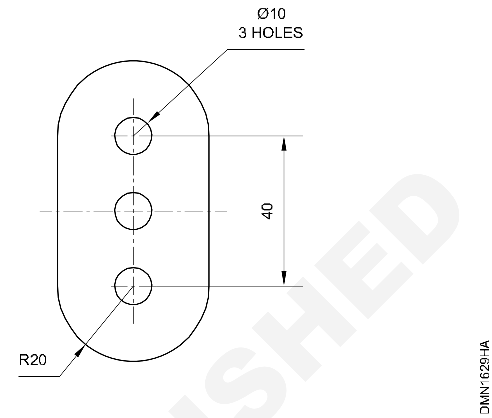


- Mark the other dimensions as shown in figure.
- Thick the required lines of the template.
- Erase the unwanted lines and complete the figure.

Sketch the curved shape blank plane figure as given in figure. (Fig 9)

Exercise 10: Draw a vertical straight line and horizontal straight line intersecting each other at right angles. (Fig 10)

Fig 10

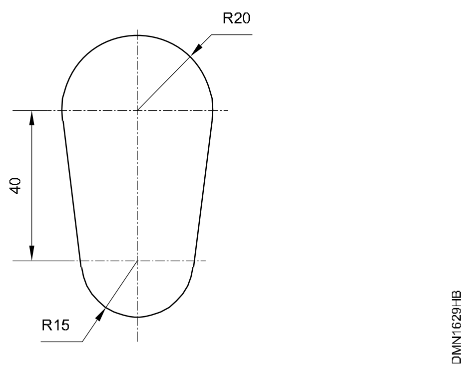


- Mark off 20 mm on either side of the vertical line from the intersecting point of the straight lines.
- Sketch semi-circle of R 20 mm top and bottom as in figure.
- Join the two semi-circles with vertical lines.
- Sketch the three circles of ϕ10 mm.
- Darken the lines and complete the figure (10)

Exercise 11: Sketch the template as shown. (Fig 11)

- Draw a vertical straight line.
- Draw two horizontal straight lines intersecting the vertical line keeping 40 mm away.
- Sketch the two curves as in figure and join the curves.
- Erase the unwanted lines and complete the figure.11

Fig 11



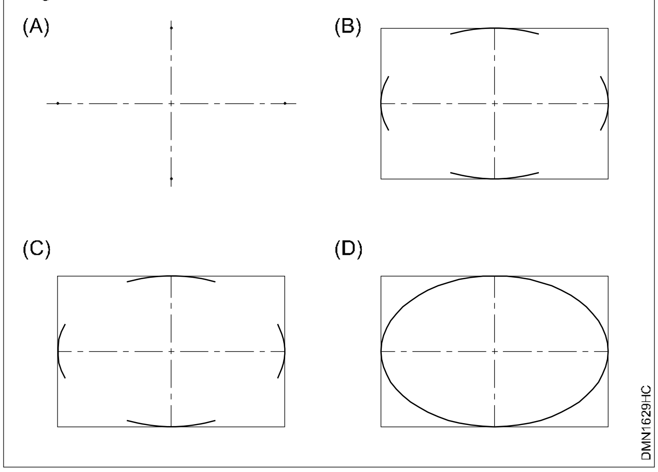
Exercise 12: To sketch an ellipse of given major and minor axis. (Fig 12)

- Draw a horizontal and a vertical line intersecting each other at right angles.
- On the horizontal line mark the half of the major axis on either side of the centre and similarly half of the minor axis on the vertical line.

© NIMI NOT TO BE REPUBLISHED

- Through these points draw horizontal and vertical parallel lines and form a rectangular box.
- Sketch the small arcs with thin lines.
- Join the other portion by smooth curve and complete the ellipse. (Fig.12)

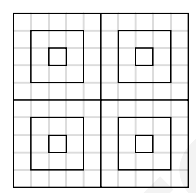
Fig 12



Exercise 13: Draw the pattern of 50 mm side by free hand. (Fig 13)

- Draw a square by free hand.
- Divide one horizontal and one vertical side into each ten equal parts.
- Draw a thin horizontal and vertical line through the parts marked.
- Darken the squares as per exercise drawing.
- Rub off the thin construction lines and complete the exercise. (Fig 13)

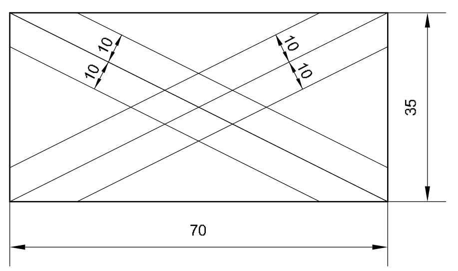
Fig 13



Exercise 14: Draw the pattern of sides 70 mm and 35mm by free hand proportional to the size. (Fig 14)

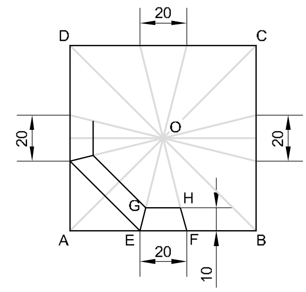
- Draw a rectangle proportionately.
- Join the diagonals.
- Draw parallel lines to the diagonals approximately at 10mm distance from each other as shown in the exercise.

Fig 14



Exercise 15: Draw a square ABCD of side 80 mm approximately by free hand. (Fig 15)

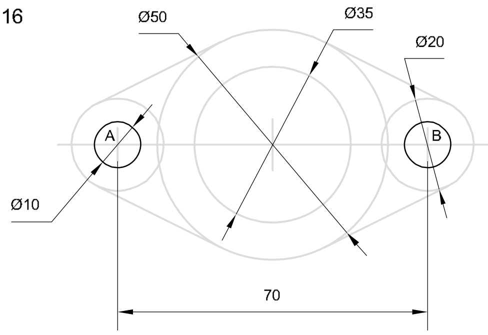
Fig 15



- Join diagonals (thin line).
- Draw the perpendicular bisectors from two adjascent sides (free hand).
- On side AB, mark EF = 20 mm.
- Join E and F to centre of square.
- Draw a line at a distance 10 mm parallel to EF.
  The parallel line cuts the inclined lines EO and FO at G and H.
- Join GH, GE and HF.
- Follow the procedure and draw trapeziums similar to EFHG on the remaining three sides.
- Join the lines shown in the Fig 15 and rub off the thin line and finish the drawing.

Exercise 16: Sketch the given pattern by free hand. (Fig.16)

Fig 16



- Mark the midpoint of the line AB.
- Draw free hand circles of ϕ 35 and ϕ 50 on the midpoint of the vertical line.
- Draw two circles ϕ 20 mm using A and B are the centres.
- Draw two circles of ϕ 10 from points A and B.
- Complete the drawing after removing unwanted lines.

Exercise 17: Sketch the given figures A to E proportionately (Fig 17)

Exercise 18: Sketch the given figures in the square grid by free hand A to D (Fig 18)

© NIMI NOT TO BE REPUBLISHED

Fig 17

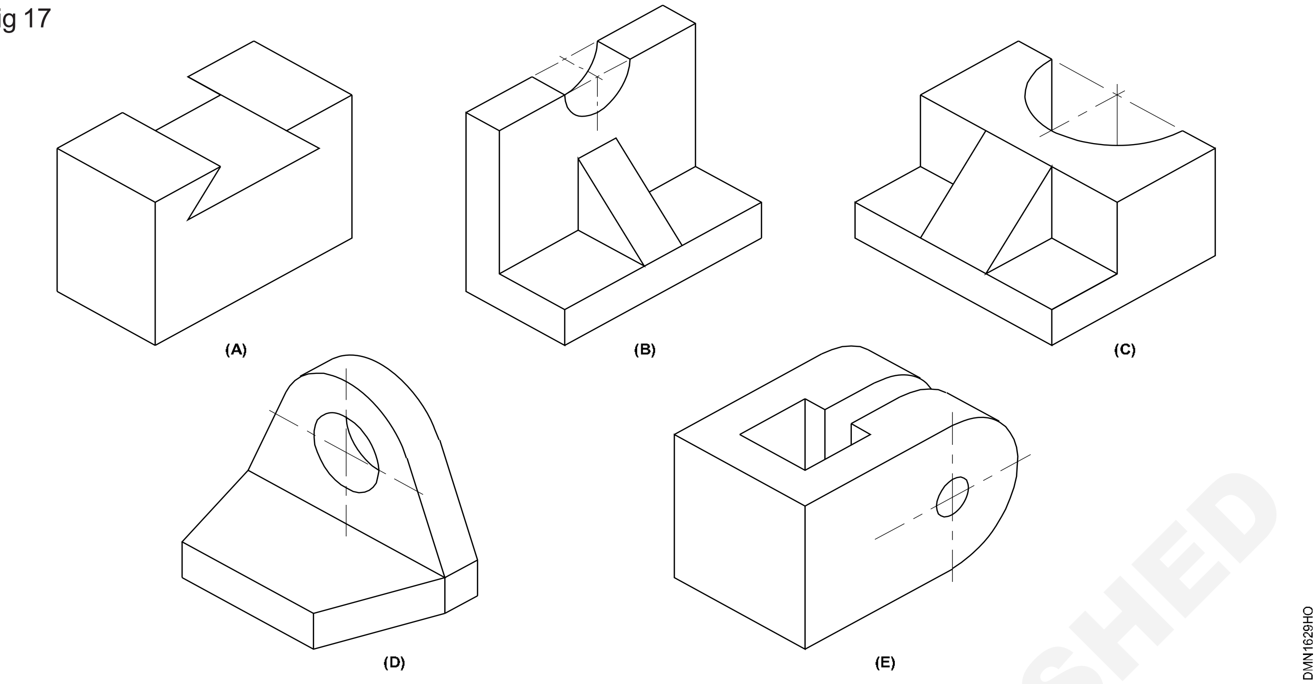
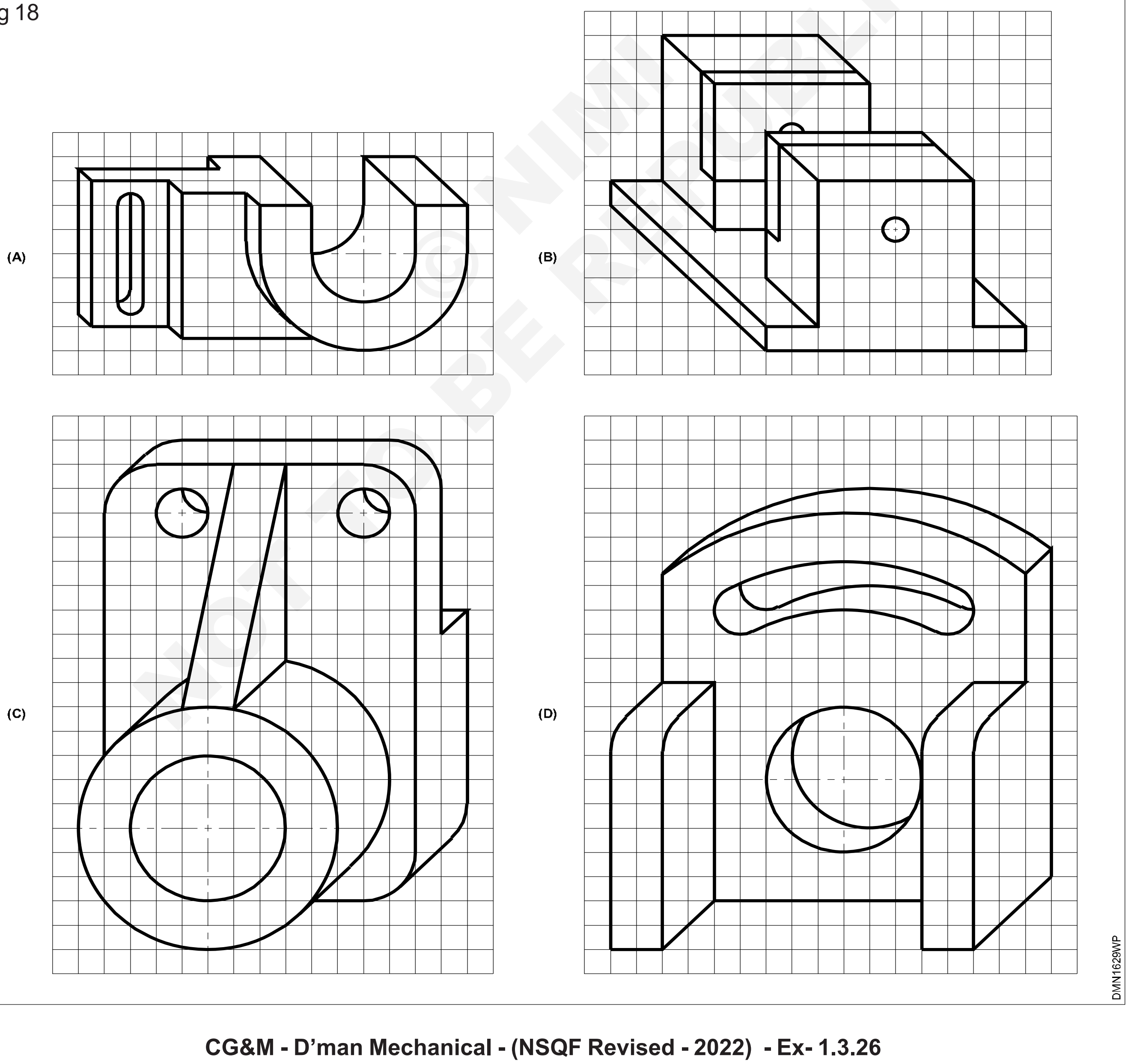


Fig 18



© NIMI NOT TO BE REPUBLISHED

Exercise - 19: Draw the given tools and equipments by free hand (Fig 1 to 13)

Fig 1

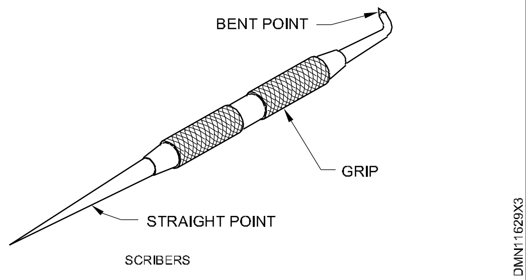


Fig 2

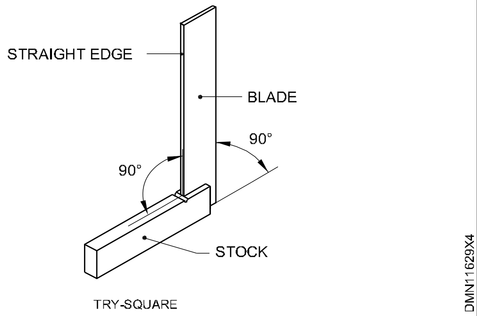


Fig 3

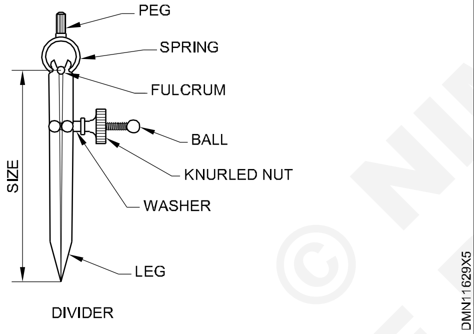


Fig 4

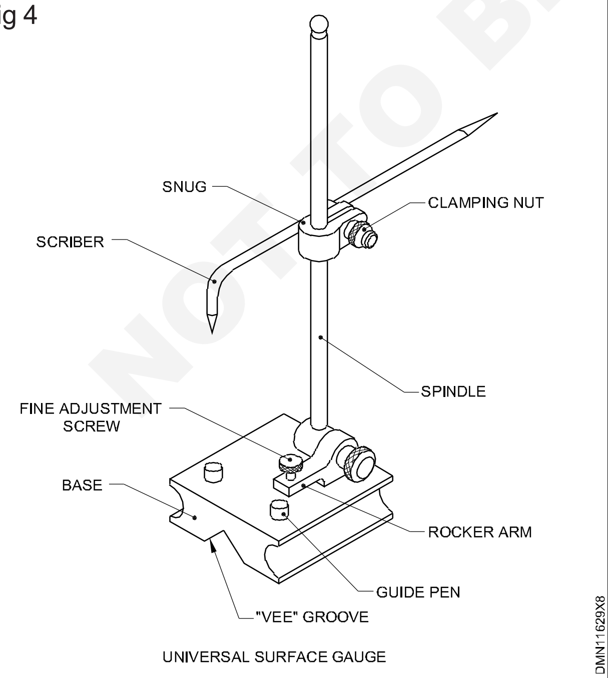


Fig 5

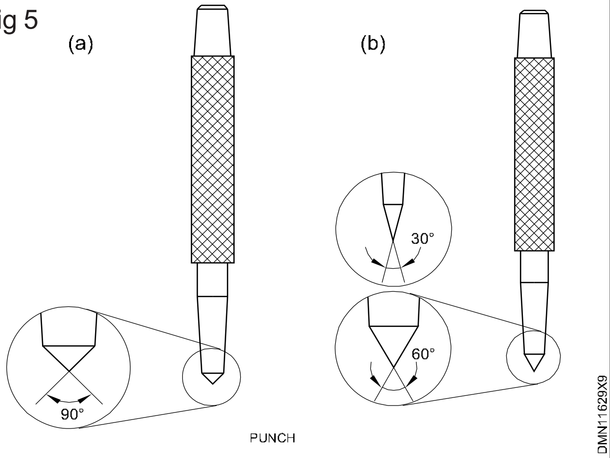


Fig 6

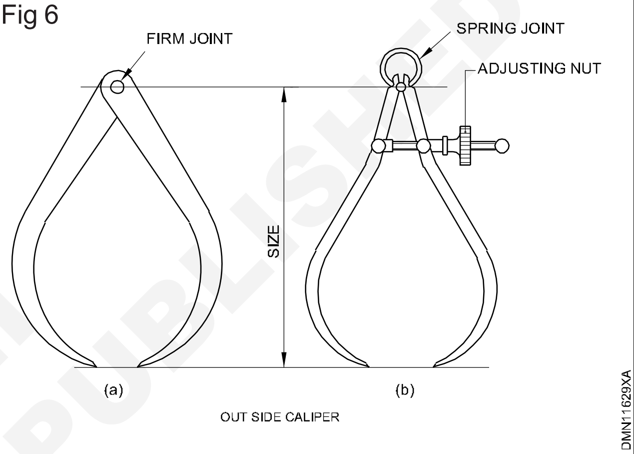


Fig 7

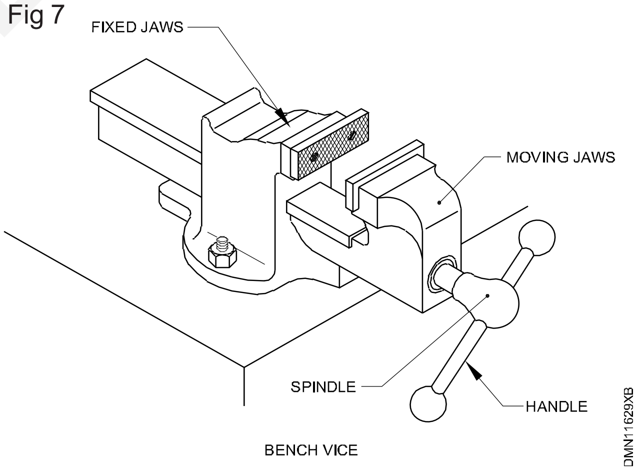
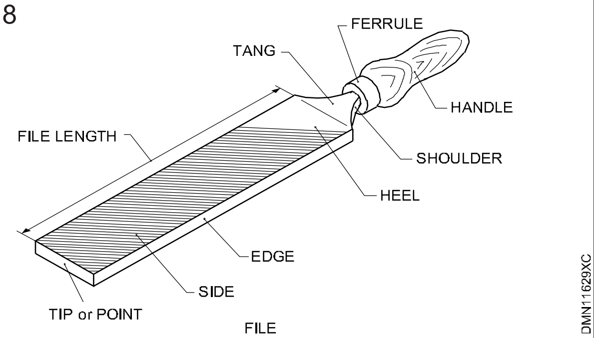
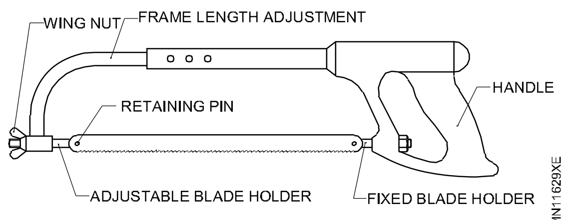


Fig 8



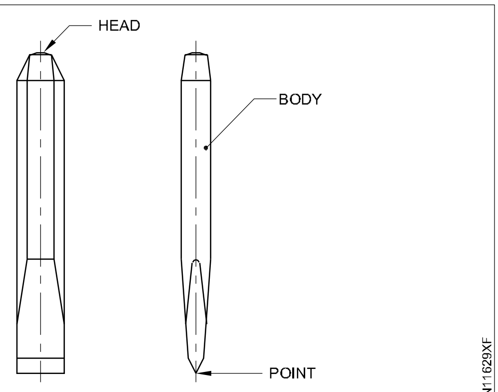
© NIMI NOT TO BE REPUBLISHED

Fig 9



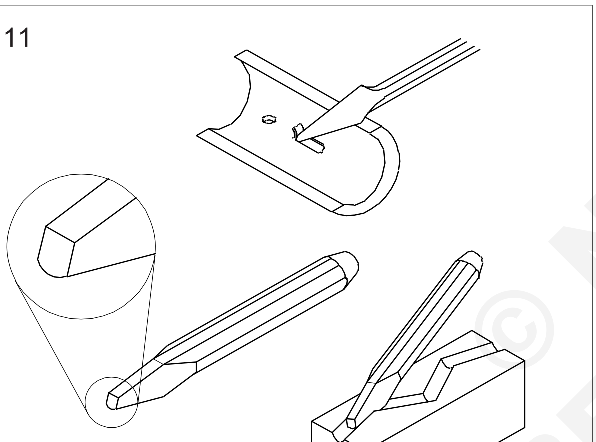
HACKSAW FRAME

Fig 10



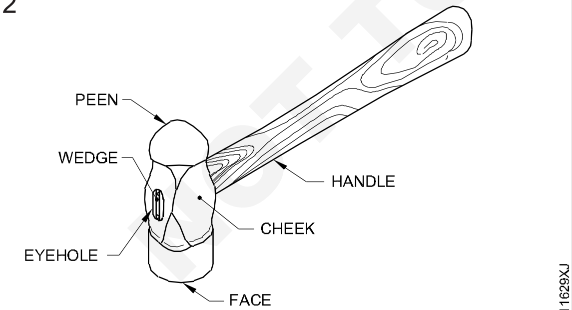
CHISEL

Fig 11



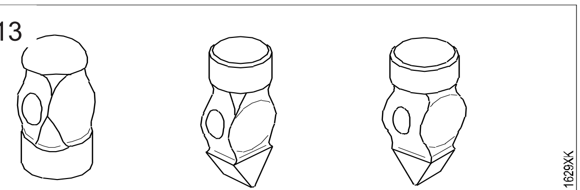
HALF ROUND NOSE CHISEL

Fig 12



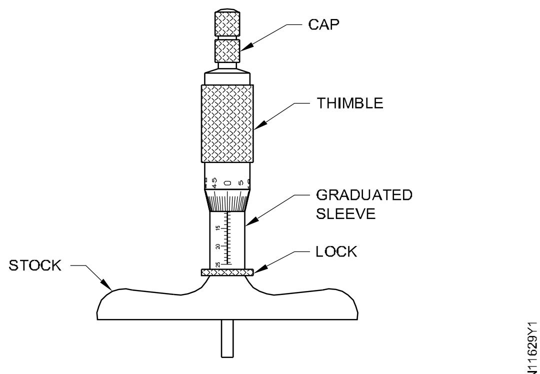
BALL PEIN HAMMER

Fig 13



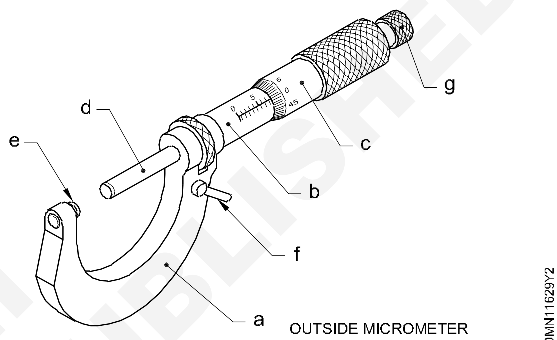
Exercise -20: Measuring instruments by free hand (Fig 1 to 5)

Fig 1



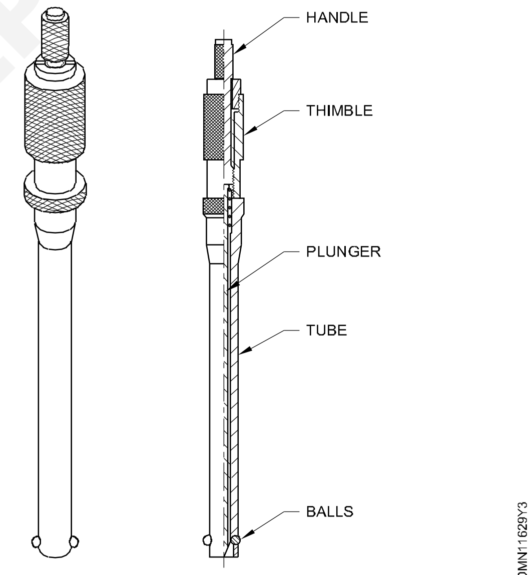
DEPTH MICROMETER

Fig 2



OUTSIDE MICROMETER

Fig 3



© NIMI NOT TO BE REPUBLISHED

Fig 4

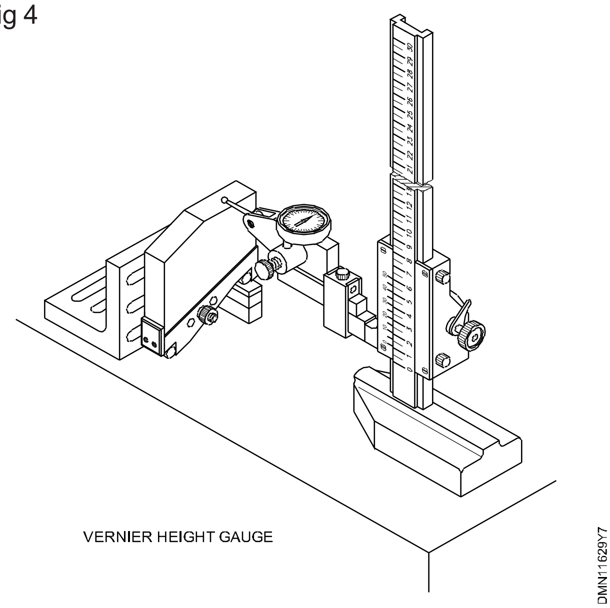
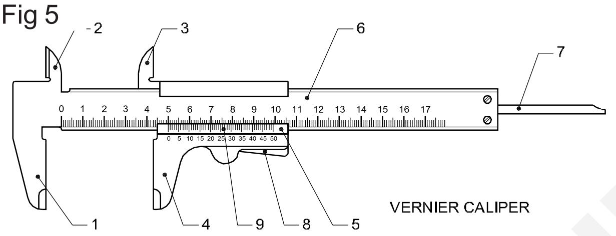


Fig 5



Exercise -21 : Draw the machines Fig 1 to 3 by free hand with proper line to dimensions.

Fig 1

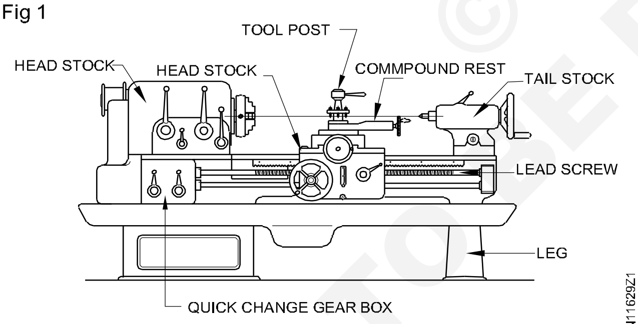


Fig 2

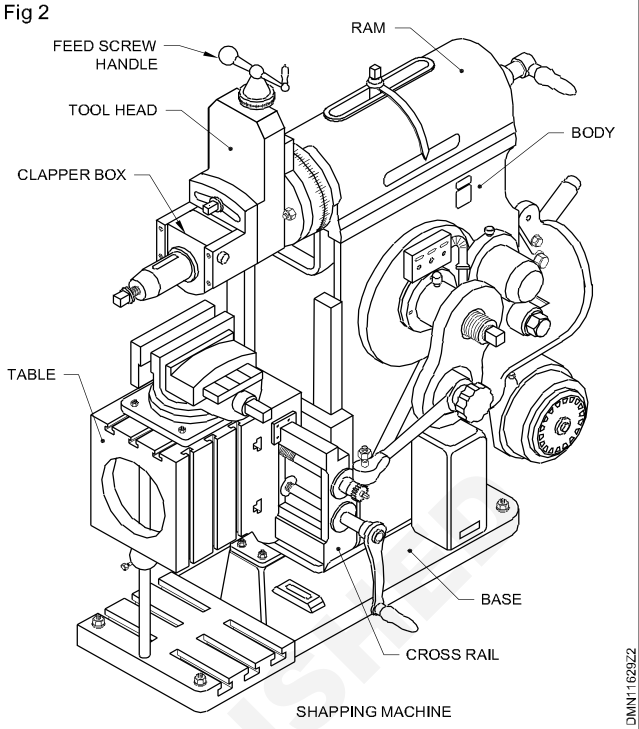
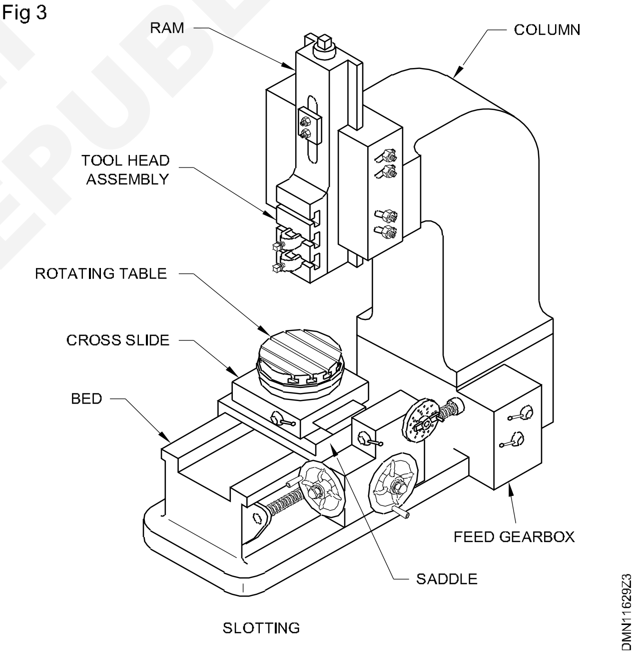


Fig 3



© NIMI NOT TO BE REPUBLISHED

Conventions signs and symbols

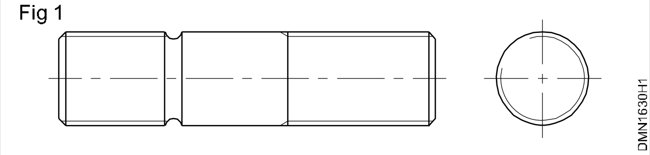
Objective: At the end of this exercise you shall be able to
- **draw the standard conventional representation of the following objects.**

PROCEDURE

Exercise 1 : Draw the given drawing with standard proportional dimensions

Visible screw thread (Fig 1)

Fig 1



- Study the given drawing carefully and reproduce it correctly.
- Proportion should be maintain.

Exercise 2 : Internal thread sectional views convention (Fig 2, 3 & 4)

Fig 2

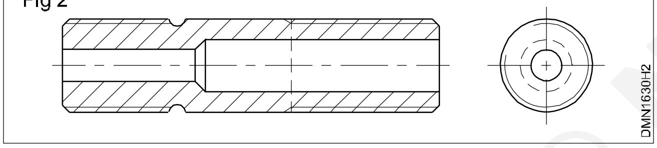


Fig 3

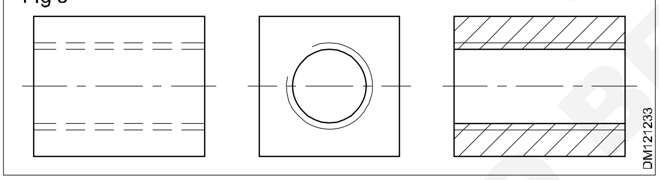
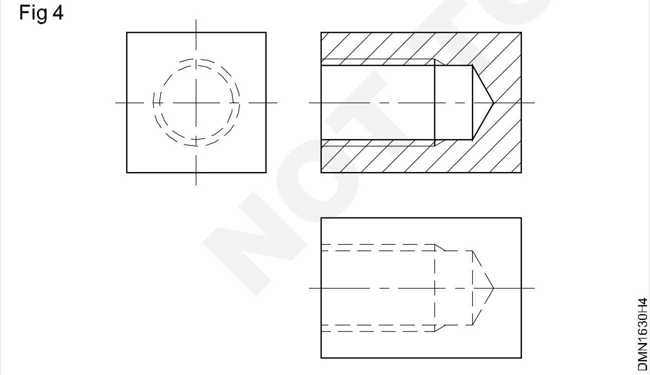


Fig 4

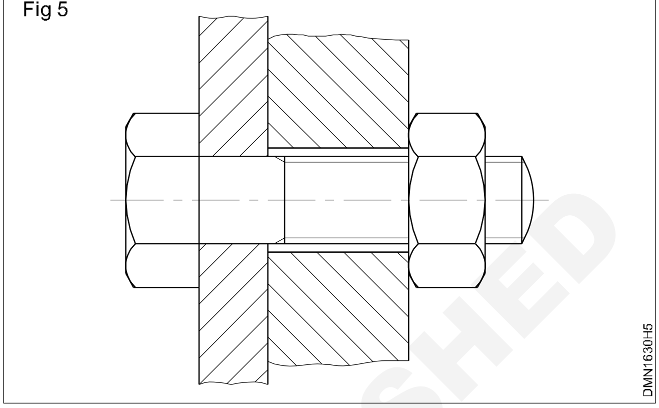


- Note that, hatching should be extended to the live defining crests of the internal thread for the root parts in section (Fig 2,3, & 4)

Exercise 3 : Draw the convention of a thread assembly (Fig.5)

- Note while drawing threaded assembly draw the bolt and nut as per I.S. standard.

Fig 5



Exercise 4: Draw the convention of actual projection/section for the given drawing of figures 6 to 19 with standard proportional as per I.S. Standard

Further information & refer I.S. 696

Fig 6

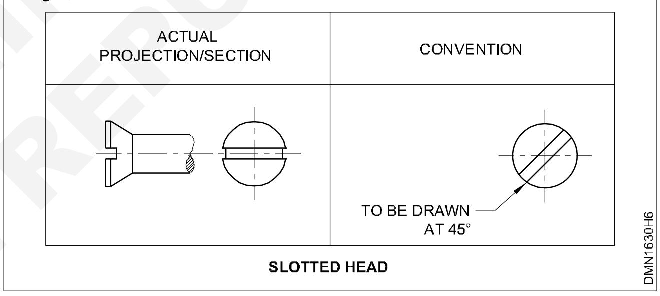


Fig 7

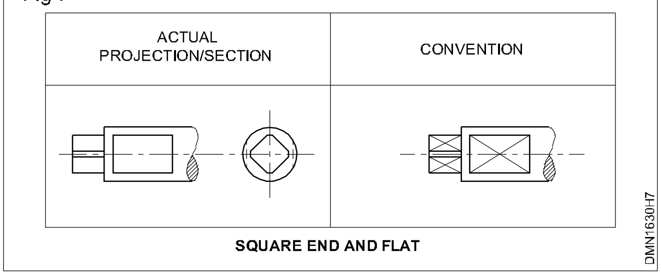
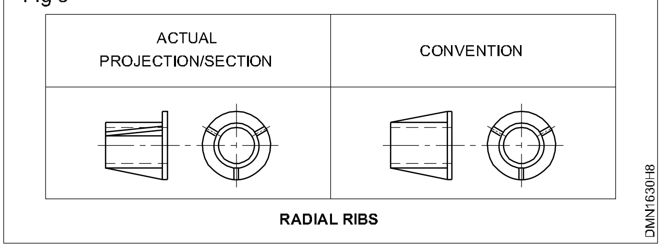


Fig 8



© NIMI NOT TO BE REPUBLISHED

Fig 9

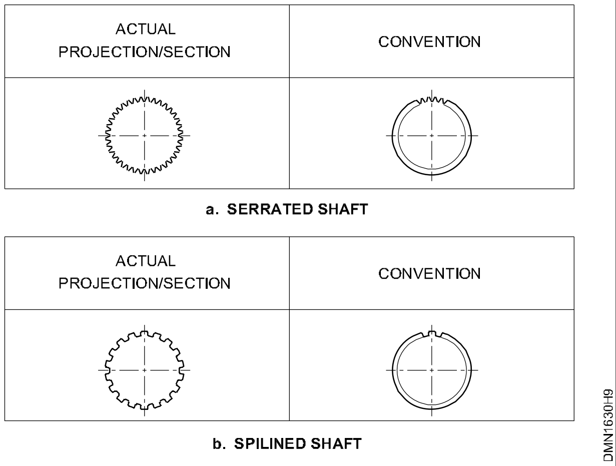


Fig 10

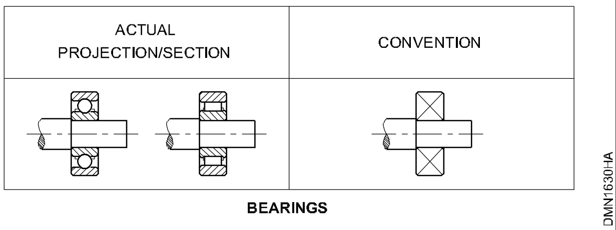


Fig 11

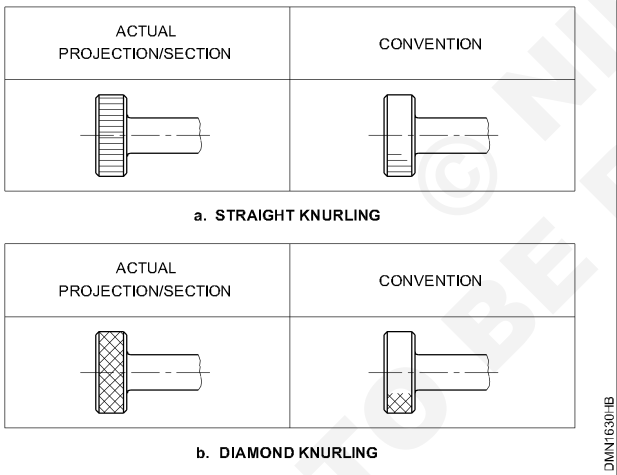


Fig 12

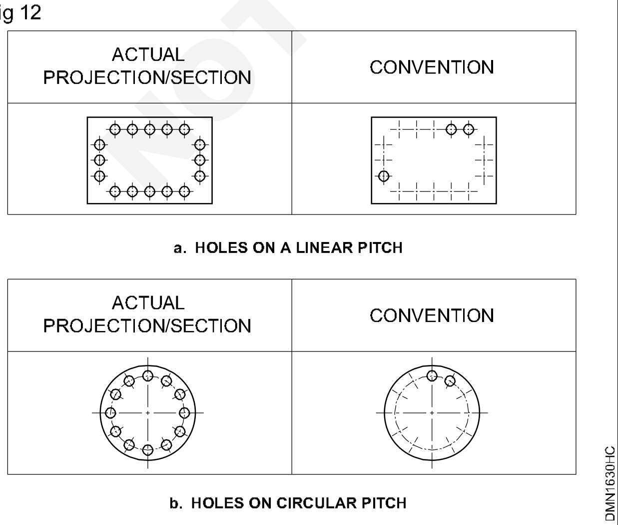


Fig 13

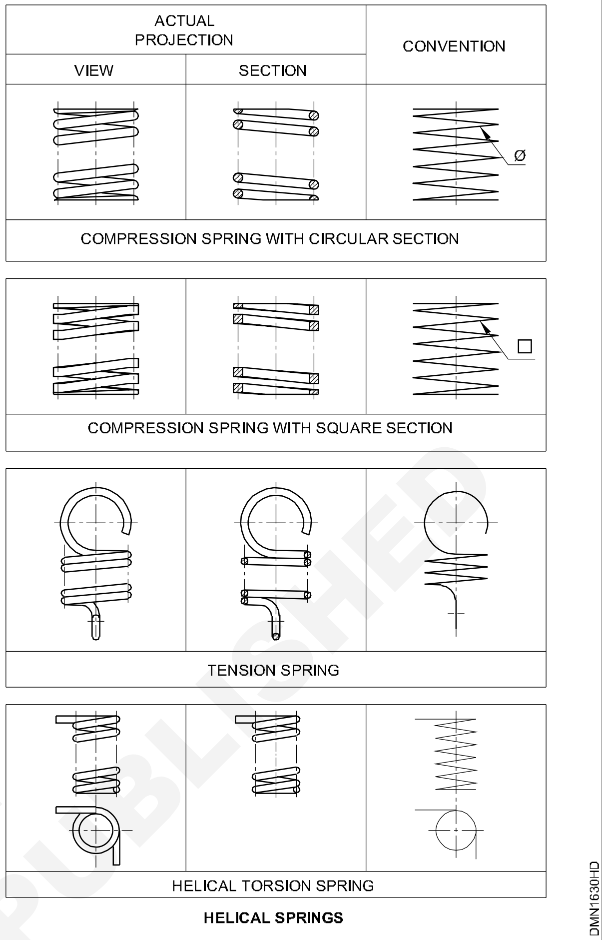
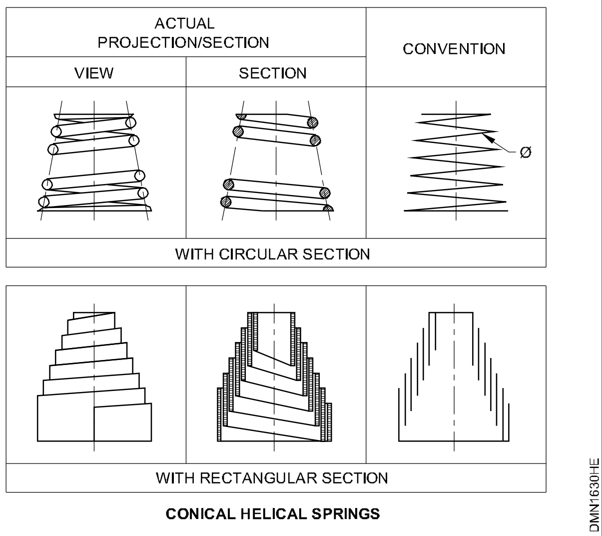
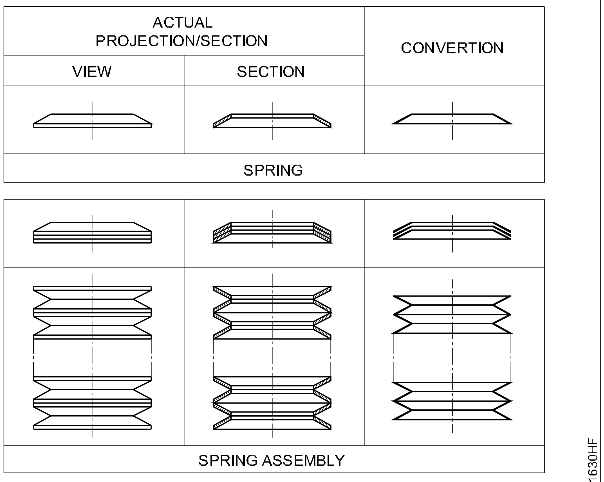


Fig 14



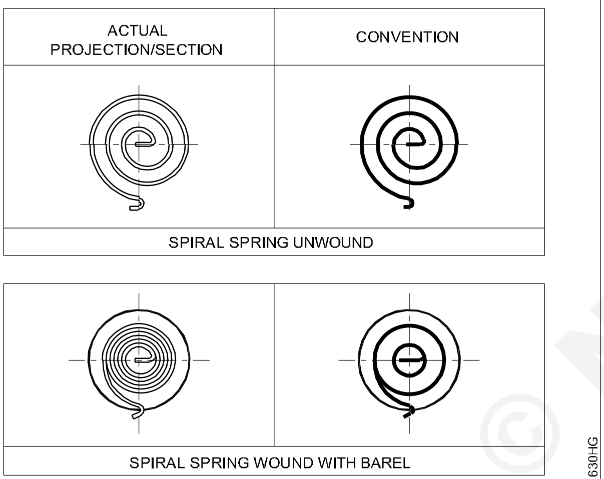
© NIMI NOT TO BE REPUBLISHED

Fig 15



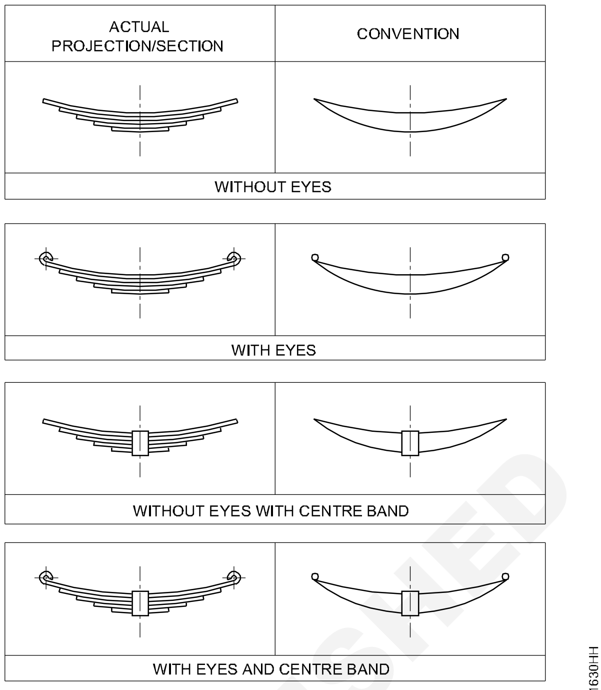
DISC SPRINGS

Fig 16



SPIRAL SPRINGS

Fig 17



LEAF SPRINGS

Fig 18

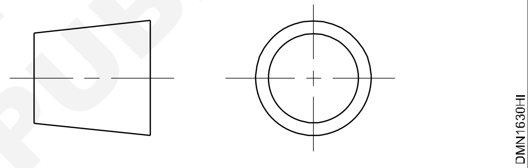
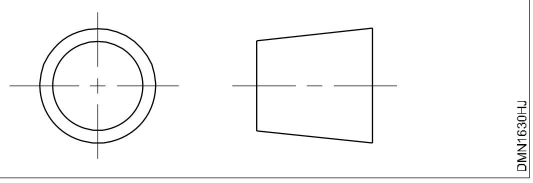


Fig 19



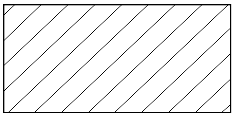
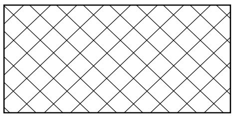
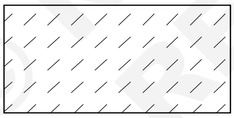
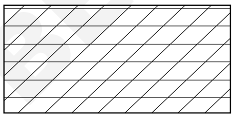
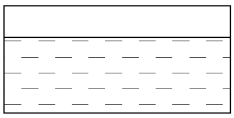
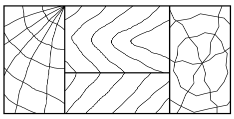
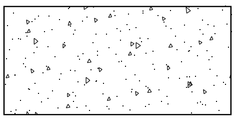
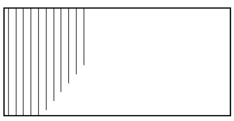
© NIMI
NOT TO BE REPUBLISHED

Draw different types of sectional lines - abbreviations for different materials as per SP - 46 - 2003

Objective: At the end of this exercise you shall be able to
- **conventional representation of different materials, gear assemblies and abbreviations used in engineering drawing.**

Exercise 1: Reproduce the conventional representation of materials using hatching shown in Table 1

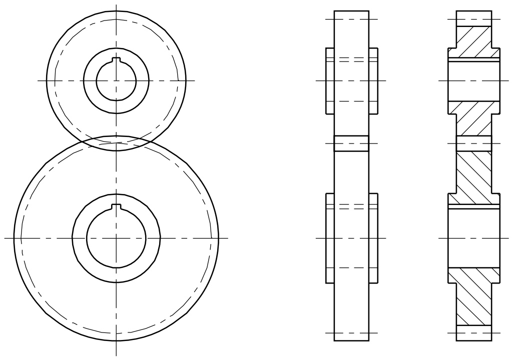
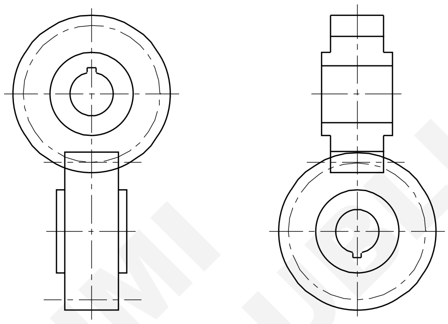
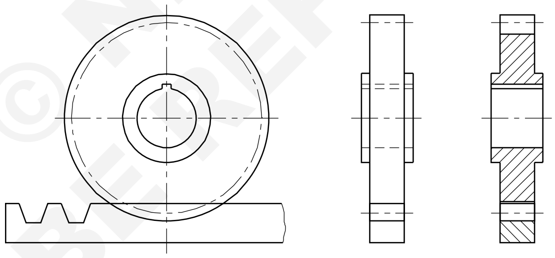
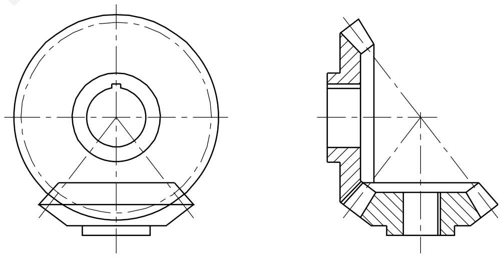
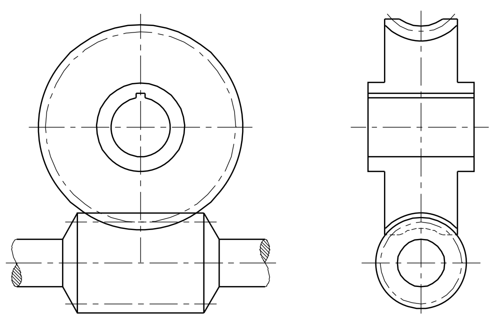
Table 1

Type	Convention	Material
		Steel, cast iron, copper and its alloys, aluminium and its alloys etc.
Metals		Lead, zinc, tin, white-metal etc.
Glass		Glass
Packing & insulating material		Porcelain, stoneware, marble etc.
Liquids		Asbestos, fibre, felt, synthetic resin products, paper, cork, linoleum, rubber leather, wax, insulating and filling materials.
Wood		Water, oil, petrol, kerosene etc.
Concrete		Wood, plywood etc.
Stacked lamination		–
		–

© NIMI NOT TO BE REPUBLISHED

Exercise 2: Draw the conventional representation of gear assemblies shown in Table 2.

Table 2

Title	Conventional representation
Spur/helical gears	
Screw gears	
Rack and pinion	
Bevel gears (Assembly)	
Worm and worm wheel	

© NIMI NOT TO BE REPUBLISHED

Abbreviations used in engineering drawing

Objectives: At the end of this exercise you shall be able to
- **state the meaning of abbreviation**
- **state the necessity of using them on drawings**
- **name the abbreviations and symbols used on technical drawings**
- **state typical use of conventions and representation of common features on technical drawings.**

Exercise 1: Reproduce the abbreviation view in the engineering drawing

Abbreviations: Abbreviations are short form of word or words which commonly used. Abbreviations and symbols be used sparingly only.

- When space saving in a drawing is essential
- Periods (fullstop symbol) are not to be used except where abbreviations marks a word. For example Fig 1.
- For hyphenated words, abbreviations are to be hyphened. Eg. Equi-spaced as Equi-SP.
- Sometimes one and the same letter symbol may represent more than one term or quantity. Eg. N - North as well as NEWTON. In such cases, it is advisable not to use such symbols to mean two different units in a single drawing. If it becomes unavoidable, the symbols may be provided with suitable subscript.

Typical uses of some abbreviations are shown below as per IS:11670

In general all the abbreviations are in capital letters.

– Across corner	A/C
– Across flats	A/F
– Alteration	ALT
– Approved	APPD
– Approximate	APPROX
– Arrangement	ARRGT
– Assembly	ASSY
– Auxiliary	AUX
– Bearing	BRG
– Cast iron	CI
– Cast steel	CS
– Centimeter	CM
– Centres	CRS
– Centre to centre	C/C
– Centre line	CL
– Centre of gravity	CG
– Chamfered	CHMMED
– Cheese head	CH HD
– Circumference	OCE
– Continued	CONTD
– Constant	CONST
– Counterbore	CBORE
– Countersunk	CSK
– Countersunk head	CSK HD
– Cylinder/Cylindrical	CYL
– Diameter	DIA
– Dimension	DIM
– Drawing	DRG
– Equi-spaced	EQUI-SP
– External	EXT
– Etcetera	etc.
– Figure	FIG
– Full indicated movement	FIM
– General	GEN
– Ground level	GL
– Hexagon/Hexagonal	HEX
– Horizontal	HORZ
– Hydraulic	HYD
– Head	HD
– Indian Standard	IS
– Inspection/ed	INSP
– Inside diameter	ID
– Insulation	INSUL
– Internal	INT
– Left hand	LH
– Long	LG
– Machine/Machinery	M/C
– Manufacturing	MFG
– Materials	MATL
– Maximum	MAX
– Mechanical	MECH
– Minimum	MIN
– Miscellaneous	MISC
– Modification	MOD
– Nominal	NOM
– North	N
– Not to scale	NTS
– Number	No.
– Outside diameter	OD
– Opposite	OPP
– Pitch circle diameter	PCD
– Quantity	QTY
– Radius	R
– Radius	RAD
– Reference	REF
– Required	REQD
– Right hand	RH
– Undercut	U/C

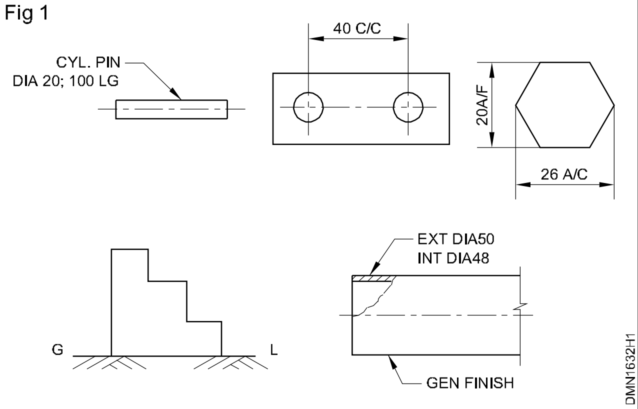
© NIMI NOT TO BE REPUBLISHED

– Weight WT
– With reference to WRT
– With respect to WRT
– Trapezoidal (Thread) Tr

Exercise 2: Application of symbol and abbreviation. (Fig.1)

Fig 1 show use of some of the above symbols and abbreviations.

Fig 1



Symbols used in engineering drawing

Angle (Structural section)	L
Approximately equal to	≈
Beam	
Channel	]
Degree (angle)	°
Degree celcius	℃
Diameter	ϕ
Horse power	hp
Parallel	//
Perpendicular	⊥
Minute and second	' and "
Square	☐

© NIMI NOT TO BE REPUBLISHED

Orthographic drawing of solids cube - prisons - cone & pyramids - finding the true shape of the surfaces cut by oblique planes

Objectives: At the end of this exercise you shall be able to
- **draw the auxiliary views of the inclined faces of geometrical solids**
- **draw the T and shape of geometrical figures.**

Exercise 1: Draw elevation, sectional plan and the true shape of the section of a square prism.

- Length of side of square prism standing vertically.
- One diagonal of the base is perpendicular to VP and another diagonal parallel to VP.
- Cutting plane makes 45° to the axis and intersects the axis 40 mm above the base.

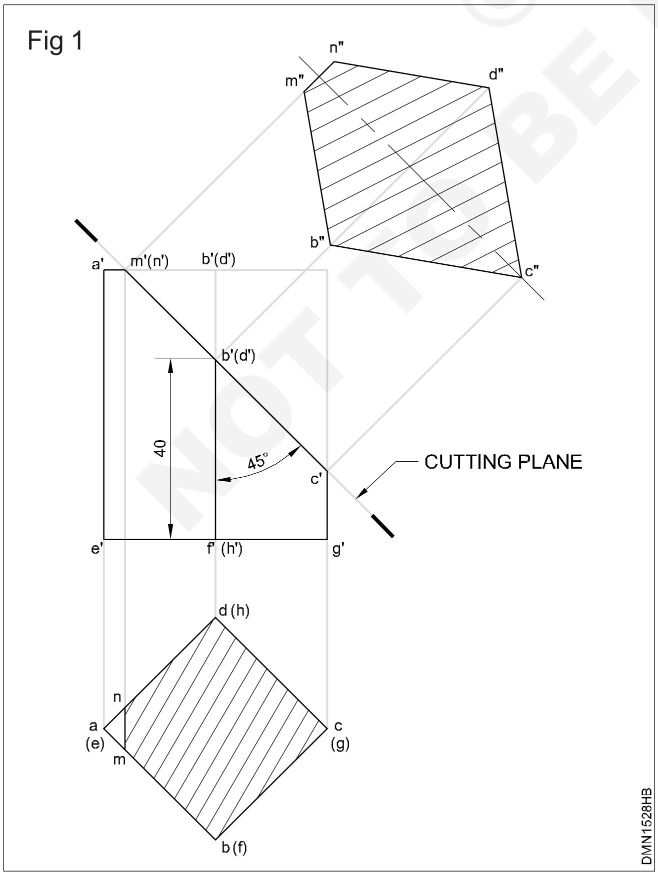
Draw the plan and elevation of the prism. (Fig 1)

- Draw the cutting plane in the elevation of the drawing.
- From the point m' draw projector to meet the plan at mn.
- Hatch the portion of the plan and complete the required sectional plan.

To get the true shape

- Draw a line parallel to the cutting plane.
- Draw projectors perpendicular to the cutting plane from points m',b' & c' and extend beyond the line, drawn parallel to the cutting plane.

Fig 1



- Transfer the distances mn and db symmetrically about the line and also mark c".
- Join m"-n", n"-d", d"-c", c"-b" & b"-m" and hatch the area to complete the required true shape. (auxiliary view)

Exercise 2: Draw the sectional plan, elevation and true shape of the cut surface of a cylinder given the details as under.

– Cylinder is of diameter 50 mm and height 60 mm stands on HP with its axis vertical.

– Cutting plane makes 40° to the horizontal and intersecting the axis at the mid-point of the vertical axis.

Draw the plan and elevation of the cylinder. (Fig 2)

- Indicate the cutting plane in the elevation.
- Divide the plan into any number of equal parts, (say 2) and mark the points a,b,c....l.
- Project the points a to l vertically to intersect the cutting plane line at a'b'c' etc.
- Project horizontally the points a,b...l in the plan by transfer method for the side view.
- Mark the intersection points of the corresponding projection in the previous two steps and complete the end view.

To draw the true shape of the section

- Draw a line AB parallel to the cutting plane line.
- Draw perpendicular projectors perpendicular to the cutting plane line.
- From points a',b', c' extend beyond the line AB.
- Mark the points a'_1,b'_1, c'_1 etc such that the distance l "b" k"c" at in the end view are equal to lb, kc etc in the plan.
- Join the points a'_1,b'_1, c'_1 and complete the true shape.

Exercise 3: Draw the sectional plan, elevation and true shape of the surface of a cone given with the following details.

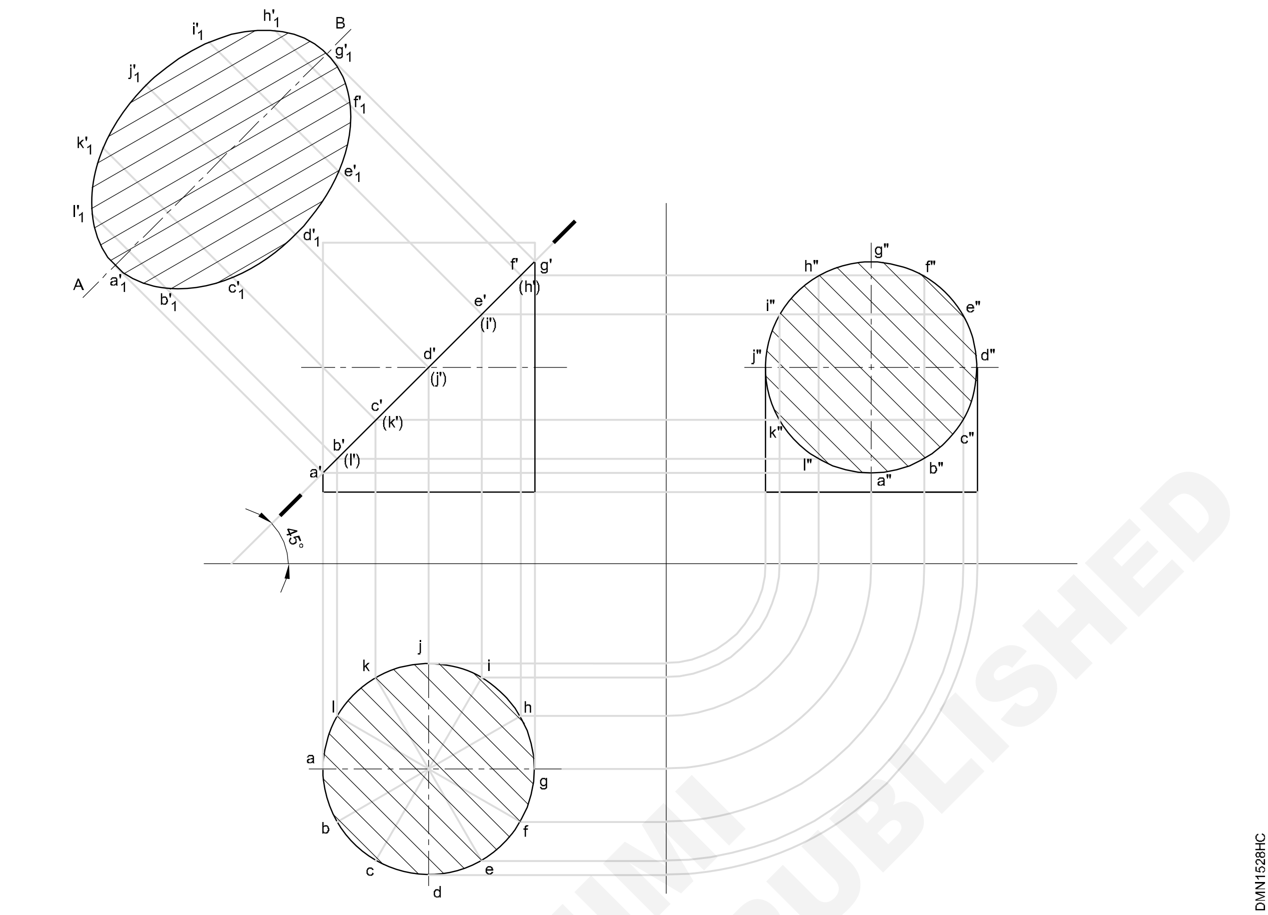
– Diameter of cone is 50 mm and height of cone is 65 mm.

– Standing vertically on HP.

– Cutting plane is parallel to slant length of the cone in the elevation at a distance of 10 mm.

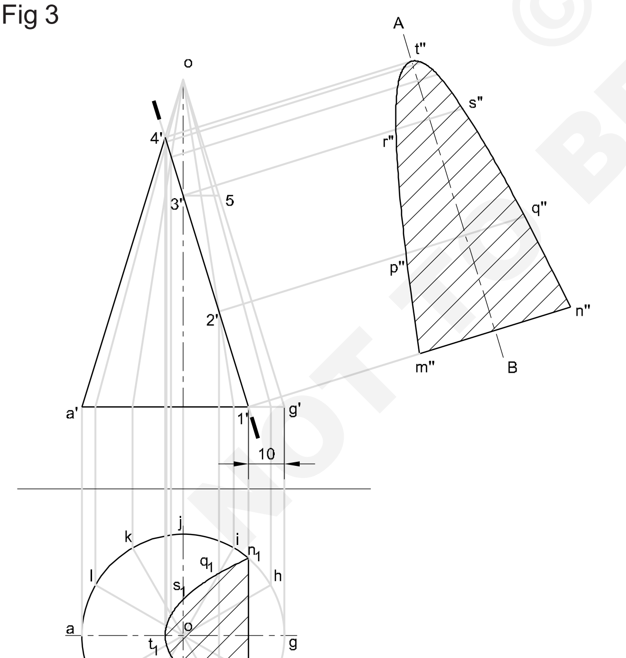
© NIMI NOT TO BE REPUBLISHED

Fig 2



Draw the plan and elevation of the cone for the given positions. (Fig 3)

Fig 3



- Draw the cutting plane in the elevation and mark the points 1',3' & 4'.
- Divide the plan into 12 equal parts and mark a,b,c,d...l.
- Project the points upwards and get the intersecting point 2.
- Project the point 1',2',3' & 4' downwards and obtain the points $m_1n_1q_1s_1t_1r_1$ & p_1.
- Joint the points and hatch the space. This is the required plan.
- Draw a line AB parallel to cutting plane at a suitable distance.
- Project the point 1',2',3' & 4' from the cutting plane, intersecting AB and extend beyond AB.
- Transfer the dimensions m_1n_1, p_1q_1, r_1s_1 and point t_1.
- Joint the line m"n" and draw a smooth curve through the points m",p", r", t", s", q" & n" and hatch the required auxiliary view.

Exercise 4: Draw the sectional plan, elevation and true shape of the cut surface of the hexagonal pyramid given the details as under:

– Side of the hexagon is 25 mm height of the pyramid is 65 mm.

– Stands vertically on its base with one edge of the base is parallel to VP.

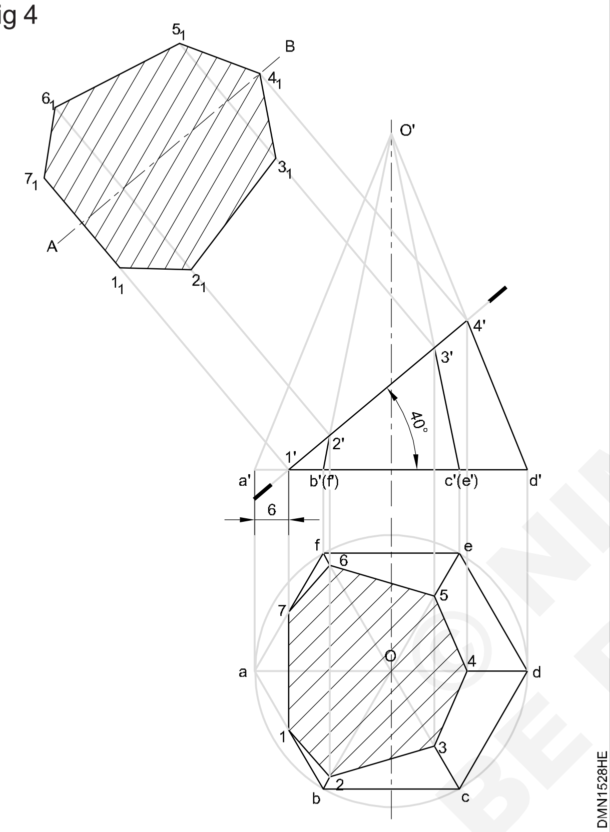
– Cutting plane makes 40° to HP and intersects the base at a distance of 6 mm from the left corner of the base.

© NIMI NOT TO BE REPUBLISHED

Draw the elevation and plan for the given position. (Fig 14)

- Draw the cutting plane in the elevation and mark points 1',2',3' & 4'.
- Project these points downward and beyond the line ad in the plan.
- Mark the points of intersection of the radial lines in the plan and projectors drawn in the previous step.
- Join the points marked in the previous step to form a closed figures and hatch the area. This together with the hexagon already drawn is the required plan.

Fig 4



To draw the true shape

- Draw a line AB parallel to the cutting plane.
- Draw projectors perpendicular to the cutting plane from points 1',2',3' & 4' and extend beyond AB. On the projectors drawn set off 1_1-7_1 equal to 1-7 of plan. Similarly set off the other points 2_1-6_1, 3_1-5_1 by transfering from the plan equals to 2-6, 2-5 respectively. The point 4_1 obtained by projecting the point 4'.
- Join all the points to form a closed figure and hatch the same to get the required true shape of the section.

Exercise 5: Draw the plan, elevation and (true shape) auxiliary view of a pentagonal pyramid of base 35 mm and height 65 mm given the condition as under:

– Standing vertically with one edge of the pentagonal base parallel to VP.

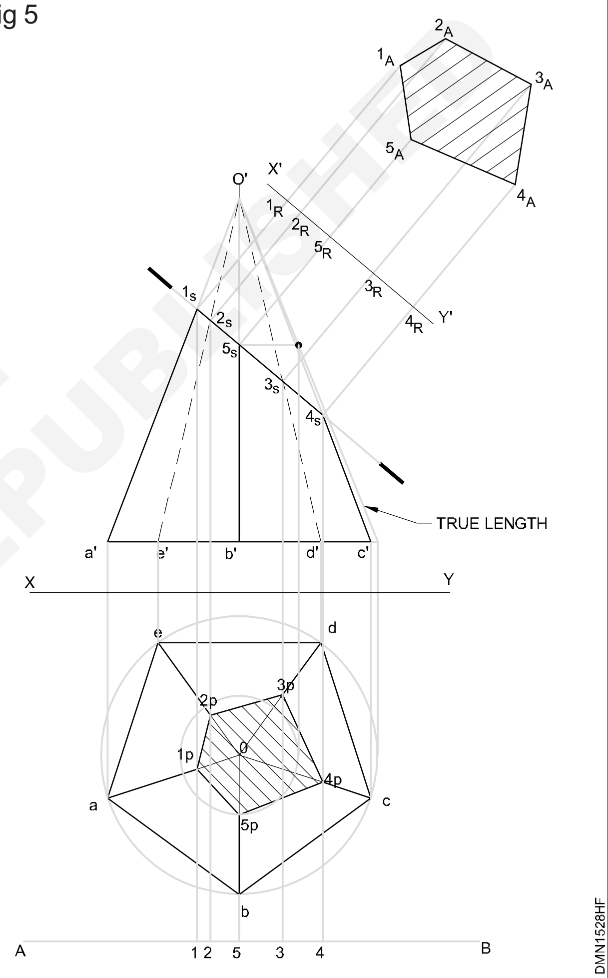
– The pyramid is cut by a cutting plane sloping towards left, at an inclination of 45° to HP passing through the axis at a point 40 mm above the base.

Draw the plan and elevation of the pentagonal pyramid. (Fig 5)

- Draw the cutting plane line and mark 1s, 2s, 3s, 4s & 5s at the intersection of this line and the lines of surfaces in front elevation.
- Draw the vertical projectors from the intersecting points cutting the radial line ao, co, do and eo at 1p, 2p, 3p and 4p respectively.

To obtain the point 5p in the plan. Draw a line parallel to base through 5s meeting the true length. Take the distance as radius set off with `O' as centre in the plan and 05p on the line Ob.

Fig 5



- Join 1p, 2p, 3p, 4p & 5p and hatch the space. this is the required sectional plan.
- Draw a reference line x'y' parallel to the cutting plain line.
- Draw perpendicular projectors to the cutting plane line from the points 1s, 2s, 5s & 4s beyond the reference line X'Y'.
- Draw line AB parallel to XY below plan.
- Project points 1p, 2p, 3p, 4p & 5p down to touch the line and mark points 1,2,5,3 & 4.
- Transfer the distance 1-1P from 1R and mark 1_A.

© NIMI NOT TO BE REPUBLISHED

- In the same way transfer 2-2p, 5-5p, 3-3p & 4-4p and get points 2A, 5A, 3A & 4A.
- Join points 1A, 2A, 3A, 4A & 5A and form the auxiliary view.

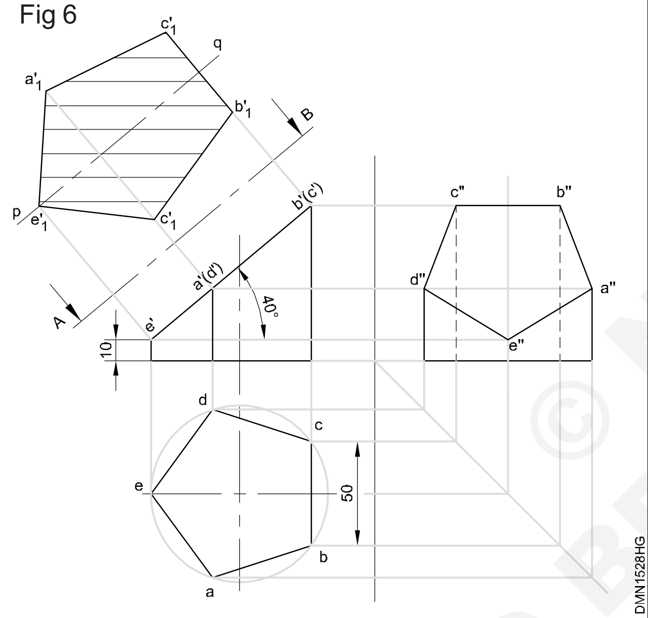
Exercise 6: Draw the plan, elevation, side view and true shape of the truncated surface of the pentagonal prism of side 50 mm given the following details:

– Side of prism 50 mm
– Prism standing vertically.
– One side of the prism is perpendicular to VP.
– The truncated surface makes 40° to the horizontal and at a height of 10 mm to the base.

Draw the plan and elevation of the truncated prism.(Fig 6)

- Mark the corners.
- Draw the centre lines of the prism.

Fig 6



- Draw the side view by projecting from plan and elevation.
- Mark the corners of the side view.
- Draw a line pq parallel to the inclined surface at a suitable distance.
- Project from the truncated surface and transfer the dimensions from side view to locate the corner points of the auxiliary view.
- Join the points to complete the required auxiliary view.

– The truncated cone is standing on HP.

Exercise 7: Draw the plan, side view and true shape of a truncated cone shown in figure given its position as under:

Draw the plan and elevation of the cone before it is truncated. (Fig 7)

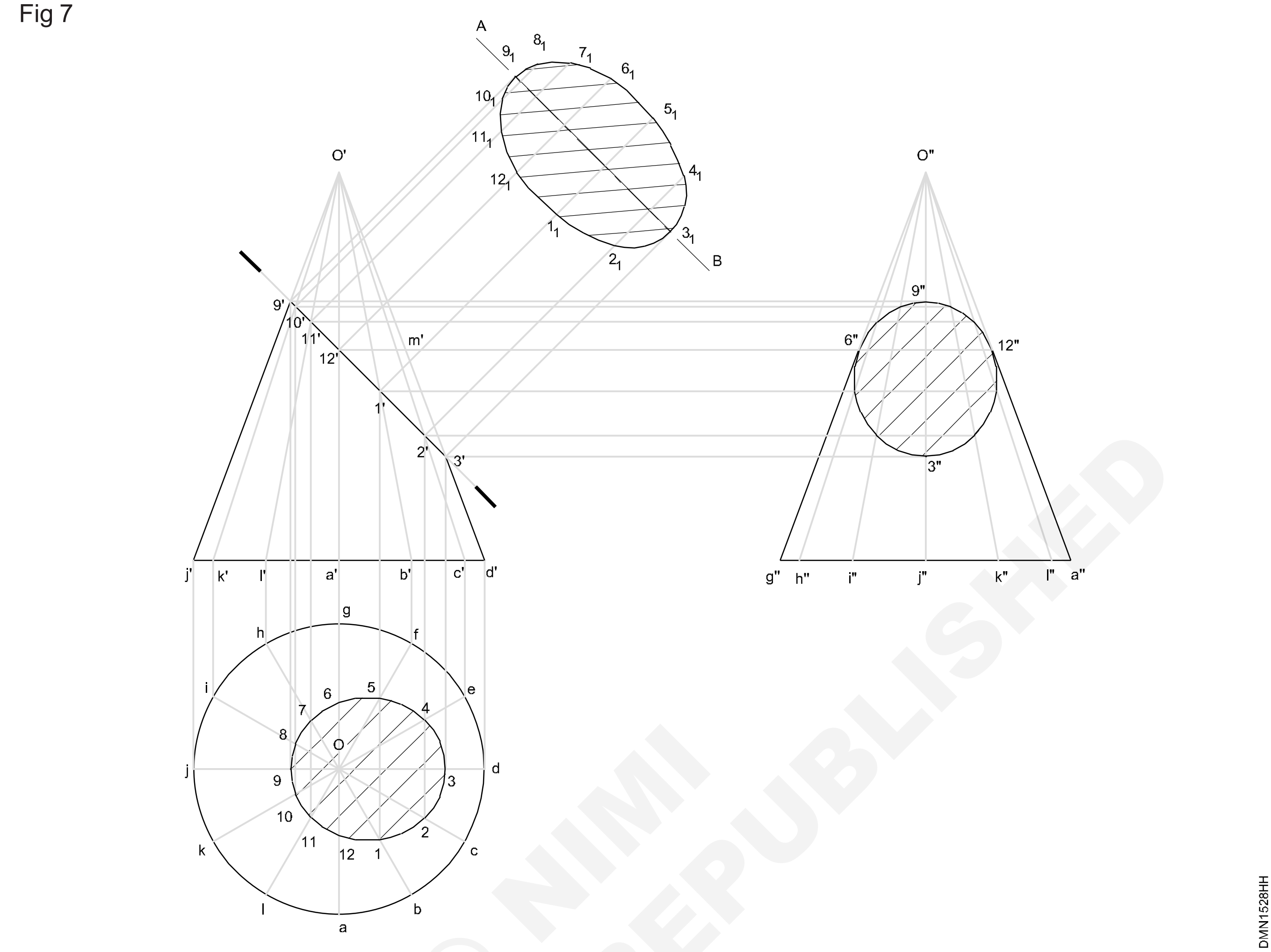
- Form the required elevation by drawing the 40° inclined line or edge.
- Divide the plan i.e circle of diameter 45 mm into 12 equal parts and mark them as shown.
- Draw vertical projectors to meet the base in the elevation and mark them as shown.
- Join these points with the apex of the cone and mark the points of intersection of these lines with the inclined line.
- From the points marked in the previous step, draw projectors downwards for the plan, horizontal projectors for the side view and project perpendicular to the 40° inclined line for auxiliary view.
- Mark the intersecting points of vertical projectors on the corresponding radial lines drawn from b,c,d,e,f,h,i,j,k,l at 1,2,3,4,5,7,8,9,10 & 11.
- Set off 0-6 and 0-12 equal to 12' - m' of elevation.
- Join the points 1 to 12 smoothly and complete the plan.
- Draw projectors from the plan and mark the intersecting points with the corresponding horizontal projectors and complete the side view.

To draw the auxiliary view

- Draw a line AB parallel to 40° inclined edge of the truncated cone.
- Draw perpendicular projectors from points 3', 2', 1' etc to the line AB and beyond.
- Project 3' & 9' meeting AB at 3_1 & 9_1 respectively.
- On the projectors drawn from the cutting plane set off 2_1-4_1, 1_1-5_1, 12_1-6_1, 11_1-7_1, and 10_1-8_1, equals to the distance 2-4, 1-5, 12-6, 11-7 and 10-8 of plan respectively.
- Join the points 1_1 to 12_1 smoothly and complete required auxiliary view.

© NIMI NOT TO BE REPUBLISHED

Fig 7



© NIMI NOT TO BE REPUBLISHED

Surfaces development of solids cylinder - prisons - core - pyramids and their frustum

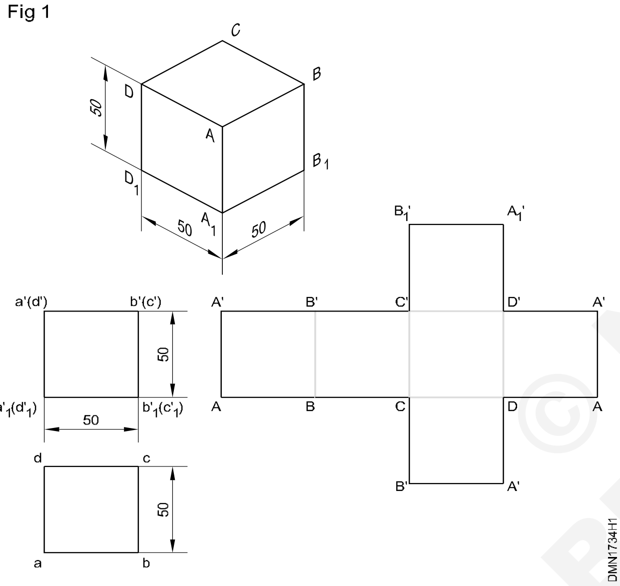
Objectives: At the end of this exercise you shall be able to

- **draw the developments of regular objects bounded by plane surfaces - cube, prisms etc.**
- **draw the developments of regular objects bounded by single or double curved surfaces - cylinder, cones, spheres**
- **development of regular objects with cut at some portions - frustum of cone, frustum of pyramid, cylinder/prism with cuts.**

PROCEDURE

Exercise 1: Draw the development o the surfaces of a cube of side 50mm. (Fig 1)

Fig 1

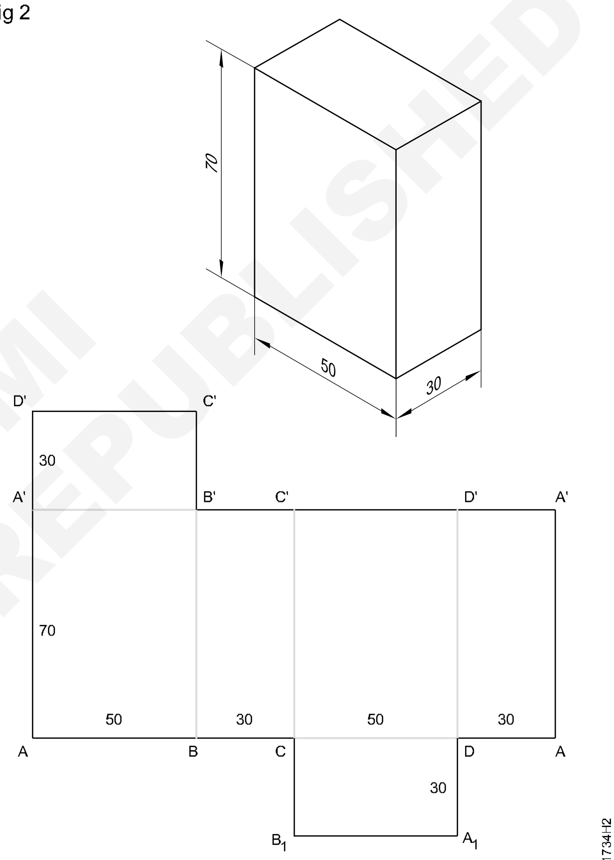


- Draw the elevation and plan of the cube.
- From the front view stretch out (Project) the line AA & A'A' from points b'$_1$ & b' horizontally.
- Set off AB, BC, CD & DA equal to 50 mm each (side of square).
- From C & D draw perpendiculars and mark off /CB' & DA' equals to 50 mm.
- Similarly erect perpendiculars from points C' & D' such that C'B'$_1$, & D'A'$_1$ equals to 50 mm.
- Darken the lines as shown in Fig 1 to get the required development of the cube.

Exercise 2: Draw the development of the surface a rectangular prism of size 50 mm x 30 mm and height 70 mm by parallel line method. (Fig 2)

- Draw a rectangle of length equals to the perimeter of the prism. Length = 2 (l + b) = 160 mm and height equals to the height of prism (70 mm).
- Mark AB; BC; CD and DA equals to 50, 30, 50 & 30 mm respectively.

Fig 2



DEVELOPMENT OF A RECTANGULAR PRISM

- Draw perpendiculars from the points A,B,C,D and mark as A', B', C', D'.
- Draw a rectangle A'B'C'D' on A'B' of size 50 x 30 mm.
- Draw another rectangle CD A_1B_1 on CD of size to 50 x 30 mm, the end faces of the prism. Figure obtained is the development of the total prism.

Exercise 3: Draw the development of the lateral surface of a open hexagonal prism of side 30 mm and height 80 mm. (Fig 3)

- Draw the elevation and plan of the hexagonal prism.
- Project A'A' & AA from the elevation C'C'$_1$ shall be equal to 6 x 30 = 180 mm.
- On A'A' set of A'1, 1-2, 2-3 etc. equal to the side of the hexagon.

© NIMI NOT TO BE REPUBLISHED

- Through A', 1,2,3 etc, draw vertical lines meet at AA, 1',2',3' etc to complete the required lateral surface development of the hexagonal prism.

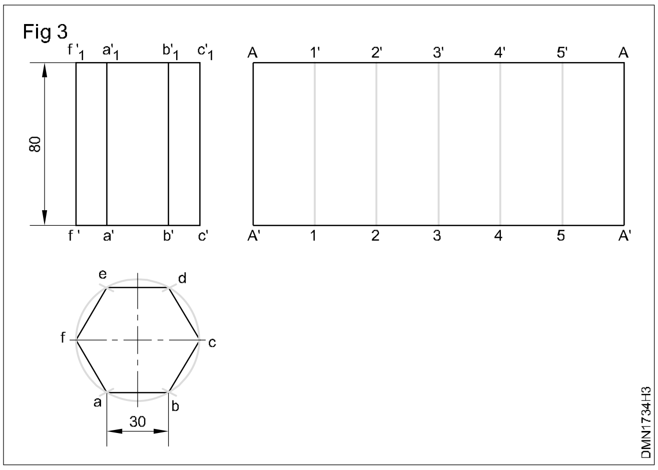


Fig 3

Exercise 4: Draw the development of the lateral surface of an open cylindrical drum of dia 40 mm and height is 60 mm. (Fig 4)

- Draw the plan and elevation of the drum as stated.
- Project the front view and draw the side view to a length of circumference of the base of the cylinder.

Circumference = $\pi D = \pi \times 40$ mm = 125.6 mm

Rectangle thus formed is the development of cylinder.

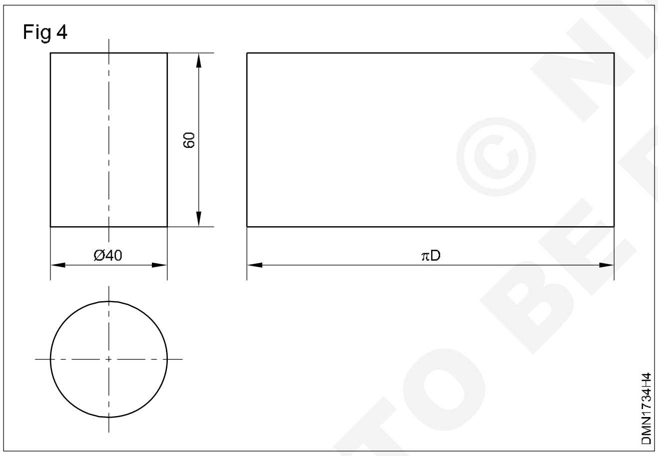


Fig 4

Exercise 5: Draw the development of a cone of base 60 mm and height 40 mm. (Fig 5)

- Draw the plan and elevation of the cone.
- Divide the plan circle into number of equal parts (say 12 parts) and mark.

> **Development is more accurate if the number of equal parts are more.**

- Project these parts to the base of the cone.
- Join these points to the vertex of the cone.
- Locate O_1 vertex for the development of cone.
- Draw an arc from the vertex as centre and length of slope as radius.
- Set divider on the straight distance between two consecutive points on the plan.

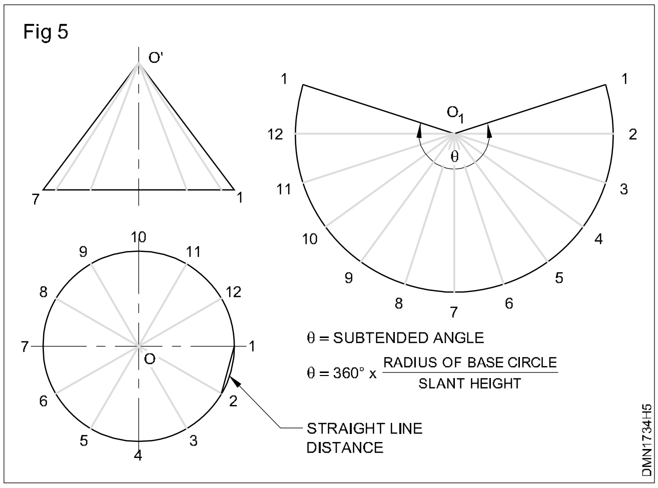


Fig 5

- Transfer the distance along the arc as many times according to the divisions on the plan.
- Join points 1 O_1 1and complete the development.

> **This method is only an approximate method. The straight line distance taken is slightly smaller than the arc length. More accurate method is by calculating actual circumference and dividing it into number of segments.**

Exercise 6: Draw the development of the lateral surface of a square pyramid of base 40 mm and vertical height 60 mm. (Fig 6)

- Draw the plan and elevation of the pyramid.

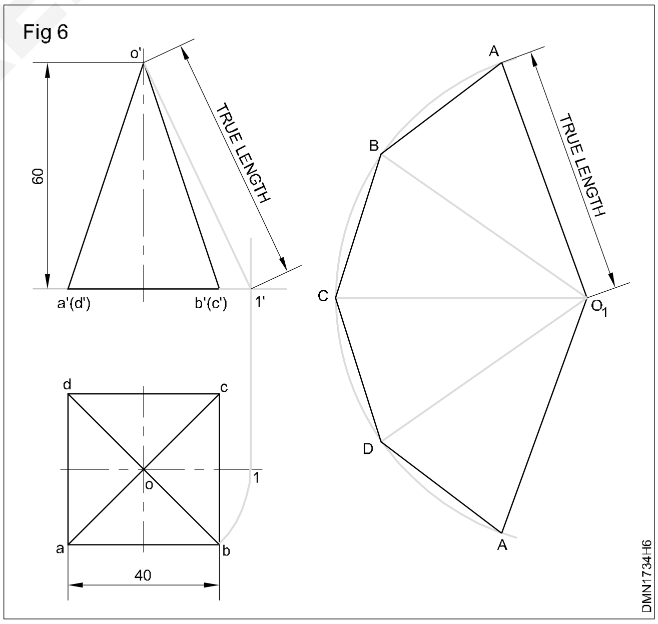


Fig 6

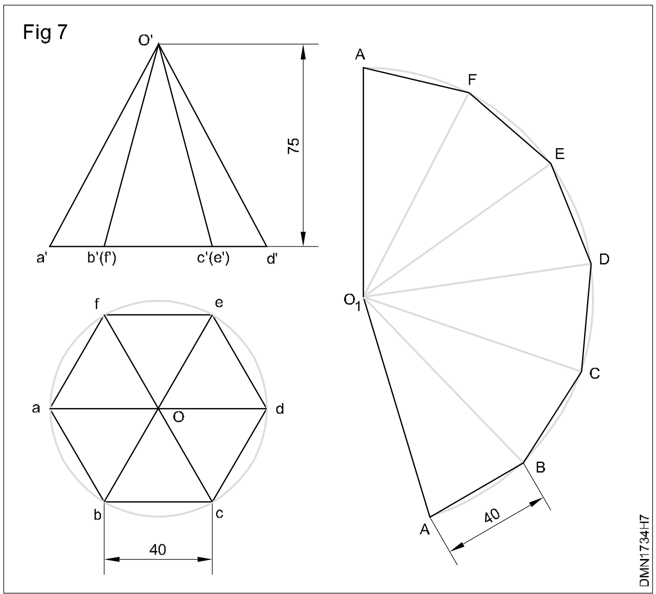
- With `O' as centre in top view and ob as radius, draw an arc to meet the axis at 1. (O' - Vertex)
- Project the point 1 to front view to meet the base line at 1'.
- Join O'1' which is the true slant length of the pyramid.
- With `O_1'as centre and true length as radius draw an arc and set off the sides of the pyramid on the arc at A,B,C,D & A.

© NIMI NOT TO BE REPUBLISHED

- Join O_1A, B, C, D, AO_1 which is the required development.

Exercise 7: Draw the development of the lateral surface of a hexagonal pyramid of side 40 mm and height 75mm. (Fig 7)

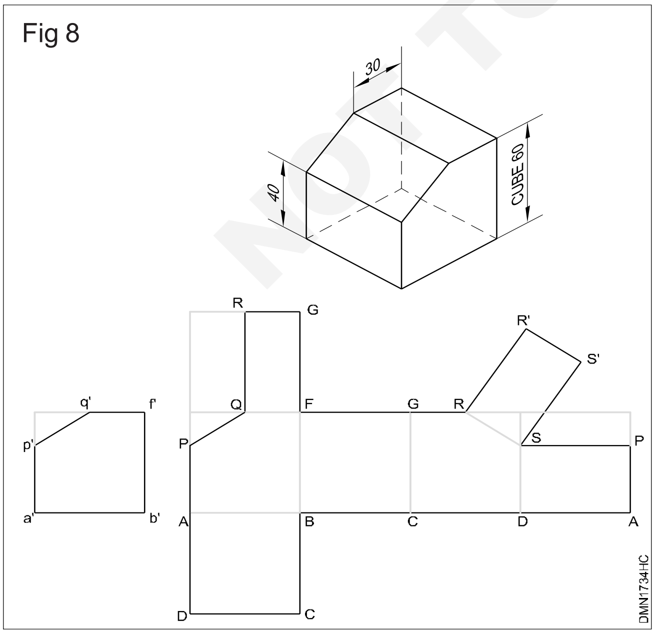
Fig 7



- Draw the top view and front elevation of the hexagonal pyramid.
- With `O_1 ' as centre and slant length as radius draw an arc.
- Set off six equal sides (40 mm) on the arc at A,B,C,D,E,F & A.
- Join O_1, A,B,C,D,E,F and A O_1. Complete the lateral surface development of the pyramid.
- The circumference of each cone as the straight line distances (π x d) of its base.
- Development of cone 1

Exercise 8: Draw the development of surfaces of the box. (Fig 8)

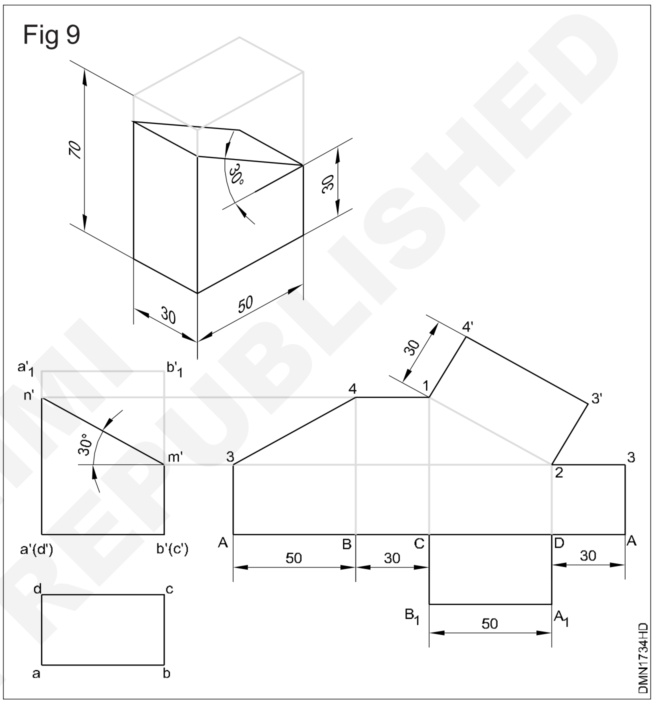
Fig 8



- Assume there is no slope surface and draw the development of a cube of 60 mm as given in Ex. No.1.
- Draw lines PQ and RS in the surfaces 1 and 3 in the basic development equivalent the shape shown in the isometric view of the box.
- Similarly join a rectangle of size equal to the surface 7 shown in isometric view with line RS or PQ and complete the development after erasing the construction lines.

Exercise 9: Draw the development of a rectangular prism as stated under and as shown in Figure. Prism is cut by a cutting plane at 30°, 30 mm from base on width side. (Fig 9)

Fig 9



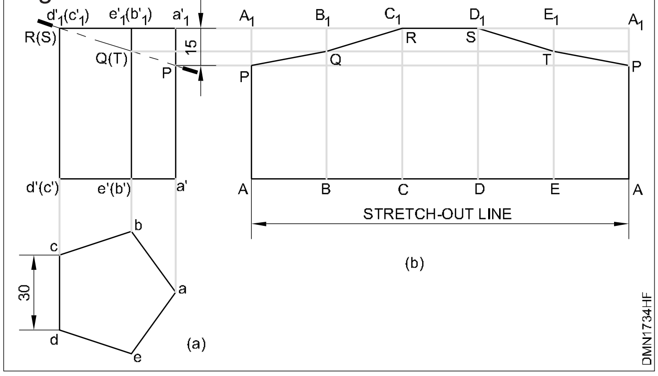
- Draw the top view and front view of the rectangular prism.
- Mark 30 mm on front view from b' (c') to meet the line b'b'_1 at m'
- At m' make an angle of 30° such that the cutting plane meet the line a'-a'_1 , at n'.
- Project b', m', n' horizontally and mark of AB = 50, BC = 30, CD = 50 & DA = 30 mm.
- From A,B,C,D,A of the front view, draw vertical lines and mark points 3, 4,1,2 & 3_1 .
- Draw 1-4' and 2-3' perpendiculars to 1-2 equals to 30 mm and draw CB_1 & DA_1 perpendicular to CD and equals to 30 mm.
- Thick the lines throught A,B,C,B_1,A_1,D,A which is the development of the given prism.

Exercise 10: Draw the development of the lateral surface of the truncated pentagonal prism as positioned. (Fig 10)

- Draw the top view and front view of the given solid as positioned and stated in Fig 10.

© NIMI NOT TO BE REPUBLISHED

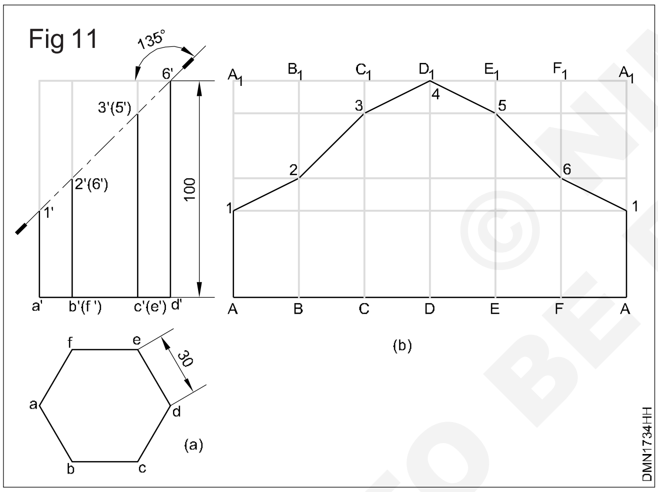
Fig 10



- Draw the cutting plane line as shown in figure intersecting the edges at P,Q,R.
- Project from front view a' the stretch out line AA and setoff the sides AB, BC, CD, DE and EA.
- Project the points P,Q,R from the front view on the corresponding edges of the prism.
- Join points P,Q,R,S,T and P with straight lines completes the development.

Exercise 11:Draw the development of a hollow hexagonal prism as positioned. (Fig 11)

Fig 11

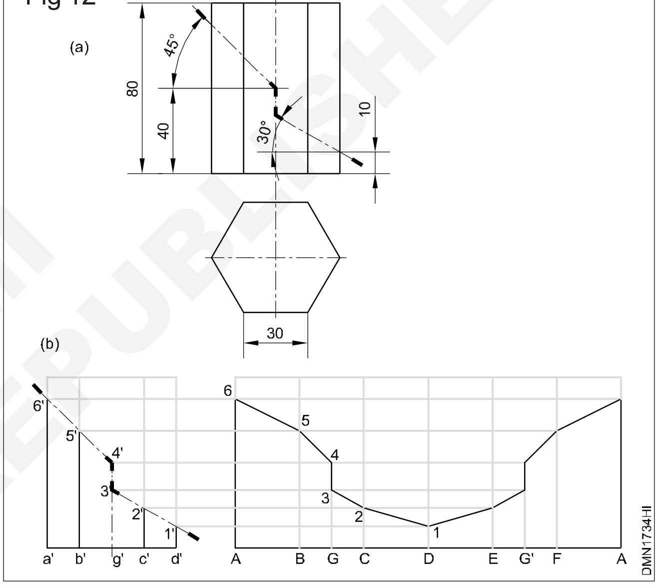


- Draw the elevation and plan of the hexagonal prism in the given position as stated.
- Draw the cutting plane line in the elevation and mark the cutting points 1',2' (6') 3'(5') & 6.
- Draw the plan of the prism as shown and name the corners. (Fig 11)
- From the elevation project the stretchout line A_1A_1 and AA and draw the development of the lateral surface as done in earlier exercise.
- From elevation through points 1',2',3' draw horizontal lines to intersect at 1,2,3,4,5,6 & 1 respectively.
- Join all the points in sequence and complete the required development. (Fig 11)

Exercise 12:A hexagonal prism of side 30 mm and height 80 mm is cut along the cutting plane. (Fig 12)

- Draw the plan and elevation of the hexagonal prism.
- Draw the cutting plane 30° 45° as indicated. (Fig 12)

Fig 12



- Consider the prism as whole and draw the full development.
- From the cutting point of the front view. Draw the horizontal lines to intersect the development at 1,2,3,4,5 & 6. Join all the points by straight lines. Complete the other half in the same procedure and complete the required development. (Fig 12)

© NIMI NOT TO BE REPUBLISHED

Development of an oblique cone with elliptical base cone with elliptical base

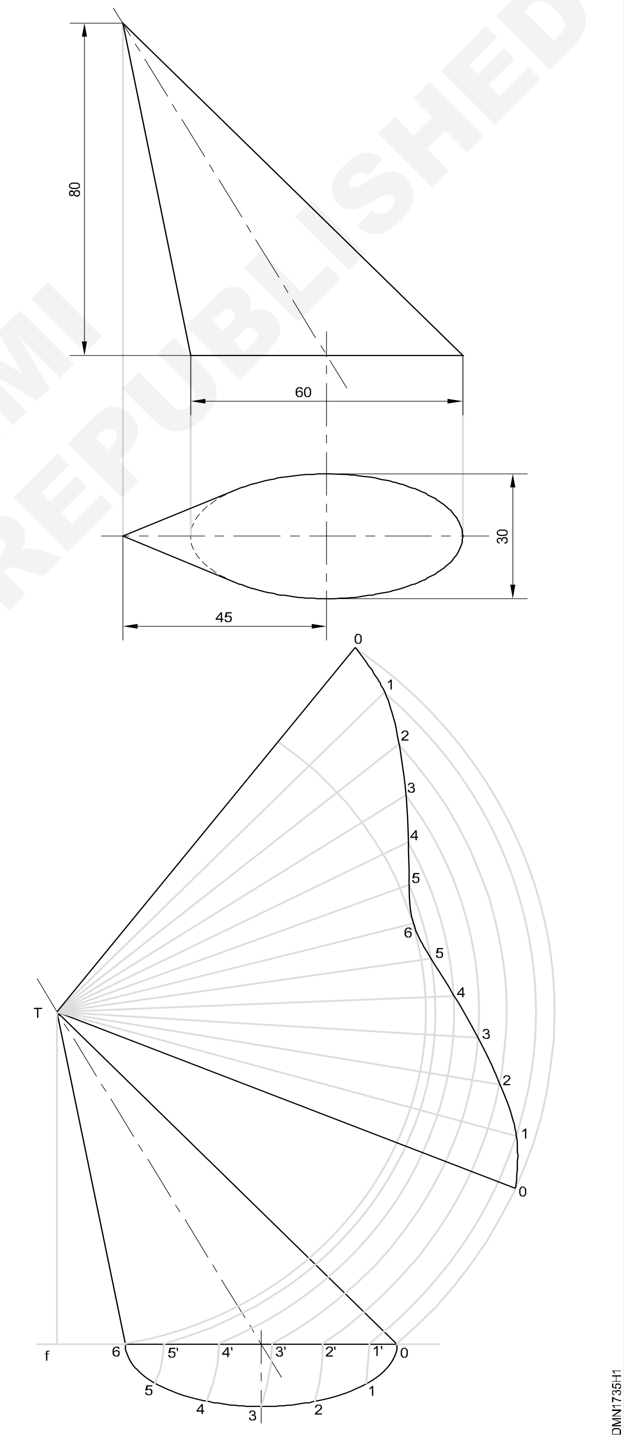
Objective: At the end of this exercise you shall be able to
- **construct the development of an oblique cone with elliptical base.**

PROCEDURE

Exercise 1 : Draw the elevation of its oblique elliptical cone

- Major axis 60mm
- Vertical height 80mm
- Draw the elevation of the oblique elliptical cone (Fig 1). On the base draw half plan of the cone as shown in Fig.1.
- Divide the circumference of the base into 12 equal parts, whereas it has been shown 6 equal parts.
- From the point 'T' appex of the cone draw a perpendicular to the base meeting at 'f'.
- Now with 'f' as centre, f1 as radius and 'f' as centre, draw arcs and obtain the points 2'3'... and 5'.
- 'T' as centre and T0 as radius swing arc and set off T0 and Td as shown in Fig 1.
- In the same procedure swing arcs with 'T' as centre and T1', T2', T3', T4', T5' and T6' as radius.
- Set off the points on the arcs with the true length T1', T2'... etcs.
- Join all these points C, 1,2,3 ... by a smooth curve to obtain the required lateral surface development of the elliptical base oblique cone and complete the drawing.

Fig 1



© NIMI NOT TO BE REPUBLISHED

Development of three piece pipe elbow - a pipe hole through it - a bucket and a funnel

Objectives: At the end of this exercise you shall be able to
- **draw the curve of intersector and surface development**
- **draw the development of lateral surface of a funnel**
- **draw the development of three cylindrical pipes as positioned.**

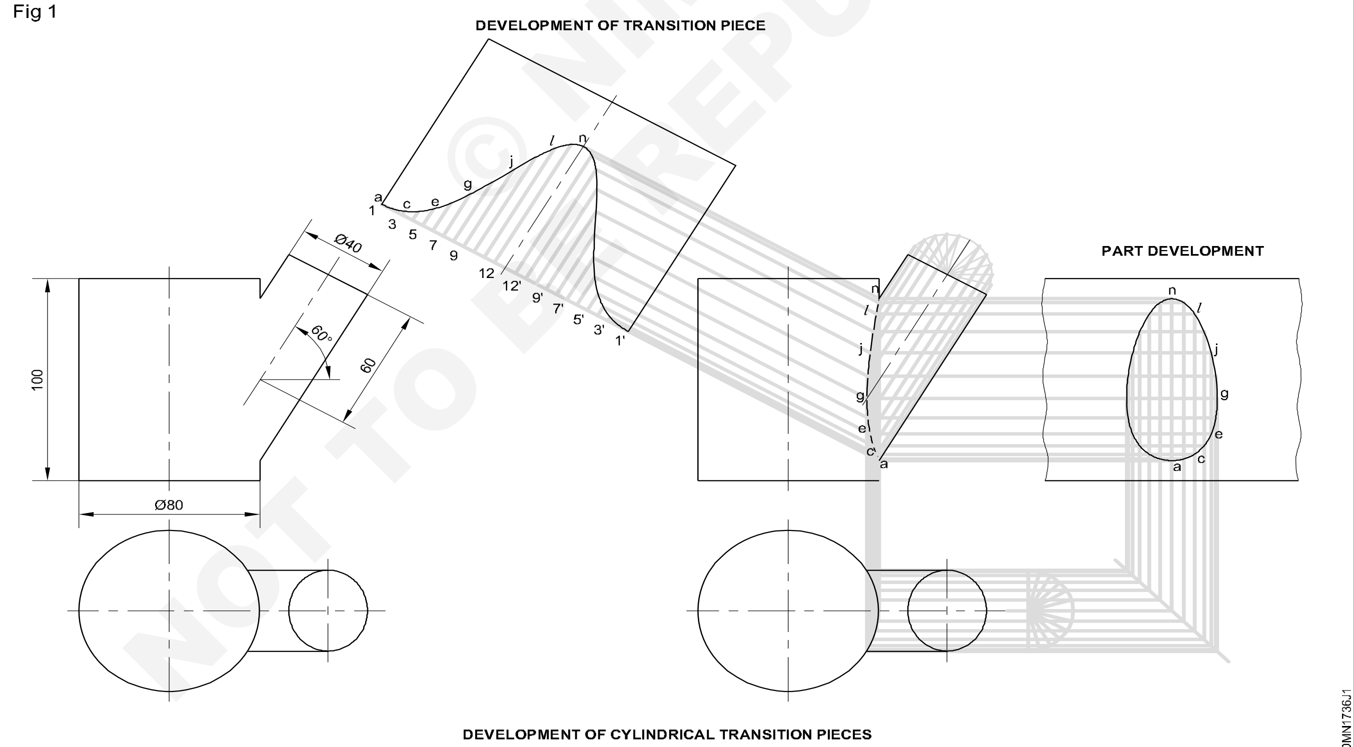
PROCEDURE

Exercise 1: Fig.1

A vertical cylinder dia 80,100 long is intersected by another cylinder of dia 40 at 60°. (Fig 1) Draw the curve of intersection and the surface development.

- Divide the branch pipe in the top view and mark the corresponding division on it.
- By projection from to top view draw the intersecting curve on the elevation.
- Draw the horizontal projectors from the points on the FV as shown.
- Transfer the points on branch pipe a,b,.. on to the corresponding projectors.
- Join all the points with a smooth curve representing developments of hole.
- Draw the full development of the branch pipe at right angles to its axis.
- Transfer the points on to the development showing that of transition pipe.

Fig 1

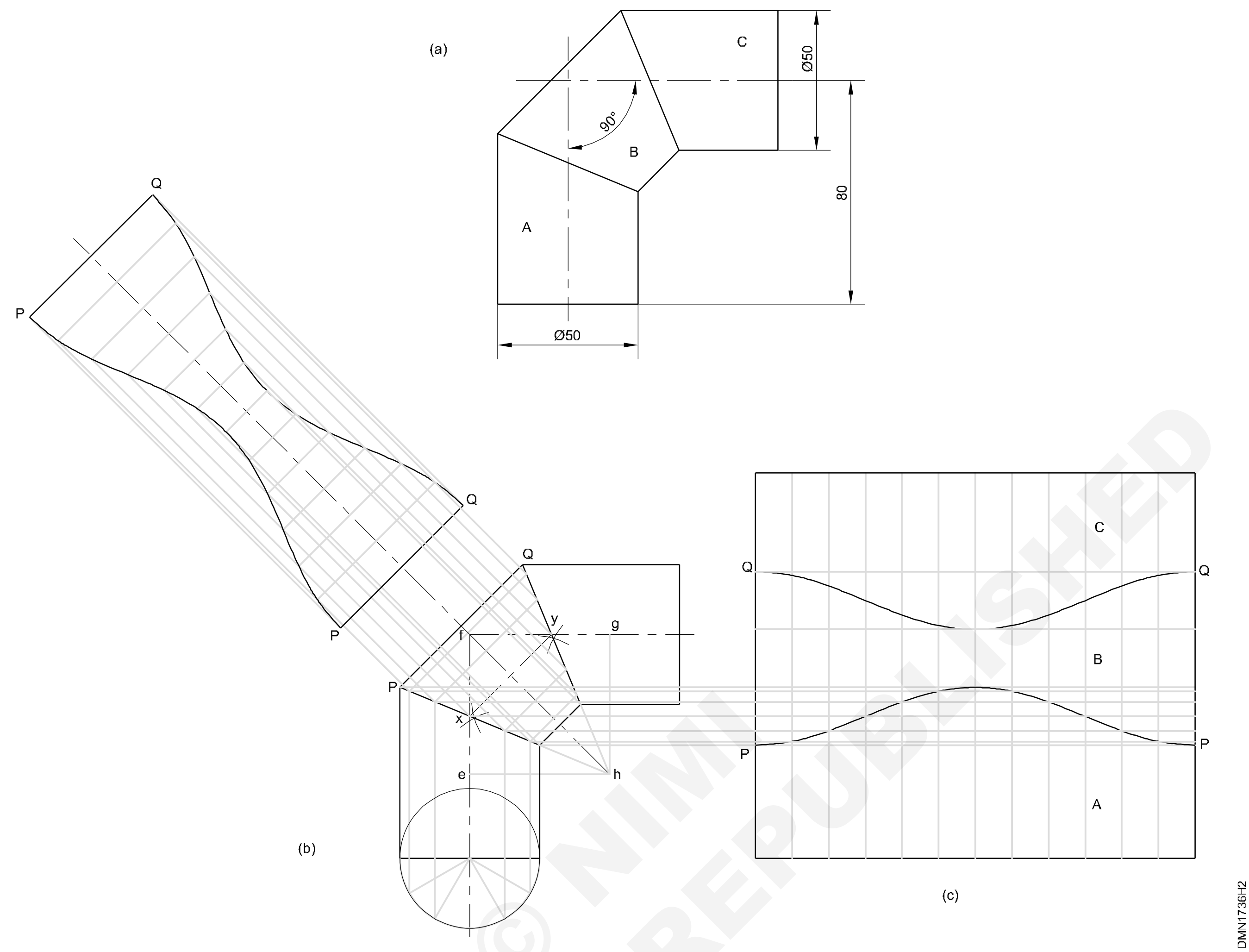


© NIMI NOT TO BE REPUBLISHED

Exercise 2: Draw the development of the lateral surface of the three pieces of cylindrical elbow pipes. (Fig 2)

- Draw the front view of the elbow as given in the figure.
- Draw the square `efgh' of sides equals to diameter of the pipes. (50 mm)
- Bisect the angle `ehf' by the bisector `bh' and the angle `ghf' by the line `qh' to intersect `ef' and `gf' at x & y respectively. xy is the axis of middle piece B.
- Parts A & C are similar shape of cylinder truncated at one end only.
- The part A is developed, which is in line with base.
- The part B is truncated at both ends, it is developed on the stretch outline through h at right angles to xy. (like auxiliary view)

Fig 2



- As the curve B is similar to the curves of A & C and hence the three developments may be drawn combined. (Fig 2c)

Draw the development of the lateral surface of a funnel as positioned. (Fig 3)

- The parts (A & B)of the funnel are in the shapes of frustum of cones.
- Development of cone and frustum of cone are already dealt in earlier exercises. Follow the previous procedures and draw the developments of both parts A and B.

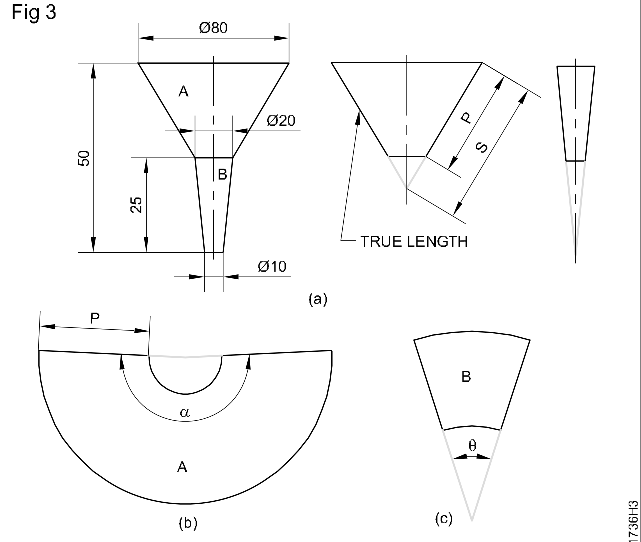
Formula for finding angle

$$\alpha = \frac{\text{Radius of base cone circle}}{\text{Slant height}} \times 360^\circ$$

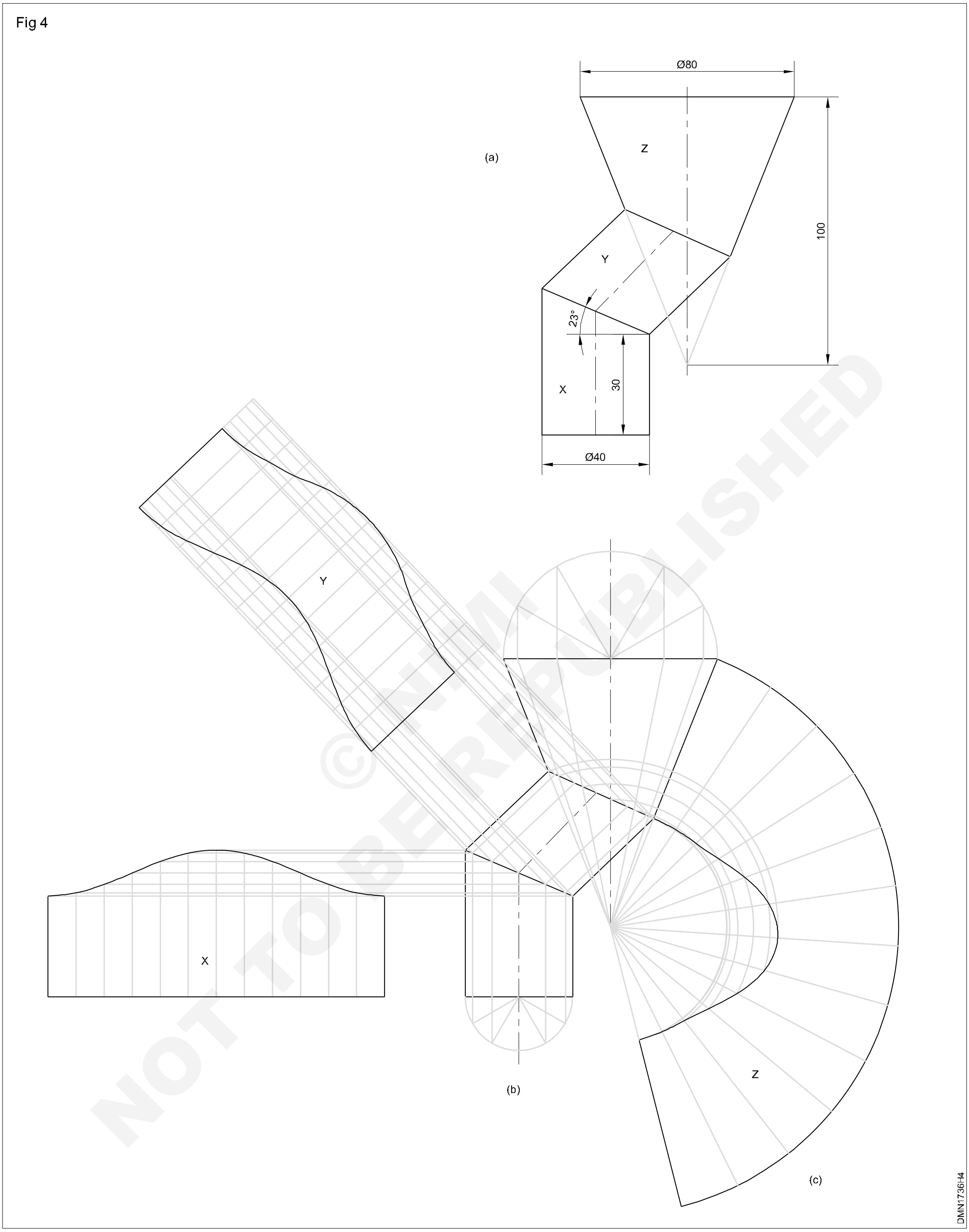
Develop the sheet metal required for the funnel. (Fig 4)

- The sheet metal funnel (Fig 4a) consists of conical part Z and two cylindrical pipes Y and X.
- Draw the development of pipes referring to earlier exercises and the shape of the development. (Fig 4b & 4 c)

Fig 3



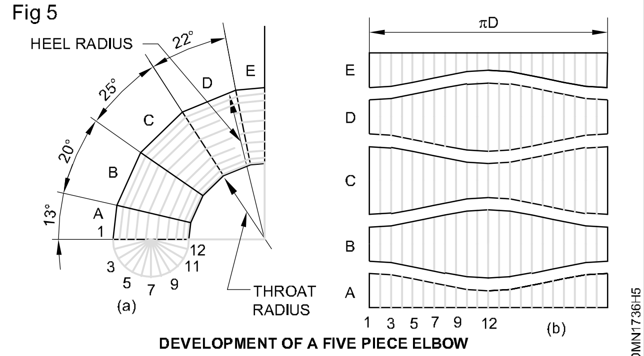
DEVELOPMENT OF A FUNNEL



Draw the development of the lateral surface of the elbow of pipes joined. (Fig 5)

- Draw the view of the pipe as given.
- Find the circumference/perimeter graphically.
- Develop the lateral surface as done in earlier exercises for each part A,B,C,D & E.

Fig 5



DEVELOPMENT OF A FIVE PIECE ELBOW

Draw the development of intersecting cylinders of dia 30 mm at 120°. (Fig 6)

All the cylindrical pipes are of same diameter and intersecting each at equal angles. Hence in this case the development of all the pipes are same and so the development of one pipe will represent other pipes.

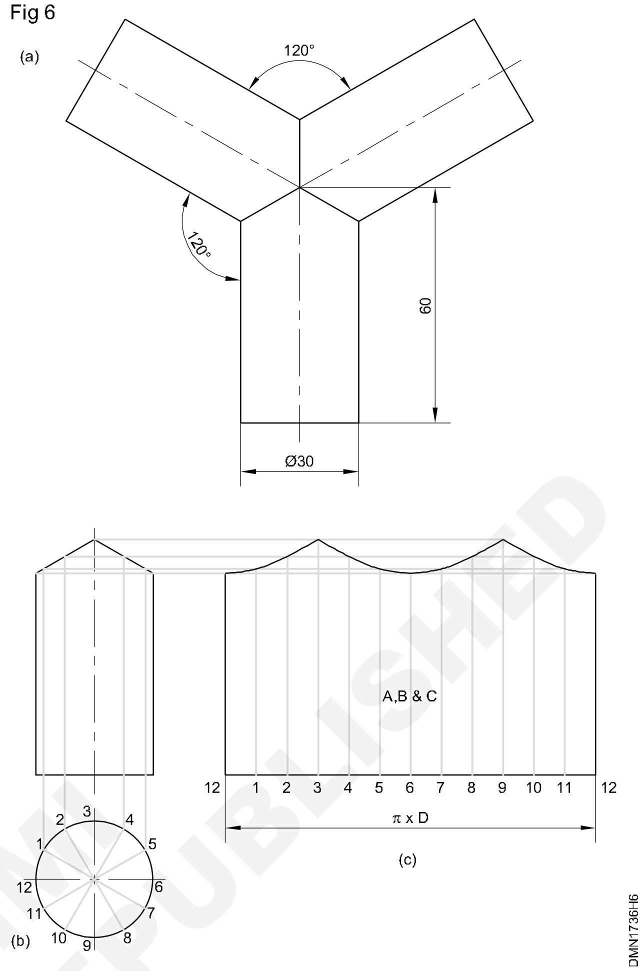
- Draw the plan and elevation of the pipe `A' and mark the division on the plan. (Fig 6b)
- Draw the vertical projectors from the plan to front view to meet the line of intersection.
- Draw horizontal projectors from these points on to the development.
- Mark the intersecting points and join with a smooth curve to complete the required development.

Three cylindrical pipes of X,Y,Z form a `Y' piece. (Fig 7) Draw the lateral surface development of each pipe.

In the three pipes XYZ, Y & Z are similar in size and shape, hence their developments are also similar.

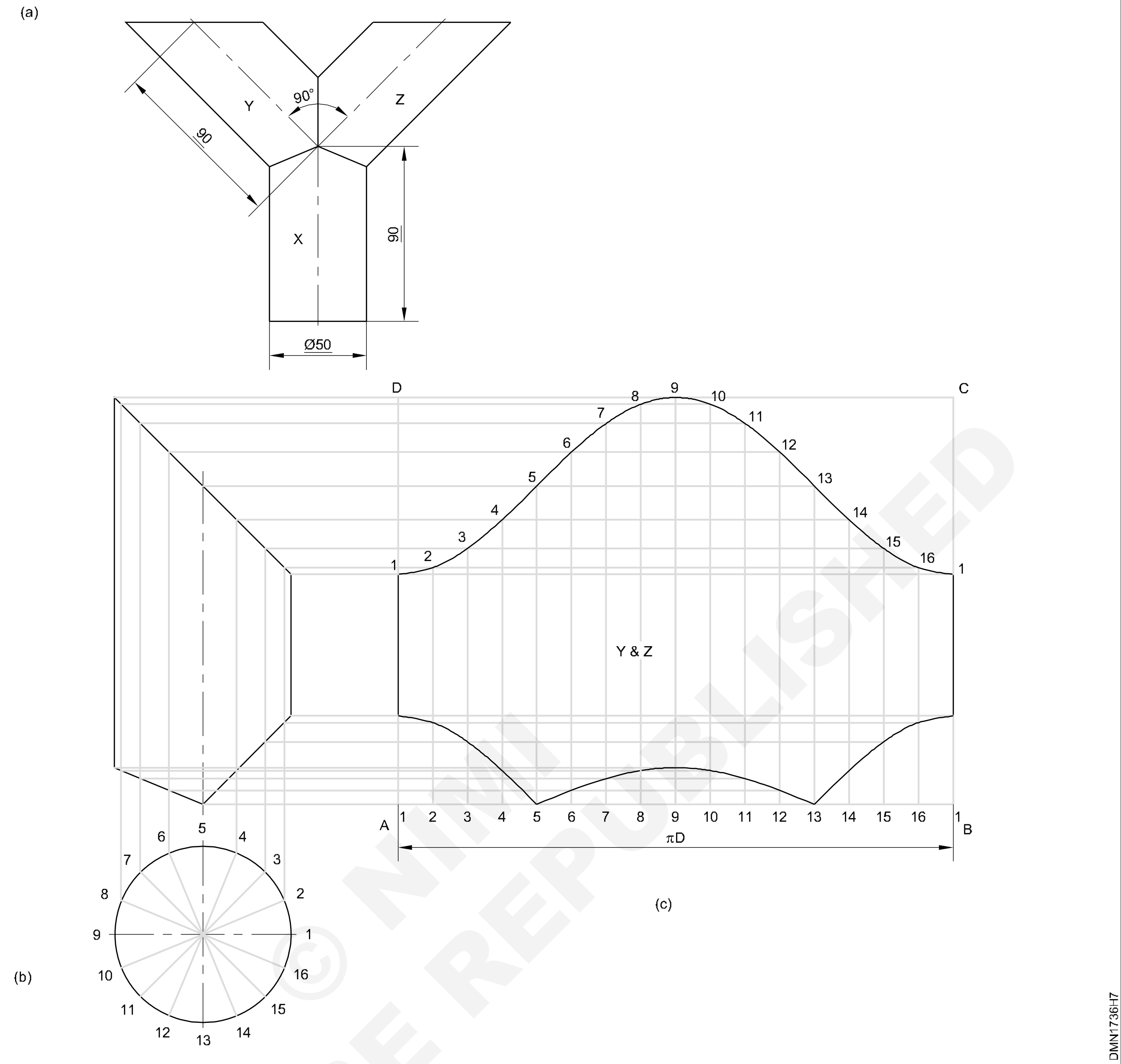
- Draw the development of pipe `X' as in the previous exercise.
- Draw the elevation and plan of pipe `Y' as shown.
- Divide the plan circle into 16 equal parts.
- Project the points to the elevation.
- Draw the rectangle ABCD in which AB is equal to πD
- Draw the development of pipe Y as shown.

Fig 6



© NIMI NOT TO BE REPUBLISHED

Fig 7



NOT TO BE REPUBLISHED © NIMI

Construct orthographic of interpenetrating solids (cylinder - cones - prisons and pyramids) of axes at right angles to each other and inclined to each other

Objective: **At the end of this exercise you shall be able to**
- **draw the line of intersection of prism with prism.**

Exercise 1

Draw the line of intersection of prisms.

Two square prisms A and B positioned as stated below intersect each other. Draw the plan, elevations and show the line of intersection. Prism `A' is resting vertically and with two of its lateral faces making 45° to X'Y'. (VP) The axis of prism `B' intersects `A' at mid-point and is perpendicular to each other, also lateral face of prism `B' makes 45° to H.P (x,y) and its axis parallel to VP. The dimensions of prisms are:

– **Side 40 mm and height 60 mm (Prism A)**

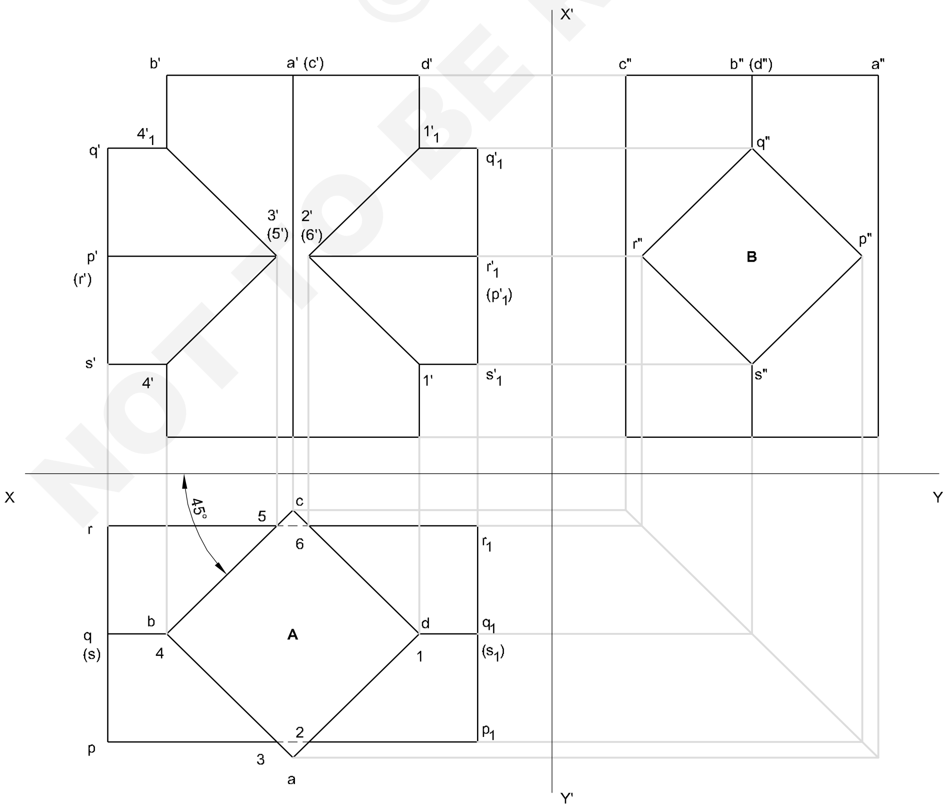
– **Side 35 mm and length 80 mm (Prism B)**

Draw the top view of 40 mm square prism, with its two sides at 45° to (VP) X'Y' line.

- Mark the corners as a,b,c & d.
- Draw the front view and the end view for the prisms A & B with space in between and mark the corners as shown.
- Draw a square of side 35 mm, faces at 45° to the (HP) XY on the end view.
- Mark the corners as p", q", r" & s" as shown.
- Draw its projection to the top view and mark the points where the lines meet the square a,b,c & d as 1,2,3,4,5 & 6.
- Draw the vertical projectors from points 1,2,3 & 4 on to the front view.
- Draw horizontal projectors from corners p",q",r" & s" of EV on to the FV intersecting projection line from TV.
- Mark the intersecting points 1', 2', 3', 4', 4_1' & 1_1'.
- Join the points 1'2', 2'1_1', 1'4', 3'4_1'.

The lines 1'-2', 2'-1_1', 4'-3', 3'-4_1' are the lines of intersection. (Fig 1)

Fig 1



PRISMS INTERSECTING AT RIGHT ANGLES

DMN1837H1

© NIMI NOT TO BE REPUBLISHED

Exercise 2 (Fig.2)

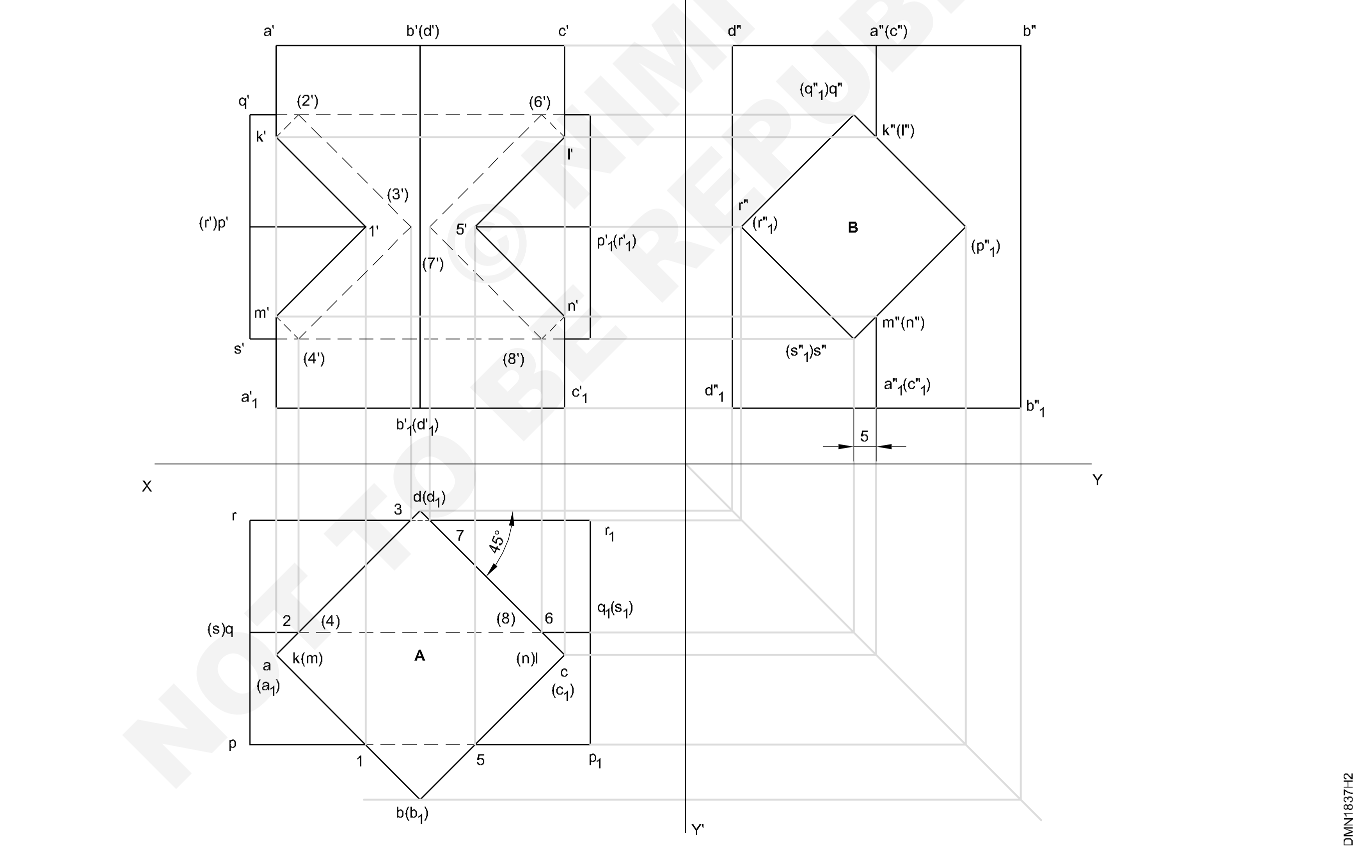
Two square prism A and B positioned as stated below, intersect each other. Draw the plan, elevations and show the line of intersection of Prism `A' resting with its base on HP. Two of its rectangular faces making an angle of 45° to X'Y' (VP). Prism `B' penetrates with prism `A' such that the axis are 5 mm apart, intersecting at mid-point is perpendicular to each other. The lateral surface of prism `B' makes an angle of 45° with XY (HP) and its axis parallel to X'Y' (VP). The dimensions of prisms are:

- **Side 45 mm height 80 mm (Prism A)**
- **Side 35 mm length 75 mm (Prism B)**

Draw the front elevation, top view and side view of the vertical prism (A) for the given position and dimensions.

- Draw the side view of the horizontal prism for the given position and dimensions, such that its axis 5 mm apart from the axis of vertical prism.
- Project the front view and top view of the horizontal prism from the end view.
- In the top view, mark 1 where the horizontal edge PP_1 pierces the front vertical rectangular face ab (b_1) (a_1). Mark the other points as shown in Fig 2 in the top view of the vertical prism. Project these intersection points to the top view and obtain k(m) and l (n) as shown. (Fig.2)
- Project from the top view the points 1,2,3 & 4. Draw vertical projectors upwards to intersect the corresponding edges of the horizontal prism in front view at 1' (2') (3') & (4') respectively.
- Project from the side view from points k" and m" to intersect the projectors drawn from top view from points k(m) to meet at k' and m' respectively in front view.
- Draw the visible lines and invisible lines in the front view by projecting the points from top view (lk & l(m) as shown in figure. l'k' and l'm' as thick lines in front view. k' (2') (2') (3') (3'4') & (4') m' as dotted lines. Complete the lines intersection on the left of the front view. Similarly complete the line of intersection on the right of front view.

Fig 2



Exercise 3 (Fig.3)

Two square prism of A & B positioned as stated below intersects each other. Draw the plan, elevations and show the line of intersection. Prism `A' is resting on its square base and its face are at 45° to XY line. (HP) Prism `B' intersects at 10 mm from base at 45°. The dimensions of prisms are:

- **Side 50 mm height 100 mm (Prism A)**
- **Side 40 mm height 80 mm (Prism B)**

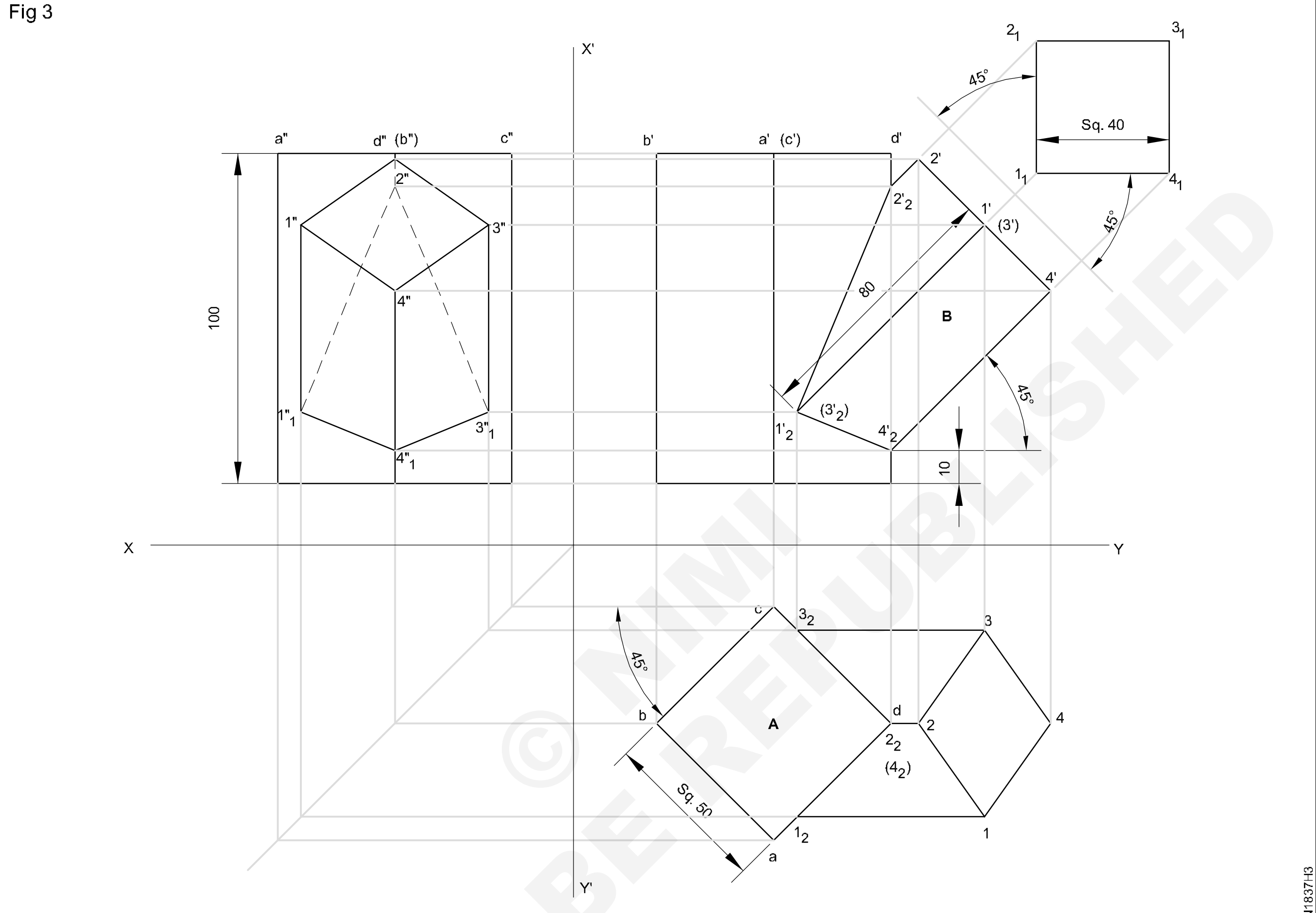
By drawing projectors, draw the front view top view and end view of the vertical prism.

- mark a height 10 mm from base and draw 45° line as shown.

© NIMI
NOT TO BE REPUBLISHED

- draw a line perpendicular to the auxiliary plane line.
- draw a square of 40 mm at 45° to the Auxiliary plane line.
- project the corners on to the vertical prism.
- mark the points 2^1 and 4^1 on the vertical corner edge.
- project and draw the top view of the oblique prism, mark the points 1,2,3, & 4, on the top view.
- draw horizontal lines from points 1,2,3, on to the top view of vertical prism meeting at 1_2, 2_2, 3_2 & 4_2.
- draw vertical projector from the top view and projectors from AV.
- join corners 2' - 1' & 1',4' by straight line.
- add the end view as shown. (Fig 3) Lines 2' - 1' & 1' - 4' are the intersection lines of the prism.

Fig 3



SQUARE PRISMS INTERSECTING AT 45° ANGLE

© NIMI NOT TO BE REPUBLISHED

Exercise 4: (Fig 4)

An Octagonal prism (A) and a Hexagonal prism (B) positioned as under intersecting each other. Draw the plan, elevations and the line of intersection. Prism `A' resting on its base with a face parallel to x'y' (VP). Prism `B' is intersecting the Prism `A', such that the axis `B' prism makes an angle of 30° to XY (HP). Both axis of A & B prisms meet at 20 mm above the base and 8 mm in front of `A' prism.

Dimensions of Prisms are:

– Octagonal prism side 40 mm, height 100 mm

– Hexagonal prism side 20 mm

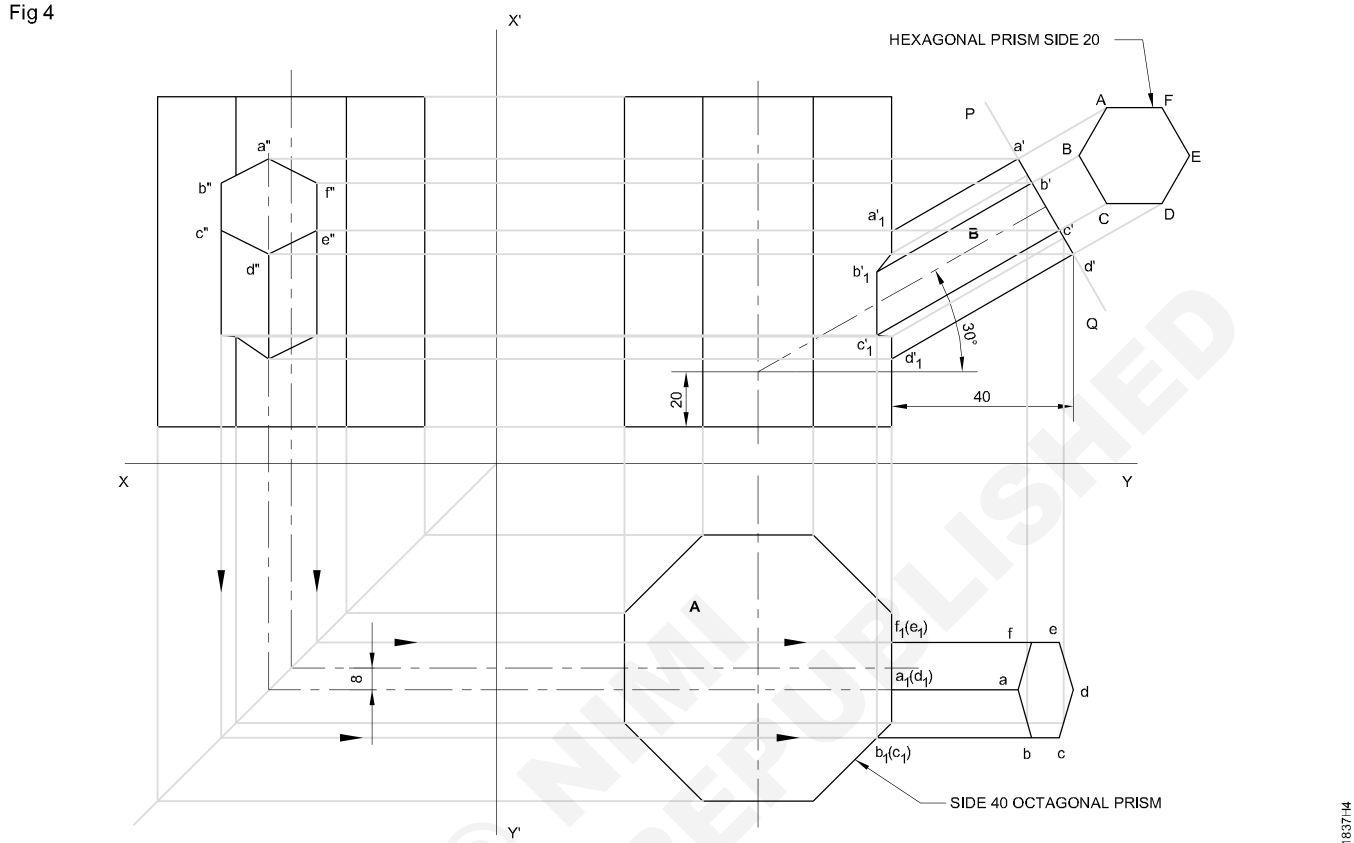
– Projected length of hexagon intersecting octagon is 40 mm.

Draw the plan, elevation and side view of prism `A'. (Octagonal)

- Draw the inclined axis at 30° to XY (HP) and 20 mm above the base, meeting on the vertical centre line of the prism `A'.
- Draw the auxiliary view of the prism `B' (Hexagonal) on the auxiliary plane as shown in Fig 4.
- Draw a line PQ perpendicular to the inclined axis of the hexagon.
- Draw projectors from the auxiliary view of the hexagon parallel to inclined axis of prism `B', intersect PQ at a' b' c' & d' and meets the surface of the prism `A' at c'_1 & d'_1.
- On the top view, draw a horizontal centre line of prism `B' 8 mm in front of the horizontal centre line of prism `A'.
- Draw vertical projectors from points a' b' c' & d' downwards on the top view.
- Transfer the width of prism `B' from the side view.
- Join fe, ed, dc, ba and af.

- Draw horizontal protectors from points a,b (top view of hexagon) to meet top view of prism `A' at b_1, a_1 & f_1.
- Draw vertical projectors upward from the points b_1, a_1 & f_1 intersecting the projectors drawn parallel to the inclined axis from the points a', b', c' & d' at c'_1 & b'_1.
- Join the line of intersection as shown. (Fig 4)

Fig 4



HEXAGONAL PRISM INTERSECTING OCTAGONAL PRISM AT 30°

© NIMI NOT TO BE REPUBLISHED

Generate the curves of intersection of cylinder penetrating through a sphere - cone and a cylinder

Objectives: At the end of this exercise you shall be able to
- **draw the interpretation of cylinder to cylinder**
- **draw the interpretation of cylinder cut the prism**
- **draw the interpretation of cone with cylinder**
- **draw the interpretation of cone with prison, and cone**
- **draw the interpretation of sphere with prison and etc.**

PROCEDURE

Exercise 1 (Fig 1) : The cylinders A & B are positioned as shown, (Fig 1) intersects each other at right angles. Draw the plan, elevation, side view and show the curve of intersection.

- Draw the three views of cylinder `A' as positioned shown. (Fig 1)
- Draw the side view of the cylinder `B', as circle of diameter equals to 40 mm, such that its centre is the mid-point of the axis of cylinder `A'.
- Divide the circle into 12 equal parts and number them.
- Draw the front view and top view of cylinder `B' projecting from the side view of the horizontal cylinder.

Consider that a number of horizontal section planes passing through the generators of the horizontal cylinder to cut both cylinders. For all the horizontal sectional planes, the sectional top view will always be a circle of `n' diameter. Also the sectional top view of the vertical cylinder will a circle of `m' diameter.

Fig 1

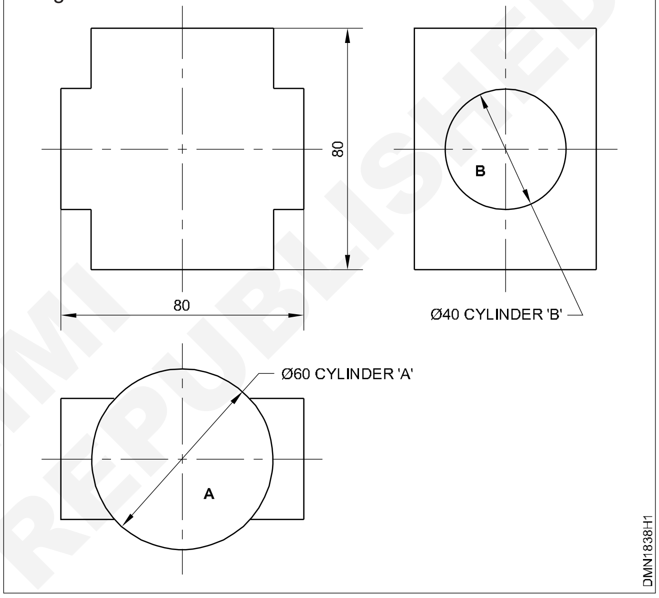
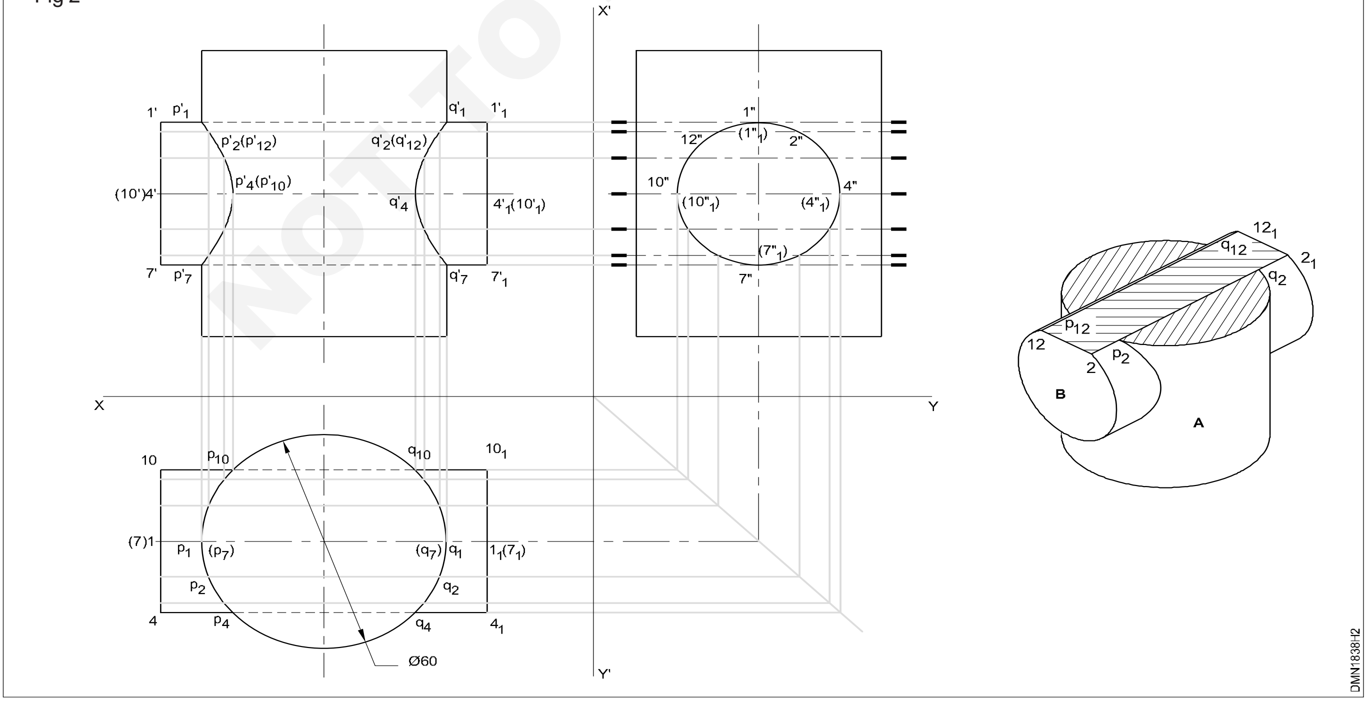


Fig 2



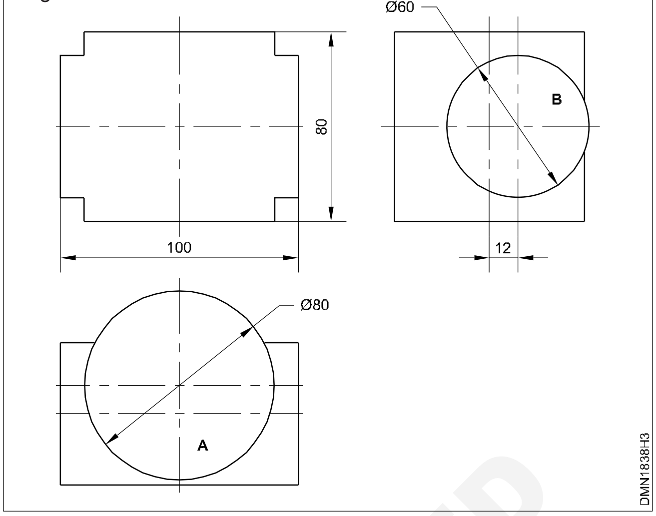
© NIMI NOT TO BE REPUBLISHED

- Draw series of cutting planes on the end view of cylinder `B'.
- Draw horizontal projectors on to the vertical cylinder (A).
- The line 1 - 1_1 in top view intersects the circle at p_1 & q_1.
- Draw vertical projectors from these intersection points P_1 & q_1 to intersect the line 1'1', in front view at p'_1 and q_1' respectively.
- Considering the second horizontal plane 2 2_1 in top view, obtain the corresponding point in the front view P'_2 (p'_{12}, q'_{12}) and q'_2.
- Repeat the same procedure for other series of section planes passing through generators, obtain intersection points in front view.

Join the obtained intersection points in the front view by a smooth curve, which is the curve of intersection of cylinders A & B as stated.(Fig.2)

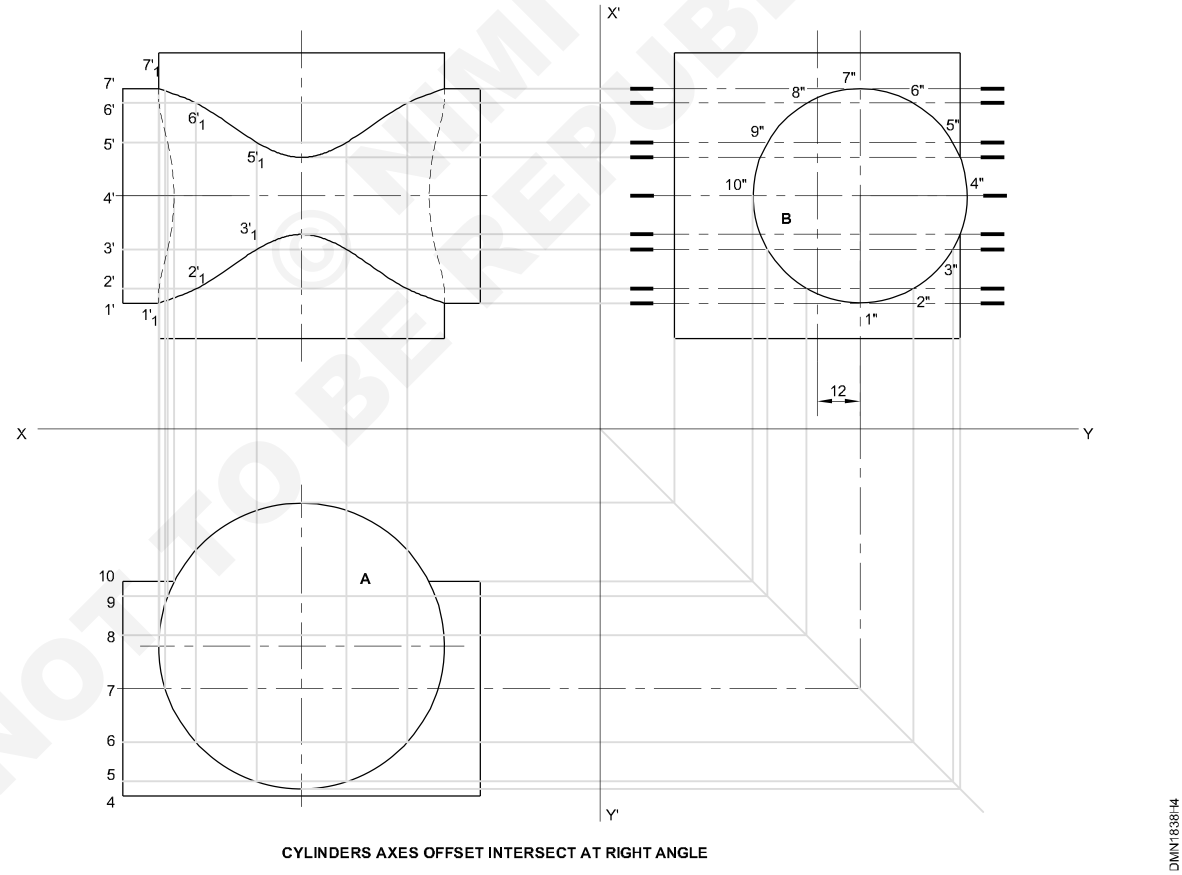
Exercise 2: A vertical cylinder `A' and a horizontal cylinder `B' are positioned. (Fig 3) Draw the plan, elevation, side view and show the curve of intersection. (Cutting plane method)

Fig 3



- Draw the three views of the vertical cylinder `A' as positioned.
- As the axis of the horizontal cylinder `B' is 12 mm in front of the axis of cylinder `A', so draw the side view (circle) of the cylinder `B' 12 mm to the right side of axis of cylinder `A'. (Fig.4)

Fig 4



CYLINDERS AXES OFFSET INTERSECT AT RIGHT ANGLE

© NIMI NOT TO BE REPUBLISHED

- Draw its front elevation and top view and mark the generators as explained in previous exercises.
- Divide the circle of cylinder `B' shown in side view into 12 equal parts.
- Mark the corresponding divisions in other views.
- Draw the horizontal projectors from the divisions marked meets the top view of the vertical cylinder `A'.
- draw vertical projectors to the corresponding horizontal
- join all the intersecting points forming the interpenetrating curves of the prism.

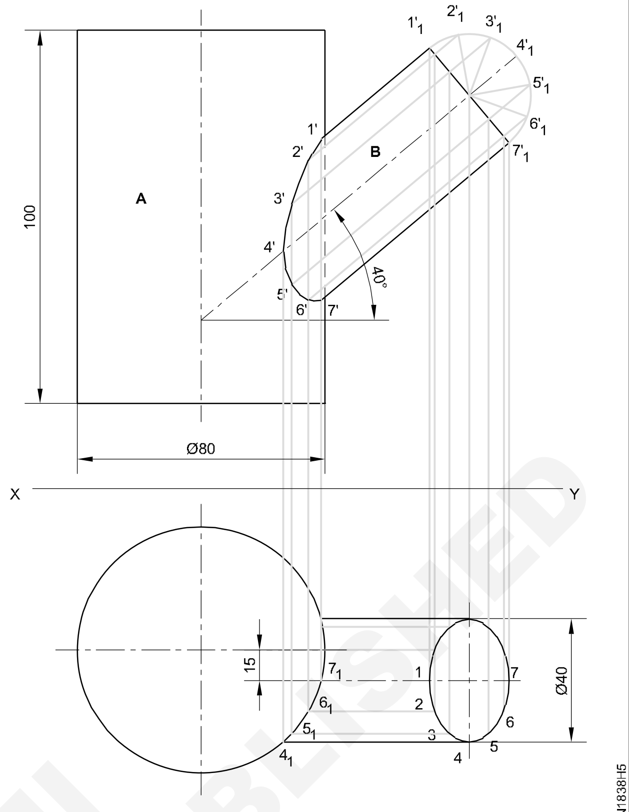
Exercise 3: A thin cylinder of dia 80 mm resting vertically is joined to a 40° branch pipe of dia 40 mm as shown in Fig 5. Draw the intersection curve of the cylinders. The axes of both the cylinders are 15 mm apart.

- Draw outlines of the pipes as shown in Fig 5.
- Divide branch pipe surface into equal parts by drawing semi-circle and mark as $1'_1, 2'_1, 3'_1, \ldots 6'_1$ as shown in Fig 5.
- Mark the corresponding points on the top view of the branch pipe projected from the front view as 1,2,3....7
- Draw horizontal projectors from these points to meet the dia 80 mm circle and number them in the top view. (Fig 5)
- Draw vertical projectors from these points on to the front view intersecting the projection lines from the semi-circle.
- Mark the intersecting points and join with smooth curve.

Exercise 4: Two cylinders of A & B are positioned as shown in Fig 6. Draw the plan, elevation and draw the curve of intersection.

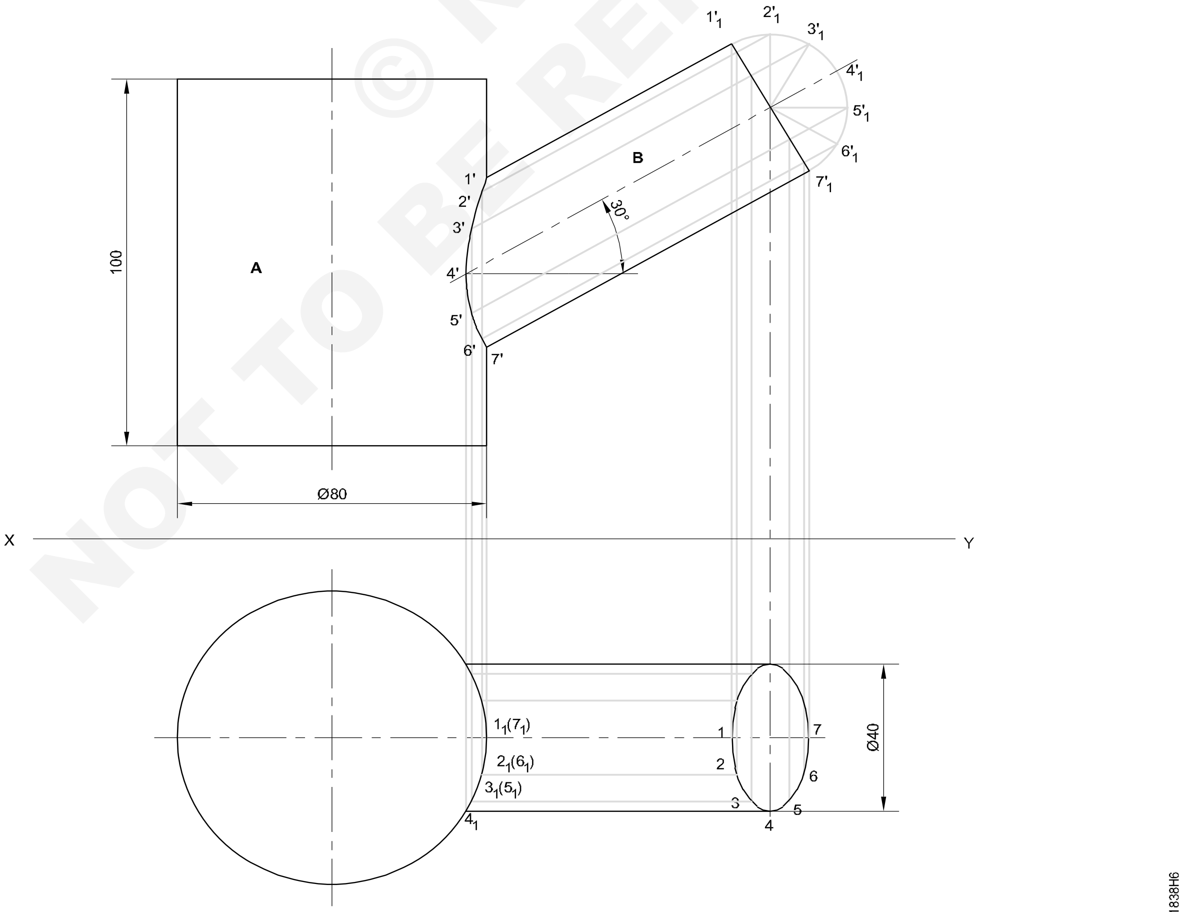
- Draw the plan and elevation of the cylinder, such that the cylinder `B' intersects the vertical cylinder `A' at an angle of 30°. (Fig 6)
- Draw the curve of intersection by adopting procedures as in earlier exercises. (Fig.6a)

Fig 5



CYLINDERS AXES OFFSET INTERSECTING AT ANGLE

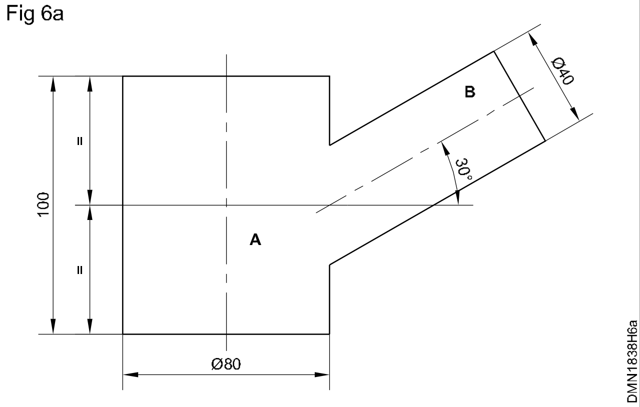
Fig 6



CYLINDERS AXES INTERSECTING AT ANGLE

© NIMI NOT TO BE REPUBLISHED

Fig 6a



Exercise 5: The axis of two cylinders A & B intersect on the centre line at 45° are positioned as shown in Fig 7. Draw the plan, elevation and the intersection curve.

- Draw the given view of the cylinders as stated in position.
- Draw the plan for the given elevation.
- Draw the semi-circle of the branch cylinder, divide it into 6 equal parts and number them.
- Draw the projectors from these points parallel to the inclined axis of cylinder `B'. Projectors intersecting in the front views.
- Mark the corresponding points on the top view of the cylinder `A' by drawing horizontal projectors from the top view of cylinder `B'.
- Draw vertical projectors from these point to meet the inclined projectors drawn from the semi-circle of cylinder `B'.
- Join the intersecting points which is the required curve of intersection. (Fig 7a)

In this example the curve projected as straight lines.

Fig 7a

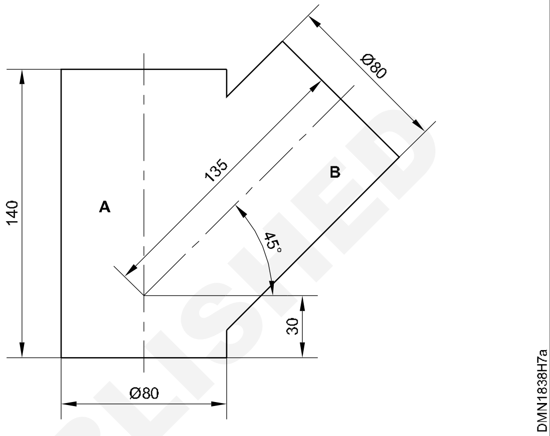
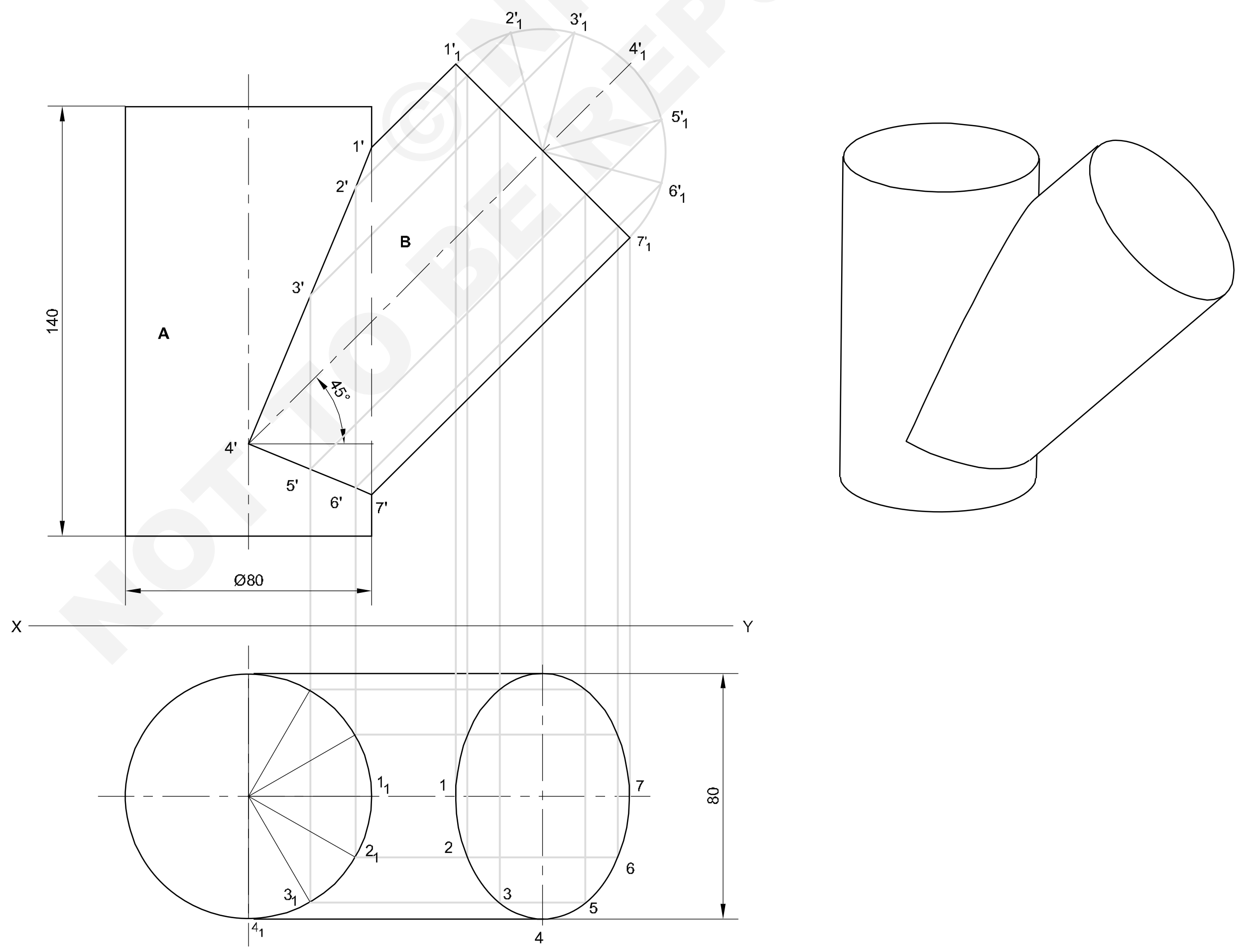


Fig 7



CYLINDERS AXES INTERSECTING AT ANGLE

©NIMI NOT TO BE REPUBLISHED

Ex.6 : A cylinder resting on the base vertically an X Y line (HP). Another cylinder 'B' is parallel to X'Y'. (VP) and inclined at 30° to XYC (HP) and bisects the axis of the cylinder A, shown in figure 8. Draw the curve of intersector

- Draw the front view top view of the vertical cylinder 'A'.
- Draw the front view of cylinder 'B' such that its axis inclined at 30° to XY line (HP) and bisect the axis of cylinder 'A'.
- Draw the top view of the cylinder 'B' as shown in Fig 8a by drawing projectors from its auxiliary view.
- Mark the intersection points on the top view and project these points on to the front view.
- Join all these points by a smooth curve to obtain the curve of intersection as stated. (Fig 8a)

Fig 8a

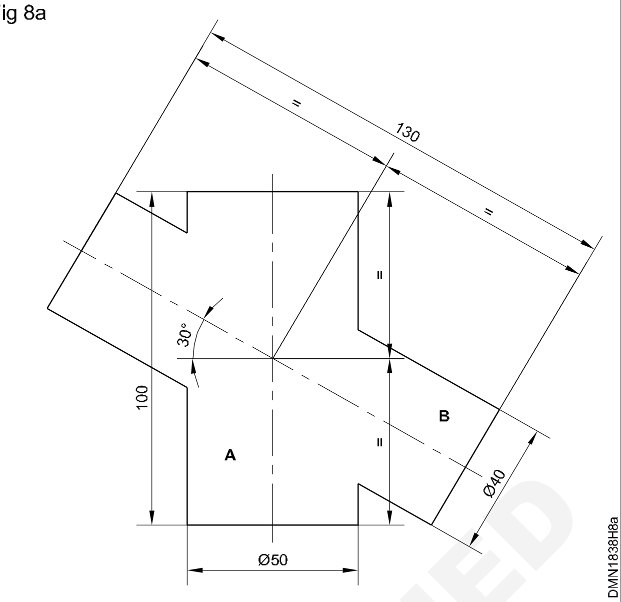
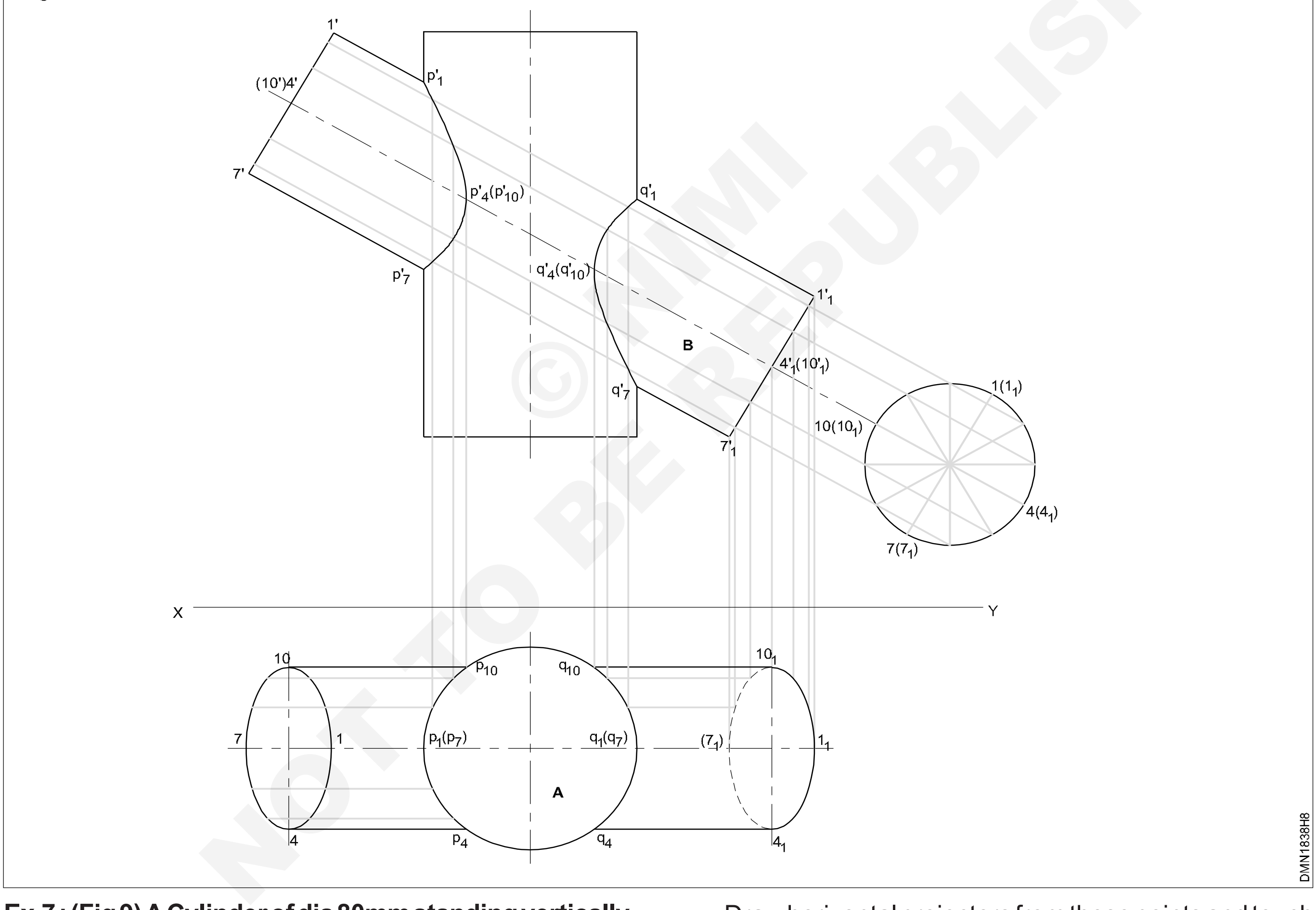


Fig 8

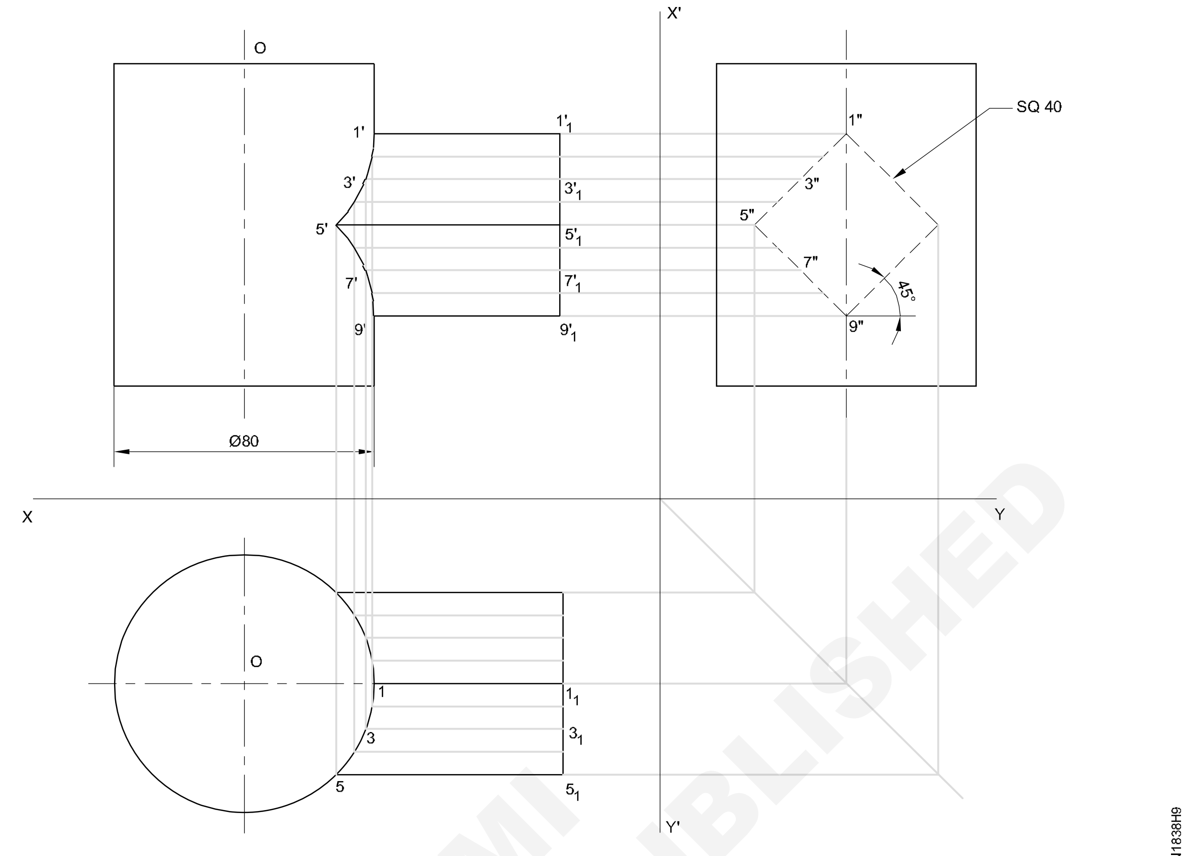


© NIMI NOT TO BE REPUBLISHED

Ex.7 : (Fig 9) A Cylinder of dia 80mm standing vertically is intersected by a square prism of side 40mm. The faces of the square are at 45° to the HP. Draw the views showing the interpenetrating curve.

- Draw the end view, top and the outline of the front view.
- Draw a number of horizontal cutting planes on the end view.
- Draw the projections of these planes on the top view and number them.
- Draw horizontal projectors from these points and touch the circle. (Cylinder)
- Draw vertical projectors on to the front view.
- Draw horizontal projector from end view on to the front view, meeting the vertical projectors. (Fig 9)
- Join all the intersecting points by a smooth curve.

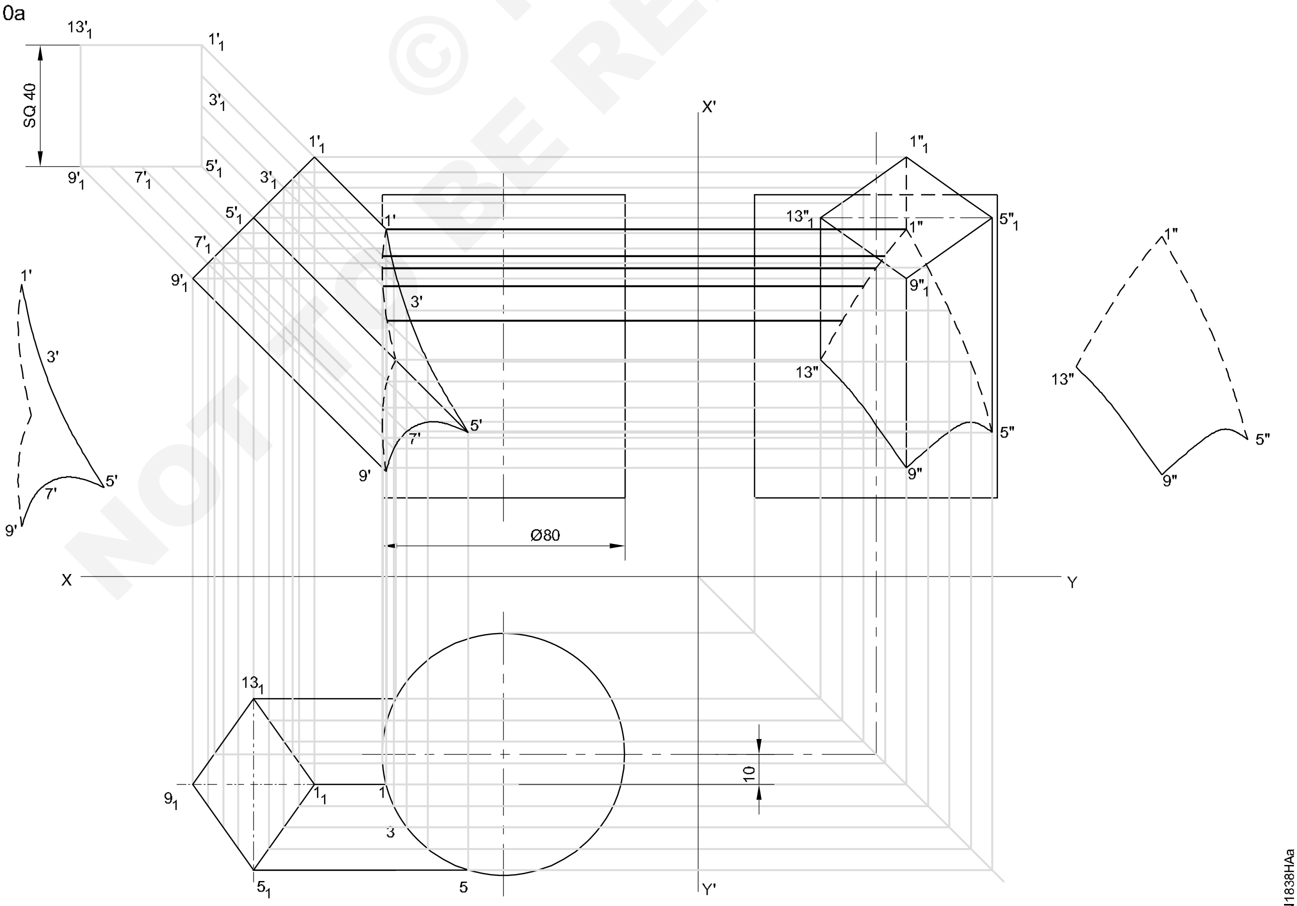
Fig 9



CYLINDER AXIS INTERSECTING SQUARE PRISM

Exercise 8 (Fig 10)

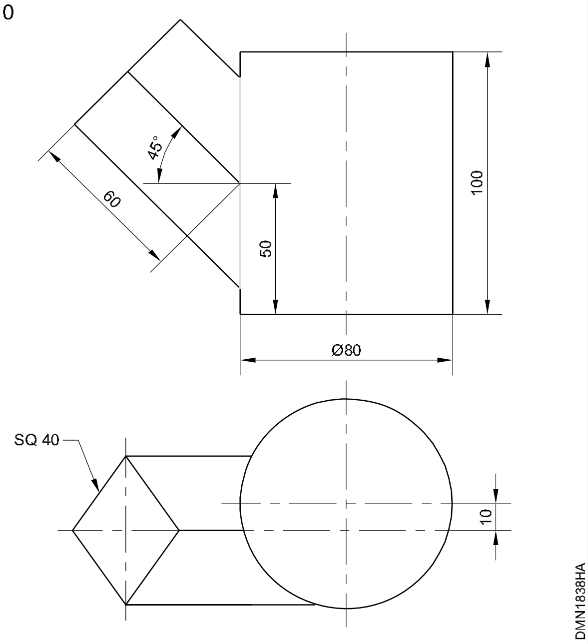
Fig 10a



CYLINDER AXIS OFFSET INTERSECTING SQUARE PRISM

The figure shows that a cylinder of dia 80 standing vertically is intersected by square prism of side 40 mm such that the face of the square prism makes 45° with HP and its axis offset by 10 mm. Draw its intersecting curves. (Fig 10a)

Fig 10



Exercise-9: (Fig 11)

A vertical cone `A' is penetrated by another cone `B' as positioned and stated as under.

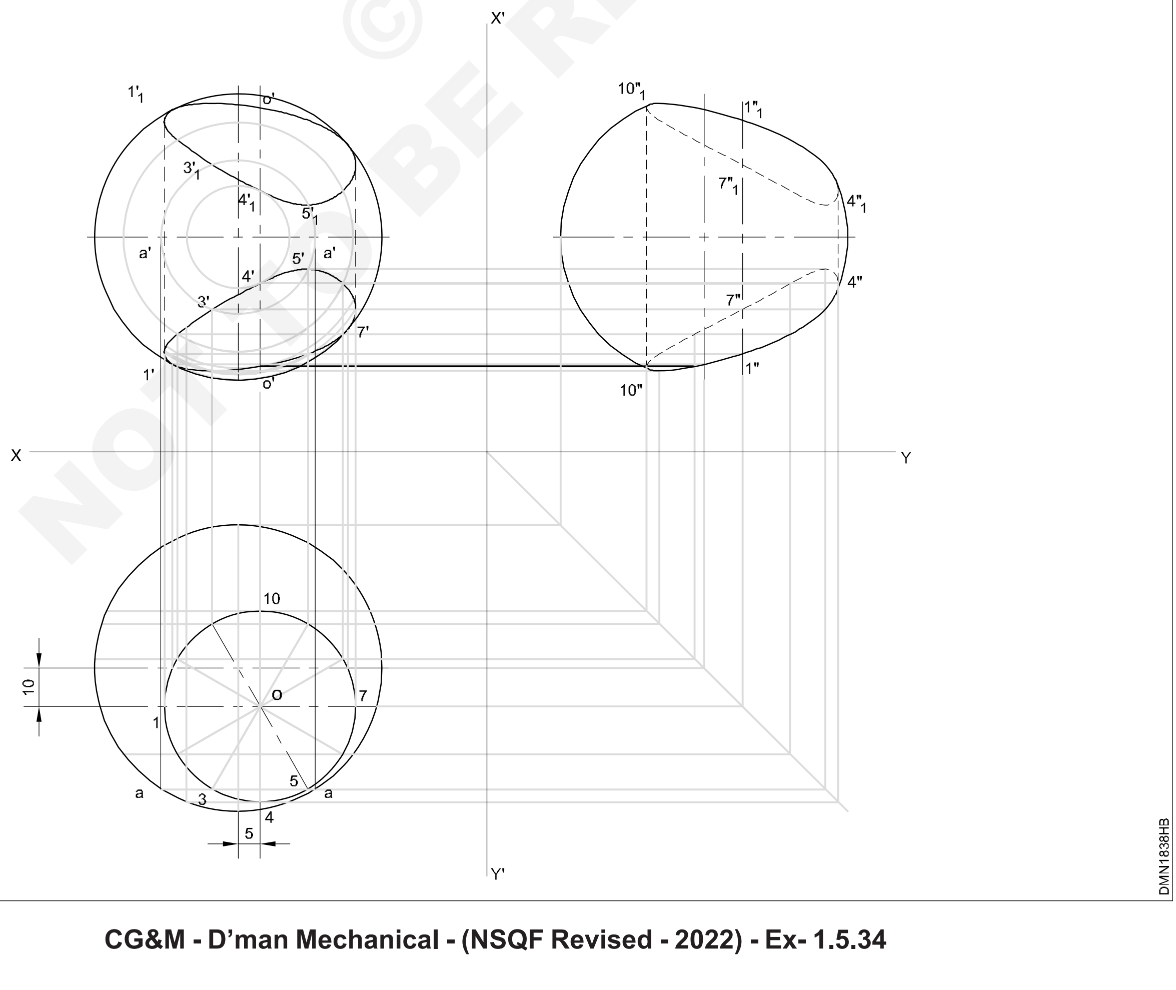
The axis of the two cones bisect each other at right angles.

The axis of the penetrating cone is parallel to the X'Y' (VP).

Draw the curve of intersection for vertical cone `A' 90 mm diameter axis 90 mm long. Cone `B' 75 mm diameter and height 100 mm.

- Assume that the horizontal cutting plane coincides with a line a'd' in front view.
- The section of vertical cone is circle of diameter e'e'.
- The section on horizontal plane will project as hyperbola in top view.
- In top view mark points projecting through a' and identical on both sides of the horizontal axis.
- In top view 1-1 = twice a'1' of front view. In same way project through b', so that to meet in top view at 2-2.
- draw the hyperbola curve as practiced in earlier exercises dealt in plane geometry.
- In top view with `0' as centre and dia e'e' draw a circle, cutting the hyperbola points at p_1 and q_1.
- Project the points p_1 and q_1' vertically upwards to meet the cutting planes at a'd' in front view to obtain points p_1q_1 p' and q'_1 which are the points on the curves in two views front view and top view respectively.
- In the same way assume additional sectional planes, preferably at equal distance on both sides of axis.
- Similarly the hyperbola and circles in the top view and front view to obtain the points of intersection. (Fig 11)

Fig 11



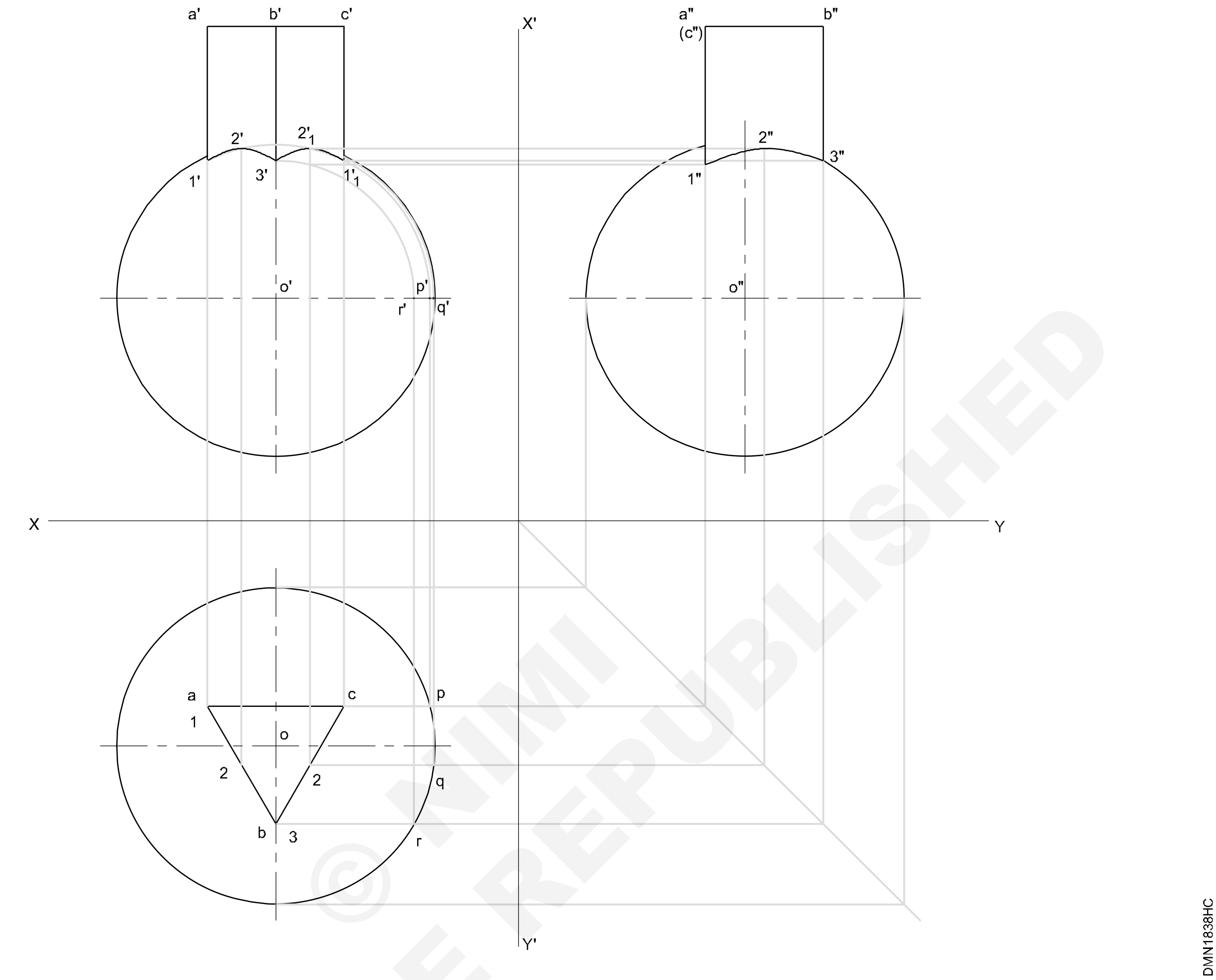
© NIMI NOT TO BE REPUBLISHED

Exercise 10

- Draw the curve in front view and top view on both sides of axis. (Fig 12)

A hole is drilled through a sphere. The axis of hole is 10 mm away from the centre of the sphere. The vertical plane containing the centre of the sphere and the axis of the hole is 5 mm.

Fig 12



Sphere diameter = 75 mm

Hole diameter = 50 mm

- Draw the top view of the sphere.
- On the centre line of the sphere mark off 10 mm draw the vertical axis of the hole.
- From the centre of the circle, make an angle of 60° cutting the vertical axis, which will be the centre of the hole.
- Draw the top view of the hole as positioned.
- From the top view project front view and top view.
- Divide the circle of hole into 12 equal parts.
- Draw a number of cutting planes parallel to the X'Y' (VP).
- The sections of the sphere will be circles, but the hole will be cut in straight lines.
- Points on the curves will be obtained by the intersection of circles with corresponding lines.
- For example the section plane passing through points 3 & 5, then the section of sphere will be a circle of diameter a'a' in front view.
- The projector drawn through 3 & 5 will intersect the circle at point 3' & 5'.
- Obtain all other points in the same manner.
- Draw the curves through all the points.
- Project the points on the side view horizontally from the front view on the corresponding lines of the holes and draw curves through these points.

© NIMI NOT TO BE REPUBLISHED

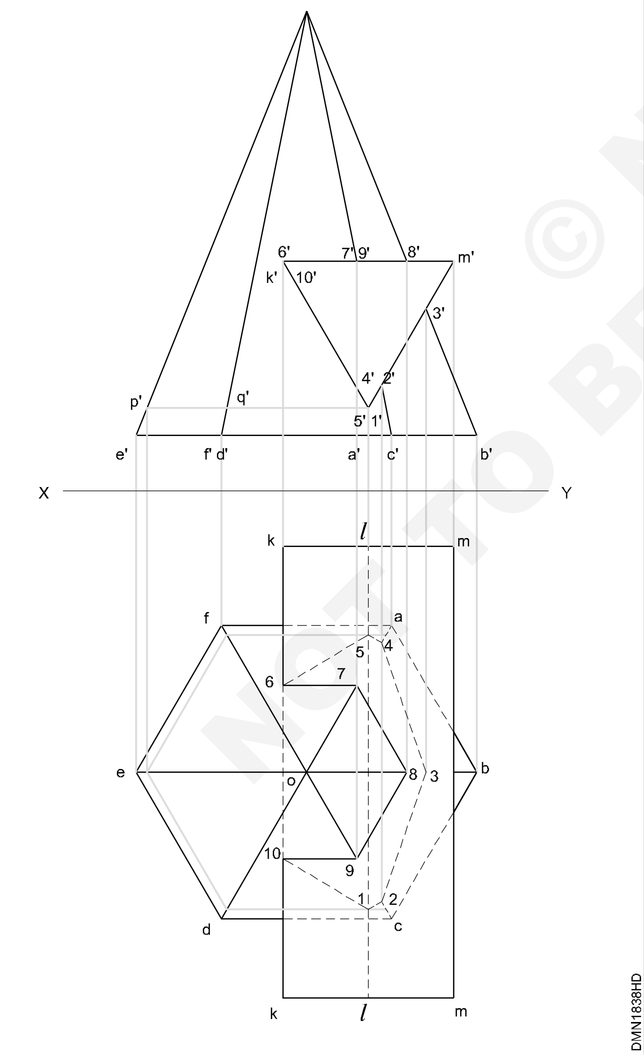
A sphere of 70 mm diameter is penetrated by a triangular prism of side 30 mm such that one of its faces parallel to XY (VP). Draw the line of intersection.

- Draw the three views of the solids (Plan elevation and side view).
- From the top view project the points 1,2,3 to meet the generator of sphere at p,q, & r.
- Project these points to front view on the horizontal axis of the sphere to meet at q',p',r'.
- With O' as centre transfer the points q',p',r' to meet at 1',3' and from top view project the point 2 - 2 to obtain the point 2' 2' on front view.
- Project the points 1',2' and 3' to side view to obtain the points 1", 2" & 3".
- In front view, join the points 1', 2' & 3' and 3',2' & 1' by a smooth curve and in side view, join the point 3", 2" & 1" by a smooth curve.

The curves drawn in front view and side view are the required curve of intersection.

Exercise 11 (Fig 13)

Fig 13



A triangular prism, penetrated into hexagonal pyramid rest on its base, such that one of its edges of prism is parallel to XY (VP). Draw the line of intersection and projection.

- Draw the front elevation and top view of the solids as positioned.
- Locate the points (vertices) in front view, corresponding to the elements of intersection between the solids.
- Project other than 1,5,6 & 10 points to top view.
- On the top view through the points 7 & 9 draw a line parallel to the base of pyramid to intersect the edge KK at 6 & 10. (Fig 13)
- In front view, draw a horizontal line through 5'1' which intersects the slanting edges at P' & q' etc.
- Draw the projectors from the base of pyramid in front view, to locate the intersection points in top view and join them to get the points 1 & 5.
- Join the points 1 to 10 in the order to obtain the required line of intersection. (Fig 13)

Exercise 12 (Fig 14)

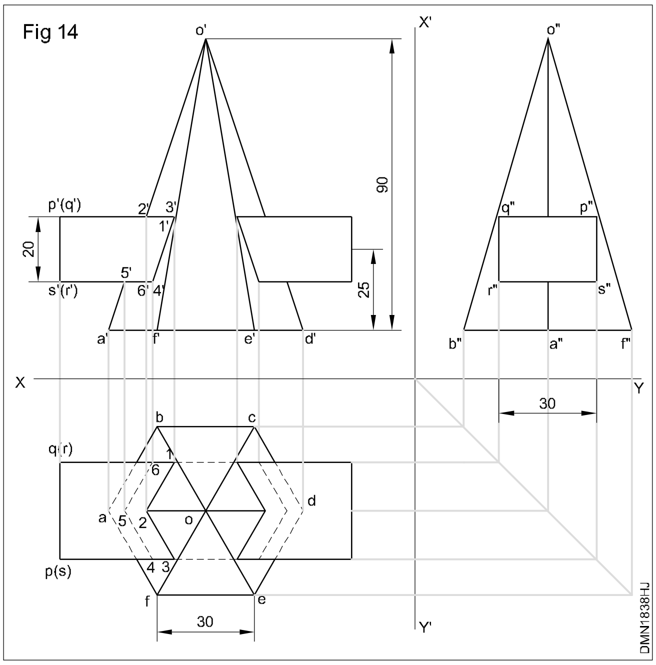
A hexagonal pyramid is resting on its base on `XY' such that one of its sides parallel to X'Y' (VP) and is penetrated by a rectangular prism. Both the axis intersects each other and the larger side of the base of the prism is horizontal and its axis 25 mm above the XY. Draw the line of intersection.

Pyramid - base 30 mm
Attitude - 90 mm
Prism - base 30 x 20

- Draw the front view, plan and side view of the solids as positioned and stated.
- Assuming the plane passing through Pq and locate the intersection point 2' between the edges O'a'and the surface P'q'.
- Project from the front view and obtain the point 2 in the top view.
- Through the point 2 in top view, draw lines parallel to ab and af to get the points 1 & 3.
- Draw vertical projectors from the points 1 & 3 upward to obtain the points 1' & 3' on the surface P'(q').
- In similar way obtain points 6,5,4 by drawing parallel to ab and af respectively on top view.
- By projecting these points vertically upward to obtain points 4', 5' & 6' on the front view.
- Join the points to obtain the line of intersection on one side of the front view.
- In same procedure draw the line of intersection on the other side of the front view. (Fig 14)

© NIMI NOT TO BE REPUBLISHED

Fig 14



© NIMI
NOT TO BE REPUBLISHED

Construct isometric views of polygons and circular lamina

Objectives: At the end of this exercise you shall be able to
- **construct an isometric scale to a given length**
- **construct isometric view of polygons and circular lamina**
- **draw the isometric views.**

PROCEDURE

Exercise 1: Construct an Isometric scale to measure upto 150 mm with minimum reading of 10 mm.

Exercise 1

- Draw a horizontal line OA.
- Draw a line OC at 45° to OA and mark 10 mm, 20 mm.....150 mm.
- Draw another line OB at 30° to OA.
- Draw vertical projectors from divisions on OC on to OB and mark the divisions as on OC.

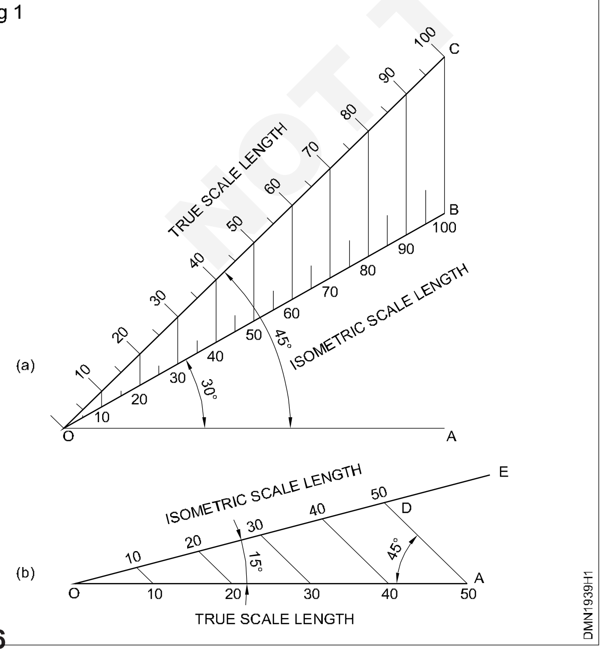
The scale on OC is the true scale and the scale on OB is the Isometric scale. (Fig 1a)

Another way of constructing isometric scale.

- Draw a horizontal OA to a known length.
- Draw another line OE at 15° to OA.
- Draw another line from point A making 45° and meet the line OE at D.
- Divide the line OA into number of divisions and mark 10,20,30,40 and 50 mm.
- From the points on the line OA, draw lines parallel to AD and mark off 10,20,30,40 and 50 on line OE.

Now the scale on OA is the true scale and the scale on OD is the isometric scale. (Fig 1b)

Fig 1



Exercise 2: Construct the following plane figures in isometric views

Draw a square of side 40mm

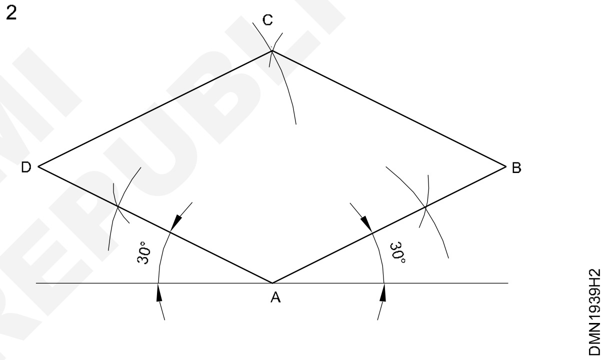
Draw a pentagon of side 20mm

Draw a hexagon of side 40mm

Draw a circle in different positions.

Exercise 2.2 : Draw a square of side 40mm Fig 2

Fig 2



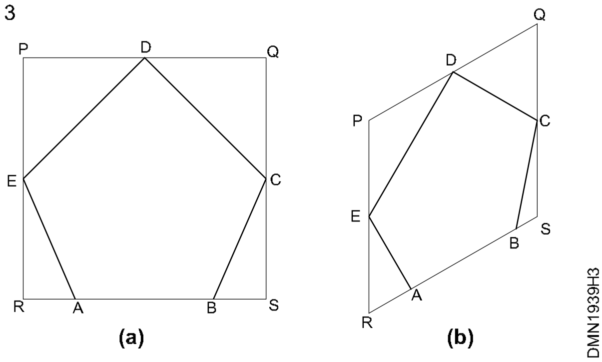
- Draw the lines AB and AD inclined at an angle of 30° from the point A equals to 40mm as shown in figure.
- With and D as centre 40mm as radius describe arcs, and let it intersect at
- Join DC and BC
- ABCD is the isometric view of the square

Exercise 3: Construct a pentagon of side 20mm

- Construct a pentagon of side 40mm as shown figure 3
- Draw the lamina PQRS in isometric view
- Set the pentagon in the lamina
- join BC, CD, DE and EA.
- ABCDE is the pentagon drawn in isometric
- View fig 3a

© NIMI NOT TO BE REPUBLISHED

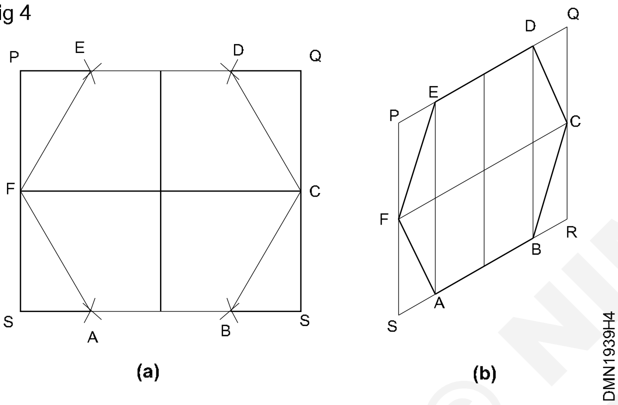
Fig 3



Construct a hexagon of side 40. (Fig.4)

- Construct a hexagon ABCDEF of side 40mm.
- Draw the rectangular lamina in isometric view (PQRS).
- Set the hexagon in the lamina as shown in figure 4a ABCDEF is the hexagon drawn in isometric view.

Fig 4



Exercise 4: Construct a circle by dia ϕ60mm isometric view of different positions first position (Fig.5a)

- Draw the rhombus ABCD equals to 60mm side being the diameter of the circle.
- Mark the center of the sides AB, BC, CD and DA at F,G, E and H respectively.
- Join BE and DG and in intersect a 1.
- Join FD and HB, which inersects at 2.
- With 1 and 2 as radius draw arcs meeting points E & G H & F respectively.
- B at centre BE as radius draw the arc EH
- D as centre BE as DF as radius arc FG
- Complete the isometric circle. (Fig.5a)

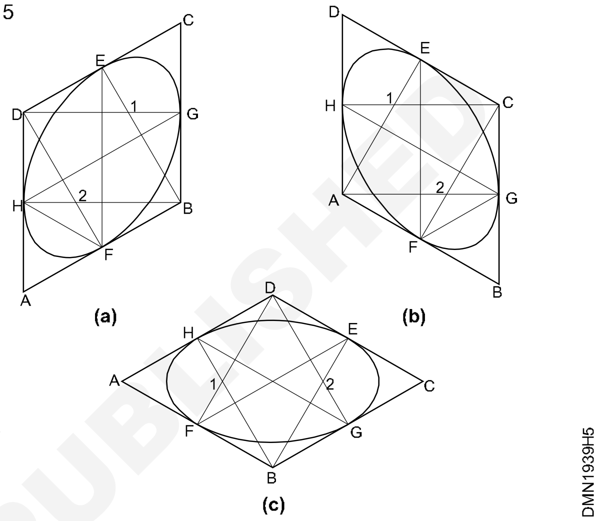
Exercise 5: Second position

- In the same procedure complete the 2nd position of the circle insometric view. (Fig.5b)

3rd position (Fig.5c)

- A done is previous exercises proceed with same procedure and complete the circular lamina. (Fig.7)

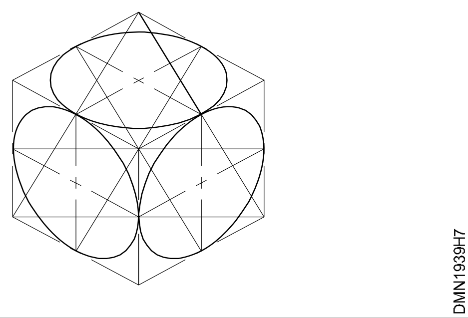
Fig 5



Exercise 6: **Draw the isometric view of the objects. (Fig.6)**

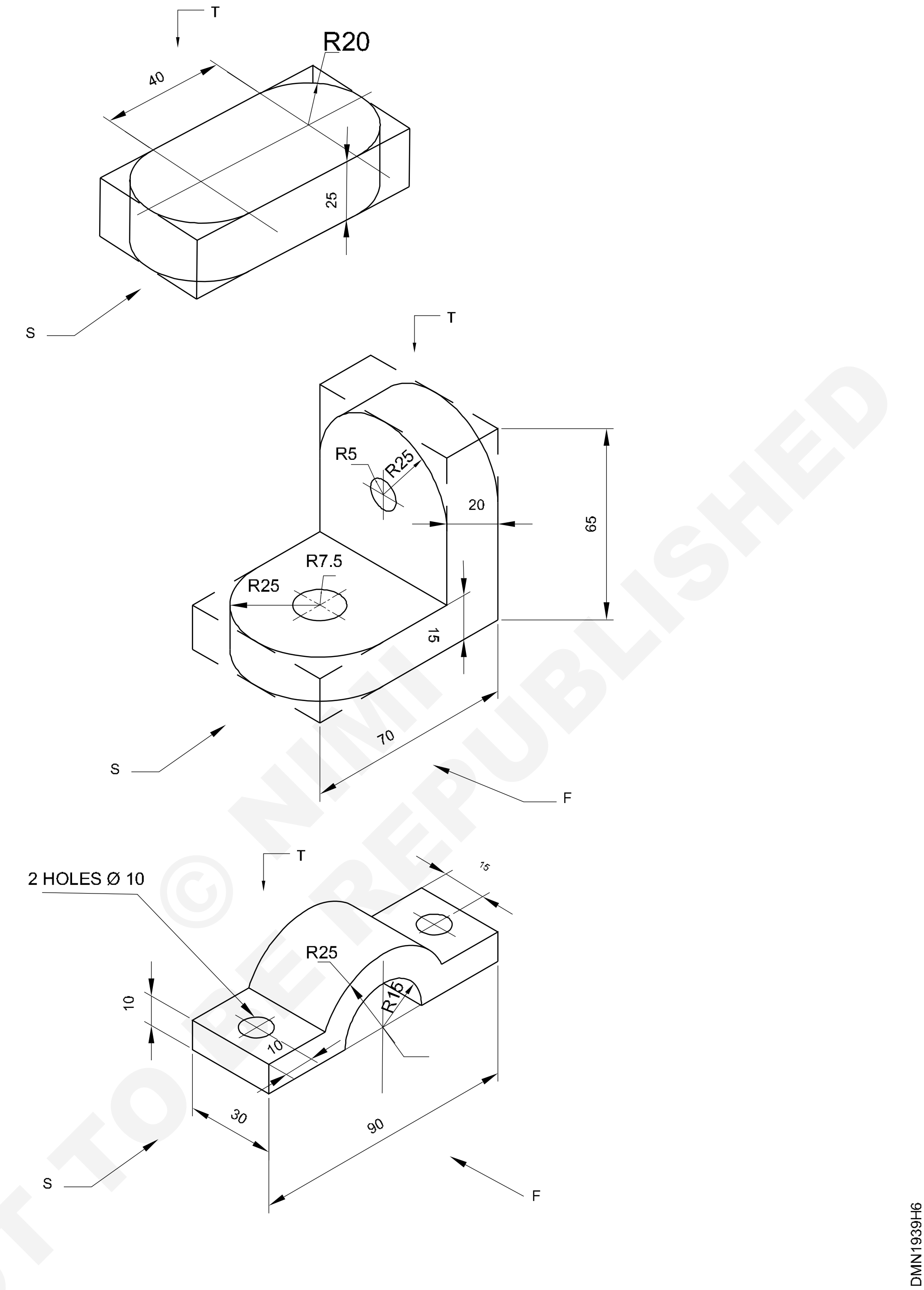
TASK 7: **Draw the isometric view of the circle in the cube (Fig.7)**

Fig 7



© NIMI NOT TO BE REPUBLISHED

Fig 6



NOT TO BE REPUBLISHED © NIMI

Draw Isometric views of solid geometrical figures from orthographic views

Objectives: At the end of this exercise you shall be able to
- **draw isometric views of geometrical figures**
- **draw isometric views of stepped blocks.**
- **draw the isometric views of need know & machined blocks.**

PROCEDURE

Exercise 1

- Draw the isometric projection of a cube of side 50mm (Fig 1)

Exercise 2

- Draw isometric projection of a rectangular prison of base 30mm x20mm and height 60mm (Fig 2)
- Read the given procedure and complete the view.

Exercise 3

- Draw the hexagonal prism of 25mm side of base and 60mm height (Fig 3 & Fig 4)
- Read the given procedure and complete the isometric view (Fig 5,6,8&7)

Exercise 4

- Draw the isometric projection of a hexagonal pyramid the side base 30mm and height its 65mm given its position follow the procedure given and complete the view.

Exercise 5

- Draw the isometric projection of a cylinder of base 50mm and height length of 70mm with is base resting on HP by off set method and four arc method
- For both method study the given procedure and complete the drawing (Fig 8 to 14)

Exercise 6

- Draw the isometric projection of a cone whose base diameter 40mm and height 60mm what its base rest on HP (Fig 15 & 17)

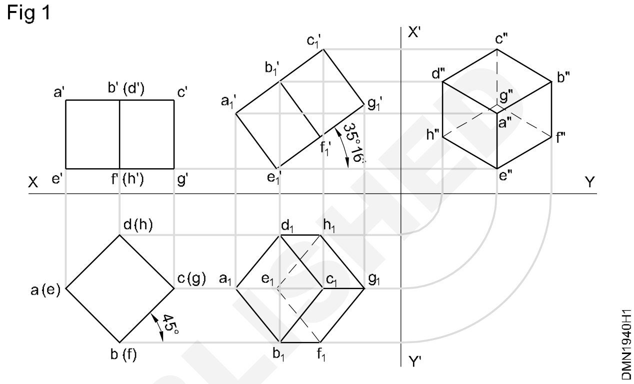
Exercise 7

- Draw the isometric projection of sloped blocks for the given dimension follow the procedure as given and complete the view
- Reproduce the isometric view of the figure shown ie Fig 19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38, 39,40,41,42,43,44,45,46,47,48, and 49.

Complete the drawing and give dimensions

Exercise 1 : **Draw the isometric projection of a cube of side 50 mm (Fig 1)**

Fig 1



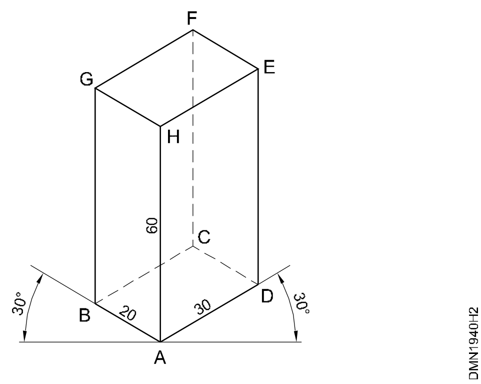
- Draw the plan and elevation of a cube of a given size with solid diagram parallel to V.P. or five of the vertical faces maximum equal (45°) angle with V.P

These two views should be drawn to the true scale.

- Tilt the front view about corner e', so that the line a'g' is parallel to XY. This means that the line a'g' is parallel to VPI and HP or it is perpendicular to AVP.
- Project from the second elevation and draw the top view. (2nd top view)
- Draw the projectors from the tilted elevation and 2nd top view and draw the side view. Now the side view is the required isometric projection of the cube.

Exercise 2: **Draw the isometric projection of a rectangular prism of base 30 mm x 20 mm and height 60mm. (Fig 2)**

Fig 2



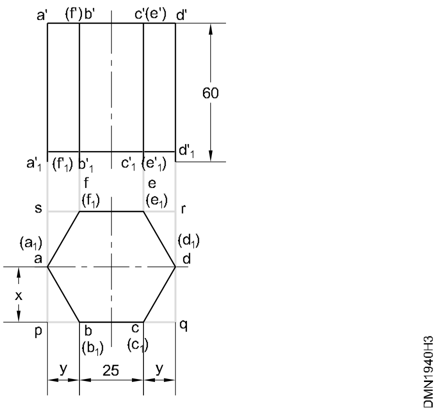
- Use isometric scale for all measurements.
- Draw the lines AB, AD, AH to 20,30 & 60 representing the isometric axes.

© NIMI NOT TO BE REPUBLISHED

- Draw lines parallel to isometric axes as shown and complete the isometric projection required.

Exercise 3: Draw the Isometric projection of the hexagonal prism of 2.5 cm side of base and 60 mm height. (Fig 3)

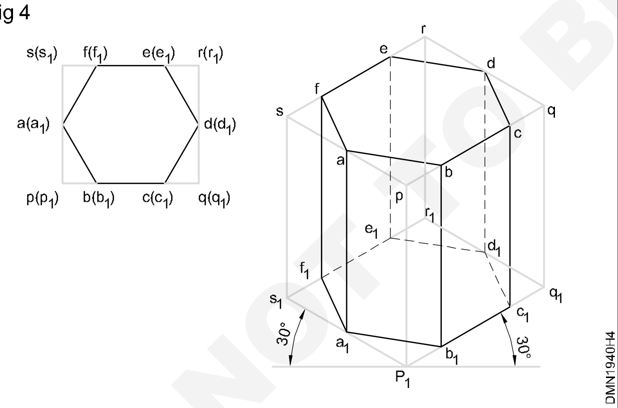
Fig 3



- Draw a hexagon of side 25 mm of its edge is horizontal.
- Draw a rectangular prism of base pqrs and height 60 mm.
- Draw the isometric view of the hexagonal base abcdef of the prism using offset method.
- Draw the top hexagonal face by drawing projection from the corners of the base.
- Make the visible edges by drawing thick lines and draw the invisible edges in hidden line.
- Rub off the unwanted lines and complete the isometric projection.

Use isometric scale for all measurements. (Fig 4)

Fig 4



Exercise 4: Draw the Isometric projection of a hexagonal pyramid of side base 30 mm and height 65 mm given its position as under

- Its base resting on HP and the edge of the base parallel to VP. (Fig 5)
- Draw the plan and elevation of the pyramid (true scale) and enclose the plan in the rectangle PQRS.
- Draw the parallelogram with two of its adjacent edges at 30° to the horizontal. (Fig 6) PQ = Isometric length of pq and PS = Isometric length of PS.
- Draw an isometric hexagon ABCDEF in the parallelogram PQRS.
- Mark the centre O and draw a vertical line from point O of height to 75 mm in isometric scale.

Fig 5

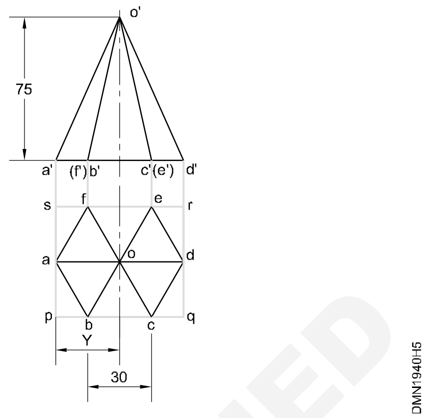
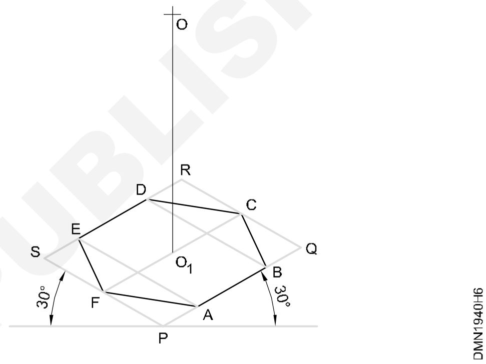
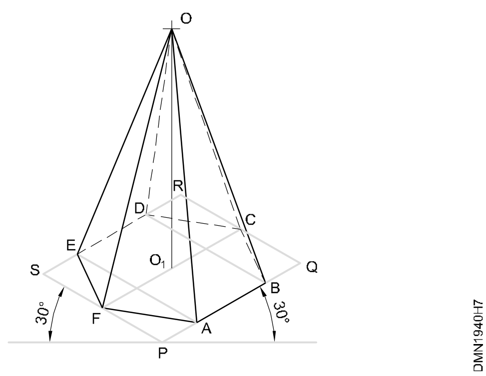


Fig 6



- Join O, with ABCDE&F to complete the required Isometric projection of the hexagonal pyramid. (Fig 7)

Fig 7



Exercise 5: Draw the Isometric projection of a cylinder of base 50 mm and height/length of 70 mm with its base resting on HP by offset method and four centre arc method.

Off-set method

- Draw the elevation and plan of the cylinder. (Fig 8)
- Draw the isometric projection of a square of side equals to the dia of cylinder. (Fig 9)
- Draw the isometric projection of a square prism of height 70 mm on the square drawn.

NOT TO BE REPUBLISHED © NIMI

Fig 8

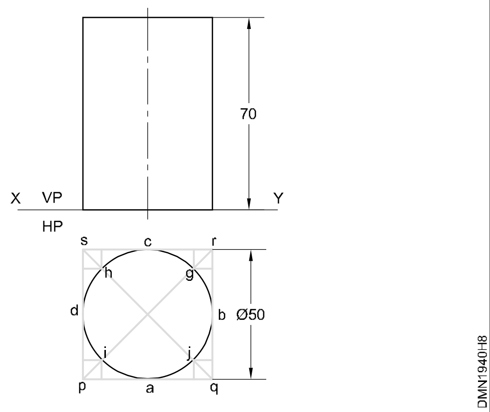
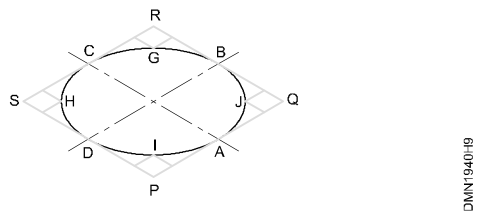
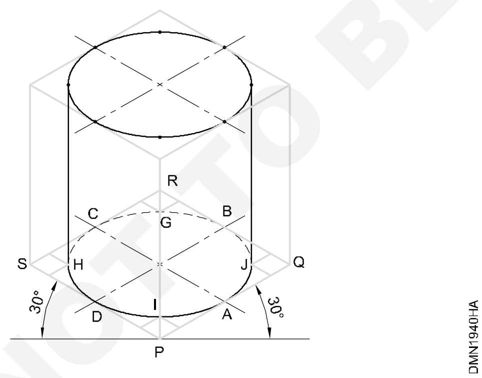


Fig 9



- The mid points of the sides of the square given four points ABCD and four more points HIJG by intersection of the diagonals with circles (located by offset method) join the points to form isometric circle.
- Draw the isometric circles for the bottom and top face of the cylinder inside the square prism using offset method.
- Draw common tangents to top and bottom isometric circles.
- Complete projection by drawing visible lines thick and invisible lines thin. (Fig 10)

Fig 10



Four Centre arc method

- Draw the elevation and plan of cylinder. (Fig 11)
- Draw the isometric projection of a square of side equals to the dia of cylinder. (Fig 12)
- Draw the isometric projection of a square prism of height 70 mm on the square drawn.
- Draw the bisectors RD and RA from R and PC and PB from P.

Fig 11

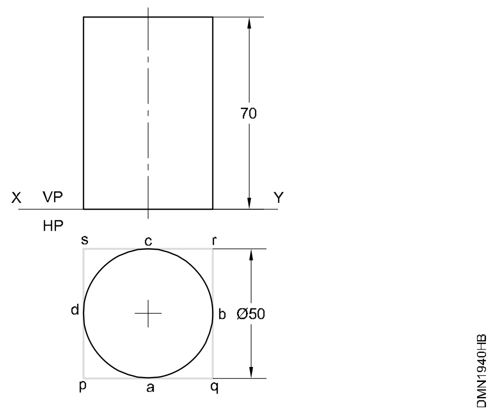
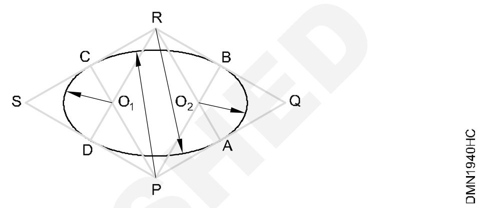
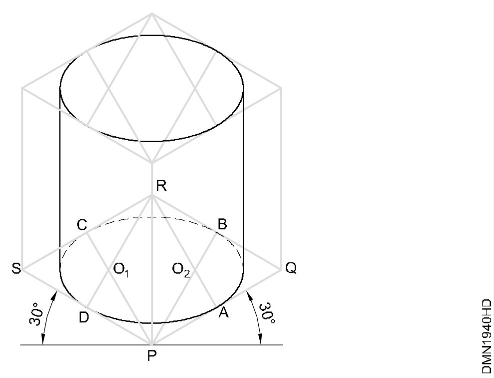


Fig 12



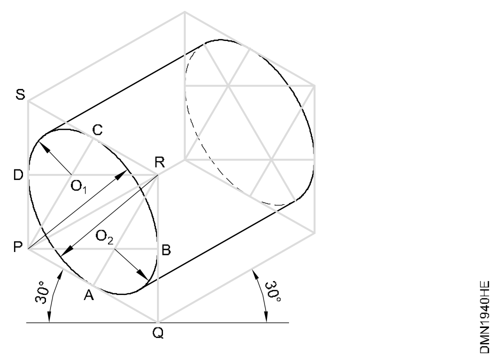
- Draw arcs with O_1 and O_2 as centres and radius O_1D and O_2A
- Draw arcs with P and R as centres and radius PC and RD.
- Draw vertical lines from the end of the ellipse.
- Draw the base as half of the ellipse.
- Complete the isometric view of the prism. (Fig 13)

Fig 13



- Fig 14 shows the cylinder in horizontal position.
- Follow the procedure of the cylinder in vertical position and complete the prism.

Fig 14

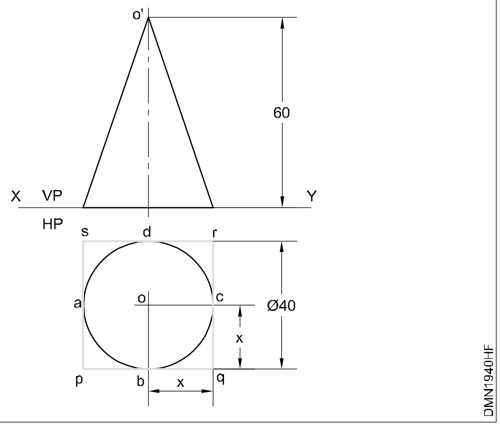


© NIMI NOT TO BE REPUBLISHED

Exercise 6

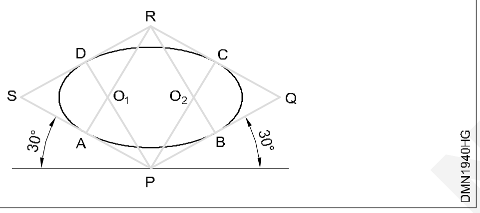
- Draw the Isometric projection of a cone whose base diameter 40 mm and height 60 mm when its base rest on HP. (Fig 15)
- Draw the plan and elevation of the cone in the true scale as shown in the Fig 15.

Fig 15



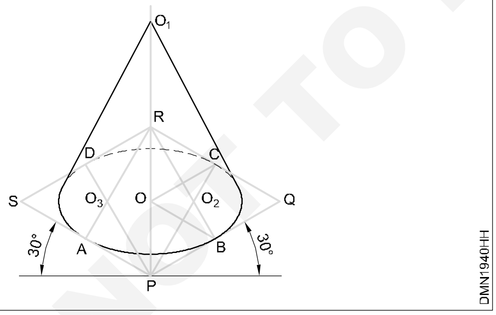
- Draw the Isometric projection of the base circle. (by four centre method) (Fig 16)

Fig 16



- Mark the centre and draw a vertical line 0.0_1 such that 0.0_1 equals to 60 mm in isometric scale.
- From `0' draw tangents to the isometric circle of the base and complete the required isometric projection of the cone. (Fig 17)

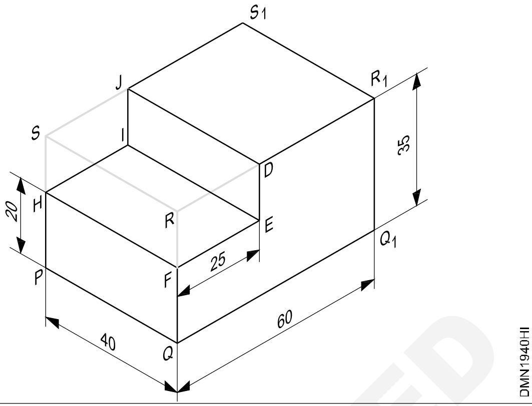
Fig 17



Exercise 7

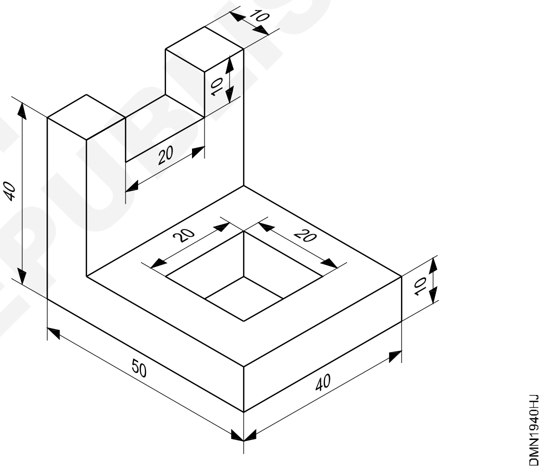
- Draw the isometric projection of a stepped block.
- Draw the isometric view of a rectangular prism of dimension equal to the overall size of the block 60 x 40 x 35.
- Using the measurements given. Draw the lines JD, DE, EF, FH, HI and IJ to facilitate removal of unwanted portion.
- Rub off lines SR, RD, SJ, SH and RF.
- Darken the remaining lines of the stepped block. (Fig 18)

Fig 18



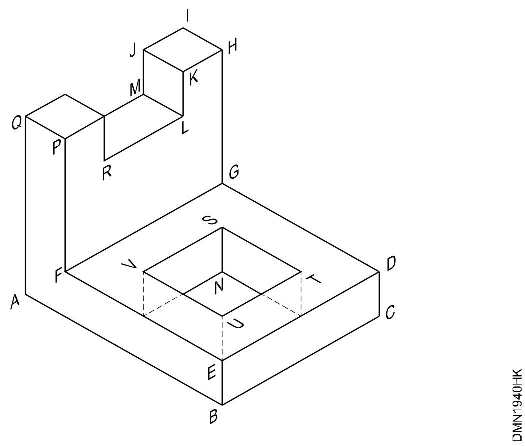
Draw the isometric projection of the component shown. (Fig 19)

Fig 19



- Draw the stepped block with slot as shown in Figure. Follow the procedure given in the previous exercise.
- Mark point UTSV as per the dimensions on the top surface EDGF. (Fig 20)
- Join UTSV

Fig 20



© NIMI NOT TO BE REPUBLISHED

- Project vertically downwards from the points UTSV and obtain the point WXYZ at bottom surface such that SZ, VN, UX & TY are equal to 10 mm. Join the point WXYZ and draw the thick lines which are all visible and complete the required isometric view of the stepped block. (Fig 20)

Use thin lines

Reproduce the blocks shown in Fig 21,22,23 & 24 in isometric projection.

- With the experiences gained in previous exercises of drawing isometric views, draw these exercises and complete the same.

All construction lines should be in thin lines. After completion of the Isometric views, in each case erase the unwanted lines and construction lines.

Fig 21

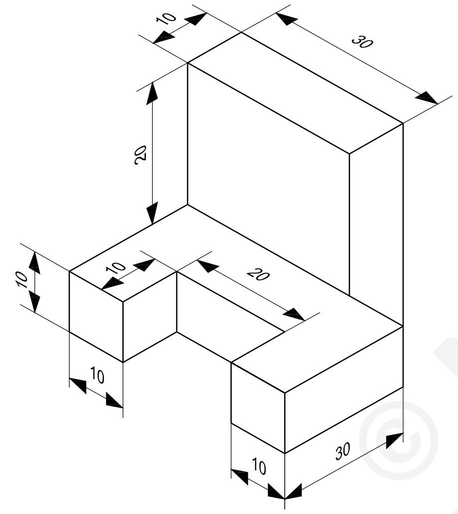


Fig 22

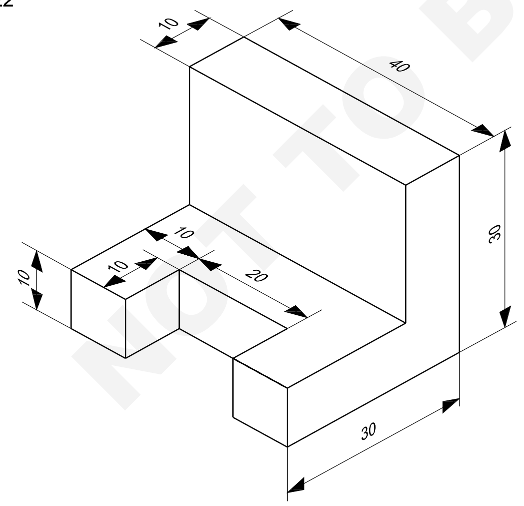


Fig 23

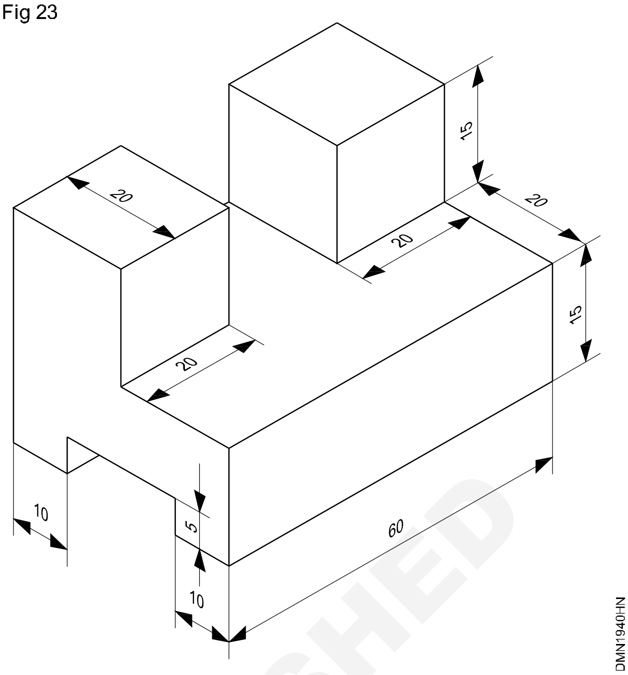
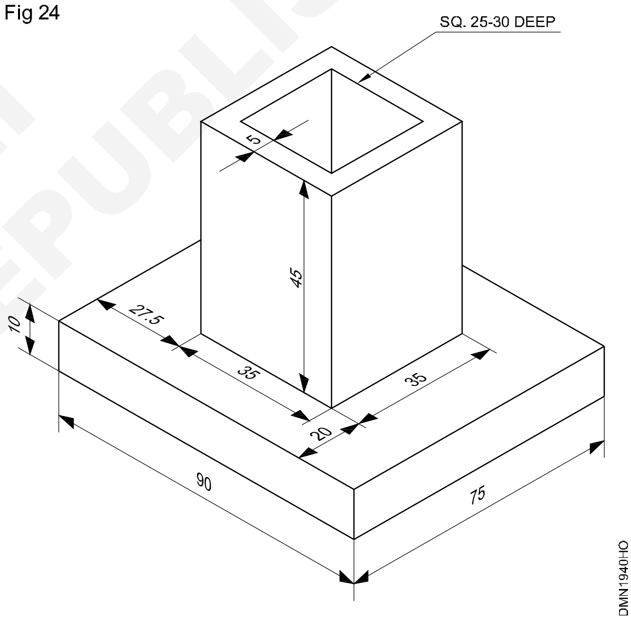


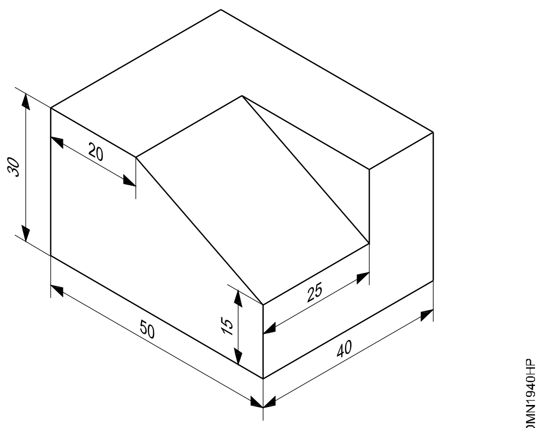
Fig 24



Exercise 7

Draw the isometric projection of the machined block shown. (Fig 25)

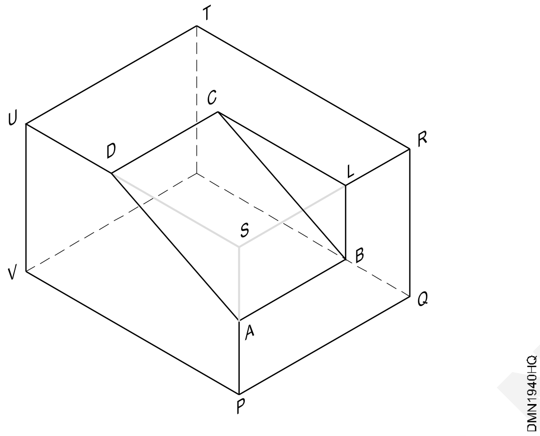
Fig 25



© NIMI NOT TO BE REPUBLISHED

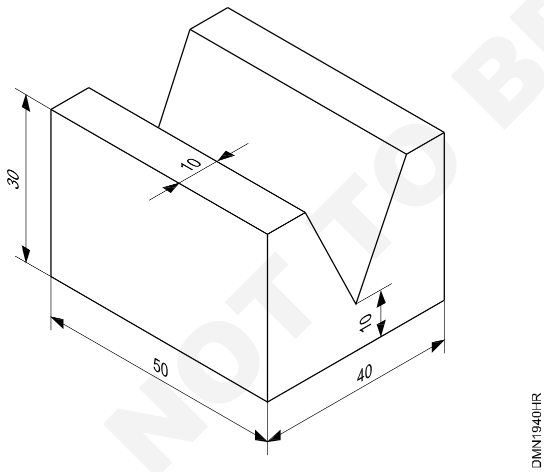
- Draw the isometric projection of the rectangular prism that envelopes the given block to dimensions shown. (Fig.26)
- Mark point A on PS at a distance of 15 mm from P.
- Draw line AB = 25 mm parallel to PQ.
- From B, draw a vertical line cutting RS at L.
- Mark point D on US such that UD = 20 mm.
- Draw a line DC parallel to UT equal to AB.
- Join AD, BC and CL to complete the required Isometric view of the block.
- Remove the extra lines and darken the required visible edges.
- Show hidden edges by dashed lines.

Fig 26



Draw the Isometric projection of the `V' block. (Fig 27)

Fig 27



- Draw the Isometric projection of the rectangular prism. (size 50 mm x 40 mm x 30 mm) (Fig 28)
- On the face ABFE, draw the lines JN & LN by offset method.
- Similarly draw lines KP & MP.
- Join MI, KJ and PN
- Erase construction lines and make the remaining lines thick hidden as the case may be.

Draw the Isometric projection of the following slant cut blocks.

- In each case draw the Isometric view of a rectangular prism to the overall sizes of the each block.
- Follow the procedure adopted in the previous exercises and complete the each Isometric view of the blocks.
- Remove the unwanted lines, draw the remaining lines thick and hidden lines as required. Complete the figures. (Figs 28 to 38)

Fig 28

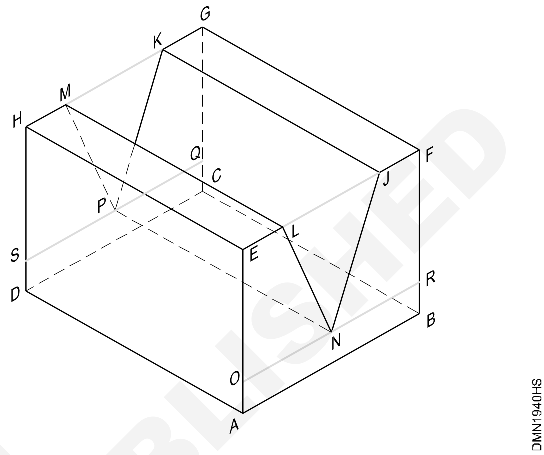


Fig 29

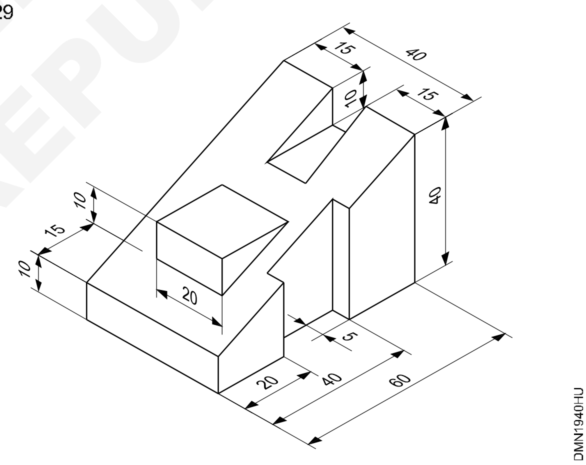
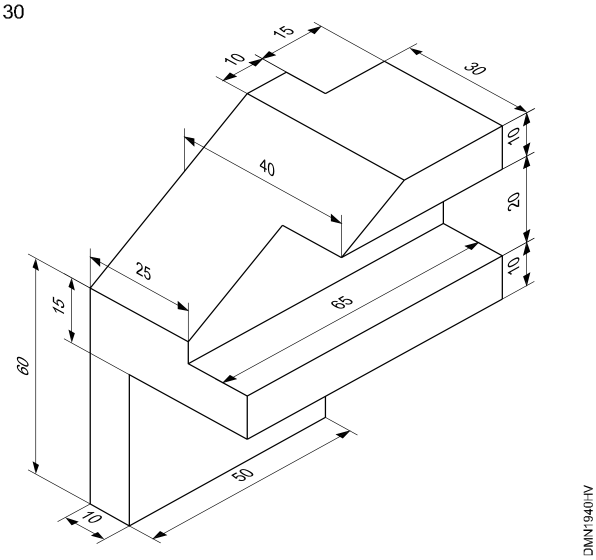


Fig 30



© NIMI NOT TO BE REPUBLISHED

Fig 31

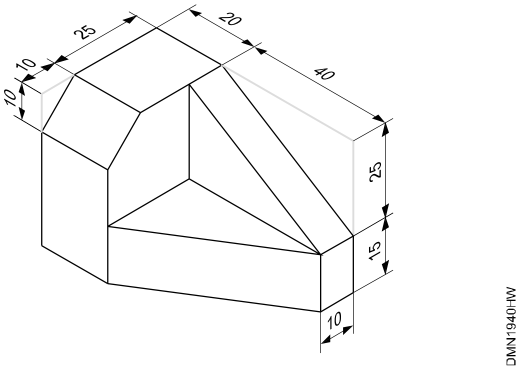


Fig 32

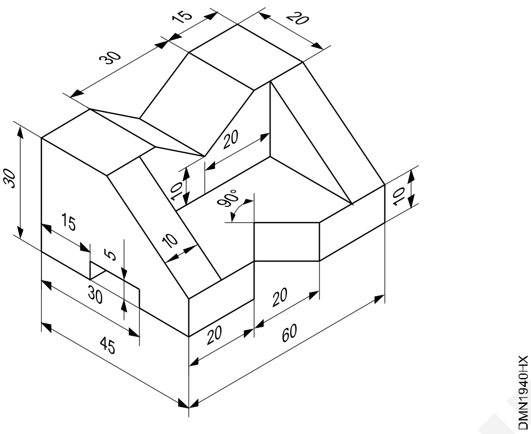


Fig 33

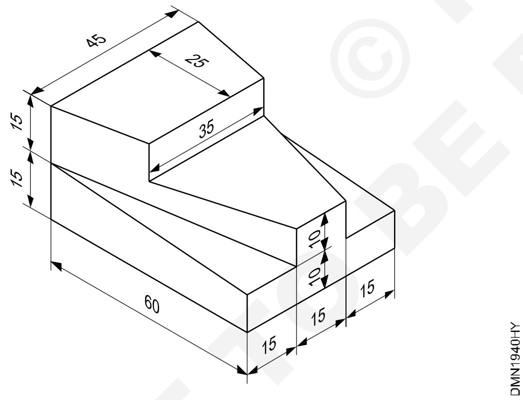


Fig 34

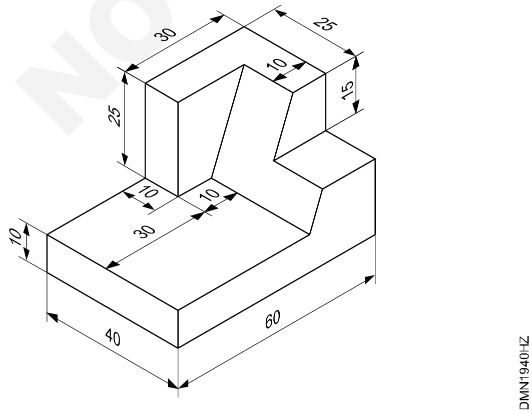


Fig 35

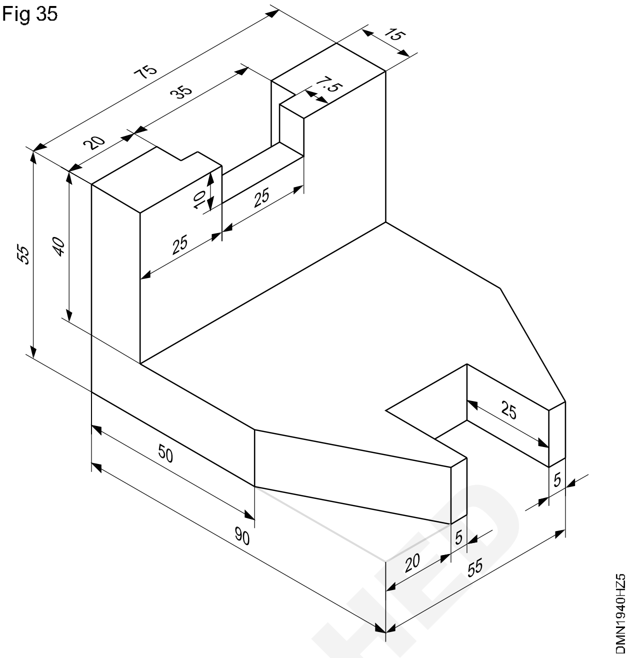


Fig 36

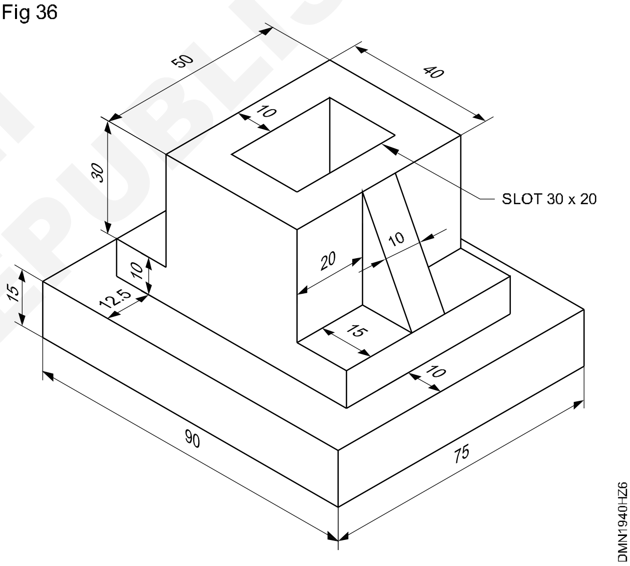
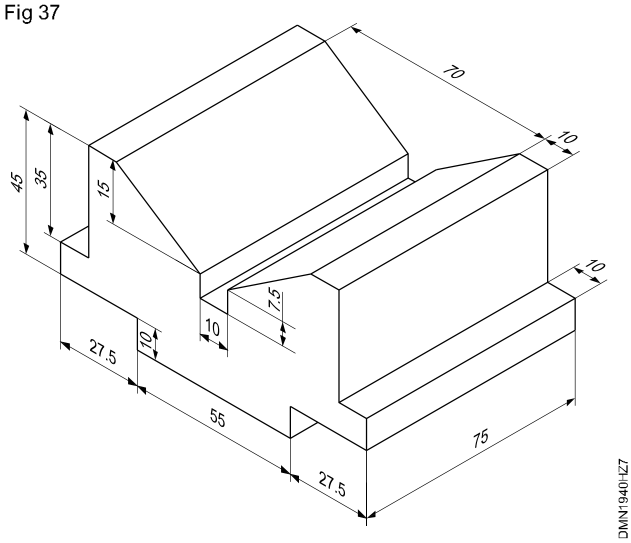
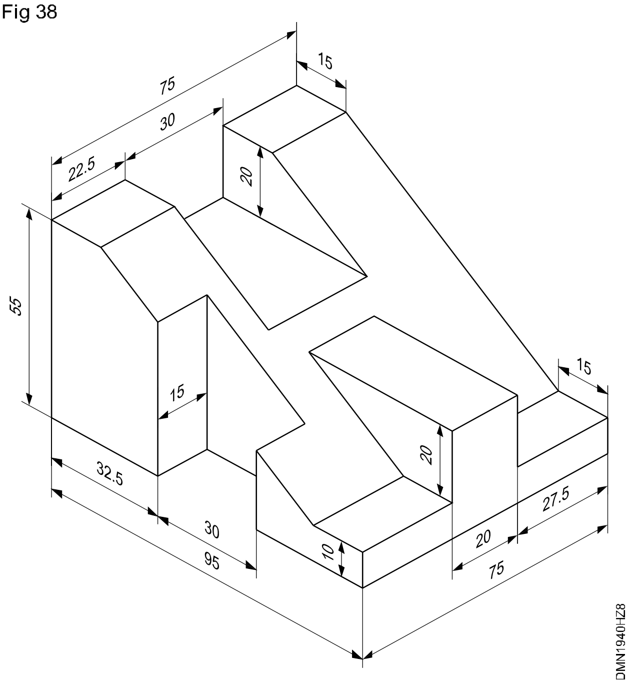


Fig 37



© NIMI NOT TO BE REPUBLISHED

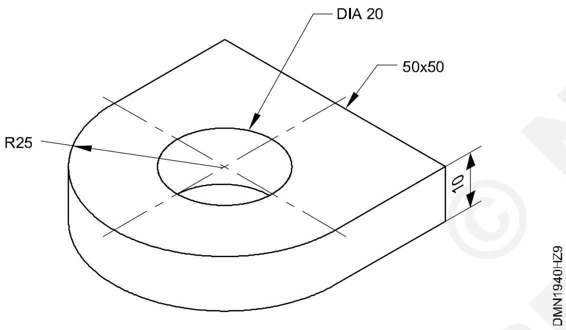
Fig 38



Exercise 39

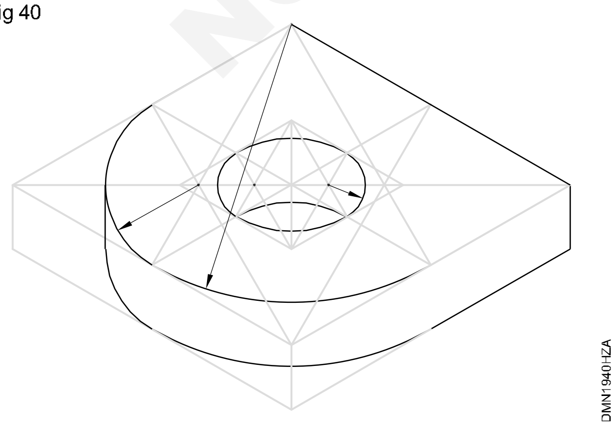
Draw the Isometric projection of the solid block. (Fig 39)

Fig 39



- Draw Isometric projection of a square prism of size 50 mm, height 10 mm showing all six faces in thin lines.
- Draw isometric circles of diameter 20 mm both on top and bottom faces of the prism at the given location.
- With the same centre, draw two isometric semi-circles.
- Join the smaller circles and the semi-circles with common tangents as shown in Fig 40.

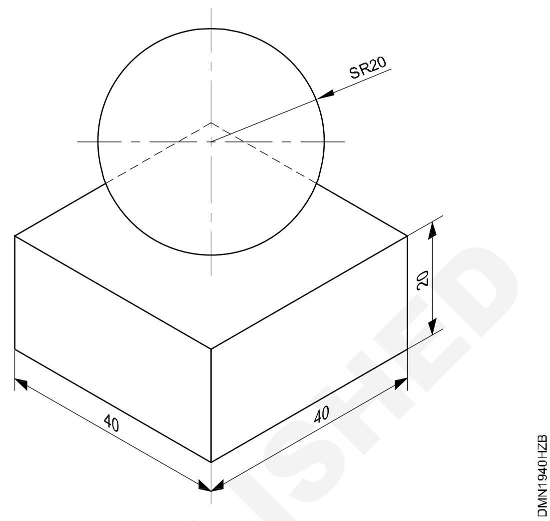
Fig 40



- Erase unwanted lines.
- Make the remaining lines thick and hidden as required and complete the figure 40.

A sphere positioned at the centre of the top face of a square prism as shown in Fig 41. Draw the Isometric projection.

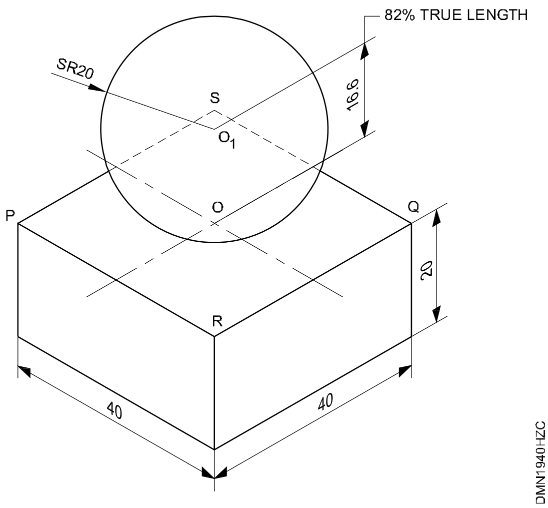
Fig 41



- Draw the Isometric projection of the square prism. (Fig 42)
- Draw the diagonal PQ & RS intersecting at centre `O'.
- From `O' draw a vertical line and mark O_1, such that OO_1 is equal to isometric length (82%) of the radius 20 mm. (16.4 mm)
- With O_1 as centre and radius 20 mm, draw a circle which is the isometric view of the sphere.

When a sphere is viewed in any direction its shape will be a circle of radius equal to the true radius of the sphere and hence the isometric projection of the sphere will be a circle of radius equal to the true radius (1:1) of the sphere.

Fig 42



Additional practice

Draw the Isometric projections of the given exercises.

- Follow the procedures of previous exercises. (Figs.43,44,45,46,47)

© NIMI NOT TO BE REPUBLISHED

Fig 43

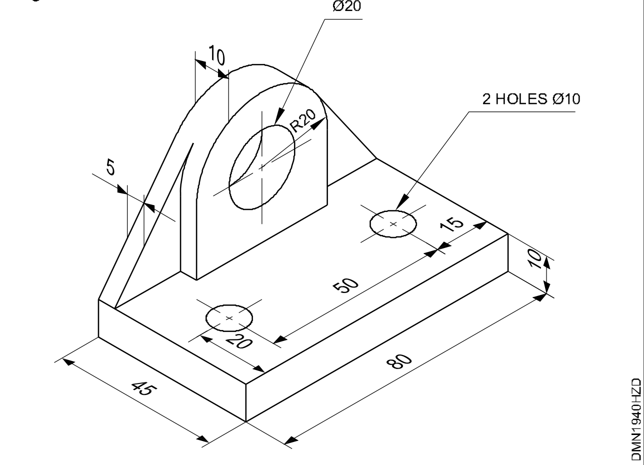


Fig 44

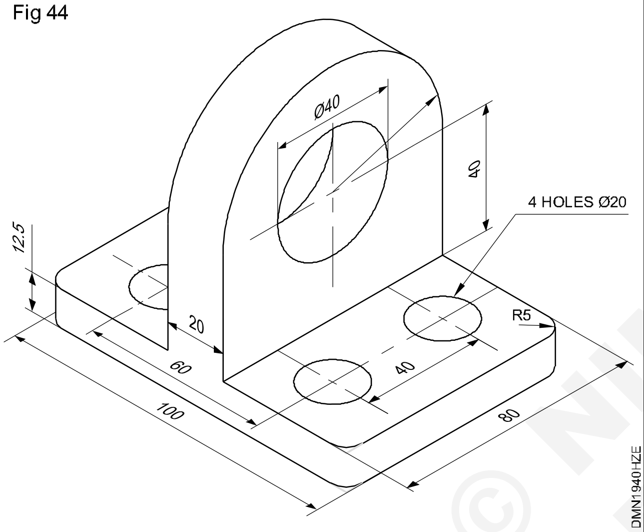


Fig 45

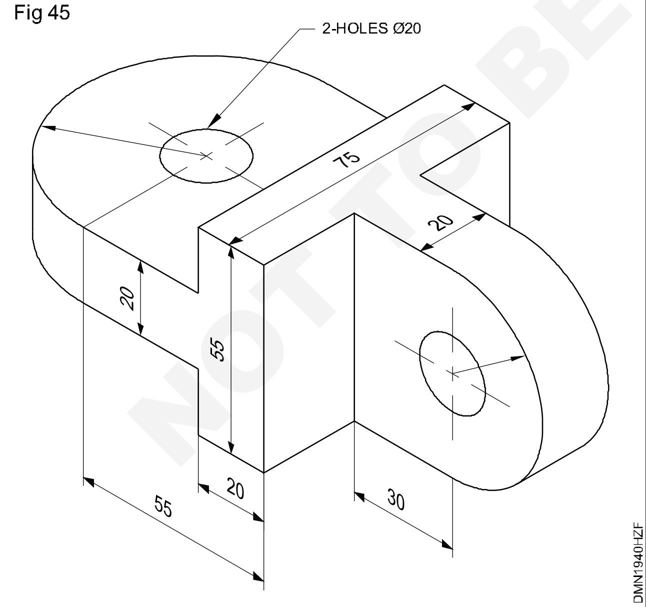


Fig 46

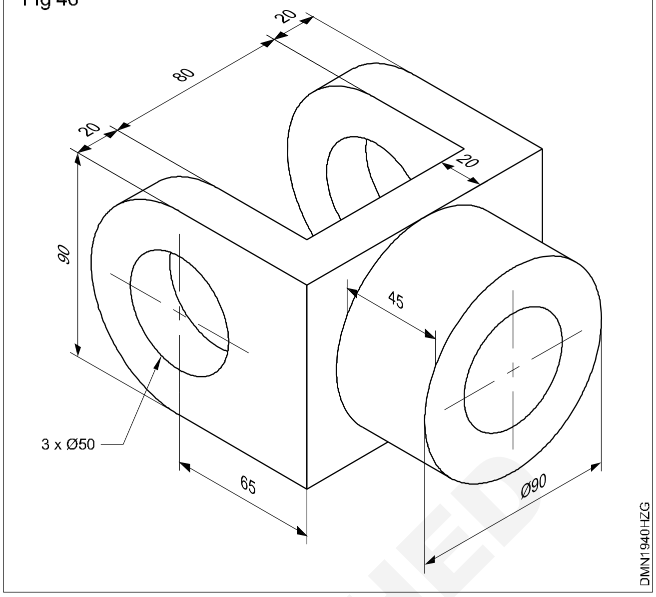


Fig 47

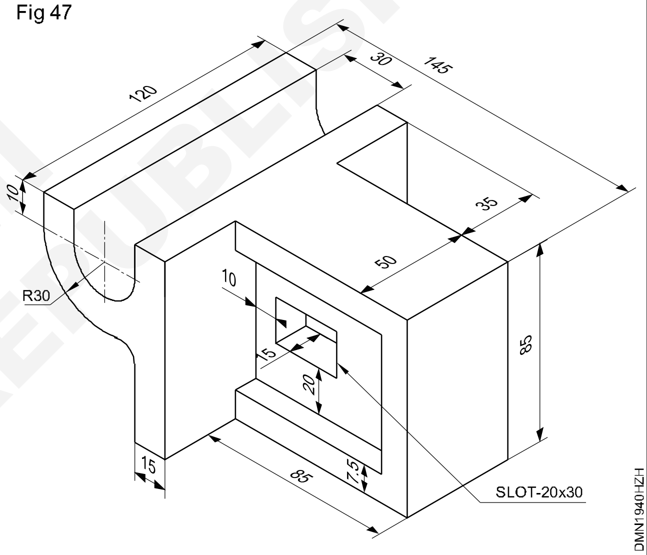
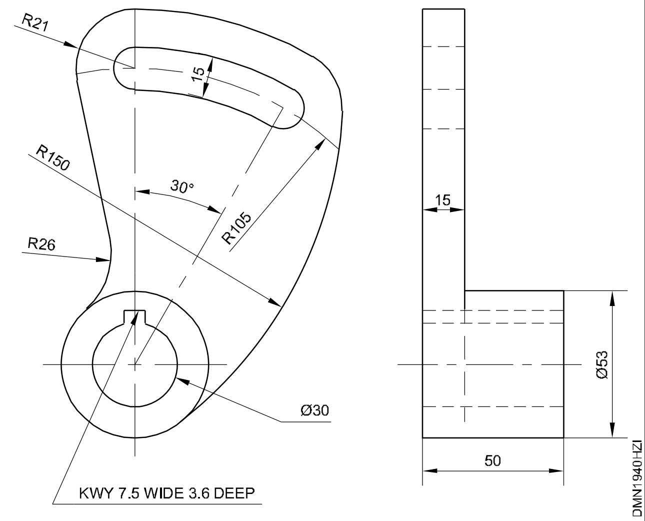


Fig 48



© NIMI
NOT TO BE REPUBLISHED

Exercise 48

For the given two views of the shaft lever, draw the isometric projection. (Fig 48)

- Follow the same procedure of the previous exercises.

Draw Isometric view of truncated cone and pyramid

Objectives: At the end of this exercise you shall be able to
- **draw the isometric view of a truncated cone for the given specifications**
- **draw isometric view of the truncate pyramid for the given data.**

PROCEDURE

Exercise 1: Draw the isometric view for the given elevation and plan of a cone

Fig 1

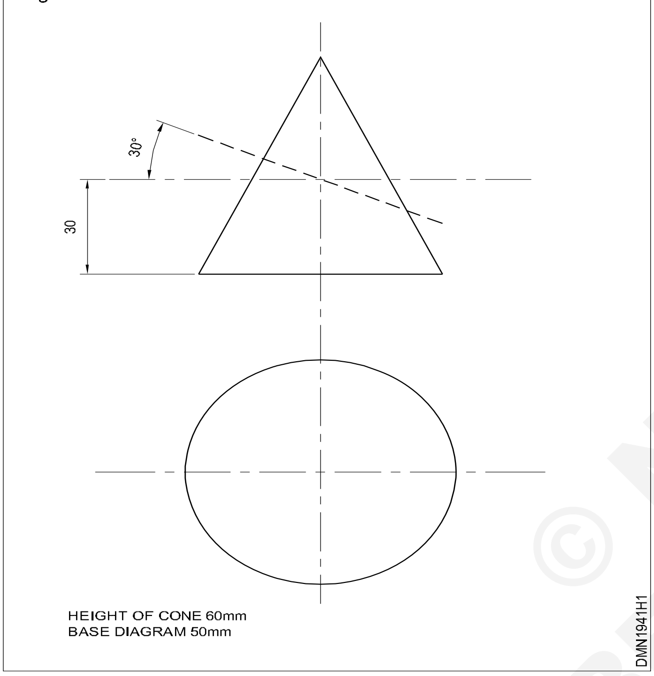
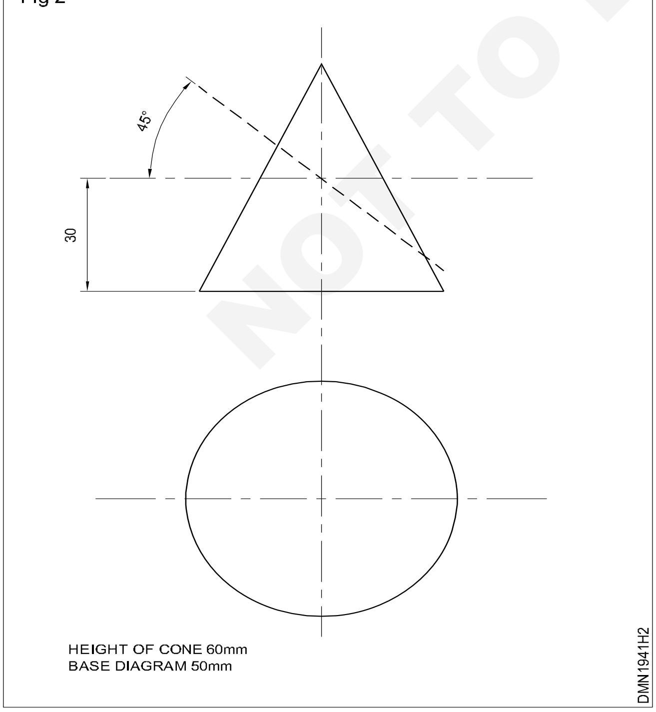


Fig 2



Exercise 2: Draw the isometric view for the given elevation and plan of a cone

Fig 3

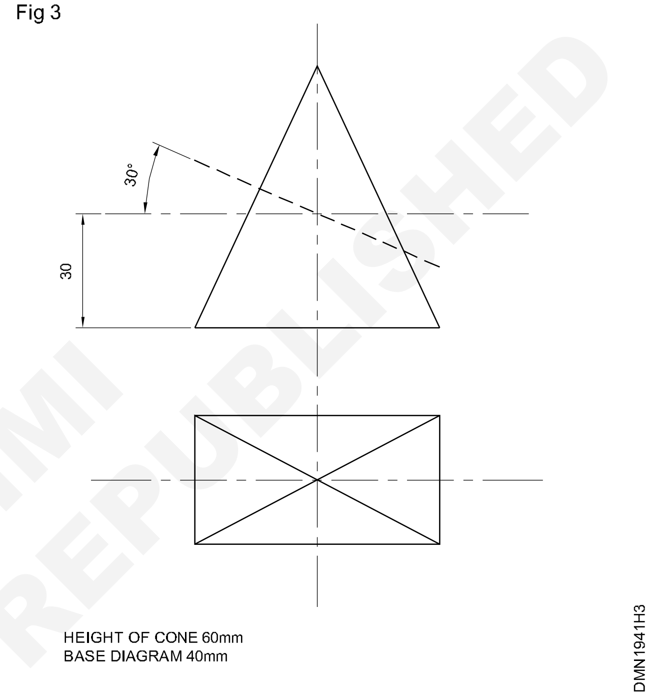
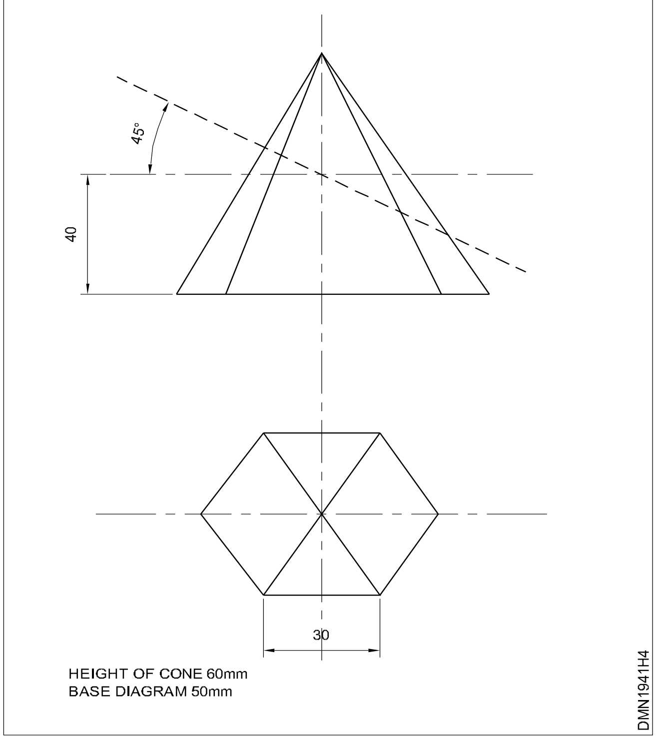


Fig 4



© NIMI NOT TO BE REPUBLISHED

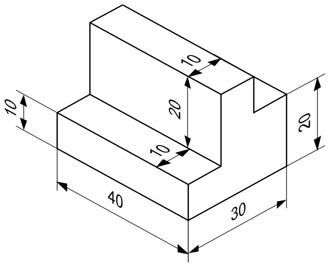
Drawing of orthographic views

Objectives: At the end of this exercise you shall be able to
- **draw the orthographic view of given blocks**
- **drawing of missing views.**

Exercise 1: For the given isometric views of different blocks & Fig 1 to 12 draw the orthographic views front elevation, plan and side view in first angle projection

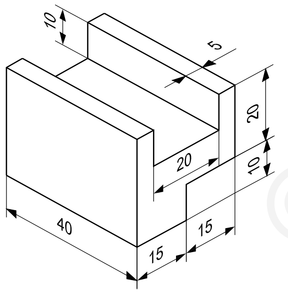
Exercise 2

Fig 1



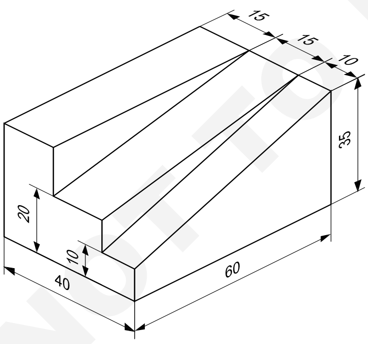
DMN1942H1

Fig 2



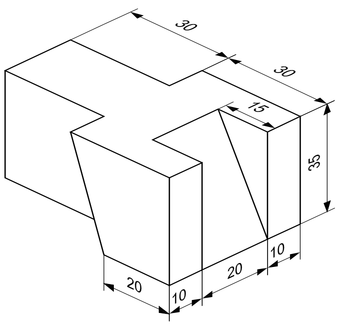
DMN1942H2

Fig 3



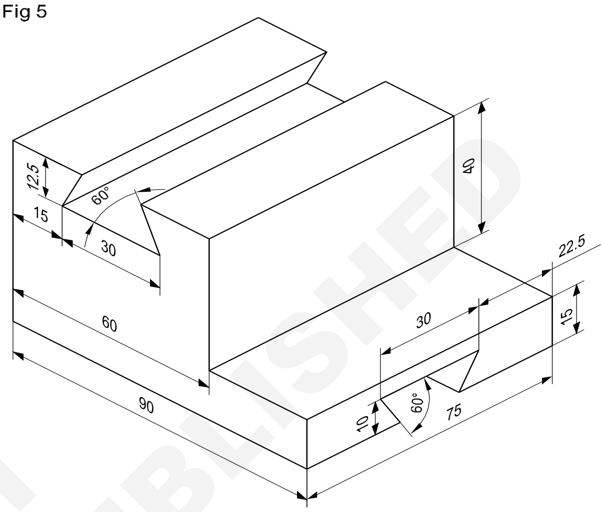
DMN1942H3

Fig 4



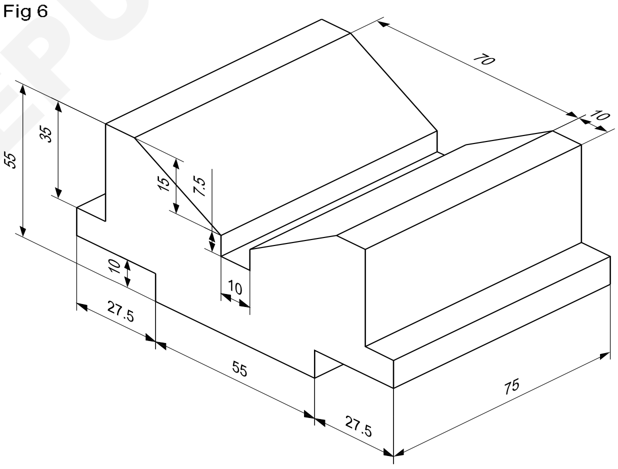
DMN1942H4

Fig 5



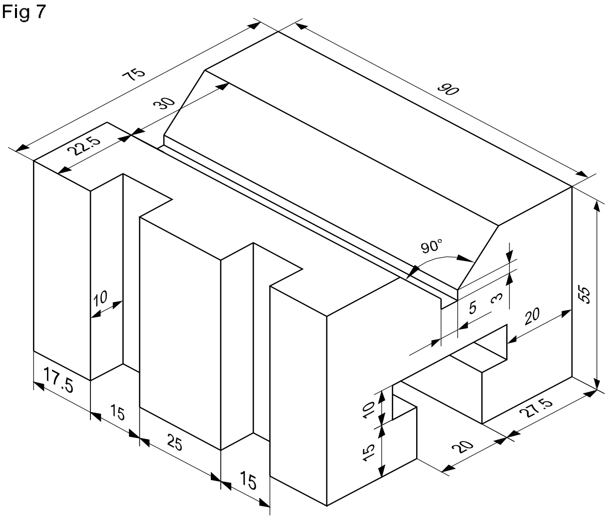
DMN1942H5

Fig 6



DMN1942H6

Fig 7



DMN1942H7

© NIMI NOT TO BE REPUBLISHED

Fig 8

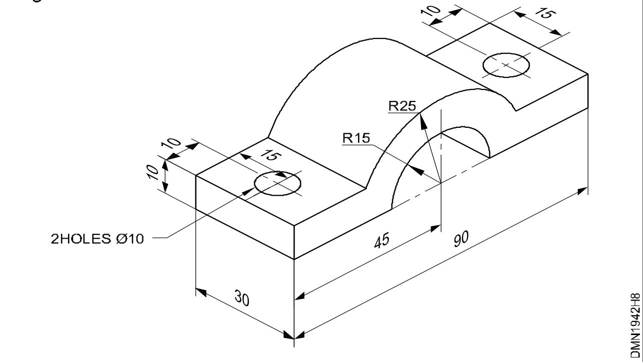


Fig 9

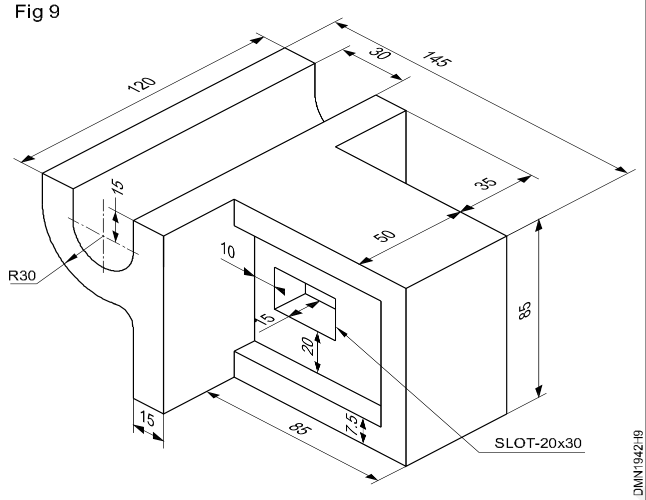


Fig 10

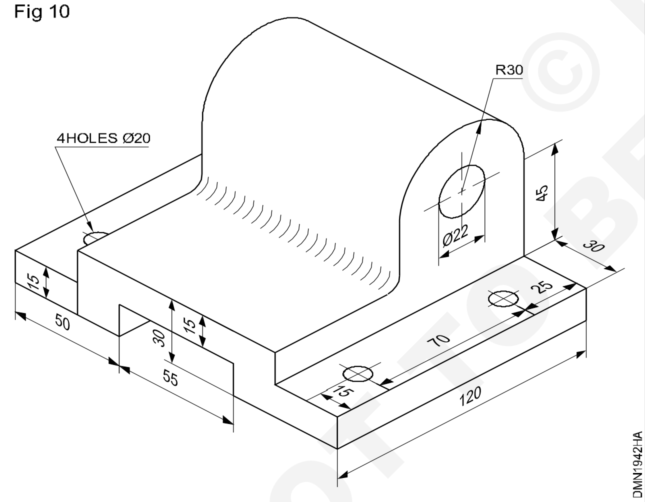


Fig 11

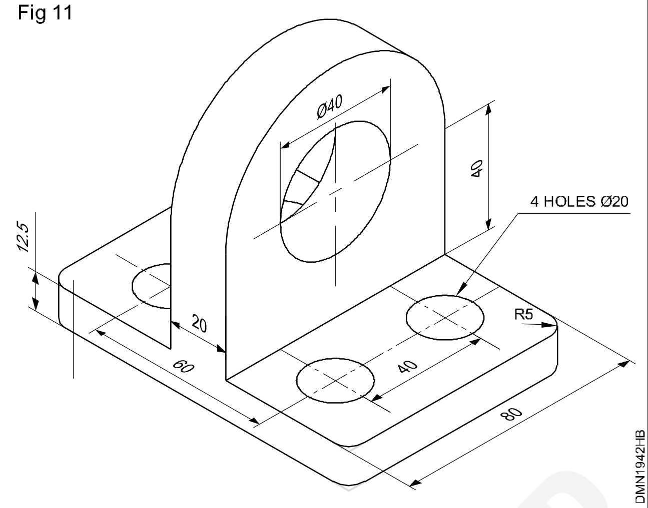
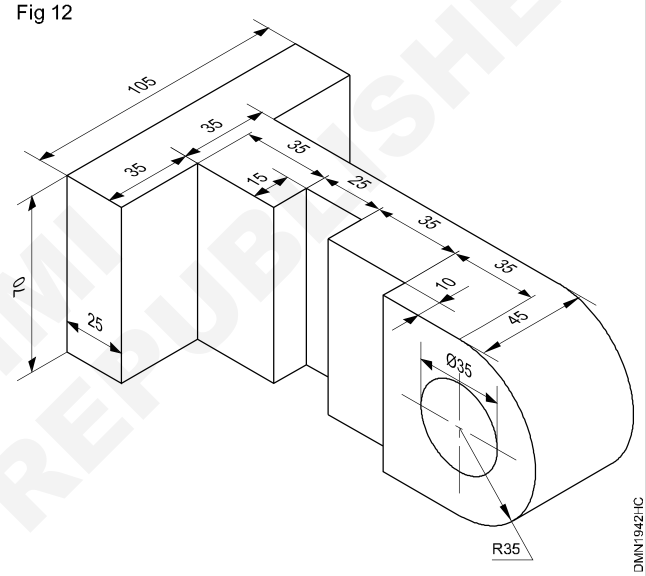


Fig 12



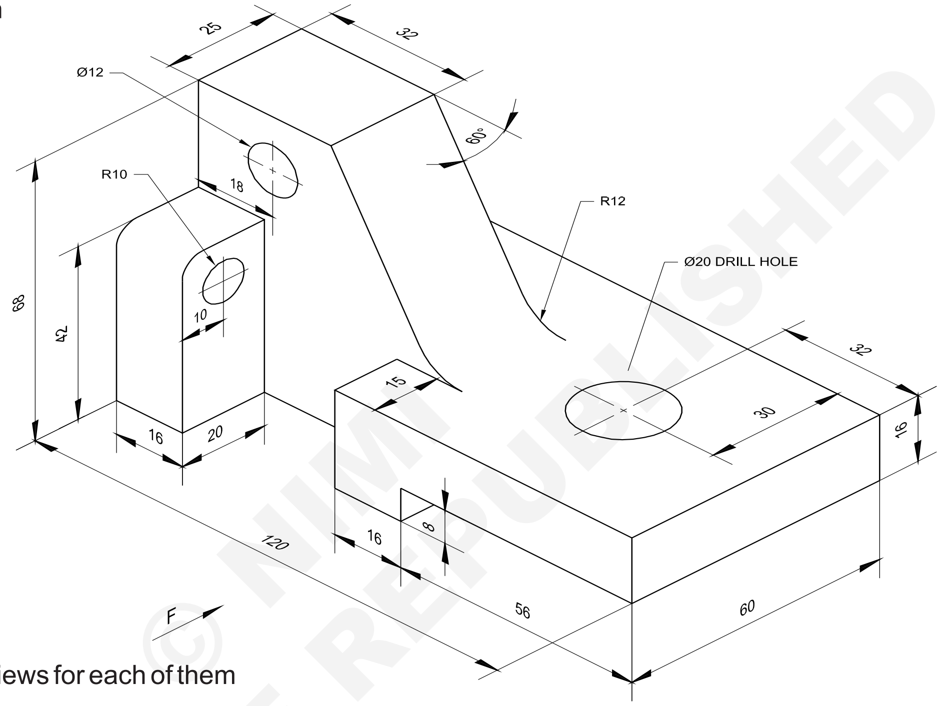
NOT TO BE REPUBLISHED © NIMI

Drawing of orthographic views of machined blocks

Objectives: At the end of this exercise you shall be able to
- **draw the isometric view of objects**
- **draw the orthographic view of each object in first angle projection.**

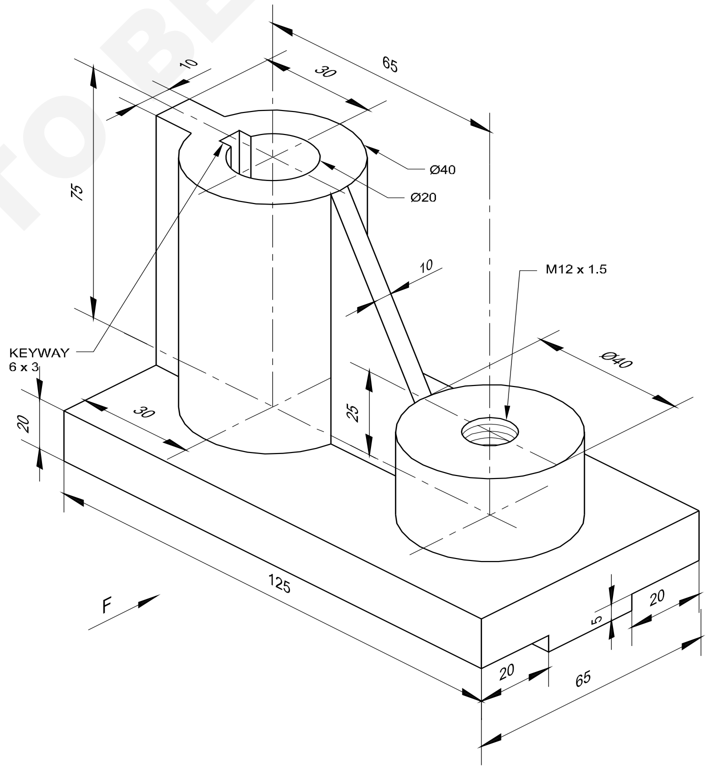
Exercise 1
- For the given exercises 1 to 8 reproduce the isometric view and draw the orthographic views in first angle projection

Fig 1



Exercise 2

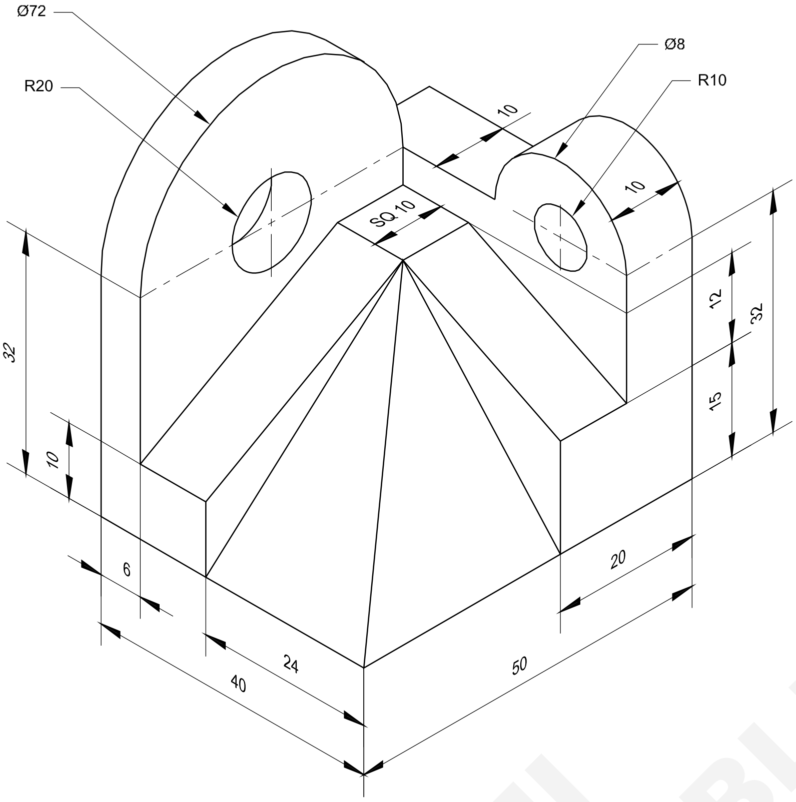
- Draw orthographic views for each of them
- Give dimensions in isometric view and also in orthographic views.



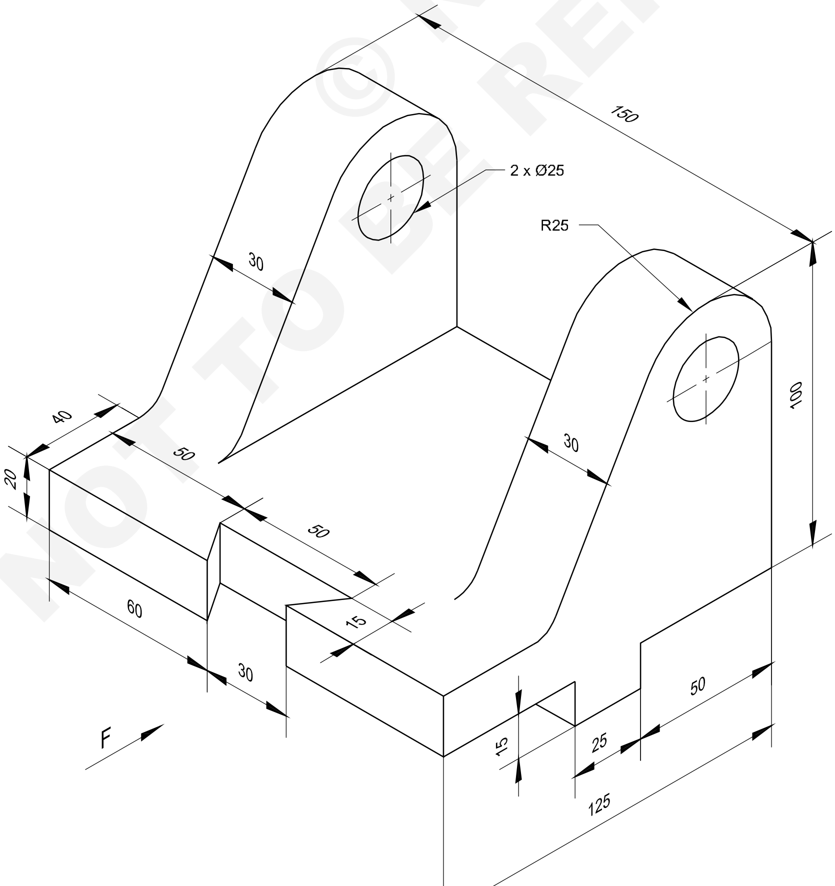
DMN1943H1

© NIMI NOT TO BE REPUBLISHED

Exercise 3



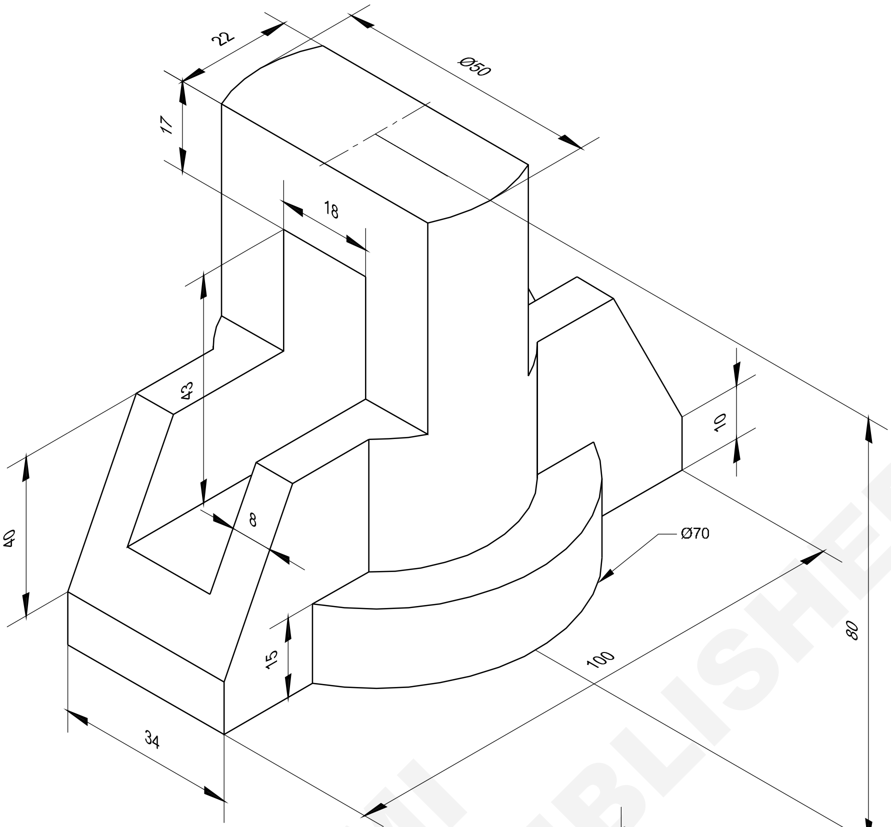
Exercise 4



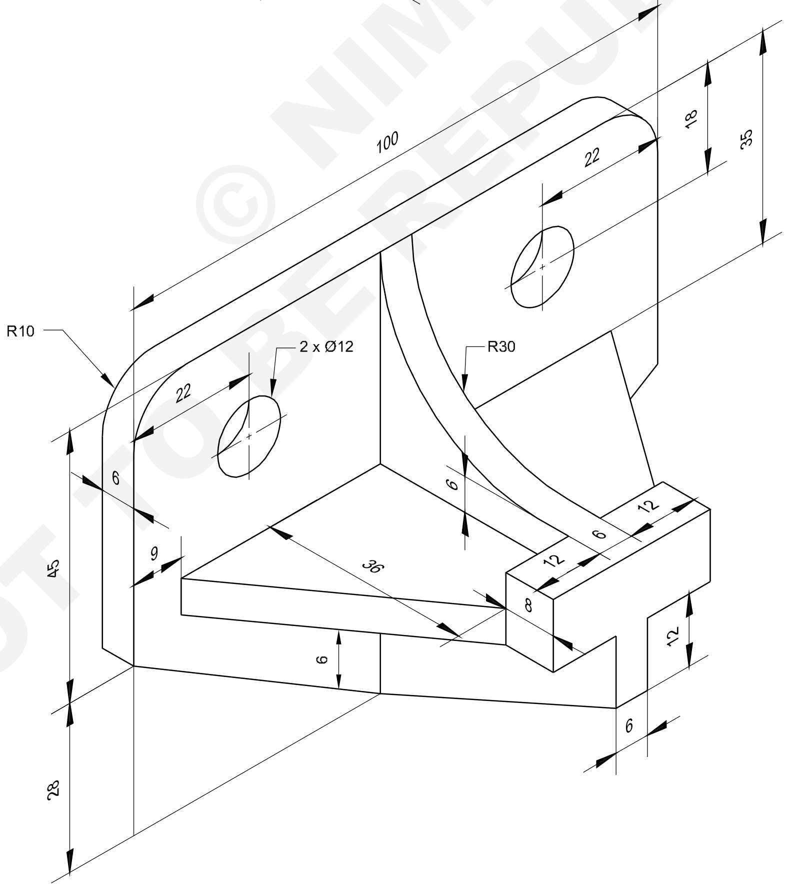
DMN1943H2

© NIMI NOT TO BE REPUBLISHED

Exercise 5



Exercise 6



DMN1943H3

Orthographic view to isometric view

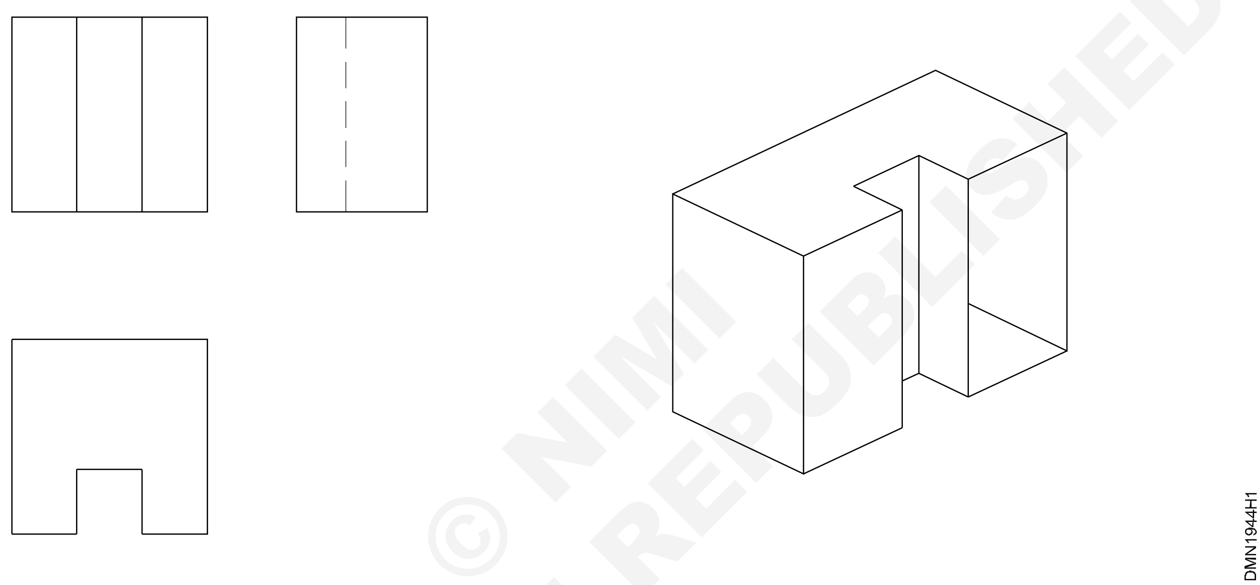
Objective: At the end of this exercise you shall be able to
- **draw the isometric view for the given orthographic.**

PROCEDURE

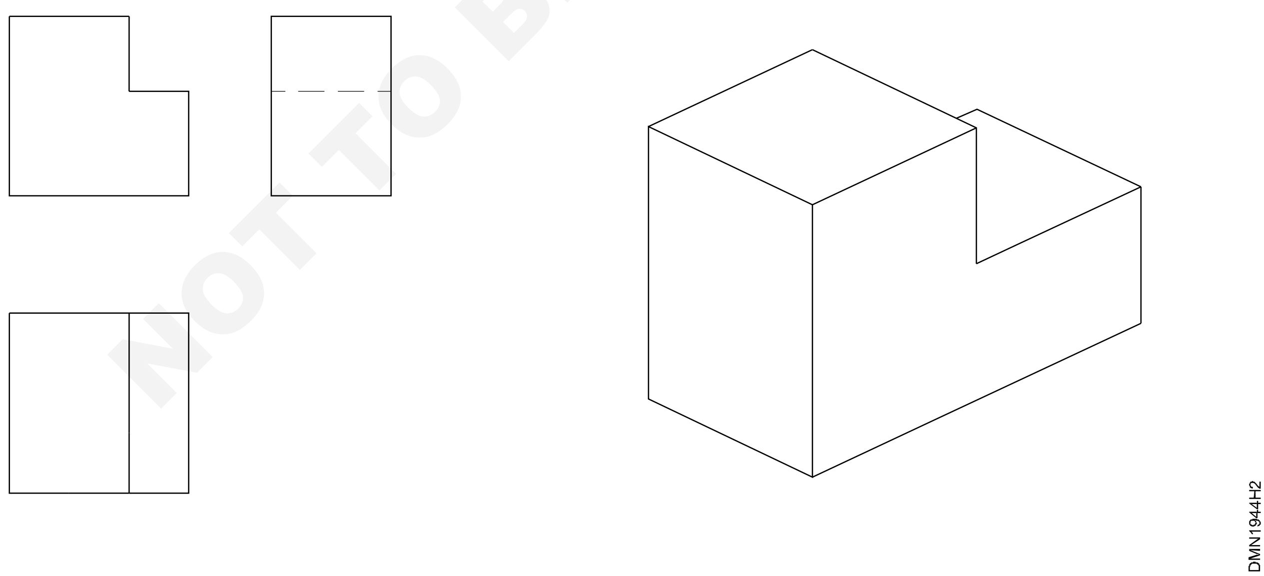
Exercise 1: Copy the given orthographic with suitable dimensions.

- Draw a rectangular prism to the required side.
- Impose the front view plan and side view of the prism.
- Imagine and visualize the object
- Remove the un wanted of the object complete the drawing
- Provide over all dimensions
- Complete the other exercises 1 to 12 in the same procedure.

Eg 1

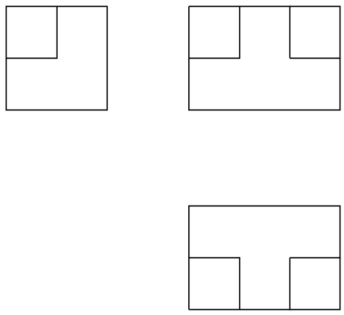


Eg 2

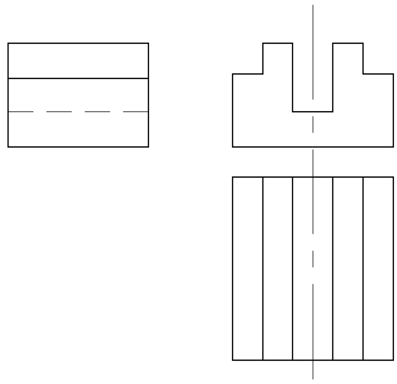


© NIMI NOT TO BE REPUBLISHED

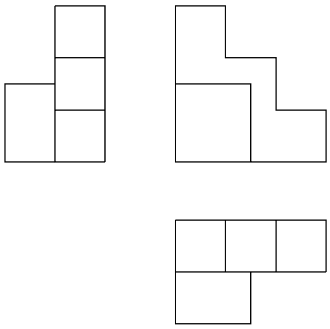
Ex 1



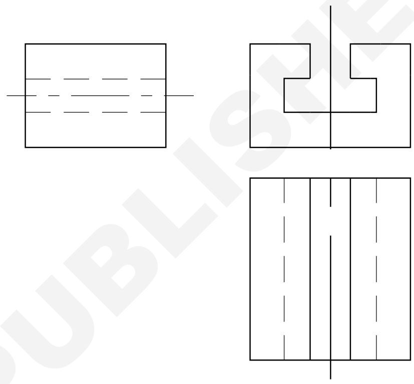
Ex 2



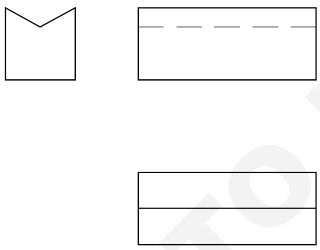
Ex 3



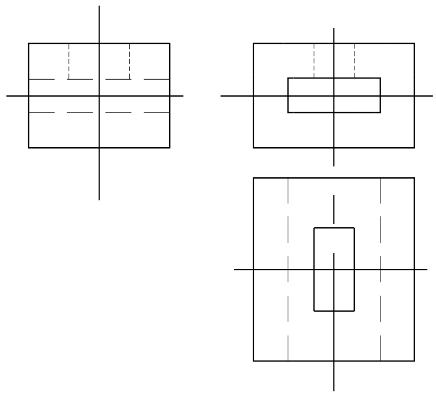
Ex 4



Ex 5



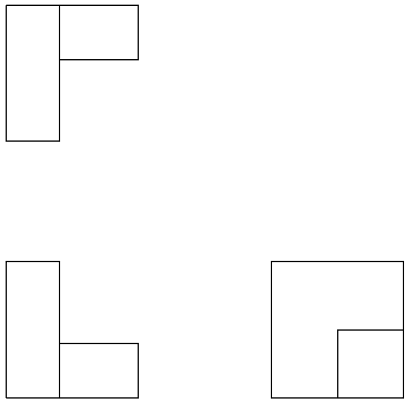
Ex 6



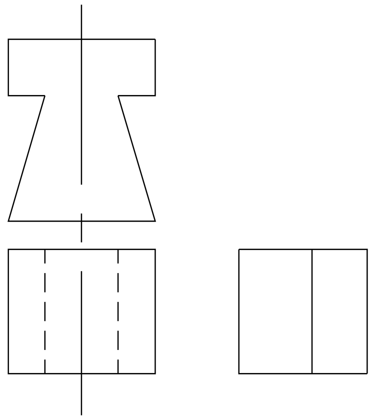
DMN1944J3

© NIMI NOT TO BE REPUBLISHED

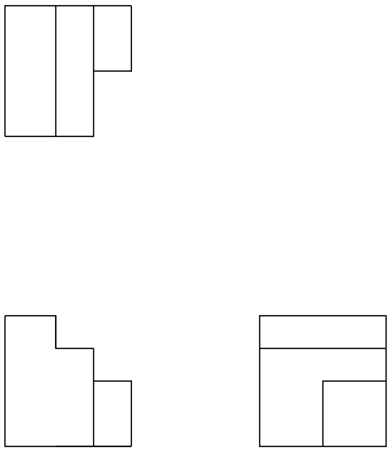
Ex 7



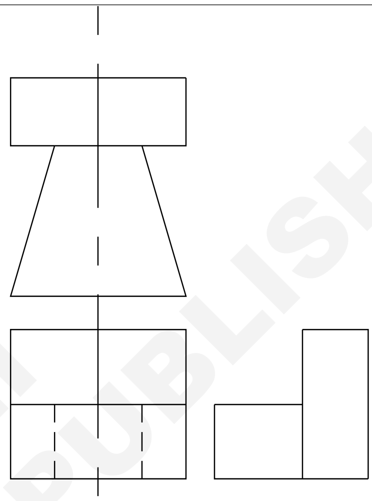
Ex 8



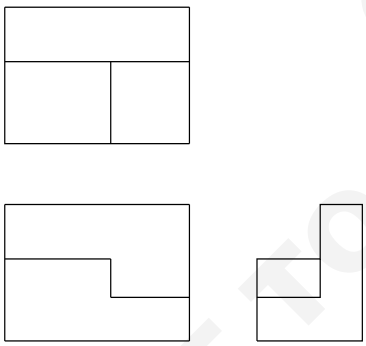
Ex 9



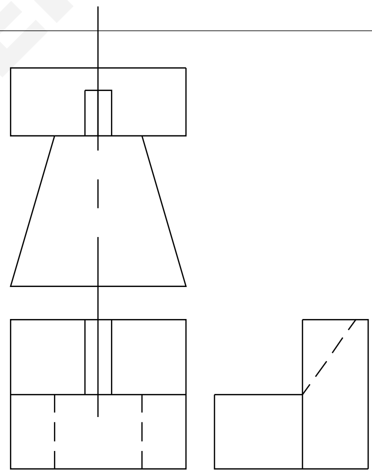
Ex 10



Ex 11



Ex 12



DMN1944J4

© NIMI NOT TO BE REPUBLISHED

Draw Isometric view of the simple journal bearing

Objective: At the end of this exercise you shall be able to
- **draw the isometric view of journal bearing, ball bearing, roller bearing and case bearing.**

Exercise 1 to 14 : Redraw the figures given below using suitable scale

Fig 1

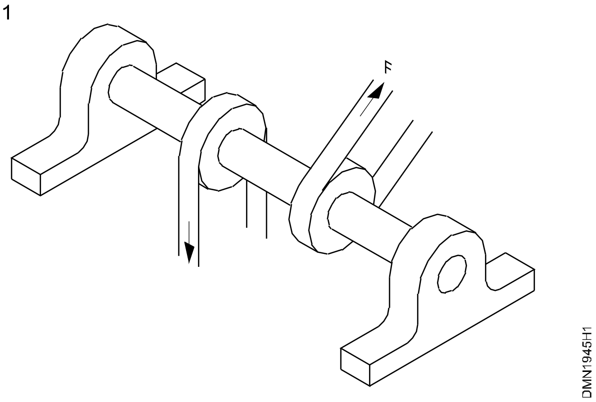


Fig 2

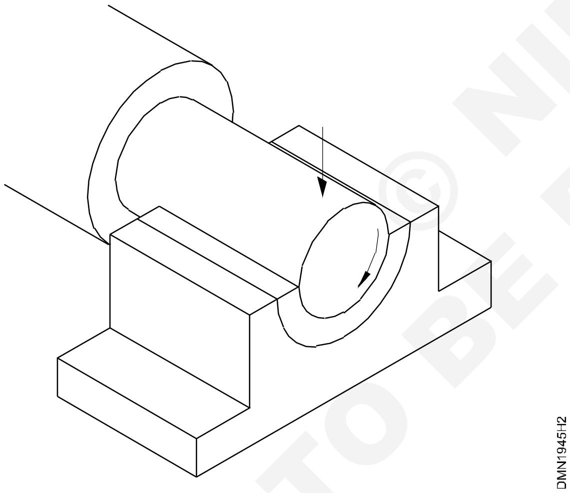


Fig 3

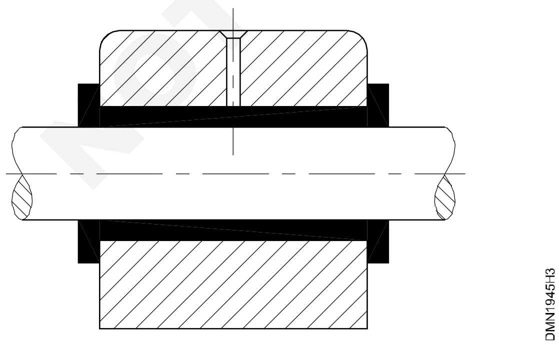


Fig 4

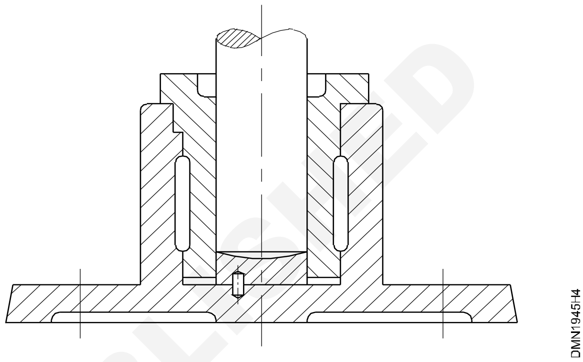


Fig 5

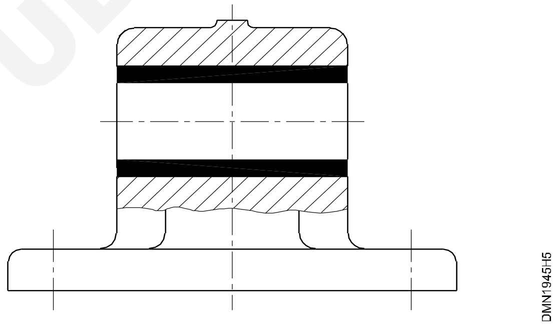


Fig 6

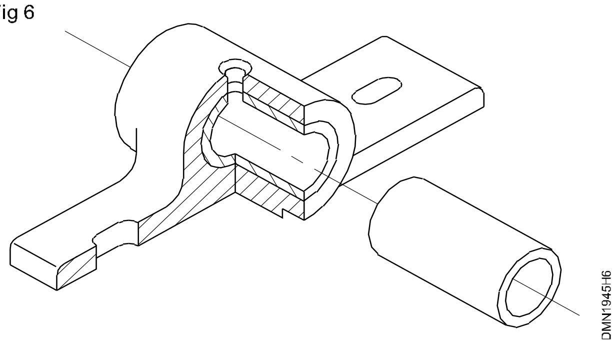
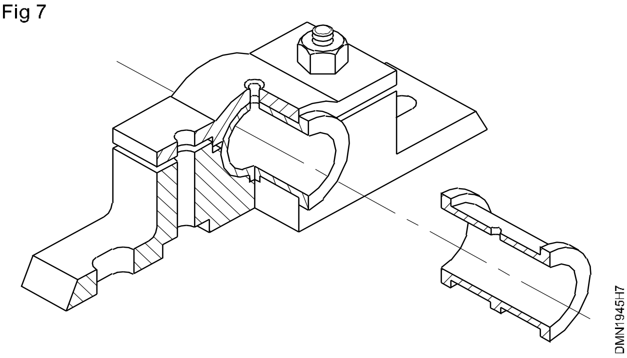


Fig 7



© NIMI NOT TO BE REPUBLISHED

Fig 8

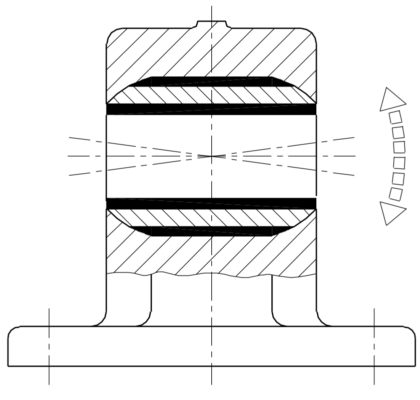


Fig 9

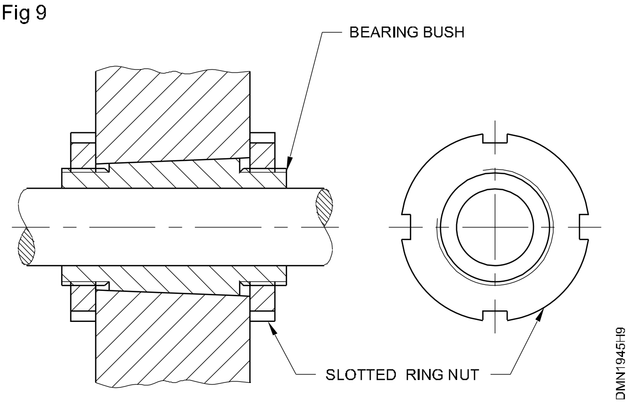


Fig 10

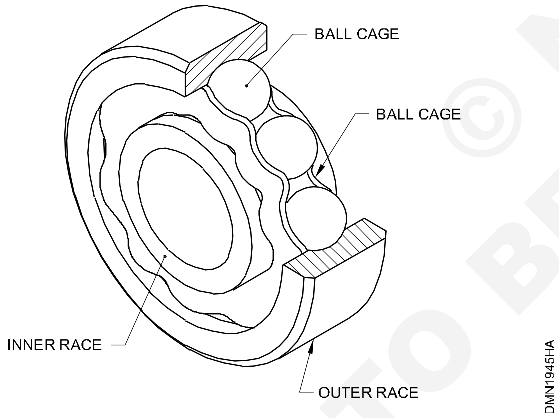


Fig 11

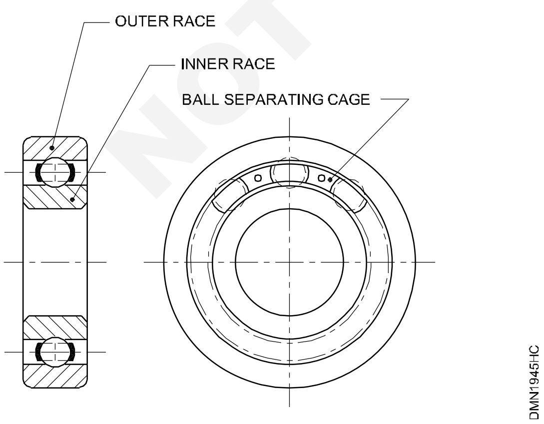
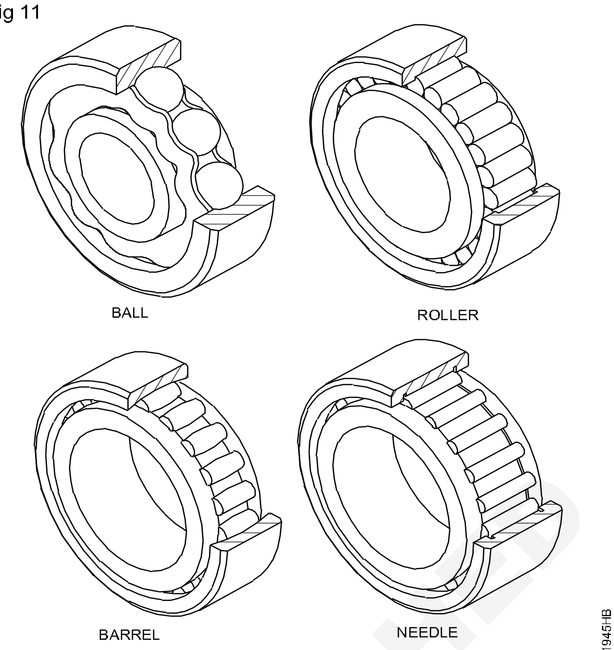


Fig 11



TYPES OF ROLLING ELEMENTS

Fig 13

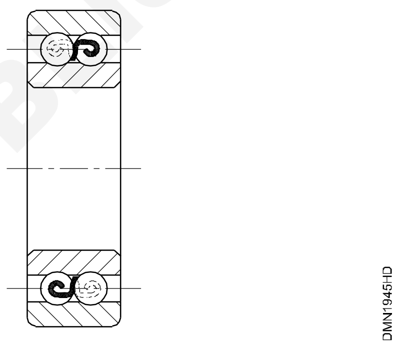
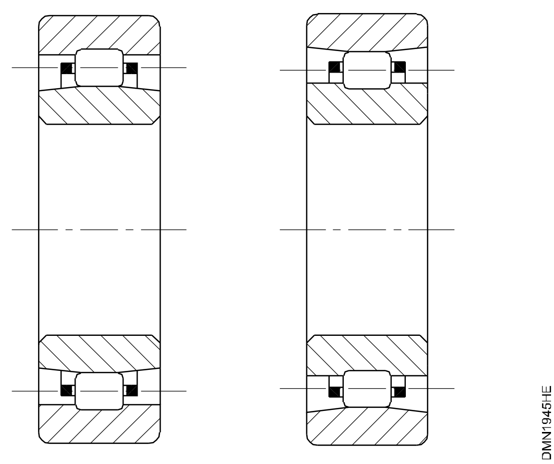


Fig 14

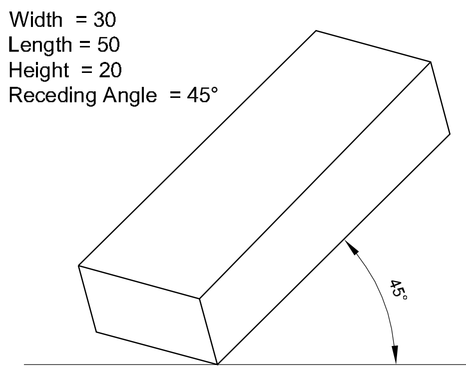


© NIMI NOT TO BE REPUBLISHED

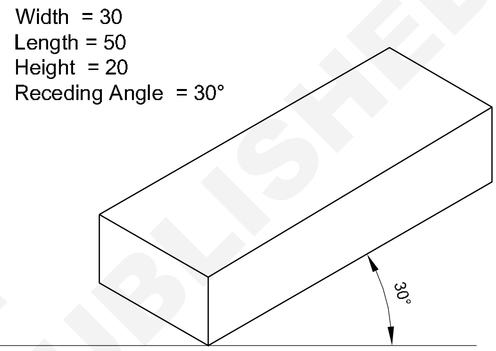
Draw the oblique projection of circular lamina in reading axes at 30° and 40°

Objectives: At the end of this exercise you shall be able to
- **draw the oblique views of rectangle witht he raceding angle of 30° & 45°**
- **draw the oblique views of a circular lamina with the receding angle of 30° & 45°.**

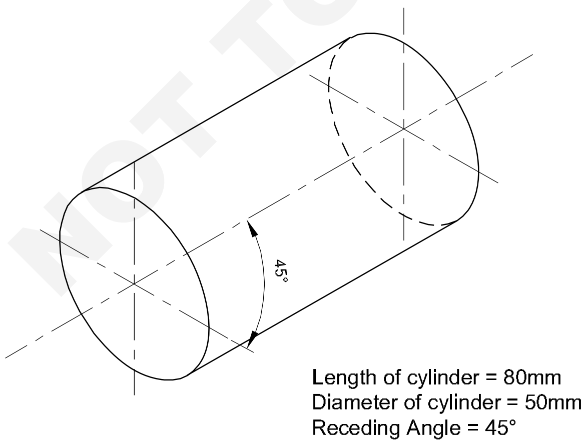
Exercise 1 : Draw the rectangle block of given data



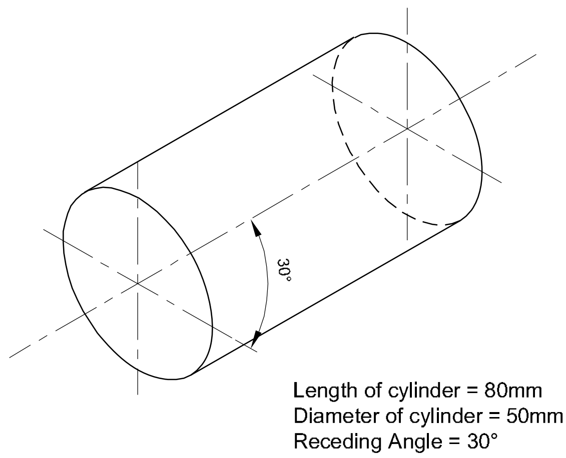
Exercise 2 : Draw the rectangle block of given data



Exercise 3 : Draw the circular lamina cylinder of given



Exercise 4 : Draw the circular lamina of cylinder for the given data



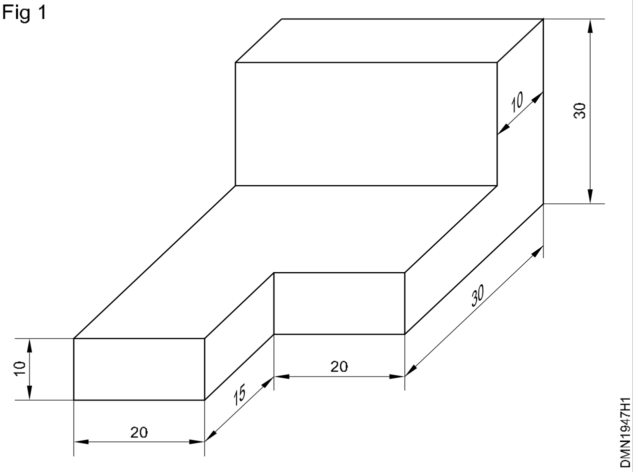
DMN1946H1

© NIMI NOT TO BE REPUBLISHED

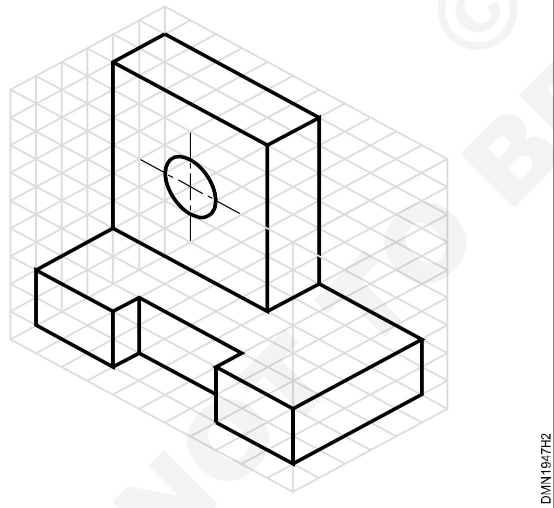
Draw the oblique projection of given blocks

Objective: At the end of this exercise you shall be able to
- **draw the oblique projections for the given objects.**

Exercise 1: Reproduce the oblique view of the object shown in Fig 1.

Fig 1


Exercise 2: Draw the oblique view in cavalier method of the component shown in isometric view. Consider each grid is of 5 mm. (Fig 2)

Fig 2


Exercise 3: Draw the oblique view of the bracket (Fig 3) by cavalier method.

Exercise 4: Draw the oblique view of the component in cabinet method. (Fig 4)

Exercise 5: Draw the oblique view (cavalier method) of the hinge. (Fig 5)

Example for Fig.1

Reproduce the oblique projection of the object shown in (Fig.1)

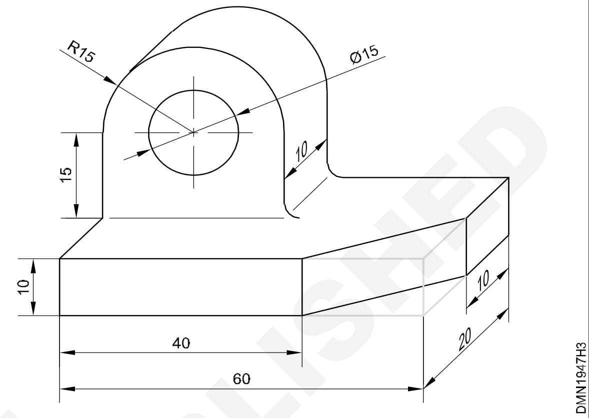
Fig 3


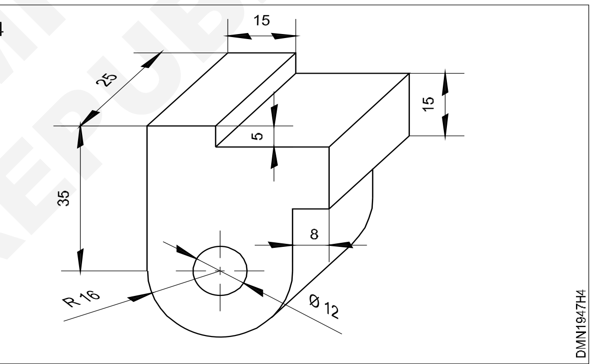
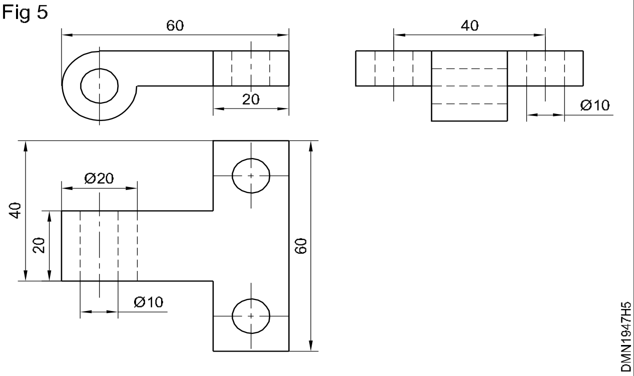
Fig 4


Fig 5


- Draw the oblique axes (may be at any angle to the horizontal 30°, 45° or 60°) and extend. (Fig 6)
- mark off the overall length, breadth and height of the object on the axis.
- Draw the enclosed box.
- Envelope the details of the object in the box by transferring dimension. (Fig 7)
- Erase the unwanted lines and darken the required lines of the surfaces. (Fig 8)

© NIMI NOT TO BE REPUBLISHED

- Mark the dimensions and complete the drawing.

(In this oblique projection, the front face of the object is placed parallel to the picture plane and shown in its true size and shape)

Fig 6

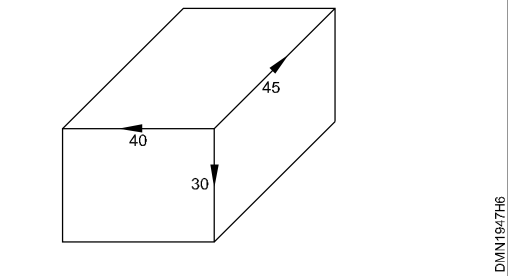


Fig 7

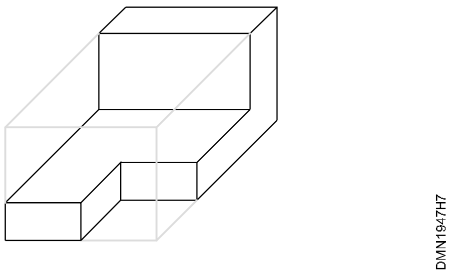
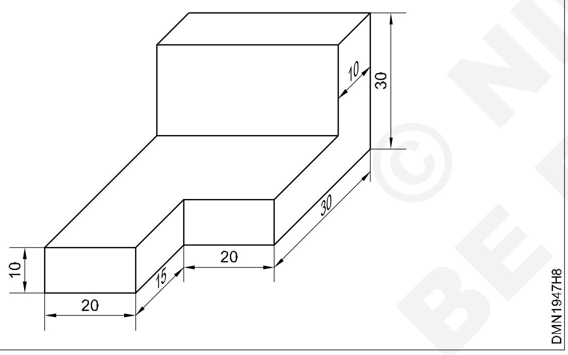


Fig 8



Ex. 2: Draw the oblique projection in cavalier method of the component shown in isometric view (Fig 2)

- Draw an enclosed box in oblique view to the overall size of the component i.e 50 x 25 x 40.
- Transfer shape of the view (isometric) to the box.
- Rub off the unwanted lines and complete the oblique view of the component.

In cavalier method the projectors make an angle of 45° with the plane of projection and the inclined surfaces are drawn 1:1 scale. (Fig 9)

Construct grid of 5 mm in thin lines.

Ex.3: Draw the oblique projection of the bracket in cavalier method

- Construct box to over all size.
- Envelope shape excluding the curved portion to the box drawn. (Fig 10)

Fig 9

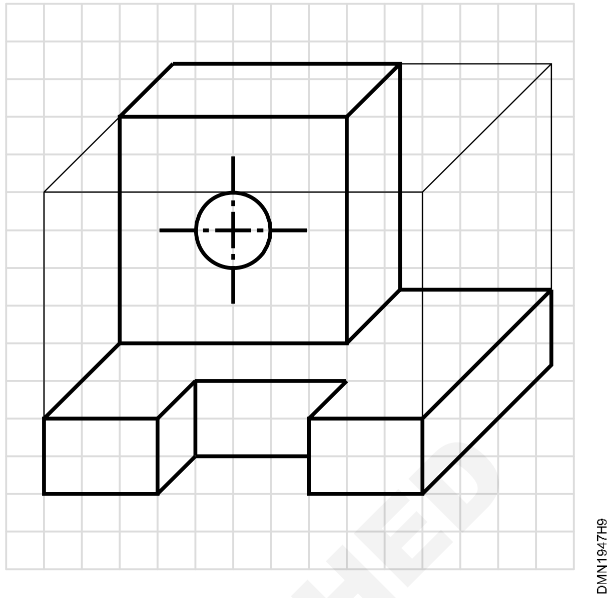
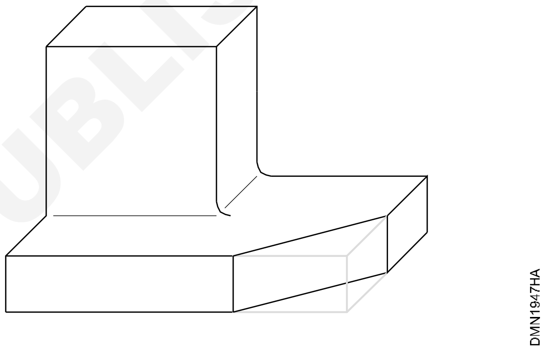
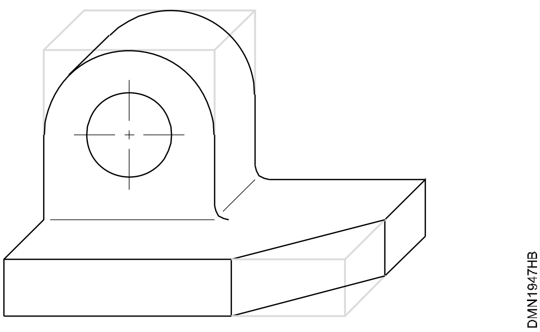


Fig 10



- Locate and mark the centre of circle/curve on both surfaces. (Fig 11)

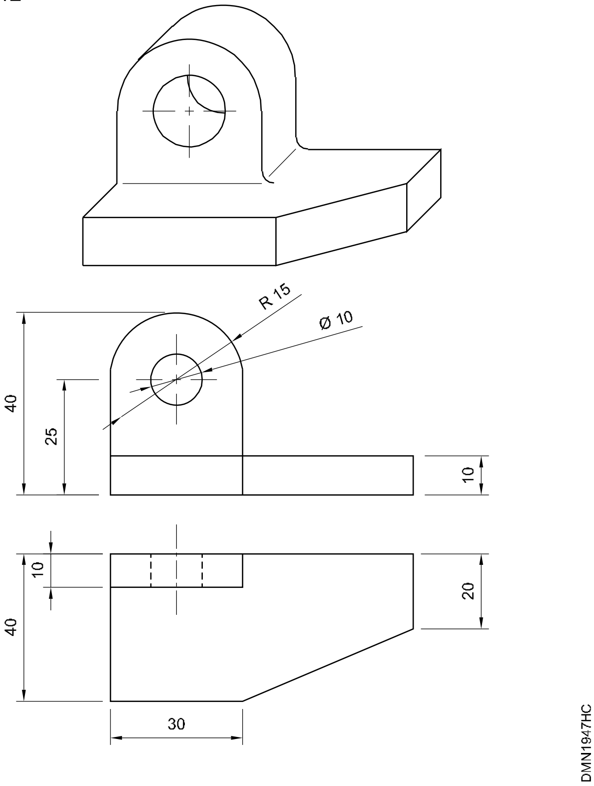
Fig 11



- Draw arcs and circles on both surfaces.
- Join the periphery of circles with a tangent.
- Rub off the unwanted lines and complete the oblique view. (Fig 12)
- Read and transfer the dimensions to the oblique view from the given orthographic views of the object. (Fig 12)

© NIMI NOT TO BE REPUBLISHED

Fig 12

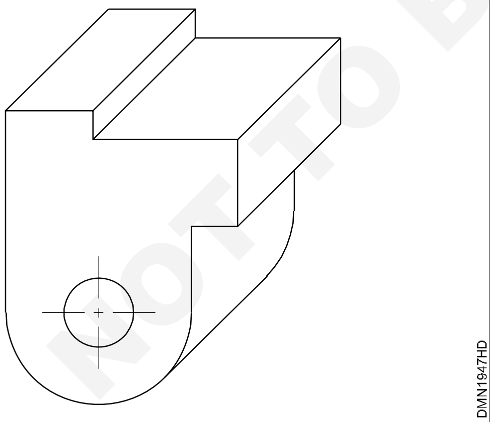


Ex.4: Draw the oblique projection of the component shown in cabinet method.

Procedure of drawing this component is similar to that of the previous exercises, except the inclined lines are to be drawn to half of the true length. (Instead of inclined lines to 25 mm draw 12.5 mm)

Figure 13 shows the oblique view of the component in cabinet method.

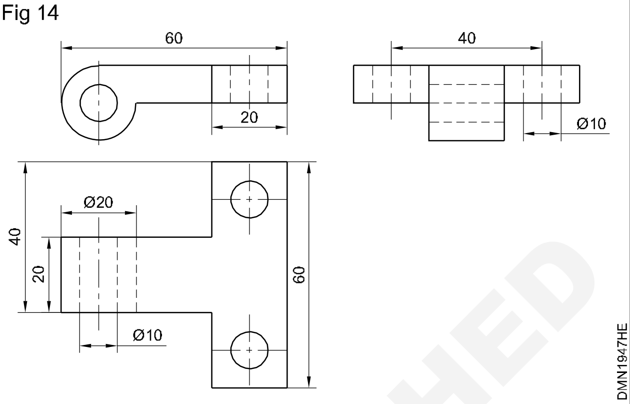
Fig 13



Ex.5 :Draw the oblique projection (cavalier method) of the hinge

- Draw a box in oblique view to the overall size of the hinge. i.e 60 x 20 x 60.
- Envelope the details visualized from the multi view. (Fig 14)

Fig 14



- Erase the unwanted lines darken the lines required and complete the oblique view. (Figs 15 & 16)

Fig 15

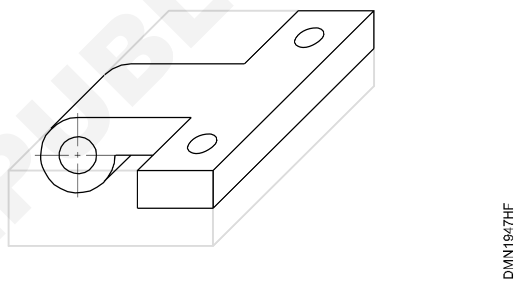
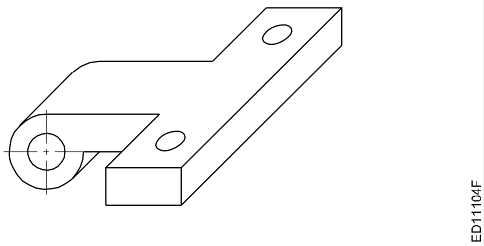


Fig 16



© NIMI
NOT TO BE REPUBLISHED

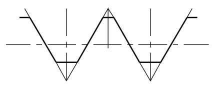
Draughtsman Mechanical - Specifications of different event types of fasteners and locking devices as per - SP - 46 - 2003

Draw the screw threads with - Sp - 46 - 2003 - Conventions

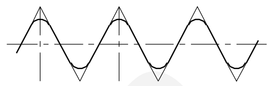
Objective(s): At the end of this exercise you shall be able to
- **draw the following types of threads/conventions by free hand and also using instruments**
- **types of vee threads**
- **square thread.**

TASK 1

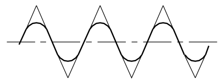
Draw the basic and design profile of ISO metric thread different types of Vee threads.



METRIC THREAD



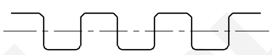
BRITISH STANDARD WHITWORTH THREAD



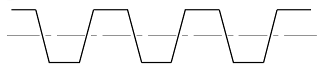
BRITISH ASSOCIATION THREAD

TASK 2

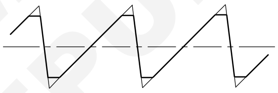
Draw the basic and design profile of square, acme, buttress and knuckle threads.



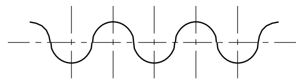
SQUARE THREAD



ACME THREAD



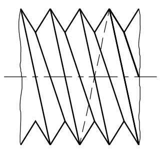
BUTTRESS THREAD



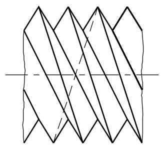
KNUCKLE THREAD

TASK 3

Draw profile of double and triple start threads.



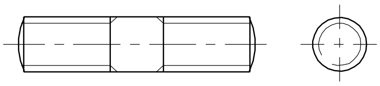
DOUBLE START



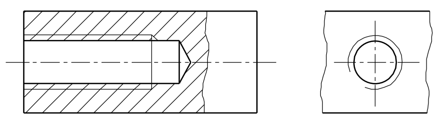
TRIPLE START

TASK 4

Draw the conventions of external, internal threads individually and in assembly.



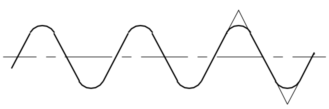
CONVENTION OF EXTERNAL THREAD



CONVENTION OF INTERNAL THREAD

TASK 5

Draw the profile of pipe threads.



PIPE THREAD

SCALE : NTS	**SCREW THREADS**	EX NO. 2.1.48
		TIME : 10hrs
PROJECTION		CODE : DMN2148E1

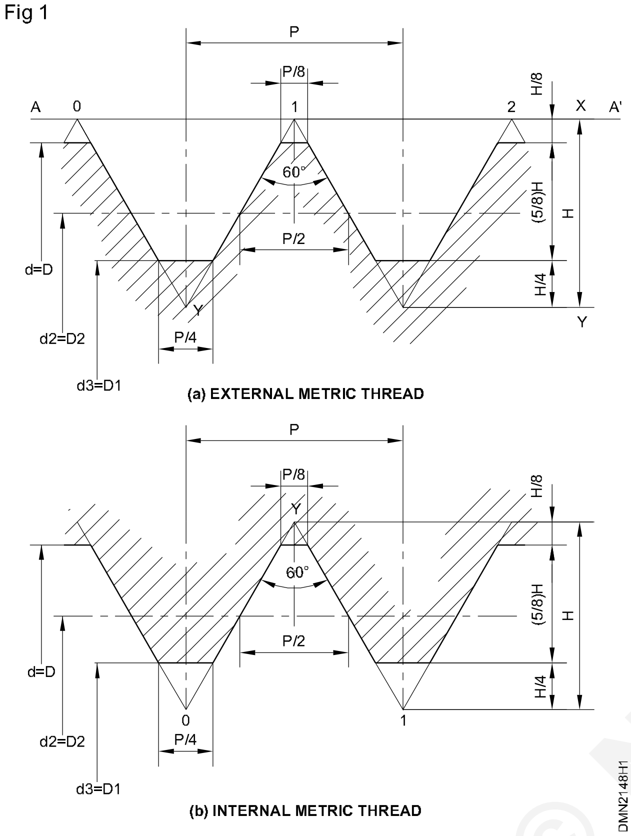
© NIMI NOT TO BE REPUBLISHED

PROCEDURE

TASK 6

Draw the basic profile of ISO metric thread of dia 30 i.e M 30 (i) External and (ii) internal. (Figs 1a & b)

Fig 1



Given nominal size of thread; 30 mm i.e M 30. Pitch of M 30 screw/bolt = 3.5, 3, 2, 1.5 and 1 mm are provided as per IS:4218 (part-1).

Assume P = 3.5 mm (Coarse pitch)

P/8 = 0.4375:P/4 = 0.8750

H = 3.0311, H/8:0.3789; H/6 = 0.5052

N.B: Since it is not possible to take the actual sizes, the sizes shall be taken as follows and for clarity purpose, assume the Enlarged scale 10:1.

- Draw a horizontal line A-A1
- Mark the pitches 0,1,2... of any convenient size say 35 mm (10:1)
- Draw three equilateral triangles OY1 with 0-1 as side 35
- Draw the altitude $H = xy = \left(\sqrt{3/2}\right)P$, and divide it into

8 equal parts.

- Mark H/8 and H/4 from top and base respectively.
- Draw similar lines on the other triangles for subsequent threads.
- Draw firm lines as shown and dimension them in terms of P and H.
- Draw a horizontal centre line (Pitch dia) through H/2 on which the thread thickness and space is equal to P/2. This is the basic profile of matric threads. (Fig 1a & 1b)

— — — — — — — —

TASK 7

Draw the basic design profile of ISO Metric external and internal thread together. Scale 10:1.

For **"External thread"**: root is changed as arc of radius R = H/6

- Divide the H into 6 equal parts
- Draw an arc to the root R = H/6 from the points
- Form 3 or 4 threads.
- Hatch the metal part as shown.

or

- Draw parallel lines to flanks at a distance of H/6, intersecting at a point.

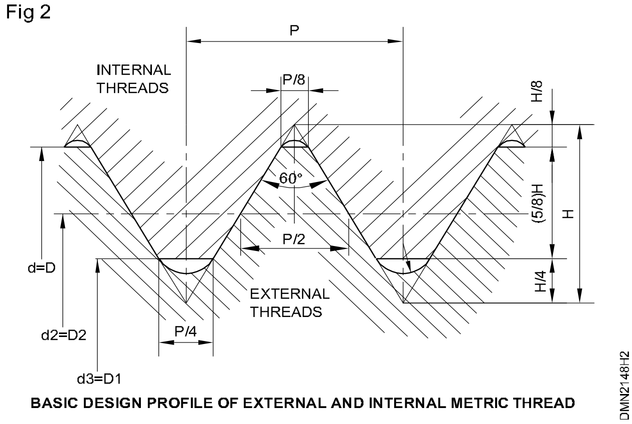
This completes the external thread.

For **"Internal thread**: Crest being the same as that of external thread

- Form the root above the crest of the external thread.
- Show for 3 or 4 threads.
- Hatch in the opposite direction show the proportions (sizes) as shown in Fig 2.

This is the ideal or theoretical design profile of metric threads.

Fig 2



— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

TASK 8

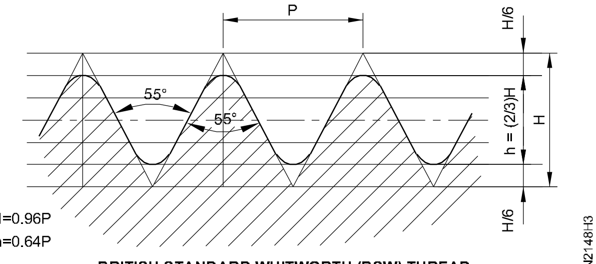
Draw the BSW (British standard into worth) thread profile to suit 1" dia (draw to enlarged scale 10:1)

1" dia has 8 threads per inch

Therefore pitch = 1/n = 1/8 inches i.e 3 mm approx.

- Draw the magnified pitch as 30 mm
- Form the triangles of apex angle 55°
- Divide the perpendicular height H into 6 equal parts H = 0.968P theoretical depth
- Mark 1/6 H on crest and root
- Draw arcs of Radius R = 0.137 P on crest and root forming actual depth h = 0.64 P
- Show proportions (Fig 3)

Fig 3



BRITISH STANDARD WHITWORTH (BSW) THREAD

— — — — — — — —

TASK 9

Draw the profile of BA thread pitch = 30 mm (magnified) (10:1)

Pitch = 30

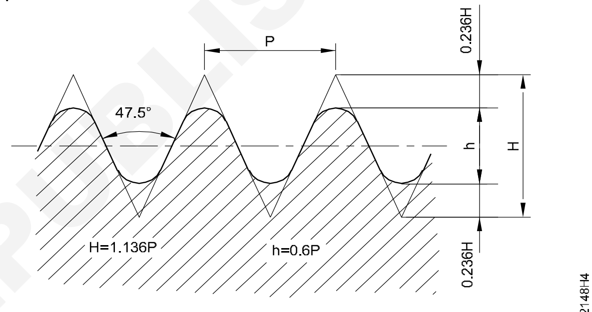
Thread angle = 47.5°

Theoretical depth (H) = 1.136P

Actual depth (h) = 0.6 P

- As in earlier example mark the pitch, thread angle and basic form (triangles).
- Draw pitch dia centre line, form the actual depth 0.6 P symmetrically on it.
- Draw the root and crest arcs, and hatch the thread Show proportions. (Fig 4)

Fig 4



BRITISH ASSOCIATION THREAD

© NIMI NOT TO BE REPUBLISHED

— — — — — — — —

TASK 10

Draw the profile of square thread for the given data.

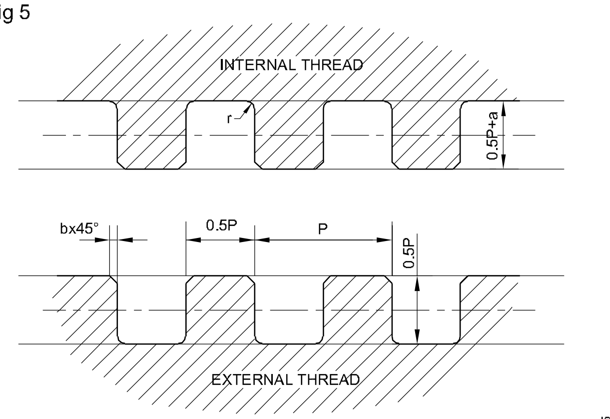
Square thread: dia 30 mm Pitch = 6 mm (Magnified) 5:1

Depth of thread = 0.5 P = 3

Thread angle = 90° (IS:4694)

- Draw two horizontal lines 15 mm apart.
- Mark spaces equal to 0.5 P i.e., 15 mm on top horizontal line
- Join 0.5 pitch line horizontally with thick lines alternately on the crest and root.
- Draw firm lines joining them, hatch the surface.
- Draw internal threads as shown and dimension the features. (Fig 5)

Fig 5



a=0.25mm, b=0.5mm, r=0.25mm

SQUARE THREAD

— — — — — — — —

TASK 11

Draw the profile of acme thread scale 10:1.

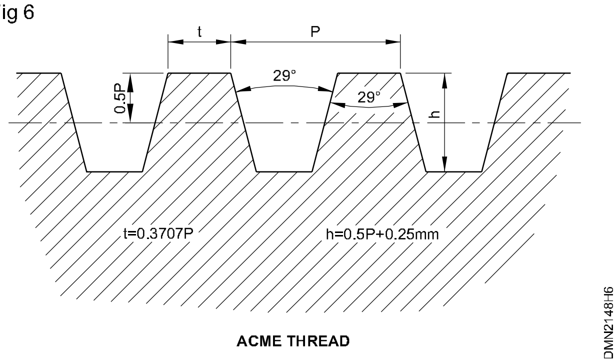
Thread angle = 29°

Depth of thread = 0.5 P + 0.25 mm = 15.25 mm or approx. 15 mm.

t (Thickness of thread on crest) = 0.3707 P = 11.121 mm or approx 11 mm.

- Draw horizontal lines 15 mm apart.
- Starting from one point on the crest line mark distances of ‘t’ and pitch (t and space).
- Set 14.5° from the points on the thickness.
- Form the thread profile and section it.
- Show proportions and thread angle. (Fig 6)

Fig 6



ACME THREAD

— — — — — — — —

TASK 12

Draw the profile of modified buttress thread as IS scale 10:1.

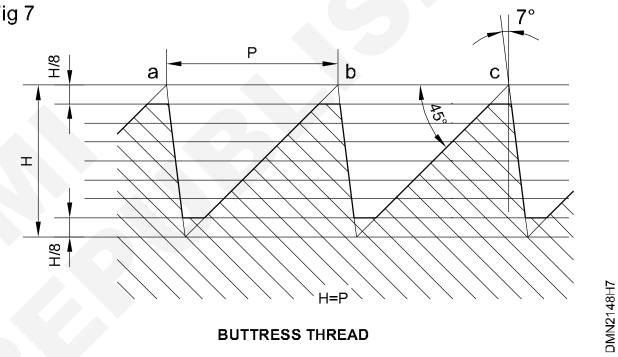
Thread angle 45° & 7° (90°). Theoretical depth H = P.

Actual depth h = 0.75 P.

Assume crest and root are flat to a depth of H/8.

- Draw the horizontal lines 30 mm (H) apart.
- Mark four pitches on top line as a,b,c.
- Set angles downwards 45° towards left and 7° towards right forming four triangles.
- Mark crest and root by H/8, draw firm (horizontal) lines.
- Mark the firm lines of thread outlines and section the surface.
- Show the proportions and thread angle. (Fig 7)

Fig 7



BUTTRESS THREAD

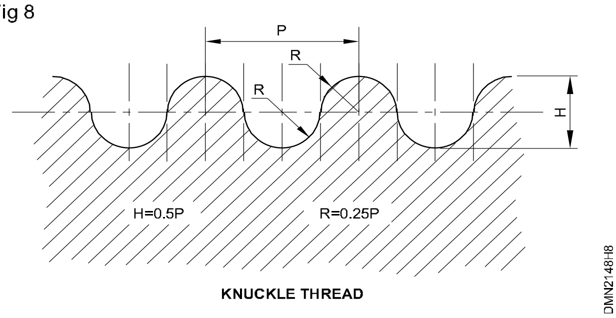
— — — — — — — —

TASK 13

Draw the profile of knuckle thread as shown. Scale NTS.

- Draw a horizontal centre line.
- Mark pitches and divide each pitch into 4 equal parts.
- Draw tangential semi circles of R = 0.25P.
- Hatch the surface and dimension it. (Fig 8)

Fig 8



KNUCKLE THREAD

— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

TASK 14

Draw double and triple start threads) (i) metric thread and (ii) square thread; dia 40 mm, pitch 3 mm and 5 mm respectively (draw to 2:1 scale) add end view.

Double start

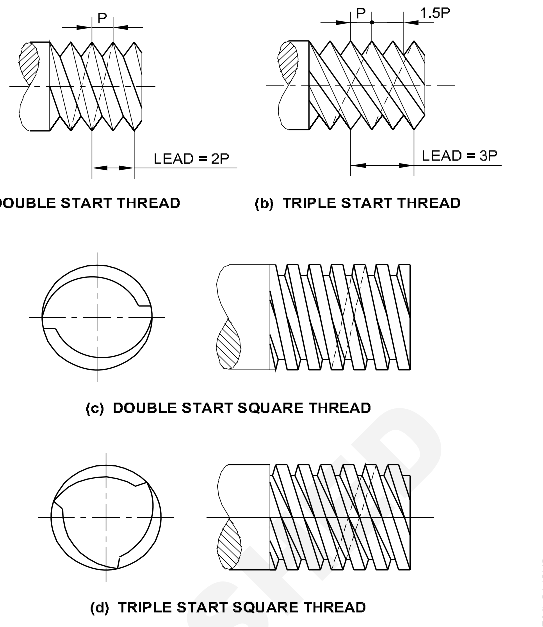
- Draw the shank and mark pitches on it as shown
- Form thread profile on one side
- Mark the slope equal to pitch and lead equal to double the pitch. (Fig 9a)
- Draw the thread form from slope and join the crest and root perpendicular difference equal to pitch.
- Draw the end view. Show thread starting at 2 places, 180^{o} apart. (Fig 9c)

Triple start thread (9b)

The procedure is same as above but lead = 3 P and slope 1.5 P

- Draw end view and show start of thread, external and internal, at 120^{o} apart. (Fig 9d)

Fig 9



— — — — — — — —

TASK 15

Draw the convention of the following external and internal threads with end views. Indicate the type of threads and size of threads.

– Metric - M36x 4
– BSW (1.1/2"-6TPI)
– Square - SQ 36x6
– ISO metric Acme (Trapezoidal - Tr40 x 7

M36 x 4 Metric Vee Thread.

- Draw two parallel lines with a space of 36mm and its centre lines.
- Draw a perpendicular thick line joining the lines.
- Draw two thin parallel lines close to the outline (approxi) 4mm depth.
- Show chamfer on ends of the external threads (bolt/ screw) end.
- Draw the end view: a circle of dia 36 mm.
- Draw thin break circle of 34 mm (approxi). (Fig 10a)

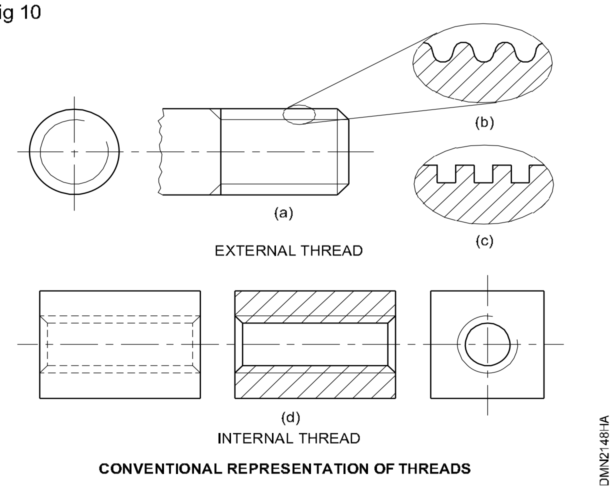
Note: For other threads draw to the sizes specified and designate accordingly. (Fig 10b & c)

For internal threads of 36 mm

- Draw end view with 36 dia thin break circle
- Draw firm circle of dia 32 (approx)
- Project and draw the front view with hidden lines as in Fig 10d.

Note: Conventional symbols for external/ internal threads are same for all type of threads except the "NOTE".

Fig 10



— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

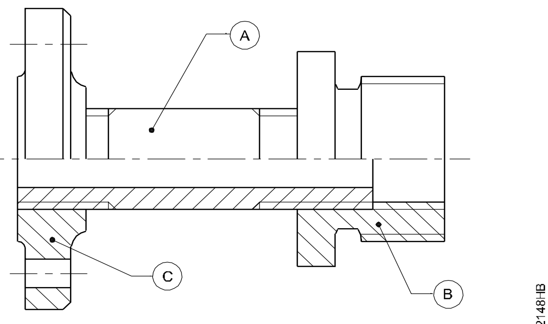
TASK 16

Draw partial/half sectional assembly of screw thread external/internal thread M40, conventionally.

- Draw the external thread convention on hollow shaft
- Draw the internal threads minor dia with thick lines major dia by thin lines on part B and C. (Fig 11)

  The convention is same for all types of threads.

Fig 11



ASSEMBLY OF THREADED PARTS

— — — — — — — —

TASK 17

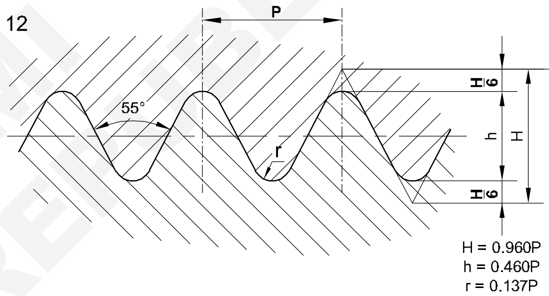
Draw the basic profile of pipe threads size 6 (Magnify 5:1) for fastening purposes. Show assembly of the same (Ref: IS:2643 Part I)

From Table pitch = 2.309

H = 0.9604 P	d = D = 163.830
h = 0.6403p	$d_2 = D_2$ = 162.351
r = 0.137p	$d_1 = D_1$ = 160.872
	h = 1.479
	r = 0.317

- Draw a horizontal line, mark four pitches on it.
- Draw vertical lines through them, mark angle 27°- 30' on either side of vertical line forming triangles.
- Draw pitch dia line as shown.
- Mark H/6 from apex and root.
- Draw arc and fillet of r equal to 0.317 mm.
- Show section of nut and bolt in opposite directions. (Fig 12)

Fig 12



PIPE THREAD FOR FABRICATION PURPOSES

— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Draw different types of Bolts, studs,nuts & washers as per SP.46:2003 conventions

Objective(s): At the end of this exercise you shall be able to
- **draw the views of fasteners by free hand as well as using instruments**
- **different types of bolts**
- **different types of nuts.**

Exercises

TASK 1

Draw the views of various types of bolts like hexagonal bolt, square head bolt, tee bolt, hook bolt, eye bolt, etc. using conventions by free hand and also using instruments.

TASK 2

Draw the views of various types of nuts as per conventions by free hand and also using instruments.

<u>PROCEDURE</u>

TASK 3

Draw M30 hexagonal bolt of shank length 100 mm according to a) General proportions (b) Indian Standard IS:1364.

Hexagonal head bolt M30.

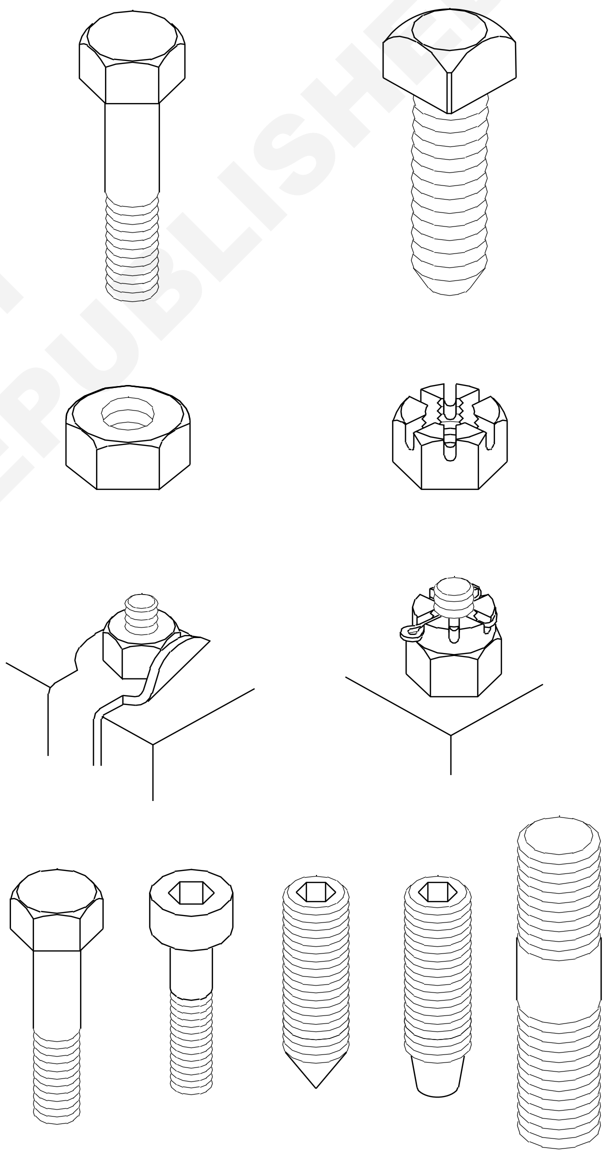
Proportion of bolt head and other features.

Given dia = 30 mm

Bolt head across flats = $\sqrt{3}$ d or 1.5d + 3 mm

Thickness 0.8 to 0.9 d

Radius of chamfer R = 1.5d or 1.4d. Length of bolt 3 to 4d approx. or more.



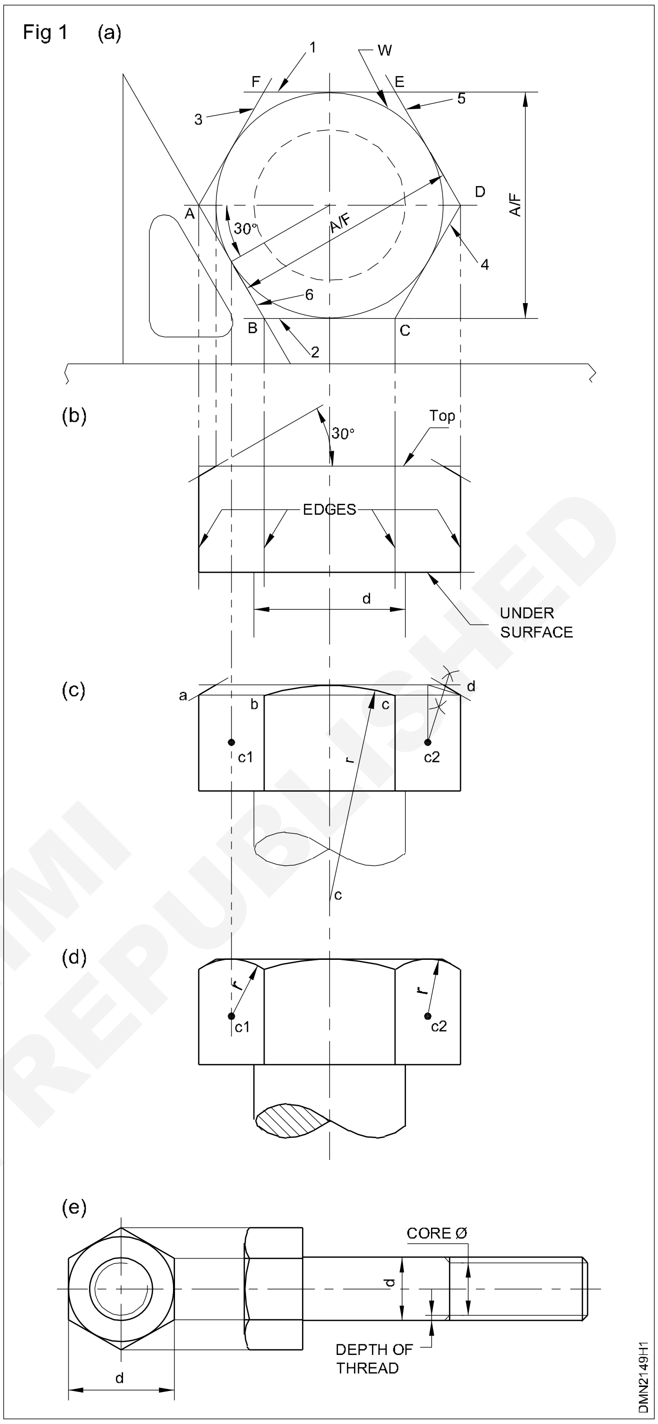
© NIMI NOT TO BE REPUBLISHED

SCALE : NTS	BOLTS, STUDS, NUTS AND WASHERS	EX NO. 2.1.49
		TIME : 10hrs
PROJECTION		CODE : DMN2149E1

- Draw a thin circle of dia $\sqrt{3}$ x d = 1,732 x 30 = 51.96 say 52mm or 1.5d + 3 = 1.5 x 30 + 3 = 48 mm
- Construct regular hexagon externally using 30°-60° set square
- Draw a concentric hidden circle of dia 30. (Fig 1a)
- Draw projectors from corners of the hexagon parallel to the axis.
- Form a rectangle, on the projectors equal to the distance 'corner to corner' of hexagon and thickness 24 mm (0.8d) as sides. (Fig 1b)
- Draw projectors from the points on dia of the circle of 'W' width of both end on to the 'Top' line.
- Draw projectors from the points B & C of the hexagon. Draw the centre lines of ab, bc & cd.
- Draw 30^{o} lines as shown in Fig 1b.
- Draw perpendicular bisector on 30^{o} line, intersecting the above centre lines, mark the points as C_1, C_2. (Fig 1c)
- Draw arcs with centres C_1,C_2 touching the top line by trial and error method. (Fig 1d)
- With b or c as centre, take 1.5d or 1.4d as radius and mark point 'T' on the centre line.
- With 'T' as centre with the same radius, draw an arc joining bc.
- Draw tangential line firm.
- Draw projection lines from the hidden circle, to the head forming the shank.

OR

- Draw the shank to the length specified. Also draw the threaded portions as per convention. (Fig 1e)
- Draw vertical projector from b on to the rectangle projector from b on to the rectangle and mark c, d.
- Draw an arc passing through c, d and touching point e.
- Draw the shank. (body)
- Draw core dia (d-2 x depth of the thread) equal to 26 mm (approx.) for all the M30 bolts .
- draw the completed views of the bolt as shown in hexagonal bolt. (Fig 1e)



— — — — — — — —

TASK 4

Draw the views of a square head bolt M30, 100 mm long IS 2585-1968.

Note: The length of the bolt ranges from 90 mm to 400 mm.

As per general proportion:

Bolt head side A/F = 1.5d + 3 = 1.5 x 30 +3 = 48 mm

Length of bolt = 5 to 8 d

Bolt head thickness = 0.8d to d

= 24 mm or 30 mm

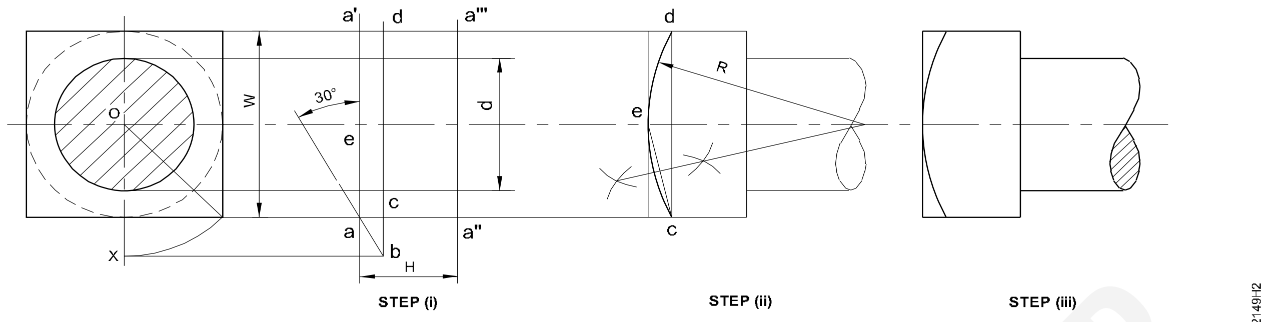
Radius of chamfer = 2d = R 60

- Draw a square of side 48 mm on centre 'O'.

© NIMI NOT TO BE REPUBLISHED

- Draw arc with half the diagonal as radius, with centre 'O' meeting the vertical centre line at 'x'.
- Draw projectors from the corner and mark a rectangle of thickness 24 mm. (a, a', a" and a'")
- Draw 30^o angle at a, on the corner of a rectangle and extend as shown.
- Draw a horizontal projector from x on to 30^o line meeting at b.(Fig 2)

Fig 2

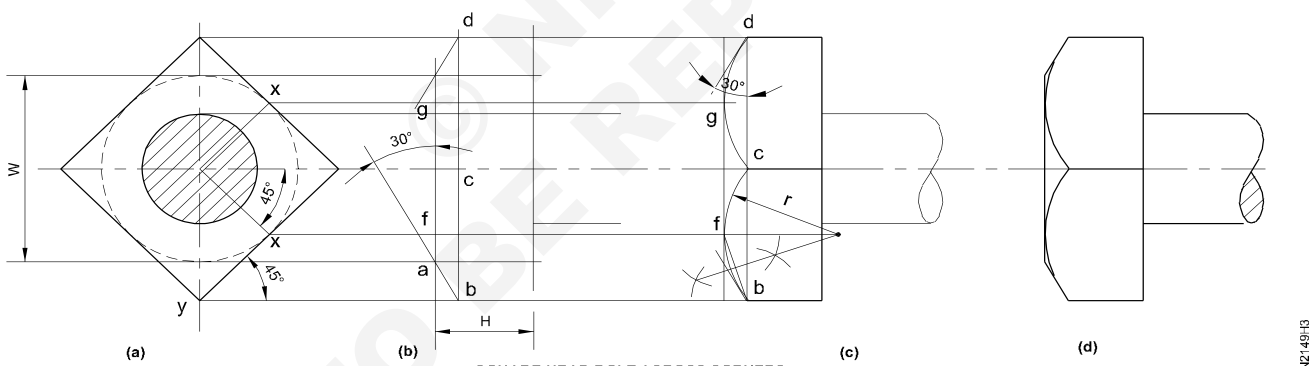


SQUARE HEAD BOLT

TASK 5

- Draw 48 mm square with sides 45° to horizontal, draw a circle touching the sides.
- Project and mark the head thickness, width across corners and projection of the circle.
- Mark 30° line on the points of circle at a.
- Mark the point b extend to the other end.
- Mark c, d on the line.
- Draw arcs as shown Fig 3.

Fig 3



SQUARE HEAD BOLT ACROSS CORNERS

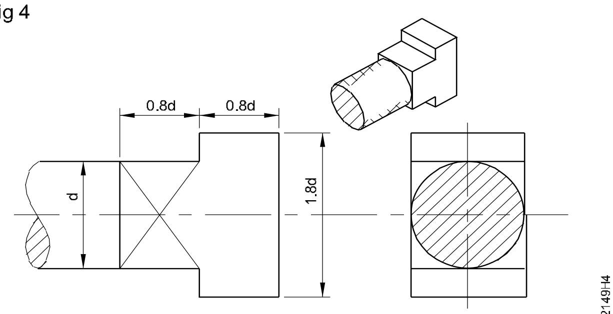
TASK 6

Draw a 'T' bolt - Standard and non-standard dia 30. (Fig 4)

Non standard bolt

- Draw the shank of a bolt dia (d) 30 mm.
- Mark a length 24 mm draw a line show diagonal lines indicating flat surface.
- Form a rectangle of 54 x 24 (1.8d x 0.8d) as shown in Fig 4.
- By drawing projectors draw the end view forming a rectangle 1.8d x d with a circle dia d (30) in the centre, which shows the section of shank dia.
- Draw tangents to the circle showing the square cross-section.

Fig 4



T - HEADED BOLT (NON-STANDARD)

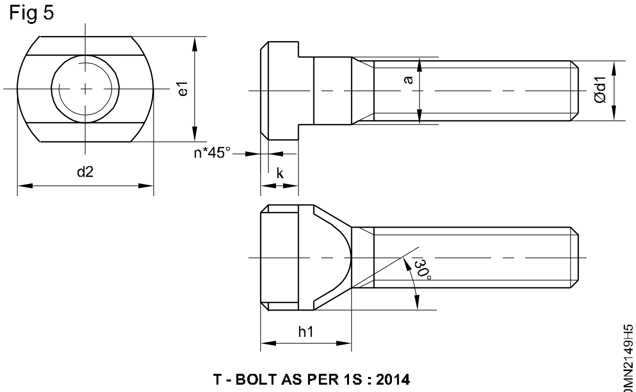
© NIMI NOT TO BE REPUBLISHED

TASK 7

Standard ‘T’ bolts IS: 2014 - 1977 used on std ‘T’ slots IS: 2013.

Follow as in above example taking dimensions as per IS: 2014-1977. (Fig 5)

Fig 5



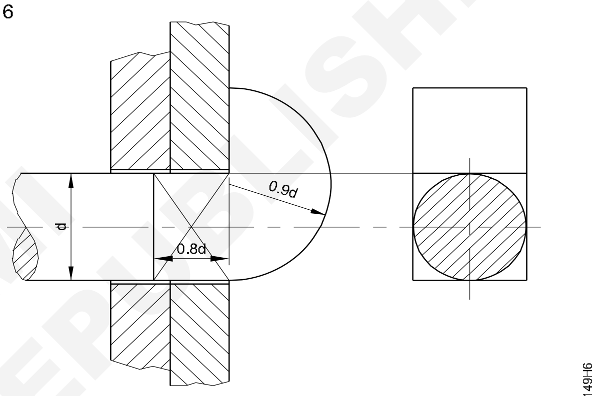
T - BOLT AS PER 1S : 2014

TASK 8

Draw the views of a hook bolt dia 50, holding a plate in position.

- Draw the shank of dia 50 mm, mark flat surface on one end, to width 0.8d = 40 mm.
- Draw a semi-circle of radius 0.9d on its end as shown.
- Draw the end view of rectangle d x 1.8d without the plates.
- Form a square from base, draw a circle (d) and hatch it. (Fig 6)

Fig 6

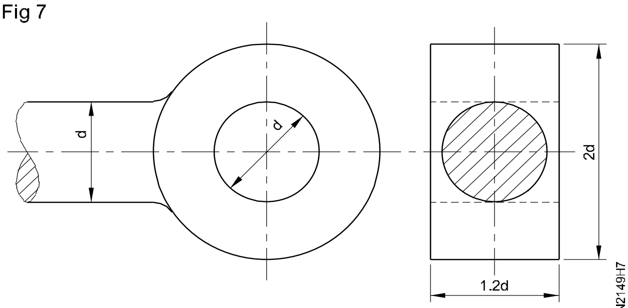


HOOK BOLT

TASK 9

- Draw the views of a eye bolt dia 40 mm.
- Draw concentric circles of dia 80 and 40.
- Draw bolt shank of dia 40 meeting dia 80, hatch the end.
- On end view mark a rectangle of 2d x 1.2d.
- Draw the circle dia 40, symmetrically in the centre.
- Hatch the circle and dimension the view. (Fig 7)

Fig 7



EYE - BOLT

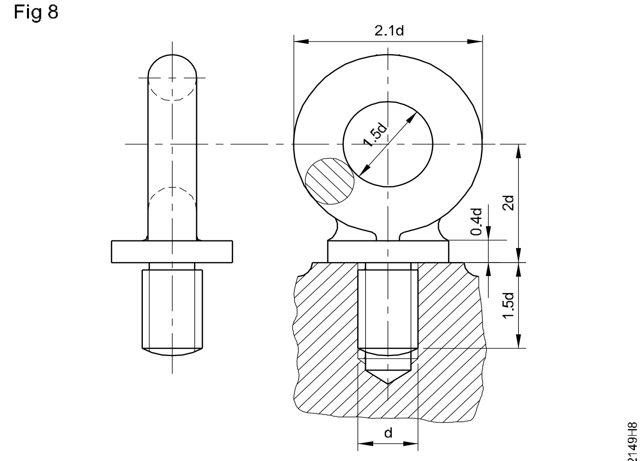
TASK 10

Draw the view of a lifting eye bolt dia 30.

- Draw concentric circles of dia 45 and dia 63 mm (1.5d and 2.1d).
- Draw collar of dia 2d and thickness 0.4d at 2d from the centre.
- Draw fillet curves, add the end view.
- Dimension the view. (Fig 8)

© NIMI NOT TO BE REPUBLISHED

Fig 8



LIFTING EYE BOLT

TASK 11

Draw hexagonal nut to suit M30 bolt given dia 30 mm.

As per IS 1364 proportions of Hex. nut width across flats = 1.5d + 3 mm = 45 + 3 = 48 mm.

Corner to corner = 2d

Thickness of nut = d or 0.9d

Radius of chamfer R = 1.4d or 1.5 d (approx.)

Angle of chamfer = 30°

It is similar to hexagon head of the bolt, additionally having tapped hole.

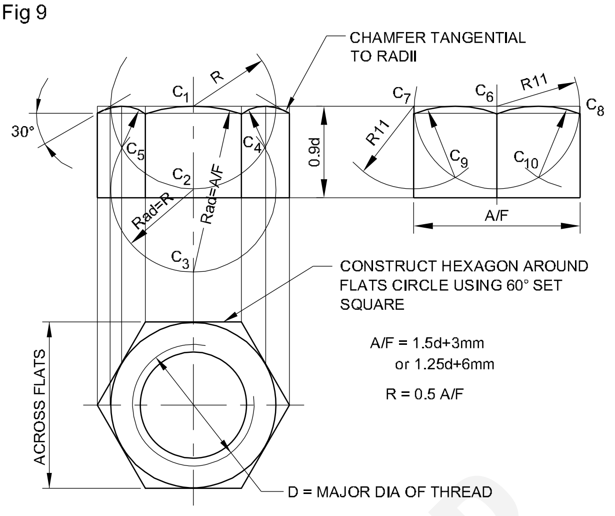
Across width method

- Mark the centre lines and draw a circle of R24 in the plan.
- Construct a regular hexagon.
- Draw a thin broken circle with dia 30, and a thick circle of dia 26 (approx.) to show the internal thread convention.
- Project lines from the corners and centre line of the hexagon.
- Mark thickness equal to 0.9 = 27 mm.
- Complete the faces as in the case of hexagon bolt head.
- Project and show the thread details in hidden lines.
- Draw the end view of the nut. (Fig 9a)
- Remove the unwanted lines and complete the views. (Fig 9b)

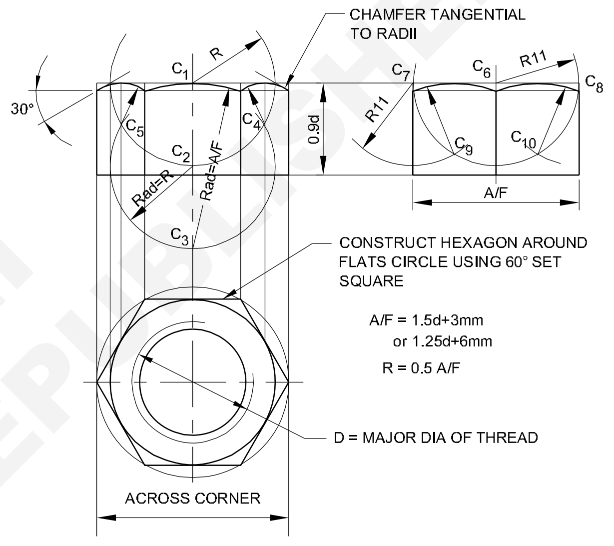
Across corner method

- Draw a circle of dia 2d = 60.
- Inscribe a hexagon in dia 60 circle.
- Inscribe a circle in the hexagon.

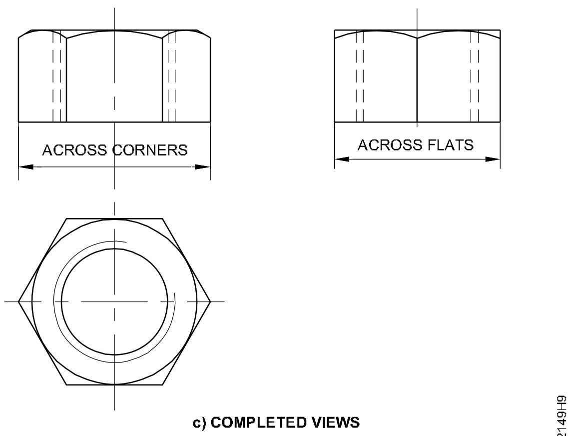
Fig 9



a) SHOWING NECESSORY CONSTRUCTION LINES



b) SHOWING NECESSORY CONSTRUCTION LINES



c) COMPLETED VIEWS

DRAWING A STANDARD HEXAGONAL NUT (ISO SYSTEM)

- Project and draw the nut to the thickness.
- Draw the thread feature.
- Draw the end view. Fig 9c shows the completed view of a hexagonal nut.

— — — — — — — —

TASK 12

Draw the views of a nut Grade C as per IS:1363 (Part 3).

Width across flats (max) 46, (min) 45.

Width corner to corner (min) 50.85 (say 51)

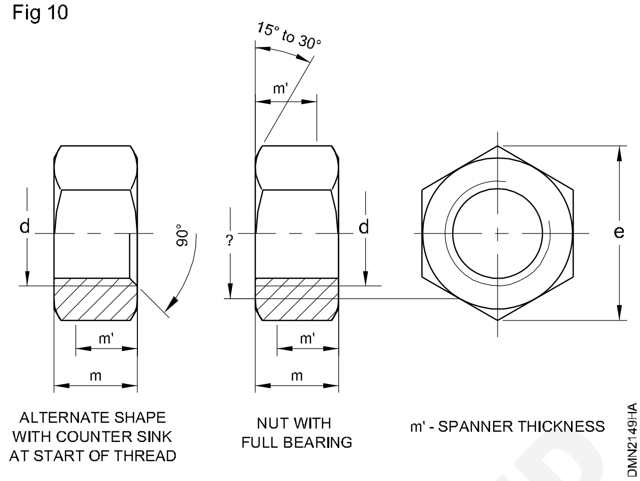
Angle of chamfer 15° to 30°·

Thickness (m) max = 26.4 say (26)

Min = 24.3 say (24)

- Draw the hexagon of size as above and draw chamfer circle.
- Draw concentric thin break circle of dia 30 and thick circle of dia 26 (core dia) approx.
- Draw extension lines from the view and
- Draw the rectangle of thickness equal to m i.e 26.4.
- Draw the chamfers of 15° or 30° on both sides from the tangential points of circle dia S as in Fig 10.
- The internal details of thread be shown by convention m_1 equal to 19.5 mm. m_1 represents the spanner height from the bearing surface. (Fig 10)

Fig 10



As per BIS generally all the nuts have both the surfaces chamfered.

Dimensions for width across flats for hexagonal screws, bolts and nuts as per IS:9519 is shown in Table 1, Lesson 1 of this exercise.

— — — — — — — —

TASK 13

Draw the regular hexagonal flanged nut to suit a bolt of M30 with flange dia 2.2d and thickness 0.25d.

As per general proportions

Corner to corner = 2d

Height of nut = d

Thickness of collar = 0.25 d

Collar (flanged) dia = 2.2 d (Fig 11)

As per IS:7795: It is a precision grade available from M8 to M36

d = 30 mm.

Flange dia d_1 (nom) = 58 mm

Across flats s (Nom) = 46 mm

Corner to corner e (max) = 51.28 mm

Total thickness m (Nom) = 45 mm

Collar (flange) thickness(a) (nom) = 10 mm

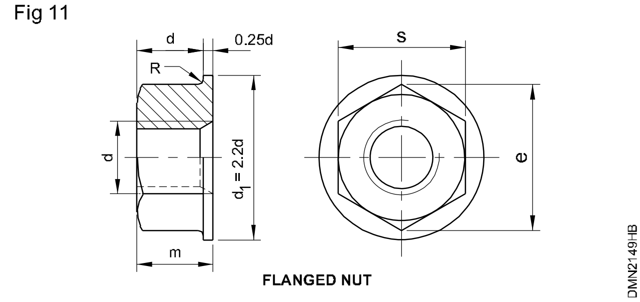
Chamfer dia d_2 = 32 mm

Chamfer thread ratio of 120°

R fillet radius = 1 mm max.

Draw tM30 regular hexagonal flanged nut as per general proportion. (Fig 11)

Fig 11



— — — — — — — —

TASK 14

Draw a cap nut to suit M30 bolt (Fig 12)

As per proportions

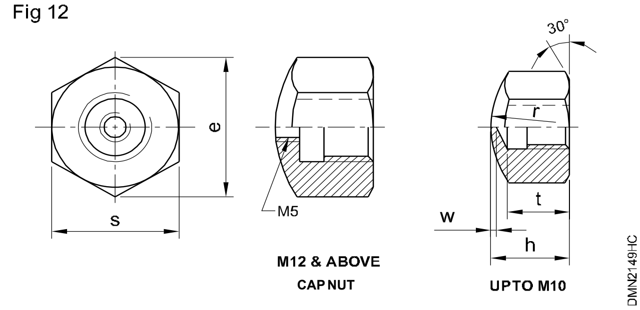
Height of nut (Hex) d=34 mm

Height of cap = 0.5d = 15 mm

Thickness of cap 0.25 d = 7.5 mm

dia of cap 1.5d + 3 mm = 48 mm

Fig 12



© NIMI NOT TO BE REPUBLISHED

As per standard (IS:2687)

Total height (h) nom = 34.

Across flats(s) nom = 46.

Across corner(e) min = 51.28.

Radius of cap (dome) r = 60.

Thickness of cap(max)W = 3 thickness of bottom

Thickness of bottom (t)-28/length of hole (t).

Draw the view as shown in Fig 12.

— — — — — — — —

TASK 15

Draw the view of the domed cap nut to suit bolt M24 (IS:7790) Material- Brass/Al or Steel.

As per proportions

> **Note: Domed cap nuts are available in ranges from M6 to M24 (10 ranges)**

dia of bolt/tapped hole = 24 mm.

Size across flats(s) = 36 mm.

Size across corner (e) (min) = 40 mm.

Total height of nut h(max) = 42mm.

Length of hole t (nom) = 31 mm.

Thickness of hexagon (m)nom = 19 mm.

dia of dome d^1 = 34 mm.

Radius of dome r = 17

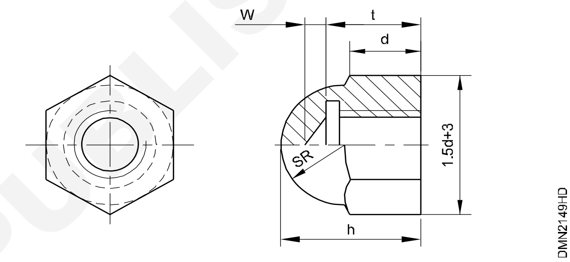
Thickness of dome above.

Conical relief (w) = 3.

Chamfer on Hexagon = 30°

- Draw a hexagon of size 40 mm across corners and 36 mm across flats;
- Draw M24 tapped hole and the circle touching the faces.
- Extend the centre line.
- Project and draw the hexagon prism of height 19 mm add the chamfer arcs on both the sides,
- At a height 20 mm from base, on the centre line draw a semi circle of r 17 and draw vertical projection touching the hexagon prism. (Fig 13)

Fig 13



— — — — — — — —

TASK 16

Draw a slotted nut as per IS:2232 (precision grade).

Thickness of nut (w) non = 33 mm

(m) = 24 mm

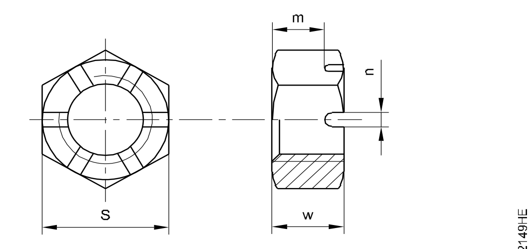
Width of slot (n) = 7 mm

Size across flats (S) = 46 mm

Split pin hole in bolt = 6 mm

- Draw a circle of dia 46 and draw hexagon on it.
- Draw the nut and its view showing the six slots, width 7 mm.
- Draw chamfers on both ends of the nut.
- Mark depth ‘m’ from base.
- Draw a semi-circle of diameter 7 mm from m.
- Add the other view. (sectional) (Fig 14)

Fig 14



SLOTTED NUT

— — — — — — — —

TASK 17

Draw a castle nut to suit a bolt M30

– as per proportion

– as per IS:2232

Bolt dia = M30.

Assume thickness of castle = 1.2d

Height of castle = 0.4 d

Width of slot =0.25d

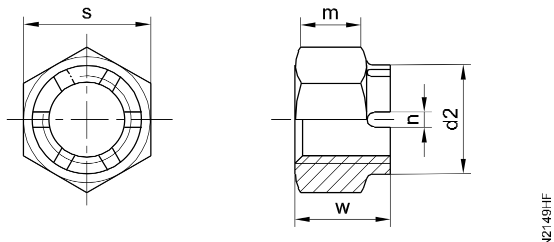
Depth of slot =0.3d

- Draw the top view of the hexagonal nut with 46 mm across flats.
- Draw a circle of dia 42, on the centre.

© NIMI NOT TO BE REPUBLISHED

- Draw the front view of the nut with chamfer on both ends, thickness 24 mm.
- Project and draw the slots of width n.
- Draw the castle 33 mm from base.
- Draw the thread convention on both the views.
- Add bolt and split pin.
- Show half sectional view of a nut. (Fig 15)

Fig 15



CASTLE NUT

TASK 18

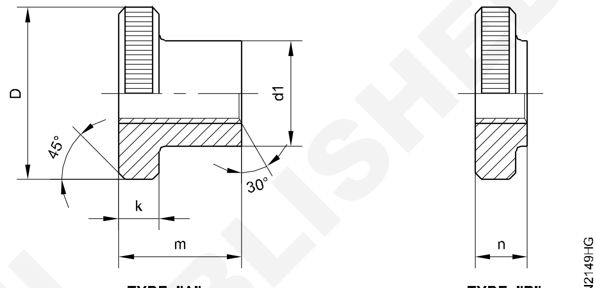
Draw a knurled nut suit to M10 screw (as per IS:s3460-1972) (Fig 16)

Dimensions as per IS:

Screw dia	-	M10
Diameter of Knurled portion (D)	-	36
Smaller dia (d^1)	-	20
Thickness of knurled end (K) Total thickness (m)	-	6
(Tape A) Total thickness	-	23
Type B (n)	-	10

- Follow the same procedure adopted in the earlier exercises and draw the knurled nuts. (Fig 16)

Fig 16



© NIMI NOT TO BE REPUBLISHED

Draw different locking arrangements of nuts, machines crews, cap screws, set screws as per conventions

Objective(s): At the end of this exercise you shall be able to
- **draw the different types of locking devices**
- **draw the different types of machine screws.**

PROCEDURE

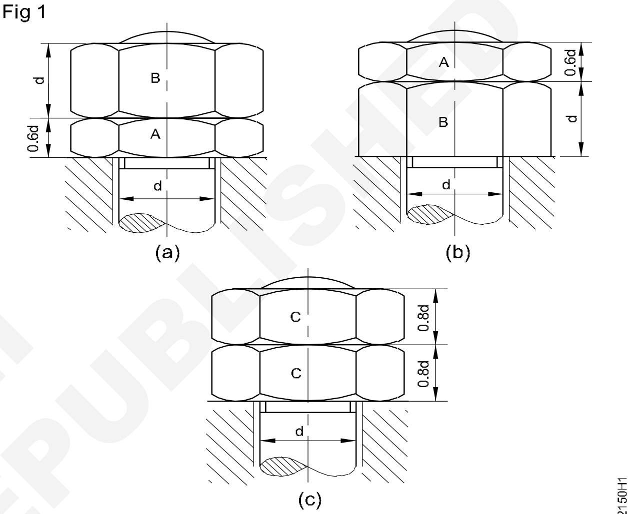
TASK 1

Draw the locking of the nut by using locknut to suit M30 bolt.

There are three types of locking by using lock nut.

- Draw the bolt end of shank dia 30.
- Place/draw a nut of thickness 0.6d and then place a nut of thickness equal to d. (Fig 1a)
- Place/draw the normal nut first and then the thinner nut of 0.60d. (Fig 1b)
- Draw both the nuts of thickness 0.8d each as shown.
- The top nuts are locking the nut in position. (Fig 1c)

Fig 1



LOCK NUTS

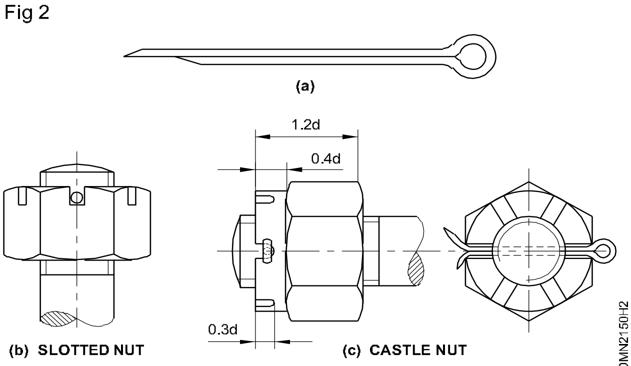
© NIMI NOT TO BE REPUBLISHED

TASK 2

Draw the locking devices using split pin with a slotted nut and castle nut, to suit M 30 bolt. (Fig 2)

- Draw a slotted nut (IS: 2232) black grade to suit M 30 bolt w = 33, m = 24, s = 40, n = 78 pin dia 6.3 mm.
- Draw split pin dia 6.3 mm passing through the slot as shown in Fig 2a.
- Draw castle nut (IS:2232) black grade and its views. W = 33, m = 24, S = 40, n = 7, pin dia 6.3 mm.(2b)
- Draw the split pin in position in both the ways. Fig 2c

Fig 2



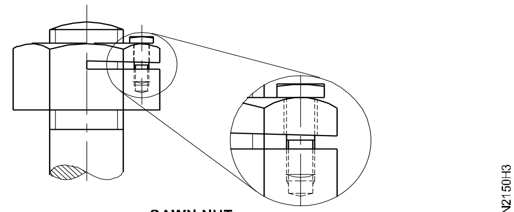
(b) SLOTTED NUT (c) CASTLE NUT

TASK 3

Draw a locking device using a set screw on a sawn nut suit to M30 bolt.

- Draw a split of 0.15 d at a distance of 0.2 d from the top, upset the centre as shown.
- Use a square head set screw of M6. (Fig 3)

Fig 3



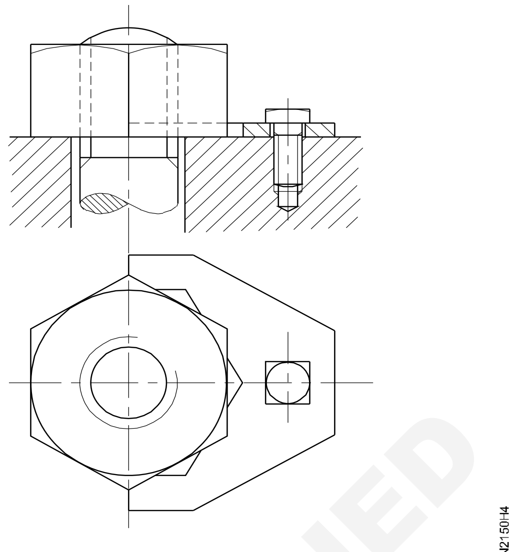
SAWN NUT

TASK 4

Draw the lock nut with lock plate for M30 bolt.

- Draw the views of the nut (M30).
- Add the plate of 0.2d thick as shown.
- Draw a square head screw (M6) holding the plate in position. (Fig 4)

Fig 4



LOCKING PLATE

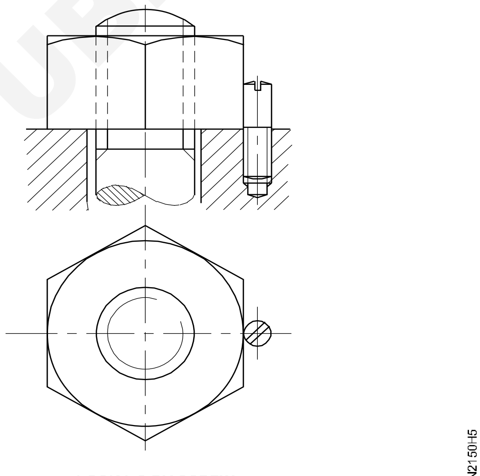
— — — — — — — —

TASK 5

Draw the views of the nut with stopper screw in position.

- Draw a small set screw by the side of the flat faced nut.
- This locks the nut from turning. (Fig 5)

Fig 5



LOCKING BY SCREW

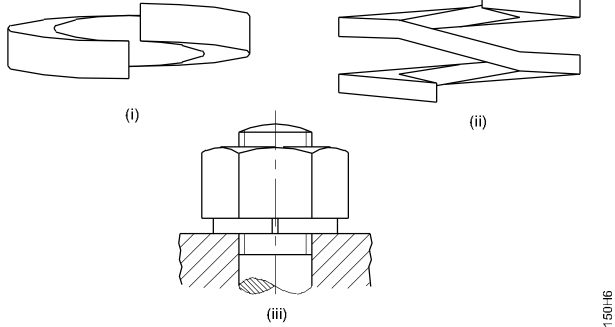
— — — — — — — —

TASK 6

- Draw a hexagon nut with spring washer of M30.
- Draw a spring washer as shown in Fig 6.

The springing action of the spring holds the nut firmly in position.

Fig 6



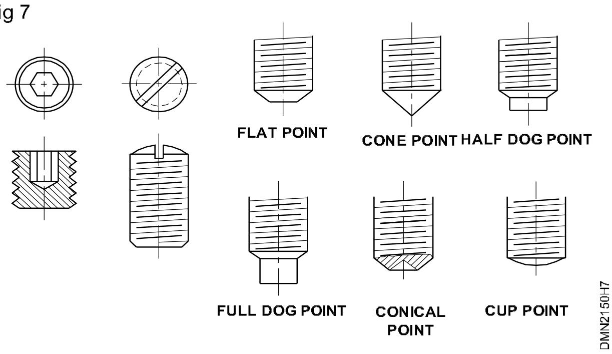
SPRING WASHER

Machine screws

Hexagonal socket set screws of screw driver slot are of five types. IS:6094 (Fig 7)

© NIMI NOT TO BE REPUBLISHED

Fig 7



They are namely as follows:

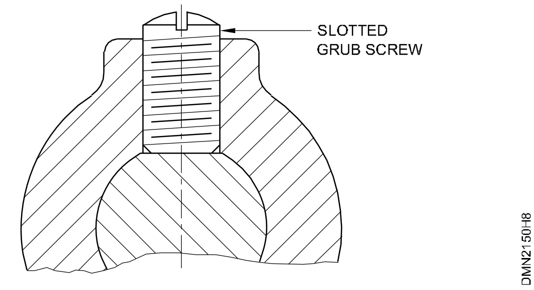
– Flat point (FP)
– Cone point (TP)
– Full dog point (FDP)
– Half dog point (HDP)
– Cup point (CP)
– Conical point

These are designated by the shape of their ends. These are available in sizes M3, M4, M5, M6, M8, M10, M12, M16, M20, M24, Max. length 60 mm. These are operated by using hex, bent key (Allen key).

Slotted grub screw as per IS: 2388 are designated by letters. (Fig 8)

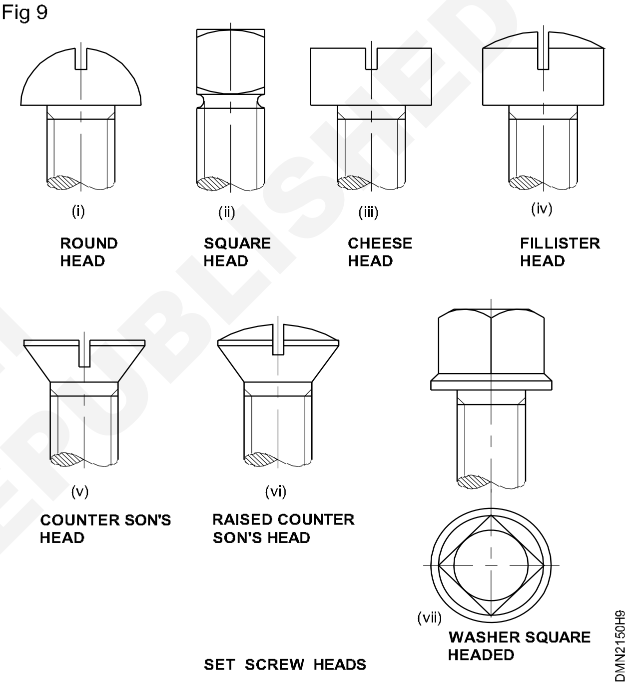
– Type A - Flat end
– Type C - Conical end
– Type E - Cylindrical dog point
– Type G - Tapered dog point
– Type J - Cup point
– Type K - Oval point

Fig 8



Set screws (Not as per BIS): These screws are operated by screw drivers or a spanner. They are available in different sizes **M 1 to M 24.** The lengths vary according to dia. (Fig 9)

Fig 9



© NIMI NOT TO BE REPUBLISHED

— — — — — — — —

TASK 7

Draw the hexagonal machine screw of M12 according to Indian standard (BIS).

As per IS:1363, these screws are available from M6 to M24.

Sizes of M12 as per IS:

Nominal size M12

Shank dia (d)

Maximum 13.1

Minimum 11.57

Length shank

Machining thread (L) 60

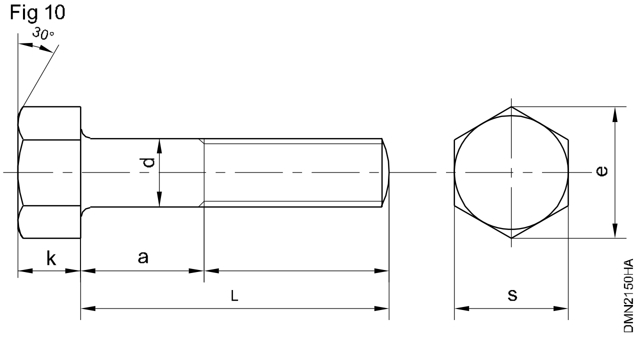
Thickness head (K) 8

Size across flat (S) 19

Size across corner (e) 20,88

Draw the hexagonal machine screw with sizes as given above. (Fig 10)

Fig 10

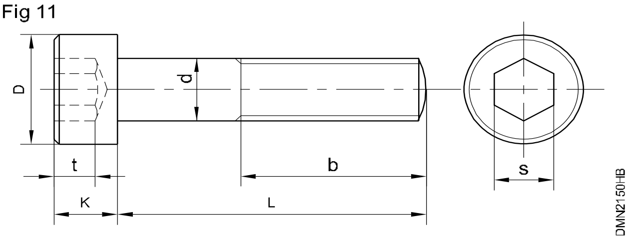


— — — — — — — —

TASK 8

Draw the hexagonal socket head cap screw of M16 course according to IS2269. (Fig 11) These screws are available from M3 to M36.

Fig 11



Different sizes of M16 as per IS:

Diameter of shank (d) - 16

Diameter of the head (D) - 24

Hexagonal hole across flat (s) - 14

Thickness of head (k) - 16

Depth of hex. hole (t) - 8.8-9.7

Length of threaded part(b)-38

Length of shank (L) - 90

— — — — — — — —

TASK 9

Draw the hexagonal socket set screws/grub screws with different points. (Figs 12 & 13)

Fig 12

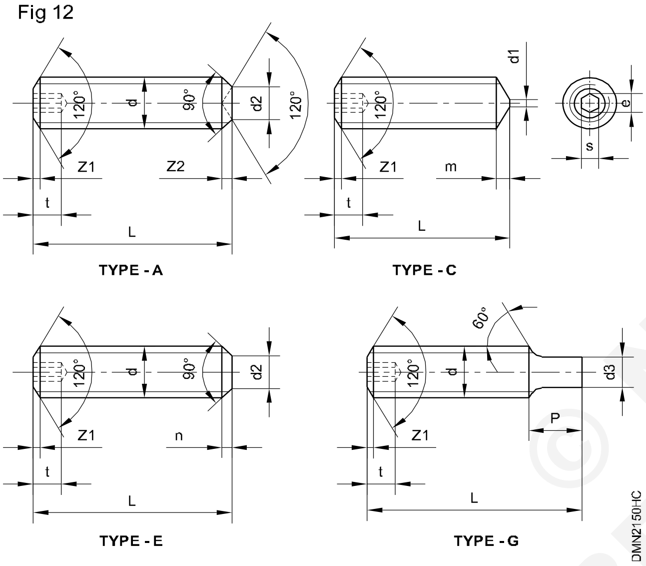
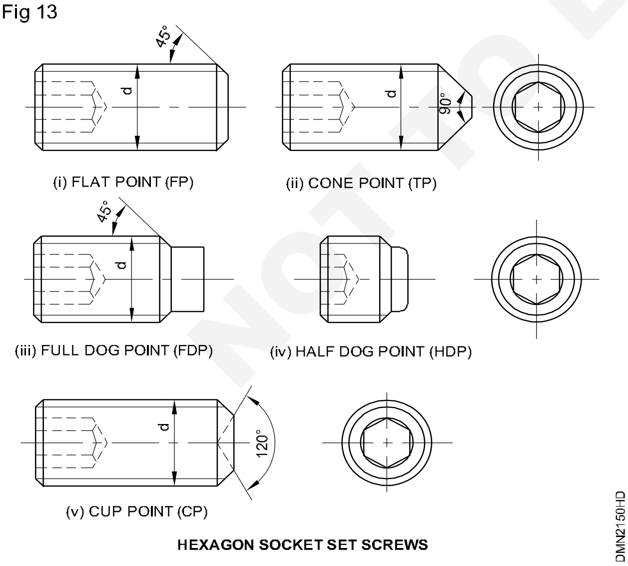


Fig 13



Nominal size - M24

Size across flat for hexagonal slot (s) - 12

Size across corner of hexagonal slot (e) - 14

Thickness of hexagonal slot (t) - 15

Thickness of head (Z^1) - 1.5

Thickness at bottom

Type A(Z^z) - 4

Thickness at bottom type C(m) - 5

Thickness at bottom

Type E (n) - 4

Thickness at bottom

Type G (p) - 11

Bottom dia d^1 (Type C) - 8

Bottom dia d^2 (Type A & E) - 16

Bottom dia d^3 (Type G) - 18

Length (L) - 80

Flat point (FP)

- Draw cylinder of dia 24 x 60 and show thread convention on it.
- Draw end view and show 15 long, hidden lines for hexagon slot in it.
- Project and show hidden details of hex. hole.
- Form the end by 45° and to dia 18. **(Fig 13) (i)**

Cone point (TP) (Fig 13) (ii)

- Draw as above and form the cone points dia form in dia 6 face the other end.

Full dog point (FDP) (Fig 13) (iii)

- Draw as above. Form full dog point at 90° or 120° forming dia 18 on the face, 12 long.

Half dog point (HDP) (Fig 13) (iv)

- Draw as FDP set screw and draw dog point 6 long.

Cup point (CP) (Fig 13) (v)

- Draw as flat point set screw.
- Draw 120° hidden lines as shown forming a cut point.

© NIMI NOT TO BE REPUBLISHED

TASK 10

Draw the stud and the hole for stud of M16 according to Indian standard

BIS No. for hole IS:4499 (Fig 14)

BIS No. for stud IS:2186 (Fig 15)

Proportions as per IS (Type A)

Length of nut end (b) - 38

Length of metal end (b^1) - 16

Depth of drilled hole (S) - 23

Length (L) - 90

- Draw the stud and the hole as per the data given above. (Fig 15)

Fig 14

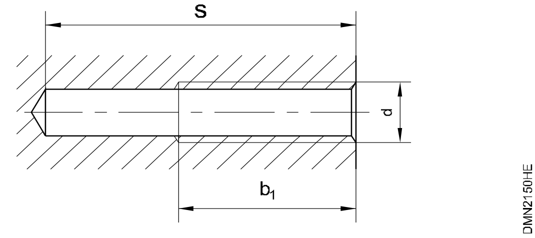
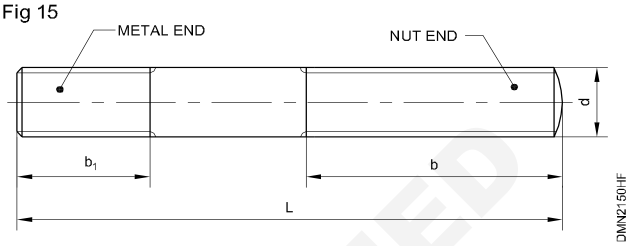


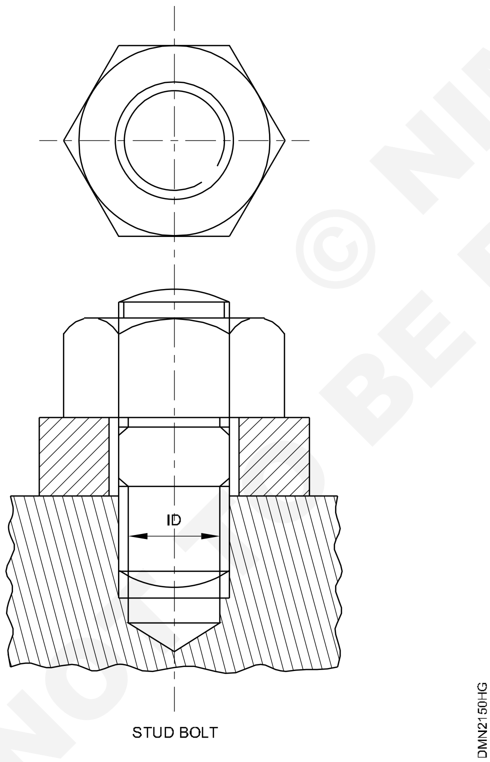
Fig 15



TASK 11

Draw the stud and bolt assembling as per BIS standard proportion. (Fig 16)

Fig 16



© NIMI NOT TO BE REPUBLISHED

Draw the half sectional view of a coupler nut

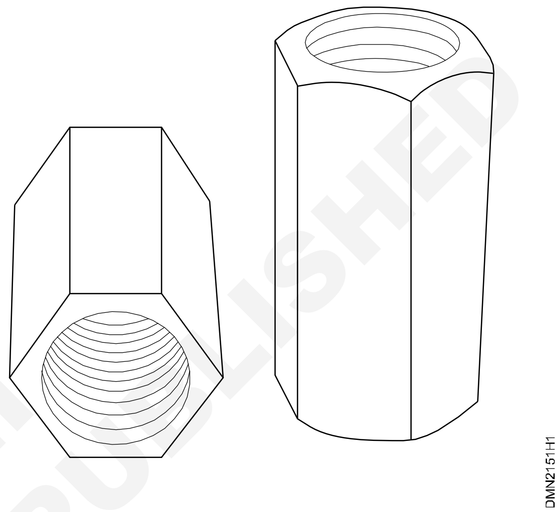
Objective(s): At the end of this exercise you shall be able to
- **draw the half sectional view of coupler nut (Hexagonal).**

TASK: **Draw the given coupler nut draw the following views (Fig 1)**

Refer: Hexagonal nut (Page No.11 - Task - 11)

(Note: Select suitable dimension with proportion)

Fig 1



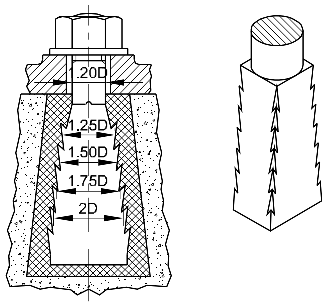
© NIMI NOT TO BE REPUBLISHED

Draw four different types of foundation bolt

Objective(s): At the end of this exercise you shall be able to
- **draw the different types of foundation bolt as per standard.**

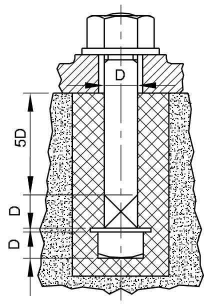
TASK 1**: Draw the following foundation bolts as shown in Figures 1 to 7**

Fig 1



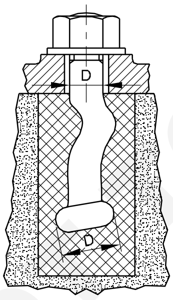
RAG BOLT

Fig 2



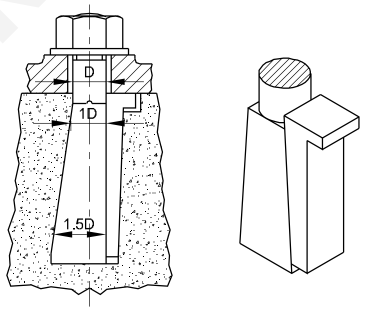
SQUARE HEADED BOLT

Fig 3



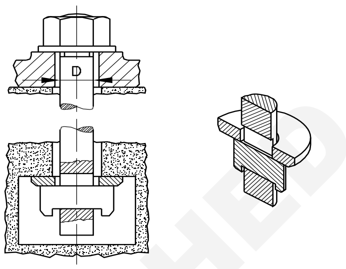
TWISTED BOLT

Fig 4



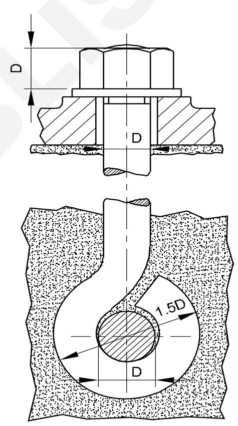
LEWIS BOLT

Fig 5



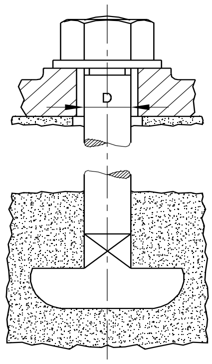
COTTER BOLT

Fig 6



LOOP BOLT

Fig 7



T-HEADED BOLT

All the dimensions should be in par with diameter of shank.
Diameter (D) = 30 mm.

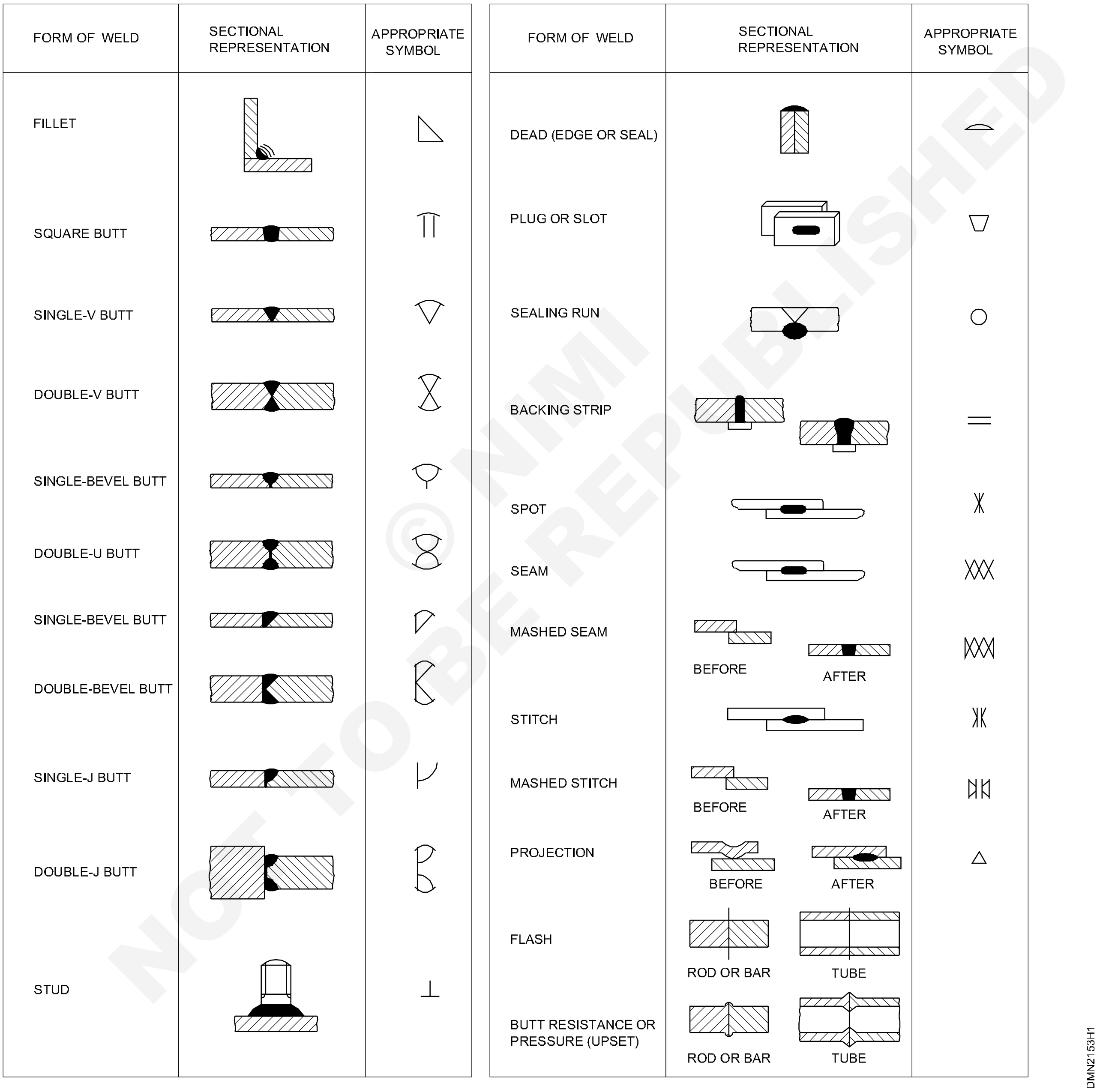
1 Rag bolt
2 Square headed bolt
3 Twisted bolt
4 Lewis bolt
5 Cotter bolt
6 Loop bolt
7 'T' headed bolt

© NIMI NOT TO BE REPUBLISHED

Draw a weld joint, representing the position and dimensioning of the weld with conventional symbols of the drawing

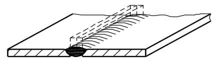
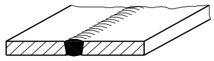
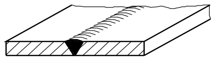
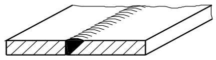
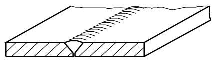
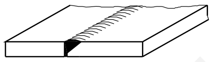
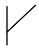
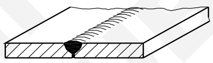
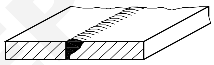
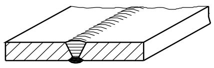
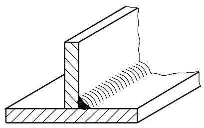
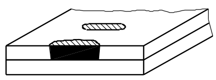
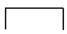
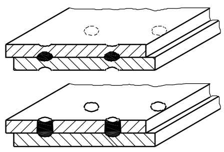
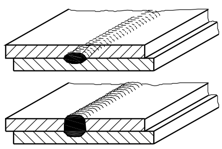
Objective(s): At the end of this exercise you shall be able to
- **draw welding symbols in the welding drawing**
- **draw the types of weld joints and their symbols.**

Fig 1



© NIMI NOT TO BE REPUBLISHED

TABLE 1 (ELEMENTARY SYMBOLS)

Sl.No.	Designation	Illustration	Symbol
1	Butt weld between plates with raised edges, (the raised edges being melted down completely)		
2	Square butt weld		
3	Single 'V' butt weld		
4	Single - bevel butt weld		
5	Single 'V' butt weld with broad root face		
6	Single bevel butt weld with broad root face		
7	Single 'U' butt weld (parallel or sloping sides)		
8	Single 'J' butt weld		
9	Backing run, back or backing weld		
10	Fillet weld		
11	Plug weld, plug or slot weld /USA		
12	Spot weld		
13	Seam weld		

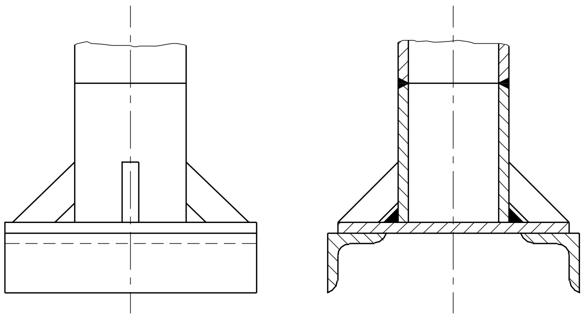
© NIMI NOT TO BE REPUBLISHED

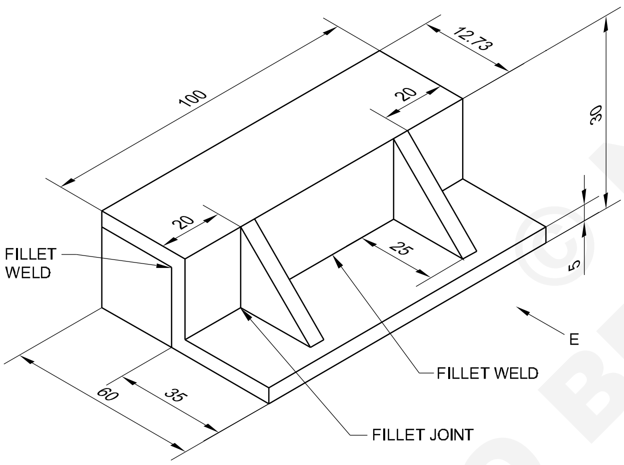
Draw the welded joints - Representing the position and dimensioning of the weld

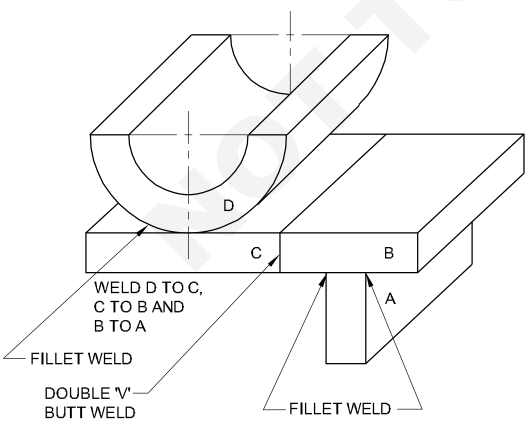
Objective(s): At the end of this exercise you shall be able to
- **draw the welded joints by showing symbolic representations.**

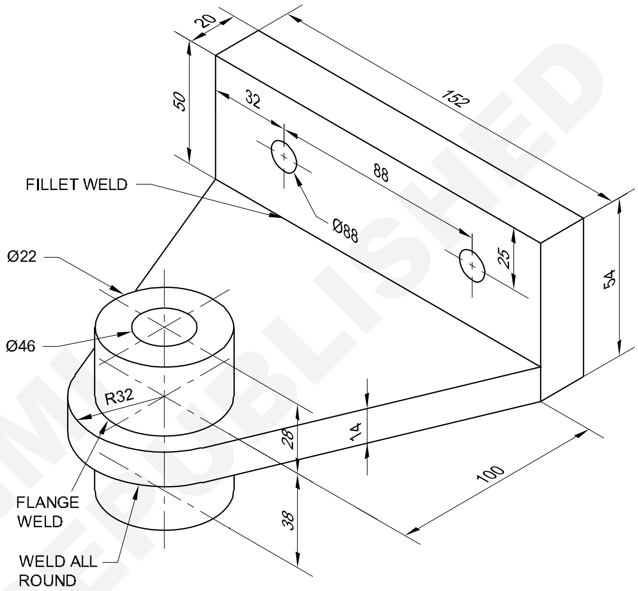
For the given views of the object, show the welded joints by drawing symbolic representations.

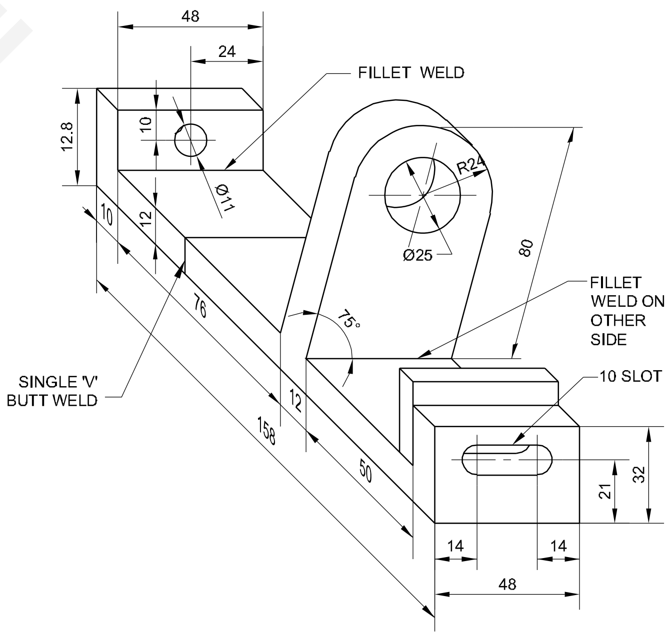
For the given views, objects prepare a working drawing and show the welded joints by drawing symbolic representations.











© NIMI NOT TO BE REPUBLISHED

SCALE : NTS	WELDED JOINTS	EX NO. 2.1.54
		TIME : 08 hrs
PROJECTION		CODE : DMN2154E1

Table 1

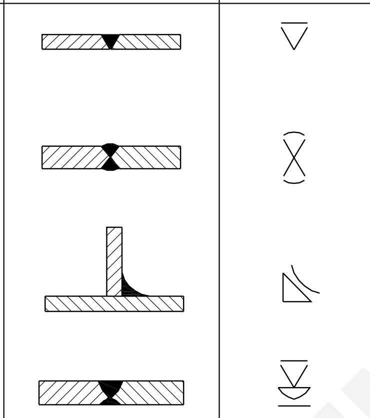
Table - 2

SHAPE OF WELD SURFACE	SYMBOL
a) FLAT (USUALLY FINISHED FLUSH)	
b) CONVEX	
c) CONCAVE	

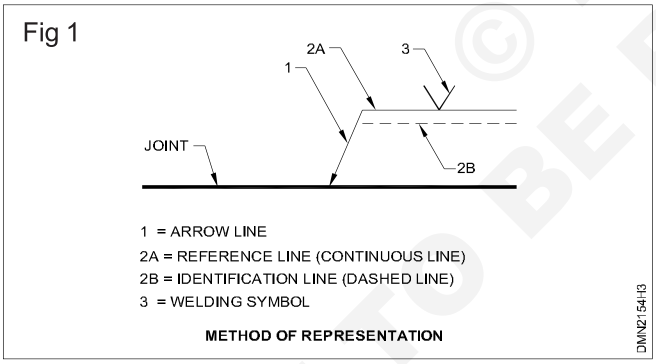
DMN2154H1

Table 2

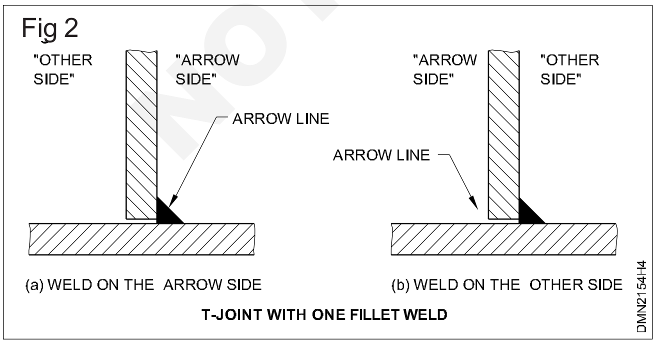
Designation	Illustration	Symbol
Flat (flush) single-V Butt weld		
Convex double-V Butt weld		
Concave fillet weld		
Flat (flash) single-V Butt weld with flat (flash) backing run		



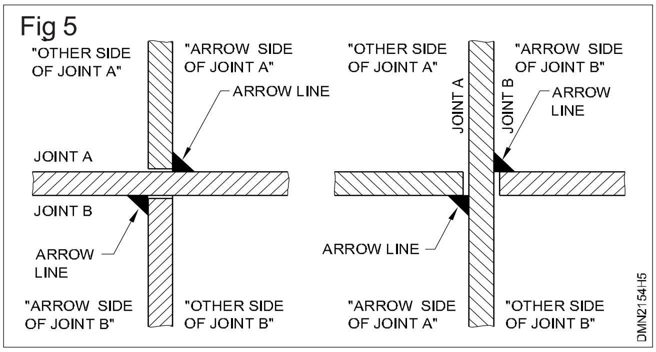
Method of representation (Fig 1)



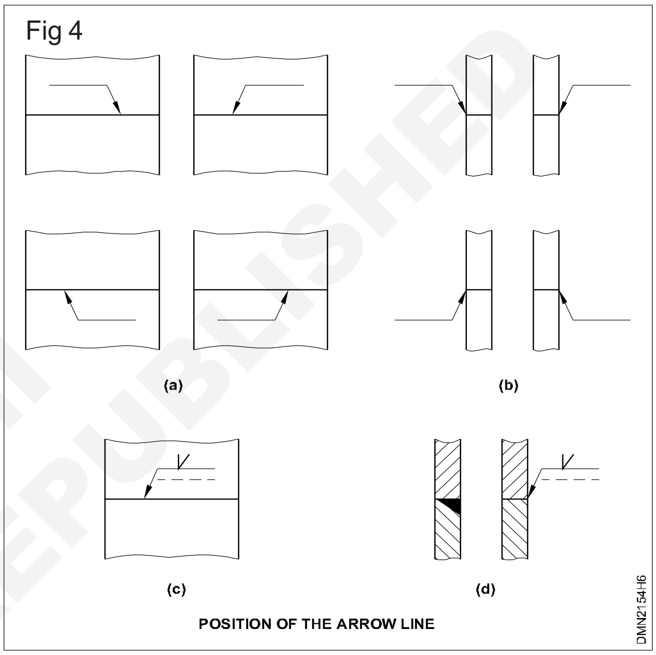
T-Joint with one fillet weld (Fig 2)



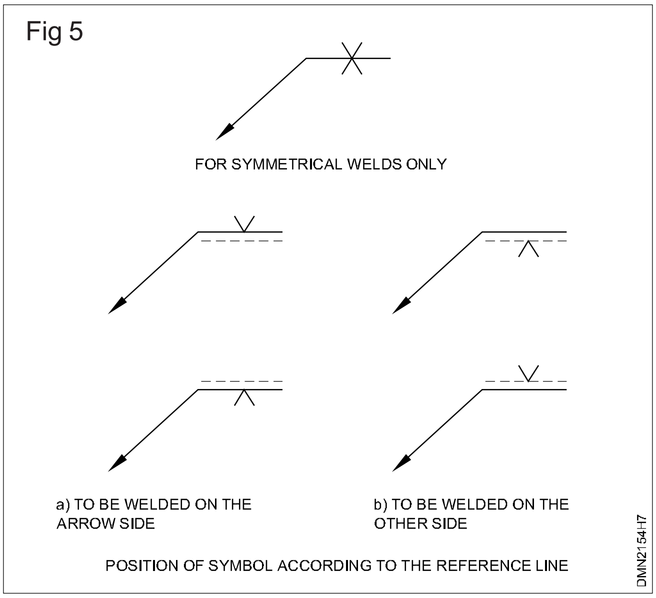
Arrow side of joint and other side of joint (Fig 3)



Position of the arrow line (Fig 4)

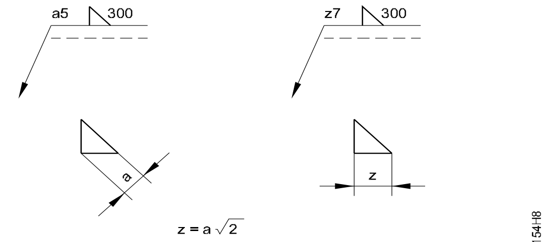


Position of symbol according to the reference line (Fig 5)



Method of indicating dimensions for fillet welds (Fig 6)

Fig 6

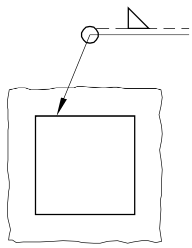


METHOD OF INDICATING DIMENSIONS FOR FILLET WELDS

DMN2154H8

Peripheral welds: When the weld is to be all around a part, the symbol is a circle, as shown in Fig 7.

Fig 7

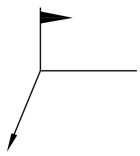


INDICATION OF PERIPHERAL WELD

DMN2154H9

Indication of field on site weld (Fig 8)

Fig 8

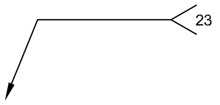


INDICATION OF FIELD ON SITE WELD

DMN2154HA

Indication of welding process (Fig 9)

Fig 9

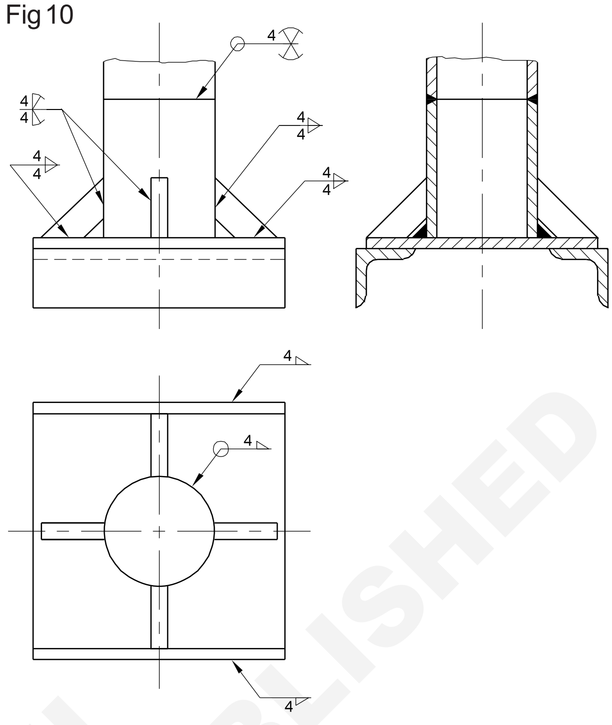


INDICATION OF WELDING PROCESS

DMN2154HB

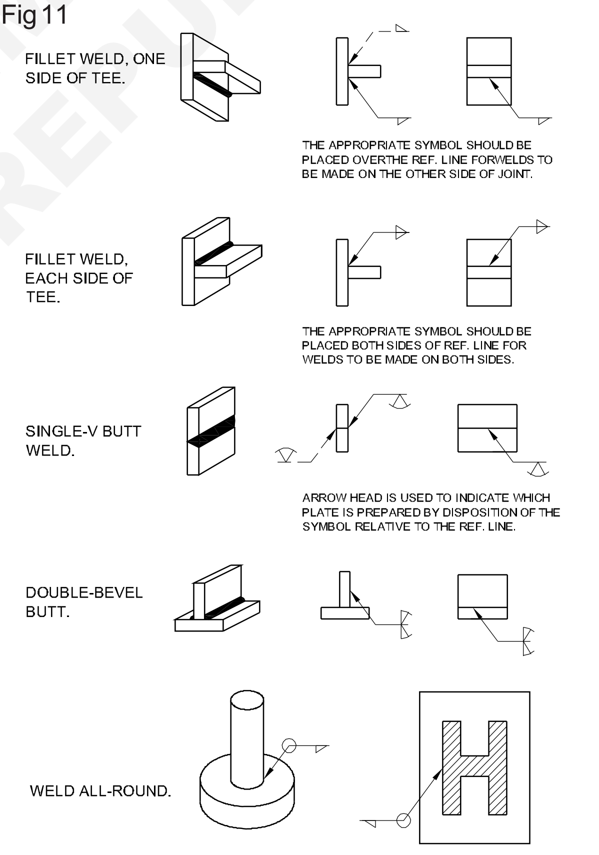
Figs 10 & 11 explains various symbols for different joint and its application.

Fig 10



DMN2154HC

Fig 11



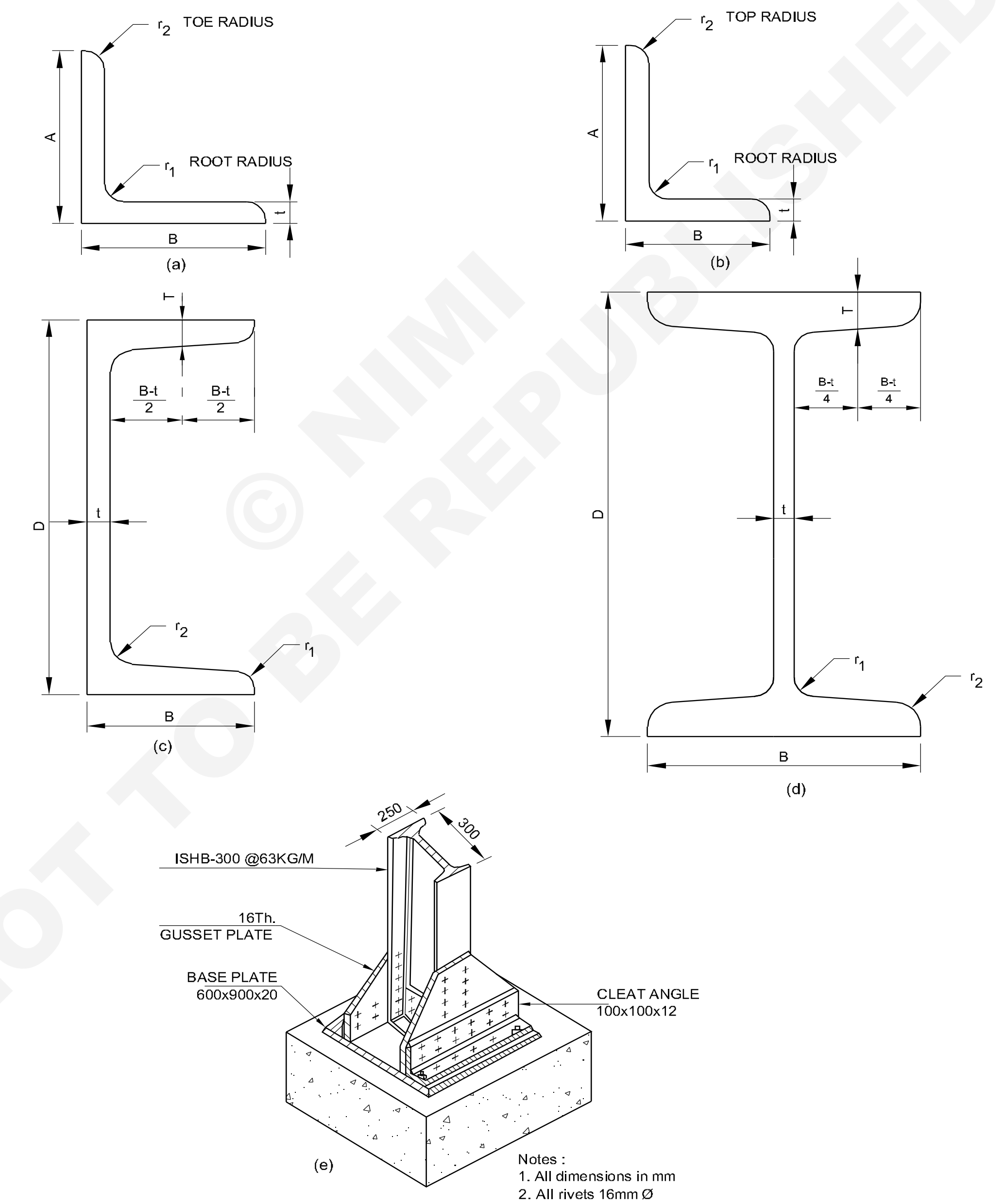
DMN2154HD

— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Draw the section of welded steel joints in structural column & bracket fabricated by plate

Objective(s): At the end of this exercise you shall be able to
- **draw the steel angles (equal and unequal legs) as per IS 808:1989**
- **draw the steel channels as per IS 808:1989**
- **draw the steel beam as IS 808:1989**
- **draw the plan and elevation of gusseted column of IS HB.**



© NIMI NOT TO BE REPUBLISHED

SCALE NTS	STRUCTURAL STEEL COLUMN	EX NO : 2.1.55
		TIME : 15hrs
PROJECTION		CODE : DMN2155E1

TASK 1: **Draw the steel angles (equal and unequal legs) as per IS 808:1989**

Draw the equal legs of an angle (Cross-sectional view) for the given specification 60x60 as IS 808:1989

t = 5.00 mm; r1 = 6.5 mm; r2 = 4.5 mm

— — — — — — — —

TASK 2: **Draw the steel channels as per IS 808:1989**

Draw the unequal legs of an angle (Cross - sectional view) for the specification 80x50 as per IS 808:1989.

t = 5.00 mm; r1 = 7.0 mm; r2 = 4.5 mm

— — — — — — — —

TASK 3: **Draw the steel beam as IS 808:1989**

Draw the Indian Standard junior beam channel (Cross - sectional view) for the specification of JC 200.

h = 200 mm; w = 70 mm; flange t = 7.1 mm, web t = 4.1 mm, r1 = 8.00 mm; r2 = 3.2 mm, flange slope 91.5'.

— — — — — — — —

TASK 4: **Indian standard wide beam**

Draw the Indian standard wide beam (Cross - sectional view) for the specification of WB. Where D is 150.

Cover width 16 mm; thickness 10.00 mm; flange t = 14.1 mm.

— — — — — — — —

TASK 5: **Draw the plan and elevation of gusseted column of IS HB**

- Draw plan and elevation of gusseted column base connected column consists of IS HB 300@63.0 kg/m for the given specifications.
- Base plates 600x900x20.
- Gusset plates 16 mm thick.
- Flange cleat angles 100x100x12.
- Rivets 16 mm.
- Holding bolt 20 mm 4 Nos.

Size of IS HB 300

D = 300 mm

B = 250 mm

T = 10.6 mm

t = 9.4 mm

r1 = 12.0 mm

r2 = 6.0 mm

Slope of flange 94°.

Steel roof truss

Objective(s): At the end of this exercise you shall be able to
- **draw the steel roof truss**
- **draw the joints of the steel roof truss.**

TASK 1: **Draw the steel roof truss**

Reproduce the steel roof truss for 12m span as per the specification given in the Fig 1.

Select suitable scale

Assume the missing dimensions

— — — — — — — —

TASK 2: **Draw the joints of the steel roof truss**

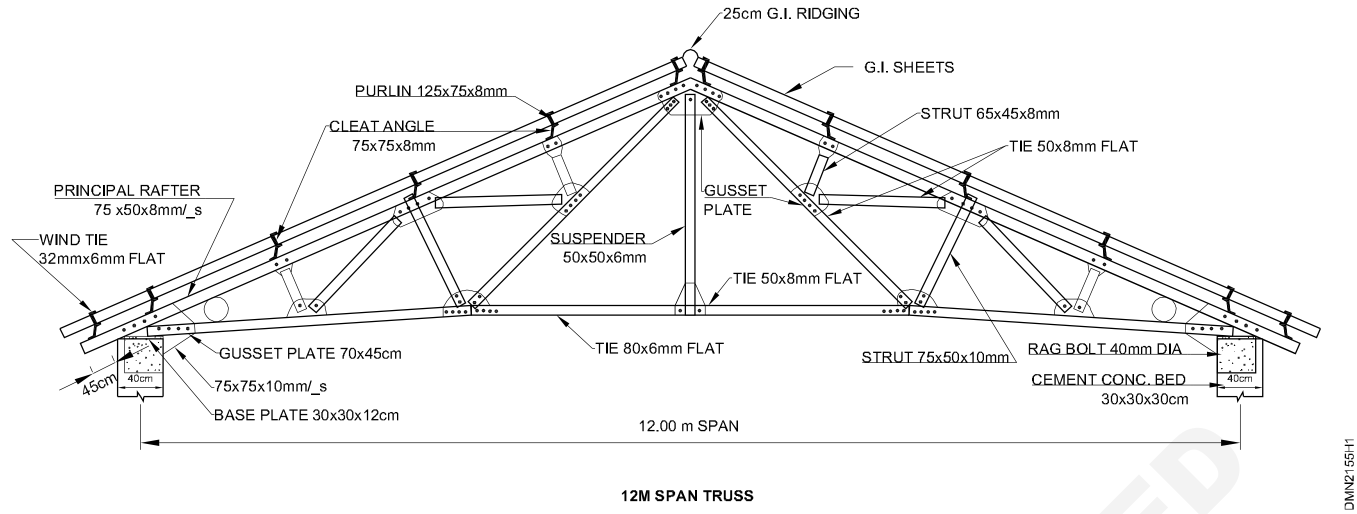
Draw to suitable scale the details of joints A,B,C and D shown in Fig 2..

Show the roofing arrangement of roof covering.

Details of joints A,B,C and D and details of roof covering.

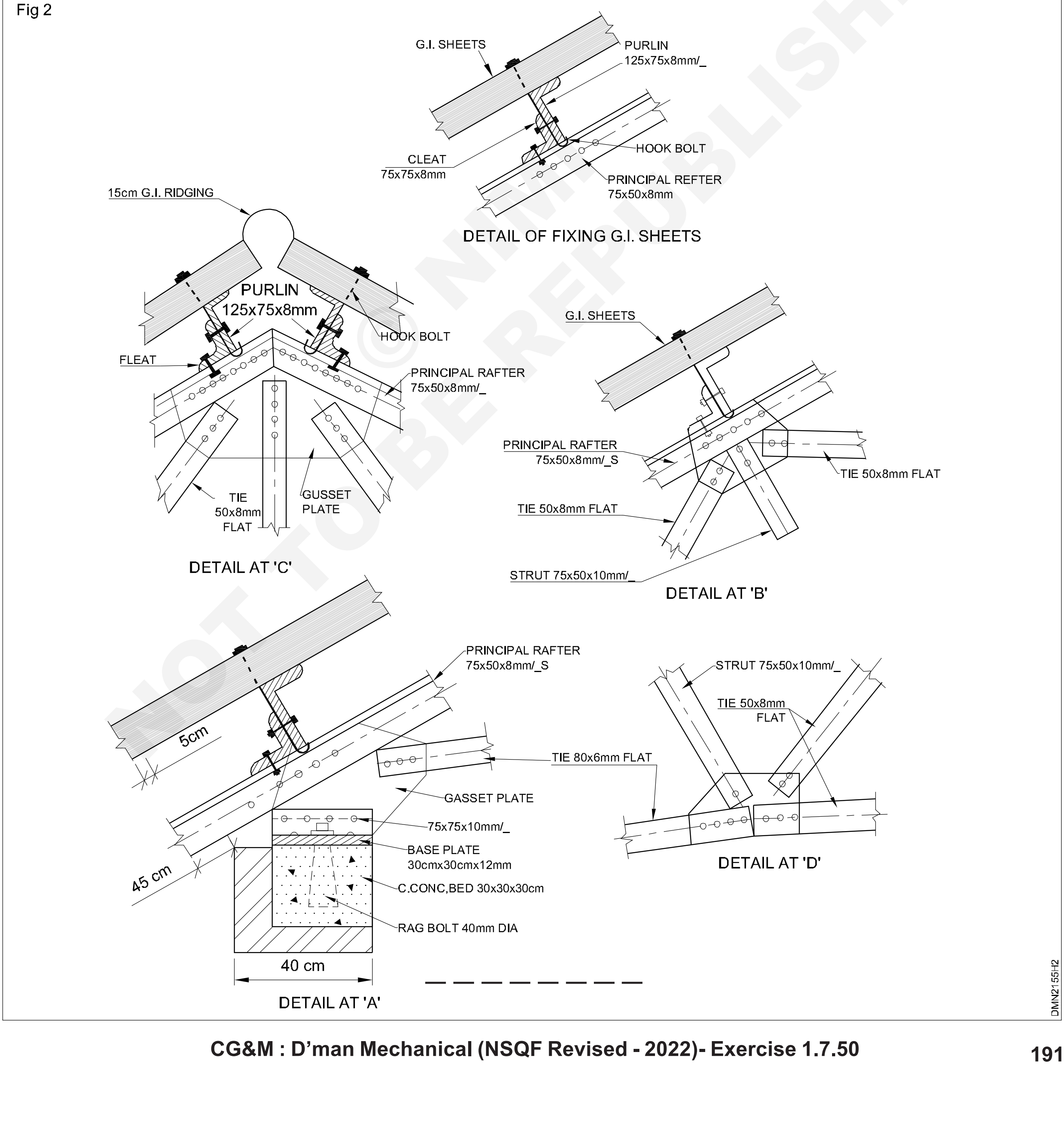
© NIMI NOT TO BE REPUBLISHED

Fig 1



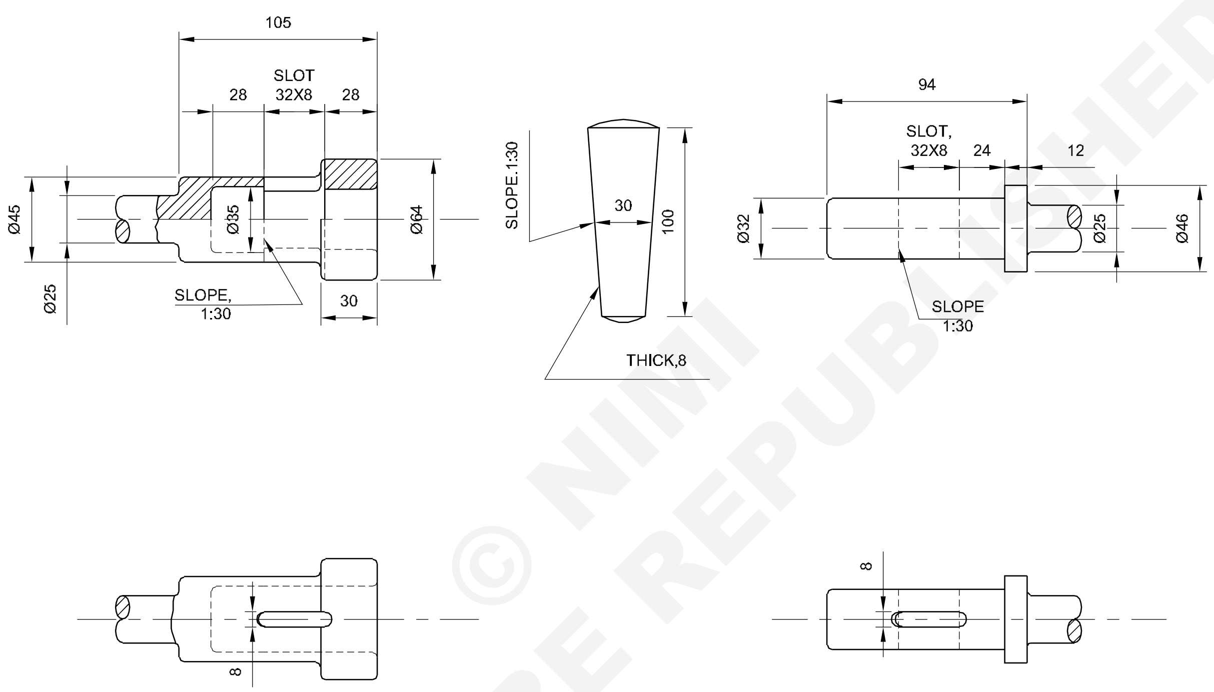
12M SPAN TRUSS

Fig 2



Draw half sectional view of a cotter joint with socket and spigot ends

Objective(s): At the end of this exercise you shall be able to
- **draw the half sectional views of cotter joints, detail and assembled views.**



© NIMI NOT TO BE REPUBLISHED

SI.NO.	NAME	MATL.	QTY.
1	SOCKET END	MS	1
2	SPIGOT END	MS	1
3	COTTER	HCS	1

SCALE NTS	SOCKET AND SPIGOT JOINT	EX NO : 2.1.56
		TIME : 18 hrs
PROJECTION		CODE : DMN2156E1

TASK 1

a Draw the detail views of the socket and spigot joint.

b Draw the following assembled view of the socket and spigot joint.

i Half sectional front elevation

ii Plan

iii Side view

iv prepare bill of material for the assembled view

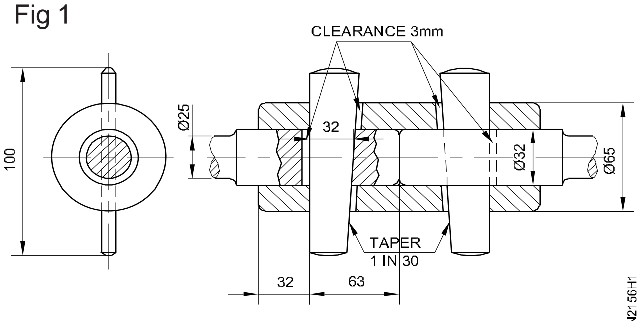
c Bill of material.

— — — — — — — —

TASK 2

Draw a double cotter joint to connect shafts of dia 25. (Fig 1)

Fig 1



COTTER JOINT WITH SLEEVE

- Draw the enlarged shaft ends butting each other.
- Draw the sleeve over it.
- Mark the cotter holes from end of the sleeve.
- Draw the cotter with mean width on the centre line of the shaft.
- Mark the taper end at 1:30 and the length.
- Mark the ends and draw the end view. (Fig 1)

— — — — — — — —

TASK 3

i Reproduce the given assembled double cotter joint to connect shaft of dia 25.

ii Draw the plan of the assembled view.

iii Prepare bill of material.

— — — — — — — —

TASK 4

Draw the detailed working drawing of the parts of the assemble view. (Fig 1)

— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Draw the different types of keys - Splined shaft - circlips and pins as per convention

Objective(s): At the end of this exercise you shall be able to
- **draw the views of different types of keys**
- **draw the assembly of shaft and hub connected with different types of keys.**

TASK 1:

Draw the views of five types of parallel keys according to the proportion to suit the shaft of dia 180 mm.

TASK 2:

Draw the views of taper keys types A to C to suit the shaft of dia 100 mm.

TASK 3:

Draw the views and assembly of saddle key both hollow and flat.

– Hollow saddle key
– Flat saddle key
– Assembly hollow key with shaft and hub.
– Assembly flat key with shaft and hub.

TASK 4:

– Draw the wood ruff key for shaft dia 100 mm.
– Draw the assembly of wood ruff key dia 100mm.

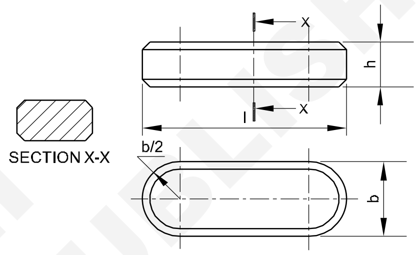
TASK 5:

– Draw the assembly of parallel key on shaft of dia 180 mm.
– Draw the assembly of taper key to suit the shaft of dia 180 mm.
– Draw an assembly of shaft and hub connected with a gib head key shaft dia 150 mm.
– Draw a wood ruff key on a shaft of dia 40 mm.
– Draw the assembly details of straight splinted shaft and hub.

TASK 6:

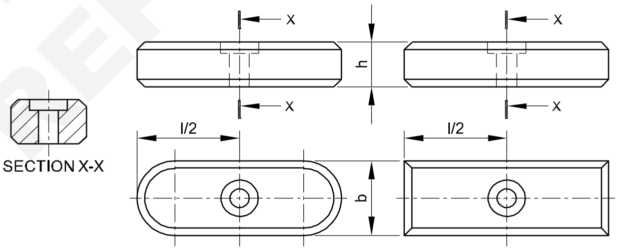
– Draw taper pins types A, B and C.

Fig 1(a)



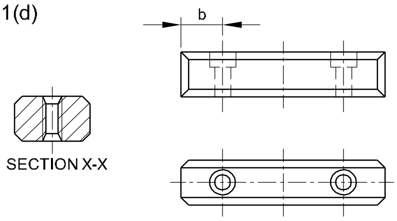
TYPE- A

Fig 1(b) Fig 1(c)



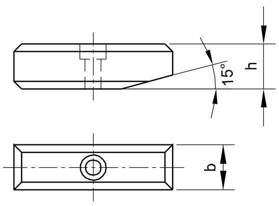
TYPE- C TYPE- D

Fig 1(d)



TYPE- F

Fig 1(e)



TYPE- G

NOT TO BE REPUBLISHED © NIMI

SCALE : NTS	DIFFERENT TYPES OF KEYS	EX NO. 2.1.57
		TIME : 10hrs
PROJECTION		CODE : DMN2157E1

PROCEDURE

TASK 1**: Parallel keys**

Draw the parallel keys as per IS:2048 to shaft of diameter 180 mm using general formula and as per standard. (Fig 1a, 1b, 1c, 1d, 1e, 1f, 1g)

- Type A - Both ends round R = 22.5 mm.
- Type C - Similar to type A but with counter bore dia 14 mm, counterbore 208.3 deep.
- Type D - Both ends square with counter bore similar to type C.
- Type F- Both ends square with hole for two retaining screws M12.
- Type G - Similar to type D but with a chamfer at 15^0.

General formula

Diameter of shaft (d) 180 mm.

Width of key 0.25 d + 2 mm

Thickness of key = 0.33 W (1/3W)

Length of key = 2d

Width = 0.25 x 180 + 2 = 47 mm

Thickness = 1/3 W = 47/3 = 16 mm

Length 2d = 360 mm

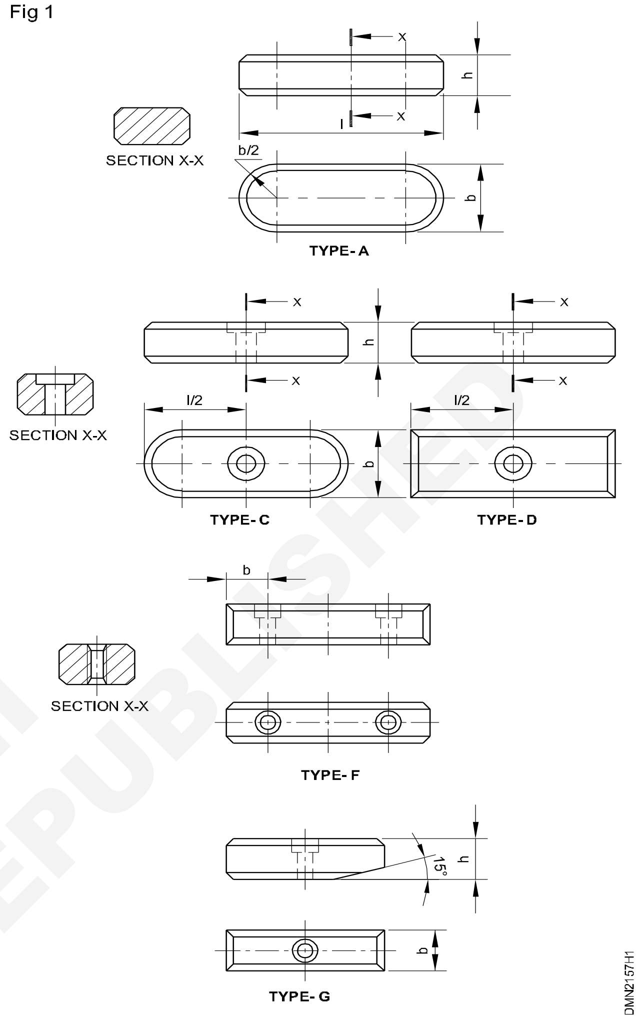
As per standard (IS:2048) for shaft 180 mm

Width of key = 45 mm

Height (thickness) = 25 mm

Length of key = 125 (min) 400 (max): chamfer 1 mm (min)

Fig 1



TASK 2**: Taper keys**

Draw the taper keys type A to C as per IS: 2292 to suit the shaft diameter 100 mm. (Fig 2 A,B & C)

General formula/sizes

Taper on taper key = 1:100

Length of key approx. 2d

Width (W) = 0.25d + 2 mm

Thickness = 2/3 x W

Length range = 80 to 360 mm

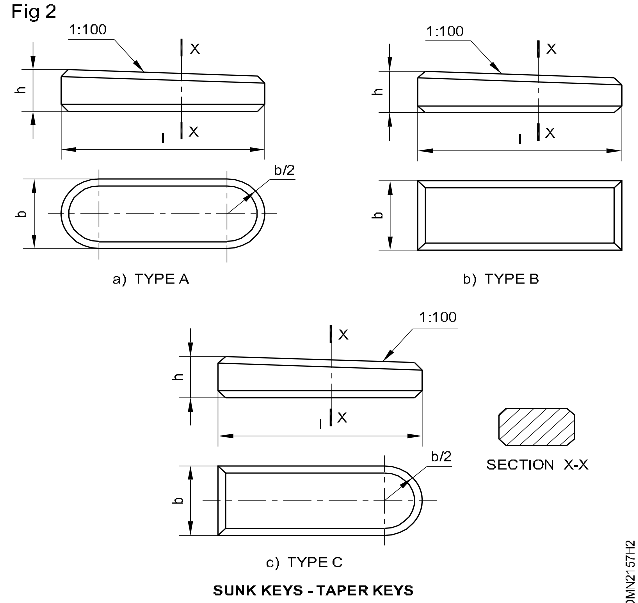
Length = 2 x 100 mm = 200 mm

Width = 28 mm

Thickness = 16 mm

Chamfer S = 0.6 to 0.8 mm

Fig 2



SUNK KEYS - TAPER KEYS

TASK 3:

Saddle keys

Type A - both ends round

Type B - both ends square

Type C - one end square and one end round

Draw the saddle keys - hollow and flat in isometric view and also the assembly. (Fig 3)

Diameter of shaft = 100 mm

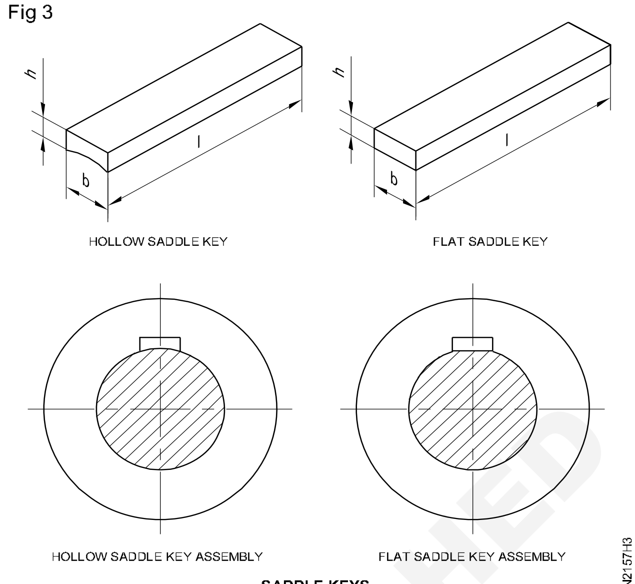
Width (b) = 0.25 d = 25 mm

Thickness (h) = 0.08d = 8 mm

Length: approx. 2d = 200 mm

– Hollow saddle key
– Flat saddle key
– Flat saddle key assembly
– Hollow saddle key assembly

Fig 3



SADDLE KEYS

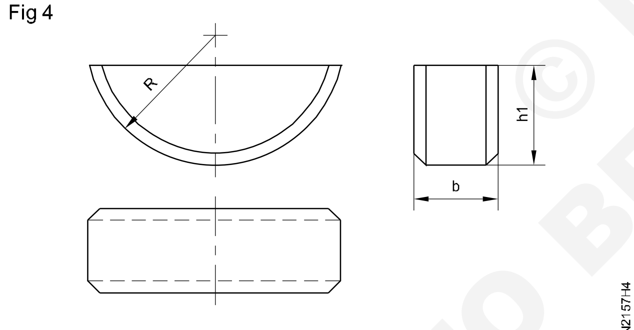
— — — — — — — —

TASK 4:

Woodruff keys

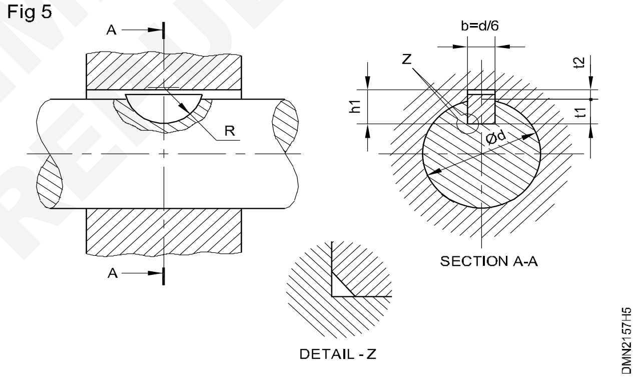
Draw the wood ruff key and also its assembly for shaft diameter 100 mm.(Figs 4 & 5)

Fig 4



WOOD RUFF KEY

Fig 5



Thickness (b) = d/6 = 16 mm

Radius (R) = 2b = 32 mm

Max. height of key (h) = 2b - 0.25b = 1.75b = 28 mm

– Wood ruff key
– Assembly

— — — — — — — —

TASK 5

Draw the assembly of parallel keys on shaft of diameter 180 mm using general formula as well as using standards. (Fig 6)

Parallel key Type A to suit shaft dia 180 mm

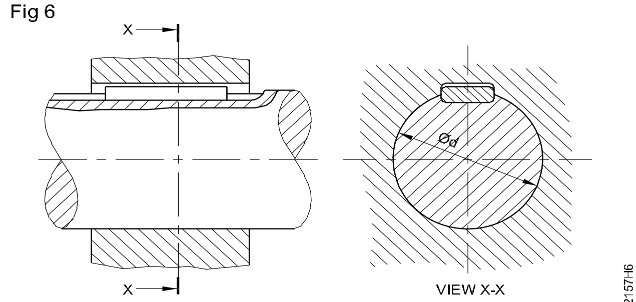
General formula for all keys = dia of shaft d

width of key = 0.25 d + 2 mm

Thickness of key = 0.33 W (1/3 W)

Length of key = 2d

Fig 6



RECTANGULAR PARALLEL SUNK KEYS

NOT TO BE REPUBLISHED © NIMI

Width = 0.25 x 180 + 2 = 47 mm

Thickness = 1/3 W = 47/3 = 16 mm

Length 2d = 360 mm.

As per standard IS:2048 for shaft 180 mm

Width of key = 45 mm

Height (thickness) = 25 mm

Length of key = 125 (min)

400 (max): chamfer 1 mm (min)

— — — — — — — —

TASK 6

Draw the taper keys as per standard (IS:2292) to suit shaft dia 160 mm. (Fig 7)

Taper key Type A, Type B and Type C mounted on shaft and hub.

Shaft dia d = 160 mm

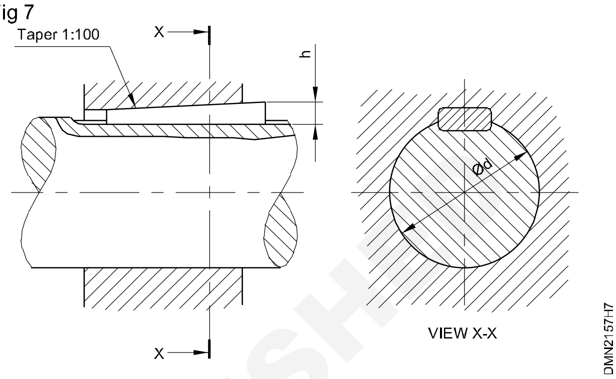
Breadth (width) = 40 mm h9

Limitation width (limits) = 0;-0.062

Height (thickness) h = 22 mm

Limits on thickness 030.130

Fig 7

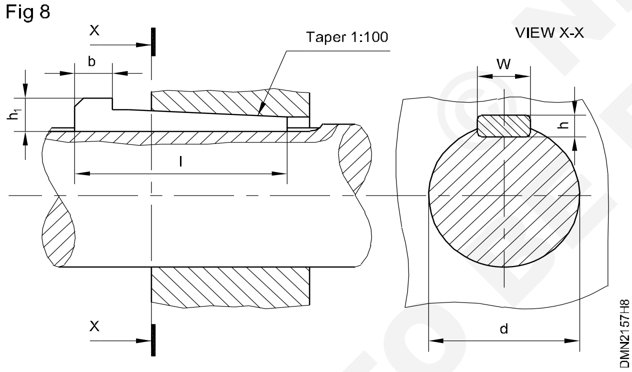


— — — — — — — —

TASK 7

Draw an assembly of shaft and hub connected with a gib head key. Assume shaft dia d = 150 mm. (Fig 8)

Fig 8



d = 150 mm; as per formula

Width of key b = 0.25d + 2 mm

150 x 0.25 + 2 = 37.5 + 2 = 39.5 mm say 40 mm

Thickness (nominal) h = 0.66b or 2/3 b = 40 x 0.66 = 26 mm

Length of key = 120 mm (say 1.5d)

Difference in thickness = 120 x 1/100 = 1.2 mm

Gib height = 1.75 h = 26 x 7/4 = 45.5 say 46 mm

Width of gib = 1.5h = 39 mm say 40 mm

As per standard IS:2293 for shaft dia 150 mm

Key width x height = 40 x 22 (for sizes above 150 mm)

Tolerance on width b 40 = 0; 0.062

Therefore max. width b = 40.00

Min. Width b = 39.938

Tolerance on thickness h = 0 - 0.130

Max. thickness (h) = 22.00

Min. thickness 22.0 - 0.130 = 21.870 mm

Height of gib h_1 = 36 mm

Length of gib = b = 20 mm

Length of key = Min 110, max 400

Taper 1:100 say 2 mm

Thickness at small end 22 - 2 = 20 mm

Draw the shaft and hub as shown with key in position.

— — — — — — — —

TASK 8

Draw a wood ruff key on a shaft dia 40 mm (max. dia of shaft on which it is used) (Fig 9)

Sizes of key as per formula

Thickness T = d/6 = 40/6 = 6.6 or 7 mm

Radius R = 2T = 14 mm

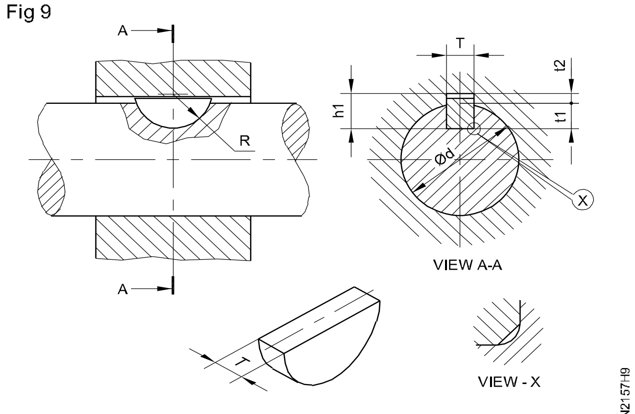
Height of key = 1.75T = 10 mm

As per IS:2294 for shaft dia 40 mm

Key size = 8.0 x 11.0 x 28.0 (in series 2)

© NIMI NOT TO BE REPUBLISHED

Fig 9



WOODRUFF KEY ON SHAFT

Limits on thickness (width) b = n_9, j_{s9} fir normal fit

p_9 P_9 for interference fit (close fit)

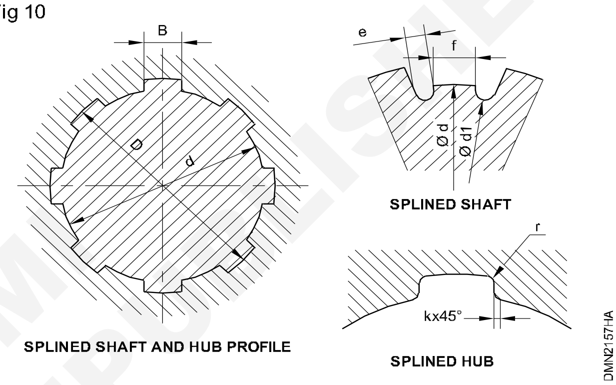
Chamfer of key 0.60 x 45^o (max. chamfer).

— — — — — — — —

TASK 9

Draw the assembly and details of straight splinted shaft and hub splice 8 x 62 x 2 - IS:2327. (Fig 10)

Fig 10



© NIMI NOT TO BE REPUBLISHED

— — — — — — — —

TASK 10

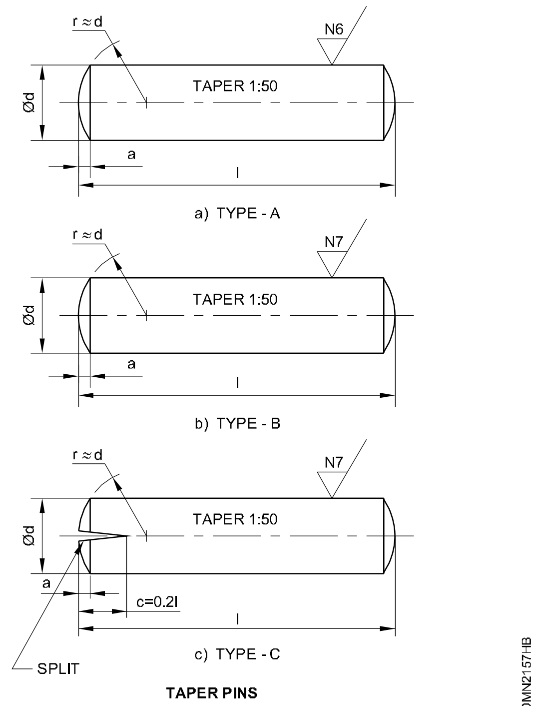
Taper pins

Draw taper pin 12 x 60 - Type A & B. Split taper pin C 20 x 80 IS:6688.

Type A & B

- Draw the cylinder of dia 12 mm, 60 long.
- Draw taper of 1:50 over the length 60 mm for type A mark surface finish N6 and N7 for type B.
- Draw the pin as above.
- Draw the split along the centre line.
- Mark surface finish as N7. (Fig 11)

Fig 11



TAPER PINS

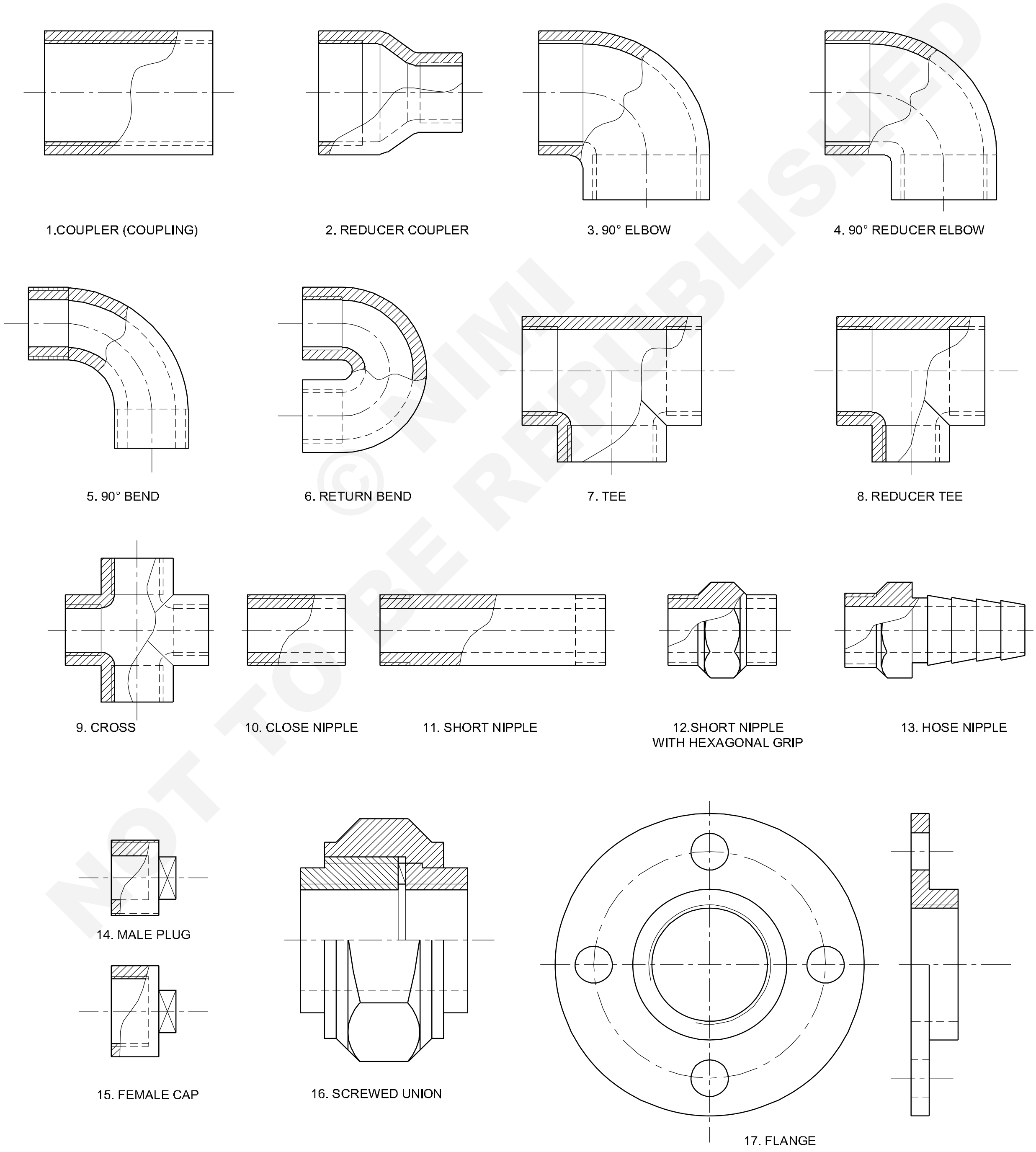
— — — — — — — —

Draw the different type of pipe fittings

Objective(s): At the end of this exercise you shall be able to
- **draw pipe fittings**
- **draw CI flanged joint**
- **draw union joint.**

TASK 1: **Draw the pipe fittings with proportional dimensions (Fig 1)**

Fig 1

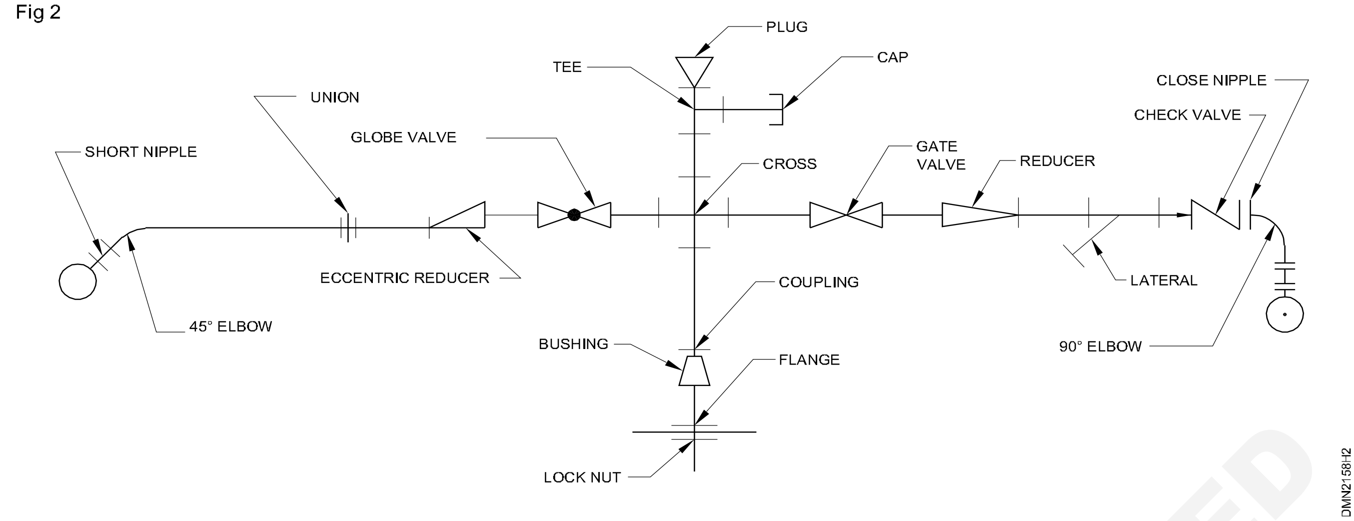


© NIMI NOT TO BE REPUBLISHED

PIPE FITTINGS

TASK 2: **Draw the piping drawing by single line method. (Fig 2)**

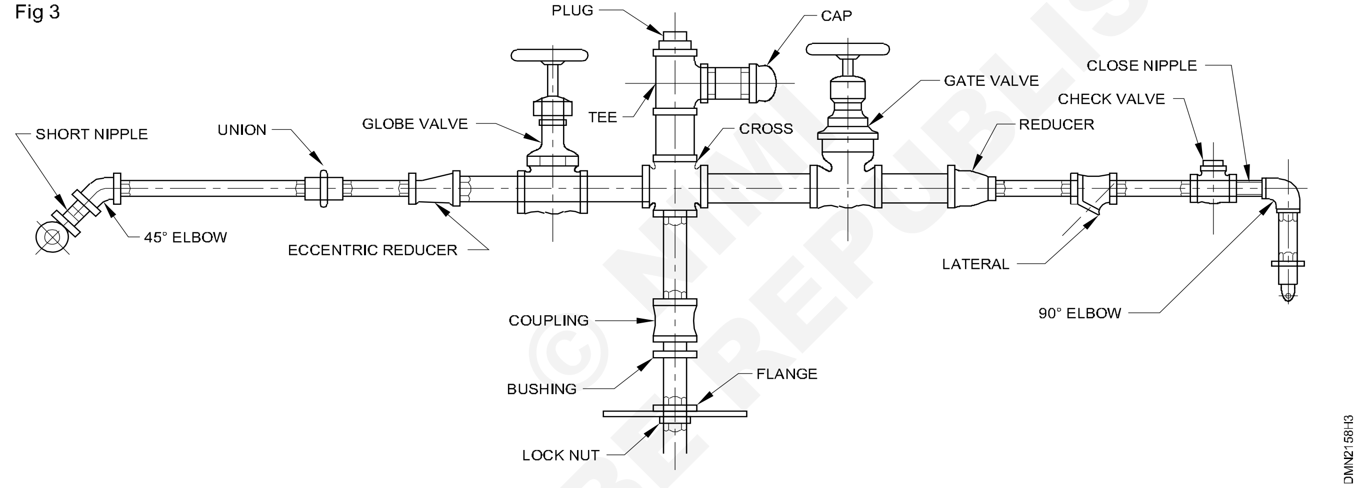
Fig 2



— — — — — — — —

TASK 3: **Draw the piping drawing by double line method. (Fig 3)**

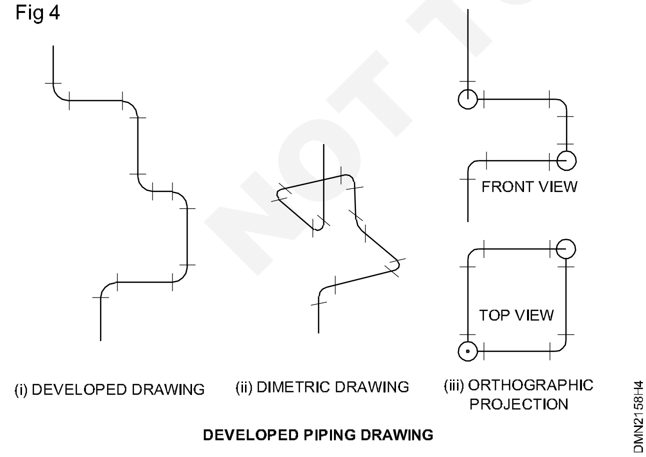
Fig 3



— — — — — — — —

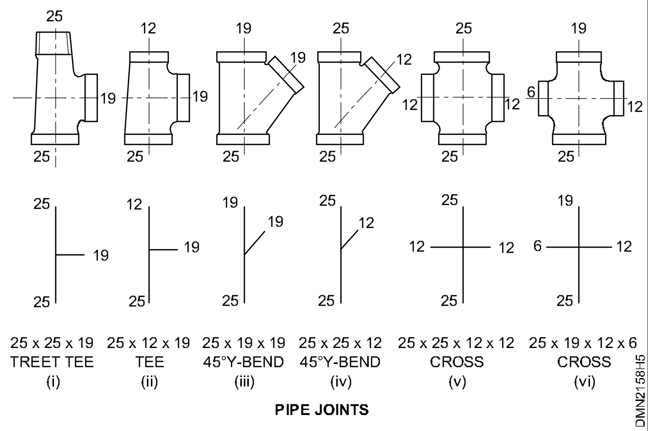
TASK 4: **Draw developed piping drawing (Fig 4)**

Fig 4



TASK 5: **Draw pipe fittings (Fig 5)**

Fig 5



— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Draw pipe joints flanged joints, welded joint, threaded joint, socket and got joint

Objective(s): At the end of this exercise you shall be able to
- **draw the different types of pipe joints.**

PROCEDURE

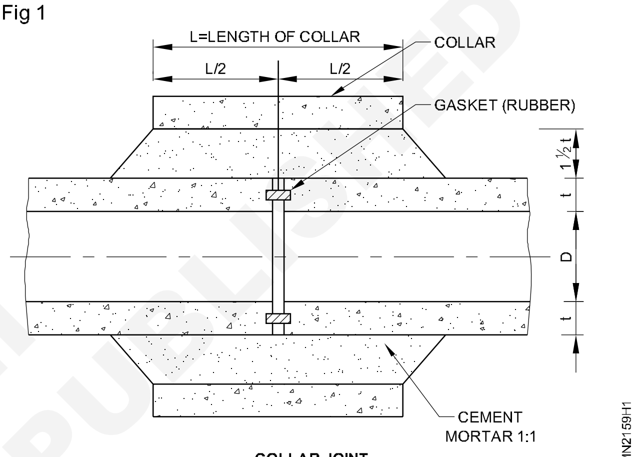
TASK 1: **Draw collar joint**

Collar joint (Fig 1)

D (Diameter of pipe) = 50 cm

t = (Thickness of pipe) = 5 cm

Fig 1



COLLAR JOINT

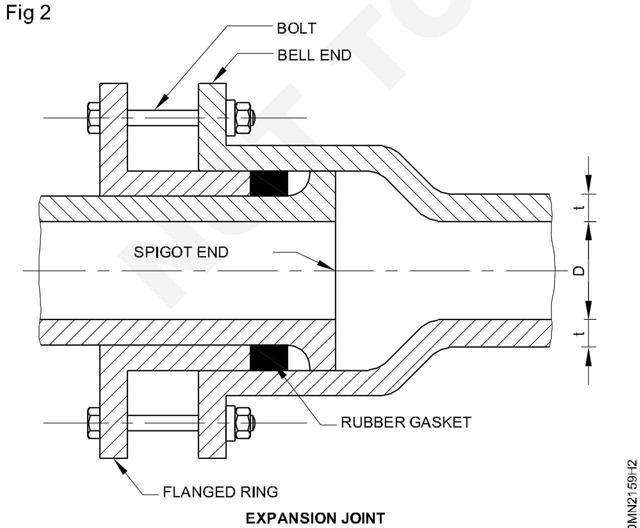
TASK 2: **Draw the typical pipe joints**

Draw the pipe joints as per given drawing

D = Diameter of pipe 10 cm

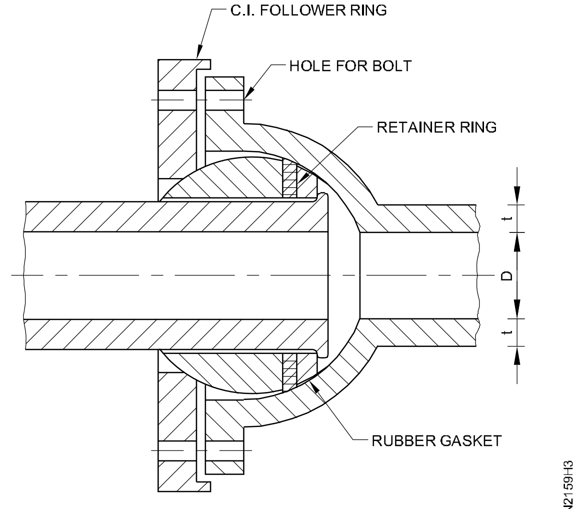
t = Thickness of pipe 1 cm (Figs 2 to 7)

Fig 2



EXPANSION JOINT

Fig 3



FLEXIBLE JOINT (UNIVERSAL JOINT)

© NIMI NOT TO BE REPUBLISHED

Fig 4

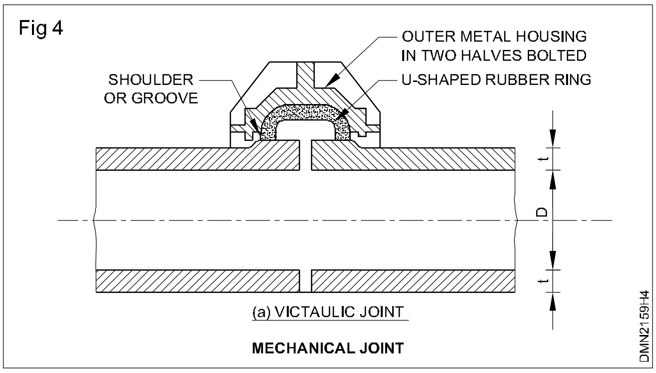


Fig 6

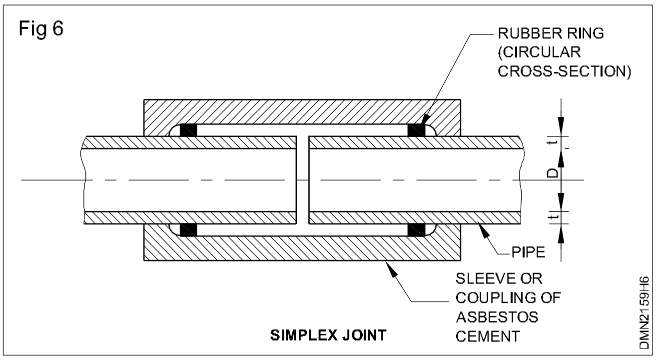


Fig 5

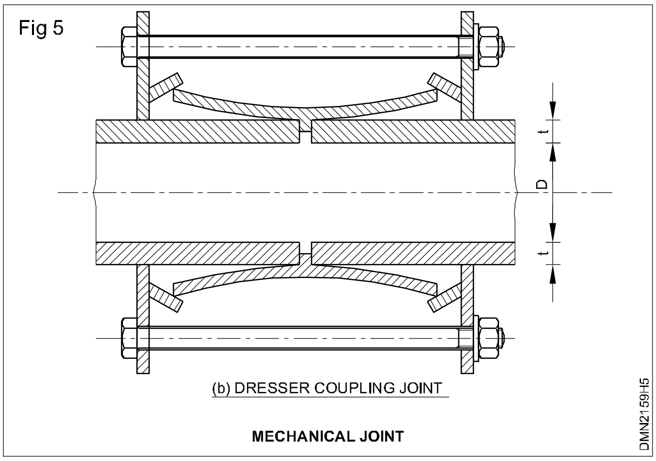
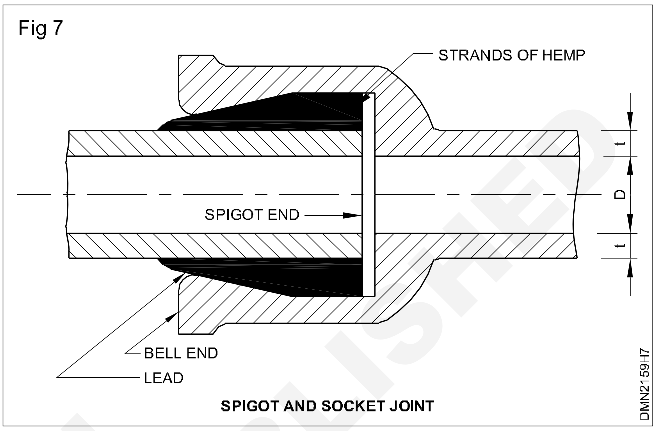
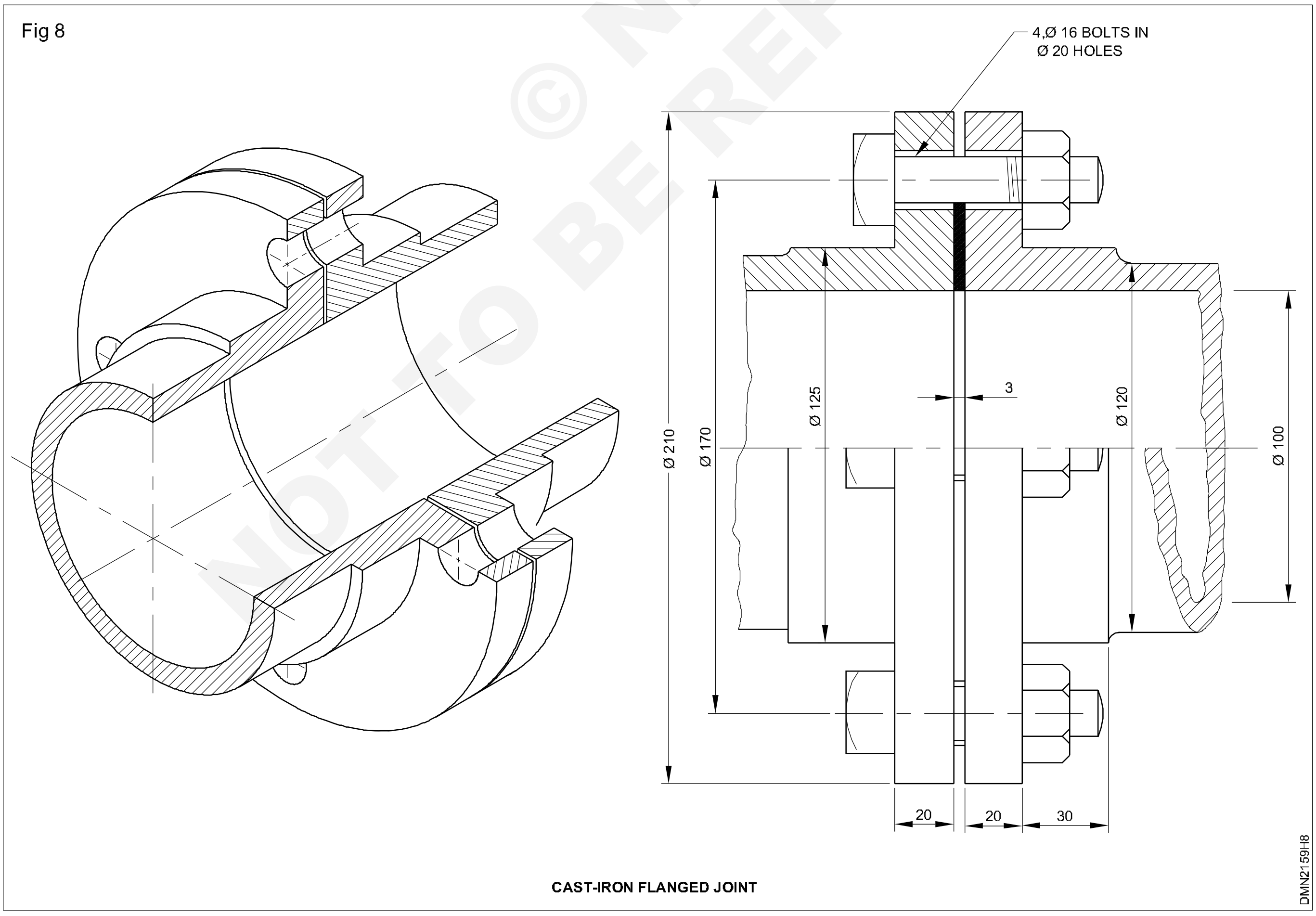


Fig 7



TASK 3: **Draw the cast iron for two 100 mm diameter (Fig 8)**

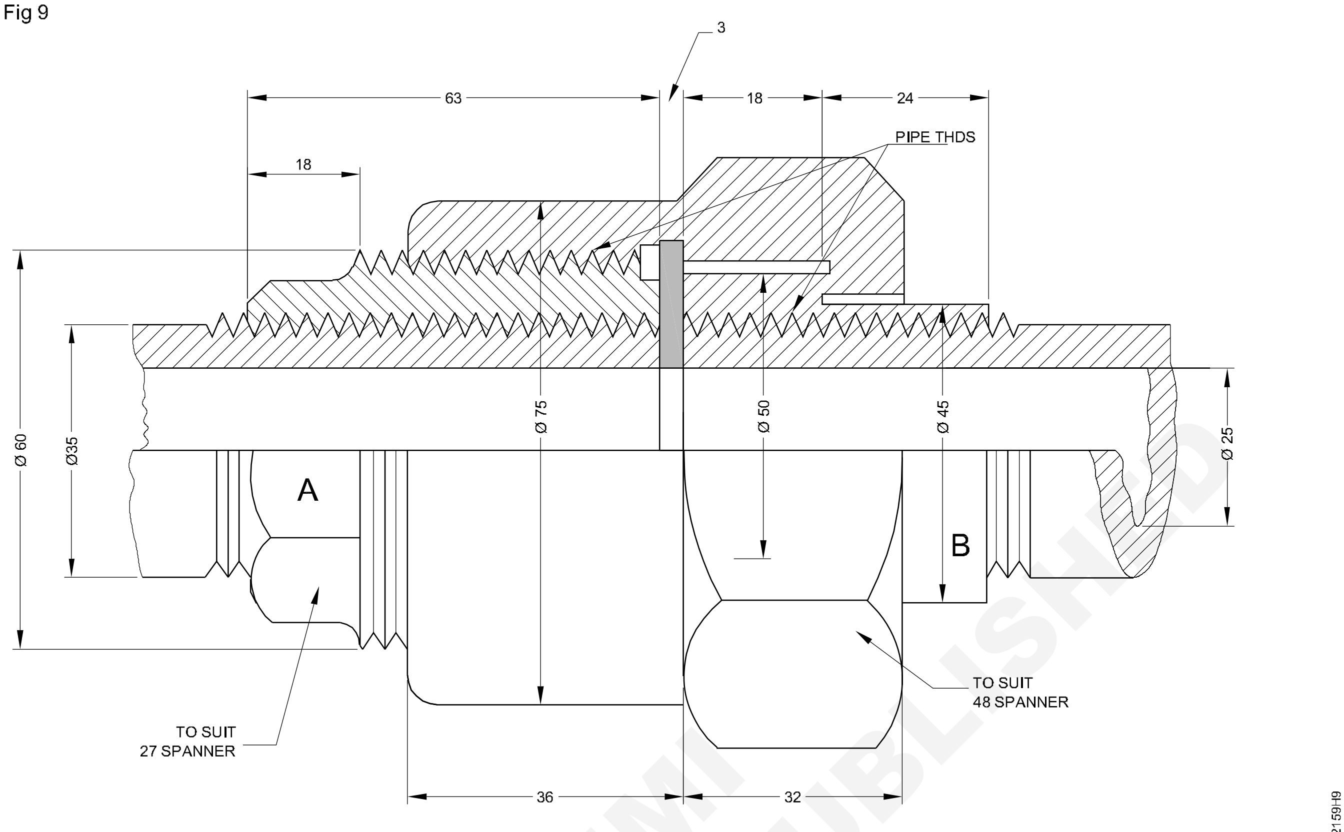
Fig 8



© NIMI
NOT TO BE REPUBLISHED

TASK 4: **Draw full size two views of an union joint for 25 mm diameter pipes (Fig 9).**

Fig 9



UNION JOINT

© NIMI NOT TO BE REPUBLISHED

Draw rolled steel section as per IS specification

Objective(s): At the end of this exercise you shall be able to
- **draw the different steel sections used for steel structures as per IS standards.**

DATA

Dimensions are given in Table

b - width of flange

h - total depth of section including the flange thickness

tf - thickness of flange

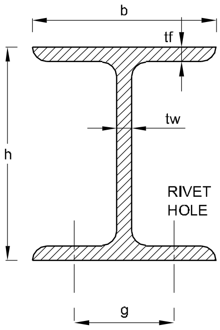
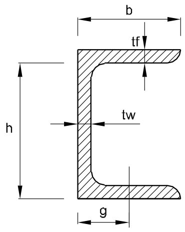
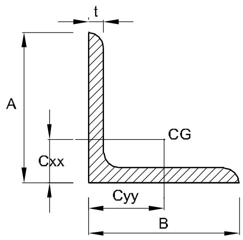
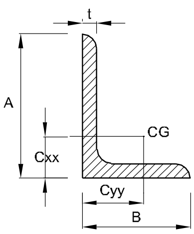
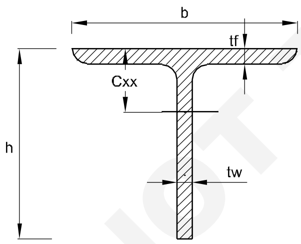
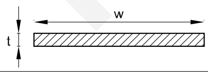
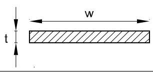
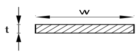
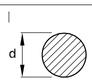
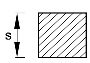
tw - thickness of web

PROCEDURE

Sketch the drawing

© NIMI NOT TO BE REPUBLISHED

INDIAN STANDARD [IS] ROLLED AND SLIT STEEL SECTIONS FOR STRUCTURAL USES

Sl. No.	Structural Sections	Description	Example	Weight (Kg) per metre	Important dimensions(mm) h	b	t_t	t_w	g
1		IS Junior beam	ISJB 225	12.8	225	80	5.0	3.7	40
2		IS Light beam	ISLB225	23.5	225	100	8.8	5.8	55
3		IS Medium WT beam	ISMB 225	31.2	225	110	11.8	6.5	60
4		IS Wide flange beam	ISMB 225	33.9	225	150	9.9	6.4	60
5		IS Column section	ISHB 225	43.1	225	225	9.1	6.5	140
6		IS Junior channel	ISJC 200	13.9	200	70	7.1	4.1	40
7		IS Light channel	ISLC 250	28.0	250	100	10.7	6.1	90
8		IS Medium WT Channel	ISMC 250	30.4	250	80	14.1	7.1	45
9		IS Equal angle	ISA 100100	9.2	A-100	B-100	t-60	Cxx=Cyy	2.67
10		Do	Do	12.1	100	100	80	Do	2.76
11		Do	Do	14.9	100	100	10.0	Do	2.84
12		Do	Do	17.7	100	100	12.0	Do	2.92
13		IS Unequal angle	ISA 100 75	8.0	A-100	B-75	t=6.0	Cxx=3.01	Cyy=1.78
14		Do	Do	10.5	100	75	80	3.10	1.87
15		Do	Do	13.0	100	75	10.0	3.19	1.95
16		Do	Do	15.4	100	75	12.0	3.27	2.03
17		IS Normal tee	ISNT 150	22.8	150	150	10.0	10.00	Cxx-3.95
18		IS Tee from ISHB	ISHT 125	27.4	125	250	9.7	8.8	2.37
19		IS Standard tee	ISST 150	15.7	150	75	11.6	8.0	4.75
20		IS Light WT tee	ISLT 100	12.7	100	100	10.8	5.7	2.13
21		IS Junior tee	ISJT 100	5.0	100	60	5.0	3.4	2.81
22		IS Rolled plate		W-900-2500mm t-5.63mm Length 2-12.5m					
23		IS Strip		W= 100-1550 t=1.6 - 10mm					
24		Mild steel flat		W=10-400mm t=3-40mm					
25		IS Round bar	ISRQ	d=5-200 mm					
26		IS Square bar	ISSQ	s=5-100 mm					

© NIMI NOT TO BE REPUBLISHED

Draw the different types of rivet heads as per conventions

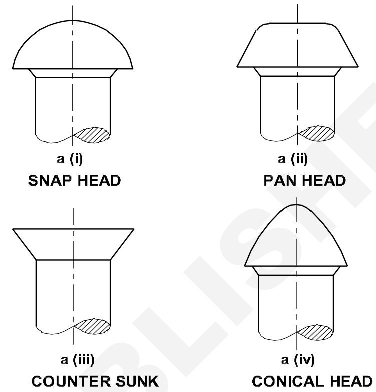
Objective(s): At the end of this exercise you shall be able to
- **draw the four types of rivet head with full specification as per Indian Standard.**

PROCEDURE

TASK 1

Draw the rivet heads shown in the figures 1.1 to 1.4according to the specification as per IS:1928 & 1929. Assume the diameter of shank = 20 mm.

Fig 1



TYPES OF RIVET HEAD

— — — — — — — —

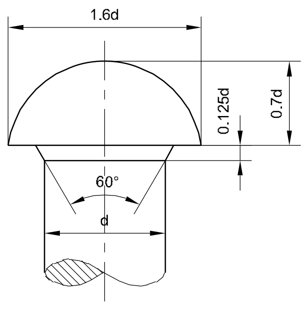
TASK 2

Snap head rivet

Draw a snap head rivet suitable for joining plates of 25 mm thick.

- Draw a thin horizontal line.
- Draw vertical centre lines.
- Mark diameter of rivet shank and head.
- Form the rivet head as per proportions.
- Draw the shank with short break.
- Draw firm lines of the edges of the rivet.
- Show the dimensions in terms of dia of shank. (Fig 1)

Fig 1



SNAP HEAD

— — — — — — — —

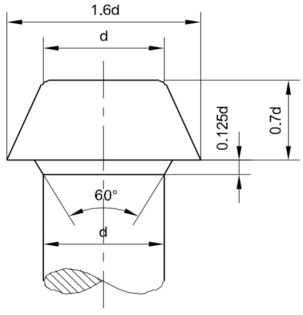
TASK 3

Pan head rivet

Draw a pan head rivet of shank diameter 30 mm. (Fig 2)

- Follow the procedure of Ex.1 (i)

Fig 2



PAN HEAD

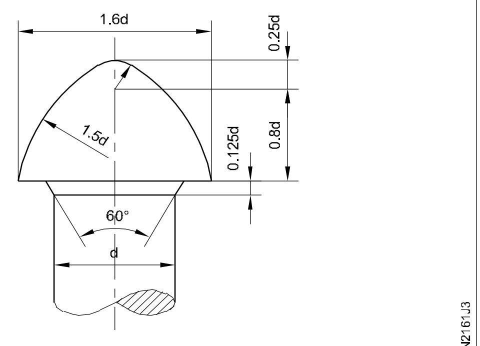
© NIMI NOT TO BE REPUBLISHED

TASK 4

Conical head rivet

Draw a conical head rivet of shows diameter 25 mm. (Fig 3)

Fig 3



CONICAL HEAD

- Draw a horizontal thin line.
- Draw a vertical centre line.
- Mark the diameter of rivet head and shank as per proportion.
- Set off 0.8d on the centre line as shown in Fig 3 from the horizontal line.
- 0.25d as radius, draw an arc as shown in Fig 3.
- 1.5d as radius, draw another arc, tangential to the previous arc of radius 0.25d.
- Draw the firm lines of the edges of the rivet.
- Show the dimensions in terms of diameter of shank.

— — — — — — — —

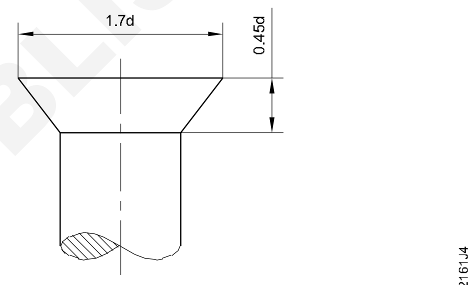
TASK 5

Countersunk head rivet

Draw a countersunk head rivet of shank diameter 30 mm.

- Draw a horizontal line.
- Draw a centre line.
- Follow the same procedure as done in Exercise 1(1) and complete the rivet head. (Fig 4)

Fig 4



COUNTERSUNK HEAD

— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Draw the riveted joints of lap joint with covers in chain and zig-zag orientation

Objective(s): At the end of this exercise you shall be able to
- **draw the three types of lap joints as per the data given**
- **draw the four types of butt joints as per the data given**
- **draw the riveted joint connecting plates at right angle.**

TASK 1

Calculations:

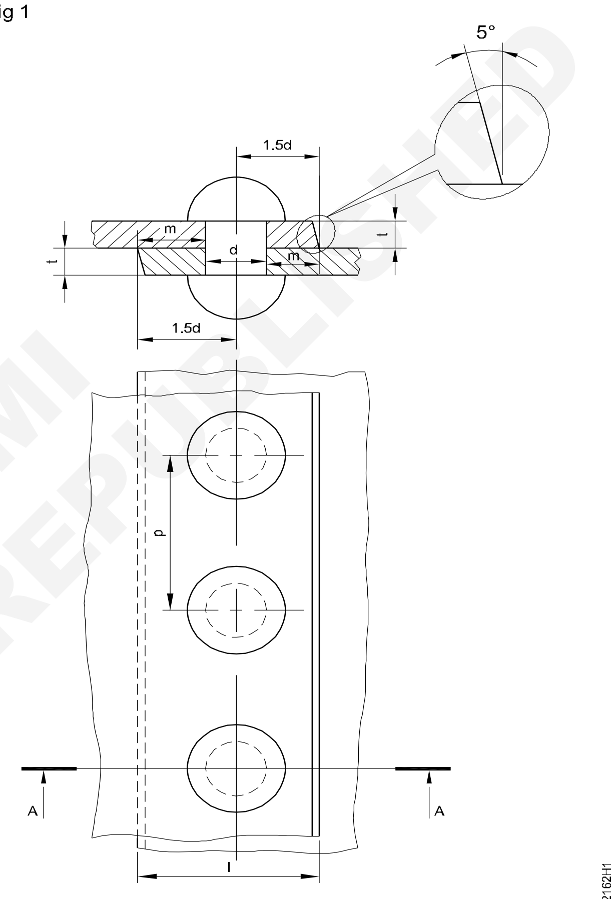
Dia of rivet = $6\sqrt{t} = 6\sqrt{25}$ = 6 x 5 = 30 mm

Pitch of rivet = 3d = 3 x 30 = 90 mm

Margin from rivet hole to end of plate = 1.5d = 1.5 x 30 = 45 mm.

- Mark vertical centre line.
- Draw three horizontal lines 25 mm apart in front elevation.
- Form the rivet heads (on 30 mm shank) on the centre line.
- Draw the plates and section them as shown
- Draw the rivet head circle and hidden circles for shank dia.
- Draw the edge of the plates in front view at 80° - 85°.
- Project the edges on to top view.
- Draw visible edges of plates and rivets in firm lines. (Fig 1a)

Fig 1



SINGLE RIVETED LAP JOINT

© NIMI NOT TO BE REPUBLISHED

TASK 2

Double riveted (chain) lap joint

Draw a double riveted lap joint/chain riveting with 35 mm thick plates. Show a minimum of 3 rivets.

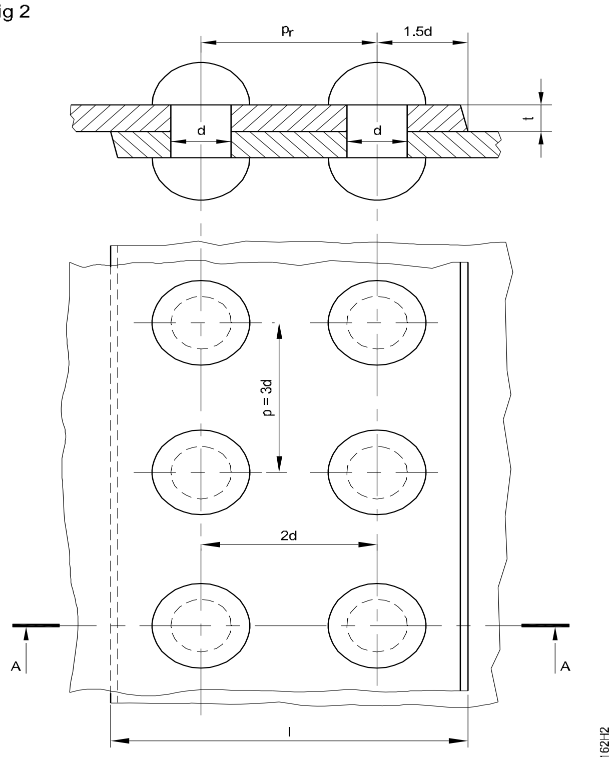
Data

Dia of rivet = $6\sqrt{t} = 6\sqrt{36}$ = 36 mm.

Pitch p = 3d = 3 x 36 mm = 108 mm
Row pitch (Pr) = 0.8 P or 2d + 6 mm = 86.4 mm or 78 mm
Margin = 1.5d = 1.5 x 36 mm = 54 mm

- Draw the plates one over the other, mark pitch (pr) and lap (l) 54 mm on either side.
- Draw the rivet heads, ends of the plates at lap and beyond short break.
- Hatch the plates in opposite directions.
- Project and draw the top view.
- Show CP. Show the proportions instead of dimensions in terms of dia of rivet. (Fig 1b)

Fig 2



DOUBLE RIVETED (CHAIN) LAP JOINT

TASK 3

Double riveted (zig-zag) lap joint

Draw a double riveted zig-zag lap joint, joining 35 mm thick plates.

Data

Dia of rivet $= 6\sqrt{t} = 6\sqrt{36} = 36mm$

Pitch P = 3d = 108 mm

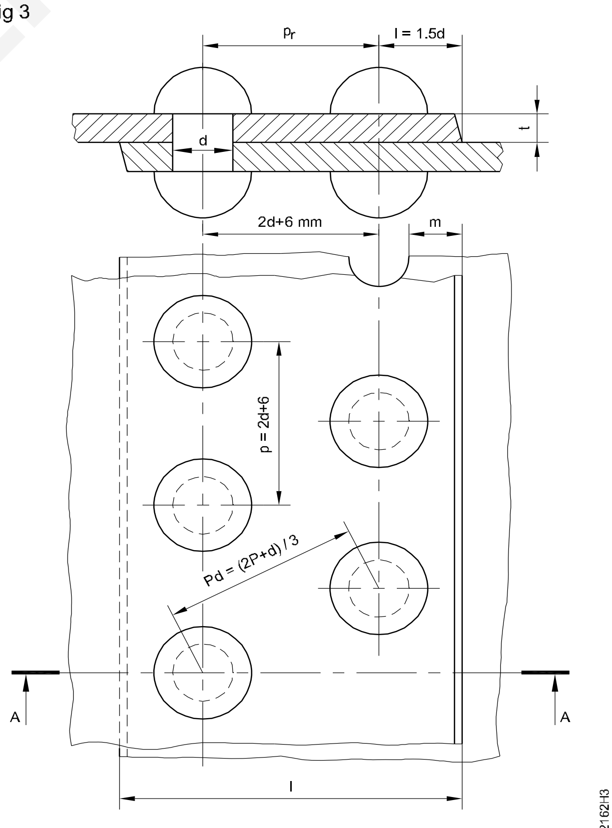
Row pitch Pr = 0.8 P or 2d + 6 mm = 86.4 mm or 78.0 mm

Diagonal pitch pd = $\frac{(2P + d)}{3} = \frac{252}{3}$ = 84 mm

Margin = d = 36 mm or lap (l) = 1.5d = 54 mm

- Draw the plates as in previous exercise and mark centre lines at Pr = 78 or 86 mm, draw rivet heads.
- Mark the ends of the plates.
- Project on to top view, mark three rivet centres at distance P (108 mm)
- Draw intersecting arcs with Pd as radius from centre.
- Draw rivet head circles and shank as hidden circles.
- Draw the edges of the plates as shown
- Show proportions of plate thickness. (Fig 1c)

Fig 3



DOUBLE RIVETED (ZIG-ZAG) LAP JOINT

© NIMI NOT TO BE REPUBLISHED

TASK 4

Single riveted (Single strap) butt joint

Draw a single riveted butt joint with single cover plates. Two plates of 36 mm thick butting each other are to be joined by riveting.

Calculations

Given plate thickness t = 36 mm

Dia of rivet = $6\sqrt{t}$ = 36 mm

Pitch of rivets P = 3d = 108 mm

Lap l = 1.5d = 54 mm

for butt joints

Single cover plate thickness

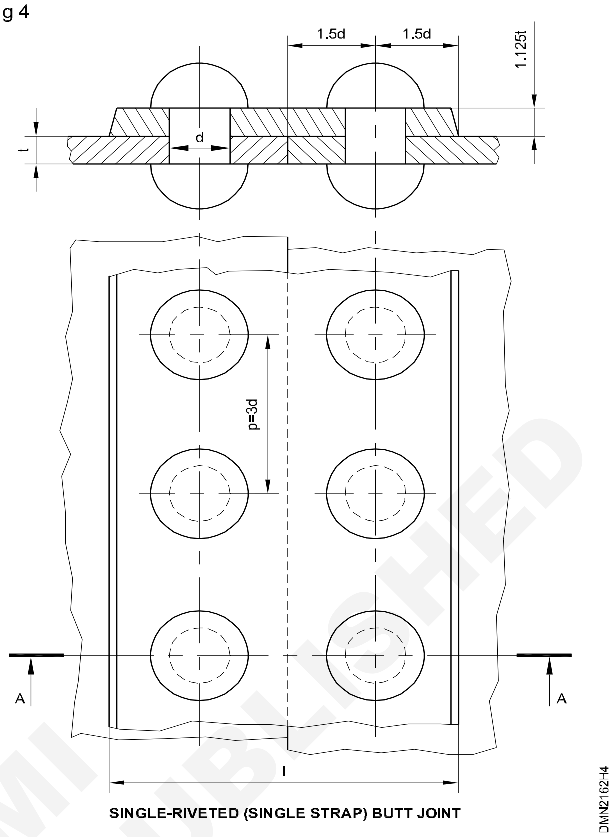
1.125 t = say 40 mm

Pitch of rivets = 3d = 108 mm

Row pitch for chain riveting = 2d + 6 = 78 mm

- Draw the plates in position with single cover plate.
- Mark the centre of rivets and draw rivets.
- Hatch the plates.
- Project and draw the top view showing minimum 3 rivets in a row.
- Show the broken end of the plates.
- Dimension the views. (Fig 2a)

Fig 4



TASK 5

Single riveted (Double strap) butt joint

Draw single riveted double strap butt joint (chain). Plate thickness 25 mm.

Calculate the rivet dia, pitch, distance etc.

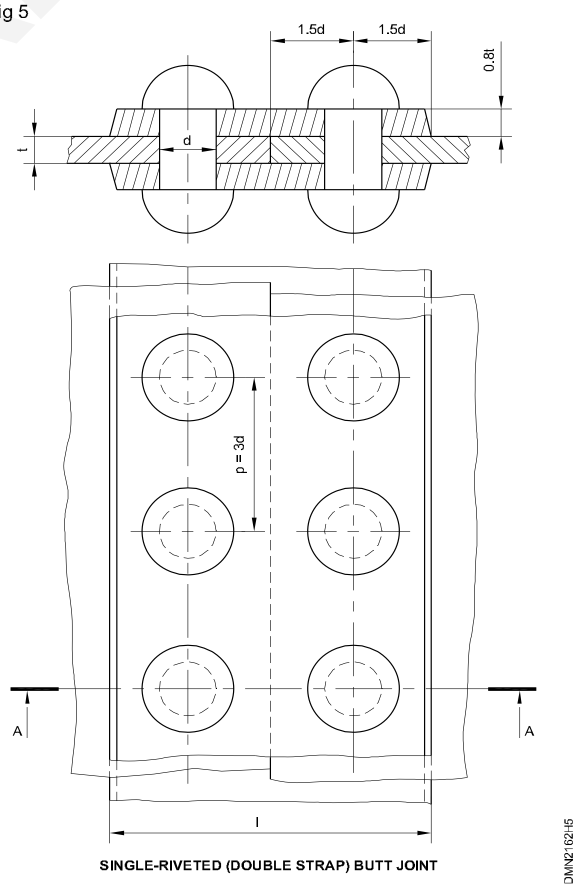
Double cover plate thickness (0.6 t to t)

Average = 0.8t

0.8 t = 20 mm

- Draw the main plates and cover plates in position.
- Mark two rows of rivets with distance as shown in Fig 2b.
- Draw the rivets and hatch the plates.
- Project and draw the top view with minimum 2 pitches.
- Show the end cover plates and main plates.
- Show dimensions in terms of dia (d). (Fig 2b)

Fig 5

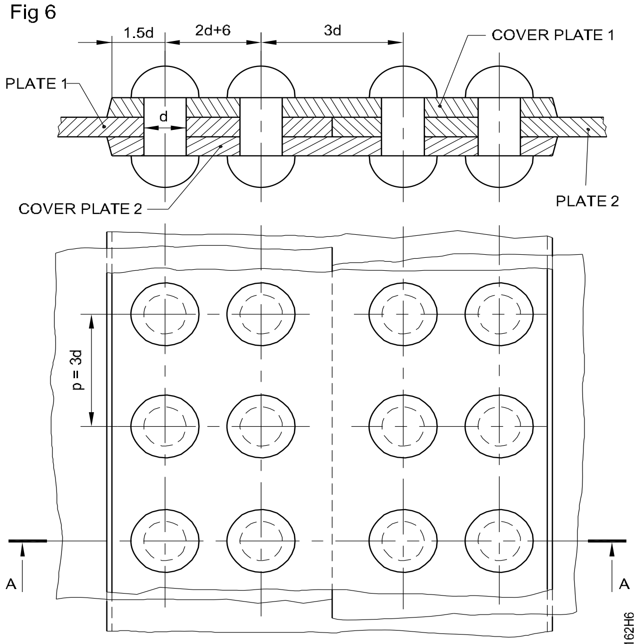


© NIMI NOT TO BE REPUBLISHED

TASK 6

Double riveted butt joint (chain) (Fig 2)

Fig 6



CHAIN RIVETED / DOUBLE RIVETED BUTT JOINTS (DOUBLE STRAP)

Draw a double riveted butt joint to join 25 mm thick plates, double cover plates chain riveting.

- Calculate the rivet diameter, row pitch, pitch, margin etc as in Exercise.
- Draw the plates with double cover plates (10d + 12 mm) long.
- Mark the centres of rivets as shown in the Fig 2(c).
- Draw the rivet head and the plate ends.
- Project and draw the plates showing thickness and rivets.
- Hatch the plates
- Show dimensions/proportions. (Fig 2c)

NOT TO BE REPUBLISHED © NIMI

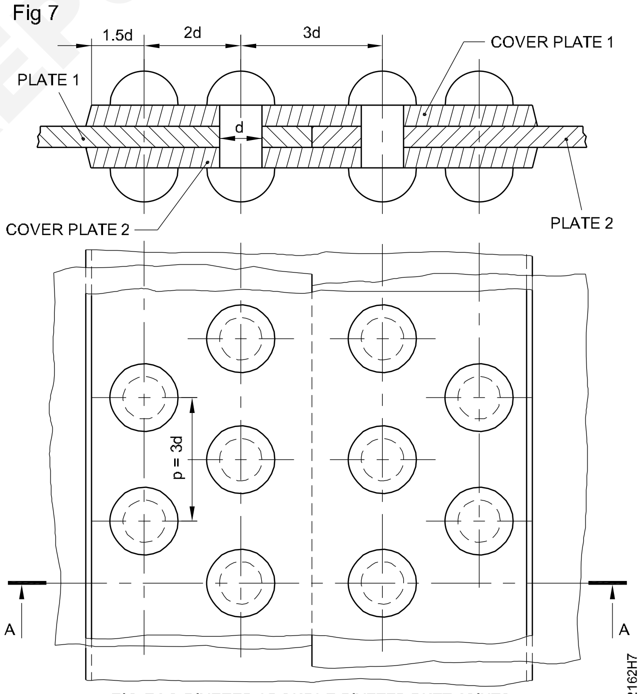
TASK 7

Double riveted butt joint (zig-zag) (Fig 2d)

Draw a double riveted butt joint to join 25 mm thick plates, double cover plates by zig-zag riveting. (Fig 2(d))

- Calculate the rivet diameter, row pitch, pitch, diagonal pitch margin etc as done in previous exercises.
- Follow the same procedure of earlier joints and complete the drawing.

Fig 7



ZIG-ZAG RIVETED / DOUBLE RIVETED BUTT JOINTS (DOUBLE STRAP)

TASK 8

Riveted joint with connection plates at right angles

Draw the riveted joints connecting plates at right angles with a & b bent plate c angle iron, plate thickness 25.

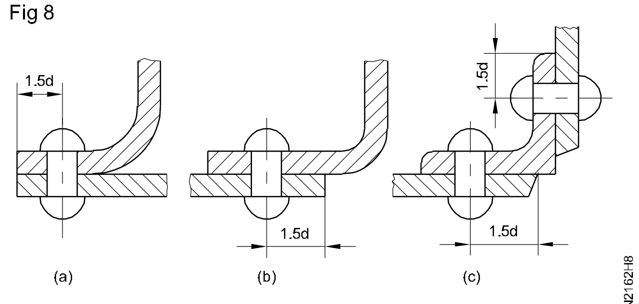
Using bent plate

- Draw the plate bent at radius not less than 2t.
- Mark the centre of the rivet 1.5d from centre of arc.
- Draw the other plate to be riveted and rivet (two methods are shown)
- Show proportions (Fig 3 a,b & c)

Using angle plate

- Mark the centre of rivet holes at 1.5d + t from the corner of the angle plate.
- Draw the plates, draw the rivets and hatch.
- Show proportions. (Fig 3)

Fig 8



CONNECTION OF PLATES AT RIGHT ANGLES

— — — — — — —

TASK 9

Two I sections of LB 150 are riveted to both sides of the I section of LB 200 is shown in the Figs 4 & 5. Draw the front and top view of the riveted structure as per IS. Use snap head rivets.

Sizes of I section

	D	B	T	t
LB 200	200	100	7.3	5.4
LB 150	150	80	6.8	4.8

Assume suitable scale

- Follow the earlier exercises for deciding the size of head, shank, pitch, number of rivets required.

Fig 9

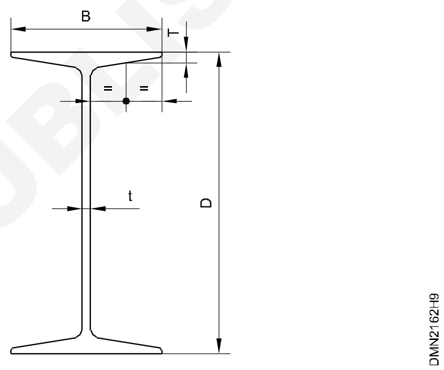
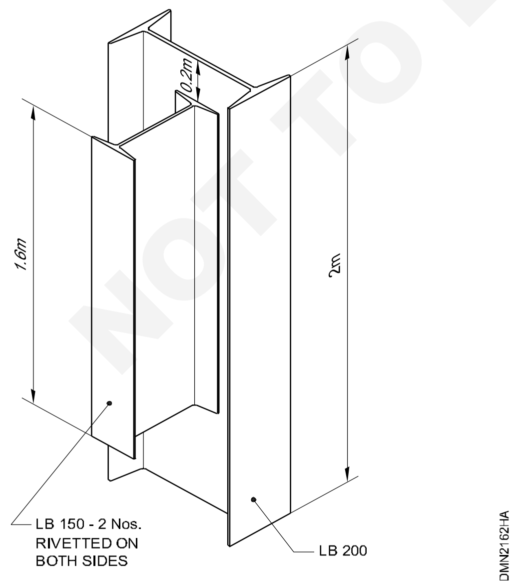


Fig 10



— — — — — — — —

Uses of different types fitters hand tools

Objectives: At the end of this Ex: you shall be able to
- **identify the marking tools used in fitting shop**
- **identify the sawing tools used in fitting shop**
- **record the names of tools in table.**

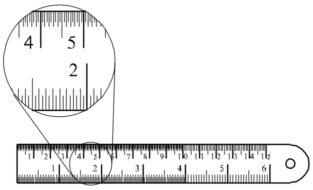


Fig 1

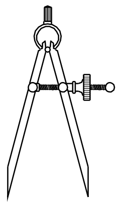


Fig 2

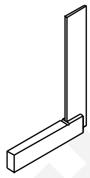


Fig 3

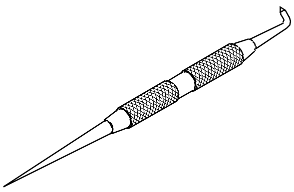


Fig 4

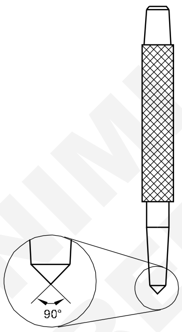


Fig 5

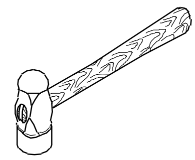


Fig 6

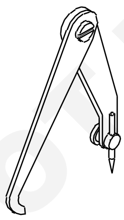


Fig 7

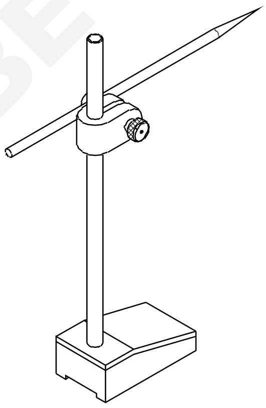


Fig 8

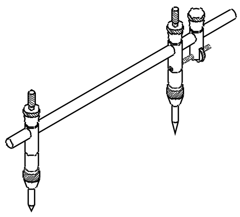


Fig 9

© NIMI NOT TO BE REPUBLISHED

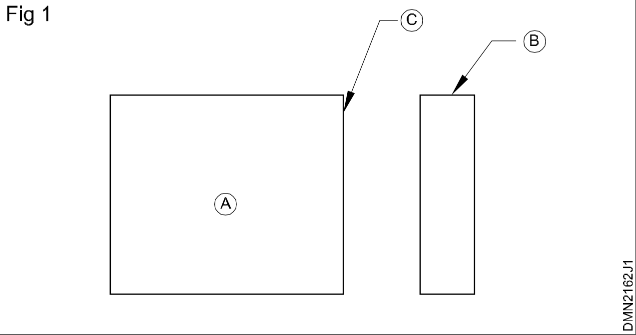
1	-	-	-	01	1	2.2.63
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

FITTER - HAND TOOLS	TOLERANCE :	TIME : 5Hrs
	CODE NO. DMN2263E3	

Job Sequence

- Check the raw material size using steel rule.
- Remove the scaling by flat rough file.
- File side (A) with flat batard file. (Fig 1)

Fig 1

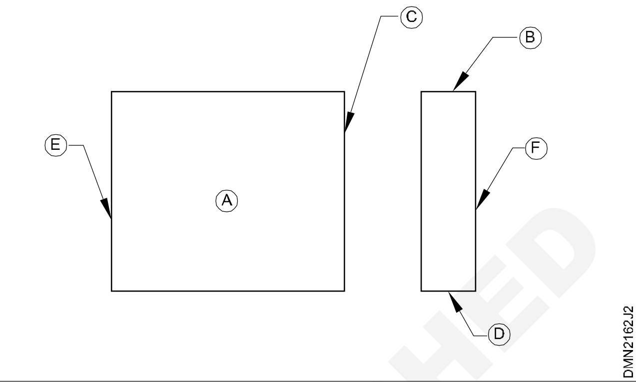


- Check the flatness by blade of a try square.
- File side (B) and maintain the squareness with respect to side (A).
- Check the squareness with a try square.

The side A,B and C are mutually perpendicular to each other. (Fig 1)

- Set jenny caliper to 74 mm using steel rule.
- Draw parallel lines of 74 mm to side (B) and (C).
- Punch the marked line using dot punch and ball pein hammer.
- Set and file sides (D) and (E) to 74 mm and maintain squareness to all other sides.
- Maintain (D) and (E) parallel to side (B) and (C). (Fig 2)

Fig 2



- Check the dimensions with a seel rule and squareness with a try square.
- File surface (F) and maintain the thickness of 9 mm parallelism to side A.
- Remove sharp edges. Apply little amount of oil and preserve it for evaluation.

© NIMI NOT TO BE REPUBLISHED

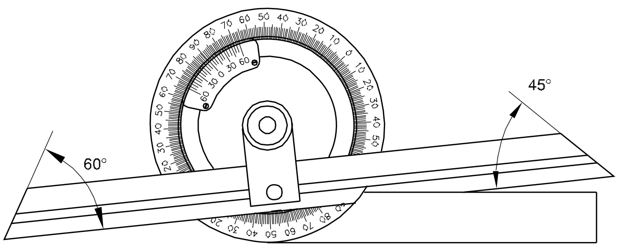


Fig 10

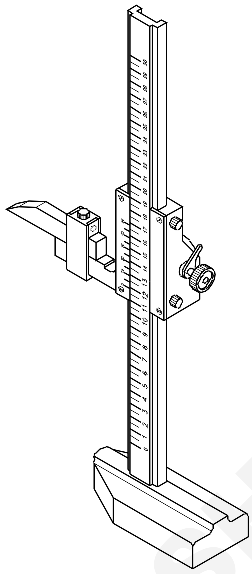


Fig 11

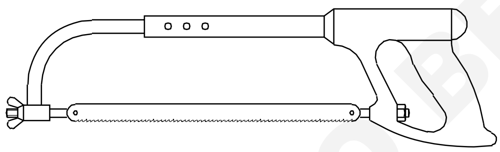


Fig 12

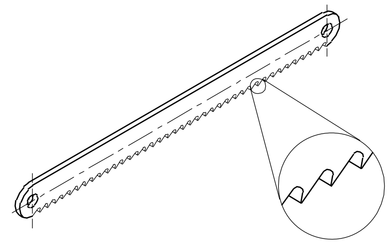


Fig 13

© NIMI NOT TO BE REPUBLISHED

-	-	-	-	-	-	2.2.63
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

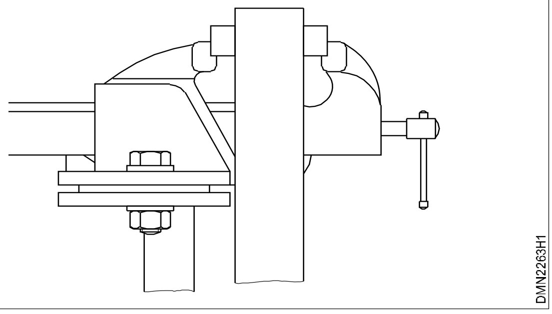
	FITTER HAND TOOLS	TOLERANCE : / TIME:
		CODE NO. DMN2263E4

Bench vice

Objective(s): This shall help you to
- **position a bench vice on the workbench**
- **follow the precautions to be observed while using a bench vice.**

Positioning of the bench vice: vices are mounted rigidly on a workbench with the fixed jaw in line with the bench edge to permit a long work to be clamped in a vertical position. (Fig 1)

Fig 1



For the convenience of working, the vice should be held at a correct height i.e when the first is pressed against the chin, the elbow should touch the top of the vice. For further height adjustments, wooden platforms can be used. (Fig 2)

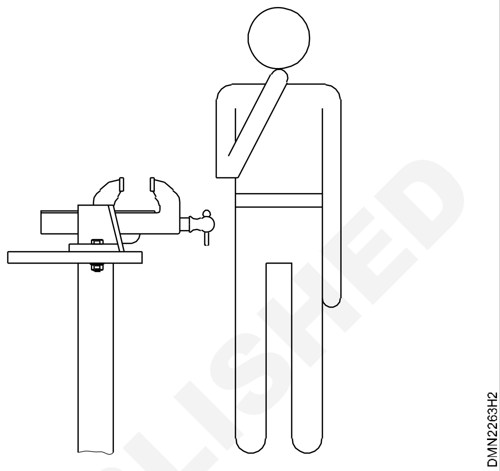
Precautions

Clamp the work as low as possible on the vice. Do not give extra leverage while tightening the work.

Lubricate the spindle and the box-nut periodically. Dont tighten the jaws of the vices without any work in between.

Do not hammer on the vices for levelling metal.

Fig 2



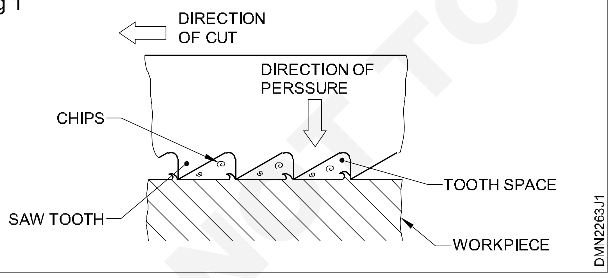
© NIMI NOT TO BE REPUBLISHED

Hacksawing

Objective(s): This shall help you to
- **fix hacksaw blades maintaining correct tension and direction**
- **cut metal pieces with a hacksaw.**

Fixing of hacksaw blades: The teeth of the hacksaw blade should point in the direction of the cut and away from the handle. (Fig 1)

Fig 1



The blade should be held straight, and correctly tensioned before starting.

While starting the cut make a small notch. (Fig 2)

The cutting movement should be steady and the full length of the blade should be used.

Apply pressure only during the forward stroke. (Fig 3)

Atleast two to three teeth should be in contact with the work while cutting. Select a fine pitch blade for thin work. (Fig 4)

Fig 2

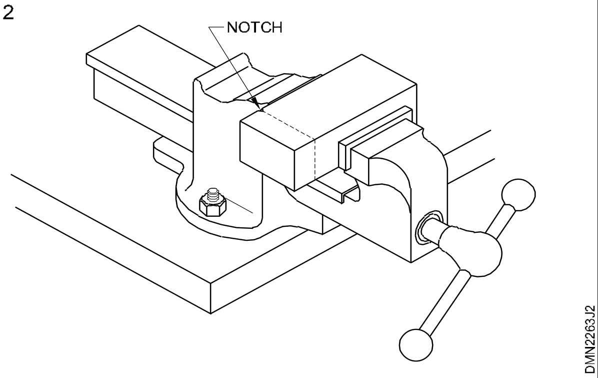


Fig 3

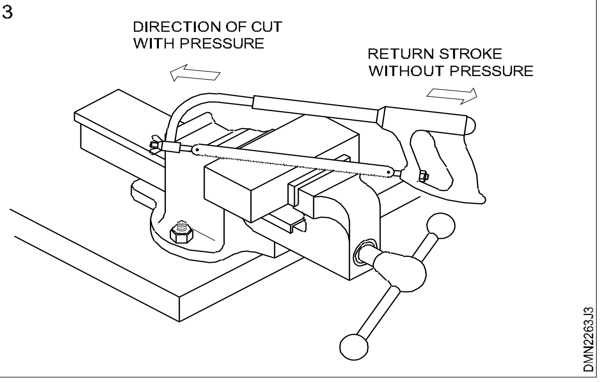
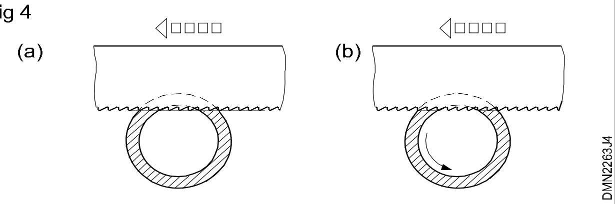


Fig 4



Turn and change the position of the pipe while hacksawing.

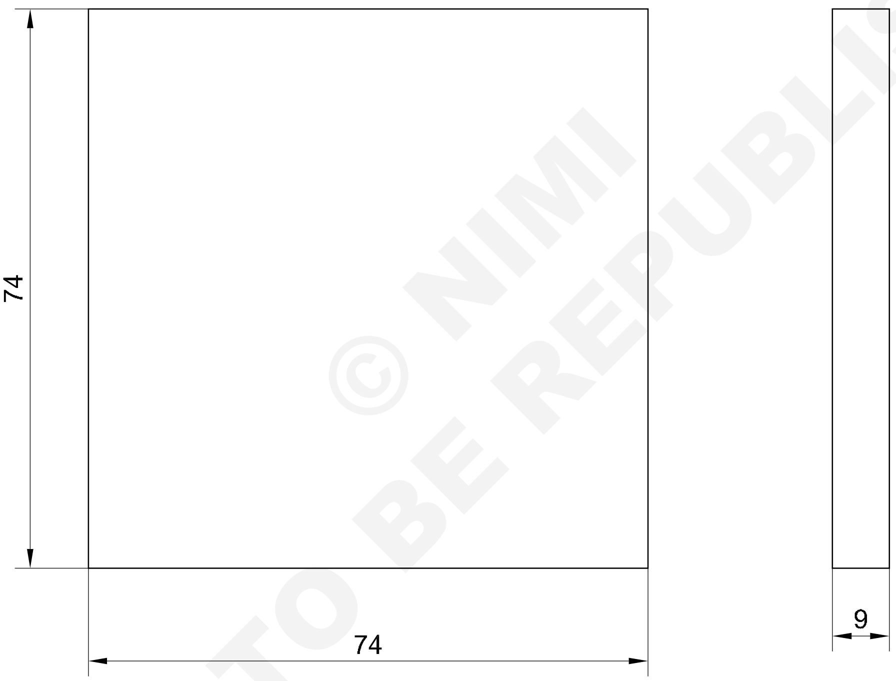
Normally, a coolant is not necessary while hacksawing.

Do not move the blade too fast. While finishing a cut, slow down to avoid breakage of the blade and injury to yourself and others.

© NIMI NOT TO BE REPUBLISHED

Work on M.S. plate as per drawing exercise - drilling a hole on the centre mark

Objective(s): At the end of this Ex: you shall be able to
- **hold the job in a bench vice horizontally for filing**
- **file a flat surface**
- **check the flatness of filed job using straight edge/try square blade**
- **check the squareness of the job with try square.**



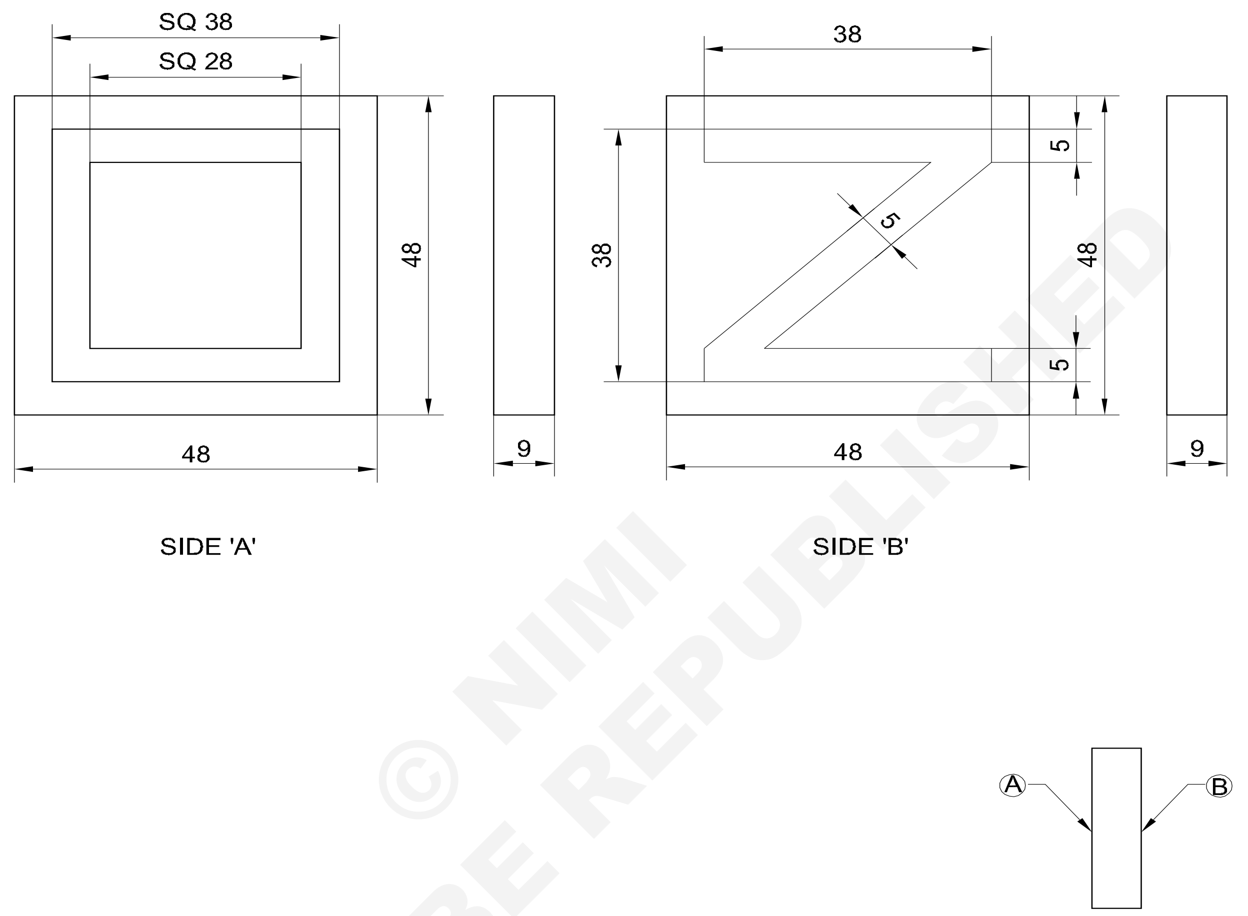
© NIMI NOT TO BE REPUBLISHED

1	75 ISF10 - 75	-	Fe310	-	-	2.1.62
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	FILING FLAT AND SQUARE (ROUGH FINISH)	TOLERANCE : ±0.5mm	TIME : 10 Hrs
		CODE NO. DMN2162E1	

Filing practice, surface filing, marking of straight and parallel lines with odd leg caliper and steel rule

Objective(s): At the end of this Ex: you shall be able to
- **file and finish the flat to the required size**
- **mark lines using odd leg caliper**
- **punch the marked lines.**



© NIMI NOT TO BE REPUBLISHED

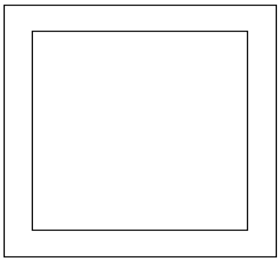
1	50 ISF 10-50	-	Fe310	-	-	2.2.63
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	MARKING WITH ODD LEG CALIPER AND STEEL RULE				TOLERANCE : ±0.5mm	TIME : 5 Hrs
					CODE NO. DMN2263E1	

Job Sequence

Mark on side A.

- Check the raw material size using steel rule.
- File 3 sides mutually perpendicular to each other.
- Mark and file to size 48 x 48 x 9 mm.
- Set 5 mm in odd leg caliper and draw parallel lines to all sides. (Fig 1)

Fig 1



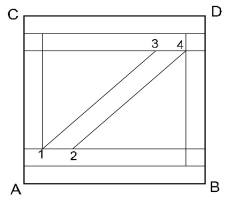
DMN2263K1

- Similarly, set 10 mm in odd leg caliper and draw parallel lines to all sides. (Fig 2) Punch on the marked line.

Mark on side B.

- Set 5 mm in odd leg caliper and draw parallel lines to side AB, CD, CA and DB.(Fig 2)
- Set 10 mm and draw parallel lines to side AB and CD.

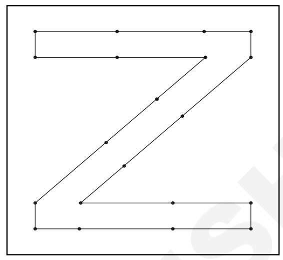
Fig 2



DMN2263K2

- Mark 5 mm on line 1 and 2, 3 and 4 as as shown in Fig 3.

Fig 3



DMN2263K3

- Join point 1 and 3, 2 and 4 and punch witness marks as shown in fig 3.
- Apply little oil and preserve it for validating the marking/

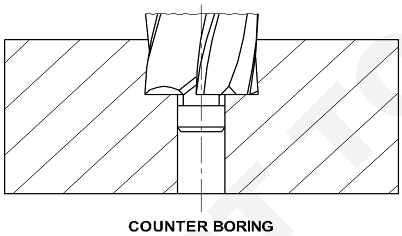
NOT TO BE REPUBLISHED © NIMI

Drilling a hole

Objective(s): This shall help you to
- **counterbore holes of different sizes concentric to the drilled holes.**

Selection of counter bore sizes: BIS recommends different sizes of counter bores based on the sizes of the clearance holes. (Fig 1)

Fig 1

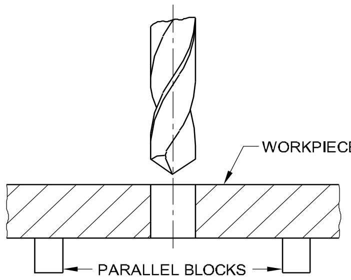


DMN2263L1

Procedure

Fix the job in the machine vice, square to the axis of the machine spindle.Use parallel blocks. (Fig 2)

Fig 2



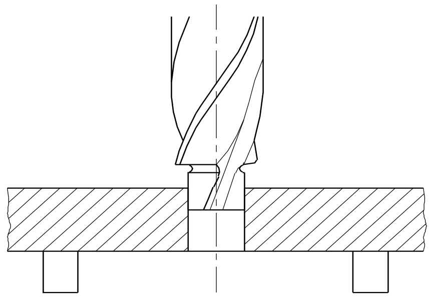
DMN2263L2

Set the location of the drilled hole position using the correct diameter drills.

Align the spindle axis with the drilled hole. For accurate work, drill and counterbore in one setting.

Mount and fix the counterbore tool on the drilling machine spindle. (Fig 3)

Fig 3



DMN2263L3

Select the counter bore according to the screw size.

BIS: Bureau of Indian Standards

Set the spindle speed of the drilling machine to the nearest calculated RPM.

Use the formula

$$V = \frac{\pi \times D \times N}{1000}$$

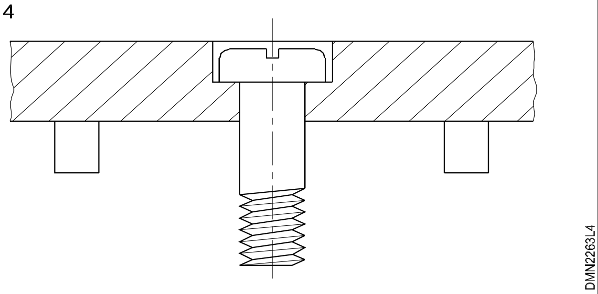
(Consider the value of 'V' as 1/3rd of the drilling cutting speed)

Counter bore the hole to a depth equal to the length of the screw head. (Fig 4)

Use the depth stop arrangement for controlling the depth of the counter bore hole.

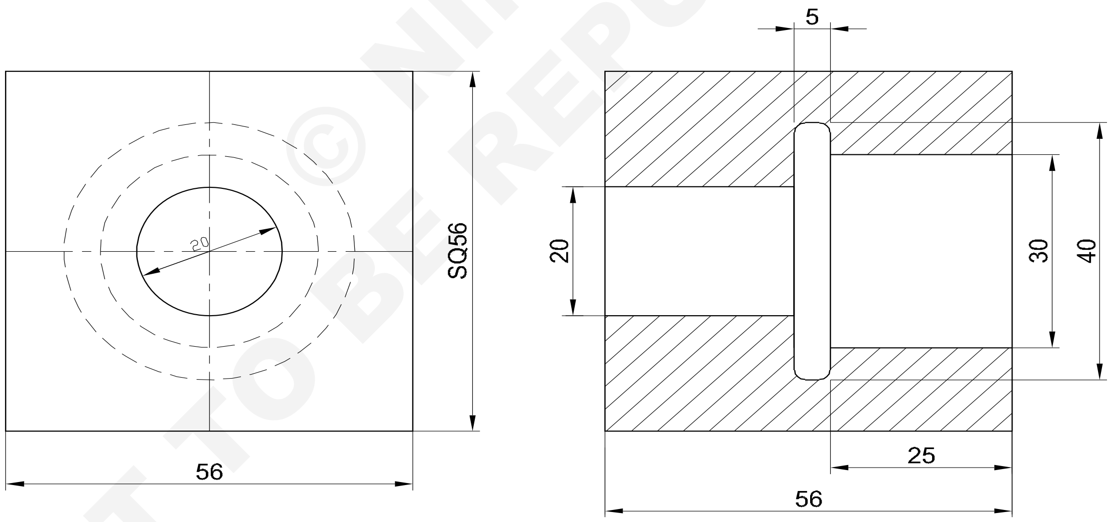
Check the depth of the counter bore hole. (Use the correct screw for checking the depth and seating)

Fig 4



Perform and drilling, boring and grooving operations

Objective(s): At the end of this Ex: you shall be able to
- **face the work squareness to all the sides**
- **drill hole to required size**
- **select the receasing tool**
- **cut the recess**
- **bore a hole to an accuracy ±0.2 mm.**



1	Ø80 - 60	–	Fe310	–	1	2.2.63
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**MAKE SQUARE BLOCK BY TURNING,USING-4 JAW CHUCK AND PERFORM DRILLING, BORING AND GROOVING**	DEVIATIONS ± 0.1°	TIME : 25Hrs
		CODE NO. DMN2263E2	

© NIMI NOT TO BE REPUBLISHED

Job Sequence

- Check the raw material.
- Hold the job in 4 jaw chuck and face the end
- Calculate the maximum size of the squareness possible in given round rod.
- Reset and face the other end and maintain total length of job to 56 mm and remove the job from chuck.
- Set the job in 'V' block and mark centre line of the job with help of vernier height gauge.
- Rotate the job to set vertical position of centre line with help of try square.
- Set vernier height gauge 26 mm above the centre line with help of try square.
- Scribe the horizontal line.
- Follow the same procedure for marking other sides.
- Punch the witness mak of the square.
- Hold the job in 4-jaw chuck in vertical position.
- Set witness mark to parallel of the chuck face and face the job.
- Follow the same procedure for other sides.
- Maintain the measurement side of the square is 56 mm.
- Make centre drill, pilot drill and 18 mm drill simultaneously.
- Enlarge the hole by bring to 20 mm and step bore 30 x 30 mm length.
- Cut groove as per drawing withhelp of grooving tool.
- Check the dimensions.

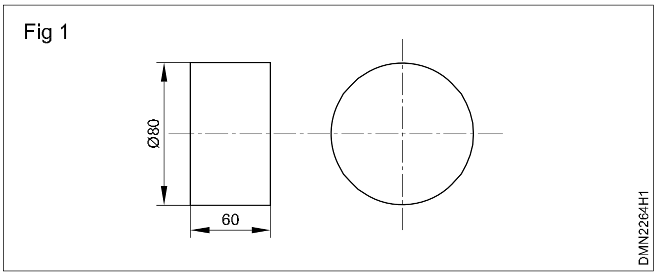
© NIMI NOT TO BE REPUBLISHED

Cut a round box in the power hacksaw machine to the required size

Objective(s): At the end of this Ex: you shall be able to
- **marking the square in round rod**
- **boring and recessing.**

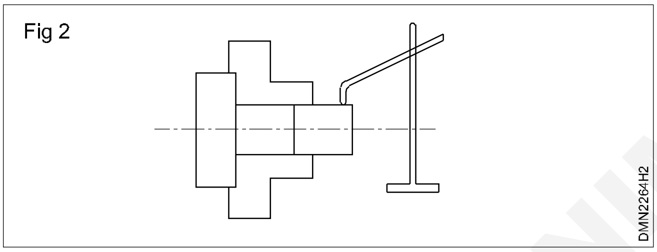
Check the raw material.(Fig 1)

Fig 1



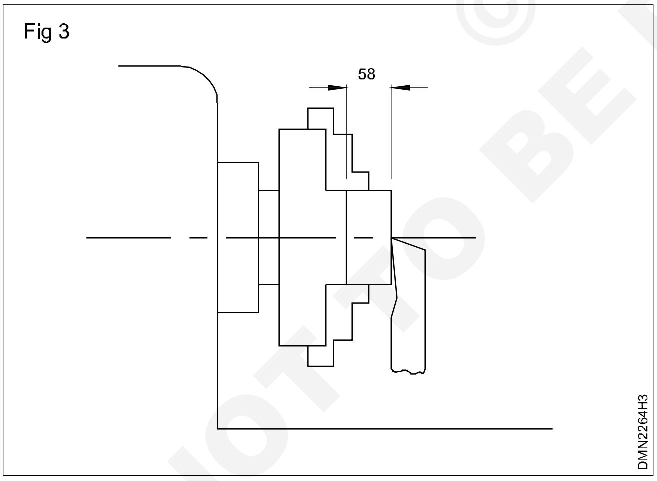
Set the job. (Fig 2)

Fig 2



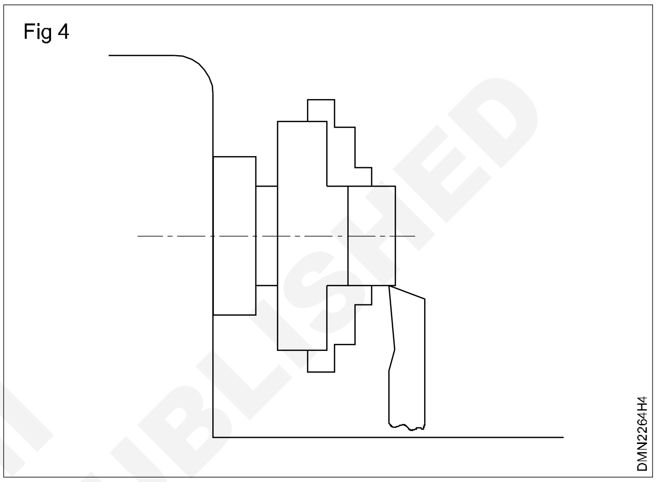
Facing one end of the job. (Fig 3)

Fig 3



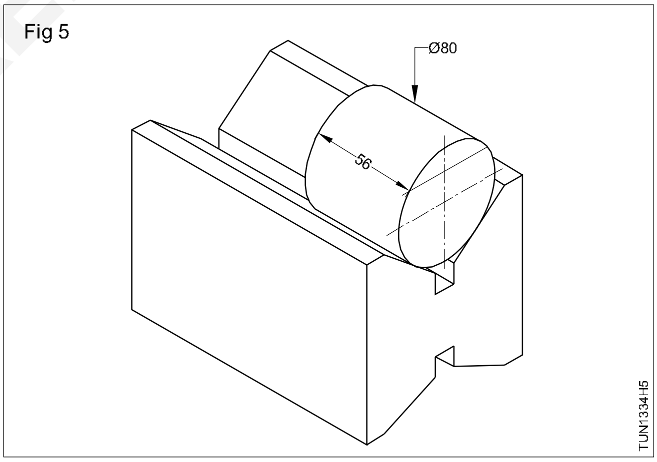
Face the other end and length is equal to side of the square. (Fig 4)

Fig 4



Apply the marking media and set 'V' block marking the side of square and punch witness marks. (Fig 5)

Fig 5



© NIMI NOT TO BE REPUBLISHED

Micrometer

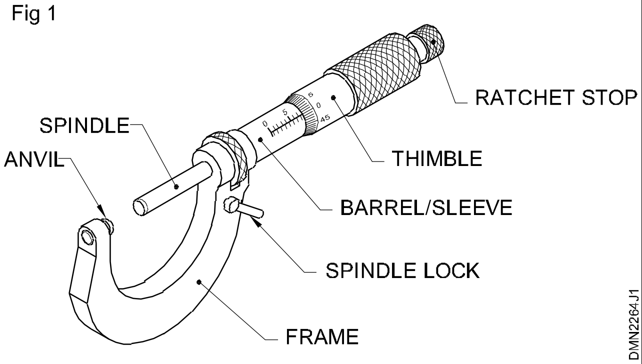
Objective(s): At the end of this Ex: you shall be able to
- **different parts of micrometer**
- **how to work.**

TASK 1: **Draw the below shown micrometers & mention its parts**

A micrometer is a precision instrument used to measure a job, generally within an accuracy of 0.01 mm.

Micrometers used to take the outside measurements are known as outside micrometers. (Fig 1)

Fig 1



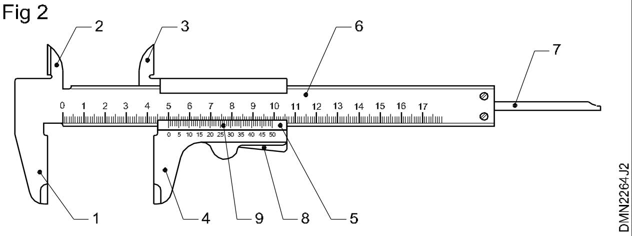
Sl. No	Parts Name	Use
1		
2		
3		
4		
5		
6		
7		

— — — — — — — — —

TASK 2: **Draw and identify the parts of a vernier caliper**

A vernier caliper (Fig 2) is a precision measuring instrument. It is used to measure upto an accuracy of 0.02m.

Fig 2



Movable Jaws (3 and 4)

Movable jaws are part of the vernier slide. One jaw is used for external measurements, and the other for internal measurements. (Figs 3 & 4)

Fig 3

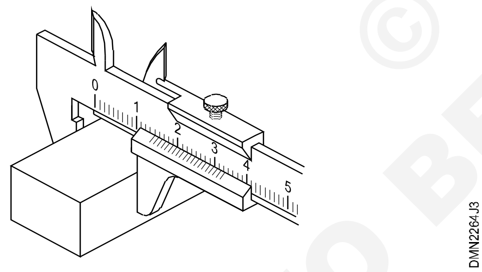
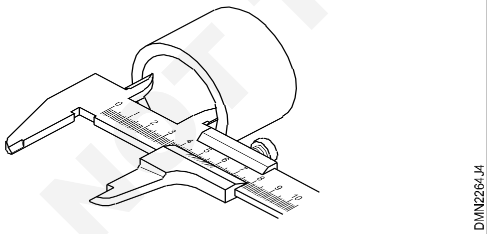


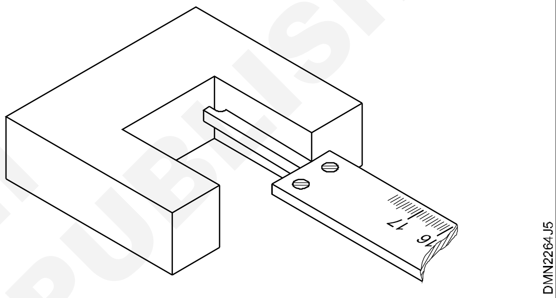
Fig 4



Depth bar (5)

The depth bar is attached to the vernier slide and is used for depth measurements. (Fig 5)

Fig 5



Sl. No	Parts Name	Use
1		
2		
3		
4		
5		
6		
7		

© NIMI NOT TO BE REPUBLISHED

Hacksaw

Objective(s): At the end of this Ex: you shall be able to
- **identify the parts of a hacksaw frame specify hacksaw blades.**

TASK 1: **Draw the following figure**

A hacksaw blade is a thin narrow steel band with teeth, and two pin holes at the ends. It is used along with a hacksaw frame. (Fig 1) The blade is made of either low alloy steel (LA) or high speed steel (HS) and is available in standard lengths of 250 mm and 300 mm. (Fig 2)

Fig 1

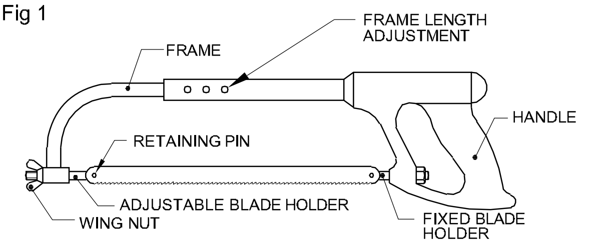
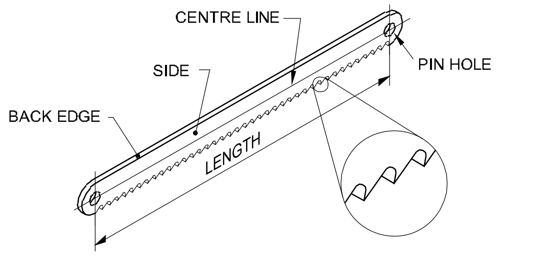


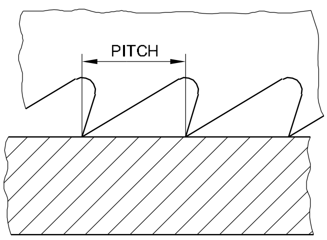
Fig 2



Pitch of the Blade (Fig 3)

The distance between adjacent teeth is known as the 'pitch' of the blade.

Fig 3



Sl. No	Parts Name	Use
1		
2		
3		
4		
5		
6		
7		

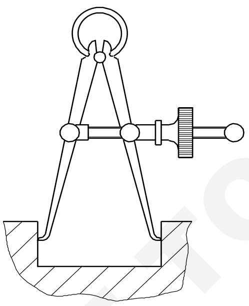
Caliper

Objective(s): At the end of this Ex: you shall be able to
- **name the commonly used calipers.**

TASK 1: **Draw the following figure**

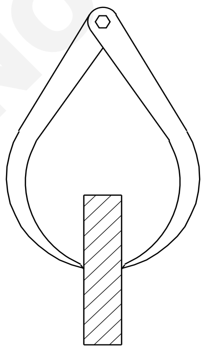
Inside calipers (Fig 1)

Fig 1



Outside calipers (Fig 2)

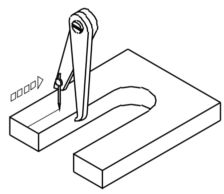
Fig 2



Jenny calipers (Fig 3)

Task for calipers.

Fig 3

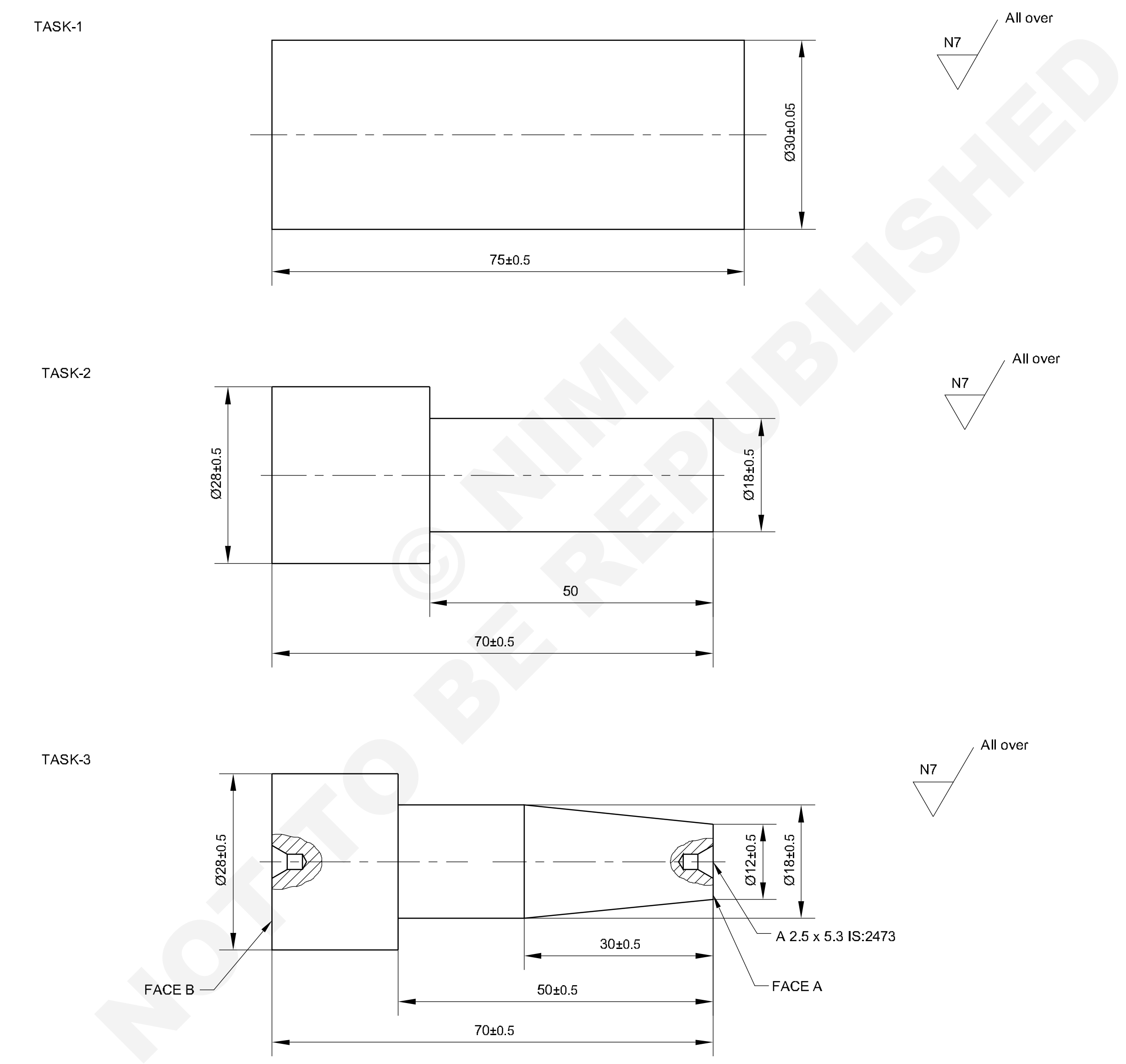


Sl. No	Parts Name	Use
1		
2		
3		
4		
5		
6		
7		

© NIMI NOT TO BE REPUBLISHED

Facing and turning the box as per dimensions

Objective(s): At the end of this Ex: you shall be able to
- **true the work piece on a 4 jaw chuck**
- **face the work piece to the required length to an accuracy of ±0.5 mm**
- **plain turn and step turn to an accuracy of ±0.5 mm**
- **disassemble chuck and mount driving plate**
- **prepare and mount work between centres**
- **taper turning by offset method**
- **measure with outside calipers and a steel rule.**



© NIMI NOT TO BE REPUBLISHED

SCALE NTS	**FACING, PLAIN TURNING, STEP TURNING AND TAPER TURNING**	DEVIATIONS AS SPECIFIED	TIME 25h
		CODE NO. DMN2264E1	

PROCEDURE

TASK 1: (Fig 1)

Facing and plain turning

- Check the raw material
- Hold the job in a 4 jaw chuck about 50 mm outside and true it.
- Face one end.
- Turn ϕ 30 to about 40 mm length.
- Reverse the job and reset it, holding on ϕ 30 mm.
- Face the other end to a total length of 75 mm ±0.5, and turn the outer diameter ϕ 30 mm.
- Check the dimension with a steel rule and calipers.
- Deburr the workpiece.

— — — — — — — —

TASK 2: (Fig 2)

Step turning

- Check the material size.
- Hold the job in the 4 jaw chuck and true it.
- Hold the facing tool in the tool post to the correct centre height with proper packing pieces.
- Run the job with suitable spindle speed and face one end of the job.
- With the help of a straight turning tool, turn the job to 28 mm diameter, to possible length.
- Turn the step having 18 mm diameter to 50 mm length.
- With the help of a side knife tool turn the shoulder at right angle.
- Reverse the job and hold in the chuck and true it.
- With the help of a facing tool, face the job to get the required 70 mm length after running the job with a calculated spindle r.p.m.
- Turn to ϕ 28 mm.
- Deburr the sharp edges.

— — — — — — — —

TASK 3: (Fig 3)

Taper turning by offset method

- Check the components for dimensions by using vernier.
- Hold the work in 28 Dia end.
- Mount the drill chuck in tailstock end.
- Mount suitable centre drill securely in the drill chuck.
- Set the lathe to about 1000 r.p.m
- Do centre drill on face A (Refer skill information)
- Reverse load on 18 Dia end in 4 jaw chuck and do centre drill on face B.
- Remove the 4 jaw chuck.
- Fit drive plate with dead centre and use a suitable carrier for 28 dia.
- Align tailstock centre with dead centre at the head end.
- Calculate the tailstock offset using the offset formula.

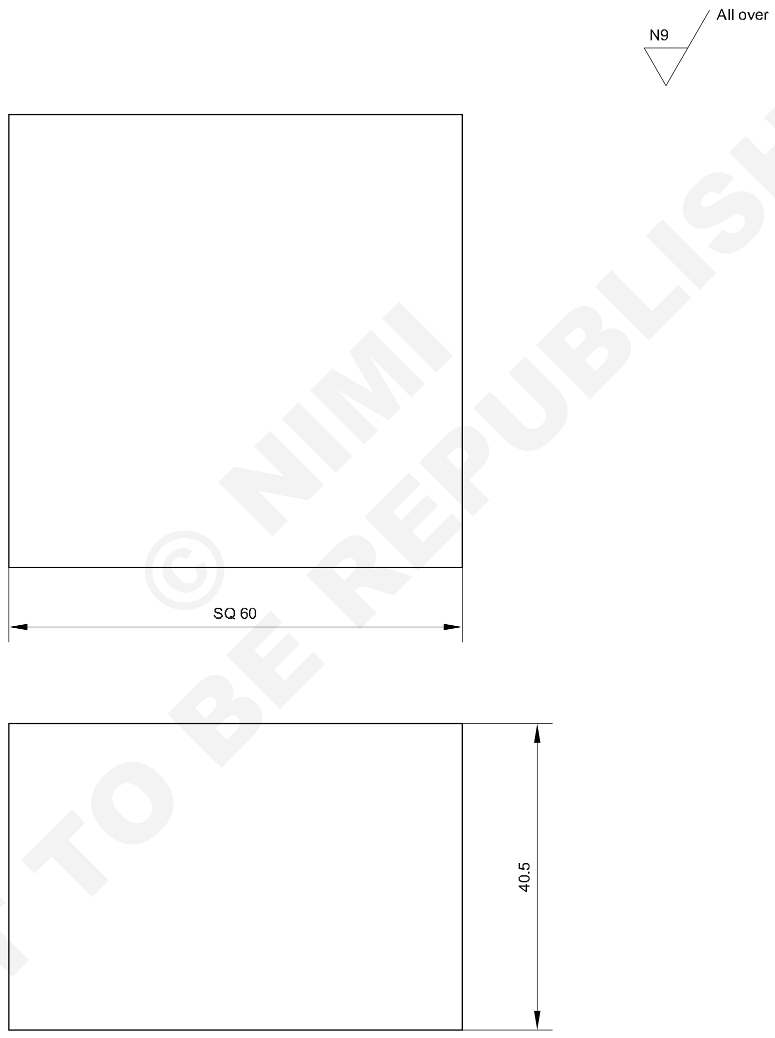
  (Refer skill sequence)
- Offset the tailstock body to the required/calculated offset.
- Turn the taper for a short length.
- Check the taper angle for accuracy.
- Continue taper turning and finish.
- Deburr the sharp edges.

— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Plain milling

Objective(s): At the end of this Ex: you shall be able to
- **operate the different controls of a plain milling machine/vertical milling machine**
- **set the job in the machine vice for machining**
- **mount a slab milling cutter/face milling cutter on the arbor**
- **layout the job as per the drawing using a vernier height gauge**
- **check the level and squareness of the job using a trysquare**
- **remove the cutter and the arbor from the machine spindle.**

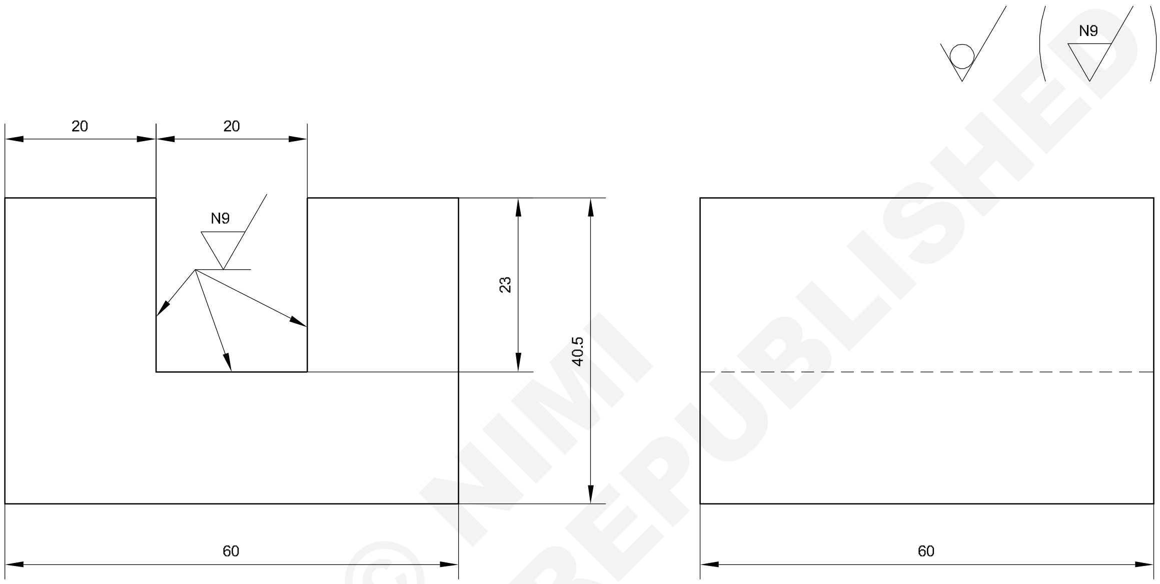


© NIMI NOT TO BE REPUBLISHED

SCALE 1:1	**PLAIN MILLING**	DEVIATIONS ±0.1	TIME 15h
		CODE NO. DMN2265E1	

Milling a slot

Objective(s): At the end of this Ex: you shall be able to
- **mount a side and face milling cutter/end milling cutter**
- **set the job in the machine vice for machining**
- **check the width of the slot using a vernier caliper**
- **check the depth of the slot using a vernier depth gauge.**



© NIMI NOT TO BE REPUBLISHED

SCALE 1:1	MILLING A SLOT	DEVIATIONS ±0.1	TIME 10h
		CODE NO. DMN2265E2	

PROCEDURE

TASK 1: **Plain milling**

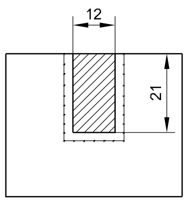
- Check the raw material for the correctness of the size. (Deburr, if necessary)
- Align the machine vice with reference to the column using a dial indicator.
- Mount a ϕ 27 long arbor and slab milling cutter of ϕ 63 x 90 x 27 bore for the horizontal milling machine.
- Set the r.p.m of the cutter to 100 min^{-1}
- Mount a ϕ 27 stub arbor and a shell end mill cutter of size ϕ 63 x 40 x 27 bore for the vertical.
- Set the r.p.m of the cutter near to 100.
- Hold the workpiece in the vice and align the milling cutter for machining.
- Mill one of the six sides flat.
- Bring the milled side against the fixed jaw and place a round rod between the movable jaw and the side opposite to the milled side as you did for shaping Ex: and mill the second side.
- Follow the procedure of holding similar to that of shaping Ex:.
- Machine the block, check the right angle and size using tri-square and vernier caliper.

— — — — — — — —

TASK 2: **Milling a slot**

- Check the dimensions of the block 60 x 40.5.
- Mark the dimensions as per drawing and punch witness marks.
- Hold the job on the machine vice using parallel blocks.
- Mount the side face milling cutter 100 x 12 x 27 in the centre of the arbor and set the spindle speed to 100 r.p.m.
- Align the workpiece with reference to the cutter.
- Mill the slot in the middle of the job giving a depth of cut of 4 mm upto a depth of 21 mm. (Fig 1)

Fig 1



- Offset the job towards the column by 4.0 mm (Fig 2) and mill the width to 16 mm to a depth of 23 mm. (Fig 2) Offset the job away from the column by 8 mm and mill the slot to 20 mm wide and 23 mm deep. (Fig 3)

Fig 2

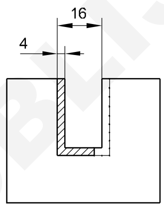
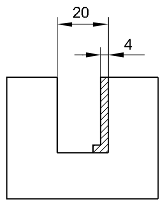


Fig 3

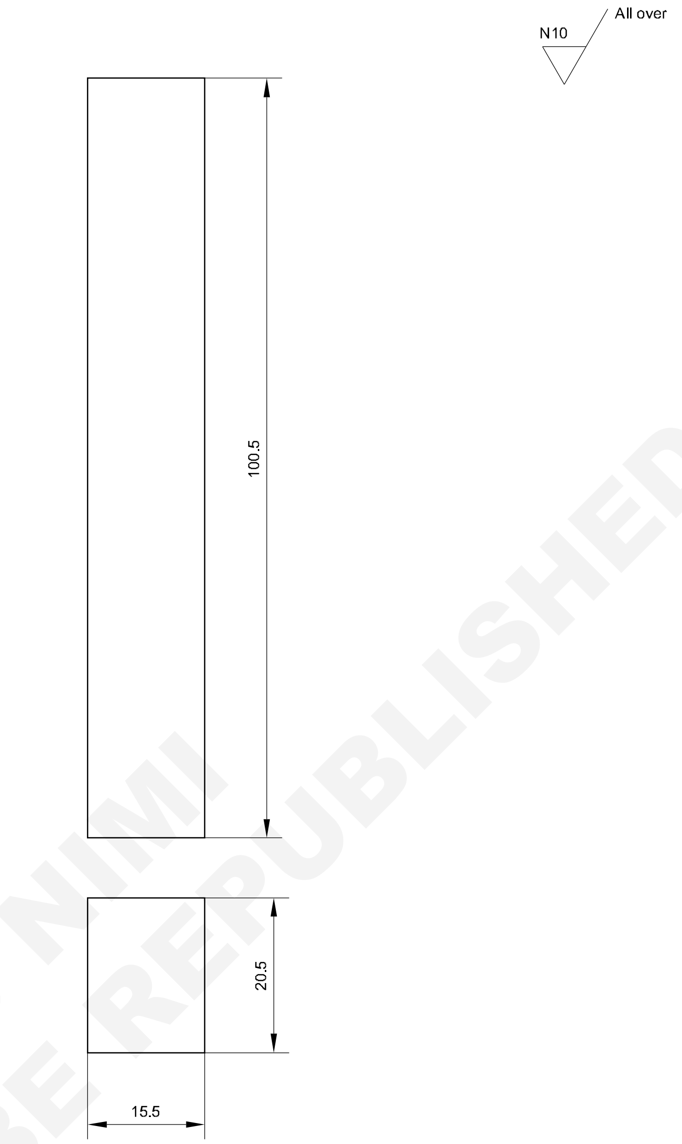


- Check the size of the slot
- Deburr and measure.

© NIMI NOT TO BE REPUBLISHED

Shaping a rectangular cast iron block

Objective(s): At the end of this Ex: you shall be able to
- **mark and punch the outline cast iron block**
- **align a machine vice on the shaper table in position**
- **fix workpiece in machine vice**
- **select and fix the tool on the tool head**
- **set shaper for machining**
- **shape flat horizontal surfaces within an accuracy of ± 0.2 mm**
- **check flatness and squareness with a try square (R)**
- **check dimensions with a vernier caliper (R).**

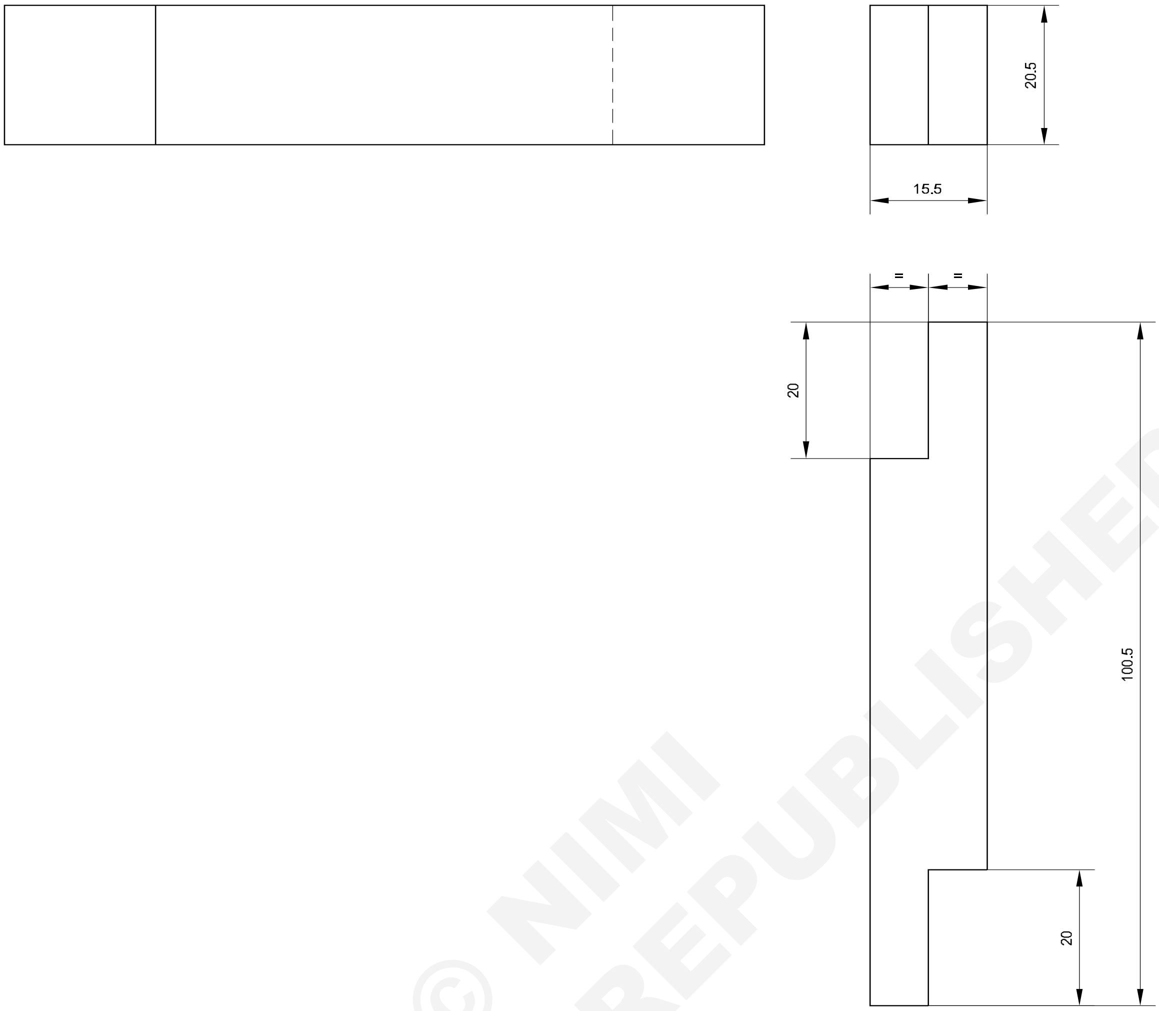


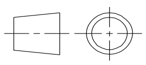
SCALE 1:1	**SHAPING A RECTANGULAR CI BLOCK**	DEVIATIONS ±0.1	TIME 15h
		CODE NO. DMN2265E3	

© NIMI NOT TO BE REPUBLISHED

Slotting steps in a cast iron block

Objective(s): At the end of this Ex: you shall be able to
- **slot external faces to an accuracy of ± 0.1 mm on a slotting machine.**



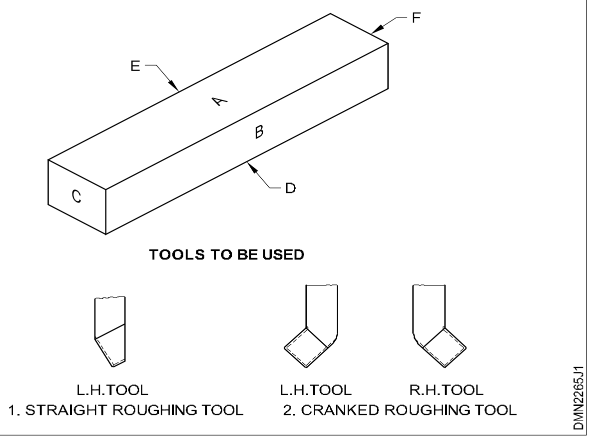
SCALE 1:1	**SLOTTING STEPS IN A CI BLOCK**	DEVIATIONS ±0.1	TIME 10h
		CODE NO. DMN2265E4	

© NIMI NOT TO BE REPUBLISHED

TASK **1:**

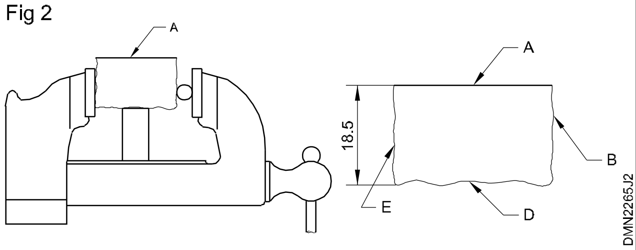
- Clamp the machine vice securely on the machine table.
- Fix the tool in the tool post.
- Remove scales on the job by filing, emery and clean the surfaces.
- Check dimensions
- Keep surface 'D' on the parallel block. Clamp the job. Ensure that the parallel block does not move.
- Shape surface 'A' flat to a depth of 2 mm. (Fig 1)
- Keep surface 'A' against the fixed jaw and surface 'E' on the parallel.

Fig 1



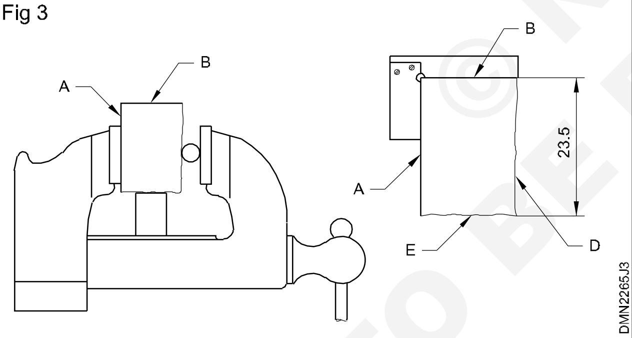
- In the middle of the surface D, a round rod is kept between the job and the movable jaw for line contact to avoid lifting of the job.
- Shape surface 'B' at right angle to surface 'A' (Fig 2) by removing about 2 mm material.

Fig 2



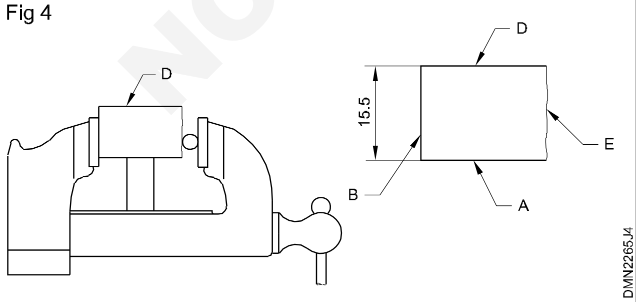
- Clean and apply suitable marking medium all over the surfaces.
- Keep surfaces 'A' on surface plate and scribe lines on faces B and E to a height of 15.5 mm using a vernier height gauge.
- Keep the surface 'B' on surface plate. Scribe lines surface A and D to a height 20.5 mm.
- Punch mark with prick punch all along the scribed lines at equal distance.
- Keep surface 'A' on the parallel blocks.
- Shape surface `D' maintaining a size of 15.5 mm. (Fig 3)

Fig 3



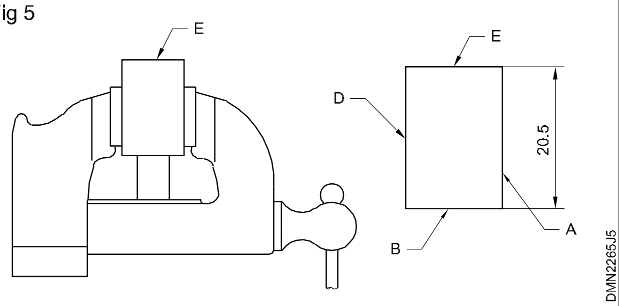
- Keep surface 'B' on the parallel blocks.
- Shape surface 'E' maintaining a size of 20.5 mm. (Fig 4)

Fig 4



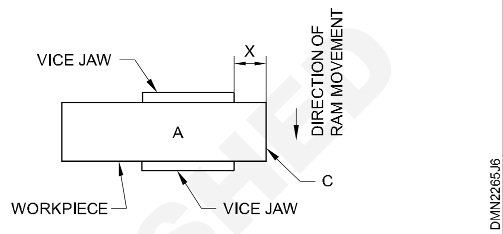
- Keep surface 'D' on the parallel blocks.
- Set the work, projecting it atleast 10 mm (x) from the sides of the vice. (Fig 5)

Fig 5



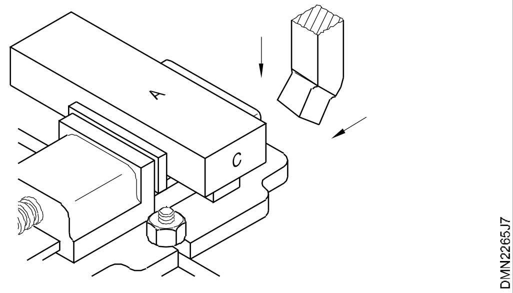
- Use a left hand cranked tool and shape surface 'C' to a depth of 2 mm. (Fig 6)

Fig 6



- Keep surface 'C' on surface plate and scribe line at a height of 100.5 mm with vernier height gauges on faces A and E.
- Punch mark with prick punch on the lines.
- Keep surface 'D' on the parallel blocks.
- Set the work projecting it atleast 10 mm from the sides of the vice.
- Use a right hand cranked tool and shape surface 'F' maintaining dimension 100.5. (Fig 7)

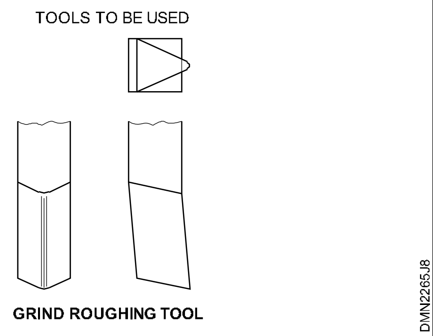
Fig 7



- Check the raw material for its size.

  Mount and align the job on the circular table.
- Grind the tools as in Fig 8.

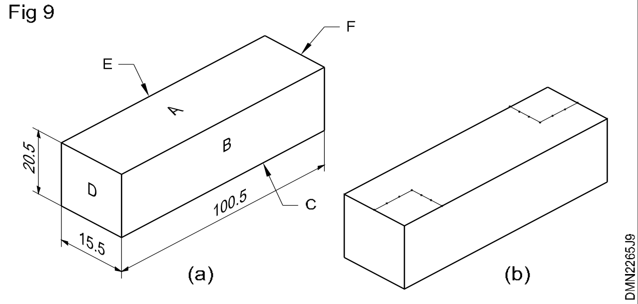
Fig 8



© NIMI NOT TO BE REPUBLISHED

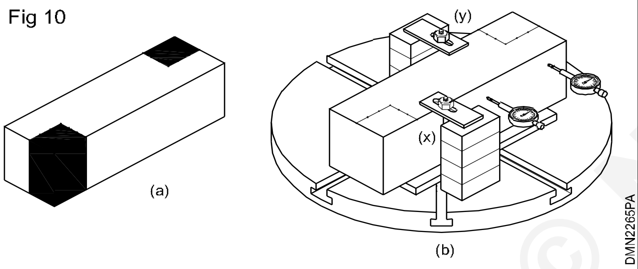
- Slot the surfaces A,B,C,D,E and F flat and square for reference. (Fig 9a)
- Mark and punch the outline using a surface plate and height gauge. (Fig 9b)

Fig 9



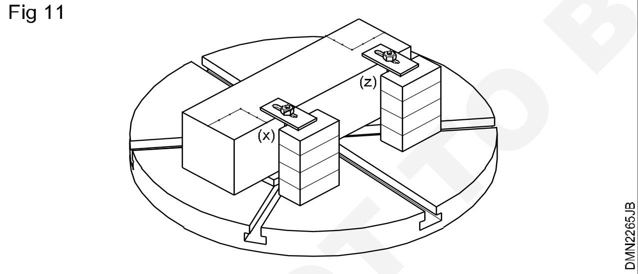
- Align the slotting tool for slotting.
- Set the stroke length and position of the ram.
- The shaded portion is to be removed by slotting. (Fig 10a)
- Align surface B along with the table using a dial indicator. (Please note that clamp (y) is temporary). (Fig 10b)

Fig 10



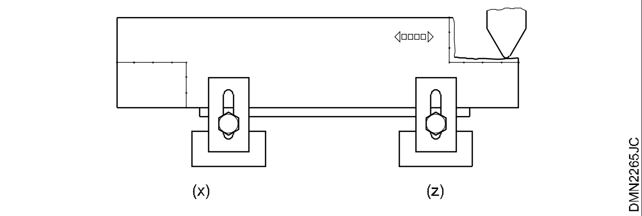
- Add clamp (z), and remove clamp (y). (Ensure that the setting is not disturbed). (Fig 11)

Fig 11



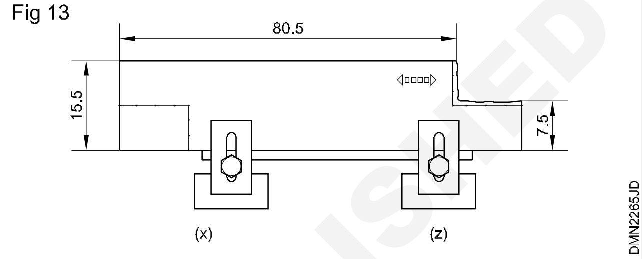
- Remove the material using a roughing tool, keeping around 1 mm (allowance) for the finish cut. (Fig 12)

Fig 12



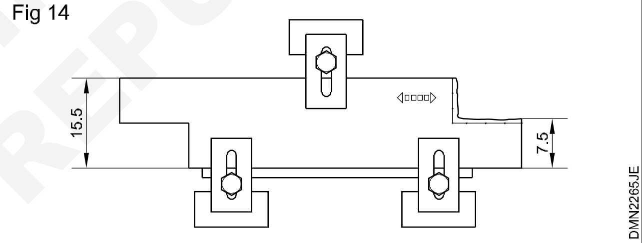
- Slot the step using a finishing tool maintaining dimensions and slot the corner using a cornering tool. (Fig 13)

Fig 13



- Change the setting for machining the other corner. Repeat the earlier steps to slot the step maintaining. (Fig 14)

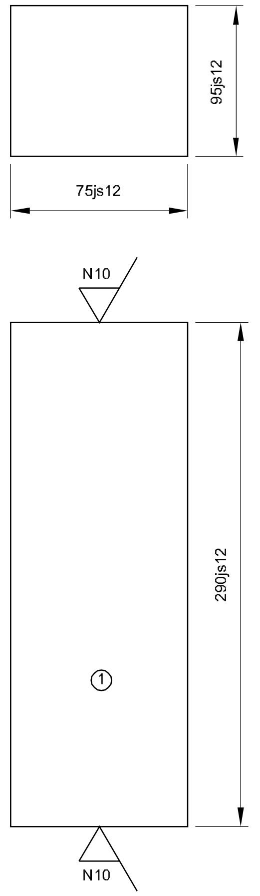
Fig 14

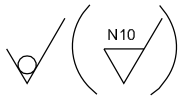


© NIMI NOT TO BE REPUBLISHED

Planning a rectangular block

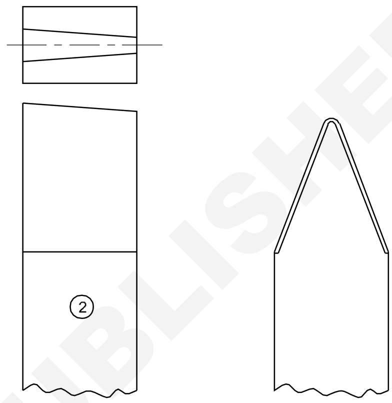
Objective(s): At the end of this Ex: you shall be able to
- **mount the vice on the machine table**
- **align the vice jaws parallel to the direction of table travel**
- **clamp the workpiece in the machine vice**
- **mount a straight tool in the tool post**
- **adjust the stroke length and position to suit the work piece**
- **plane all the surfaces at right angles to each other and achieve the dimensions within the limits of ± 0.15 mm.**





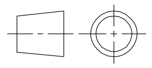
SIZE	ES/es	EI/ei
290js12	+0.260	-0.260
95js12	+0.175	-0.175
75js12	+0.150	-0.150

TOOL TO BE USED



ROUND NOSE TOOL

SCALE NTS



PLANING A BLOCK

DEVIATIONS ±0.1

TIME 15h

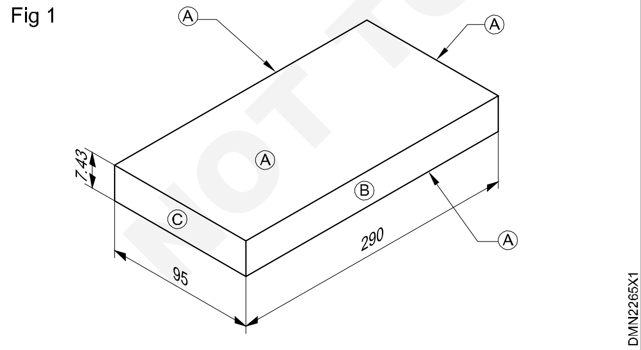
CODE NO. DMN2265E5

© NIMI NOT TO BE REPUBLISHED

Job Sequence

- Check the raw material size for correctness. (Fig 1)

Fig 1



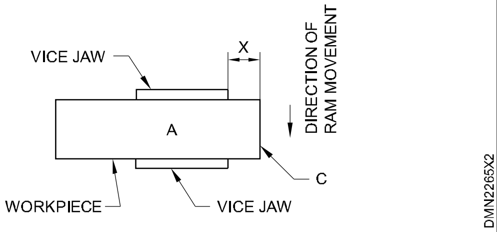
- Clamp the job in the vice which is aligned to the machine table.
- Clamp a left hand roughing tool in the tool head.
- Adjust the stroke length tool in the tool head.
- Confirm that the tool point does not hit the work when the table is moving.
- Bring the tool just to touch the top surface of the work and note the reading of the graduated collar.
- Take the tool away from the work surface.
- Apply 2 mm depth and start the table movement.
- Apply cross-feed by hand approximately 0.5 mm/ stroke, rough cut and complete the surface (A).
- Apply 0.8 to 1 mm depth of cut and finish the machining of surface (A). Apply manual feed.
- Deburr the job.
- Re-clamp the job such that the machined surface is against the fixed jaw and the surface 'B' is on top.
- Machine the surface (B).
- De-clamp the job and deburr the same.
- Clamp the job such that the machined surface (A) is resting on the parallel block and surface (B) is against the fixed jaw.

Ensure that the parallel blocks are not sliding or moving.

- Machine surface (D) and maintain 75 mm.
- De-clamp and deburr the job.
- Keep the surface (B) on the parallel blocks and tighten it to the machine surface (E).
- Finish machine surface (E) maintaining 95 mm. Check squareness using a try square.
- De-clamp and deburr the job.
- Clamp the job for planning surface (C).

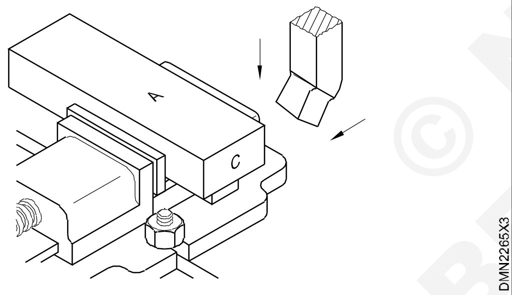
See that surface (C) is projecting out of the edge of the vice about 10 to 15 mm (x). (Fig 2)

Fig 2



- Tighten the right hand cutting tool in the tool post. (Fig 3)

Fig 3



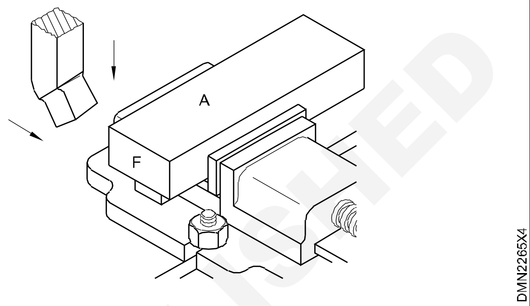
Ensure that the tool head position is vertical.

- Set the length and position of stroke.
- Machine surface (C) manually by vertical feed.
- Check the squareness of surface (C) with respect to (A) & (B).

If squareness is out of limit, adjust the tool head to correct vertical position.

- De-clamp and deburr the job. (Fig 4)

Fig 4

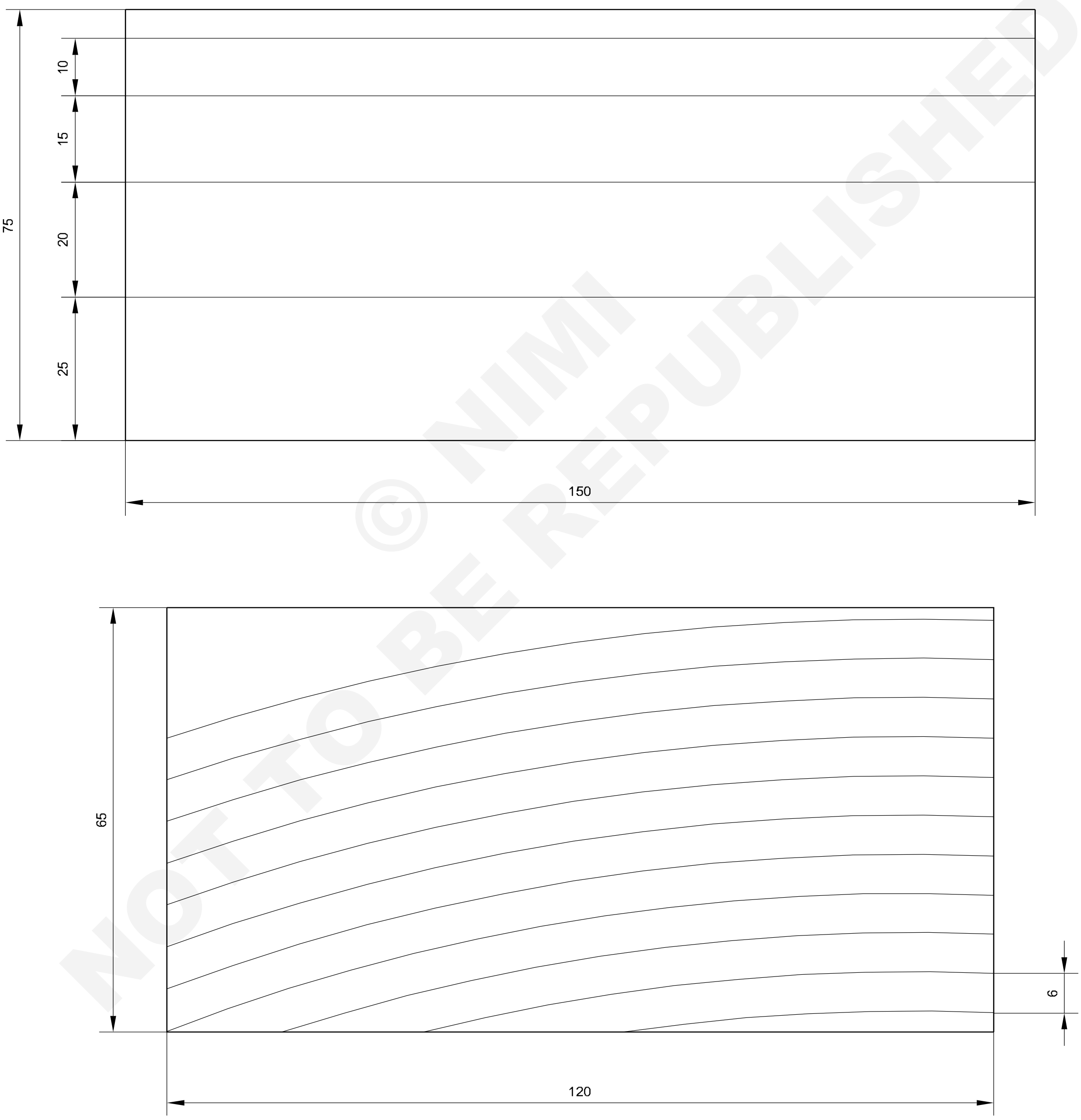


- Change the position of the job to machine surface (F).
- Repeat the machining procedure and maintain the dimension 290 mm.
- De-clamp and deburr the job.

© NIMI NOT TO BE REPUBLISHED

Mark and cut sheet metal

Objective(s): At the end of this Ex: you shall be able to
- **flatten a metal sheet using wooden mallet**
- **transfer dimensions from steel rule to wing compass**
- **mark parallel lines using `L' square**
- **mark curved lines using wing compass**
- **cut sheet metal as per marking straight lines and curved lines.**

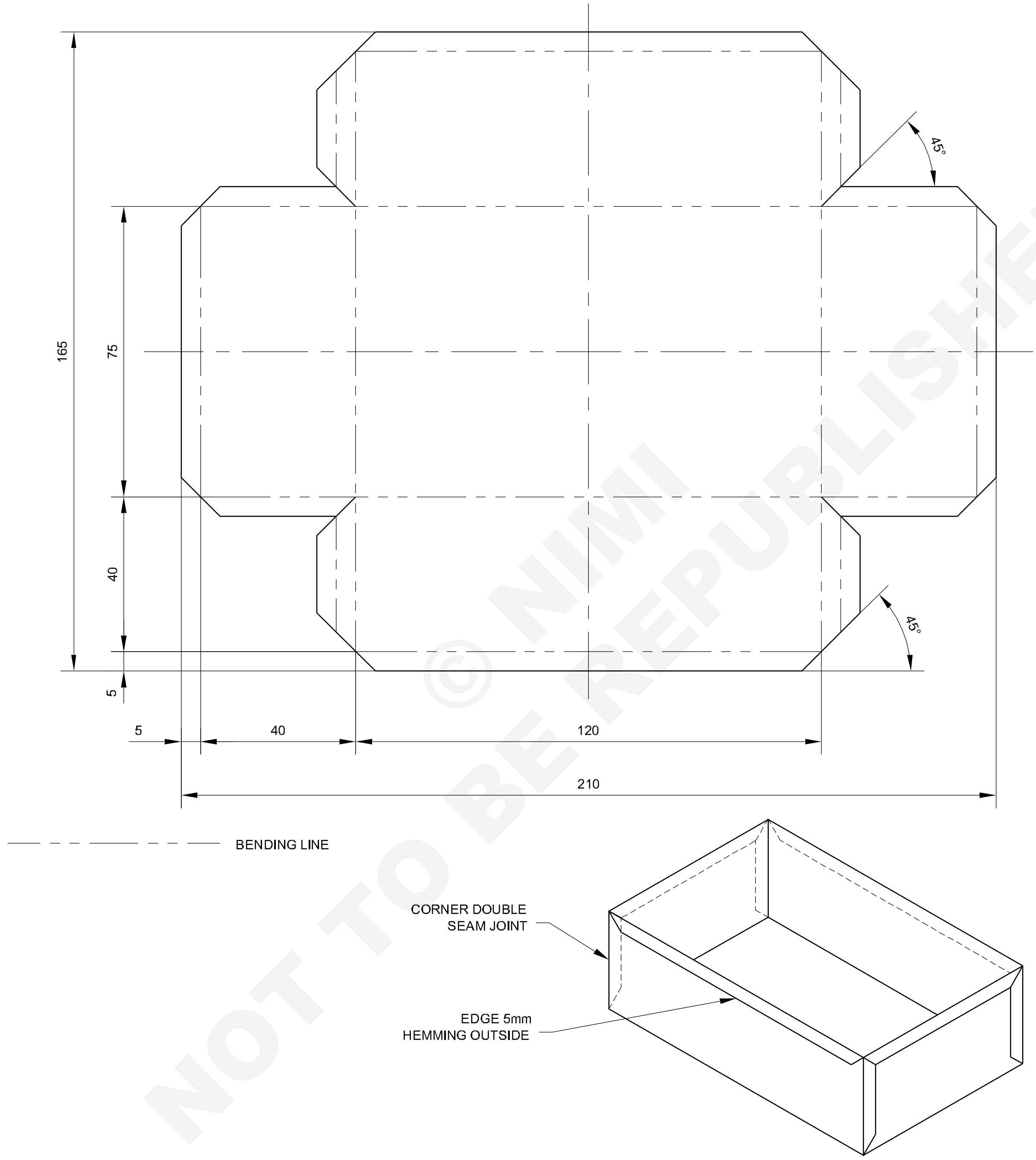


© NIMI NOT TO BE REPUBLISHED

SCALE NTS	**MARK AND CUT SHEET METAL** - IN A STRAIGHT LINE - IN A CURVED LINE	DEVIATIONS ±0.5	TIME 10h
		CODE NO. DMN2266E1	

Making rectangular tray with corner double seam

Objective(s): At the end of this Ex: you shall be able to
- **develop a rectangular tray by the parallel line method**
- **sheet metal to shape and size using straight snips**
- **make single hemming using a Tinman's anvil**
- **bend the sheet to 90° using a Tinman's anvil.**



© NIMI
NOT TO BE REPUBLISHED

SCALE NTS	MAKING RECTANGULAR TRAY WITH CORNER DOUBLE SEAM	DEVIATIONS ±0.5	TIME 15h
		CODE NO. DMN2266E2	

PROCEDURE

TASK 1:

- Check the size of the sheet steel as per sketch using a steel rule.
- Level the sheet on the workbench on a bench stake using a mallet.
- Mark a rectangle on the sheet metal as per sketch using 'L' square, steel rule and scratch awl.
- Set the steel rule on the outline of the sheet for 25 mm.
- Mark off two 'V' marks at 25 mm from each long side.
- Scribe a line through the 'V' marks, throughout the length of 150 mm.
- Mark other lines 20 mm, 15 mm, 10 mm and 5 mm apart from each other.
- Hold the sheet by the left hand.
- Cut the sheet by the right hand on the line, using straight snips.

— — — — — — — —

TASK 2:

- Check the size of the rectangular sheet as per sketch, using a steel rule.
- Level the sheet on a levelling plate using a mallet.
- Attach another sheet for making the larger curve.
- Transfer the measurement from the steel rule to the wing compass for the desired radius.
- Mark the first curved line on the sheet.
- Mark 10 curved lines equidistant, 6 mm.
- Cut on the marked curved lines by bend snips.
- Start cutting the curved lines always from the nearest edge with the straight snips.

— — — — — — — —

TASK 3:

- Check the size of sheet as per sketch using a steel rule.
- Level the sheet on the levelling plate using a mallet.
- Develop the tray by the parallel line method.
- Cut the sheet as per lines by straight snips.
- Cut the corners by straight snips.
- Bend all the four edges marked `A' in Fig 1 downwards (bend has to appear outside the box after folding the box) to 180° upto the dotted line (P). (Fig 2)

Fig 1

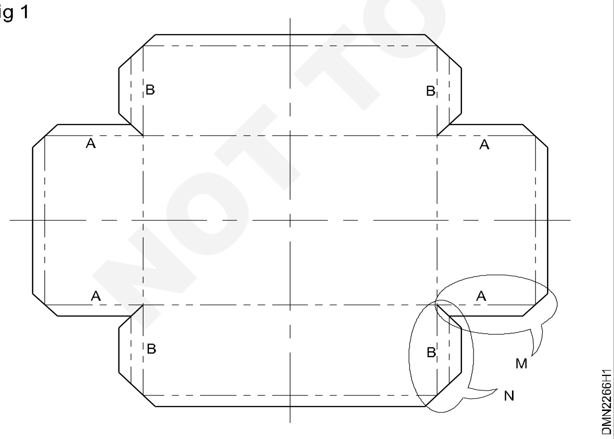
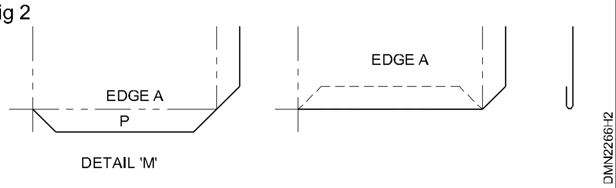


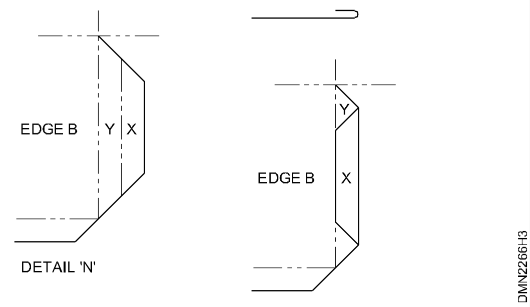
Fig 2



Bend all the four edges marked `B' in Fig 1 as stated below:

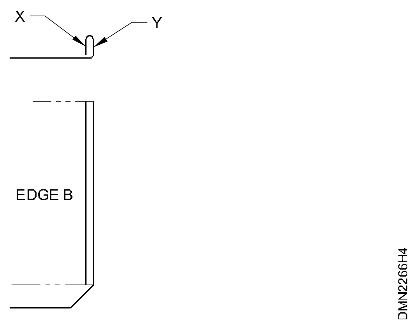
– First fold the portion marked `X' in Fig 3 upwards (inside the box) to 180°.

Fig 3



– Then bend the portion marked `Y' in the same direction to 90°. (Fig 4)

Fig 4

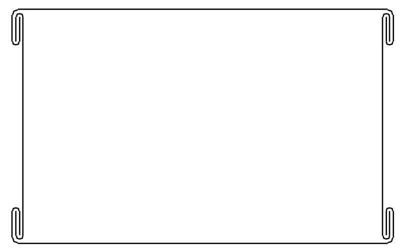


© NIMI NOT TO BE REPUBLISHED

Use a small metal piece inside the first fold while folding `Y'.

- Make a single hemming on the four sides tray.
- Bend the four sides to 90° using a Tinman's anvil.
- Join the four corners by double seam joint. (Fig 5)

Fig 5

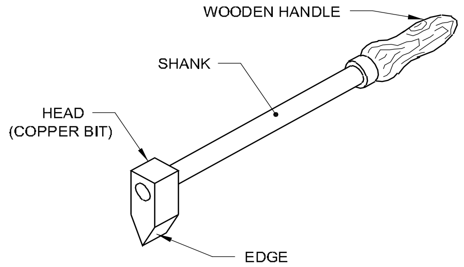


TOP VIEW OF THE BOX

— — — — — — — —

Hand tools for Sheet metal (Figs 1 to 8)

Fig 1



SOLDERING IRON (HATCHET TYPE)

Fig 2

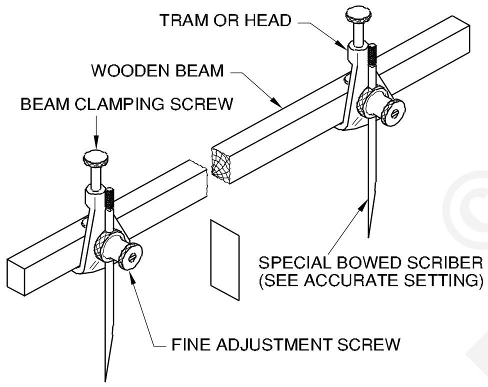
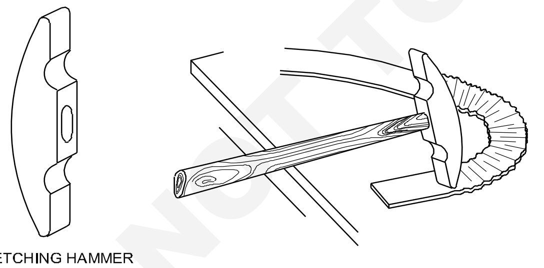


Fig 3



STRETCHING HAMMER

Fig 4

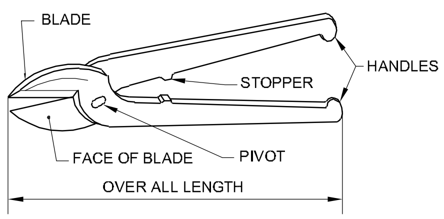


Fig 5

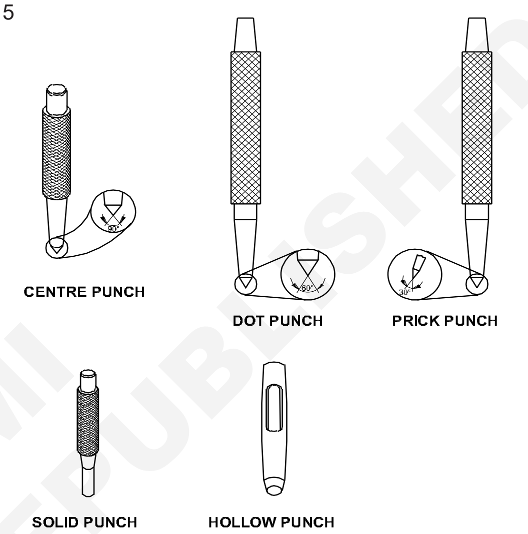


Fig 6

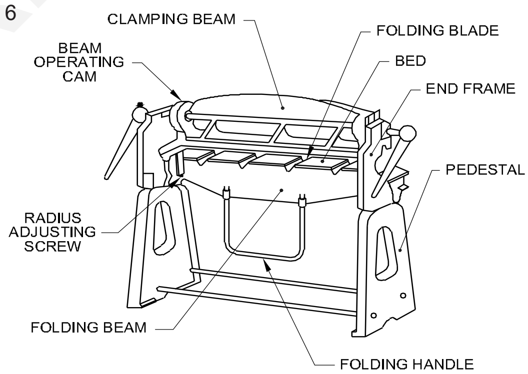
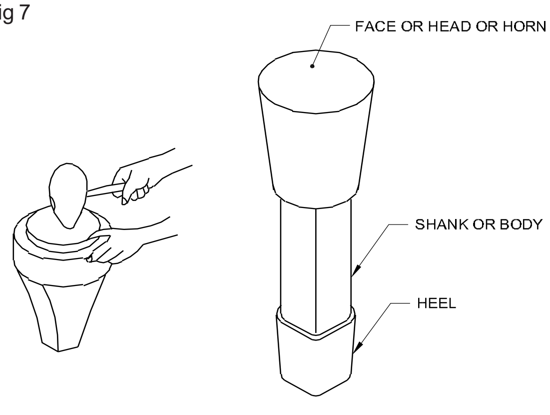


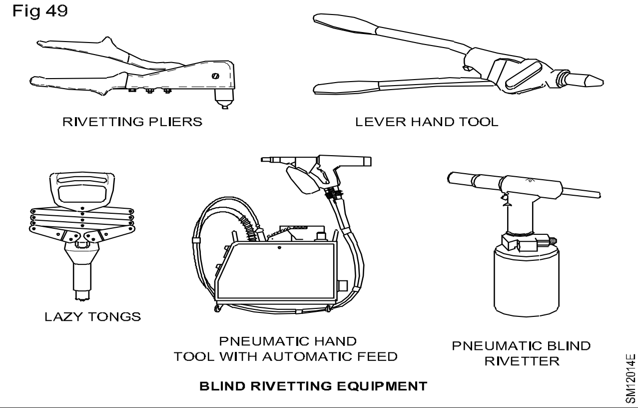
Fig 7



ROUND BOTTOM STAKE

NOT TO BE REPUBLISHED © NIMI

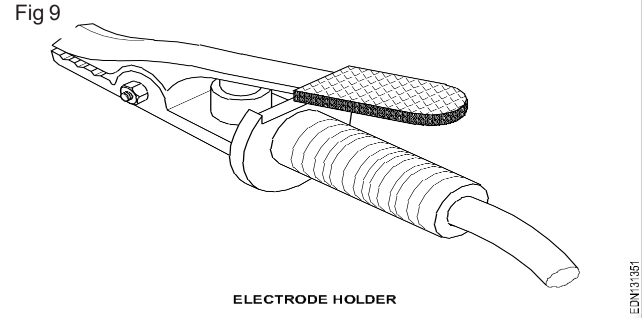
Fig 49



Hand tools for Welder

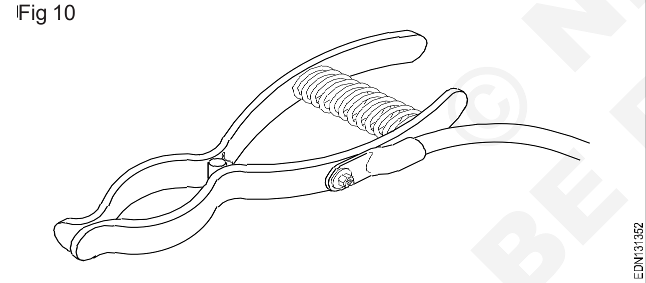
Electrode holder (Fig 9)

Fig 9



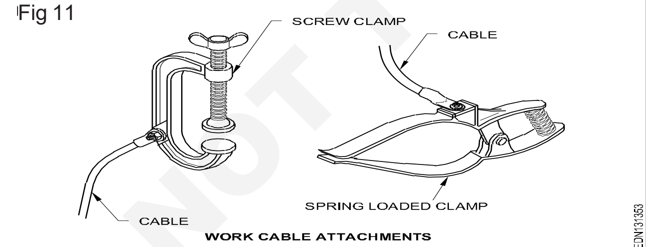
Earth clamp (Fig 10)

Fig 10



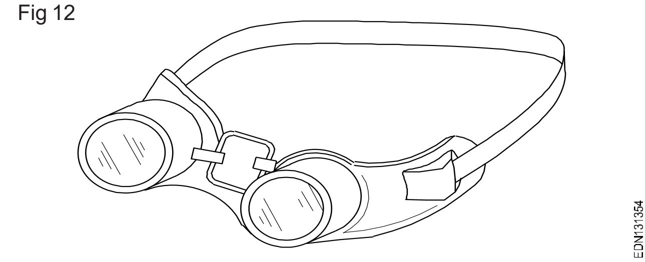
Work cable attachments (Fig 11)

Fig 11



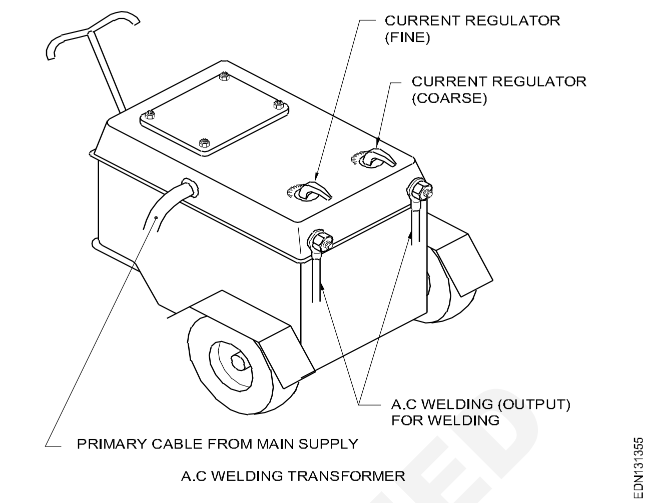
Googles (Fig 12)

Fig 12



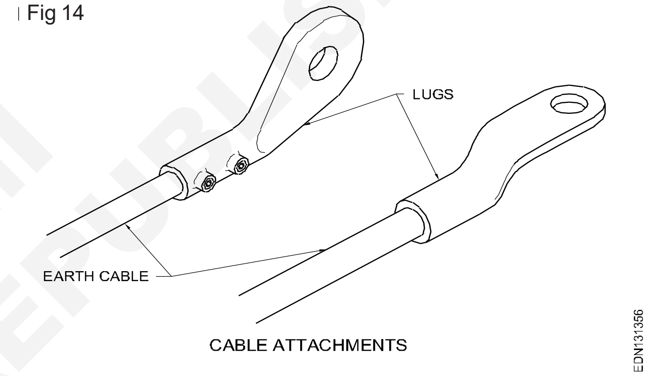
A.C. Welding transformer (Fig 13)

Fig 13



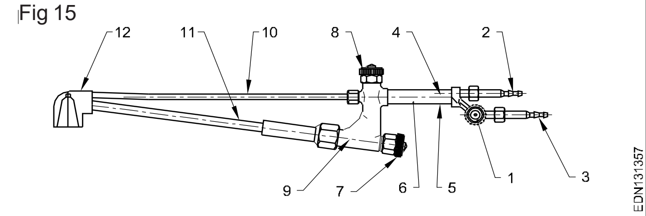
Cable attachments (Fig 14)

Fig 14



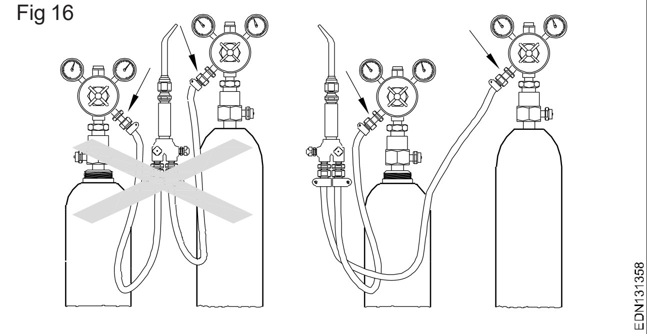
Cutting torch (Fig 15)

Fig 15



Regulator (Fig 16)

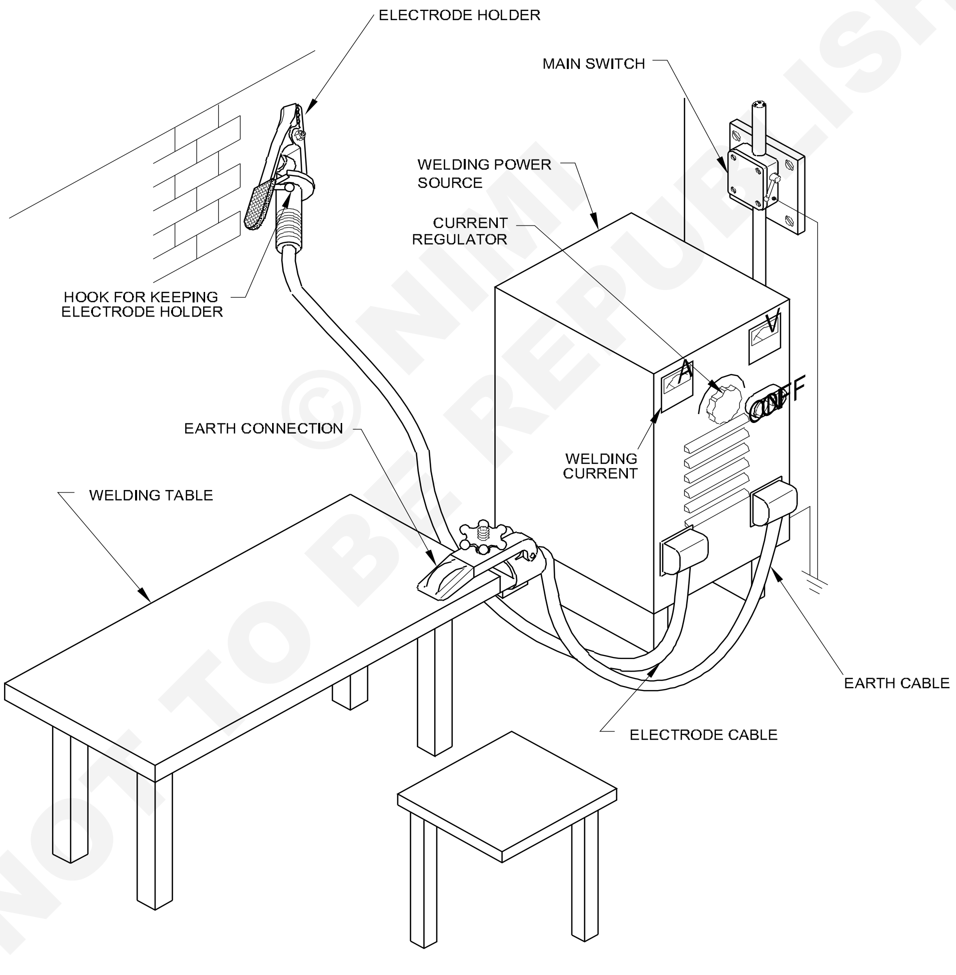
Fig 16



NOT TO BE REPUBLISHED © NIMI

Setting up of arc welding plant

Objective(s): At the end of this Ex: you shall be able to
- **operate the controls of arc welding machines safety and in sequence**
- **select the cables, electrode-holders and earth clamps of the right capacity**
- **connect the cables with the welding machine and the job**
- **start and stop the arc welding plants.**



© NIMI NOT TO BE REPUBLISHED

SCALE NTS	SETTING UP OF ARC WELDING PLANT	DEVIATIONS	TIME 5h
		CODE NO. DMN2267E1	

PROCEDURE

TASK 1**: Setting up arc welding plant**

- Check the welding machine and other accessories as per drawing.
- Connect the welding machine to the power supply.

> **Be sure that the main supply switch and the welding machine are properly earthed.**

- Start the welding machine and check its functioning.
- Check and ensure the welding cables, electrode, and earth are without any loose connection.
- Connect the earth cable to the welding table or work using the earth clamp.
- Hang the electrode-holder on an insulated hook provided near the welding table.
- Place portable screens around the welding table for the safety of others.
- Clean and replace broken/spattered filter and plain glasses of the welding screen.
- Remove all the combustible materials near or around the welding area.
- Check that the welding accessories such as chipping hammer, steel wire brush, tong and chipping goggles are in working condition.
- Wear safety apparels (such as leather apron, gloves, sleeves, leggings, jacket, shoes and cap) to ensure personal safety.
- Welding cables should be connected with the right terminals of the machine.
- The main switch, welding cables, electrode-holder and earth clamp should be of the required capacity.

> **Electricity is a good servant but a bad master.**
>
> **Ensure that the connection of the welding plant is done by a qualified electrician.**

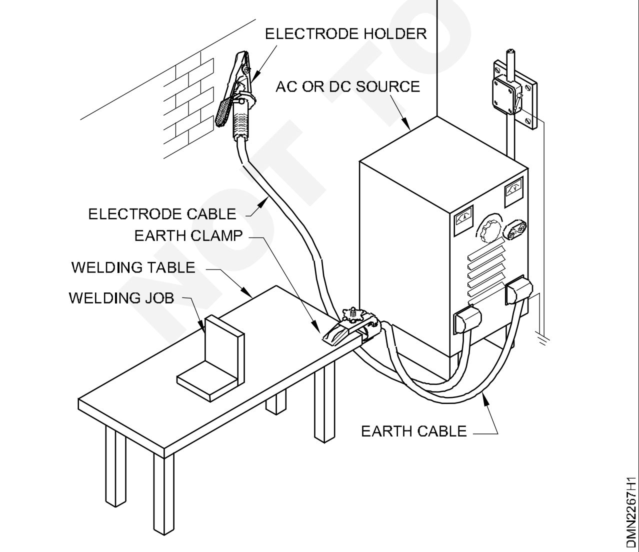
Skill sequence

Operating the controls of arc welding machines

Objective(s): This shall help you to
- **operate the controls of the arc welding machines safey**
- **connect the welding cables with the welding machine and job**
- **safeguard yourself against work hazards**
- **start and stop the arc welding transformer, generator and rectifier.**

Arc welding machines are designed to get suitable current for welding purposes. (Fig 1)

Fig 1



Connect the welding machine to the main supply as follows:

– Install the welding machine near the main supply, keeping the mains supply wire as short as possible to avoid electrical power losses.

– Call a skilled electrician for permanent connections to the main supply since it carries dangerously high voltage.

Ensure that the main switch fuses and power cables and cable lugs are of the required capacity.

If the main supply connection is of the plug type, the welder can himself connect the main supply.

Check the operation of the main switch.

Check the operation of the current regulator.

Check the operation of the on/off switch.

> **Connect the welding cables with the welding machine and job.**

© NIMI NOT TO BE REPUBLISHED

Welding cables are used to carry the welding current from the welding machine to the electrode-holder and job.

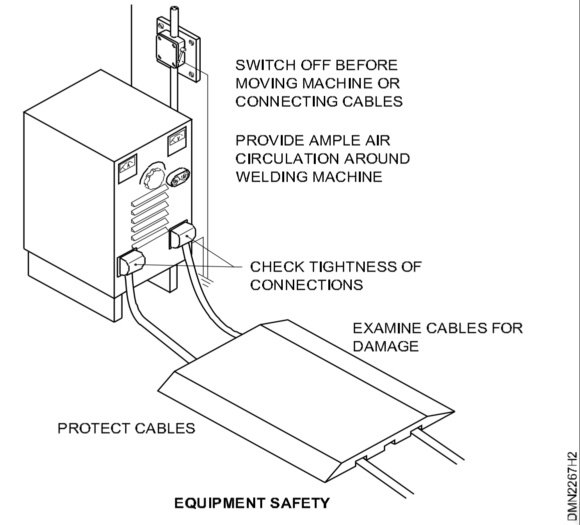
– Inspect the electrode and earth cables for damage of the insulations.

– Inspect the electrode-holder and the earth clamp for their functions.

The welding cables, electrode holder and earth clamp should be of required capacity.

Connect the electrode and earth cables to the welding machine terminals tightly. (Fig 2)

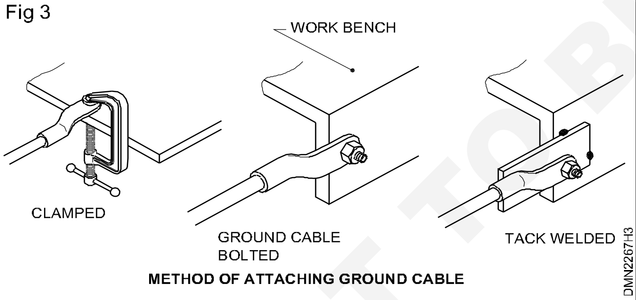
Fig 2



Ensure that the cables are with the right terminal and the main supply switch is 'off '.

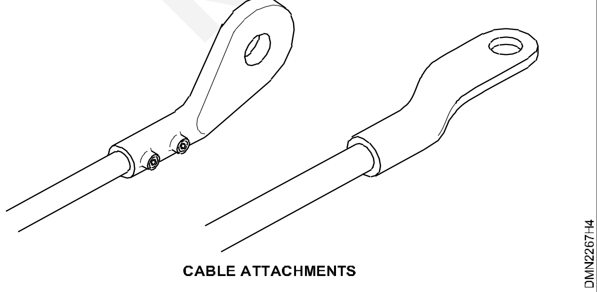
Connect the other end of the earth cable with the welding table or work tightly using the earth clamp. (Fig 3)

Fig 3



Always use suitable lugs for cable connections. (Fig 4)

Fig 4

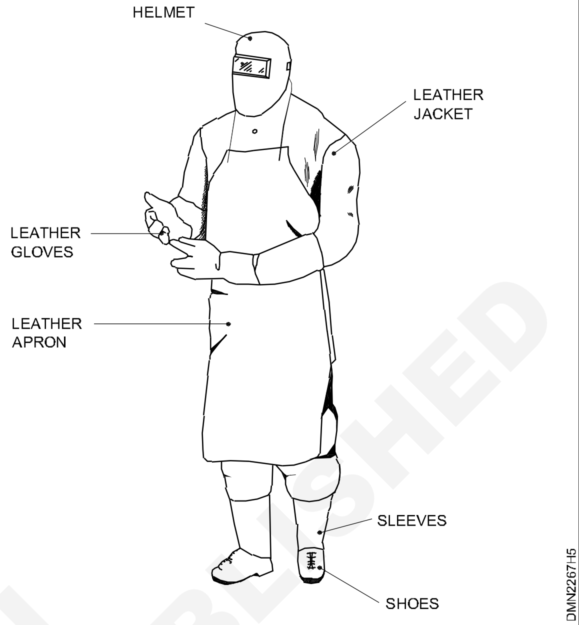


Place the electrode-holder on an insulated hook provided near the welding table.

Never keep the electrode-holder on an uninsulated welding table.

Wear safety apparels. (Fig 5)

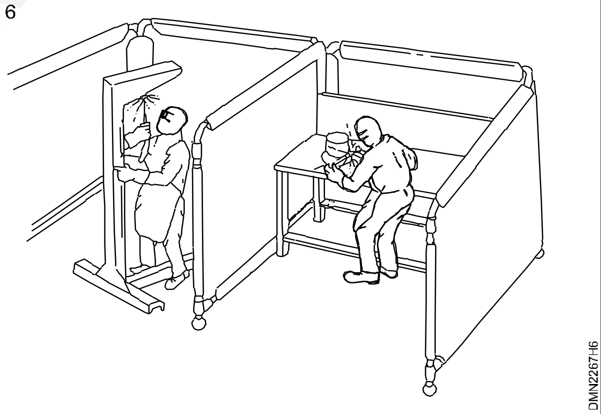
Fig 5



Safety apparels are designed to protect the welder from welding dangers.

Use a covered welding booth or portable screen around the arc welding table for the safety of other workers. (Fig 6)

Fig 6



Check the coloured and cover glasses of the welding screen for damage.

Replace heavily spattered and cracked glasses.

Use coloured glasses of a proper shade.

Starting and stopping of arc welding machines

Switch 'on' the main supply of the welding transformer.

Start and stop (2-3 times) the welding transformer using the On/Off switch provided with the machine.

Switch 'on' the main supply of the welding generator.

NOT TO BE REPUBLISHED © NIMI

Start and stop (2-3 times) the welding generator using start-delta-starter provided with the machine.

Put the starter 'on' star, wait for a few seconds and then put the switch in delta position to avoid damage to the machine.

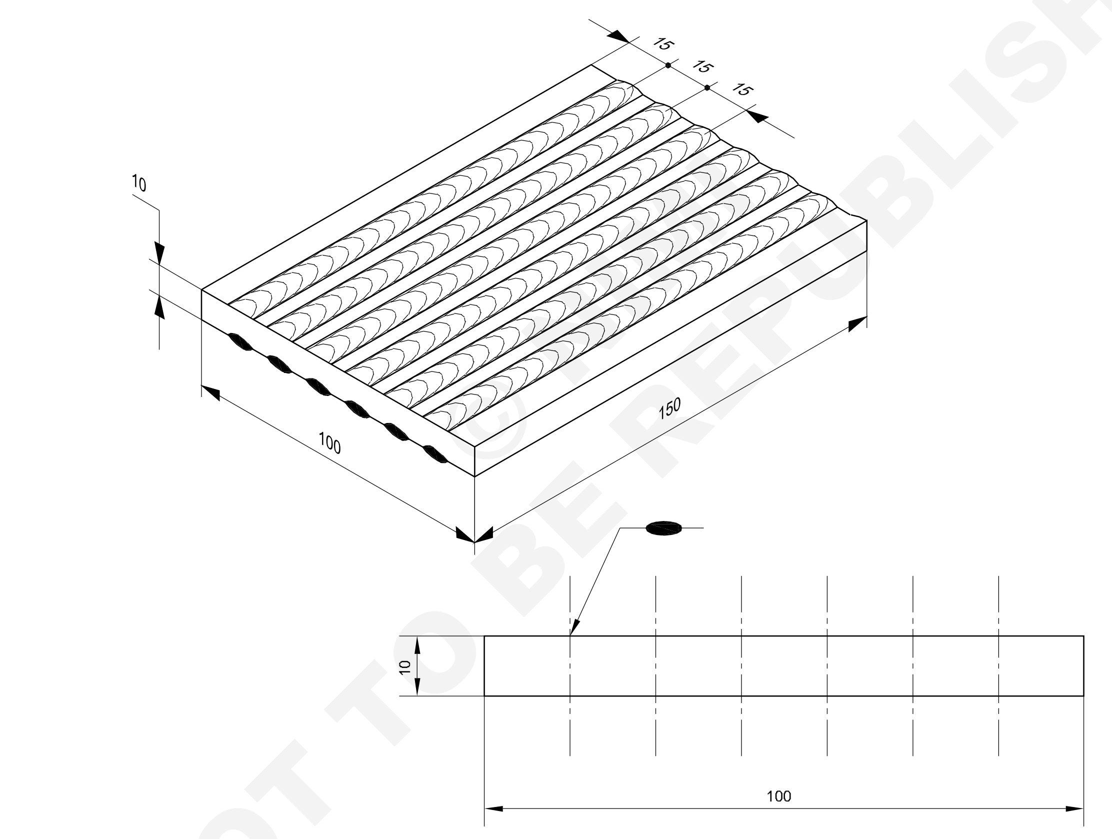
Switch 'on' the main supply of the welding rectifier.

Start and stop the welding rectifier 2-3 times using the On-Off switch provided with the machine.

Straight line beading on M.S. plates in flat position (arc)

Objective(s): At the end of this Ex: you shall be able to

- **strike and maintain electric arc to start the weld without freezing the electrode with the job**
- **deposit uniform straight bead in flat position**
- **clean the slag and spatter from the weld bead using a chipping hammer and wire brush**
- **inspect deposited beads and ensure that they are**
  - **of uniform width and height**
  - **free from weld defects.**



SCALE NTS	STRAIGHT LINE BEADING ON M.S. PLATES IN FLAT POSITION (ARC)	DEVIATIONS	TIME 5h
		CODE NO. DMN2267E2	

NOT TO BE REPUBLISHED

TASK 1:

- Clean the plate surface (job) with a steel wire brush and file.
- Layout parallel lines on the job surface as per drawing and mark with a centre punch.
- Set the plate on the welding table in a flat position.

Ensure the plate is well grounded with the welding table.

- Wear protective clothing (safety apparels).

Ensure the filter glass of screen is in order.

- Fix a 4 mm ϕ M.S electrode in the holder.
- Ensure the jaws of the electrode-holder are clean.
- Set the welding current to 150 to 170 amps approximately and start the welding machine.
- Connect the electrode cable with the negative on the DC machine.
- Strike the arc on a scrap piece for trial and observe the current setting.

Ensure the burning of the electrode is normal.

- Readjust the welding current if it is necessary.
- Deposit straight line beads on the workpiece along the punched line from one edge to the other.

The run length per electrode (of 400 mm length) may be 230 mm.

- Remove slag from the weld bead using a chipping hammer and clean with a steel wire brush.

Use a chipping screen while de-slagging.

- Inspect deposited beads for:
  - uniform width and height
  - straightness
  - uniform ripples
  - slag inclusion
  - overlap
  - unfilled crater

© NIMI NOT TO BE REPUBLISHED

Striking and maintaining of arc and laying short length beads

Objective(s): This shall help you to
- **set welding current conditions on the welding machine**
- **strike and maintain the arc by the scratching and tapping methods**
- **lay short length beads.**

Striking the arc is a basic action throughout the welding operation.

It will occur every time the welding is to be started.

It is an essential basic skill to learn arc welding.

Setting welding current conditions

Select the electrode size as per the thickness of the metal to be welded or as recommended. (Table 1)

TABLE 1

Plate	Electrode	Current
Thickness in mm (aprox.)	Size ø mm	Range (amperes)
1.6	1.6	40 - 60
2.5	2.5	50 - 80
4.0	3.2	90 - 130
6.0	4.0	120 - 170
8.0	5.0	180 - 270
25.0	6.0	300 - 400

The electrode size (dia.) should not be more than the thickness of the metal to be welded.

Use M.S. electrodes 4.0 mm ø and 3.15 mm ø.

Set the welding current on the welding machine as per the electrode size to be used, using a current regulator.

- For 4.0 mm ø = 140 - 150 amps
- For 3.15 mm ø = 100 - 125 amps

Connect the electrode to negative if the machine is a DC.

Striking/maintaining of arc

Ensure safety apparels are worn.

Fix the electrode in the holder.

Hold the electrode about 30 mm above the job piece at one end at 75° angle to the surface line. (Fig 1)

Scratching method (Fig 2)

Bring the welding screen in front of your eyes.

Strike the arc by dragging the electrode quickly and softly across the welding job using wrist movement only.

Fig 1

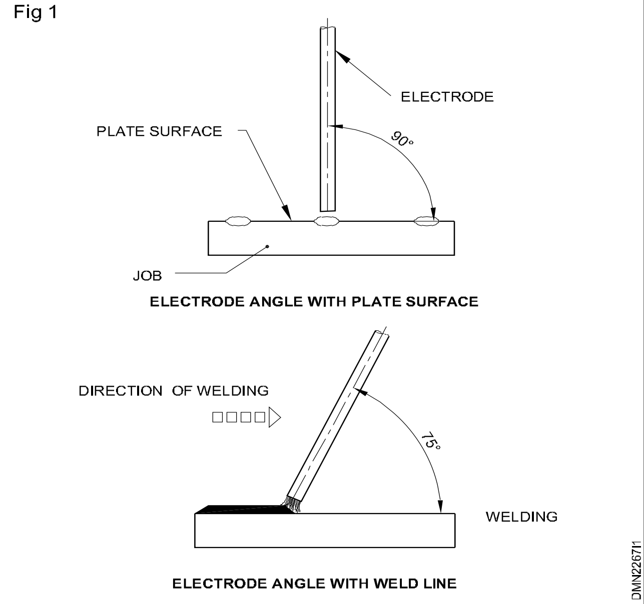
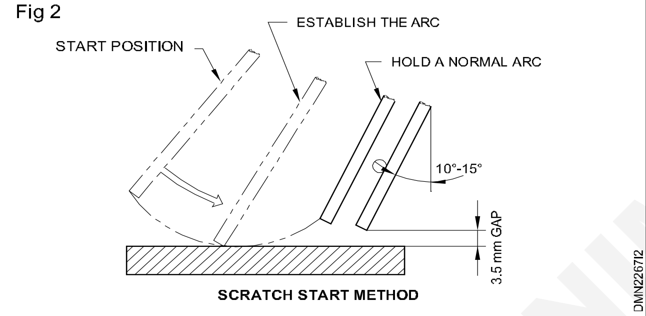


Fig 2



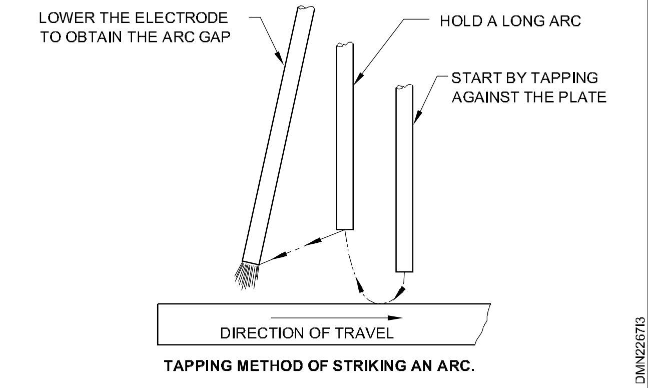
Withdraw the electrode app. 6 mm from the surface for a few seconds and then lower it to approx. 4 mm distance to maintain the arc.

Strike the arc by moving the electrode down to touch the job surface lightly.

Move the electrode up slowly approximately 6 mm for a few seconds and then lower it to approximately 4 mm from the surface to maintain a correct arc.

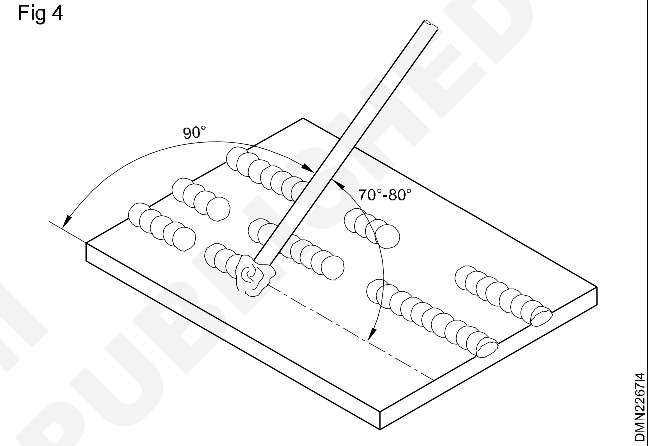
> **The tapping method is mostly recommended as it does not put pit marks on the job surface.**
>
> **If the electrode freezes (sticks) to the plate, it should be immediately freed by a quick twist of the wrist to avoid its overheating or spoiling. (Fig 3)**

Fig 3



Laying short beads (Fig 4)

Fig 4



Deposit short beads of 20 - 25 mm length by:

– feeding down the electrode to the weld pool at a uniform rate

– moving in straight line 20 - 25 mm distance with uniform speed

– holding the electrode of 70 - 80° angle with the weld line

– breaking the arc quickly at the end of the short bead.

© NIMI NOT TO BE REPUBLISHED

Straight line beading on M.S plate in flat position

Objective(s): This shall help you to

- **prepare and set job pieces for straight line beading**
- **deposit straight line beads on M.S plate in flat position**
- **inspect the welded beads for surface defects.**

Introduction

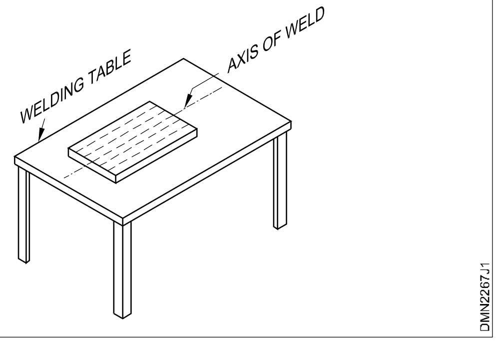
These beads are similar to those described in the previous Ex: except that they are longer.

You may find difficulty in maintaining a steady arc length for the entire length of the weld and the beads may likely be uneven in width and height.

Practice will make you perfect.

Preparation and setting of job piece (Fig 1)

Fig 1



Prepare a M.S. plate piece 100 x 10 x 150 by hand using a hacksaw and file.

To get a straight line bead a punched line will be of much help. The distance between the lines can be 15 mm.

Set the job on the welding table in a flat position with the punched surface facing up.

> **The job surface should be perfectly clean. Good electrical contact between the job and the welding table is a must.**

Deposition of straight line beads

Select a 4.00 mm ø M.S. electrode and set 150 - 170 amps welding current in range.

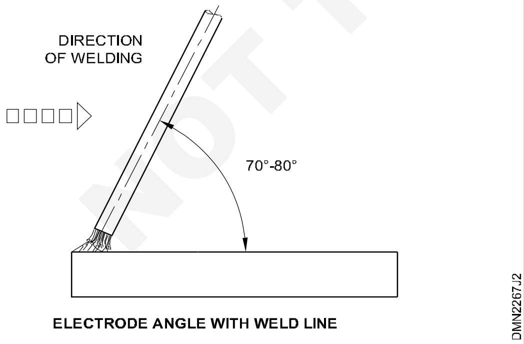
Connect the electrode to the negative on the DC welding machine.

Always follow the current range according to the diameter of the electrode.

Check for proper melting of the job and electrode on a scrap piece.

Hold the electrode at an angle of 70° to 80° with weld line/ punched line. (Fig 2)

Fig 2



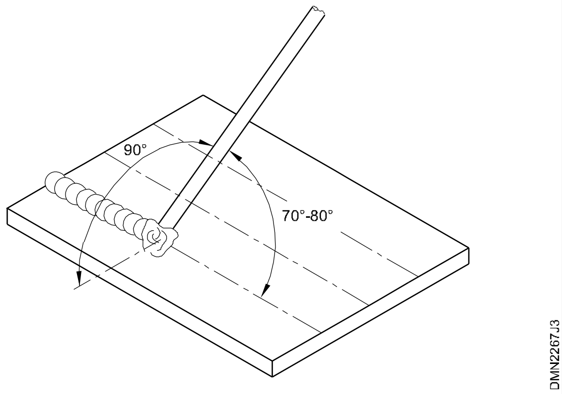
Deposit straight line beads taking the punched lines as a guide maintaining: (Fig 3)

– the medium arc length (i.e. 3 mm length)

– correct travel speed (approximately 150 mm per minute)

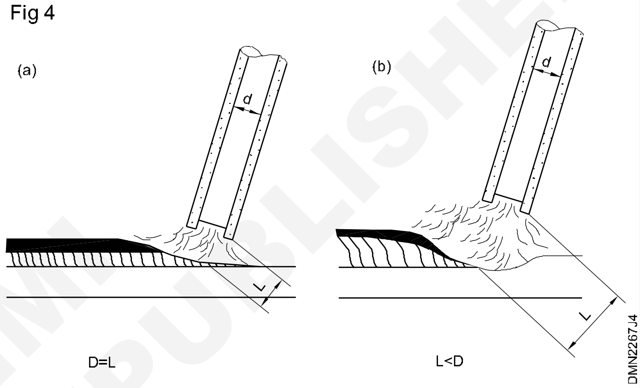
– correct electrode position.

Fig 3



The electrode should be moved towards the job to maintain a 3 mm gap between the tip of the electrode and the molten pool. (Fig 4)

Fig 4



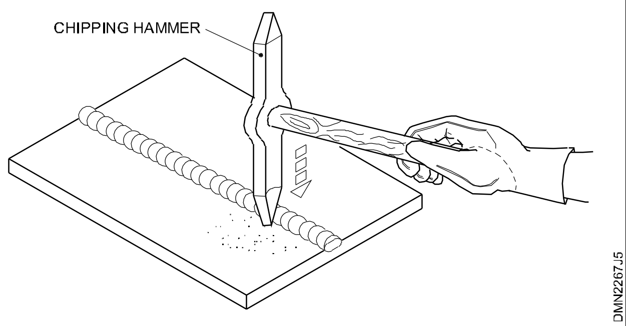
Welding screen glasses should be clean enough to see the arc action on the molten pool and punched line mark.

Listen to the arc's steady sharp crackling sound while welding. It indicates uniform burning of the electrode.

Adjust the travel speed by watching the electrode melting rate and flowing through the molten pool to form the deposited metal. The uniform travel speed along and towards the line of the weld gives a uniform bead.

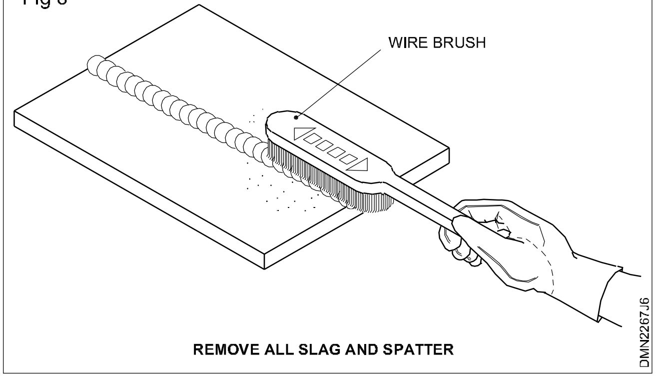
Cleaning and inspection of weld beads: Remove the slag and spatters from the weldment using a chipping hammer and wire brush, so that the metal surface of the bead is exposed for checking for any defects. (Figs 5 & 6)

Fig 5



© NIMI NOT TO BE REPUBLISHED

Fig 6



REMOVE ALL SLAG AND SPATTER

Use chipping goggles during slag removal.

Hold the hot job with a pair of tongs.

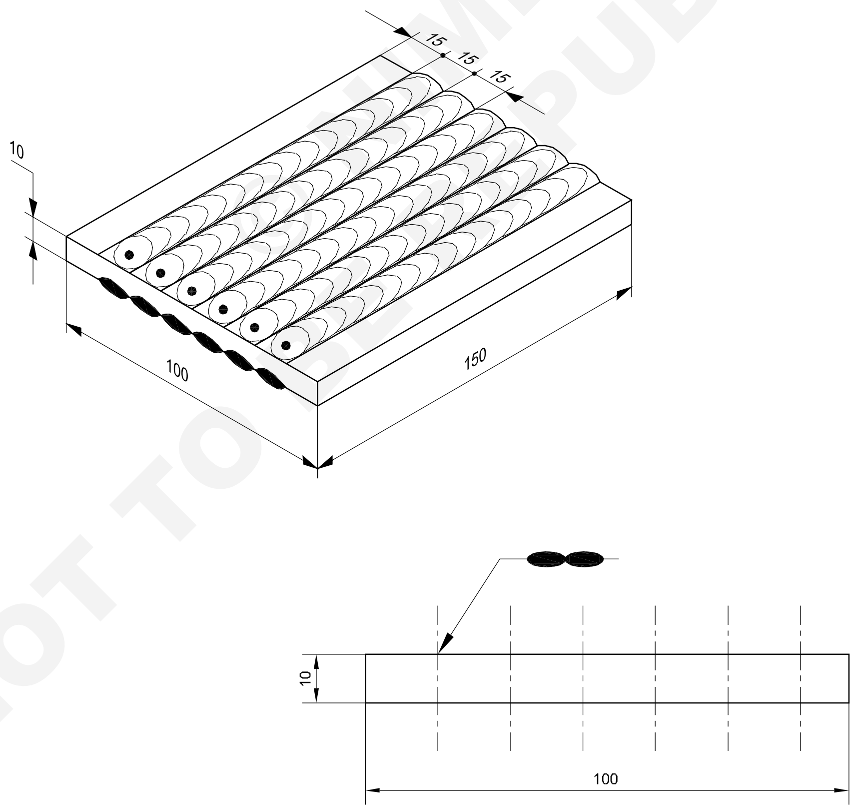
Inspect the deposited beads and note any variation in the:

- width and height
- depth of fusion
- length of run or straightness
- surface defects such as slag inclusion, porosity etc.

Laying of weaved beads on M.S. plates in flat position

Objective(s): At the end of this Ex: you shall be able to

- **deposit uniform beads by weaving the electrode within 2 marked lines in flat position**
- **maintain the required arc length, electrode travel speed and angle**
- **restart and end the bead without crater defect**
- **ensure that the deposited bead conforms to the specified size and is defect-free by inspection**
- **inspect to ensure the welds are:**
  - **of the specified size**
  - **free from defects.**



SCALE NTS	LAYING OF WEAVED BEADS ON M.S.PLATES IN FLAT POSITION	DEVIATIONS	TIME 5h
		CODE NO. DMN2267E3	

NOT TO BE REPUBLISHED

TASK 1:

- Prepare the job to size as per drawing.

Ensure the job piece is free from oil, grease etc. before grinding.

- Clean the job surface with a steel wire brush and by grinding the edges.
- Mark parallel lines on the job surface as per drawing for depositing weave beads and punch.
- Set the workpiece (job) on the welding table in a flat position.
- Wear protective clothing (safety apparels).
- Inspect the welding screen glasses for spatters and for suitable shade number.
- Set the welding current between 150 - 170 amps for 4 mm ø M.S. electrodes.
- Observe the electrode burning rate on a scrap piece and readjust the current, if necessary.
- Deposit the weaved beads on the workpiece between the punched lines from one end to the other.
- Restart the weld whenever the arc is put off or when changing electrode or otherwise.
- Stop weld in the end and fill up the crater.
- De-slag the weld bead using a chipping hammer and clean with a steel wire brush.

Use chipping goggles and tongs during deslagging.

- Inspect the deposited weaved beads for:
  - uniform width and height
  - overlap on sides of weld
  - slag inclusions
  - unfilled crater
  - straightness of beads
  - restarting defects.
  - uniform ripples
- Repeat the Ex: till you produce uniform weaved beads, with correct restarts and stops.

  (Refer to Skill Information)

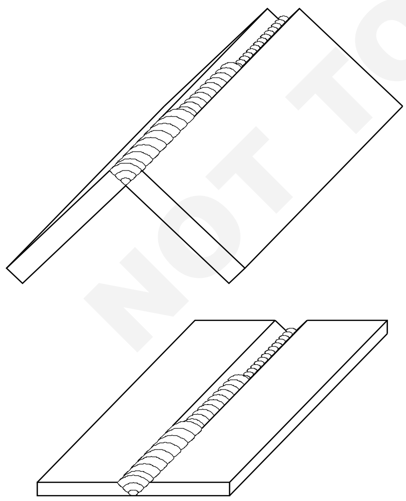
Laying of weaved beads on M.S plate in flat position for different joints

Objective(s): This shall help you to
- **grind the M.S plate on a pedestal grinder to correct size safely**
- **deposit uniform weaved beads in flat position of corner joint and single 'V' butt joint**
- **restart and stop the beads without defects.**

General job information: It is often necessary to deposit wider beads than those deposited as per the previous Ex: (straight beads).

Weaved beads are required while welding deep groove joints (Fig 1) and multi-pass welds.

Fig 1



Grinding: The plates supplied for practice are either gas cut plates or sheared plates with irregular edges. To make the edges straight, they are ground to form square using a grinding machine.

While grinding, wear gloves, grinding goggles and ensure the gap between the work-rest and the grinding wheel is less than 3 mm.

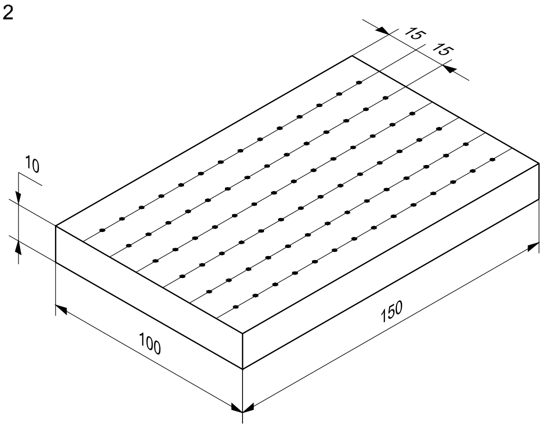
Do not lean on the grinding machine to give more pressure to the job.

Check the squareness of the edges with a try square.

Deposition of weaved beads in flat position

Prepare M.S. plate piece 100 x 10 x 150 with punched lines 15 mm apart for laying weaved beads. (Fig 2)

Fig 2



© NIMI NOT TO BE REPUBLISHED

Ensure 150 - 170 amps current setting for a 4.00 mm ø M.S. electrode.

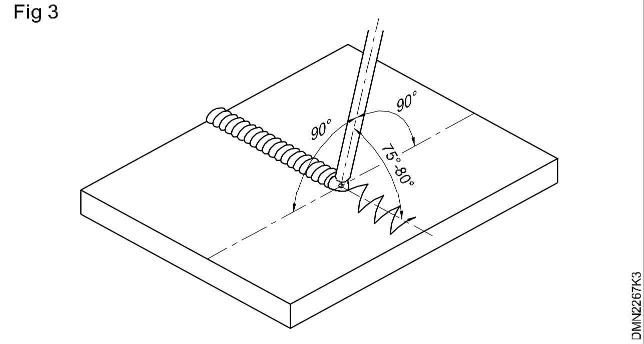
Position the electrode with the weld line at an angle of 75° - 80°.

Position the electrode with the adjoining plate surface at an angle of 90° giving side-to-side weaving motion using the arm movement.

Deposit the weaved beads between the punched lines by:

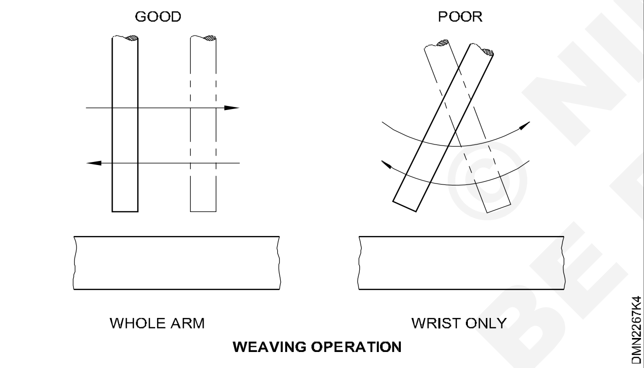
– positioning the electrode correctly (Fig 3)

Fig 3



– weaving the electrode side-to-side. (Fig 4)

Fig 4



Restrict the weaving motion to three times the electrode diameter.

Advance the bead on each weave by not more than 2.3 mm, so that the light, thin, molten slag will always be kept away from the molten pool of metal.

Advancing the bead too far ahead will result in slag inclusion and poor appearance.

Restarting of bead

To ensure a good restart, proper fusion and fill up at the crater, proceed as follows. (Fig 5)

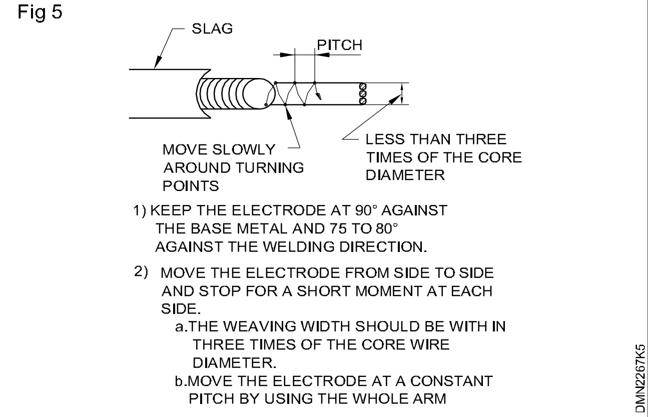
Remove the slag about 25 mm from the end of the crater.

Restart with a long arc at the forward edge of the crater.

Move the arc slowly across the crater reducing the arc length.

Start forward travel at the normal rate with medium arc length.

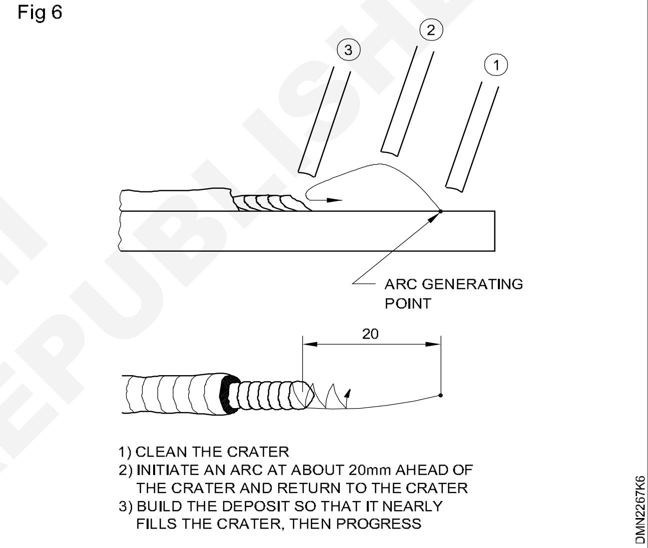
Fig 5



Ending the bed

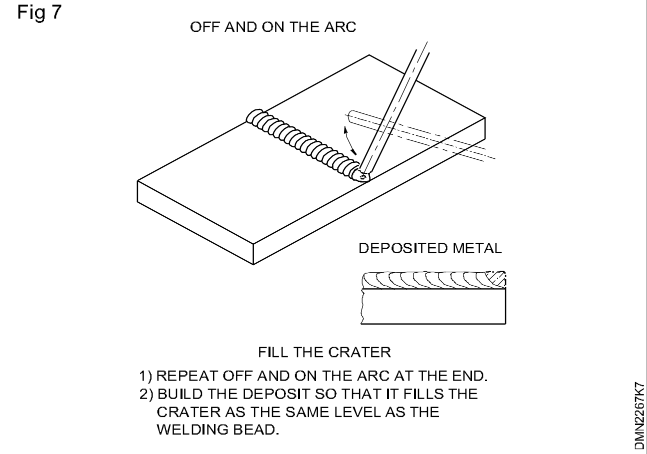
At the end of each weld bead fill up the crater as follows. (Fig 6)

Fig 6



Stop the forward movement of the electrode at the end of the weld. (Fig 7)

Fig 7



Change the angle of the electrode.

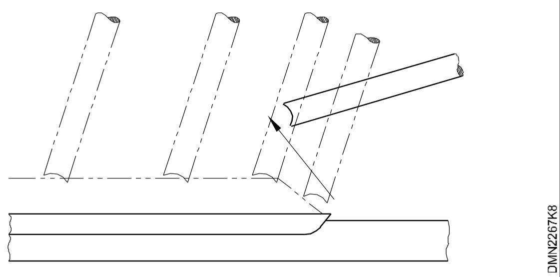
Move back along the weld about 15-20 mm.

Hold for a few seconds to fill the crater.

© NIMI NOT TO BE REPUBLISHED

Break the arc quickly. (Fig 8)

Fig 8



Inspect the following. (Fig 9)

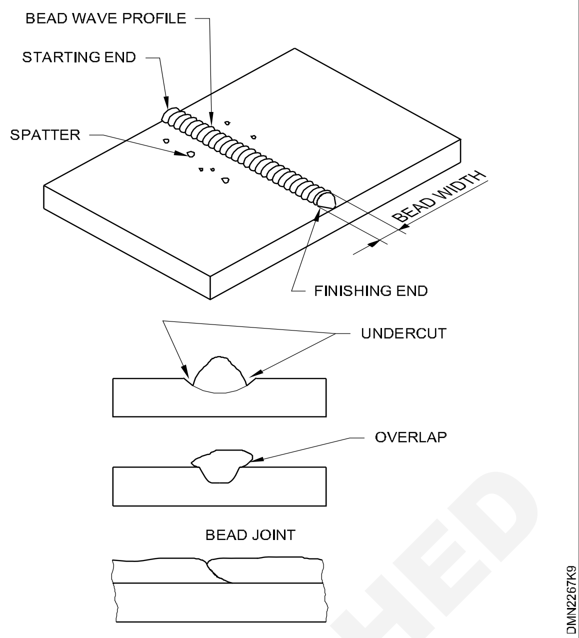
Finishing condition of the bead ends.

Bead form (width, reinforcement and wave profile).

Undercut and overlap.

State of bead joints.

Fig 9



Setting of oxy-acetylene plant

Objective(s): At the end of this Ex: you shall be able to
- **move gas cylinders observing safety practices**
- **crack oxygen and acetylene cylinders**
- **connect oxygen and acetylene regulators on respective cylinders**
- **connect blow pipe to regulators using rubber hoses with hose protector in correct place**
- **test for leakage at connections for dissolved acetylene gas connections and for oxygen gas connections**
- **ignite the acetylene gas using spark lighter and set the flame**
- **set neutral, carburizing and oxidizing flames**
- **extinguish gas flame avoiding backfire**
- **close down the oxy-acetylene welding plant maintaining the correct sequence**
- **observe safety practices while working on oxy-acetylene gas welding plant.**

TASK 1:

- Move oxygen and acetylene cylinders from the store to the gas welding area.

  Ensure full cylinders are kept separately from the empty cylinders.

- Position the gas cylinders in a trolley and secure them with a chain.
- Remove caps and clean the valve sockets of both the oxygen and acetylene cylinders by cracking the cylinder valves.

Ensure that your hands are free from grease or oil.

- Connect the oxygen regulator to the oxygen gas cylinder (right hand threads).
- Connect the acetylene regulator to the acetylene gas cylinder (left hand threads).

Ensure the pressure adjusting screws of both regulators are in a released condition.

- Insert the hose connector at the regulator end and the hose-protectors at the blowpipe end.

  (Use black hose for oxygen line and maroon hose for acetylene line.)
- Blow into the hose-pipes for removing dirt or dust.

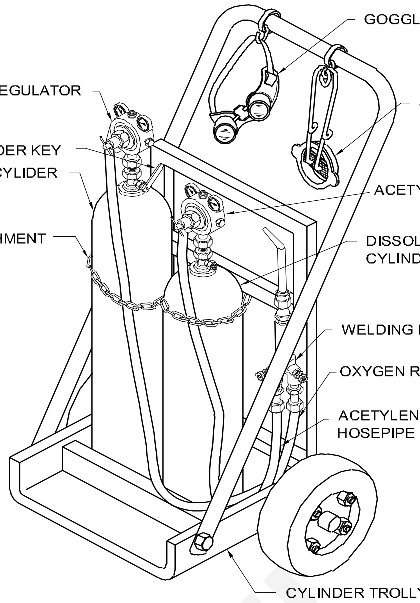
Acetylene connections have left hand threads with a cut on the corners of the nut while oxygen connections have right hand thread without a cut.

Open the cylinder valves slowly and adjust 0.15 kg/cm² pressure on both the regulators.

Check for leaks in all connections using soap solution for D.A. connection and fresh water for oxygen connection.

(Refer to Skill Information for further details.)

NOT TO BE REPUBLISHED © NIMI



SCALE NTS	SETTING OF OXY-ACETYLENE PLANT	DEVIATIONS	TIME 5h
		CODE NO. DMN2267E4	

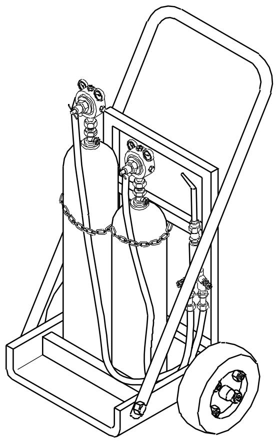
© NIMI NOT TO BE REPUBLISHED

Attaching gas regulators

Objective(s): This shall help you to
- **fix regulators to gas cylinders.**

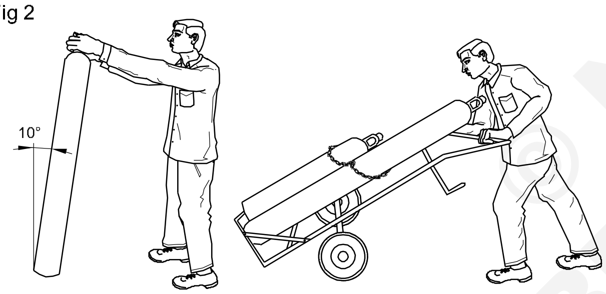
Keep the cylinders upright in the cylinder stand and secure them with a chain. (Fig 1)

Fig 1



While moving, the gas cylinders should be kept slightly inclined to the vertical position and the protector cap used to avoid damage to the cylinder valves. (Fig 2)

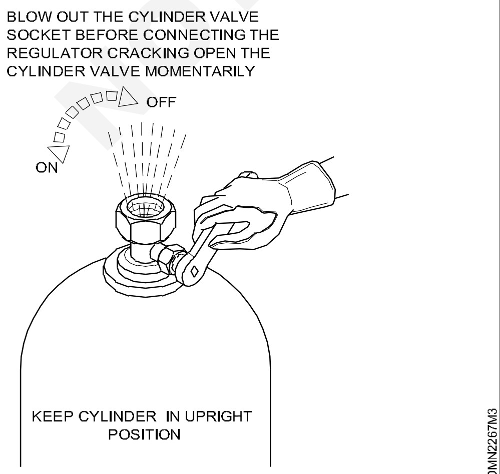
Fig 2



Do not roll the cylinders horizontally on the ground.

Crack the gas cylinder valves by quickly opening and closing them. (Fig 3)

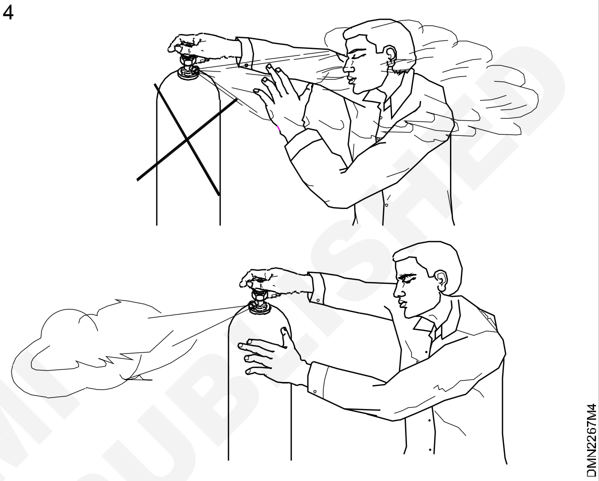
Fig 3



Dirt and dust particles from the cylinder valve sockets are cleaned to avoid leakage of gas due to improper seating and also to prevent the dust particles from entering into the regulators which may cause damage to the regulators.

Always stand to one side while cracking the cylinders. (Fig 4)

Fig 4



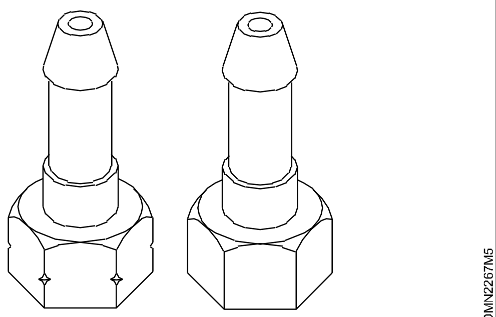
Attach the gas regulators with the cylinder valves.

Release the pressure adjusting screws of both regulators before attaching them.

Be sure to connect the correct regulator on cylinders. Acetylene connections have left hand thread and oxygen ones right hand thread.

The acetylene regulator connecting nut will have a groove cut on it (Fig 5) and the pressure gauge dial will be of maroon colour.

Fig 5



All threaded connections should be fixed initially by tightening by hands and then only a spanner should be used. This will help to avoid assembly with cross thread leading to damage to threads.

Always use the correct size spanner to prevent damage to the nuts. (Fig 6)

© NIMI NOT TO BE REPUBLISHED

Fig 6

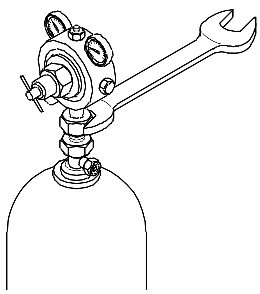
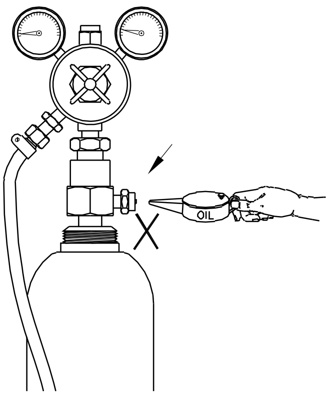


Fig 7



It is dangerous to apply lubricants in the threaded assemblies of gas welding equipment as it can cause fire. (Fig 7)

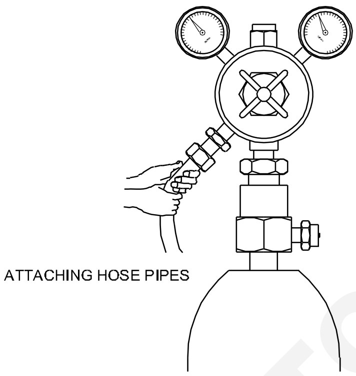
While tightening avoid undue force. The connections should be just tight.

Attaching blowpipe to regulators

Objective(s): This shall help you to
- **attach rubber hose-pipes to regulators**
- **observe safety practices.**

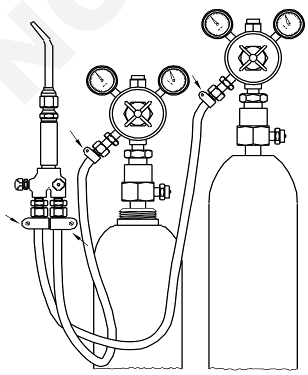
Fixing rubber hoses: Attach one end of the black hose-pipe to the oxygen regulator outlet and the maroon coloured hose-pipe to the acetylene regulator outlet. (Fig 1)

Fig 1



Secure the joints using hose-clips to ensure good grip and to avoid gas leakage. (Fig 2)

Fig 2



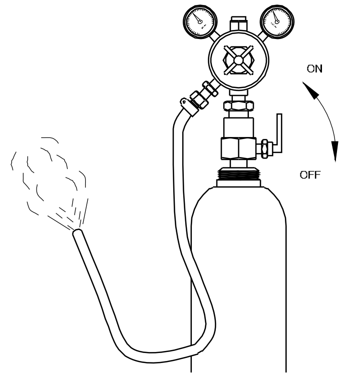
USE HOSE CLIPS BEFORE CONNECTING TO REGULATOR AND BLOW PIPE

Do not use oil or grease for fixing hoses.

Use a screwdriver to tighten the hose-clips.

Blowing out the hose-pipes (Fig 3)

Fig 3



ATTACH NEW HOSES TO REGULATORS AND TO DISPEL DUST ETC., QUICKLY PASS PRESSURISED GAS TO ATMOSPHERE MOMENTARILY.

NOTE: THIS SHOULD BE DONE BEFORE FITTING HOSE PROTECTORS

Hold the loose end of the hose-pipe away from the body.

Turn on the pressure adjusting screw of the regulator to which it is connected.

Exert sufficient pressure to blow out dust or dirt particles if any are tapped inside the hose-pipe and then release the pressure adjusting screw.

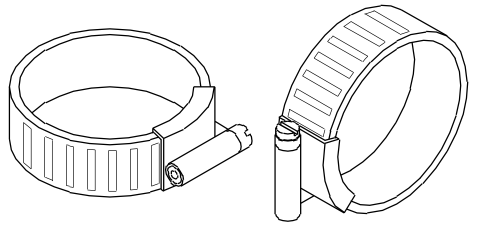
Repeat the same for the other hose also.

Always use the correct size hose-clips. (Fig 4)

Hose-clips are available in the following sizes: i.e. 5 mm, 6 mm, 8 mm and 10 mm. The sizes indicate the inside diameter of hoses.

© NIMI NOT TO BE REPUBLISHED

Fig 4

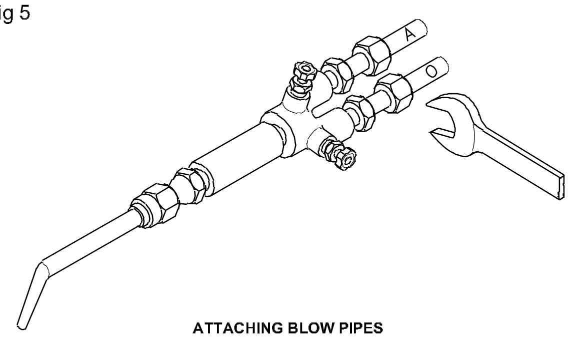


HOSE CLIPS

Attaching blowpipe

The other end of the hose-pipe is to be attached to the blowpipe inlets. (Fig 5)

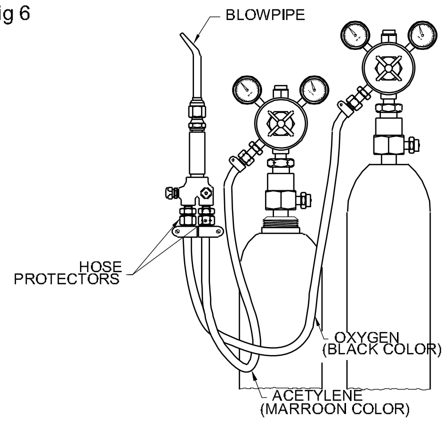
Fig 5



ATTACHING BLOW PIPES

Fix the hose-protectors at the blowpipe ends. The hose-protectors with a groove at the corners are fixed on the acetylene hose-pipe and connected to the acetylene inlet of the blowpipe. The hose-protectors without cutting marks are fixed on the oxygen hose-pipe and connected to the oxygen inlet of the blowpipe. (Fig 6)

Fig 6



CYLINDERS

The hose-protectors protect against the return flow of gas from the blowpipe to the rubber hoses.

Ensure the hose connections with the return valves (hose-protectors) are attached on the blowpipe side.

Adjusting gas pressure and testing for leakage

Objective(s): This shall help you to

- **adjust gas pressure according to the nozzle size**
- **test leakage of gas in connections to ensure safety.**

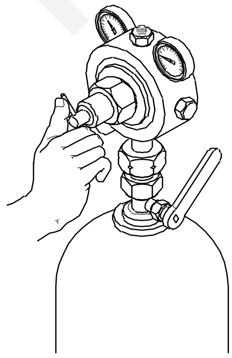
Adjusting the gas pressure: The gas pressure for both oxygen and acetylene has to be adjusted at regulators according to the size of the nozzle.

The size of the nozzle is selected according to the job material and thickness.

For adjusting the gas, open the valves of both the cylinders slowly by one turn and set the pressure on both regulators as 0.15 kg /cm^2 for small size nozzles, by tightening the pressure adjusting screws. (Fig 1)

The pressure can be read on the working pressure gauge of gas regulators.

Fig 1

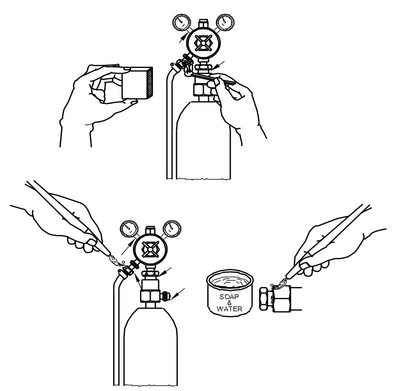


Testing for leakage

All connections must be tested for leakage.

Apply soap water solution for acetylene connections and fresh water for oxygen connections. (Fig 2)

Fig 2



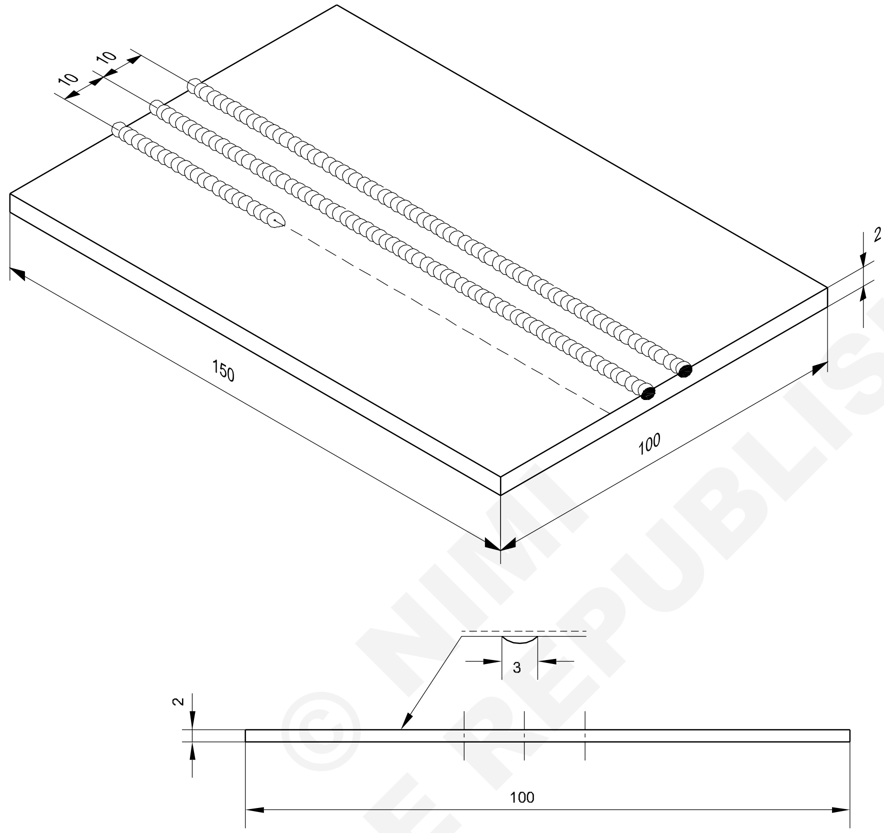
Use of soap water on oxygen connections may lead to fire hazards.

Never use matches or flame light during leakage test.

© NIMI NOT TO BE REPUBLISHED

Fusion run with filler rod on M.S. sheet in flat position

Objective(s): At the end of this Ex: you shall be able to
- **produce molten pool of required size by the manipulation of the blow pipe and flame**
- **add filler metal at the required rate and place by manipulating the filler rod**
- **deposit fusion run with the filler rod in flat position using leftward technique**
- **clean and inspect the deposited beads for surface defects.**



SCALE NTS	FUSION RUN WITH FILLER ROD ON M.S. SHEET IN FLAT POSITION	DEVIATIONS	TIME 5h
		CODE NO. DMN2267E5	

© NIMI NOT TO BE REPUBLISHED

TASK 1:

- Clean and finish the sheet pieces to dimensions using file and emery paper.
- Mark and punch straight parallel lines on the sheet surface as per drawing.
- Set the job piece on the welding table in flat position.
- Select and fix the nozzle size 3 and set acetylene/ oxygen pressure 0.15 kg/cm^2.
- Select copper-coated, mild steel, (CCMS) filler rod of 1.6 mm ϕ.

Wear safety apparel.

- Adjust the neutral flame.
- Hold the blow pipe at an angle of 60°- 70° with the punched line of the job and make a small molten pool at the right hand edge of the line.
- Keep the flame cone distance 2.0 to 3.0 mm above the job surface.
- Hold the filler rod in the left hand, pointing near the molten pool with an angle of 30° - 40° with the line of weld.

- Fuse the end of the filler rod by dipping at the centre of the molten pool and add filler metal on the job surface to form a weld bead.
- Move towards left with uniform speed along the punched line with a slight circular motion to the blow pipe.
- Move the filler rod up and down (piston like motion) at a constant speed.
- Add enough rod into the molten pool to build up the bead evenly in height and width.
- Co-ordinate the rate of travel of the blow pipe with the filler rod to control the size of the bead and the required penetration.
- Keep the welding rod end within the flame to avoid oxidation.
- Stop at the left edge by filling the crater properly.
- Extinguish the flame and cool the nozzle.
- Clean the weld surface. Inspect for even ripples and uniform width/height of weld bead.

(Refer to Skill information)

Lighting, setting, extinguishing oxy- acetylene flame and closing down plant

Objective(s): This shall help you to
- **ignite and extinguish the oxy-acetylene flame for gas welding**
- **set neutral, oxidising and carburising flames**
- **shut the oxy-acetylene plant for stopping work.**

Flame Igniting

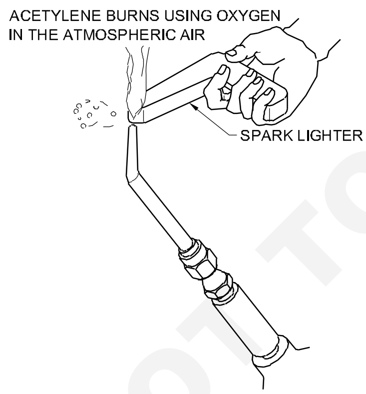
Ensure safety apparels are worn.

The pressure of oxygen and acetylene is 0.15 kgs/cm^2 for nozzle No.3.

While setting pressure on the regulator, keep the blowpipe control valve open for accurate setting.

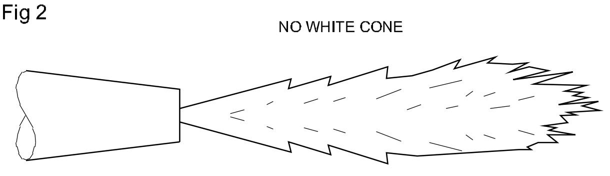
Open the acetylene control valve 1/4 turn of the blowpipe and ignite with a spark lighter. (Fig 1) Acetylene burns using the oxygen in the atmospheric air.

Fig 1



Adjust the acetylene till the black smoke disappears. (Fig 2)

Fig 2



ACETYLENE FLAME IN ATMOSPHERIC AIR

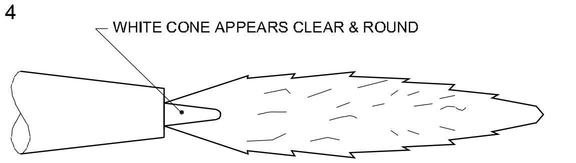
Observe the flame and add oxygen by opening the oxygen control valve of the blowpipe. (Fig 3)

Fig 3

ADDITION OF OXYGEN

Flame adjusting: To adjust the neutral flame, add sufficient oxygen to make the white cone clear and round. (Fig 4)

Fig 4



NEUTRAL FLAME WITH SUFFICIENT OXYGEN

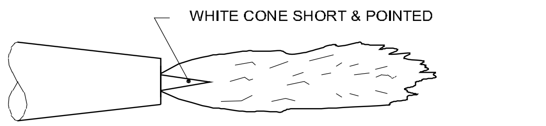
The gas mixture from the blowpipe has equal volume of oxygen and acetylene.

To adjust the oxidising flame, allow more oxygen to flow.

The white cone will become short and sharp.

The flame will produce a hissing sound and will have a short length. (Fig 5)

Fig 5



OXIDISING FLAME WITH MORE OXYGEN

© NIMI NOT TO BE REPUBLISHED

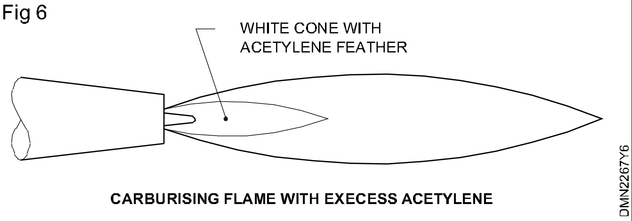
The gas mixture from the blowpipe has more volume of oxygen than acetylene.

To adjust the carburising flame, adjust the flame to neutral and then add acetylene.

The white cone will become long surrounded by a feather-like portion.

The flame will burn quietly having more length. (Fig 6)

Fig 6



CARBURISING FLAME WITH EXECESS ACETYLENE

The gas mixture from the blowpipe has more volume of acetylene than oxygen.

Extinguishing the flame

To extinguish the flame close the acetylene valve (blowpipe) first and then the oxygen one.

Closing down the plant

At the close of work, shut off the plant in the sequence given below.

Close the acetylene cylinder valve.

Close the oxygen cylinder valve.

Open the blowpipe acetylene valve and release all the gas pressure.

Open the blowpipe oxygen valve and release all the gas pressure.

Both the pressure gauges on the regulators should read zero.

Release the acetylene regulator pressure adjusting screw.

Release the oxygen regulator pressure adjusting screw.

Close the blowpipe acetylene valve.

Close the blowpipe oxygen valve.

Ensure

– there is no fire around the equipment

– the gas is completely exhausted by dipping the nozzle in water.

Fusion runs without filler rod in flat position by gas

Objective(s): This shall help you to

- **prepare the job to the required size**
- **hold the blow pipe and flame in correct position to obtain proper fusion of metal**
- **make fusion runs without the filler rod to produce uniform beads**
- **visually examine the fusion beads.**

Homogeneous joints are produced in gas welding by melting and fusing the metal edges with the help of a gas flame.

The beginner for gas welding must practice:

– holding the blowpipe in the correct position

– fusing of the metal by using a proper gas flame

– deposit fusion run in a straight line using leftward technique.

Preparation of sheet for welding

Scribe lines at 15 mm from one edge of the given strip of 2 mm thick, 100 mm wide and 150 mm long. (Fig 1)

2 mm is the shearing allowance so that the finished size after filing will be 150 mm.

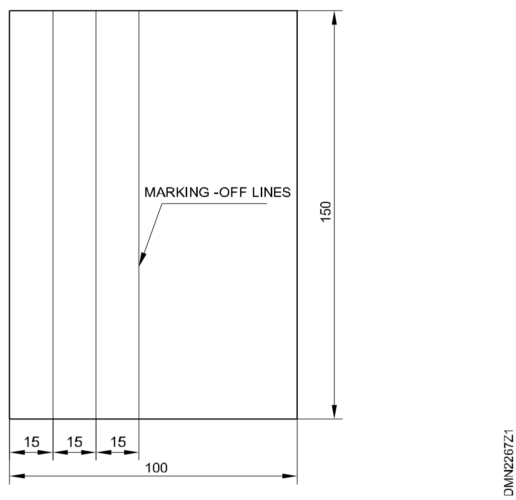
Use gloves while handling sheets.

Shear the strip to get job pieces 150 mm long x 100 mm wide x 2 mm thick size. (Fig 1)

Ensure your fingers are away from the shear blades while cutting.

Remove buckling of sheet due to shearing by hammer on the anvil.

Fig 1



File the irregular edges of the job to remove burrs and unevenness on the edge.

Cleaning and setting job piece

Remove rust if any using a wire brush and emery paper.

Do not rub with heavy pressure on the wire brush.

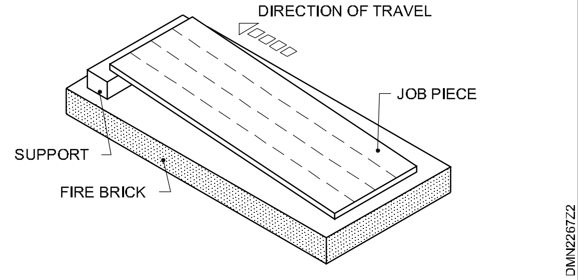
Use the emery paper rolled on a piece of wood while cleaning.

© NIMI NOT TO BE REPUBLISHED

Remove paint, oil or grease by dipping the M.S. sheet in a solvent of dilute hydrochloric acid.

Keep the job 10 mm above the work table (Fig 2) to reduce the heat conduction and to position the job flat.

Fig 2



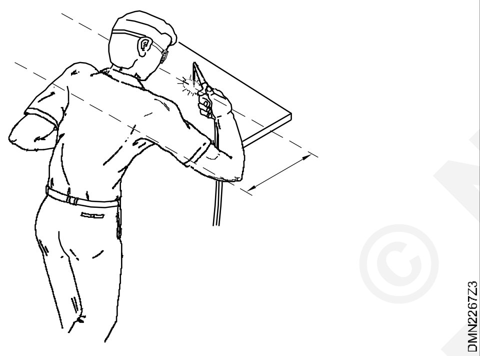
Draw lines parallel to the longer edge of the sheet and punch along the lines to serve as a guide.

Hold the blowpipe and flame in correct position for proper fusion (angle).

Position the blowpipe in such a way that:

– the axis of the joint is parallel to the operator (Fig 3)

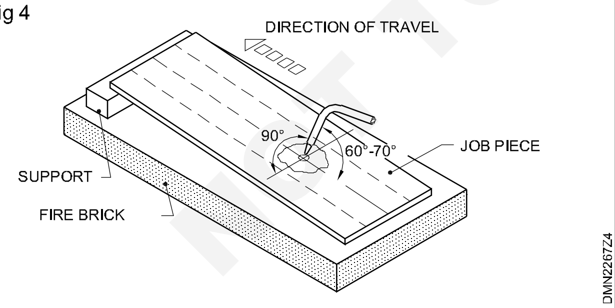
Fig 3



– there is less fatigue to the hand of the operator

– the angle of the nozzle with the welding line is between 60° - 70°. (Fig 4)

Fig 4



Fuse the metal to form a small puddle of molten pool on the job surface at the right end.

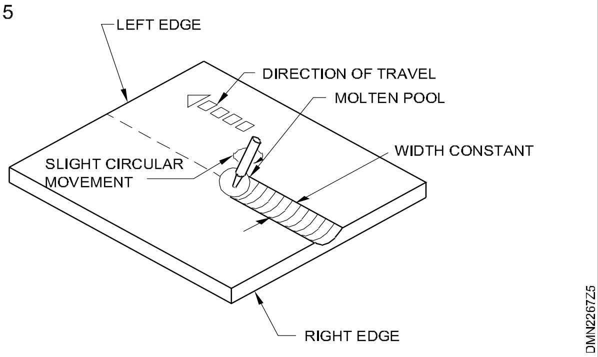
Give slight circular motion to the blowpipe.

Making fusion run without filler rod

Move the blowpipe in the leftward direction as local fusion is obtained.

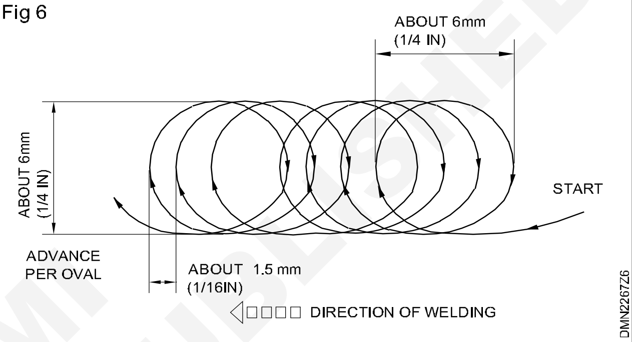
Keep the molten pool on the punch line. (Fig 5)

Fig 5



Maintain constant speed of travel with slight circular motion to the blowpipe. (Fig 6)

Fig 6



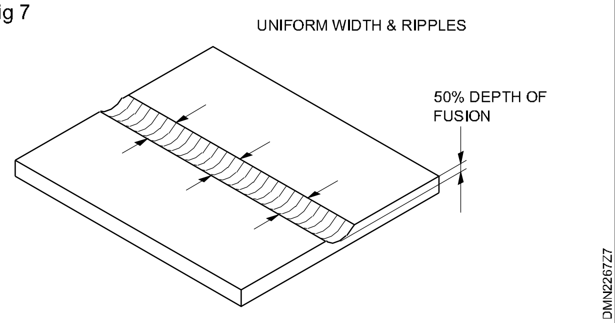
Reduce the blowpipe angle slightly near the left edge and slowly withdraw the flame to avoid burn through at the end.

Maintain 2-3 mm constant distance between the white cone of the flame and the sheet surface for proper heat input and to avoid backfire.

Visual inspection of fusion run

Visual examination can be done to ensure uniform width, ripples and proper depth of fusion (penetration) (Fig 7) for the bead after the welded job is cleaned thoroughly to remove the scales from its surface.

Fig 7



Use tongs while handling hot jobs.

Hand tools for foundary man

© NIMI NOT TO BE REPUBLISHED

Tool of foundryman

Objective(s): At the end of this Ex: you shall be able to
- **recognize the tools of foundry man.**

Fig 1

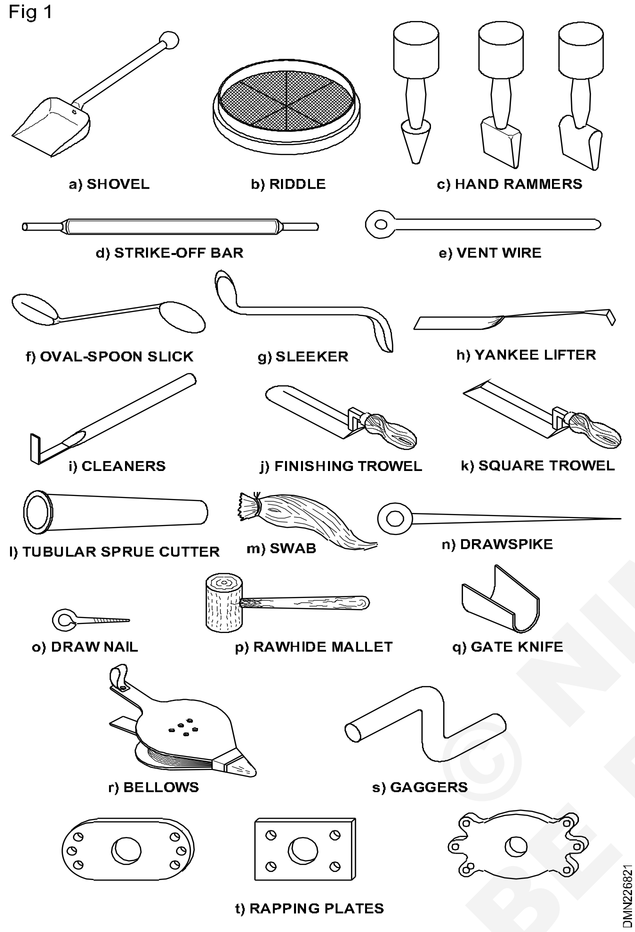


Fig 1 **Hand tools for foundary man**

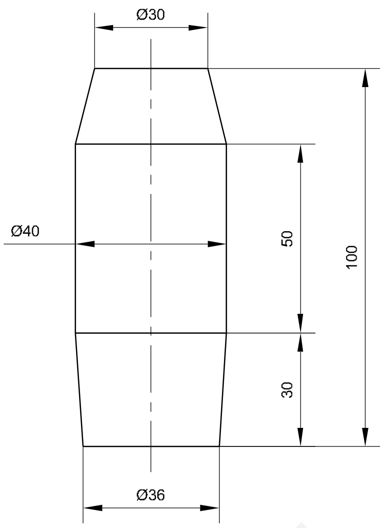
© NIMI NOT TO BE REPUBLISHED

Sl. No.	Name of the tools	Uses
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		

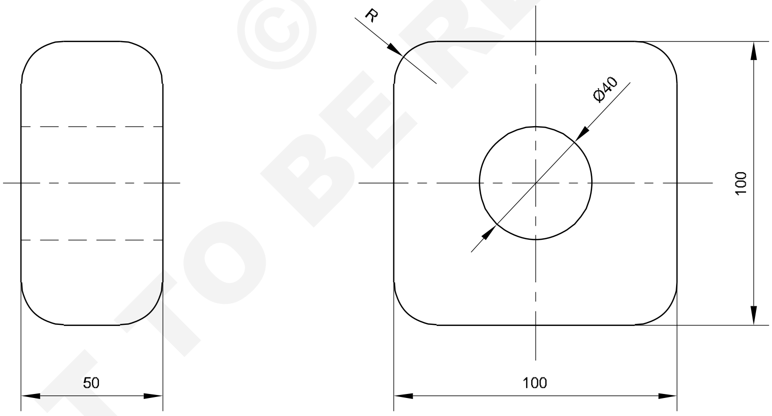
Sl. No.	Name of the tools	Uses
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

Make core and mould for casting

Objective(s): At the end of this Ex: you shall be able to
- **make core for casting using core sand**
- **prepare mould for cast iron casting using core.**



CORE



CASTING

© NIMI NOT TO BE REPUBLISHED

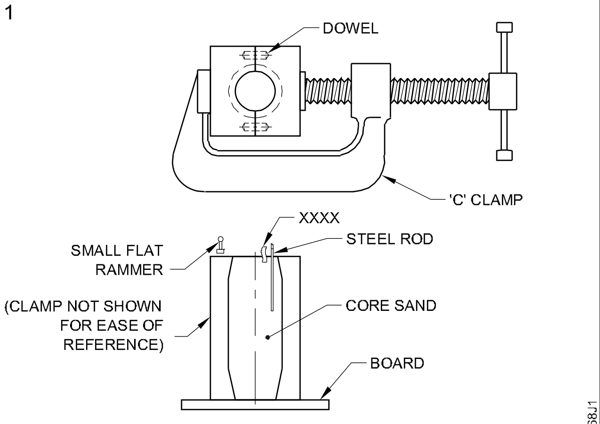
SCALE 1:1	MAKE CORE AND MOULD FOR CASTING	DEVIATIONS $^{+1.5}_{+1.0}$	TIME 25h
		CODE NO. DMN2268E1	

PROCEDURE

TASK 1: **Make core**

- Assemble the two halves of the core boxes by using a `C' clamp duly locating them by dowel pins and dowel holes (Fig 1).
- Keep the assembled core box vertically over a wooden board.

Fig 1



CORE BOX/SAND FILLING
2 HALF BOXES CLAMPED TOGETHER

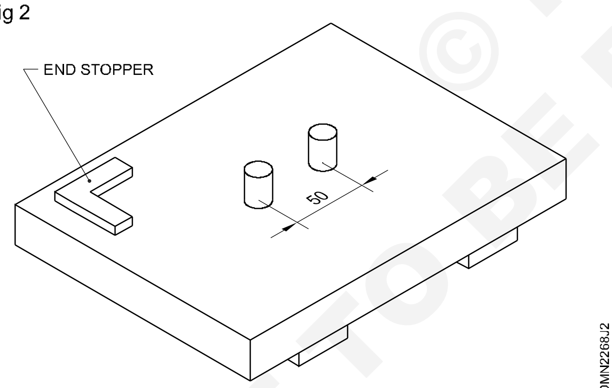
- Fill the core box with core sand and press the sand evenly using rods and rammers.
- Dry the core in sunlight or open air without removing from the box.
- Bring the core box to horizontal position.
- Unclamp and remove the top half of the box carefully.
- Remove the core gently and place it on a wooden board in horizontal position and dry it in open air or in sunlight.
- Remove the unwanted fins and smoothen the surface.
- For additional strength, if needed use water soluble binder like dextrin.
- Apply finely ground refractory coating by dipping or with a brush or by spraying all over the surfaces of the core.
- Dry the core.
- Core is ready for the assembly in the mould.

— — — — — — — — —

TASK 2: **Make Mould**

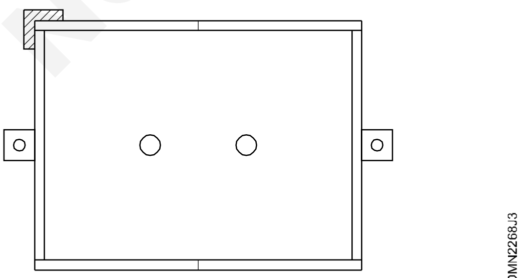
- Clean the turnover mould board and keep it on a level ground. (Fig 2)

Fig 2



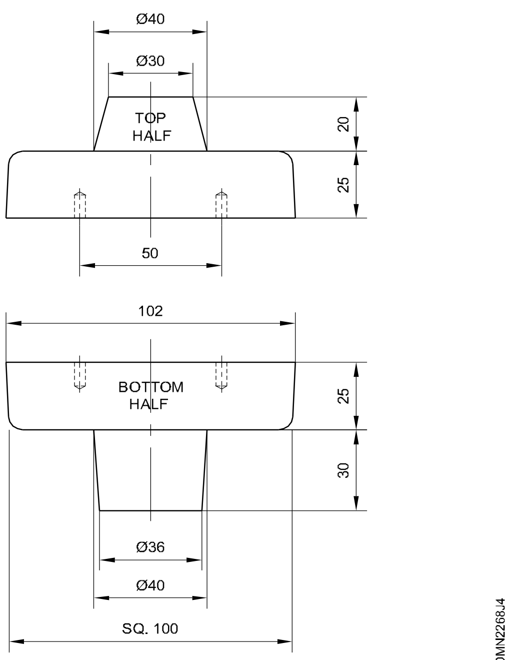
- Place the drag (bottom) box on the board in upside down position, locate with end stopper Fig 3.

Fig 3



- Clean the bottom half the pattern (Fig 4) and place it in upside down position on the board located by dowel pins.

Fig 4



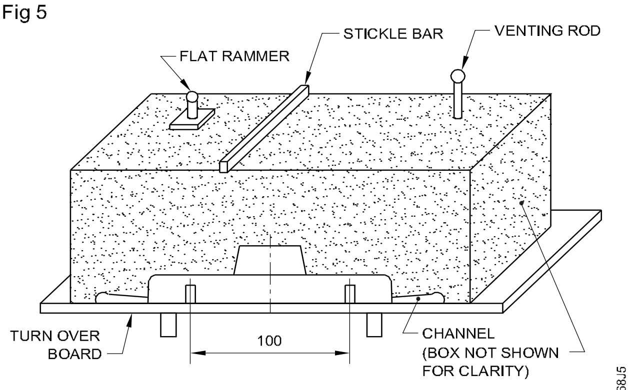
- Place channels on the board and fill up the box with moulding sand around the pattern using hand shovel upto a height of 15 mm above the pattern.
- Ram the sand evenly with a ram adding extra sand as required.

Number of intermittent ramming depends on the depth of sand filled.

© NIMI NOT TO BE REPUBLISHED

- Add more sand to a level of 50 mm above the top of the mould (bottom) box.
- Ram further using flat or butt rammer to get a flat surface 5 mm above the top of the box. (Fig 5)

Fig 5



BOTTOM HALF PATTERN WITH CORE PRINT AS POSITIONED IN BOTTOM (DRAG) BOX

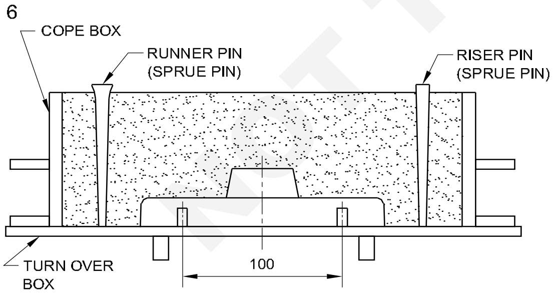
- Remove the extra 5 mm layer with a stickle bar. (Fig 5)
- Sprinkle a light layer of parting sand on the top surface.
- Pierce (vent holes) the sand with a vent rod at a pitch of 40 mm all over the surface. (Fig 5)
- Lift the drag (bottom) box turn it upside down parting sand on the sand area only.

Ensure that the pattern is free from parting sand.

Now bottom mould box with bottom half of the pattern is ready.

Prepare the cope (top) box by using the to half of the pattern (Fig 4) following the procedure for the bottom half of the pattern except that the channels are not required instead of channels place the runner and raiser rods with care at the relative position meeting the channels in the drag box while filling the moulding sand. (Fig 6)

Fig 6



TOP HALF PATTERN WITH CORE PRINT AS POSITIONED IN TOP (COPE) BOX

The top and bottom boxes are ready for mould dressing and core positioning.

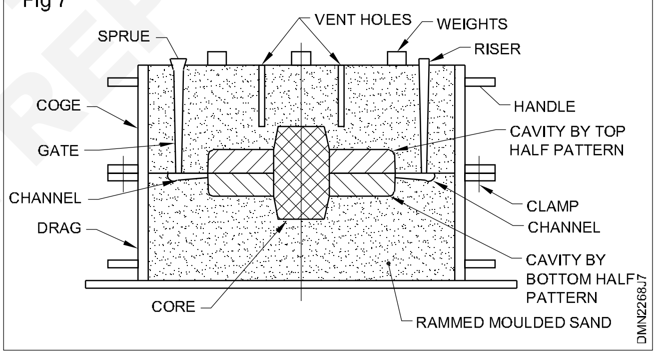
The mould can be mended using trawel, cleaner and sleeker.

- Brush off the extra parting sand in the mould boxes.
- Remove runner and raiser rods carefully.
- Wet the pattern edges with a swale.
- Loosen and lift the patterns from mould boxes using a pattern lifter and lateral tapping.
- Trim the channel connections from sprue to mould cavity and raiser/runner holes for proper flow of molten metal using trowel and cleaners.
- Apply baking sand refractory coating (blacken) in the mould cavity, runner, raiser holes and channel path.
- Blow air to remove foreign material.
- Position the core in the drag (bottom) box mould cavity.

Ensure that the core is vertical in the core print location.

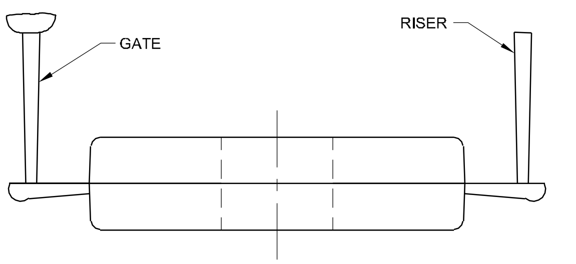
- Align and place the cope (top) box on the drag box carefully.
- Clamp the two boxes together. (Fig 7)
- Mould for the given component is ready for pouring molten metal. (Fig 7)

Fig 7



- Appearance of the casting after removing from the moulding box is shown in Fig 8.

Fig 8



SHAPE OF CASTING AS IT LEAVES THE MOULD BOX

— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Prepare a Simple wiring diagram of a residential room and identifying electrical equipment and measuring instruments

Objective(s): At the end of this Ex: you shall be able to
- **draw the wiring diagram of a building**
- **summaries the number of electrical points.**

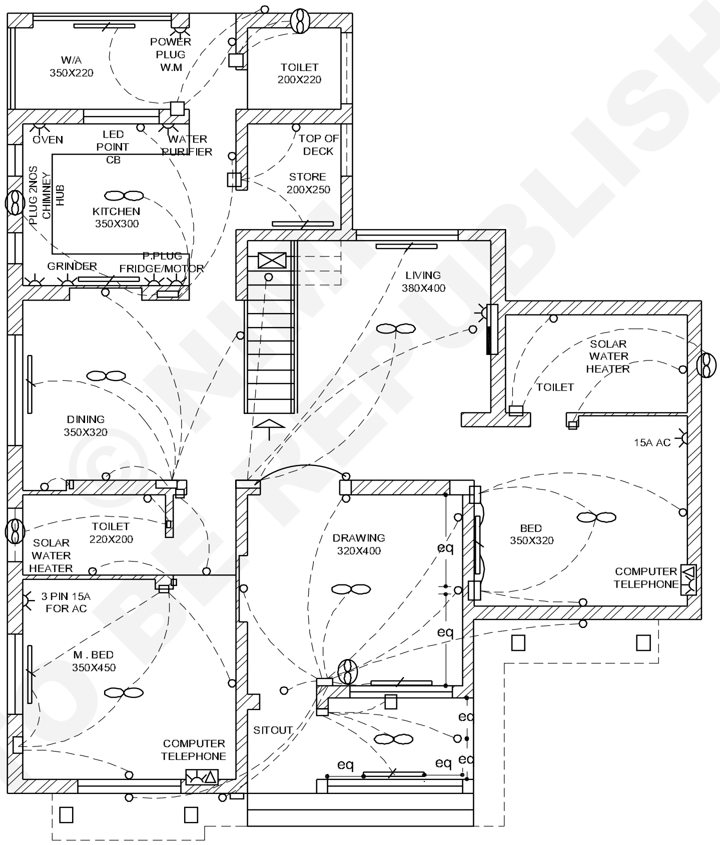
Data : Sizes of rooms are given in the plan

PROCEDURE

1 Draw the plans

2 Draw the symbols of fittings

3 Summaries the points of electrical fittings



LEGEND		
S. No.	PARTICULARS	SYMBOL
1	POWER POINT	
2	TUBE LIGHT	
3	SWITCH BOARD	
4	T.V. POINT	
5	TELEPHONE POINT	
6	CEILING FAN	
7	WALL FAN	
8	FANCY LIGHT	
9	EXHAUST FAN	
10	D.B.	
11	A.C. POWER PLUG	

WIRING DIAGRAM OF A RESIDENTIAL BUILDING

DMN2269E1

© NIMI NOT TO BE REPUBLISHED

Summarization sheet for electrical points									
Sl. No.	Rooms	Equipments number				No. of switches			
1	Sit out	1	2	1	0	6		1	0
2	Drawing room	1	3	1+2	0	8	1	1	-
3	Master bed	1	3	1	0	7	2	2	2
4	Toilet	0	2	0	1	4	0	0	0
5	Dining	1	4	1	0	7	0	1	0
6	Living	1	3	1	0	8	0	1	1
7	Bed	1	2	1	0	5	2	1	2
8	Toilet	0	2	0	1	3	0	0	0
9	Kitchen	1	2	1	1	12	0	1	6
10	Store	1	1	0	0	3	0	0	0
11	Work area	1	2	0	0	5	0	1	1
12	Toilet	0	2	0	1	3	0	0	0
	Total	9	28	9	4	57	12	9	13

Identify the type of electrical instruments

Objective(s): At the end of this Ex: you shall be able to
- **identify the type of instruments (AC/DC) and their function from the dial markings**
- **identify the type of instruments (AC/DC) from the markings on the terminal.**

TASK 1: **Identify the types of instruments (AC/DC) and their functions from the dial marking.**

1 Identify the instruments shown in Figs 1 & 2 for the type DC, AC or both - with reference to Chart. Record your response in Table 1.

2 Identify the functions of instruments by referring to the symbol on the dial. (Figs 1 & 2) Record the observation in Table 1.

3 Identify the instruments shown in Figures 3 to 8, as a single or multi-scale/ multi-range instruments and the functions. Record your response in Table 2.

NOT TO BE REPUBLISHED © NIMI

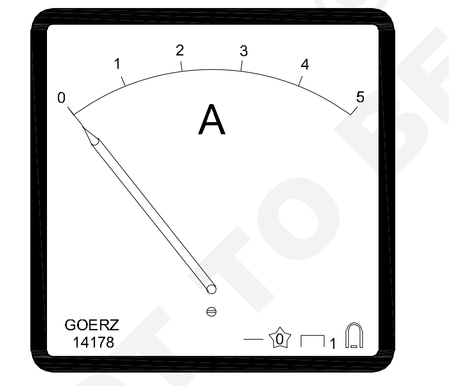
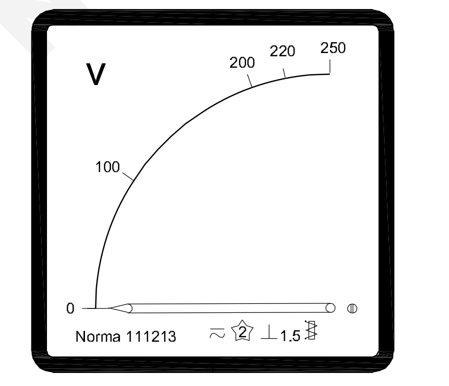
CHART 1

SYMBOLS FOR CHARACTERISING ELECTRICAL MEASURING INSTRUMENTS.

	MOVING COIL MEASURING ELEMENT
	MOVING COIL MEASURING ELEMENT WITH RECTIFIER
	MOVING IRON MEASURING ELEMENT
—	TYPE OF CURRENT: ONLY DIRECT CURRENT
~	TYPE OF CURRENT: ONLY ALTERNATING CURRENT
$\overline{\sim}$	DIRECT AND ALTERNATING CURRENT
⊥	POSITION FOR USE: VERTICAL
⊓	POSITION FOR USE: HORIZONTAL
1	INDICATION ERROR 1% ±
2.5	INDICATION ERROR 2.5% ±
3.5	INDICATION ERROR 3.5% ±
☆2	TEST VOLTAGE: 2 kV=2000 V
⚠	OBSERVE INSTRUCTIONS FOR USE

DMN2269H1

TABLE 1

Instrument	Symbol	Type AC/DC	Function
Fig 1 			
Fig 2 			

© NIMI NOT TO BE REPUBLISHED

TABLE 2

Instrument	Range:single or multi-range	Scale single or multi-scale	Function V or A or ohms
Fig 3			
Fig 4			

Fig 3

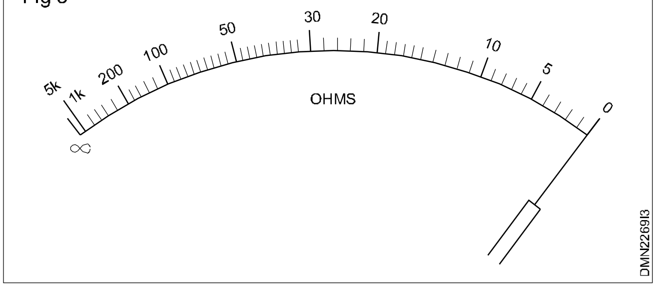
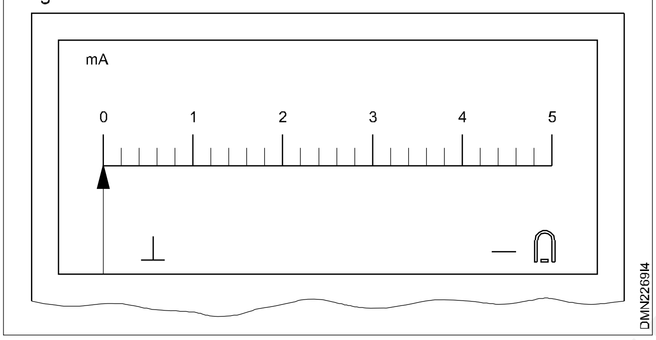


Fig 4



Instrument	Range:single or multi-range	Scale single or multi-scale	Function V or A or ohms
Fig 5			

Fig 5

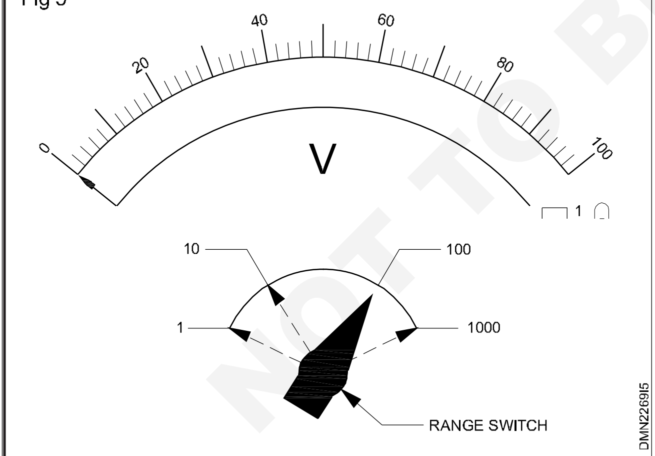


Fig 6

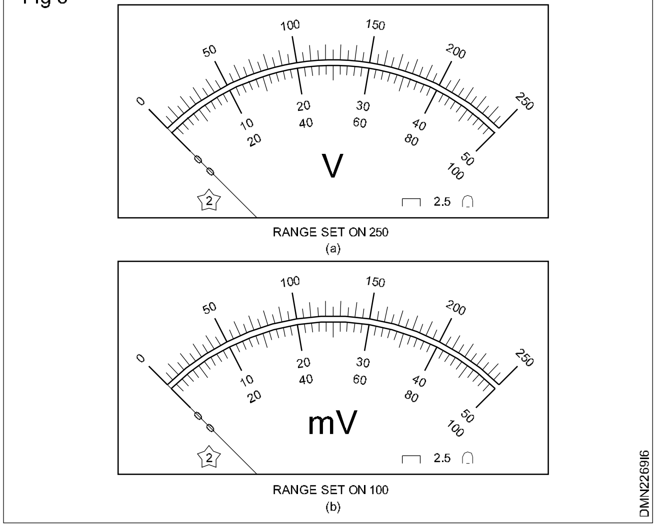
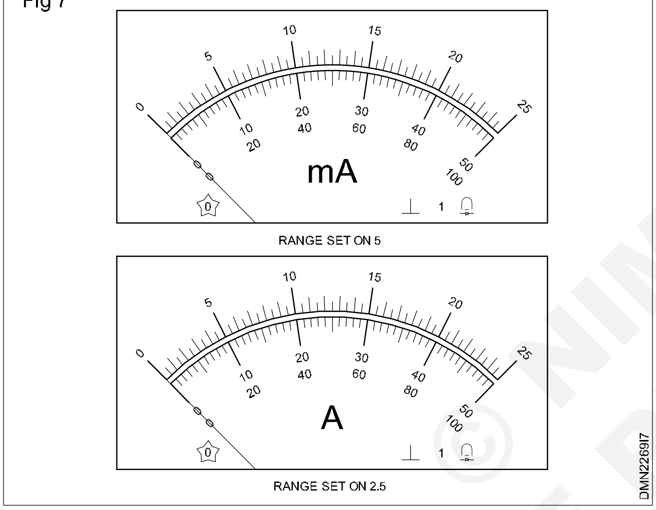
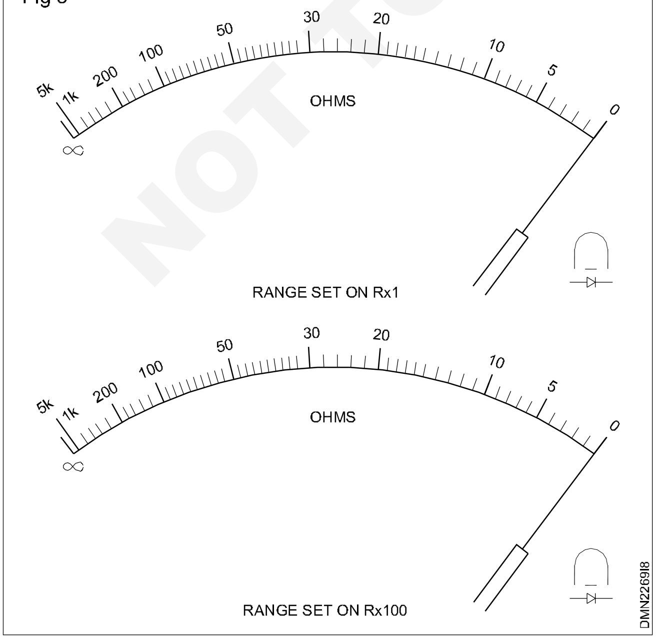


Fig 7



Instrument	Range:single or multi-range	Scale single or multi-scale	Function V or A or ohms

Fig 8



© NIMI NOT TO BE REPUBLISHED

- Identify the working position, accuracy (error of indication), type and function of the instruments in Figs 1 & 2 and record in Table 3.
- Further identify the given instruments from the laboratory and fill up the details in Table 3.

TABLE 3

Instrument	Type	Function	Accuracy	Working position
	Symbol Description	Symbol Description	Symbol Description	Symbol Description
Figure 1				
Figure 2				
Lab instrument				
Lab instrument				
Lab instrument				
Lab instrument				

The serial number of the instrument and other distinct marks should be entered under the 'instrument' column.

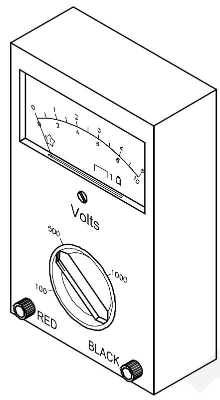
— — — — — — — —

TASK 2: **Identify the type of instrument (AC/DC) from the marking of the terminals**

1 Identify the connecting terminals of the instrument in the given Figs 1 to 3.

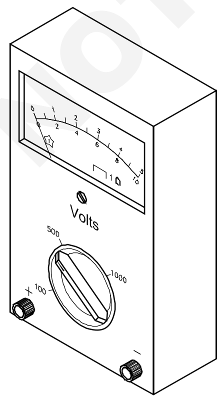
2 Note down the mark in the terminals shown in Figs 1 to 3 and record in Table.

Fig 1



DMN2269J1

Fig 2



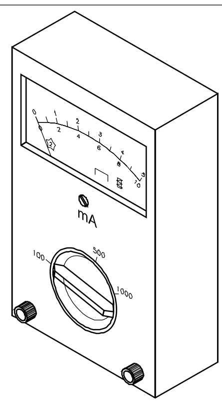
DMN2269J2

If the terminals are marked (+) and (–) or anyone of them is coloured red, the meter normally is a DC meter or MC meter.

If there is no terminal marking, then the meter normally is an AC/DC or MI-meter.

3 Refer to Figs 1, 2 & 3 and identify the type of instrument, their function and record in Table.

Fig 3



DMN2269J3

4 Identify the given instruments from the lab and enter the details in Table 4.

(The instrument serial number or other distinct marks should be entered under Inst. No.)

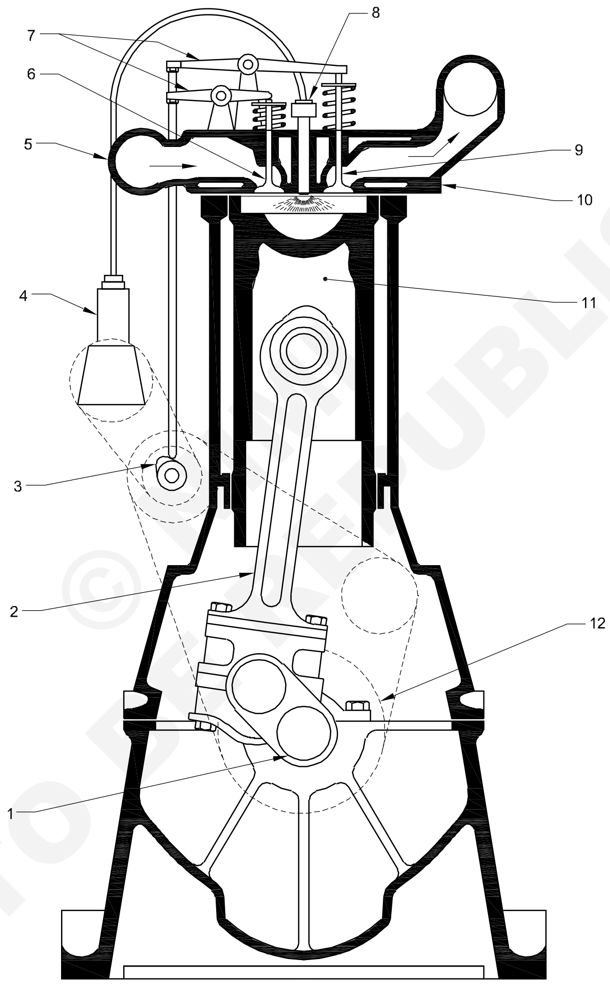
TABLE 4

Sl.No.	Inst. No.	Polarity	Function	Type
1	Fig 1			
2	Fig 2			
3	Fig 3			

© NIMI NOT TO BE REPUBLISHED

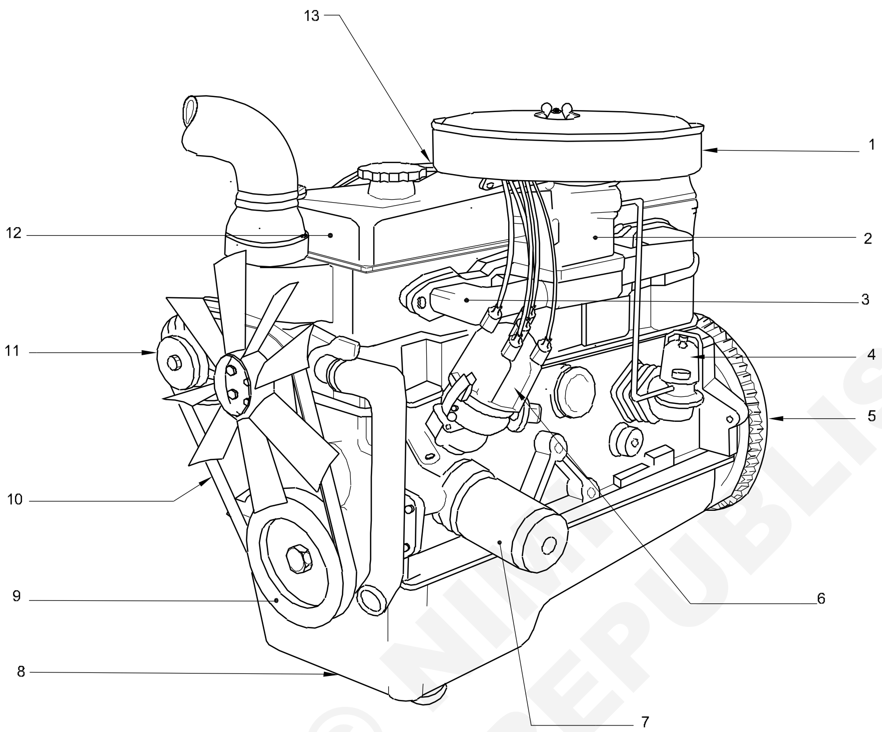
Identification of different parts of I.C. engine - four stroke (diesel)

Objective(s): At the end of this Ex: you shall be able to
- **identify and get familiarised with the critical parts of 4 stroke IC engine (Diesel and Petrol)**
- **identify and get familiarised with the critical parts of 2 stroke IC engine.**



© NOT TO BE REPUBLISHED

SCALE : NTS	IDENTIFICATION OF DIFFERENT PARTS OF I.C. ENGINE - FOUR STROKE (DIESEL)	EX NO. 2.2.70
		TIME : 15hrs
PROJECTION		CODE : DMN2270E1



© NIMI NOT TO BE REPUBLISHED

SCALE : NTS	IDENTIFICATION OF DIFFERENT PARTS OF I.C. ENGINE - FOUR STROKE (PETROL)	EX NO. 2.2.70
		TIME :
PROJECTION		CODE : DMN2270E2

PROCEDURE

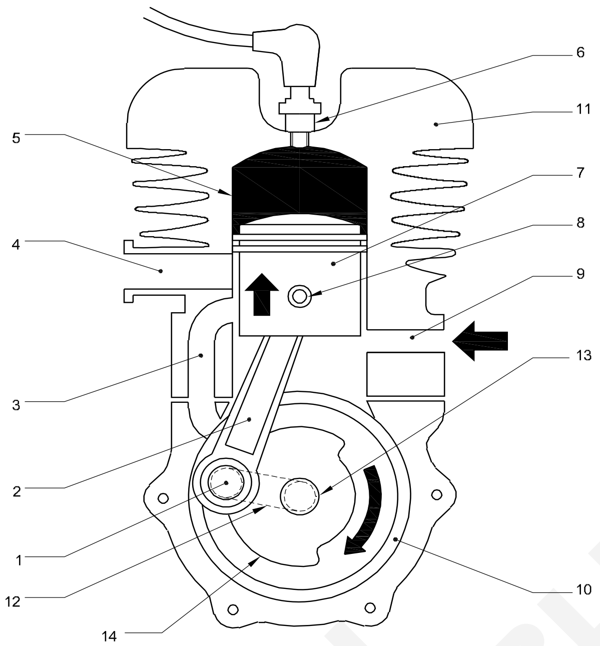
TASK 1:

4 Stroke Diesel Engine (Compression ignition)

Identify the various parts of a four stroke diesel engine and familiar with functions of critical parts after studying the sectional model of the actual engine in the workshop.

The following are the important parts of a 4 Stroke Diesel engine.

1 Crankshaft
2 Connecting rod
3 Cam and Camshaft
4 Fuel pump
5 Inlet manifold
6 Inlet valve
7 Rocker arm
8 Fuel Nozzle
9 Outlet valve
10 Cylinder head
11 Piston
12 Flywheel



SCALE : NTS	**IDENTIFICATION OF DIFFERENT PARTS OF I.C. ENGINE - TWO STROKE**	EX NO. 2.2.70
		TIME : 10hrs
PROJECTION		CODE : DMN2270E3

© NIMI NOT TO BE REPUBLISHED

TASK: 2

4 Stroke Petrol engine (Spark ignition)

The following are the important parts of a 4 Stroke Petrol engine.

1 Air-cleaner
2 Carburetor
3 Inlet manifold
4 Fuel pump
5 Flywheel
6 Distributor
7 Oil filter
8 Oil sump
9 Crankshaft pulley
10 Fan belt
11 Dynamo
12 Valve cover
13 Spark plugs

TASK: 3

2 Stroke - IC engine

Identify and name the critical parts of 2 stroke - IC engine shown in figure after studying the sectional model of the engine.

The critical parts of a 2 Stroke engine are as follows:

1 Crankpin
2 Connecting rod
3 Transfer rod
4 Exhaust port
5 Cylinder bore
6 Spark plug
7 Piston with rings
8 Small end bearing
9 Inlet port
10 Crankcase
11 Cylinder head
12 Crankshaft
13 Main bearing
14 Flywheel

Draughtsman Mechanical - Tolerances - machining symbol - surface finishing symbols - geometrical tolerances sectional views

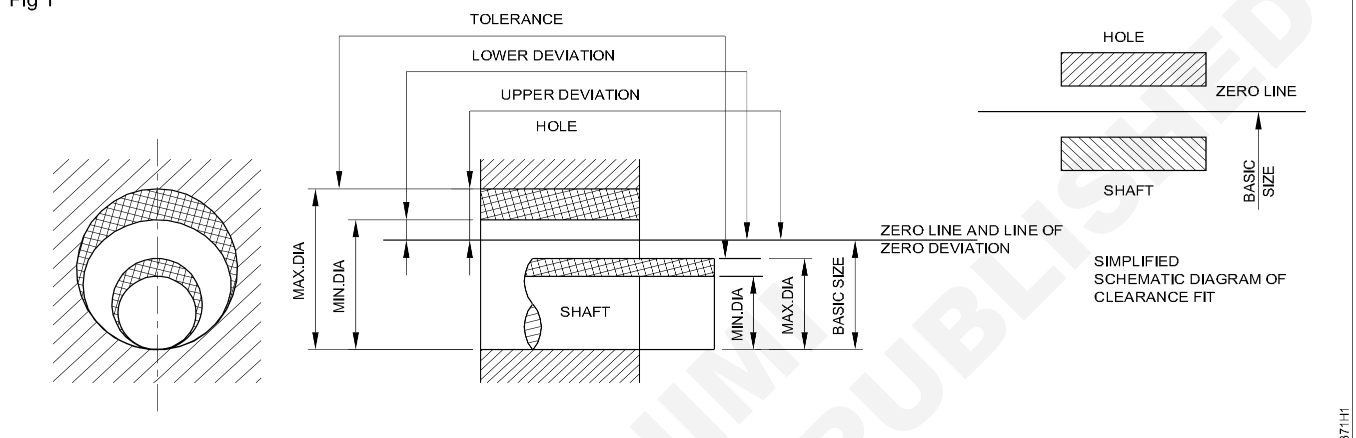
Draw the diagram illustrating basic size - deviation and tolerances

Objective(s): At the end of this exercise you shall be able to
- **draw the diagram illustrating basis size deviation and tolerances**
- **draw the diagram illustrating the hole basis and shaft basis system.**

PROCEDURE

TASK 1: **Basic size deviation and tolerances (Fig 1)**

Fig 1



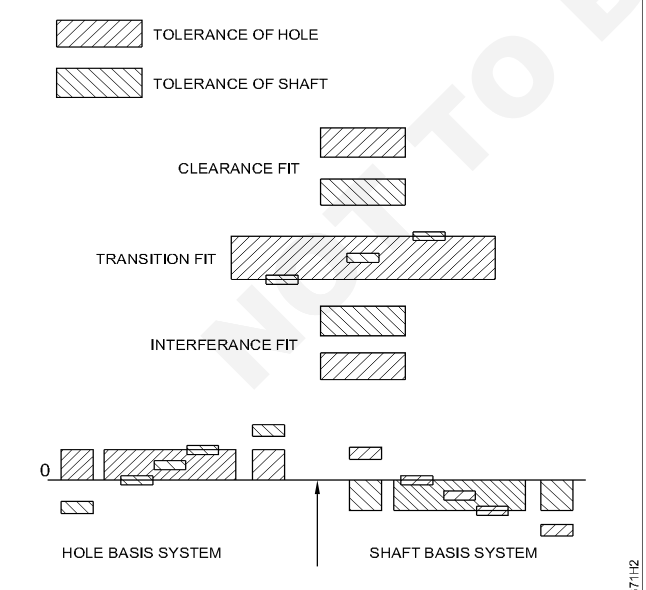
BASIC SIZE DEVIATIONS AND TOLERANCES

— — — — — — — —

TASK 2: **Ilustrating the hole basic and shaft basic system (Fig 2)**

The three classes of fits, both under the hole basis and the shaft basis are illustrated in fig 2.

Fig 2



ILLUSTRATING THE HOLE BASIS AND SHAFT BASIS SYSTEMS

— — — — — — — —

Draw the symbols for machining and surface finishes (Grades and micron valves)

Objective(s): At the end of this exercise you shall be able to
- **draw the surface roughness value (micron)**
- **draw the surface roughness symbol and grade**
- **draw the position of machining surface finish**
- **draw the surface roughness manufacturing process**
- **draw the indication of machining symbols is different parts.**

PROCEDURE

TASK 1:

The surface finish (roughness or smoothness) of components is expressed by any one of the following.

Roughness number

Grade number

Roughness symbol.

The most accepted method of representing roughness is by Grade Number or Roughness Number. The use of roughness symbol is not a common practice though some manufacturing concerns are still continuing to use them.

Roughness value - grade number

The roughness value represents the average departure of the surface from perfection over a prescribed length, and is expressed in micrometers. One micrometer will be equal to 0.001 mm (mm) and

1 mm = 0.0001 mm.

It is possible to achieve surfaces of any given roughness value. But for standardisation purposes only a few values are recommended in the Indian Standard. The Roughness values and corresponding grade numbers are given in Table 1.

TABLE 1

Roughness values Ra values in microns (Micrometre)	Roughness Grade number
50	N12
25	N11
12.5	N10
6.3	N9
3.2	N8
1.6	N7
0.8	N6
0.4	N5
0.2	N4
0.1	N3
0.05	N2
0.025	N1

— — — — — — — —

TASK 2:

Roughness symbols

These symbols indicate the practice followed in the industry, and are given here for guidance only. IS : 3073- 1967 (Table 2) states this as Assessment of Surface Roughness.

TABLE 2

In order to obtain the required surface quality, it is necessary to choose the appropriate manufacturing process.

TABLE 2

ROUGHNESS GRADE	ROUGHNESS SYMBOL
N12	∼
N11 N10	▽
N9 N8 N7	▽▽
N6 N5 N4	▽▽▽
N3 N2 N1	▽▽▽▽

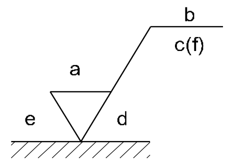
© NIMI NOT TO BE REPUBLISHED

TASK 3:

POSITION OF THE SPECIFICATION OF SURFACE TEXTURES IN THE DRAWING

The specification of surface roughness and other surface texture features should be placed relative to the symbol as shown in Fig 1.

Fig 1



a = Roughness value Ra or

Roughness grade No.N1 to N12 or

b = Production method, treatment or coating

c = Sampling length

d = Direction of lay

e = Machining allowance

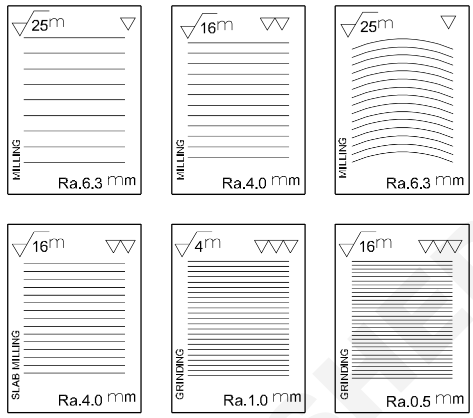
f = Other roughness values in brackets

Surface finish standard

One method of determining the surface roughness is by using a surface finish standard. (Fig 2) This is a box which consists usually of 20 blocks, each of a specific surface finish attained by a specific machining operation.

The type of machining operation is marked on each block together with the surface roughness number for height and width. Using a surface finish standard, we can make comparisons between the machined surface and the standard surface using our sense of touch.

Fig 2



However, this method is sometimes not accurate enough and the individual must be very sensitive to the different surface roughness.

If the degree of accuracy of checking is high, then the application of sensitive instrument is inevitable.

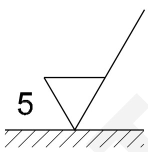
Note: More detailed information on surface texture, symbols and their representations refer IS : 10719.

— — — — — — — —

TASK 4: **Identification of machining symbols**

Machining allowance in mm (Fig 3)

Fig 3



Indication on drawings: The symbol as well as the inscriptions, should be orientated of such that they may be read from the bottom of the right-hand side of the drawing. (Figs 4 & 5)

Fig 4

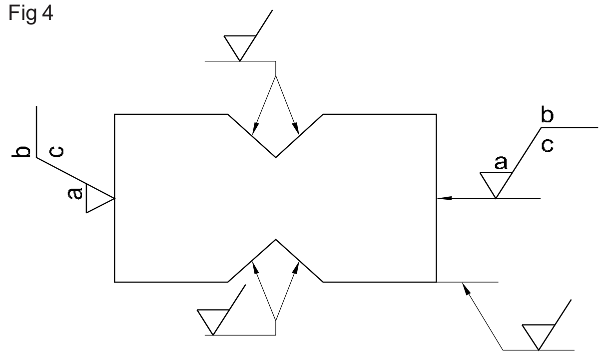
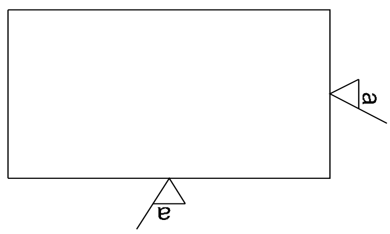


Fig 5



© NIMI NOT TO BE REPUBLISHED

General principles of dimensioning the symbol (Figs 6 & 7)

Fig 6

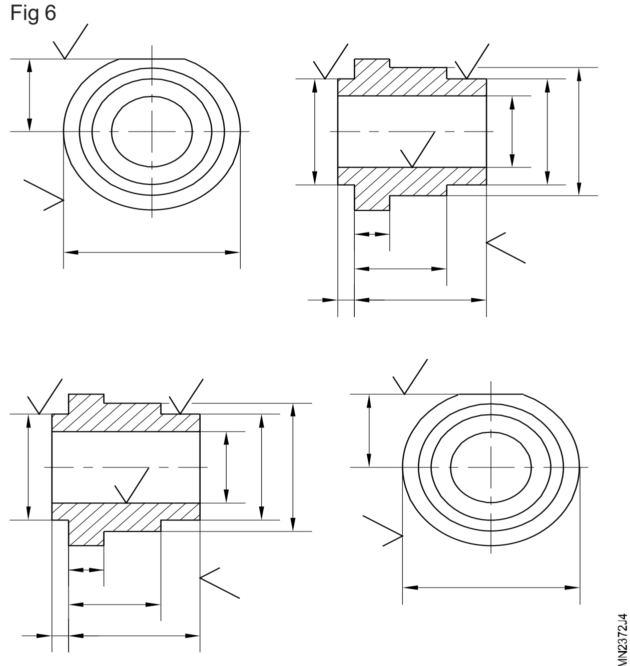
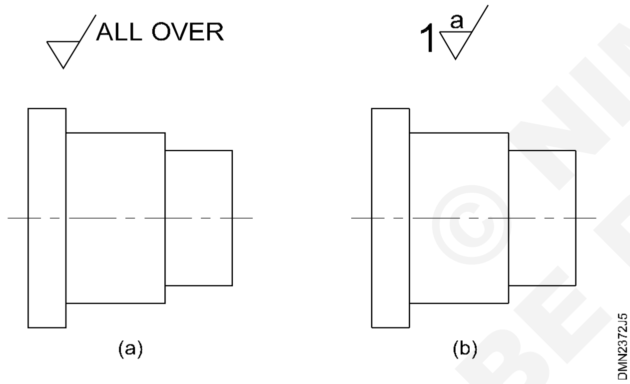
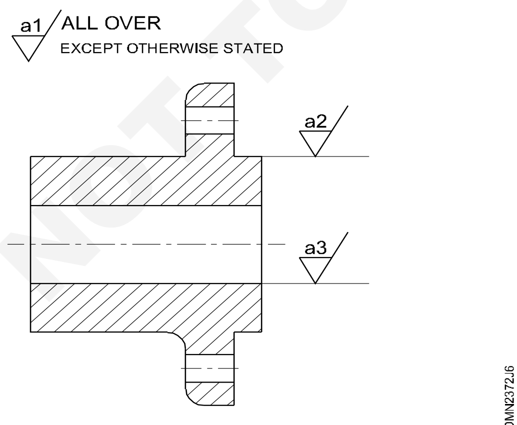


Fig 7



Notation of symbol (Fig 8)

Fig 8



Basic symbol (in brackets) without any other indication (Fig 9)

Symbol (in brackets) of special surface roughness (Fig 10)

Avoid repetition of symbols (Fig 11)

Fig 9

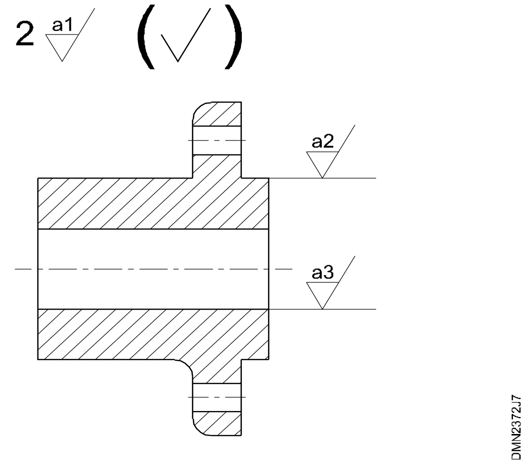


Fig 10

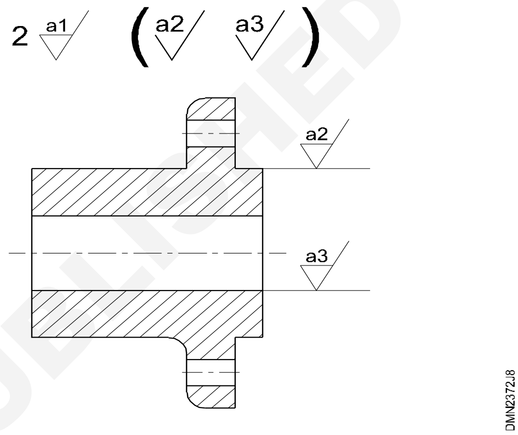
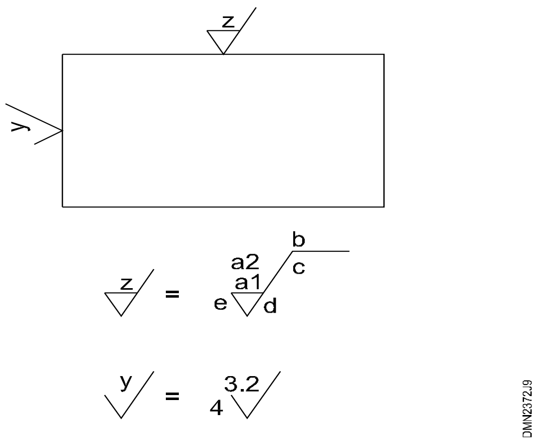
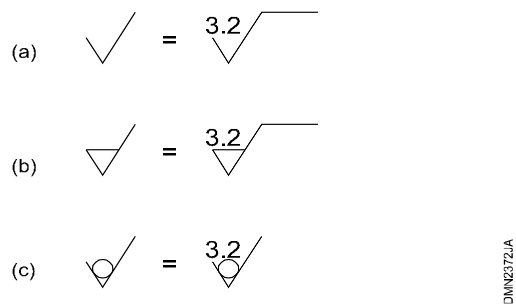


Fig 11



The symbols for surface roughness which are exceptions to the general symbol are indicated on the corresponding surfaces near the title block or in the space devoted to general notes. (Fig 12)

Fig 12



© NIMI NOT TO BE REPUBLISHED

Draw the system of indication of geometrical tolerances of position as per standard

Objective(s): At the end of this exercise you shall be able to
- **draw the recommended symbols for geometrical tolerance**
- **draw the general principle of geometrical tolerance.**

PROCEDURE

TASK 1: **Symbols for geometrical tolerance.**

Tolerances of FORM are identified by the use of symbols for the for the following characteristics.

Characteristics	Symbols
Straightness	—
Flatness	⏥
Roundness	○
Cylindricity	⌭
Profile of a line	⌒
Profile of a surface	⌓

TASK 2: **Frame for indicating geometrical tolerance (Figs 1 & 2)**

Fig 1

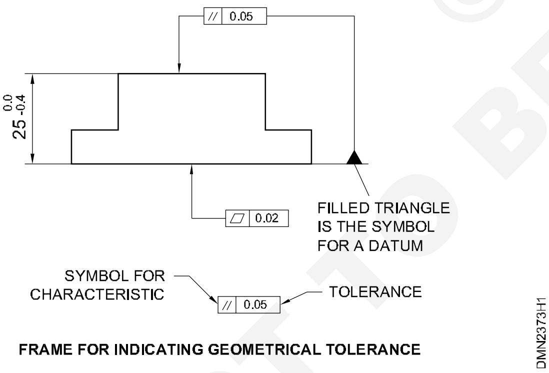
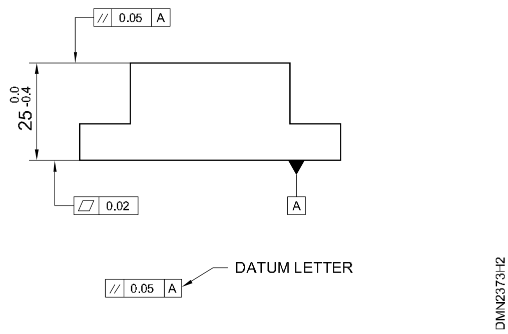


Fig 2



© NIMI NOT TO BE REPUBLISHED

Draw the machine part indicating geometrical tolerances

Objective(s): At the end of this exercise you shall be able to
- **application and tolerance for different characteristics.**

PROCEDURE

TASK 1: **Method of applying geometrical tolerance of different character (Figs 1,2 & 3)**

Fig 1

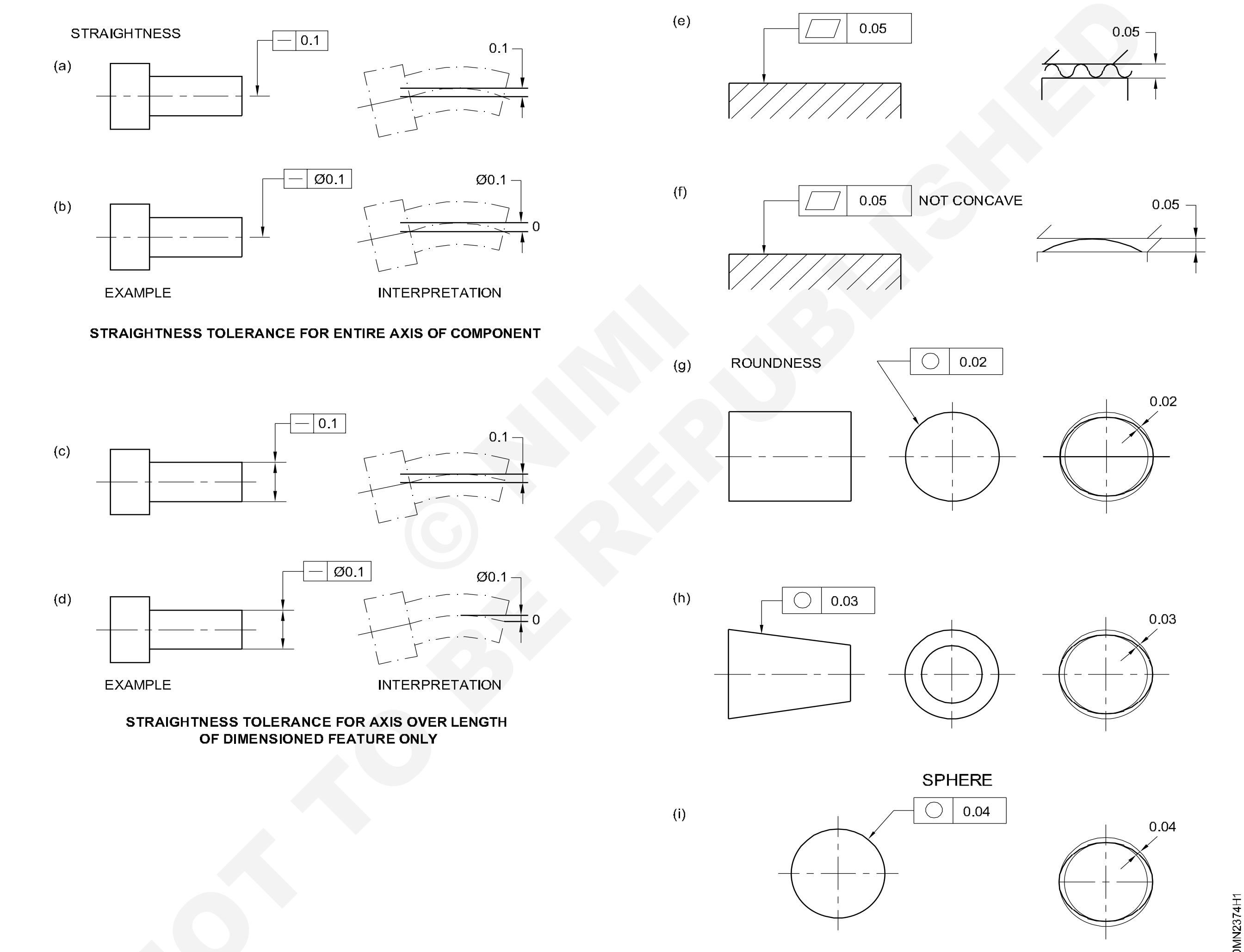


Fig 2

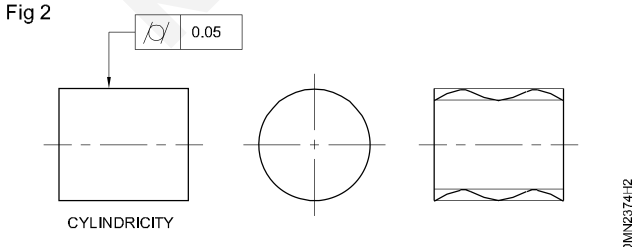
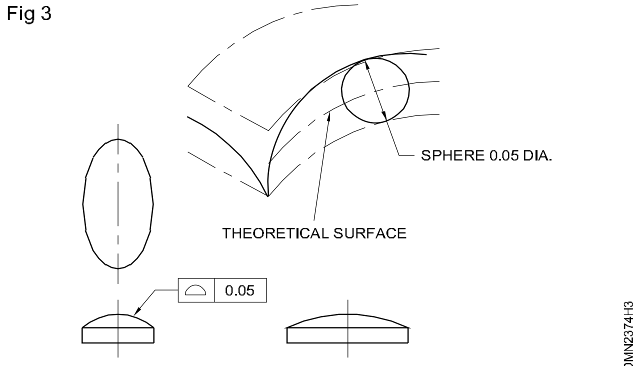


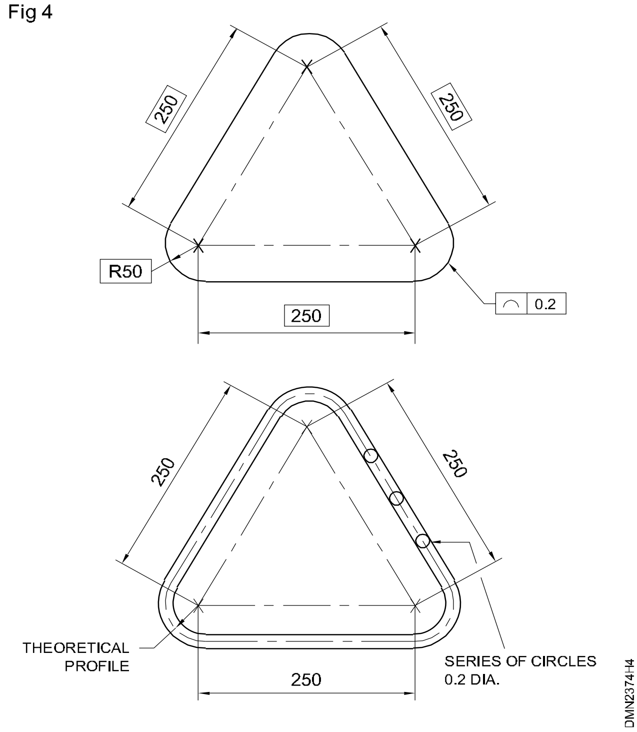
Fig 3



© NIMI NOT TO BE REPUBLISHED

TASK 2: **Application of geometrical tolerance of linear dimensions (Fig 4)**

Fig 4

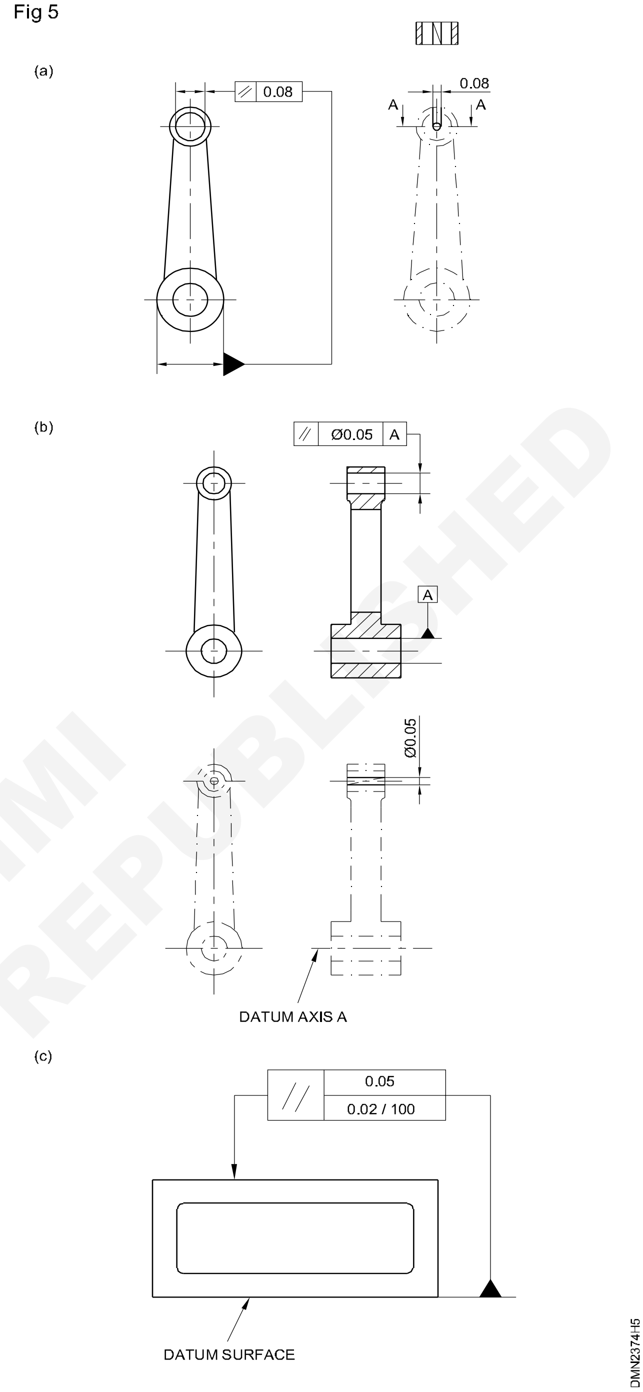


TASK 3: **Application of tolerance for three characteristics**

Characteristics	Symbol
Parallelism	//
Squareness	⊥
Angularity	∠

Figure 5 a,b and c indicates application of tolerance of control parallelism.

Fig 5

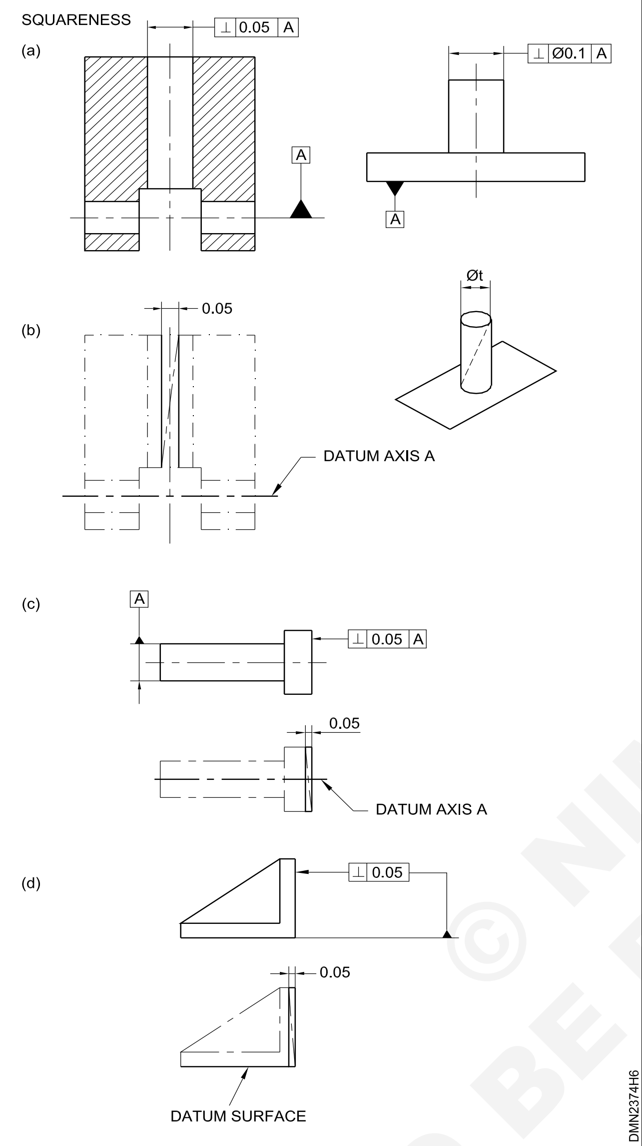


— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

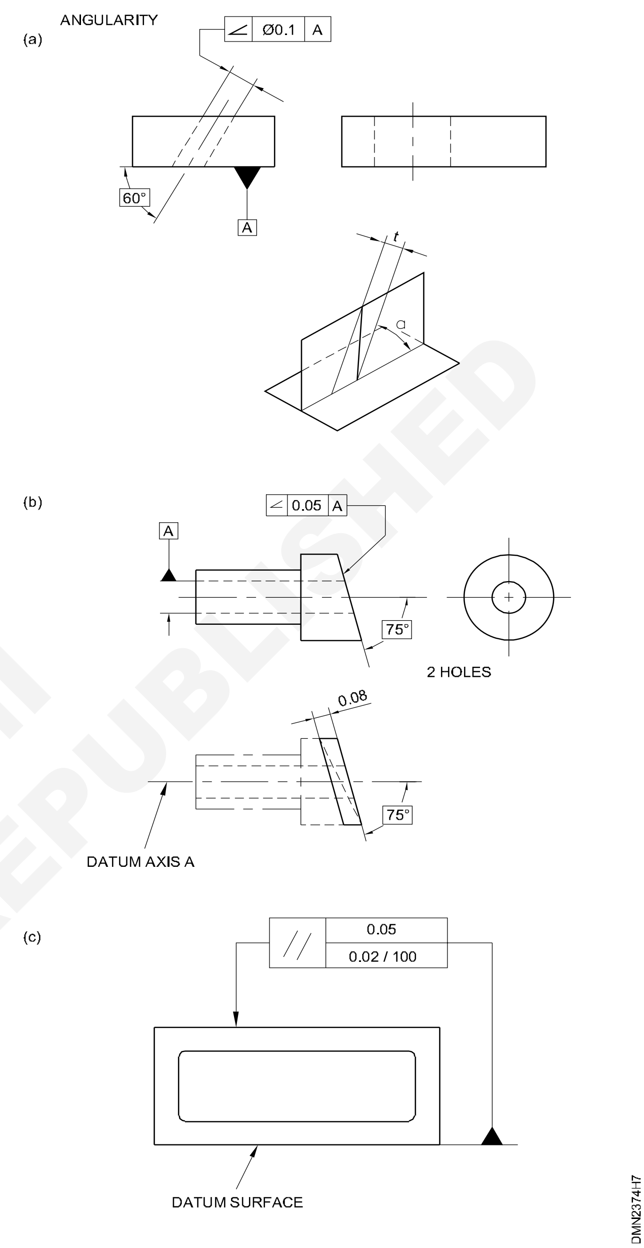
TASK 4: **Application of geometrical tolerance for "Squareness" (Fig 6)**

Fig 6



TASK 5: **Application of tolerance for the control of angularity (Fig 7)**

Fig 7



— — — — — — — —

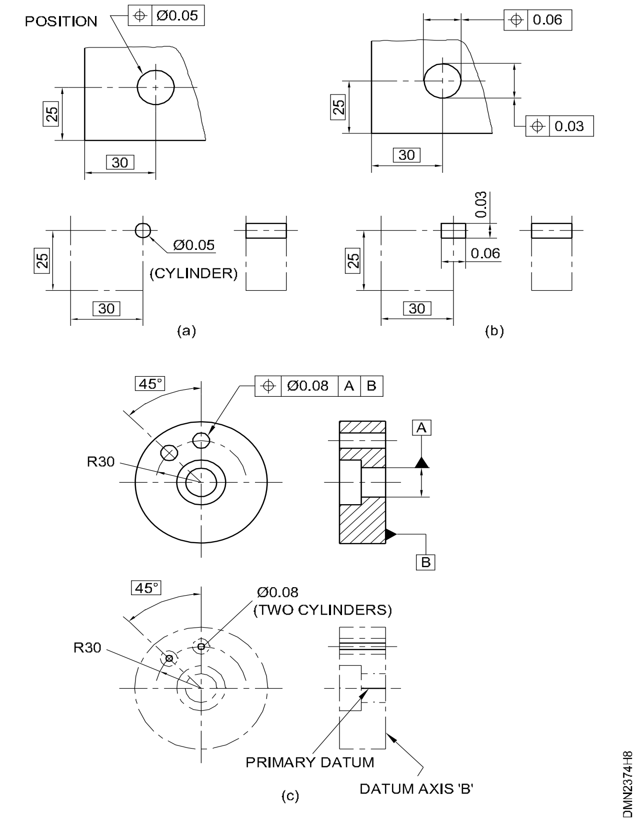
TASK 6: **Application of geometrical tolerance**

Characteristics	Symbol
Position	⌖
Concentricity	◎
Symmetry	⌯

© NIMI NOT TO BE REPUBLISHED

Characteristic of position (Fig 8)

Fig 8



Characteristics of concentricity (Fig 9)

Fig 9

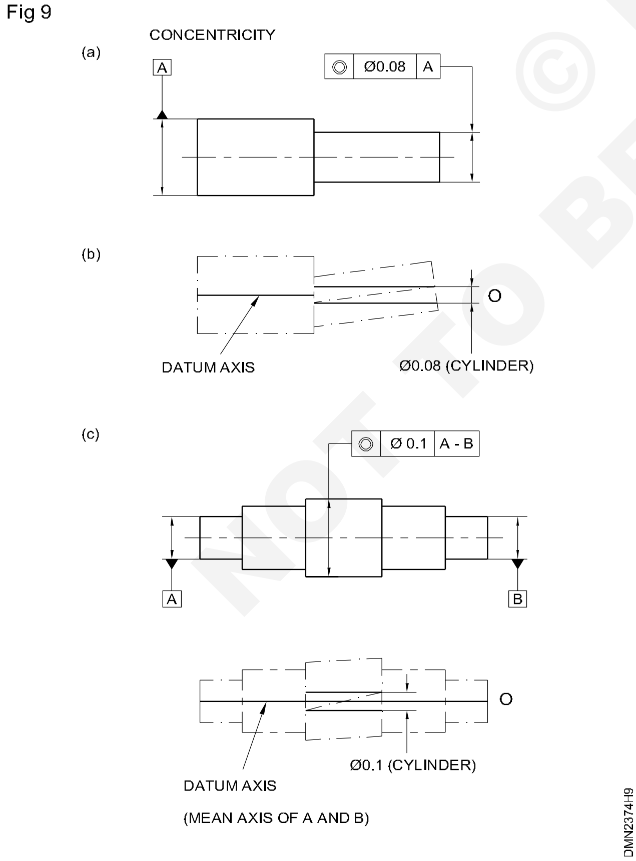


Fig 10

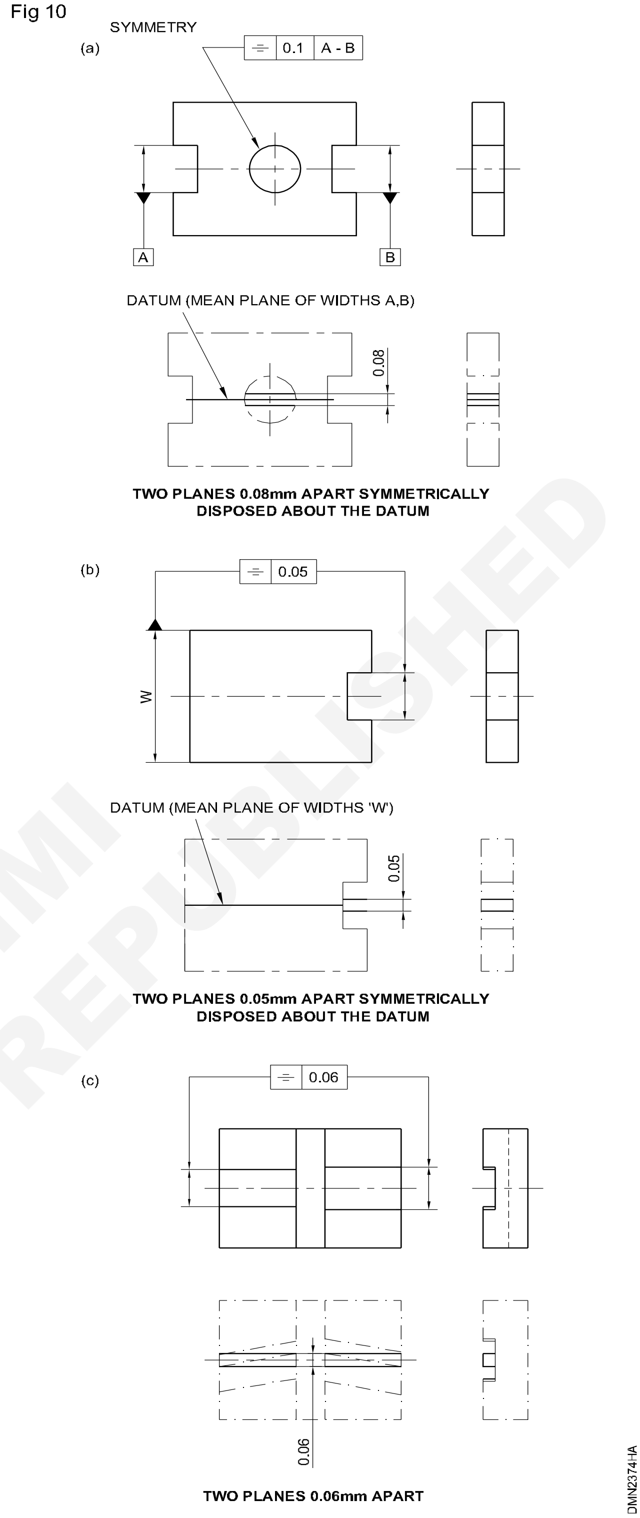
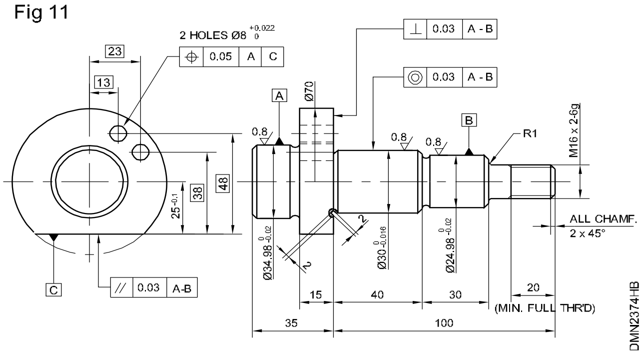


Fig 11



Characteristics of symmetry (Fig 10)

Details of geometrical tolerance (Fig 11)

© NIMI NOT TO BE REPUBLISHED

Draw the sectional views of muff couplings

Objective(s): At the end of this exercise you shall be able to
- **draw the sectional plan and side view**
- **draw the detailed drawings.**

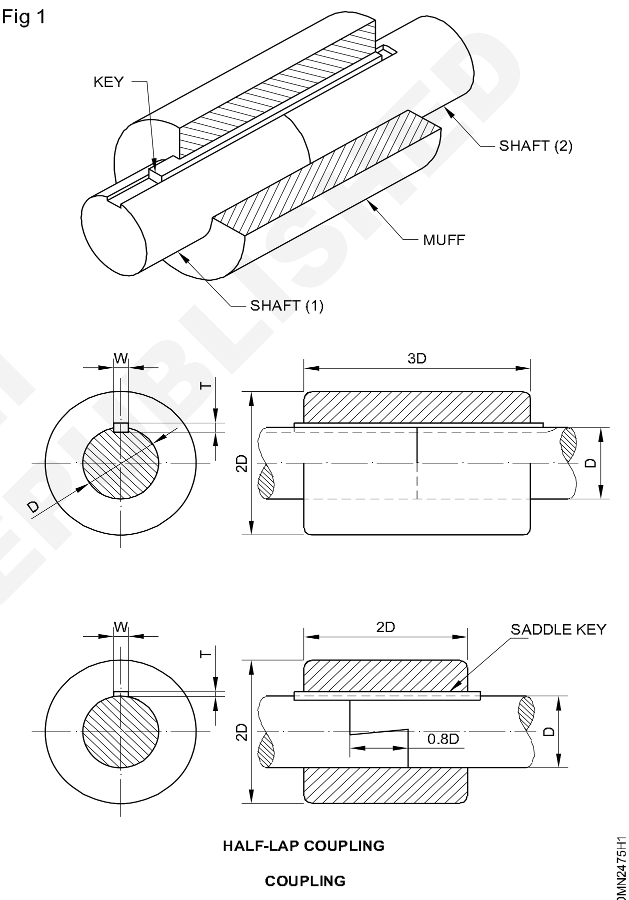
PROCEDURE

TASK 1**: Draw the detailed drawings of**

i Box of muff coupling/Sleeve coupling

ii Half lap coupling (Fig 1)

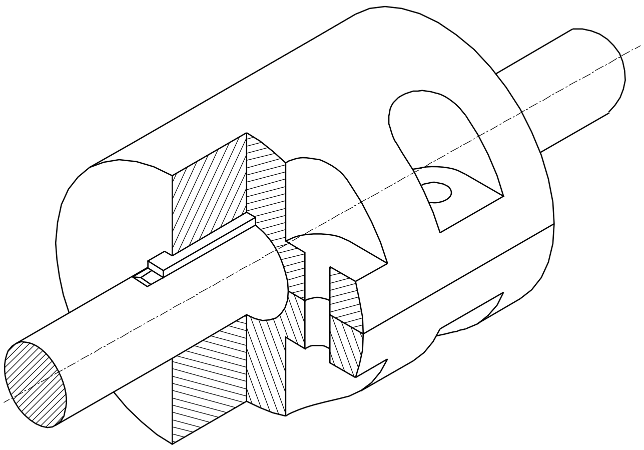
Fig 1



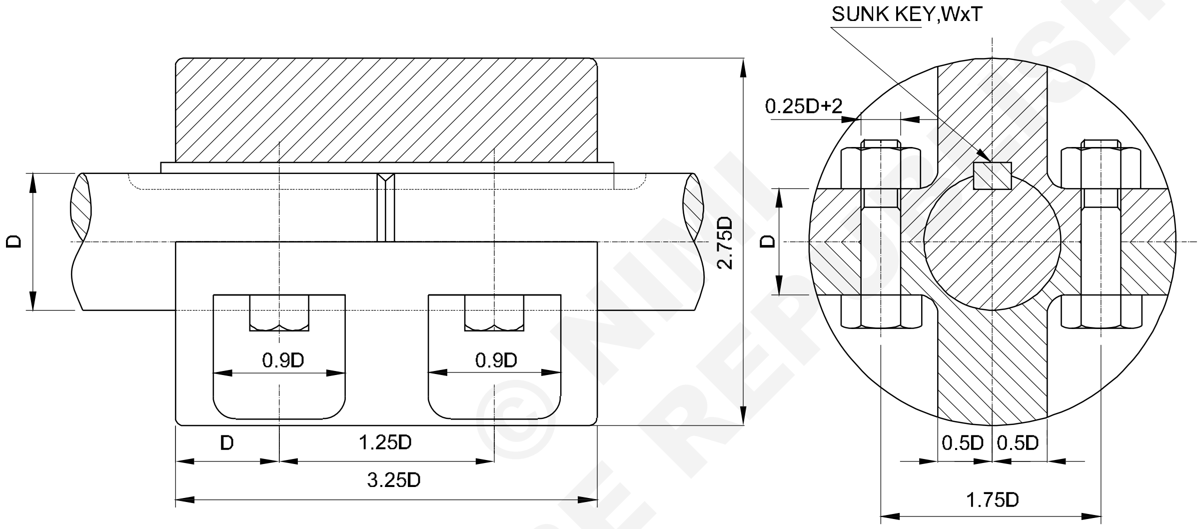
© NIMI NOT TO BE REPUBLISHED

TASK 2: **Draw the detailed drawing of split muff coupling and reproduce the assembly of the split muff coupling (Fig 2)**

Fig 2



(a)



(b)

SPLIT-MUFF COUPLING

NOT TO BE REPUBLISHED © NIMI

— — — — — — — —

Draw the detailed & assembly drawing of flange coupling

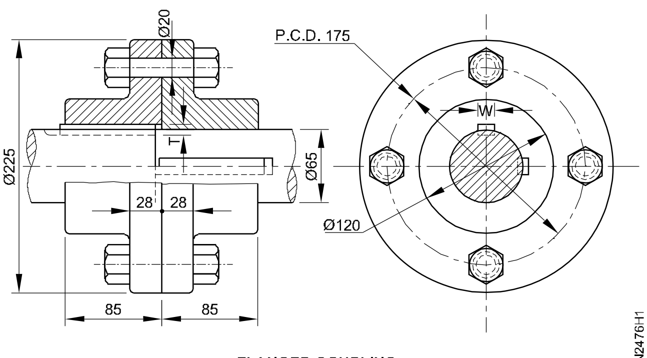
Objective(s): At the end of this exercise you shall be able to
- **reproduce the given sectional views**
- **draw the detailed working drawing of the couplings**
- **prepare bill of material.**

PROCEDURE

TASK 1:

a Reproduce the given flange coupling sectional deviation and side view (Fig 1)

Fig 1



FLANGED COUPLING

b Draw the detailed working drawing of the flanged coupling

c Prepare the bill of material

i Outside diameter of hub = 2 d

ii Pitch circle diameter of the bolts = 2.8 to 3 d

iii Thickness of the flange = 0.5 d

iv Thickness of the protective circumferential flange = 0.25 d

v Length of the hub = 1.5 d

vi No. of bolts. n = 3 for shaft diameter upto 40 mm
= 4 for shaft diameter upto 100 mm
= 6 for shaft diameter upto 180 mm

— — — — — — — —

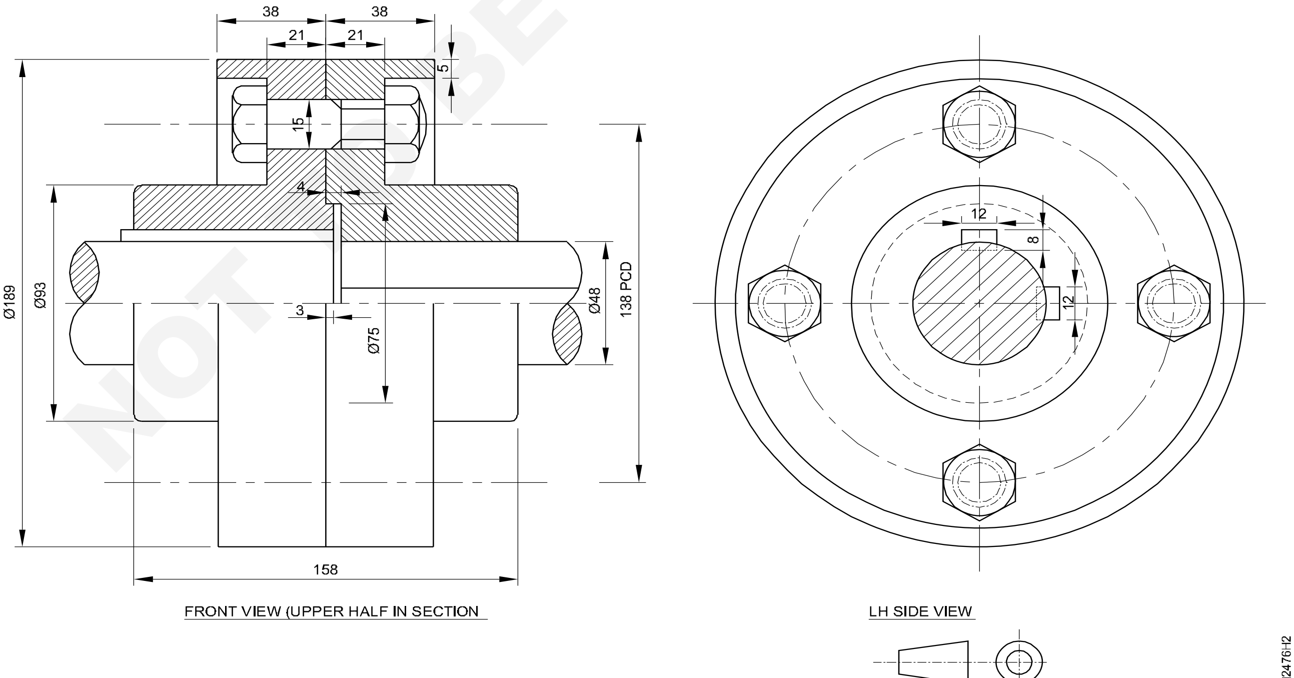
TASK 2:

a Reproduce the sectional elevation and draw the side view of the protected type flange coupling (Fig 2)

b Draw the detailed working drawing of the coupling

c Prepare bill of material

Fig 2



PROTECTED TYPE FLANGE COUPLING

© NIMI NOT TO BE REPUBLISHED

TASK 3:

a Draw the detailed drawing of the given protected coupling (Fig 3)

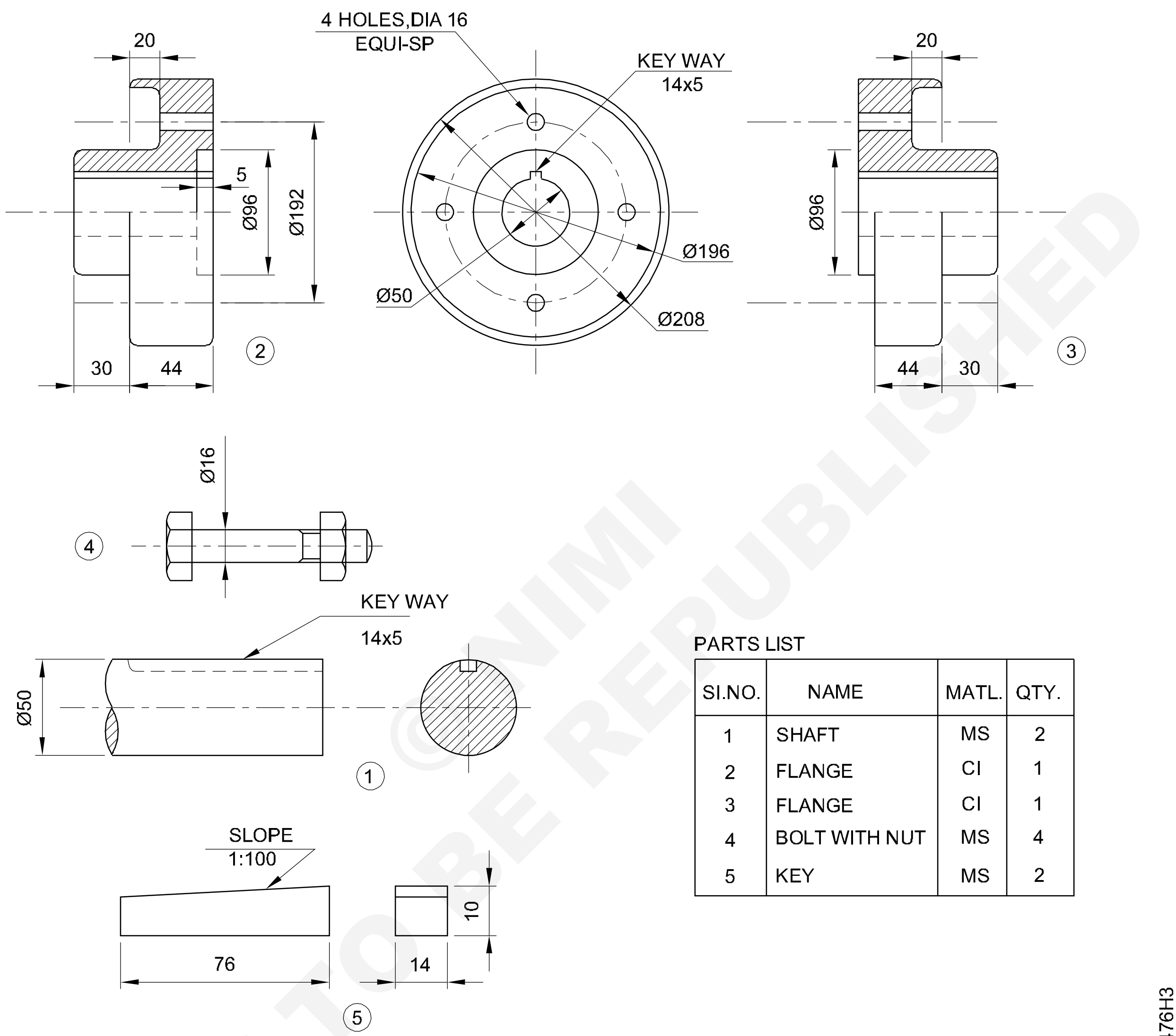
b Draw the assembly views of the protected flanged coupling

i Sectional front elevation

ii Side view

iii Bill of material

Fig 3



PARTS LIST

SI.NO.	NAME	MATL.	QTY.
1	SHAFT	MS	2
2	FLANGE	CI	1
3	FLANGE	CI	1
4	BOLT WITH NUT	MS	4
5	KEY	MS	2

PROTECTED FLANGED COUPLING

DMN2476H3

©NIMI NOT TO BE REPUBLISHED

TASK 4:

a Draw the detailed drawing of given Oldham coupling (Fig 4)

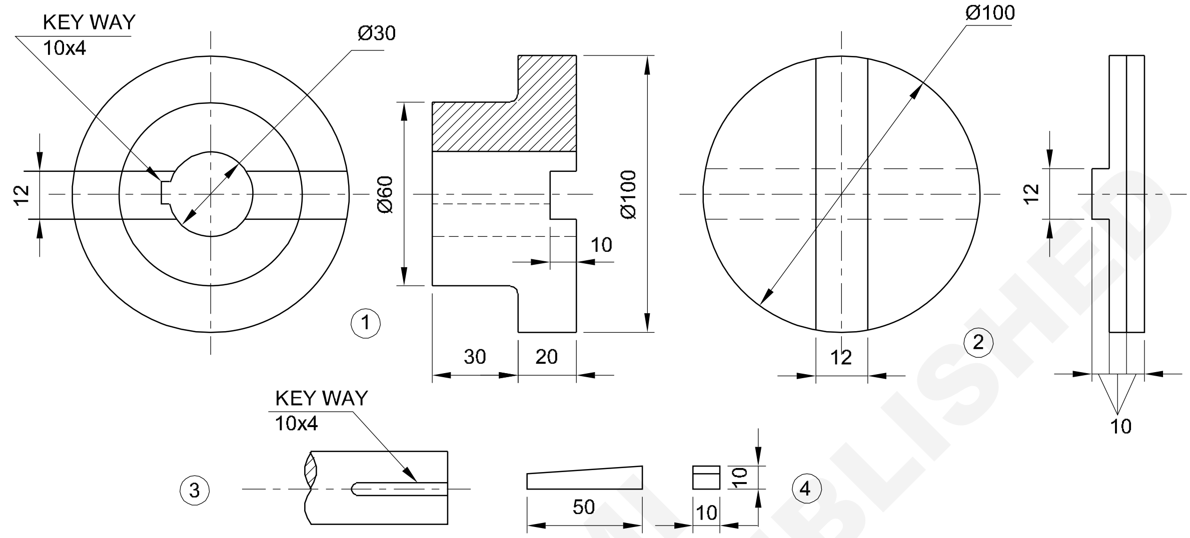
b Draw the following assembled views

  i Sectional front elevation

  ii Side view

  iii Bill of material

Fig 4



PARTS LIST

SI.NO.	NAME	MATL.	QTY.
1	FLANGE	MS	2
2	DISC	MS	1
3	SHAFT	MS	2
4	KEY	MS	2

OLDHAM COUPLING

DMN2476H4

© NIMI NOT TO BE REPUBLISHED

— — — — — — — —

TASK 5: **Bushed bin type flanged coupling (Fig 5)**

a Draw the given details of bushed pin type flanged coupling

b Draw the following assembly views of the bushed-pin type flanged coupling

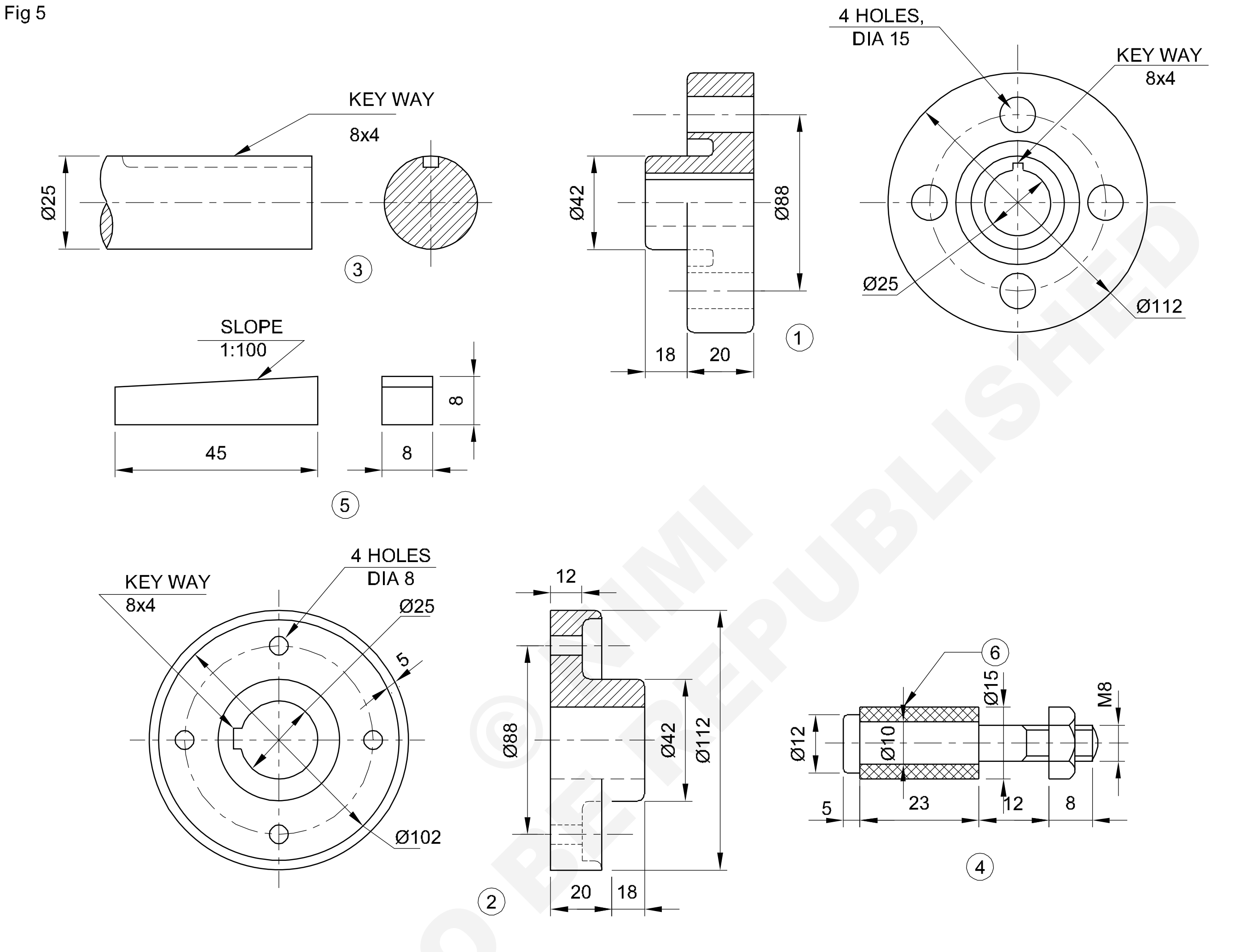
i Half sectional front elevation

ii Plan

iii Side view

iv Bill of material

Fig 5



PARTS LIST

SI.NO.	NAME	MATL.	QTY.
1	FLANGE	CI	1
2	FLANGE	CI	1
3	SHAFT	MS	2
4	PIN WITH NUT	MS	4
5	FEATHER KEY	MS	2
6	BUSH	NYLON	16

BUSHED-PIN TUPE FLANGED COUPLING

DMN2476H5

© NIMI NOT TO BE REPUBLISHED

— — — — — — — —

Draw the assembly drawing of friction grip coupling

Objective(s): At the end of this exercise you shall be able to
- **draw the assembly view of the coupling**
- **draw the details of the coupling.**

PROCEDURE

TASK 1: **Friction grip coupling or cone coupling (Fig 1)**

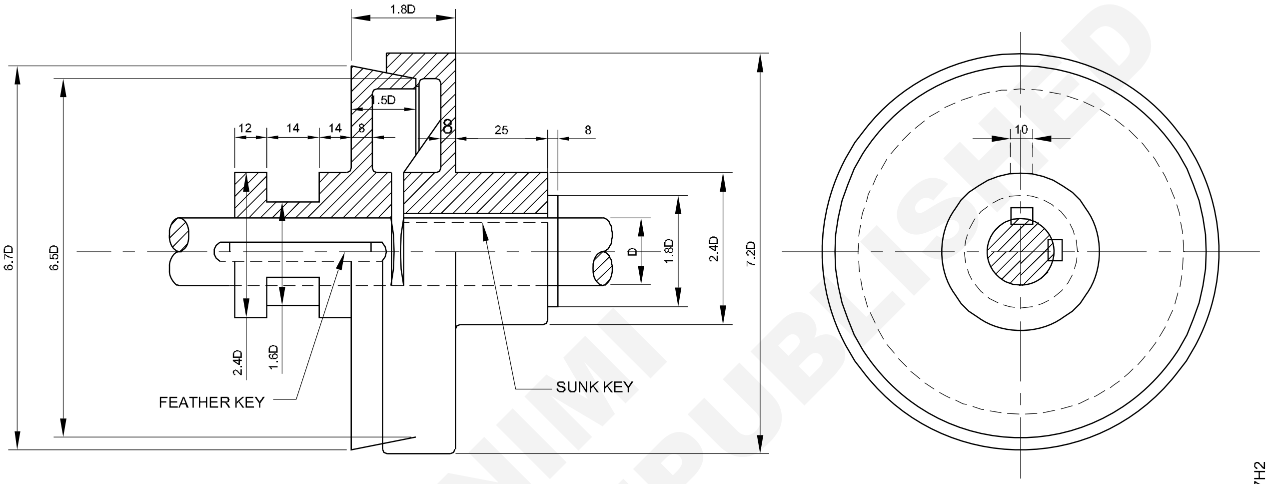
i Draw the sectional elevation of the coupling or given

ii Draw the side view

iii Draw the details of the given coupling

iv Prepare bill of material

Fig 1

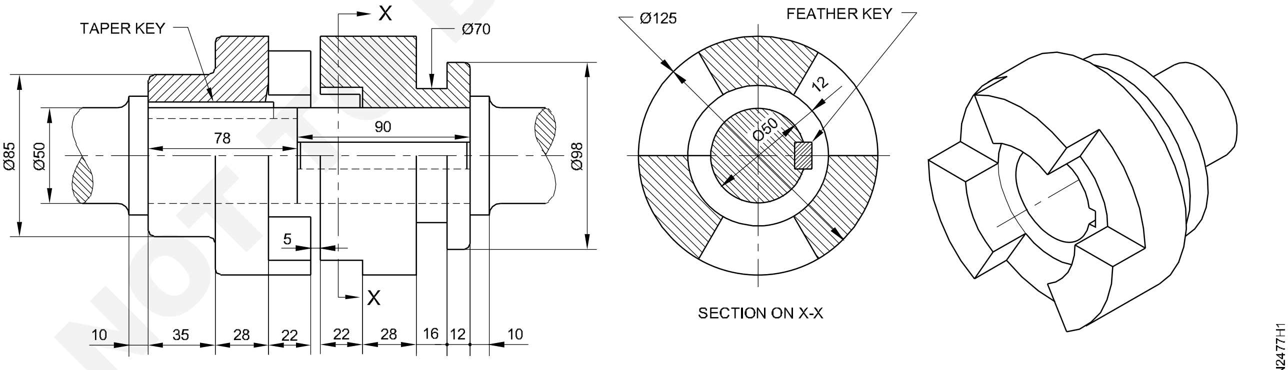


CONE COUPLING

— — — — — — — —

TASK 2: **Draw the given assembly views of the claw coupling (Fig 2)**

Fig 2

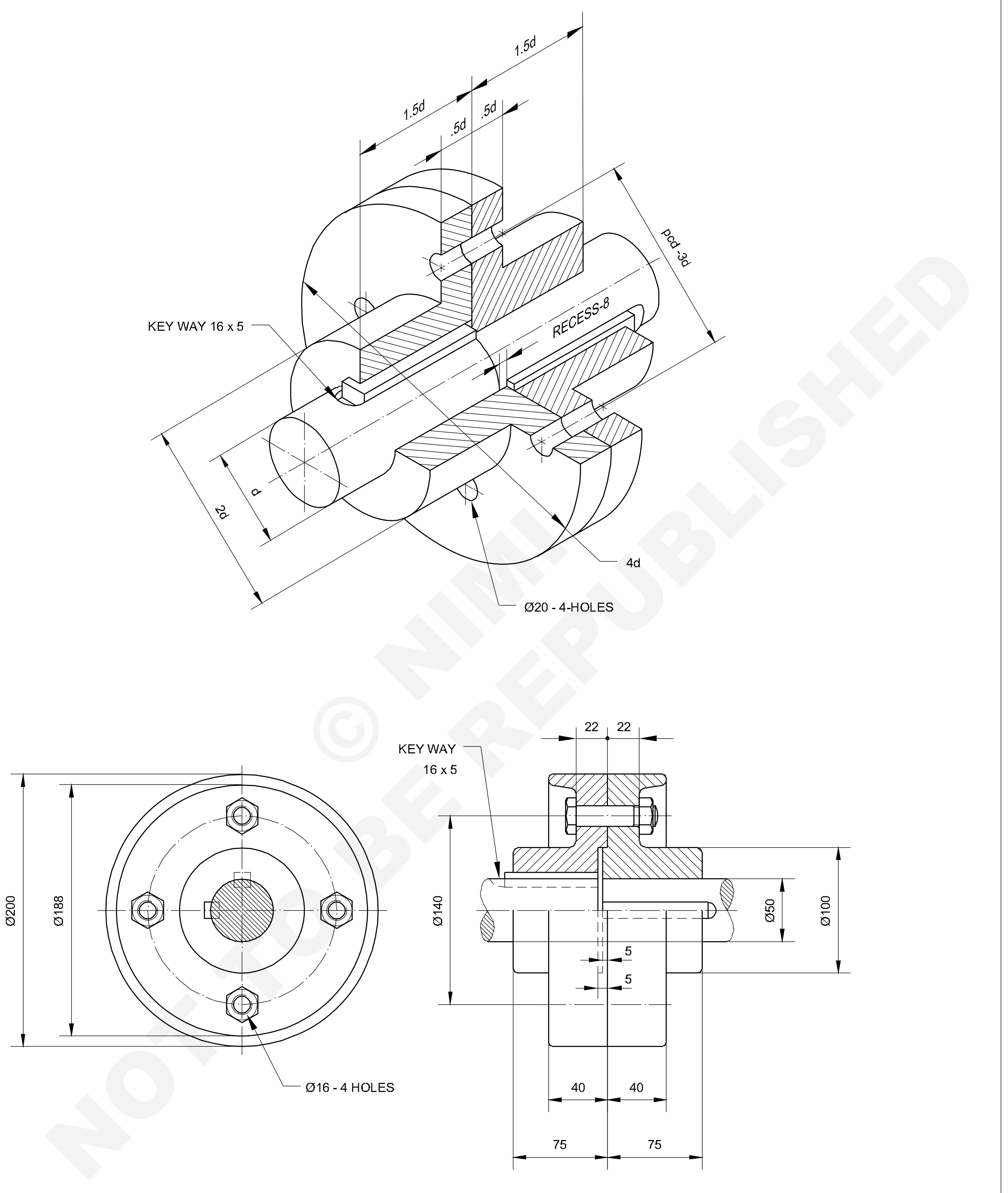


CLAW COUPLING

— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Fig 3



COMPRESSION COUPLING

© NIMI NOT TO BE REPUBLISHED

— — — — — — — —

Draw the assembly drawing of pin type flexible coupling

Objective(s): At the end of this exercise you shall be able to
- **draw the assembly views of pin type flexible coupling**
- **draw the details of the coupling.**

PROCEDURE

TASK 1**:**

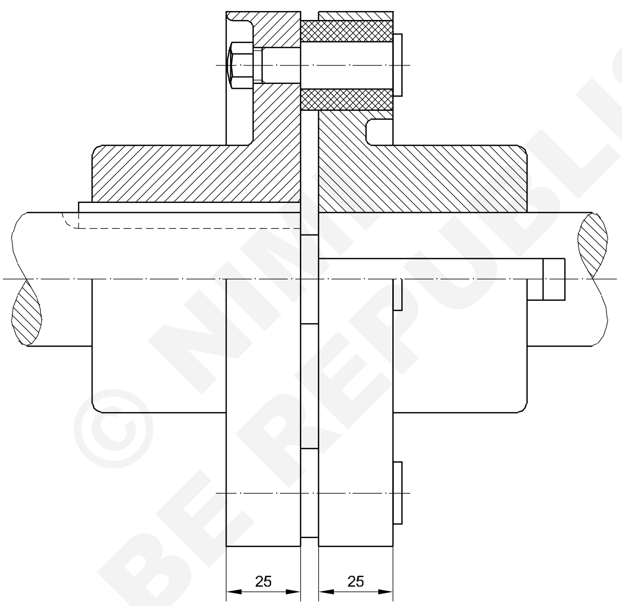
i Draw the detailed working drawing of pin type flexible coupling (Fig 1)

TASK 2**:**

i Draw the assembly views of the pin type flexible coupling

ii Prepare bill of material

Fig 1



PIN - TYPE FLEXIBLE COUPLING

© NIMI NOT TO BE REPUBLISHED

Draw the assembly drawing of universal coupling

Objective(s): At the end of this exercise you shall be able to
- **draw the details of given universal coupling**
- **draw the assembly views of the given coupling details.**

PROCEDURE

TASK 1**: Draw the working, details of the universal coupling (Fig 1)**

TASK 2**: Draw the following assembled view of the coupling**

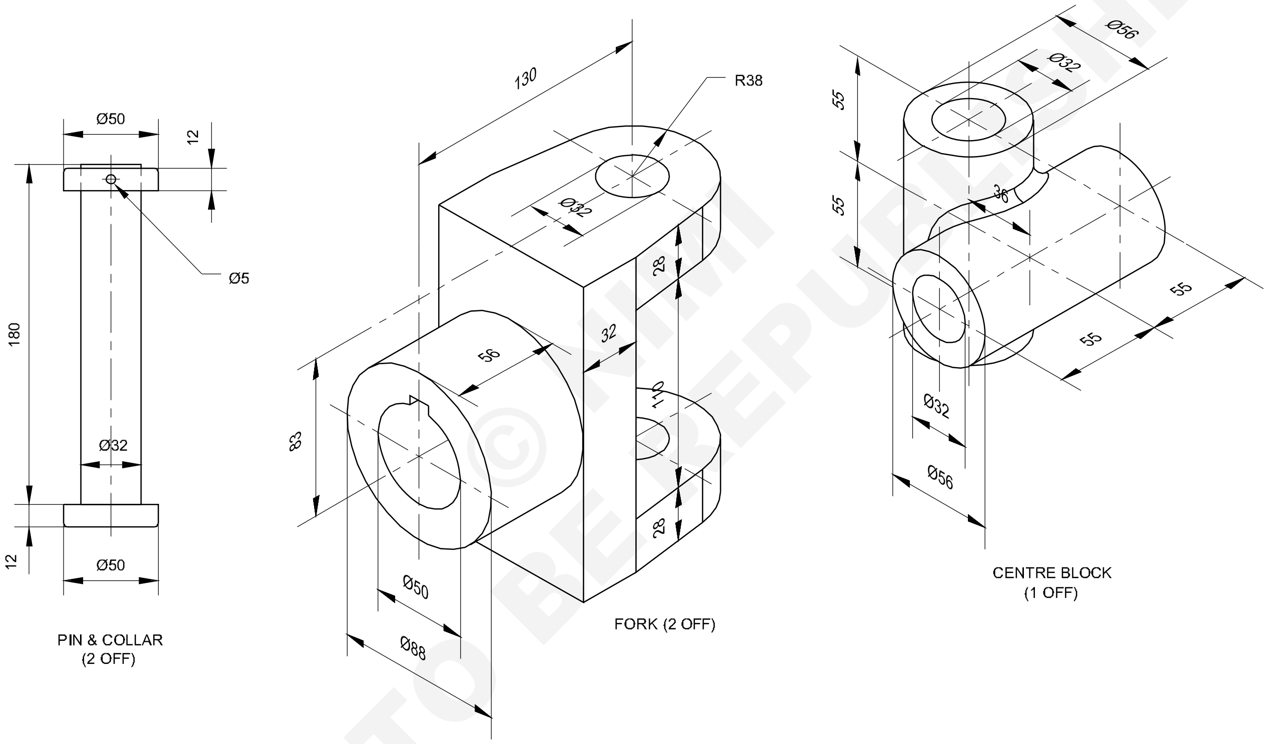
Full sectional front elevation

Plan

Side view from left

Prepare bill of material

Fig 1



UNIVERSAL COUPLING

DMN2479H1

NOT TO BE REPUBLISHED © NIMI

— — — — — — — —

Draw the simple bearing (solid bearings)

Objective(s): At the end of this exercise you shall be able to
- **draw the elevation, plan and side view of simple bearing**
- **draw the sectional view of bushed bearing.**

PROCEDURE

TASK 1:

a For given isometric view of the solid bearing (Simple bearing) (Fig 1)

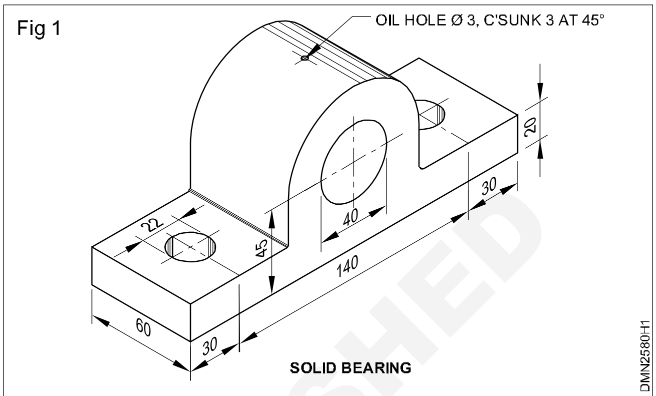
b Draw the following views

i Front elevation

ii Plan

iii Side view

Fig 1



— — — — — — — —

TASK 2:

a Given isometric view of bushed bearing. Draw the following views. (Fig 2)

b Half sectional front elevation as shown in isometric view

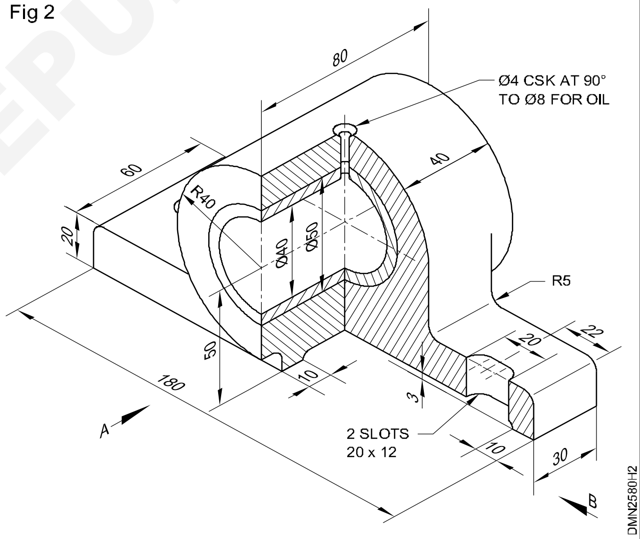
i Plan

ii Full sectional side view

Note: All the necessary dimensions should be given.

Select a suitable scale.

Fig 2



— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Draw the assembly of foot step bearing

Objective(s): At the end of this exercise you shall be able to
- **draw the elevation, plan and side view of simple bearing**
- **draw the sectional view and bushed bearing.**

PROCEDURE

TASK 1**: Draw the detail working drawing for given foot step bearing details (Fig 1)**

TASK 2**: Draw the assemble view of the following views of the foot step bearing**

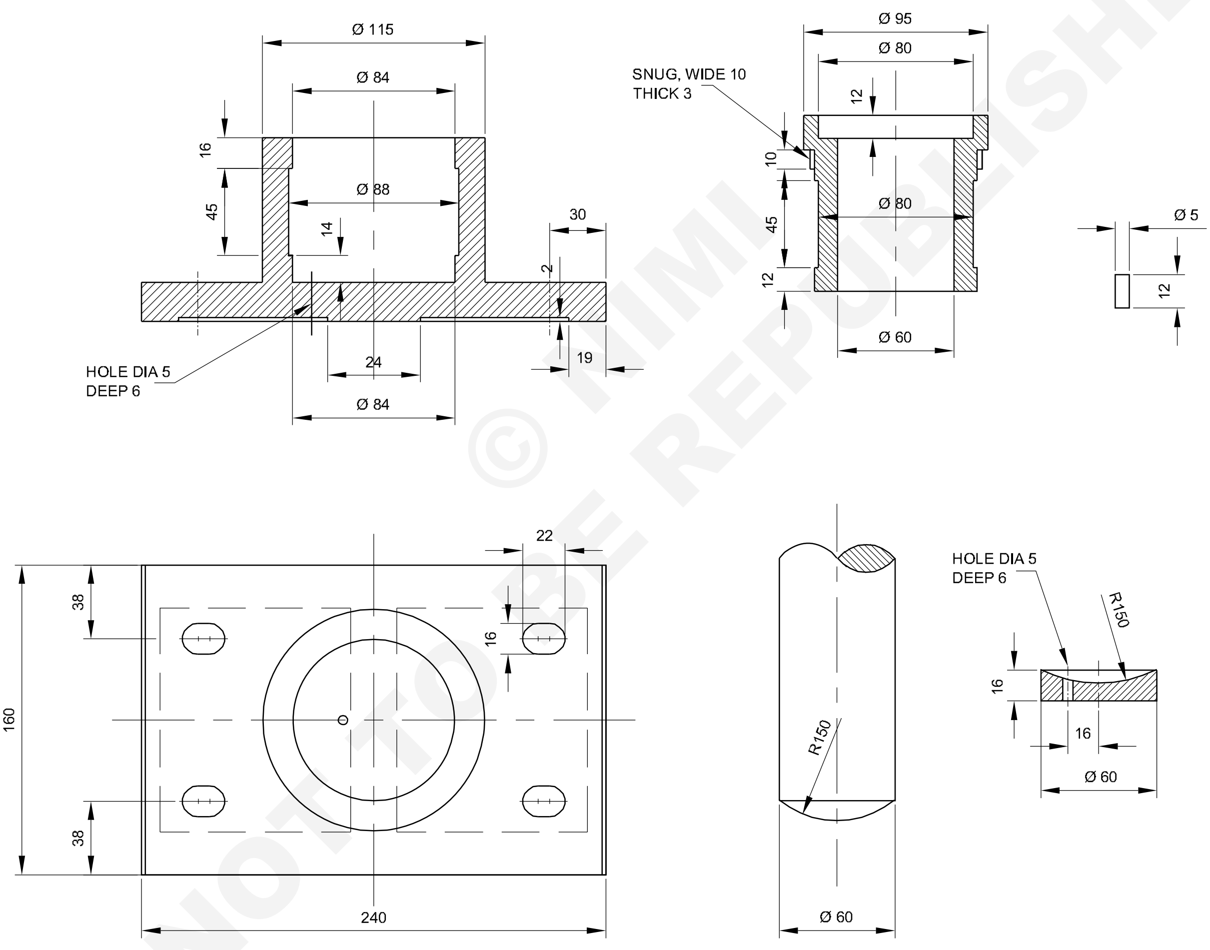
i Full sectional elevation

ii Plan

iii Side view

iv Prepare the bill of material

Fig 1



SI.NO	NAME	MATL	QTY
1	BODY	CAST IRON	1
2	BRUSH	BRASS	1
3	DISC	P BRONZE	1
4	SHAFT	MILD STEEL	1
5	BODY	MILD STEEL	1

NOTE: ALL DIMENSIONS SHOULD BE GIVEN

SELECT A SUITABLE SCALE

FOOT- STEP BEARING

DMN2581H1

© NIMI NOT TO BE REPUBLISHED

— — — — — — — —

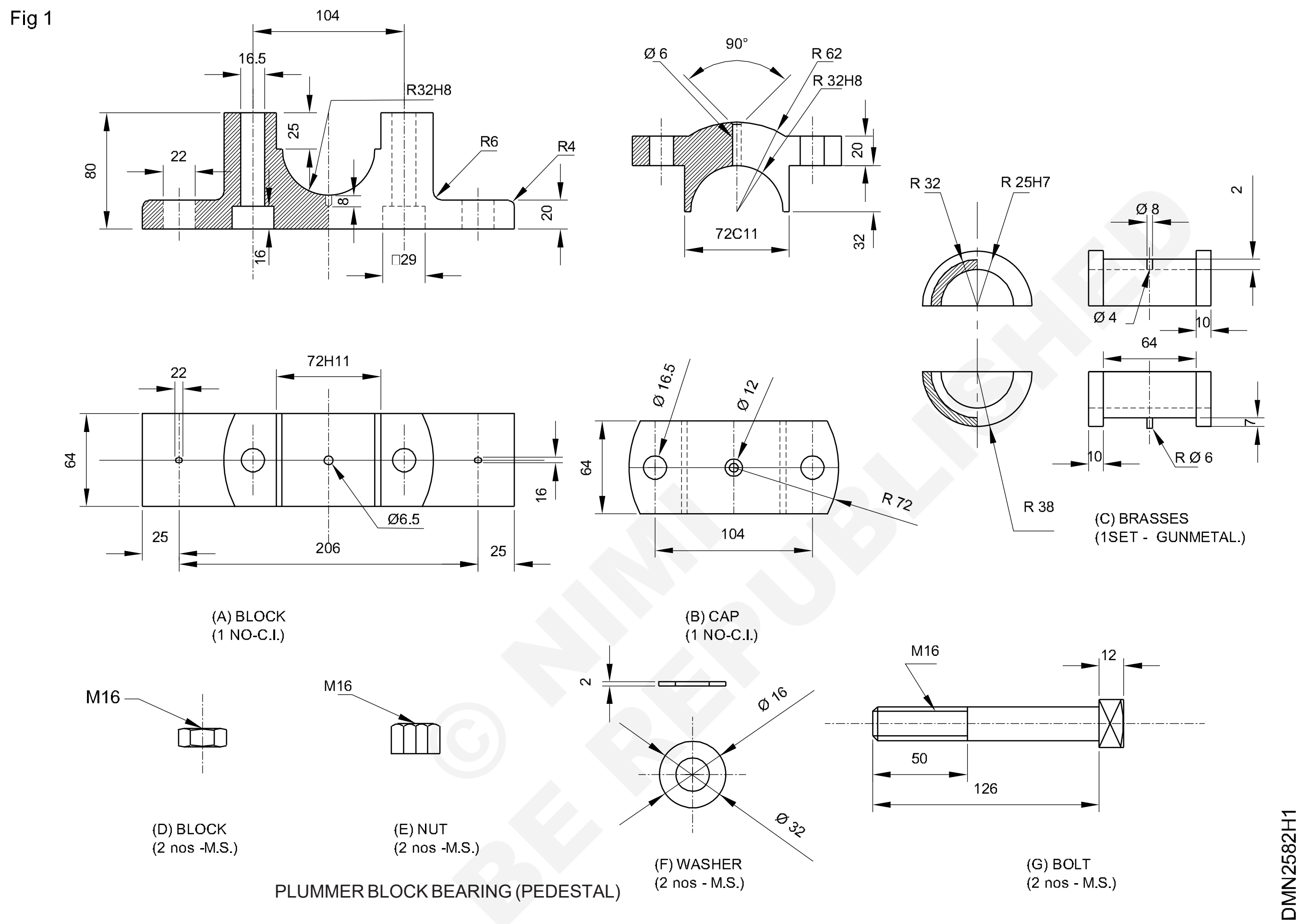
Draw the plummer block bearing

Objective(s): At the end of this exercise you shall be able to
- **details and assembly of plummer block.**

PROCEDURE

TASK 1**: Draw the detailed of the given plummer block bearing (Fig 1)**

Fig 1



PLUMMER BLOCK BEARING (PEDESTAL)

— — — — — — — —

TASK 2: **Draw the following assembled view of the plummer block bearing.**

Half sectional front elevation (left off)

Half sectional side view

Half sectional plan

Prepare bill of material

© NIMI NOT TO BE REPUBLISHED

Draw the assembly of self aligning bearing (Swivel bearing)

Objective(s): At the end of this exercise you shall be able to
- **draw the detail and assembly of self aligning bearing.**

PROCEDURE

TASK 1**: Draw the detailed of the given self - aligning bearing (swivel bearing) (Fig 1)**

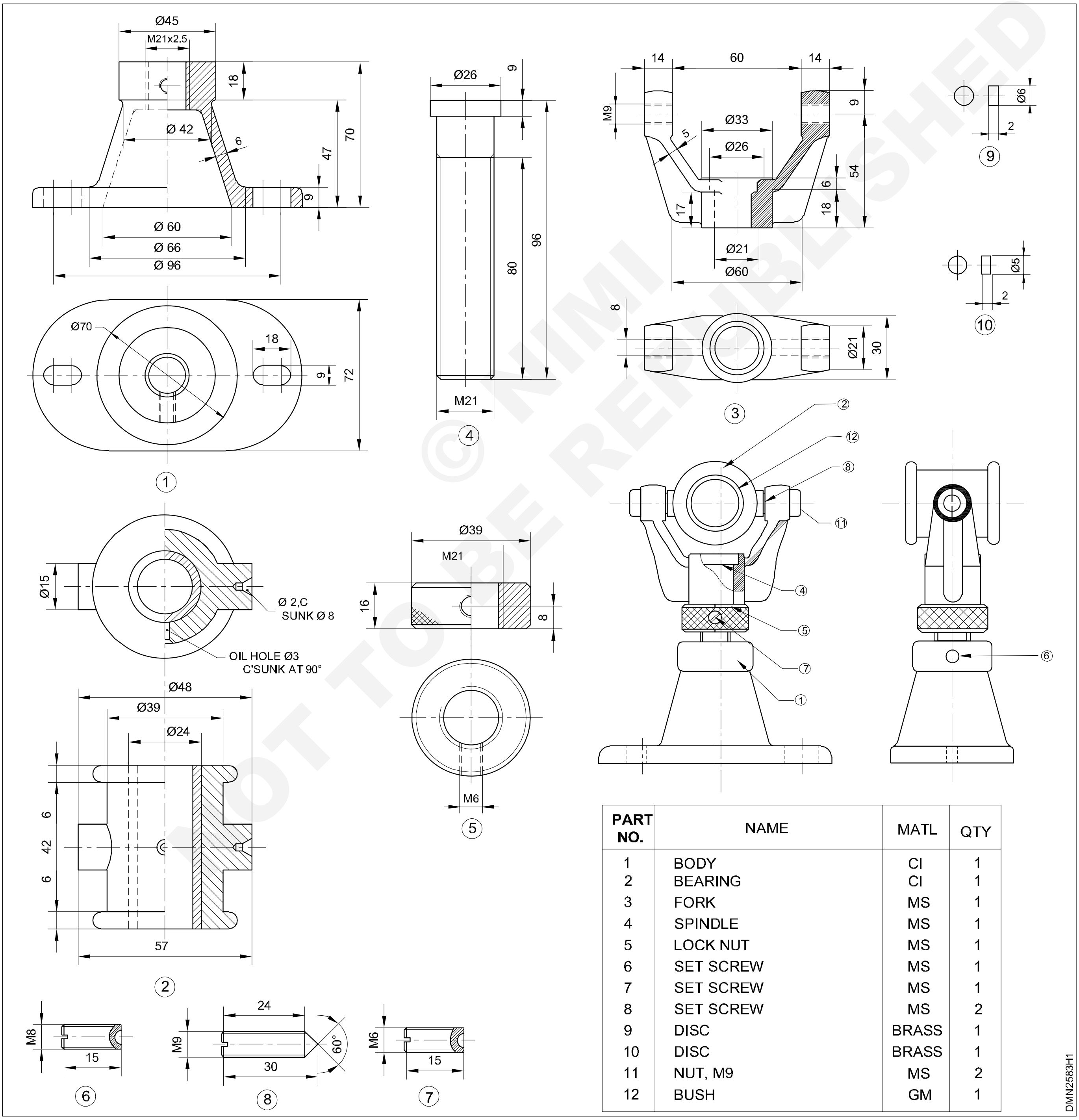
TASK 2**: Draw the following assembled view of the self - aligning bearing (swivel bearing)**

i Half sectional front elevation

ii Full sectional side view

iii Half sectional plan

iv Prepare bill of material



© NIMI NOT TO BE REPUBLISHED

PART NO.	NAME	MATL	QTY
1	BODY	CI	1
2	BEARING	CI	1
3	FORK	MS	1
4	SPINDLE	MS	1
5	LOCK NUT	MS	1
6	SET SCREW	MS	1
7	SET SCREW	MS	1
8	SET SCREW	MS	2
9	DISC	BRASS	1
10	DISC	BRASS	1
11	NUT, M9	MS	2
12	BUSH	GM	1

Gears

Objective(s): At the end of this exercise you shall be able to
- **draw the conventional representation of gears on technical drawings.**

PROCEDURE

TASK 1**: Conventional representation of gears on technical drawings**

This section deals with the conventional presentation of toothed portion of gears including worm gearing and chain wheels. It is applicable to detail drawings and assembly drawings. As a fundamental principle, a gear is represented (expect in axial section) as a solid part without teeth, but with the addition of the pitch surface in a thin long chain line.

Detail drawing (Individual gears)

Contours and edges

Represent the contour and the edges of each gear (see Figs 1,2 & 3) as if they were.

Fig 1

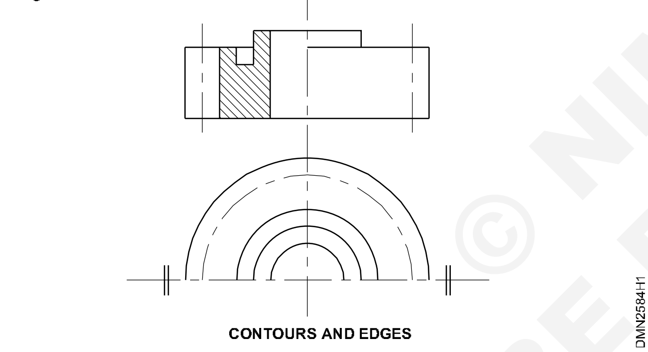
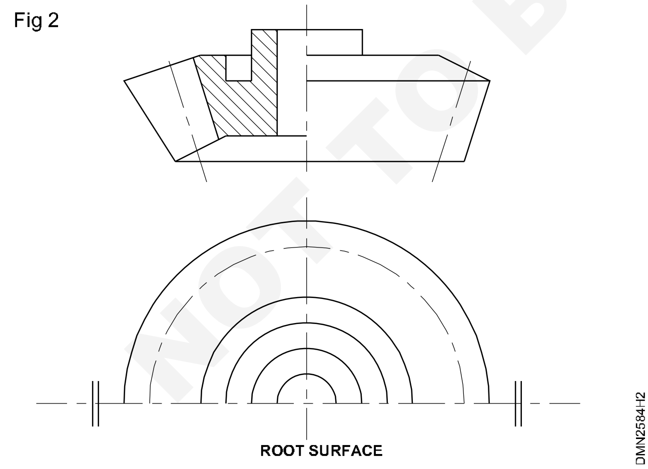


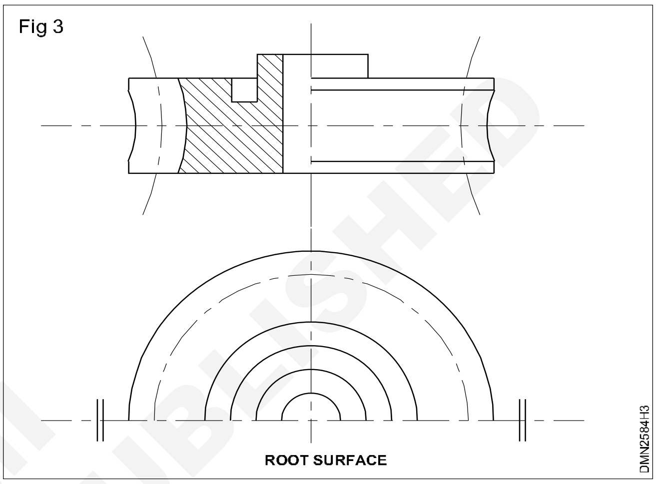
Fig 2



a In as unsectioned view, a solid gear bounded by the tip surface.

b In an axial section, a spur gear having two diametrical opposed each, represented unsectioned, even in the case of a gear that does not have spur teeth or that has an odd number of teeth.

Fig 3

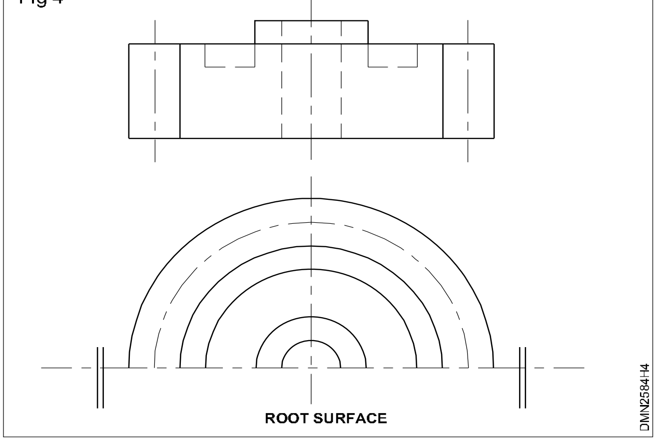


Pitch surface

Draw the pitch surface with a long dashed double dotted narrow line, even concealed portions and sectional views, and represent it.

a In a projection normal to the axis, by its pitch circle (external pitch circle in the case of a bevel gear and the median pitch circle in the case of a worm wheel (Fig 4)

Fig 4



b In a projection parallel to the axis, by its apparent contour, extending the line beyond the gear contour on each side.

Root surface

As a general rule, do not represent the root surface expect in sectional view. However, if it seems helpful to show it also on unsectional views, always draw it, in this case, as a continuous narrow line.

© NIMI NOT TO BE REPUBLISHED

Teeth

Specify the teeth profile either by reference to a standard or by a drawing to a suitable scale.

If it is essential to show one or two teeth on the drawing itself (either to define the ends of a toothed portion or rack, or in order to specify the position of the teeth in relation to a given axial plane,) draw them as continuous wide line (Figs 5 & 6)

Fig 5

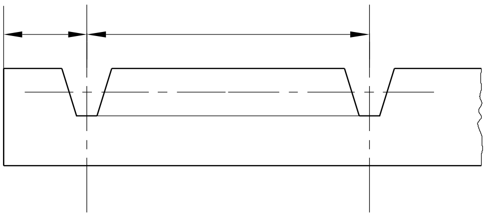
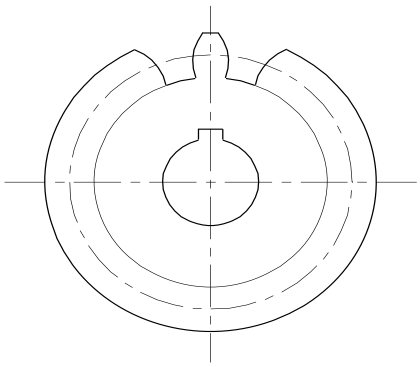


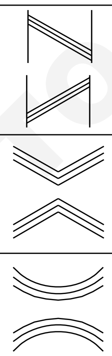
Fig 6

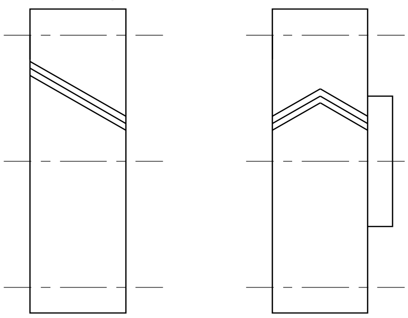


It is necessary to indicate the direction of the teeth of a gear or rack on the view of the tooth surface in a projection parallel to the gear axis, three continuous narrow lines of the corresponding form and direction should be shown (Table 1) (Fig 7)

Fig 7

TEETH SYSTEM	SYMBOL
HELICAL TO THE RIGHT	
HELICAL TO THE LEFT	
DOUBLE HELICAL	
SPIRAL	

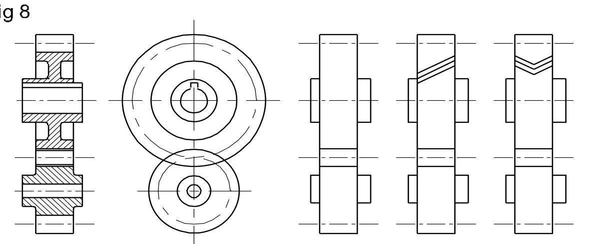




INDICATION OF DIRECTION OF TEETH

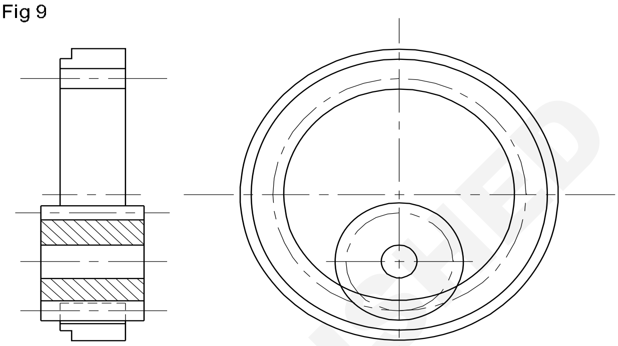
External engagement of cylindrical gear (Fig 8)

Fig 8



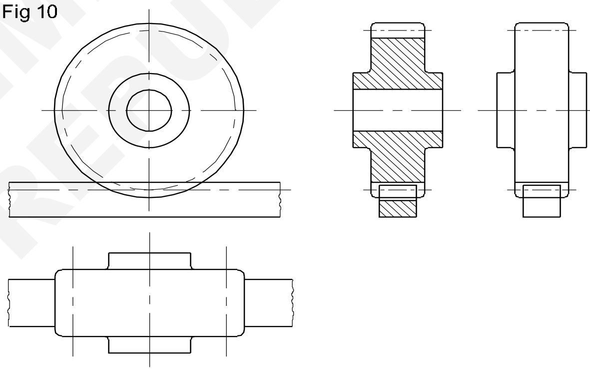
Internal engagement of cylindrical gear (Fig 9)

Fig 9



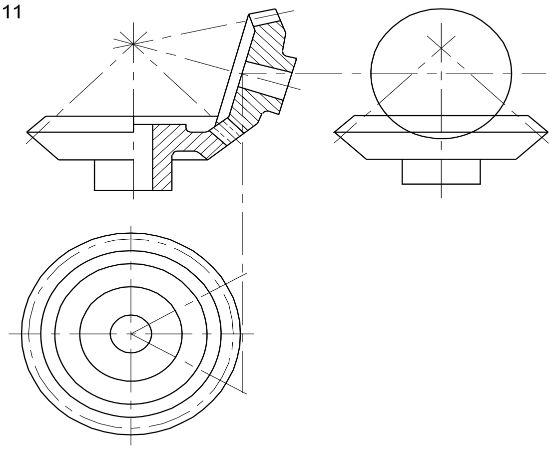
Engagement of pinion with rack (Fig 10)

Fig 10



Engagement of bevel gears, axis intersection at any angle (Fig 11)

Fig 11



Engagement with cylindrical worm, in cross-section (Fig 12)

Chain wheel (Fig 13)

© NIMI NOT TO BE REPUBLISHED

Fig 12

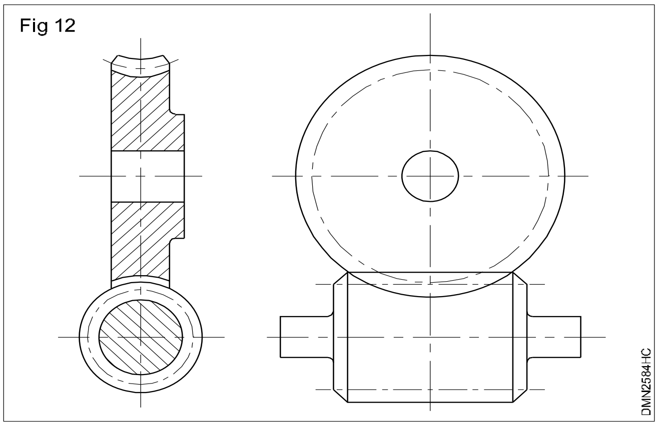
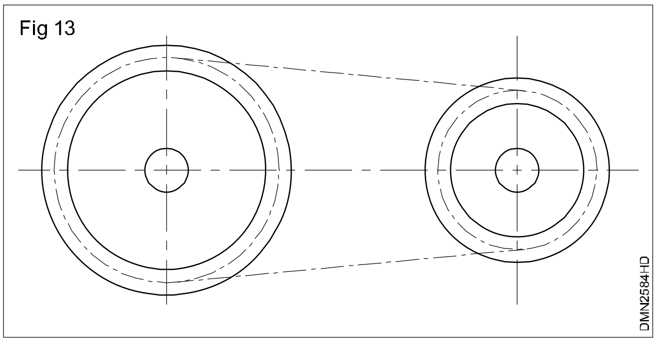


Fig 13



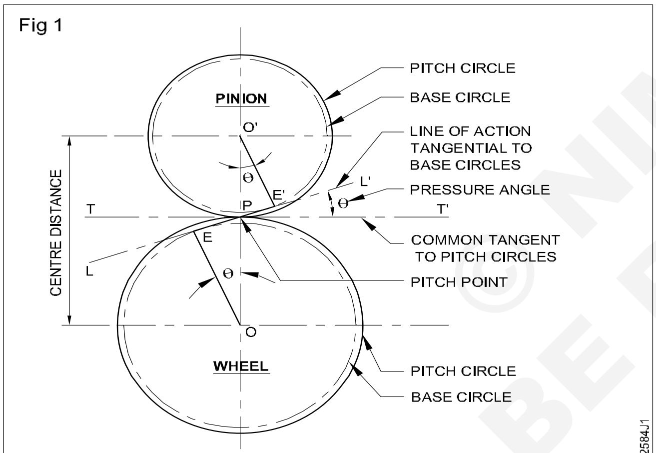
Draw the gears (spur gear)

Objective(s): At the end of this exercise you shall be able to
- **draw the conventional representation of gears**
- **draw spur gear.**

TASK 1**: Construction of base circles**

Problem (Fig 1): To draw the base circles for two matting gears of different pitch circle diameters, assuming the pressure angle to be θ.

Fig 1



CONSTRUCTION OF BASE CIRCLES

With centres O and O' (Centre distance apart), draw two circles touching each other at a point P. This the pitch point. It lies on the line joining O with O'. Through P, draw a line TT' common tangent to the two pitch circles. It will be perpendicular to OO'. Again through P, draw a line LL' making an angle (pressure angle) with TT' LL' is the line of action. Through O and O', draw lines OE and O'E, both perpendicular to LL,. Each of these lines will make an angle θ with the line OO'. With make an angle with the line OO'. With O and O' as centres, and OE and O'E' respectively as radii, draw two circles which are the required base circles. Note that the line of action LL' is tangential to these circles.

Problem 2. Draw the profile of an involute teeth for a gear having 24 teeth and module equal to 8.33 mm, and assuming a pressure angle of 20°.

Calculations:

Pitch circle diameter = No. of teeth x module

= 24 x 8.33 = 20 cm Ω 200 mm

Circular pitch = πm = π x 8.33 = 26.16 mm

Addendum = m = 8.33 mm

Clearance = 0.157 m = 0.157 x 8.33 = 1.308

Dedendum = Addendum + Clearance

= 8.33 + 1.309 = 9.639 mm

Ded circle dia = PCD - 2 x dedendum

= 200 - 2 x 9.639

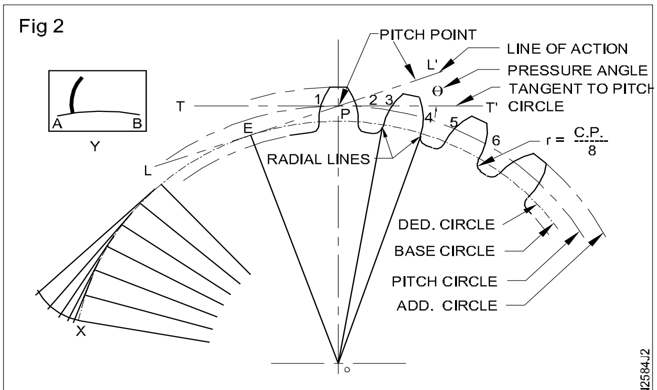
= 180.722 mm

Tooth thickness = 1.75 m = 13.08 mm

Spur gearing

Construction (Fig 2) with centre O, draw the pitch circle of 200 mm diameter. At any point O on it, draw a tangent TT'. Again through P, draw the line of action LL' inclined at (equal to 20°) to TT'. Through O, draw a line OE inclined at to OP (it will be perpendicular to LL'). With centre O and radius OE, draw the base circle. Draw the addendum and dedendum circles of diameters 216.66 mm and 180.72 mm.

Fig 2



CONSTRUCTION OF INVOLUTE TEETH PROFILE

Construct an involute curve from this base circle as shown at X. Trace out this curve and part AB of the base circle on a piece of tracing paper as shown at Y.

© NIMI NOT TO BE REPUBLISHED

On the pitch circle, mark point, 1,2,3 etc., distance

$\frac{c.p}{2} = \frac{26.18}{2} = 13.9$ mm apart. = 13.9 mm apart.

Place the tracing paper on the base circle in such a manner that the arc AB coincides with it (base circle), while the curve passes through say. The point 1. Prick a few points on the curve between the addendum circle and the base circle. Join these points by means of a French curve. Complete one side of the tooth profile by drawing a radial line below the base circle and then joining it with the bottom of the tooth space by a fillet of

radius r equal to $\frac{c.p}{8} = \frac{26.18}{8} = 3.272$ mm. mm. Reverse

the tracing paper and plot the curve through the point 2 in the same manner, thus completing a tooth profile. Repeat the constriction for each tooth.

— — — — — — — —

TASK 2 :

To draw the profile of involutes teeth for a gear having 25 teeth and a module pitch equal to 10 mm, assuming a pressure angle of 20°.

Calculation:

P.C.D = m x N = 10 x 25 = 250 mm

C.P = π x m = 3.14 x 10 = 31.4 mm

Addendum = $\frac{C.P}{\pi}$ = m = 10 mm

Add. circle dia = P.C.D + 2 x addendum

= 250 + 2 x 10 = 270 mm

Clearance = $\frac{C.P}{20} = \frac{31.4}{20} = 1.57$ mm.

Dedendum = Addendum + Clearance

=10 + 1.57 = 11.57 mm

Ded.circle dia. = P.C.D - 2 x dedendum

= 250 - 2 x 11.57

= 250 - 23.14 = 226.86 mm

Tooth thickness = $\frac{CP}{2} = \frac{31.4}{2} = 157$mm

Approximate construction of teeth profile

(1) For gears of 30 teeth and over (Fig 3) with centre O, draw the pitch circle, addendum circle and dedendum circle. The diameters may be calculated from the given data and from the tooth proportions, as shown in (problem 2) Mark a point P on the pitch circle. On OP as diameter,

i.e with radius equal to $\frac{P.C.D}{4}$ draw a semi - circle. With

P as centre, and radius equal to $\frac{P.C.D}{8}$, draw an arc

cutting the semi - circle at a point Q.

With O as centre, draw a circle passing through Q. Then this is the circle on which centres of arcs for the teeth

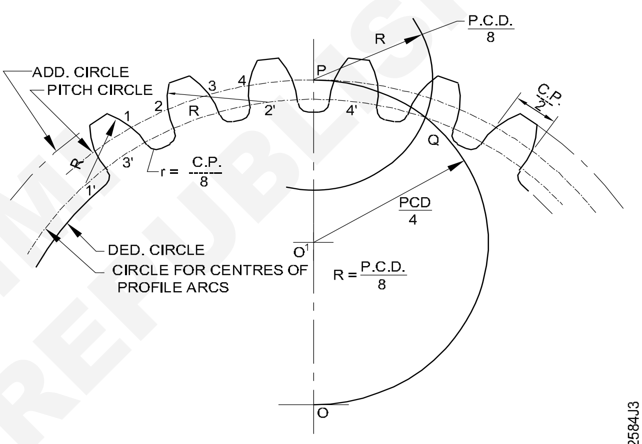
profiles will lie. The radius (for these arcs) R = $\frac{P.C.D}{8}$

To draw the arcs, mark points 1,2,3 etc on the pitch

circles and distance $\frac{C.P}{2}$ apart. With each of these points as centre and radius equals to PCD mark 1' 2' 3' etc. on profile circle, now with these points as centres and radius R, draw the profile arcs. Join each arcs with the bottom of the tooth space by a fillet of radius

r equal to $\frac{C.P}{8}$

Fig 3

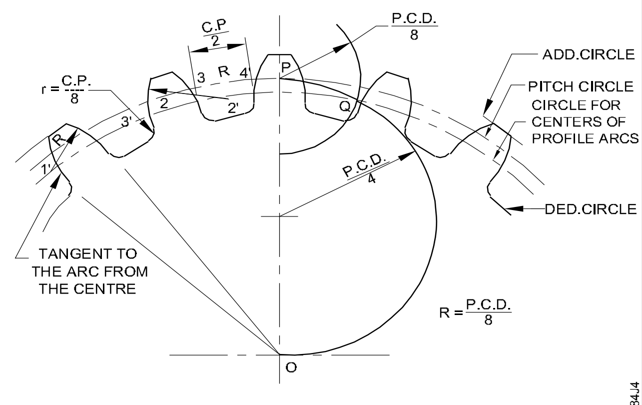


APPROXIMATE CONSTRUCTION (FOR GEARS OF 30 TEETH AND OVER)

(2) For gears of less than 30 teeth (Fig 4). Determine the centres 1',2' etc., and draw the arcs as described in (1) above. From O, draw lines tangential to these arcs. Join each of these arcs. Join each of these lines with the bottom of tooth space by a fillet of radius r equals

to . $\frac{C.P}{8}$

Fig 4



APPROXIMATE CONSTRUCTION
(FOR GEARS OF LESS THAN 30 TEETH)

© NIMI NOT TO BE REPUBLISHED

Draw two spur gear in mesh

Objective(s): At the end of this exercise you shall be able to
- **draw two spur gears in meshing positions.**

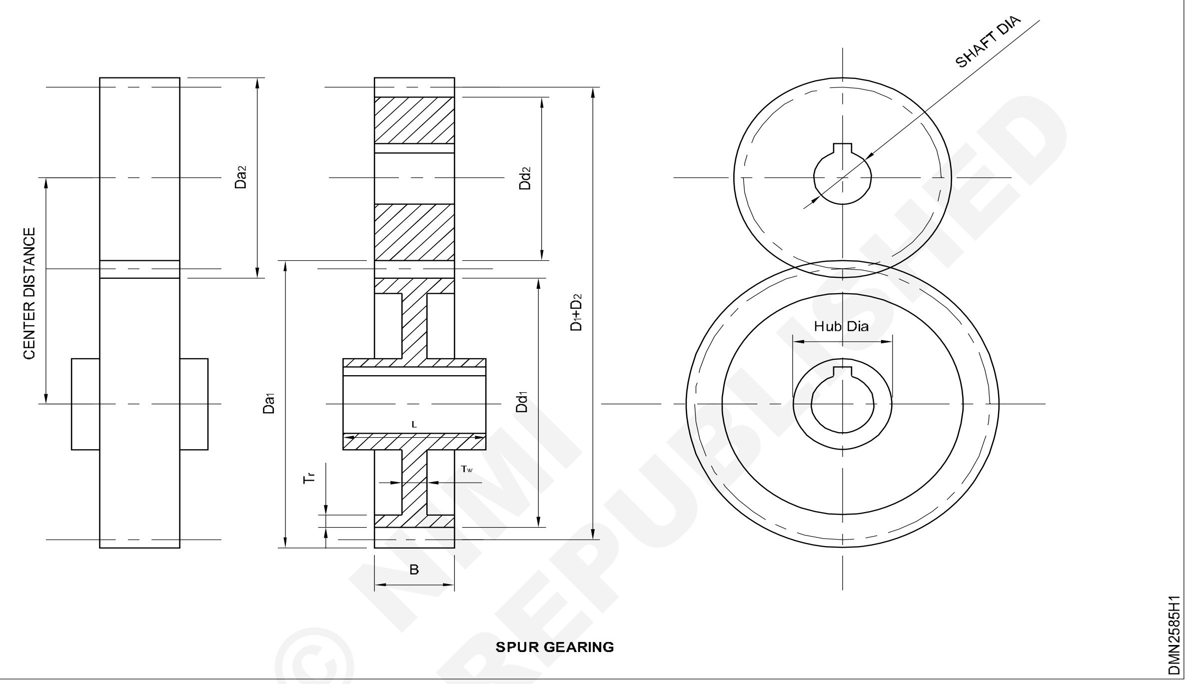
PROCEDURE

TASK 1**: Draw the two spur gears in mesh shown in Fig 1**

i Elevation

ii Side view

Fig 1



SPUR GEARING

© NIMI NOT TO BE REPUBLISHED

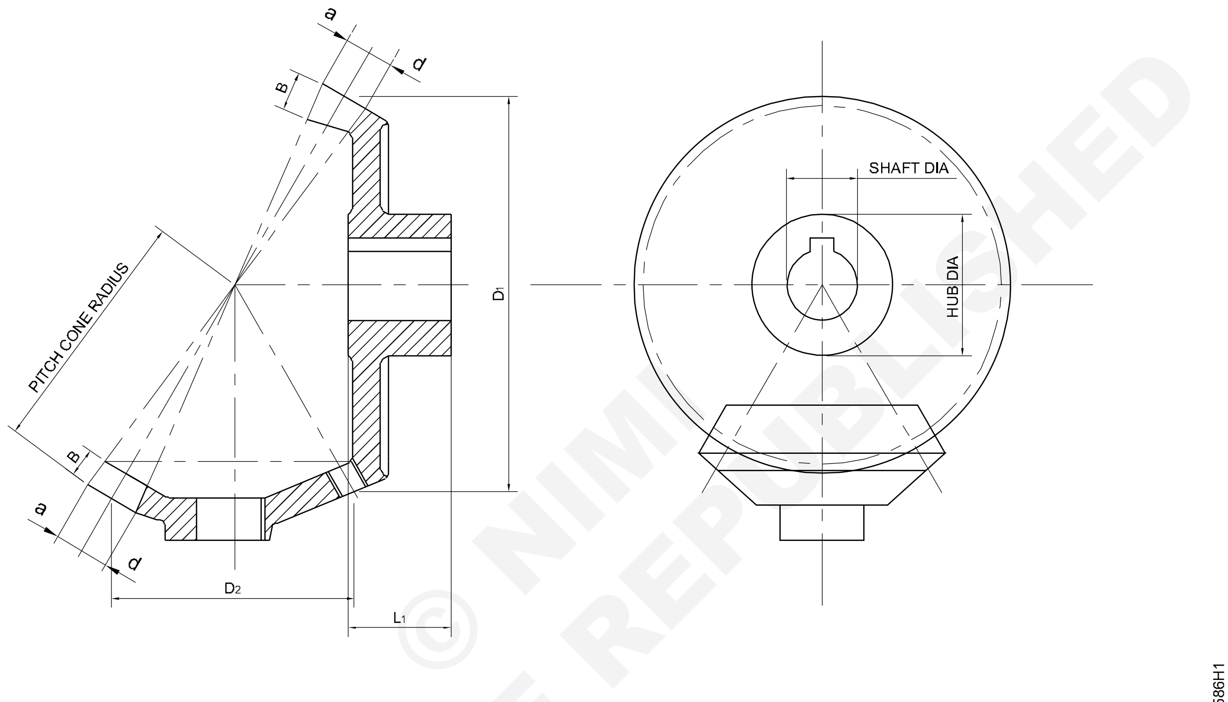
Draw two bevel gears in mesh

Objective(s): At the end of this exercise you shall be able to
- **draw the two views of bevel in mesh.**

PROCEDURE

TASK 1**: Draw the elevation and side view of the two bevel gears in mesh. (Fig 1)**

Fig 1



BEVEL BEARING

© NIMI NOT TO BE REPUBLISHED

Perform computer operation

Objective(s): At the end of this exercise you shall be able to
- **create a new folder in the desktop**
- **rename the folder by two methods**
- **arrange the icons in your desktop in four ways**
- **change desktop image**
- **change desktop image position**
- **change desktop color.**

Requirements

Hardware and Software

- Pentium PC or higher with Windows 95/98/2000/ XP with

  SVGA Color Monitor
- Microsoft Office 2000 or higher version
- Inkjet or Laser Printer
- Anti Virus Software
- Internet Connection

PROCEDURE

TASK 1: **Create a New Folder in the Desktop**

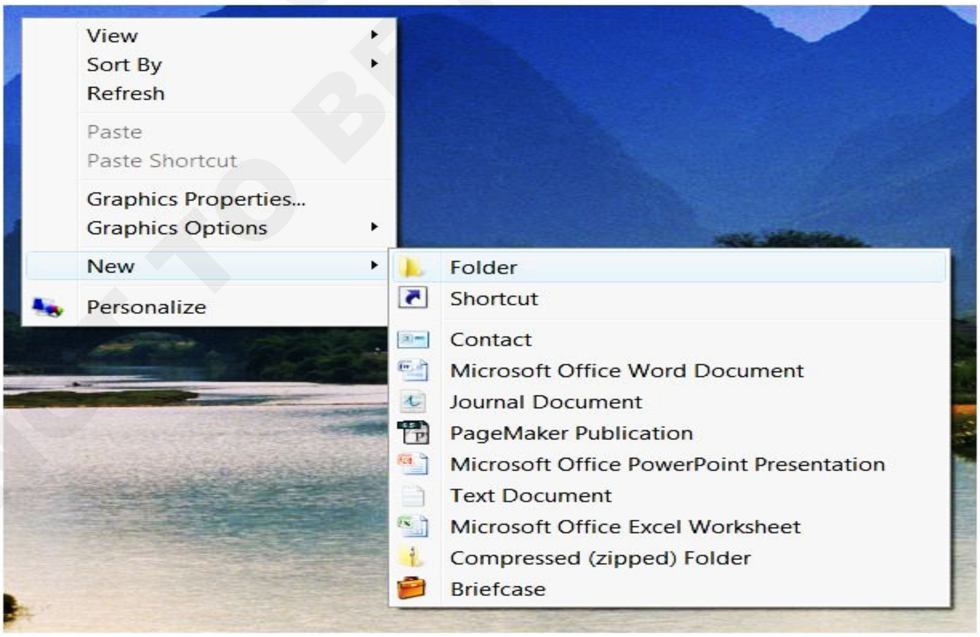
1 Boot the system, if not booted

2 Right click the mouse button in the desktop

3 Choose "New" option and

4 Click "Folder" option (Fig 1)

Fig 1



© NIMI NOT TO BE REPUBLISHED

5 Create New Folder on your desktop (Fig 2)

6 Create more number of folder, follow the Step 2 to 4

Fig 2

TASK 2: **Rename the Folder**

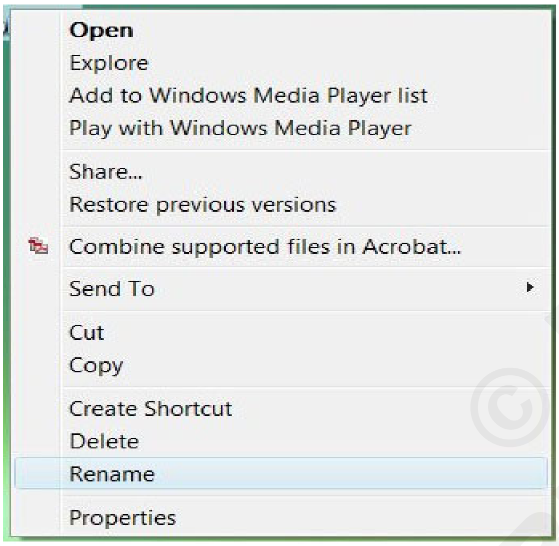
Method: 1

1 Select the desktop folder

2 Right click the mouse button and

3 Click Rename option (Fig 3)

Fig 3



4 Type the Folder name "sample" (Fig 4)

5 Renamed New Folder as sample on your desktop

Method 2: (Rename the Folder)

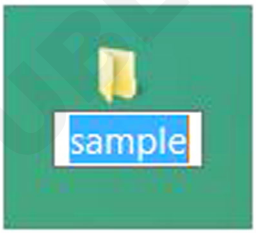
1 Select the Folder on your desktop and

2 Press F2 key and

3 Type the folder name " Sample" (Fig 4)

4 Renamed new folder as "Sample"

Fig 4



TASK 3: **Arrange the Icons on your desktop Name Wise:**

1 Right click the mouse button on your desktop

2 Select Arrange Icons By and

3 Click Name (Fig 5)

4 Displayed Name wise arranged icons on your desktop

Arrange the icons on your desktop Size Wise:

1 Right click the mouse button on your desktop

2 Select Arrange Icons By and (Fig 6)

3 Click Size (Fig 7)

4 Displayed Size wise arranged icons on your desktop

Arrange the icons on your desktop Type Wise:

1 Right click the mouse button on your desktop

2 Select Arrange Icons By and

3 Click Type (Fig 8)

4 Displayed Type wise arranged on your desktop (Fig 9)

Hide the Desktop Icons:

1 Right click the mouse button on your desktop

2 Select Arrange Icons By and

3 Click Show Desktop Icons (Fig 10)

4 Hide all folders on your desktop (Fig 11)

Unhide the Desktop Icons

1 Right click the mouse button

2 Select Arrange Icons By and

3 Click Show Desktop Icons (Fig 12)

4 Display all icons on your desktop (Fig 13)

© NIMI NOT TO BE REPUBLISHED

Fig 5

Fig 6

Fig 7

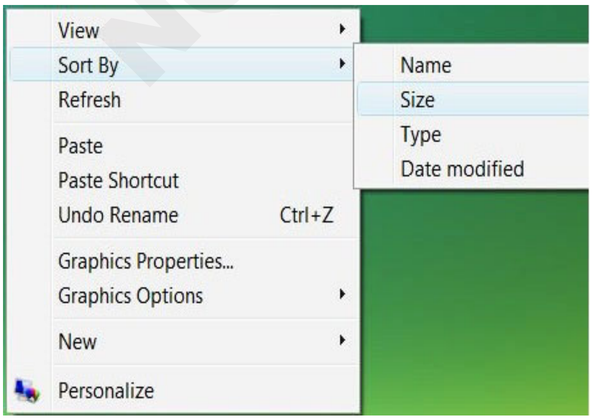


Fig 8

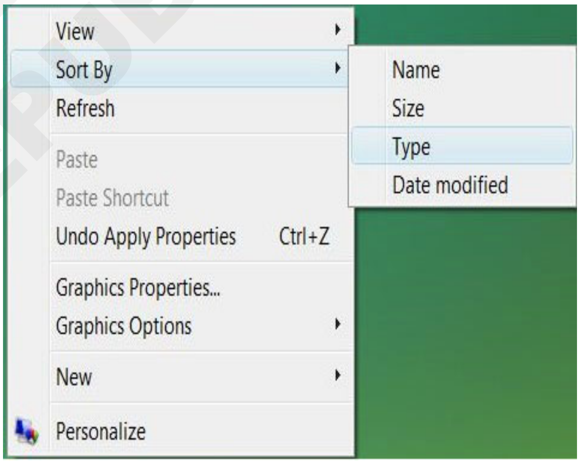
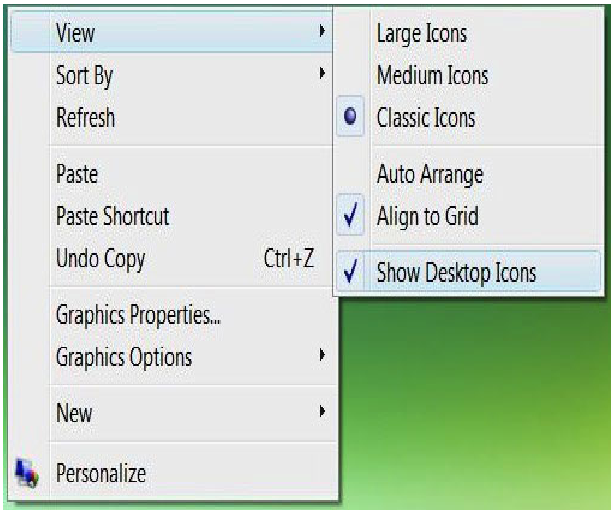


Fig 10



© NIMI NOT TO BE REPUBLISHED

Fig 9

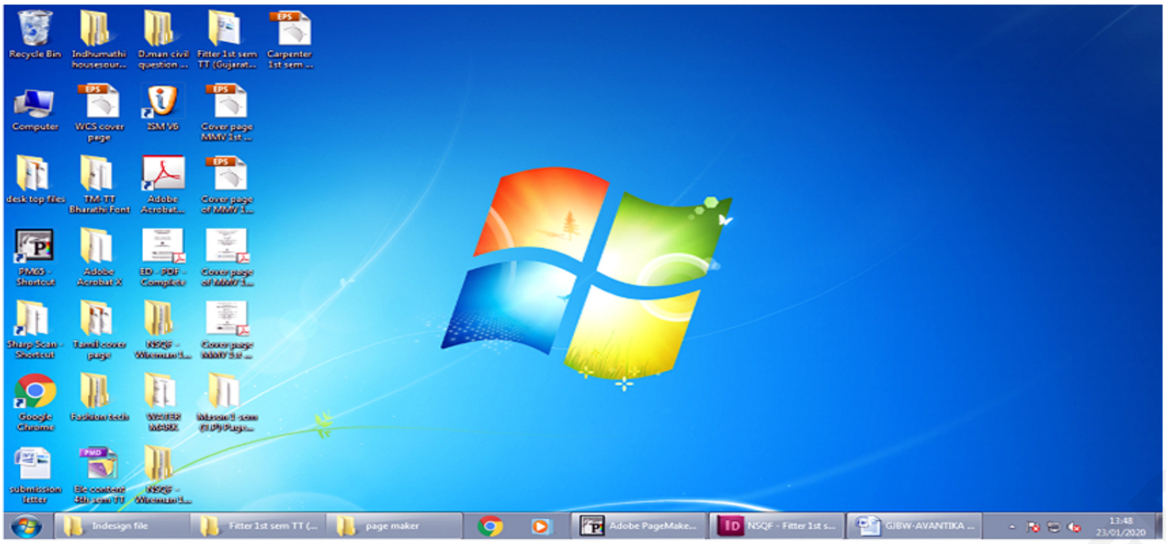


Fig 11

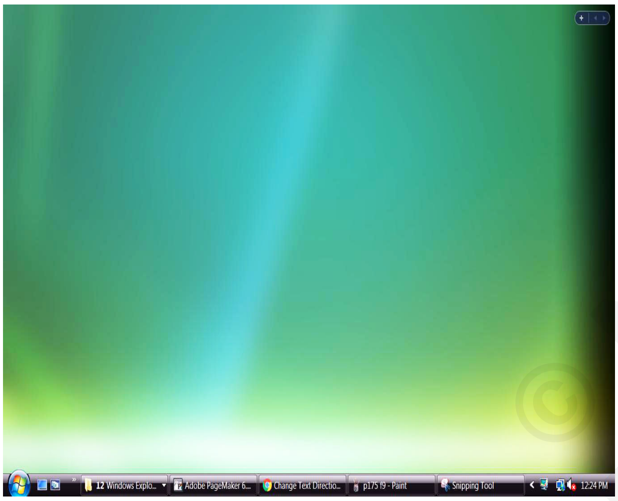


Fig 12

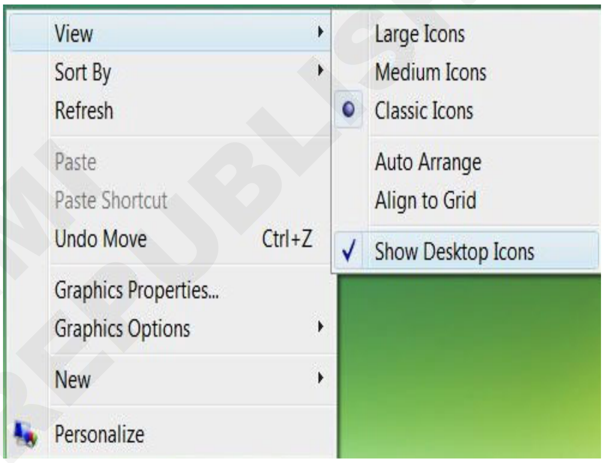
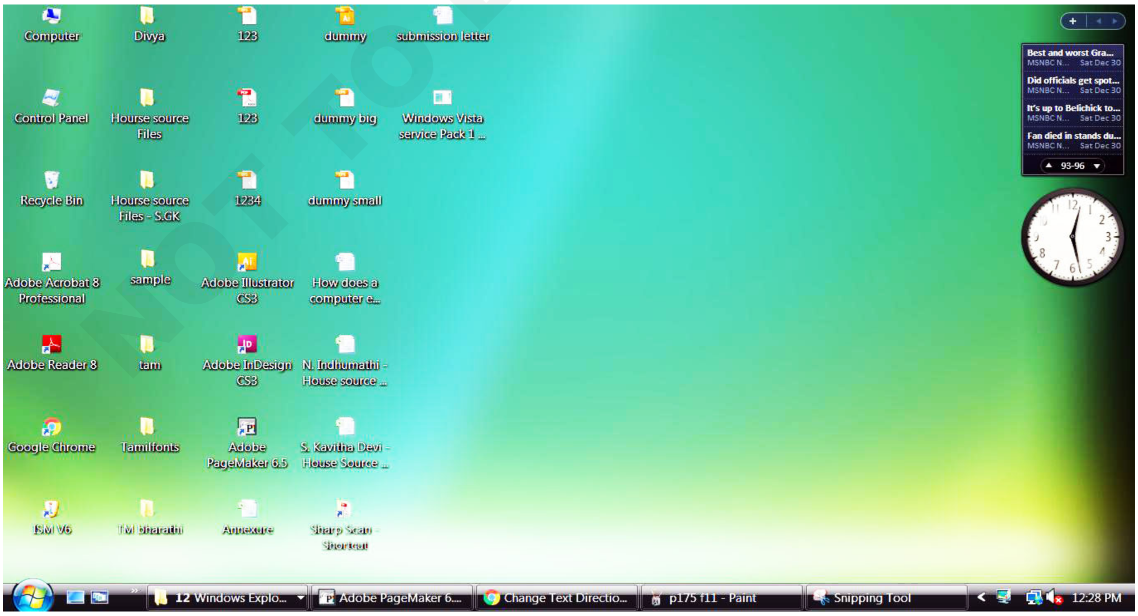


Fig 13



— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

TASK 4: **Change Desktop Image**

1 Right click the mouse button on your desktop

2 Click Properties (Fig 14)

Fig 14

3 Display properties window (Fig 15)

4 Select Desktop Options

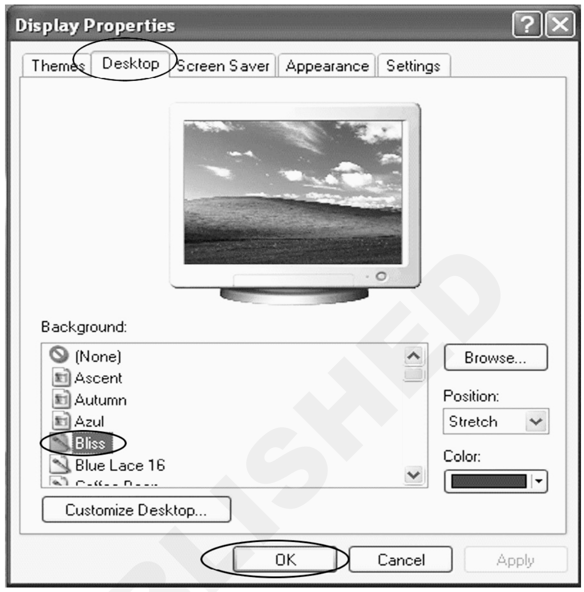
5 Choose Background Images one by one and

6 Preview the image displayed

7 Click Ok button

8 Display Bliss image on your desktop

Fig 15



— — — — — — — — —

TASK 5: **Change desktop Image Position**

Center Position

1 Right click the mouse button on your desktop

2 Click Properties

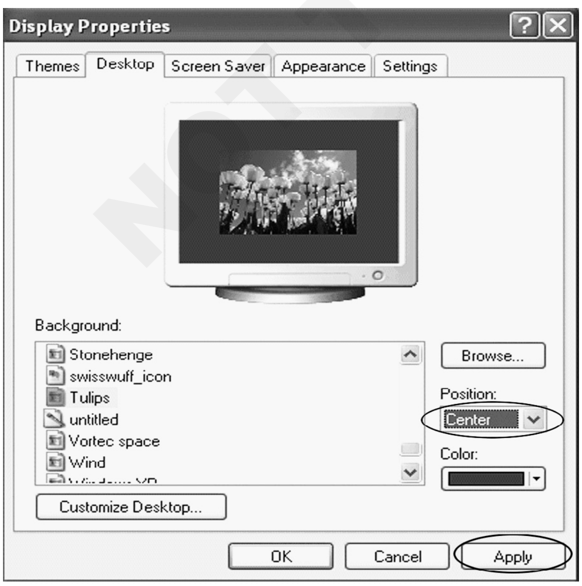
3 Display properties window appears

4 Click Positions

5 Change position type as Center

6 Display image in center position (Fig 16)

Fig 16



Stretch Position

7 Change position type to Stretch

8 Display image in Stretch position (Fig 17)

Fig 17

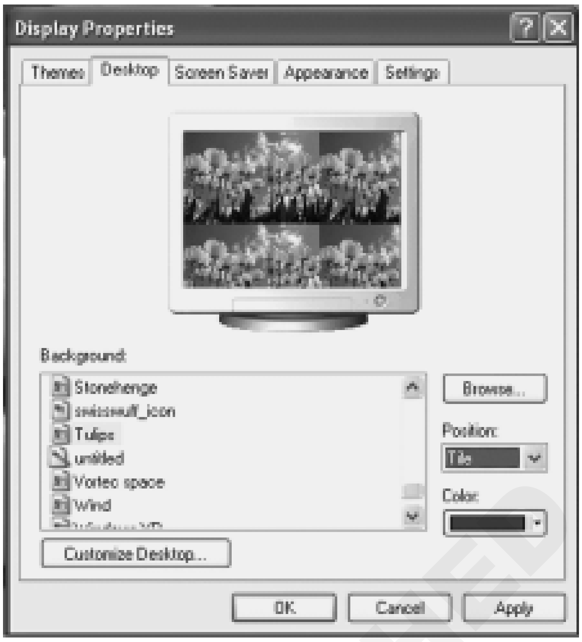
© NIMI NOT TO BE REPUBLISHED

Tile Position

9 Change position type Tile (Fig 18)

10 Displayed image Tile position

Fig 18



— — — — — — — —

TASK 6: **Change desktop Color**

1 Right click the mouse button on your desktop

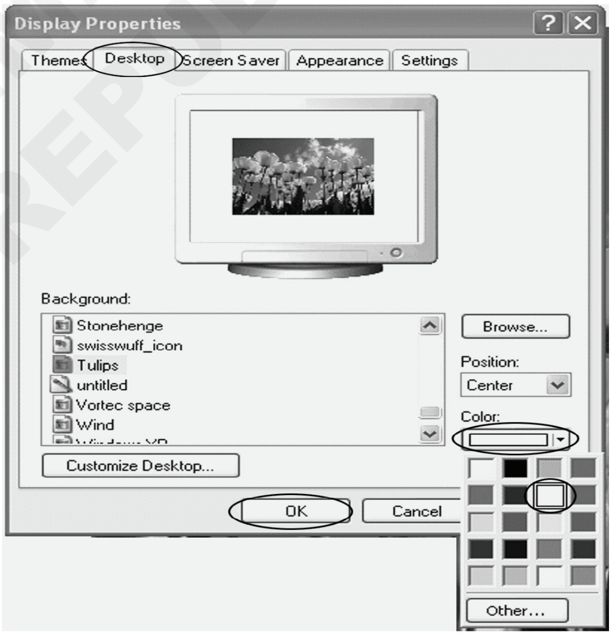
2 Click Properties

3 Select Desktop option

4 Choose Color "Yellow"

5 Yellow color displayed on your desktop (Fig 19)

Fig 19



— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Create save and print in a document work sheet, work sheet and pdf

Objective(s): At the end of this lesson you shall be able to
- **explain about a word processor**
- **invoke Microsoft Word**
- **save the documents**
- **open documents**
- **save a file with different file name.**

Word processing application software (some times just called Word processor) allows to create, edit, format, preview, print & save documents like letters, memos, reports and other text with greater ease & efficiency. One of the greatest advantage of the word processor is that it enables you to create a file of the text, to which changes can be made without retyping the entire document. The following are some of the popular word processing application packages; WORDSTAR, WORDPERFECT, MICROSOFT WORD

Microsoft Word is Windows based text processing application software. This is available as an application program under 

This gets activated after selecting 

available on the desktop. Fig 1 shows the sequence for invoking WORD.

Fig 1

The basic components of the application and document windows are as shown in Fig 2.

It is much easier to use a mouse to choose the menu options, however it is possible to do the same using a combination of keys in the keyboard, which is called as the shortcut key.

The various components of the application and document windows are:

Menu bar: This is positioned below the title bar which contains options File, Edit, View, Format, Tools, Table, Window & Help. Each of this menu item has a drop down command, which gets displayed whenever the menu is chosen. The shortcut key needed for selecting the command is displayed in the dropped down list.

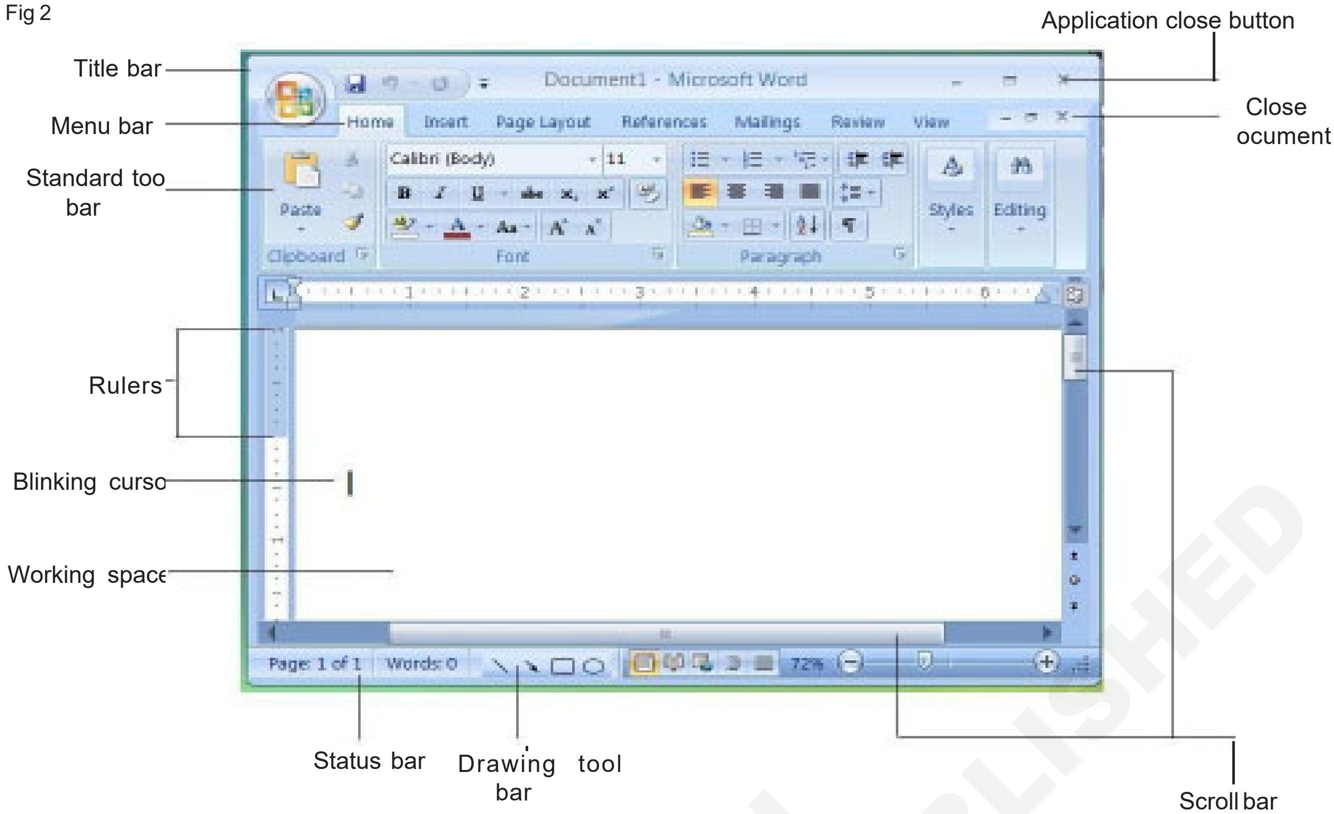
Tool bar: This displays tools as graphical icons which enable to perform tasks faster and with ease. The two most commonly used tool bars are the standard tool bar and formatting tool bar. The use of tools are explained in the later lessons.

Ruler bar: This allows to format the vertical and horizontal alignment of text in a document.

Status bar: This displays information about the active document or the task on which the user is currently working. The status bar is positioned at the bottom of the window. This includes the page number, line & column number on which the cursor is positioned.

© NIMI NOT TO BE REPUBLISHED

Fig 2



Scroll bar: The document window consists of two scroll bars: vertical scroll bar and horizontal scroll bar. The vertical scroll bar is used to move in the document vertically. It has 4 buttons, those with single arrows allow the user to scroll up/down in the document one line at a time while those with double arrows allow the user to scroll the document up/down by one page. The horizontal scroll bar is used to move the document horizontally.

WORKSPACE is the area in the document window where the text of the document can be typed.

WORD FILE is the basic unit of storage in Windows 95.

The word files are represented by (word icon) along with the file name. A file opened for use is the document. By default, a word document is saved with an file name extension .doc.

Example abc.doc

File name extension

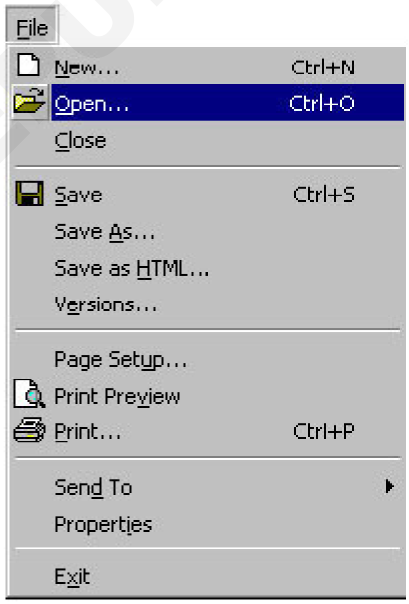
The **File** option in the menu bar supports all the actions with respect to the file activities. When the **File** option is selected a command list drops down as in Fig 3.

The following are some of the file commands under **File** menu;

New: This creates a new document.

Open: This enables opening of an existing document. A file existing at any locations on the hard disk or floppy diskette or network drive or on a network etc., can be opened form the open dialog box. The dialog box, as in Fig 4, pops up on choosing this command.

Fig 3



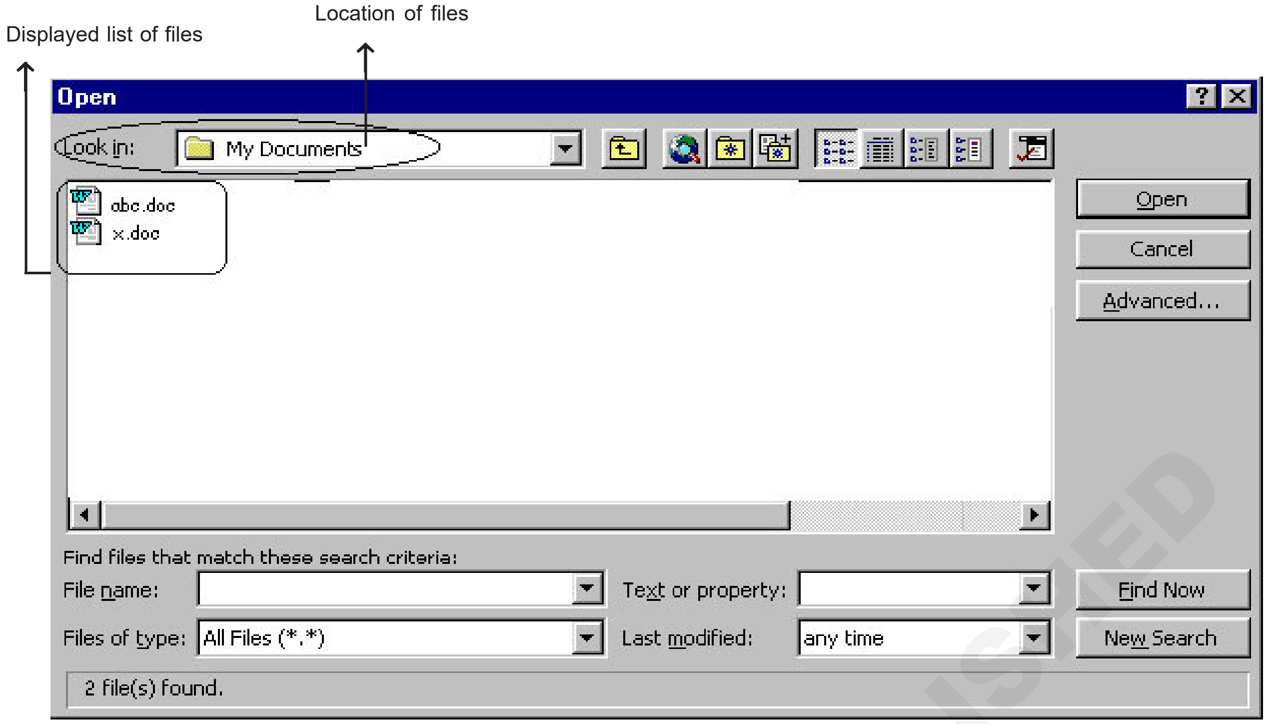
A document can be opened as a copy or opened **as read-only or** opened in **default mode**.

When a document is opened **as a copy** a new copy of the document is created in the folder that contains the original document.

When a document is opened as **read-only** document, the changes are ineffective to the opened document, however the changes can be saved to another document using Save As command.

© NIMI NOT TO BE REPUBLISHED

Fig 4



Create a New Excel Sheet, Open Existing File, Save Current File and Rename the Work Sheet

Objective(s): At the end of this exercise you shall be able to

- **create a new excel sheet**
- **open an existing file**
- **save a current file**
- **close a current file**
- **add and rename the work sheet**
- **add rows and column**
- **resize row and column.**

PROCEDURE

TASK 1: **Open the Excel**

1 Boot the system, if not booted

2 Click Start Button

3 Choose Programs

4 Click Microsoft Excel

5 Open Microsoft Excel (Fig 1)

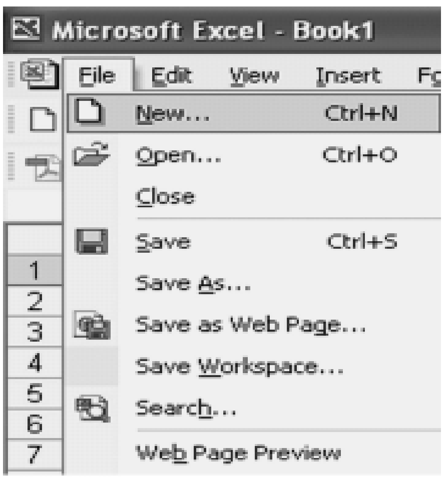
Create a New Excel Sheet

1 Choose File Menu

2 Click New option (short cut key : Ctrl + N)

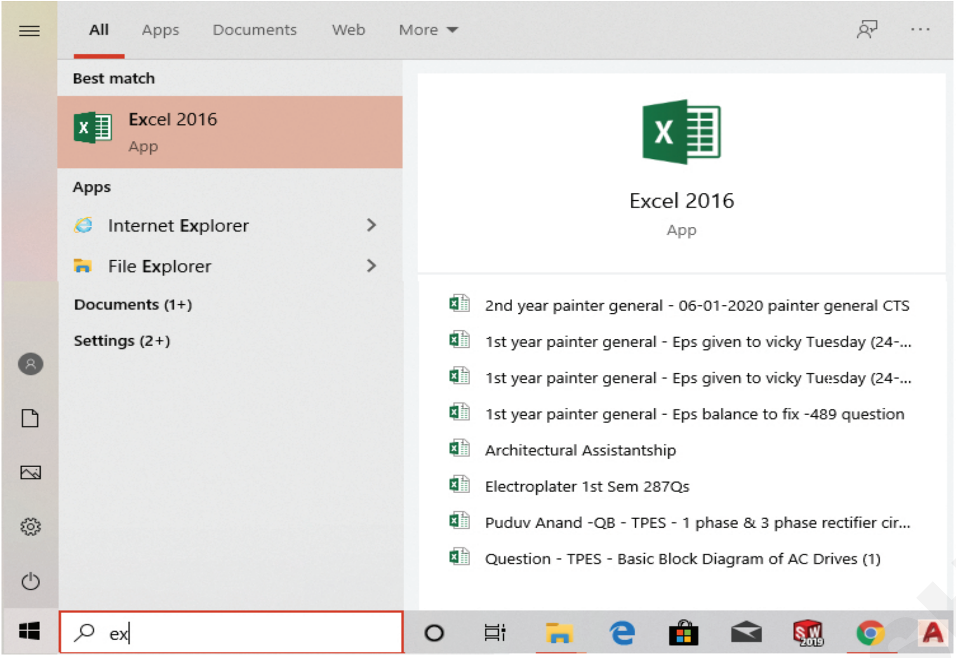
3 Create New Excel Sheet (Fig 2)

Fig 2



© NIMI NOT TO BE REPUBLISHED

Fig 1



TASK 2: **Open an Existing Excel Sheet**

1 Choose File Menu

2 Click Open option (Short cut key : Ctrl + O) (Fig 3)

3 Displayed existing file window

4 Choose existing file "sample"

5 Click Open Button

6 Open the existing file (Fig 4)

Fig 3

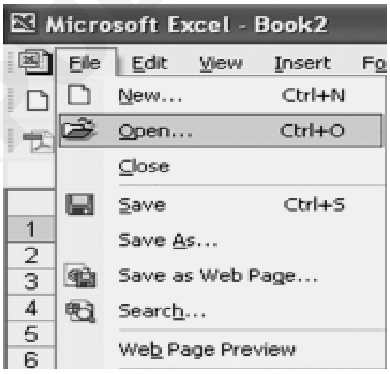
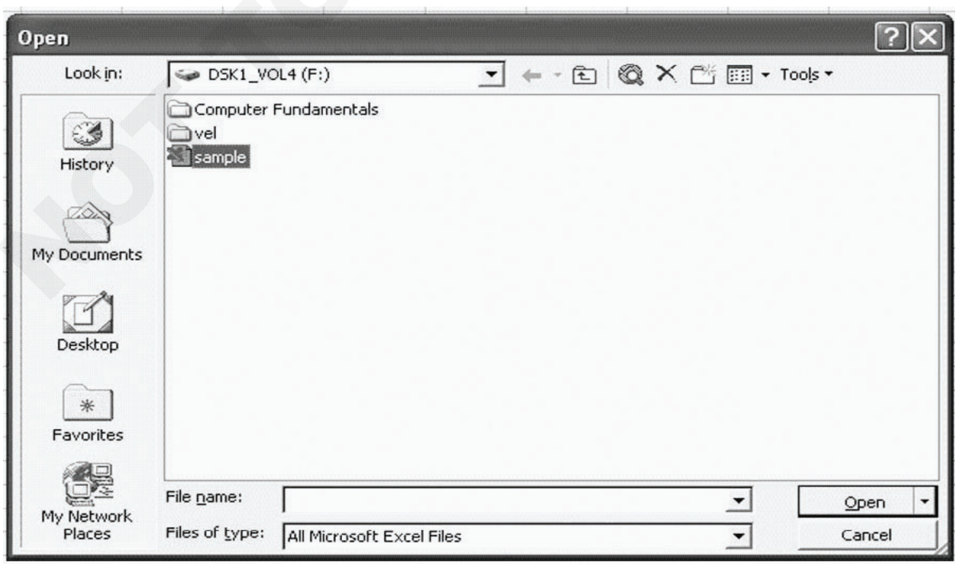


Fig 4



© NIMI NOT TO BE REPUBLISHED

TASK 3: **Save a Current Excel Sheet**

1 Create a New Excel Sheet

2 Choose File Menu

3 Click New option

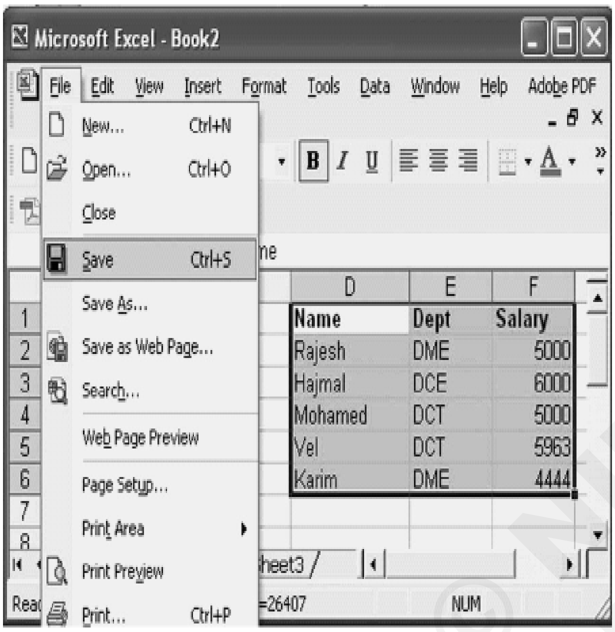
4 Created a new excel sheet

5 Type the content Name, Dept and Salary

6 Choose File Menu

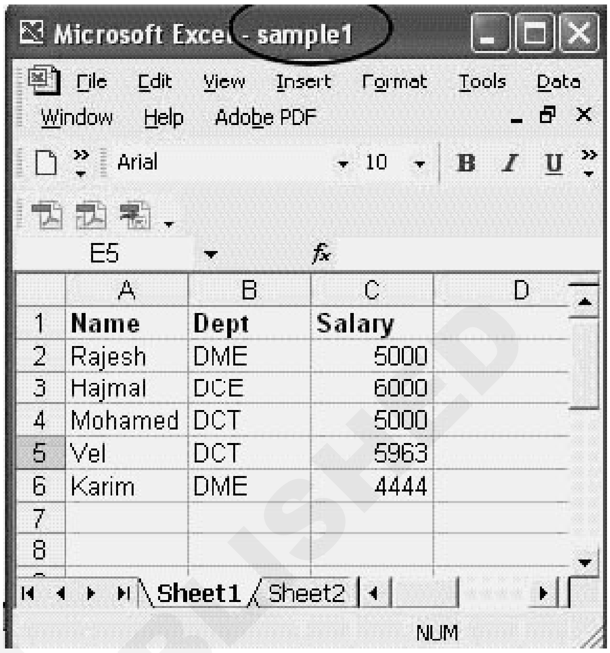
7 Click Save option (Short cut key: Ctrl + S) (Fig 5)

Fig 5



8 Save the Current excel sheet name as "sample1) (Fig 6)

Fig 6



— — — — — — — —

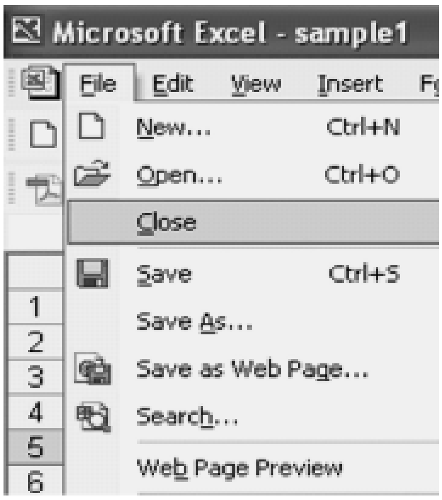
TASK 4: **Close a current excel sheet**

1 Select File Menu

2 Click Close (Fig 7)

3 Close current excel sheet

Fig 7



— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

TASK 5: **Adding and Renaming Worksheets**

1 The worksheets in a workbook are accessible by clicking the worksheet tabs just above the status bar.

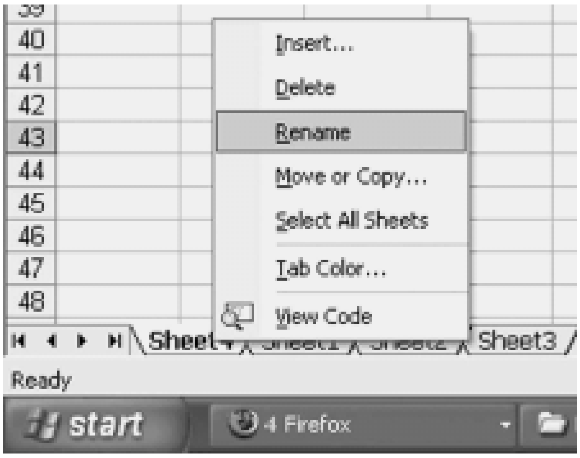
2 By default, three worksheets are included in each workbook.

3 To add a sheet, select the Insert menu

4 Click Worksheet from the menu bar.

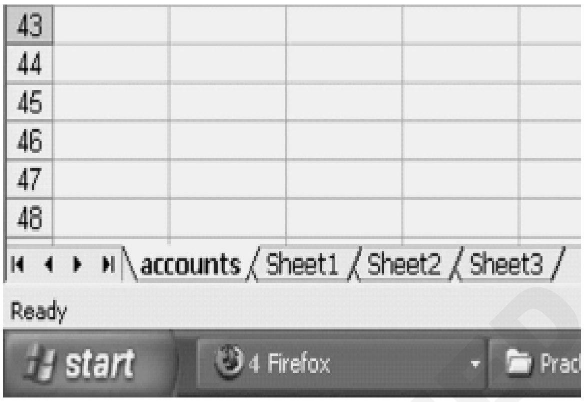
5 To rename the worksheet tab, right-click on the tab with the mouse and select Rename from the shortcut menu. (Fig 8)

Fig 8



6 Type the new name and press the ENTER key. (Fig 9)

Fig 9



TASK 6: **Adding Rows, and Columns**

Worksheets

1 Add a worksheet to a workbook by Choosing Insert menu

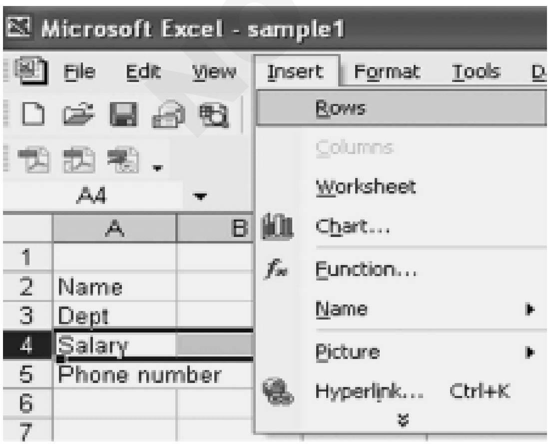
2 Click Worksheet from the menu bar.

Row

1 Add a row to a worksheet, Choose Insert Menu

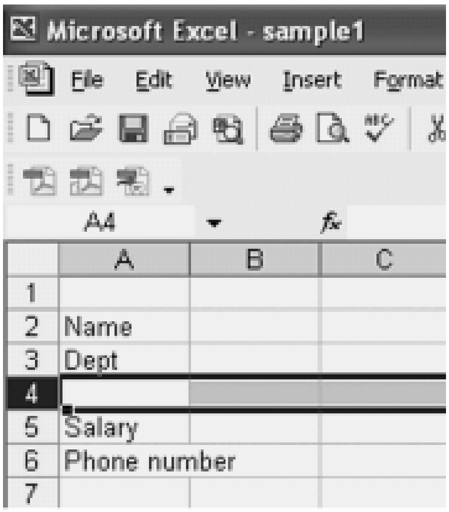
2 Click Rows list, or highlight the row by clicking on the row label (Fig 10)

Fig 10



3 Right-click with the mouse, and choose Insert. (Fig 11)

Fig 11



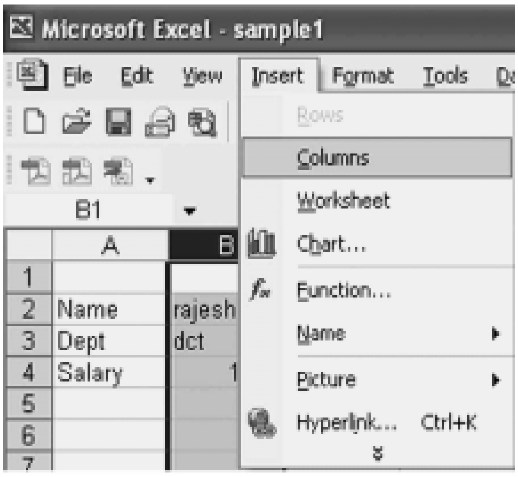
Column

1 Add a column by Choosing Insert menu

2 Click Columns list, or highlight the column by click on the column label (Fig 12)

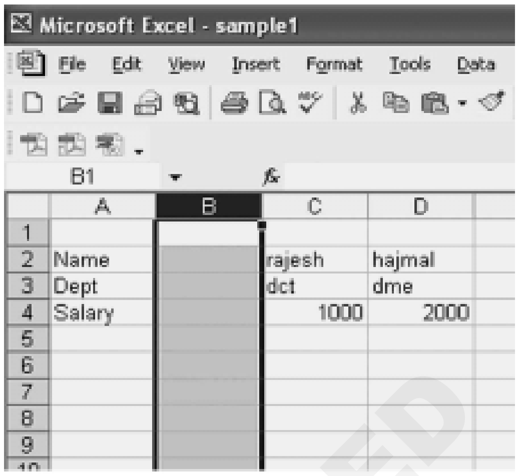
© NIMI NOT TO BE REPUBLISHED

Fig 12



3 Right-click with the mouse, and choose Insert. (Fig 13)

Fig 13

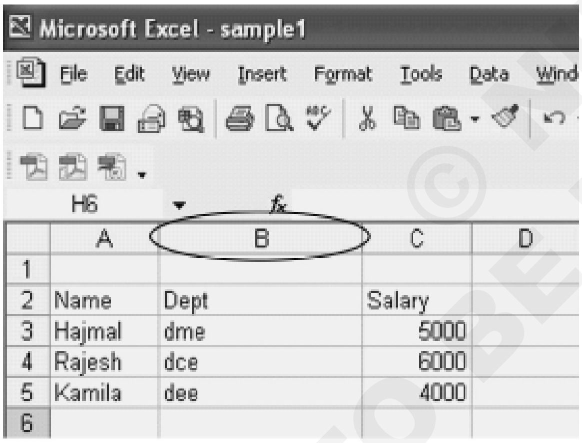


TASK 7: **Resizing Rows and Columns**

Resize a Row

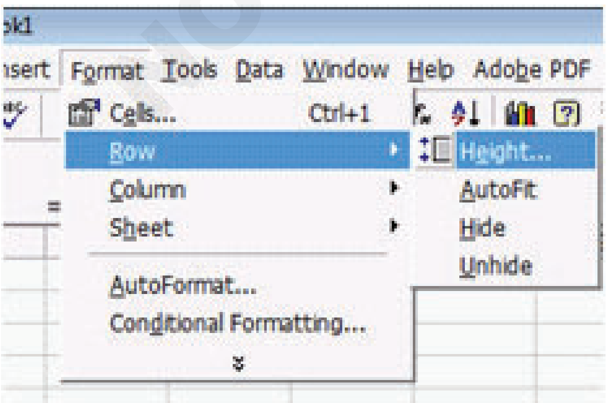
1 Place the mouse cursor on the line of row/column and resize it accordingly. (Fig 14)

Fig 14



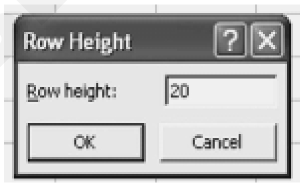
2 Choose Format menu and click row height (Fig 15)

Fig 15



3 Enter a numerical value for the height of the row. (Fig 16)

Fig 16

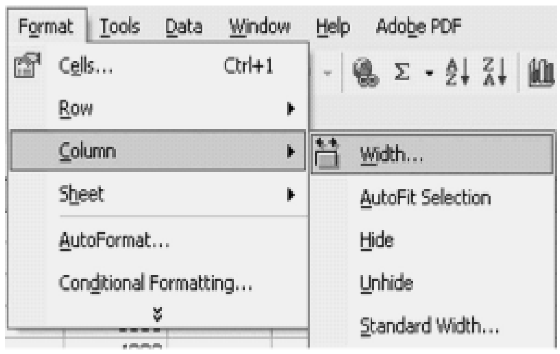


Resize a column

1 Dragging the line to the right of the label corresponding to the column you want to resize.

2 Choose Format menu and Click the column width (Fig 17)

Fig 17



3 Enter a numerical value for the width of the column. (Fig 18)

Fig 18

© NIMI NOT TO BE REPUBLISHED

Practice on Computer

Objective(s): At the end of this exercise you shall be able to
- **do the exercise susing MS word package.**

1 Type as per the pattern below.

GOVT. OF INDIA

MINISTRY OF LABOUR & EMPLOYMENT

DIRECTORATE GENERAL OF EMPLOYMENT&TRAINING

ADVANCED TRAINING INSTITUTE

CTI CAMPUS - GUINDY - CHENNAI - 600 032

Website : http://www.atichennai.org.in Email : atichn@vsnl.com Phone : OFF:- 044-2250 1211 / 2250 0252 / 2501460

TELEFAX: 044-22501460

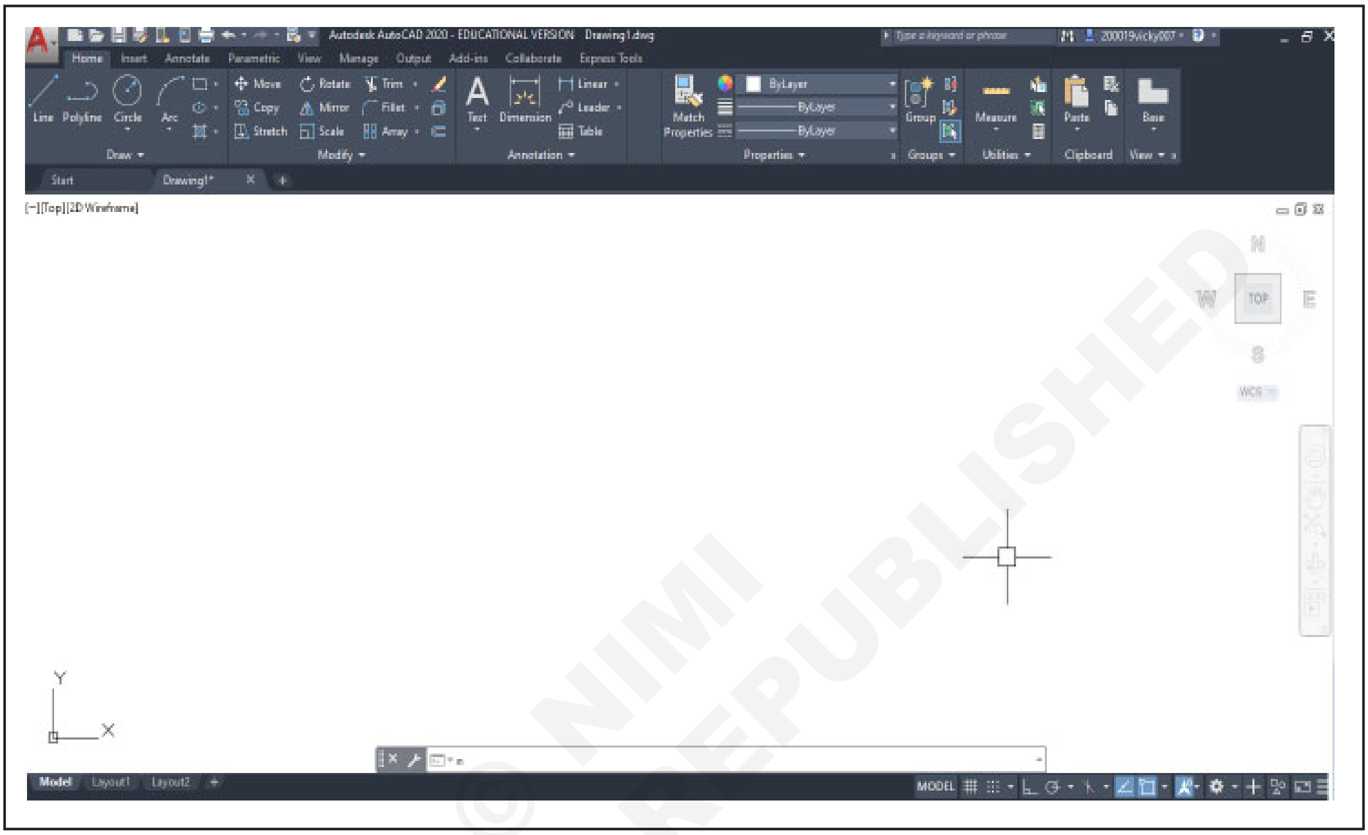
Ref. No.: Date:

— — — — — — — —

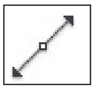
© NIMI NOT TO BE REPUBLISHED

Perform application in CAD

Objective(s): At the end of this exercise you shall be able to
- **application in cad.**



NOT TO BE REPUBLISHED © NIMI



Tool bar : Draw

Menu : Draw Construction Line

Command entry : 'x' line

Specify a point or (hor/Ver/Aug/Bisect/Offset) : Specify a point or enter an option

Find

'X' lines are useful for creating construction and reference lines, and for trimming boundaries.

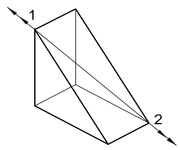
The following prompts are displayed.

Point

Specifies the location of the infinite line using two points through which it passes.

Specify through point : Specify the point (2) through which you want the xline to pass, or press ENTER to end the command.

The 'x' line is created through the specified point.

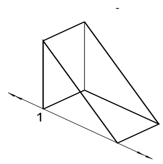


Hor

Creates a horizontal 'x' line passing through a specified point.

Specify through point : Specify the point (1) through which you want the x line to pass, or press ENTER to end the command.

The 'x' line is created parallel to the 'X' axis.

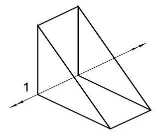


Ver

Creates a vertical 'x' line passing through a specified point.

Specify through point : Specify the point (1) through which you want the 'x' line to pass, or press ENTER to end the command.

The 'x' line is created parallel to the 'Y' axis.

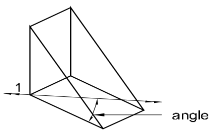


Ang

Creates an 'x' line at a specified angle.

Enter angle of 'x' line (0) or [Reference] : Specify an angle or enter.

Angle of X' line



Specifies the angle at which to place the line.

Specify through point : Specify the point through which you want the 'x' line to an 'x' line is created through the specified point, using the specified angle.

Reference

Specifies the angle from a selected reference line. The angle is measured counter clockwise from the reference line.

Select a line object : Select a line, polyline, ray, or 'x' line

Enter angle of xline <0> :

Specify through point : Specify the point through which you want the 'x' line to pass, or press ENTER to end the command.

Bisect

Creates an 'x' line that passes through the selected angle vertex and bisects the angle between the first and second line.

Specify angle vertex point : Specify a point (1)

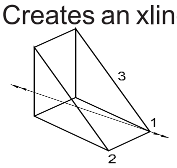
Specify angle start point : Specify a point (2)

Specify angle end point : Specify a point (3) or press ENTER to end the commend

The 'x' line lies in the plane determined by the three points.

Offset

Creates an xline parallel to another object.



Specify offset distance or (through) <current> : Specify an offset distance, enter t, or press ENTER

Offset Distance

Specifies the distance the 'x' line is offset from the selected object.

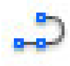
Select a line object : Select a line, polyline, ray, or 'x' line, or press ENTER

Through

Creates an xline offset from a line and passing through a specified point.

Polyline

Creates two-dimensional polylines

Tool bar : Draw 

Menu : Draw Polyline

Command entry : pline

Specify start point : Specify a point

Current line-width is <current>

Note: A temporary plus-shaped marker displays at the first point. This marker can be useful when you create long and complicated polylines. It is removed when you complete the polyline.

The PLINEGEN system variable controls the line type pattern display around and the smoothness of the vertices of a 2D polyline. Setting PLINEGEN to 1 generates new polylines in a continuous pattern around the vertices of the completed polyline. Setting PLINEGEN to 0 starts and ends the polyline with a dash at each vertex. PLINEGEN does not apply to polylines with tapered segments.

Next Point

Draws a line segment. The previous prompt is repeated.

Arc

Adds arc segments to the polyline.

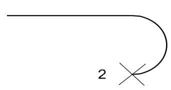
Specify endpoint of arc or

[Angle/CEnter/CLose/Direction/Halfwidth/Line/Radius/Second pt/Undo/Width]: Specify a point (2) or enter an option

Note: For the Center option of the PLINE command, enter ce; for the Center object snap, enter cen or center.

Endpoint of Arc

Draws an arc segment. The arc segment is tangent to the



previous segment of the polyline. The previous prompt is repeated.

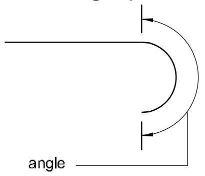
Angle

Specifies the included angle of the arc segment from the start point.

Specify included angle:

© NIMI NOT TO BE REPUBLISHED

Entering a positive number creates counterclockwise arc



segments. Entering a negative number creates clockwise arc segments.

Specify endpoint of arc or [Center/Radius]: Specify a point or enter an option

Endpoint of Arc

Specifies the endpoint and draws the arc segment.

Center

Specifies the center of the arc segment.

Specify center point of arc:

Radius

Specifies the radius of the arc segment.

Specify radius of arc: Specify a distance

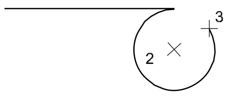
Specify direction of chord for arc <current>: Specify a point or press Enter

Center

Specifies the center of the arc segment.

Specify center point of arc: Specify a point (2)

Specify endpoint of arc or [Angle/Length]: Specify a point (3) or enter an option



Endpoint of Arc

Specifies the endpoint and draws the arc segment.

Angle

Specifies the included angle of the arc segment from the start point.

Specify included angle:

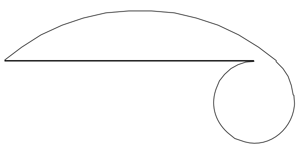
Length

Specifies the chord length of the arc segment. If the previous segment is an arc, the new arc segment is drawn tangent to the previous arc segment.

Specify length of chord:

Close

Draws an arc segment from the last point specified to the starting point, creating a closed polyline. At least two points must be specified to use this option.

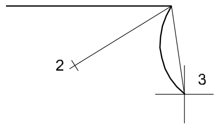


Direction

Specifies a starting direction for the arc segment.

Specify the tangent direction from the start point of arc: Specify a point (2)

Specify endpoint of arc: Specify a point (3)



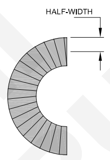
Half width

Specifies the width from the center of a wide polyline segment to one of its edges.

Specify starting half-width <current>: Enter a value or press Enter

Specify ending half-width <starting width>: Enter a value or press Enter

The starting half-width becomes the default ending half-width. The ending half-width becomes the uniform half-width for all subsequent segments until you change the half-width again. The starting and ending points of wide line segments are at the center of the line.



Typically, the intersections of adjacent wide polyline segments are beveled. No beveling is performed for non tangent arc segments or very acute angles or when a dot-dash line type is used.

Line

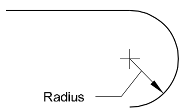
Exits the Arc option and returns to the initial PLINE command prompts.

Radius

Specifies the radius of the arc segment.

Specify radius of arc: Specify a distance

Specify endpoint of arc or [Angle]: Specify a point or enter a



Endpoint of Arc

Specifies the endpoint and draws the arc segment.

Angle

Specifies the included angle for the arc segment.

Specify included angle:

Specify direction of chord for arc <current>: Specify an angle or press Enter

Second Pt

Specifies the second point and endpoint of a three-point arc.

© NIMI NOT TO BE REPUBLISHED

Specify second point on arc: Specify a point (2)

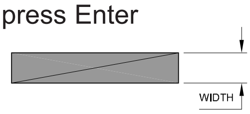
Specify end point of arc: Specify a point (3)

Width

Specifies the width of the next arc segment.

Specify starting width <current>: Enter a value or press Enter

Specify ending width <starting width>: Enter a value or press Enter



The starting width becomes the default ending width. The ending width becomes the uniform width for all subsequent segments until you change the width again. The starting and ending points of wide line segments are at the center of the line.

Typically, the intersections of adjacent wide polyline segments are beveled. No beveling is performed for non tangent arc segments, very acute angles, or when a dot-dash line type is used.

BREAK

Breaks the selected object between two points.

Tool bar : Modify

Menu : Modify Break

Command entry : break

The prompts that are displayed depend on how you select the object. If you select the object by using your pointing device, the program both selects the object and treats the selection point as the first break point. At the next prompt, you can continue by specifying the second point or by overriding the first point.

specify second break point or [First point] : Specify the second break point (2) or enter **f**.

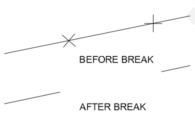
Second Break Point

Specifies a second point to use to break the object.

First point

Overrides the original first point where you selected the object with a new point that you specify.

specify first break point :

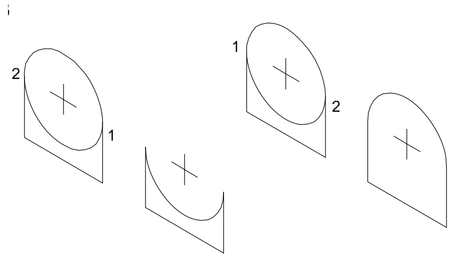


The portion of the object is erased between the two points that you specify. If the second point is not on the object, the nearest point on the object is selected; therefore, to break off one end of a line, arc or polyline, specify the second point beyond the end to be removed.

To split an object in two without erasing a portion, enter the same point for both the first and second points. You can do this by entering @ to specify the second point.

Lines, arcs, circles, polylines, ellipses, splines, donuts, and several other object types can be split into two objects or have one end removed.

The program converts a circle to an arc by removing a piece of the circle starting counterclockwise from the first to the second point.



Erase

Toolbar: Modify

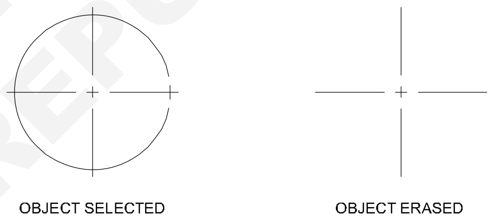
Menu : Modify - Erase

Shortcut menu: Select the objects to erase, right-click in the drawing area, and click Erase.

Command entry: erase

Select objects: Use an object selection method and press Enter when you finish selecting objects

The objects are removed from the drawing.



Undo

Reverses the effect of commands

Toolbar: Standard

Command entry: undo

Enter the number of operations to undo or [Auto/ Control/ Begin/End/ Mark/Back]: Enter a positive number, enter an option, or press Enter to undo a single operation

UNDO displays the command or system variable name at the Command prompt to indicate that you have stepped past the point where the command was used.

UNDO has no effect on some commands and system variables, including those that open, close, or save a window or a drawing, display information, change the graphics display, regenerate the drawing, or export the drawing in a different format.

Number

Undoes the specified number of preceding operations. The effect is the same as entering u multiple times.

© NIMI NOT TO BE REPUBLISHED

Auto

Groups the actions of a single command, making them reversible by a single U command. When the Auto option is on, starting a command groups all actions until you exit that command. You can undo the group of actions as if it were one action.

UNDO Auto is not available if the Control option has turned off or limited the UNDO feature.

Enter UNDO Auto mode [ON/OFF] <current>: Enter on or off, or press Enter

Control

Limits or turns off UNDO.

Enter an UNDO control option [All/None/One/Combine/Layer] <All>: Enter an option or press Enter

All

Turns on the full UNDO command.

None

Turns off the U and UNDO commands and discards any UNDO command information saved earlier in the editing session. The Undo button on the Standard toolbar is unavailable.

The Auto, Begin, and Mark options are not available when None or One is in effect. If you attempt to use UNDO while it is turned off, the following prompt is displayed:

Enter an UNDO control option [All/None/One/Combine/Layer] <All>:

One

Limits UNDO to a single operation.

The Auto, Begin, and Mark options are not available when None or One is in effect. The main prompt for the UNDO command changes to show that only a Control option or a single step of the UNDO command is available when the One option is in effect.

Enter and option [Control] <1>:

If you enter c, the previous prompt is displayed:

Enter an UNDO control option [All/None/One/Combine/Layer] <All>:

Create a standard engineering layout

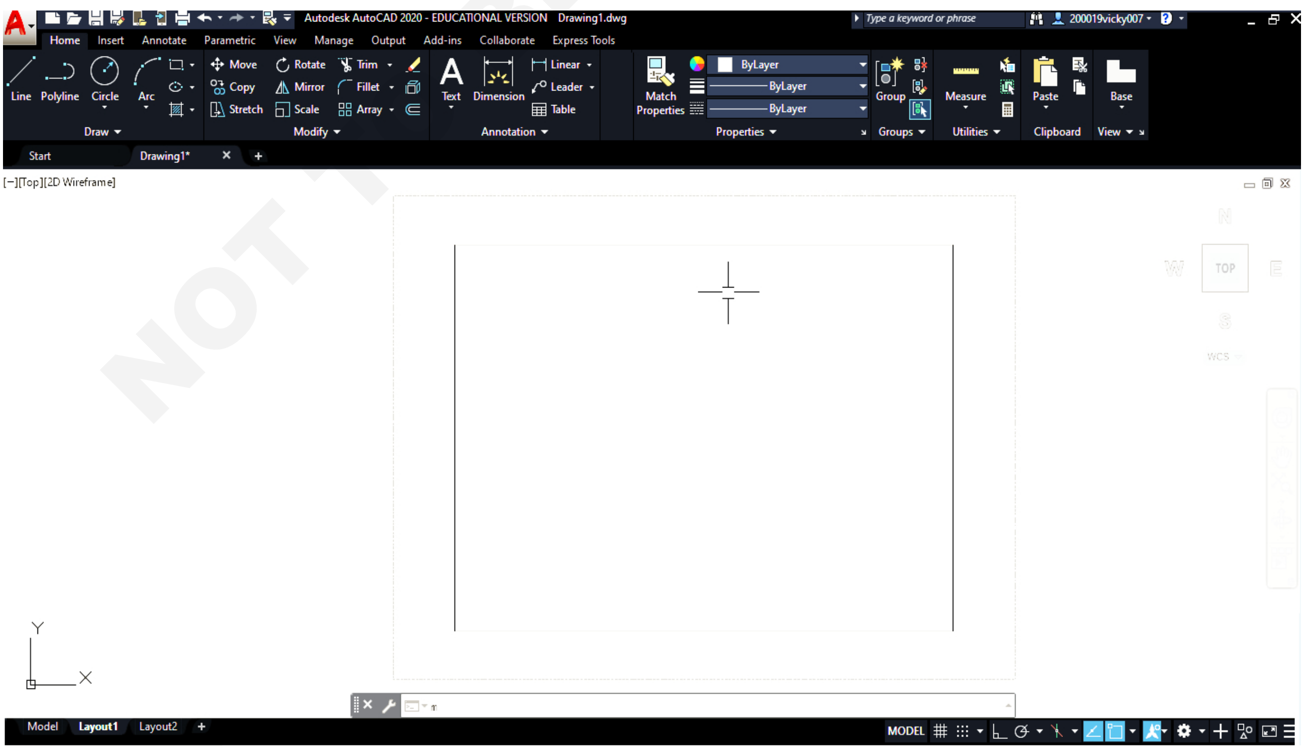
Objective(s): At the end of this exercise you shall be able to
- **creating an engineering layout.**

PROCEDURE

TASK 1: **Creating an engineering layout**

- Follow the CAD commands and complete the layout as given Fig 1.
- Create a standard engineering layout.

Fig 1



NOT TO BE REPUBLISHED © NIMI

Practice on Computer

Objective(s): At the end of this exercise you shall be able to
- **do the exercise using MS excel package.**

1 Type as per the pattern below.

COST ESTIMATION

SL. NO.	DESCTIPTION OF ITEM	LENGTH (MTR)	WIDTH (MTR)	THICKNES S (MTR)	VOLUME (CUM)	WEIGHT (KGS)	DENSITY KG/CUM)	RATE / KG (RS.)	COST (RS.)	REMARKS
				FORMULA	=E4*D4*C4	=F4*H4			=G4*I4	
1	MS FLAT	1.2	0.1	0.01	0.0012	9.42	7850	75	707	
2	MS FLAT	1.5	0.1	0.012	0.0018	14.13	7850	75	1060	
3	MS FLAT	2	0.1	0.01	0.002	15.7	7850	75	1178	
4	MS FLAT	2.5	0.075	0.01	0.001875	14.7188	7850	75	1104	
5	MS FLAT	1.5	0.05	0.01	0.00075	5.8875	7850	75	442	
								FORMULA FOR TOTAL COST	=SUM(J4:J8)	
								TOTAL COST:	4489	

© NIMI NOT TO BE REPUBLISHED

Create 2D objects using absolute coordinate system poler coordinate system and relative coordinate system

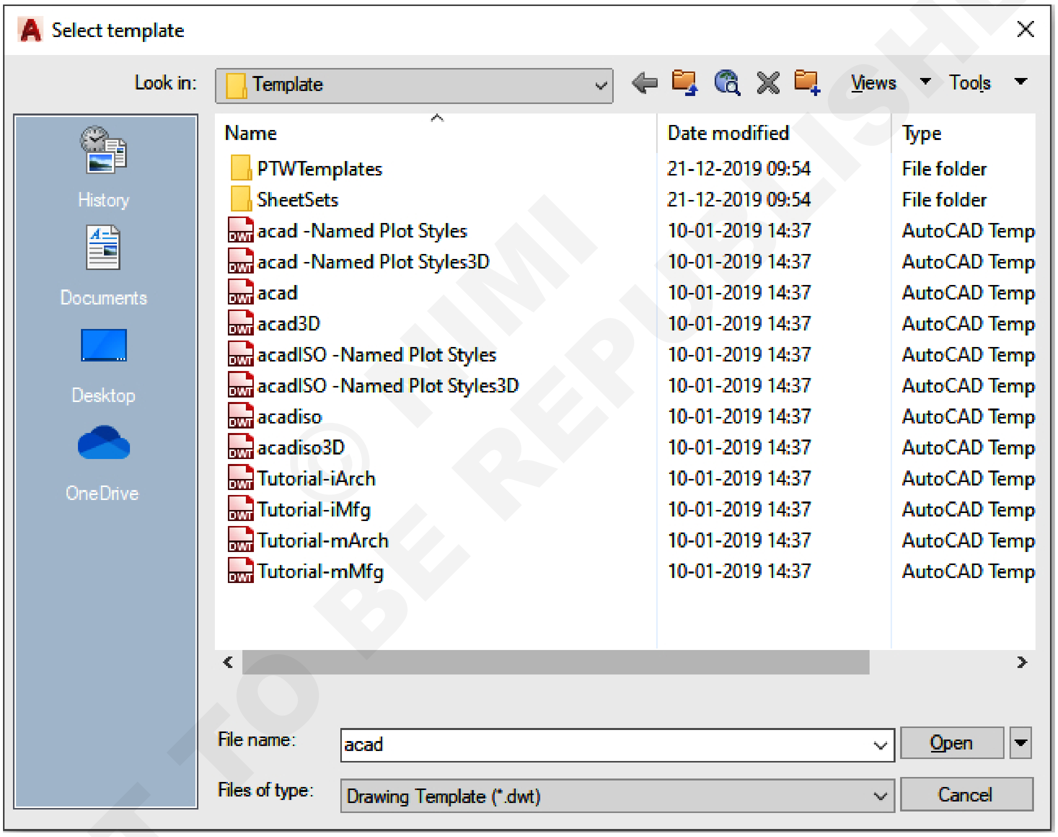
Objective(s): At the end of this exercise you shall be able to
- **starting a new drawing**
- **opening a template**
- **create a template.**

Starting a new drawing

Pull down menu: file, new.

When you invoke this command AutoCAD displays the select template dialogue box.(If you selected "show startup dialogue box' from option dialogue box you cannot see the following dialogue box. Instead of this you can see the start up dialogue box itself) (Fig 1)

Fig 1



Opening a template

The template that you create by using F 8. It will appear as a blank screen, but there are many variables that have been preset. This will allow you to start drawing immediately. You will learn how to set those variables before you complete this workbook, but for now will concentrate on learning the AutoCAD commands and hopefully, have some fun.

Let's start by opening the "1 Workbook" (Fig 2)

1 Select file/new

2 Select use a template box (third from the left).

3 Select 1 workbook helper. dwt from the list of templates.

4 Select the ok button. (Fig 3)

Create a template.

Now you can create a template. This will be a very easy task. (Fig 4)

1 Start AutoCAD as follows.

Start button/programs/AutoCAD.

The 3 letter extension for drawing file is drawing If a dialog box appears select the "Cancel" Button.

NOT TO BE REPUBLISHED © NIMI

Fig 2

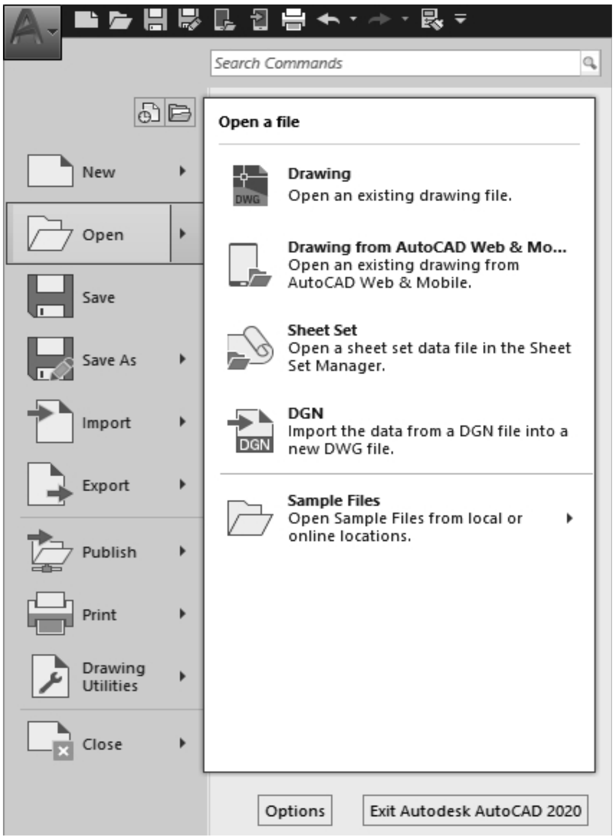


Fig 3

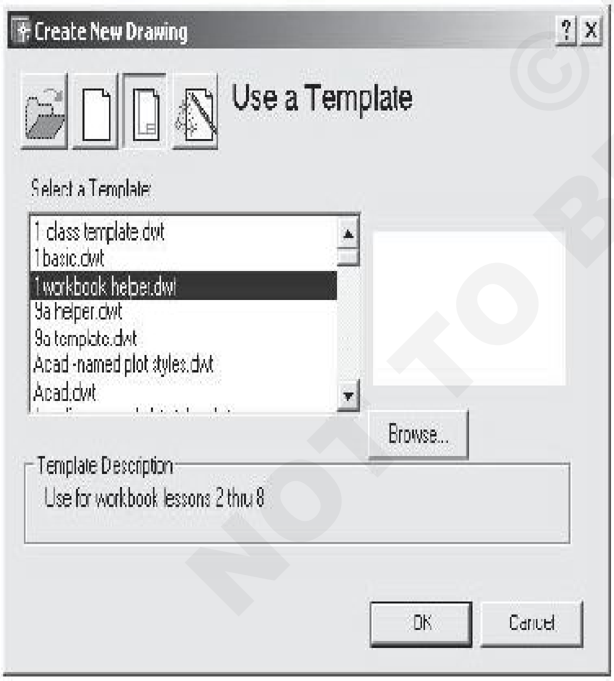
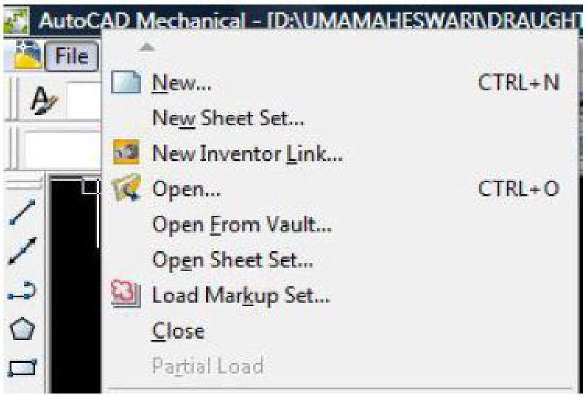


Fig 4



2 Select **file/open.**

3 Select the **directory** in which the files located.(click on the) (Figs 5,6 & 7)

Fig 5

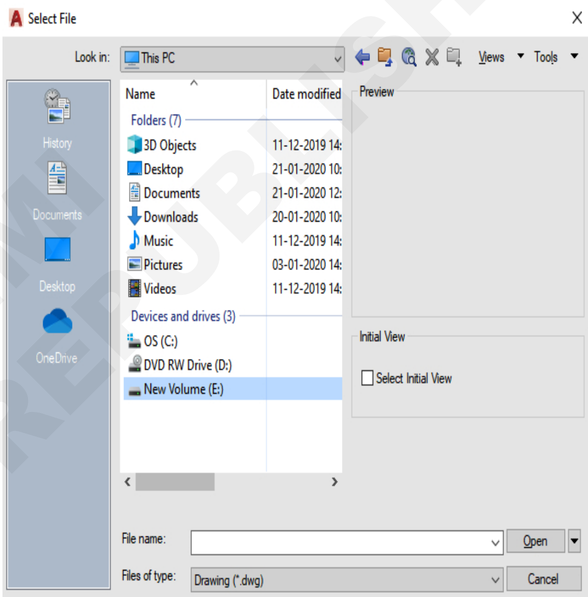
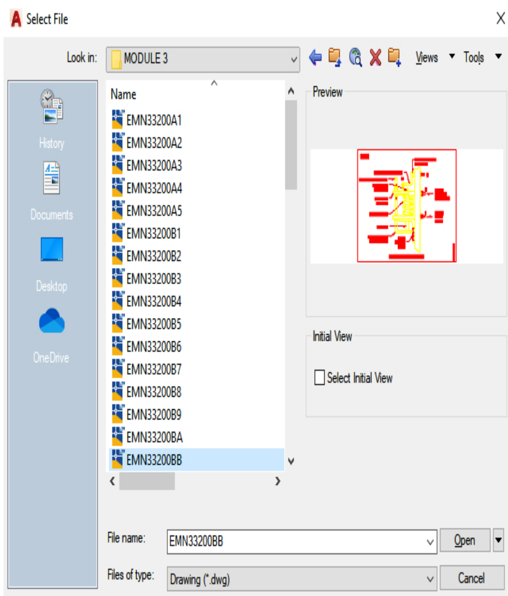
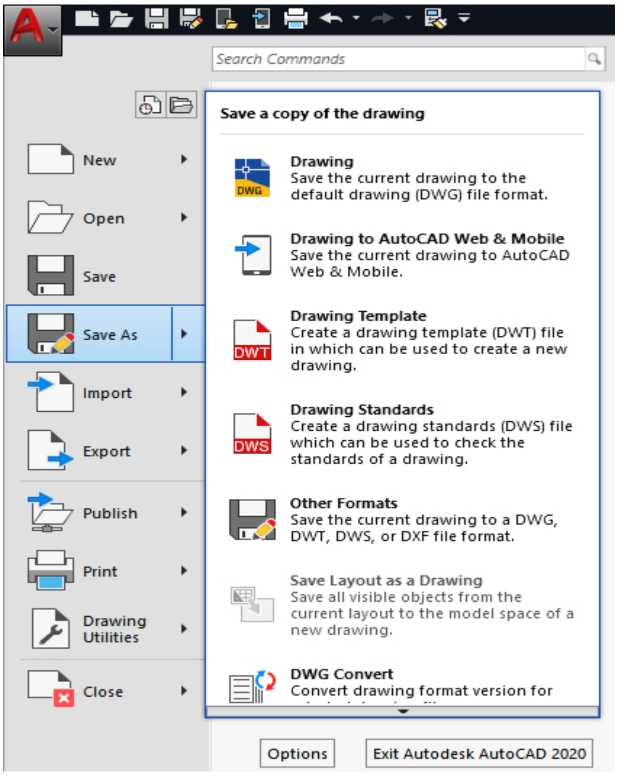


Fig 6



© NIMI NOT TO BE REPUBLISHED

Fig 7



4 Select the file **"Workbook** and then **"Open"** button.

5 Select **"File / save as"**

6 Select the **"File of type"** down arrow to display different saving formats. Select " AutoCAD drawing template (*.dwt)".

The 3 letter extension for template is "dwt".

A list of all the AutoCAD templates will appear. (Your list may be different)

7 Type the new name "1 Workbook" in the file name". box and then select the save button.

The "1" before the name will place the file at the top of the list.

AutoCAD displays numerical first and then alphabetical. (Figs 8 & 9)

8 Type a description and the select the "OK" button.

Now you have a template to use for lesson 2 through 8. At the beginning of each of the exercises you will be instructed to open this template.

Using a template as a master setup drawing is good CAD management. (Fig 10)

Creating a new drawing

New command

Create a new drawing file.

1	Choose	File, new. or
2	Press	Ctrl + N or
3	Click	The new icon or
4	Type	New at the command prompt. Command: new
5	Choose	One of the options for creating a new drawing.
6	Click	The ok button.

7. Save the drawing as another name.

TIP: New drawings can also be created from template files. (Fig 11)

Fig 8

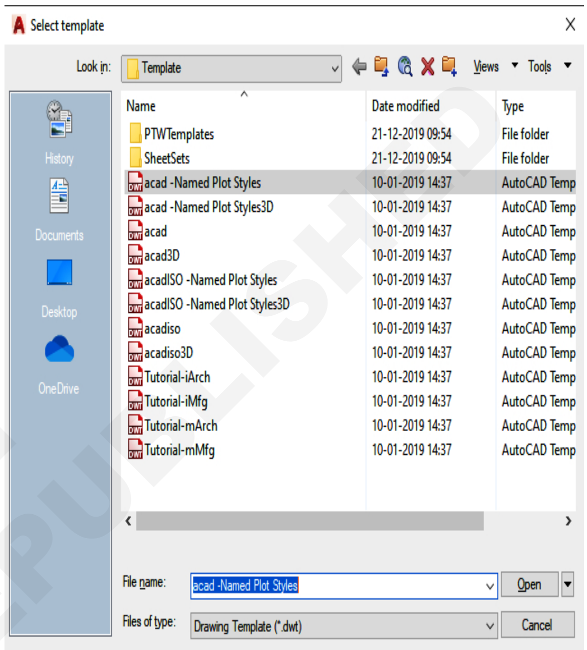
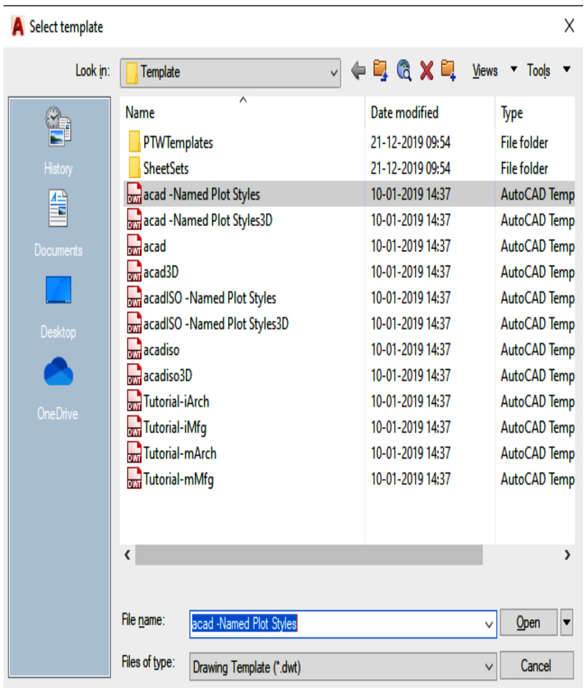


Fig 9



© NIMI NOT TO BE REPUBLISHED

Fig 10

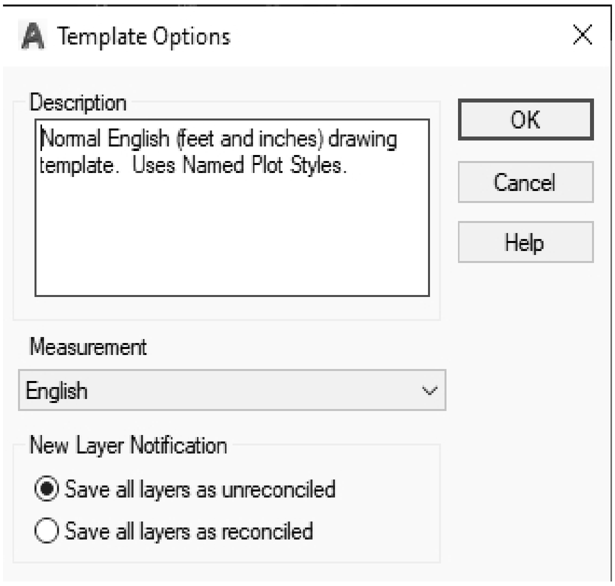
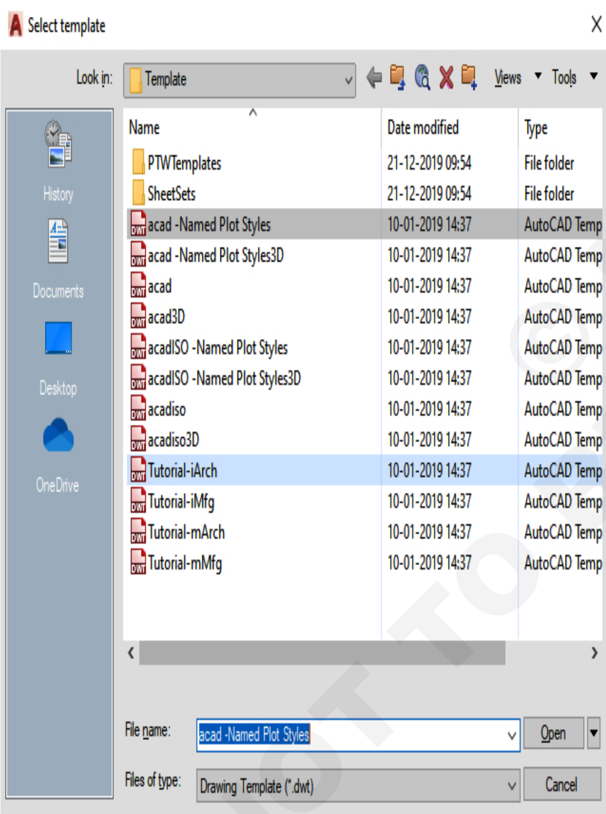


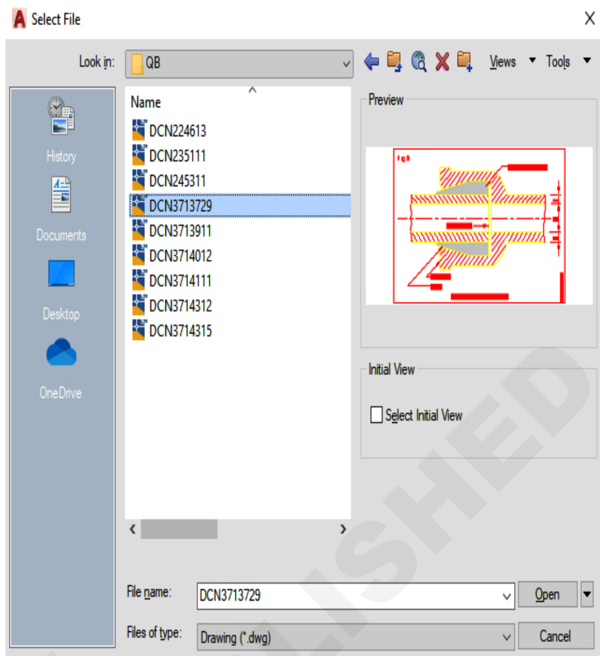
Fig 11



Open existing drawings

1	Choose	File, open. or
2	Press	Ctrl + O
3	Click	The open icon. or
4	Type	Open at the command prompt.command: open
5	Press	Enter
6	Double click	The desired directory to find the drawing to open.
7	Click	the drawing name to open.
8	Click	The ok button. (Fig 12)

Fig 12



Preview shows a bitmap image of the drawing selected. This image is the view that was last saved in the drawing.

Saving drawings

Saves the most recent changes to a drawing. The first time an unnamed drawing is saved the "Save As" Dialog box appears. AutoCAD saves its drawings as files with extensions ending in . DWG.

1	Choose	File, save or save as
2	Type	Save or save as at the command prompt command: Save or Save as
3	Press	Enter
4	Type	A new drawing name or keep the existing drawing name.
5	Click	The ok button. (Fig 13)

Various file type can be saved as

TIP: Clicking the dropdown list for file type changes the format that the drawing can be saved in.

Quick save

The Q save command is equivalent to clicking Save on the file menu.

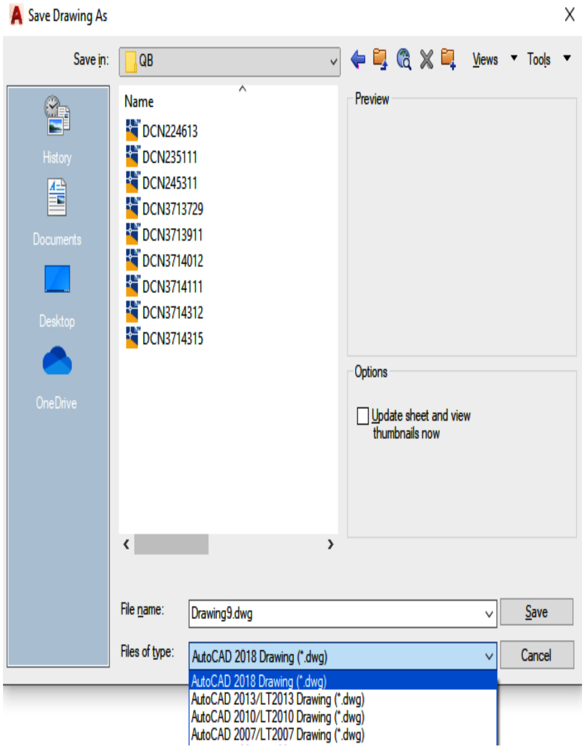
If the drawing is named, AutoCAD saves the drawing using the file format specified on the open and save tab of the Options dialog box and does not request a file name. If the drawing is unnamed, AutoCAD displays the save drawing. As dialog box **(see save as)** and saves the drawing with the file name and format you specify.

1 Press Ctrl + S.

or

© NIMI NOT TO BE REPUBLISHED

Fig 13



2 Click The save icon.

or

3 Type Q save at the command prompt, Command: Q save.

Tips: Drawings can be saved as different versions of AutoCAD (e.g. R13, R14, R2000, etc.)

AutoSave settings under Tools, options...

Existing AutoCAD

1 Choose File, exit.

or

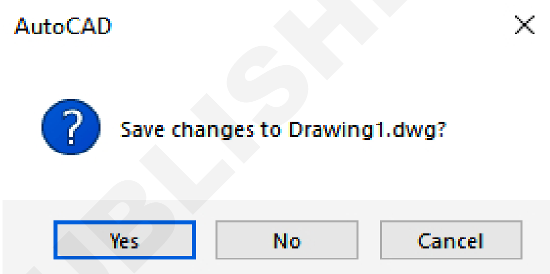
2 Type Quit at the command prompt.

Command: Quit

3 Press ENTER.

4 Click Yes to save changes or No to discard changes. (Fig 14)

Fig 14



Drawing area control

Objective(s) : At the end of this exercise you shall be able to
- **identify method of entering commands**
- **practice drawing command set up**
- **practice drawing area set up.**

Methods of entering commands

AutoCAD has 3 different methods of entering commands. All 3 methods will accomplish the same end result. AutoCAD allows you to use the method you prepare. The following are descriptions of all 3 methods and an example of how each one would be used to start command such as the line command.

1 Pull down Menu (select draw/line).

  a Move the cursor to the Menu Bar.

  b Click on a Menu header such as "Draw".

  c Slide the cursor down the list of commands and click to select.

2 Tool bars (select the line icon from the draw tool bar).

  Move the cursor to an icon on a toolbar and press the left mouse button.

3 Keyboard (Type L and <enter>).

  Type the command on the command line.

What is a shortcut menu?

In addition to the methods listed above, AutoCAD has shortcut menus. Shortcut Menus give you quick access to command options. Shortcut Menus are available when brackets [] enclose the options, on the command line. (Example below) To activate a Shortcut Menu, press the right mouse button.

Example

Select: draw /circle / center, radius._circle specify center point for circle or **[3P / 2P/ Ttr (tan tan radius)]:**

If you press the right mouse button now, the shortcut menu on the left will appear. This allows you to select the options 3P, 2P, or Ttr with the mouse rather than typing your selection.

Drawing units setup

Every object we construct in a CAD system is measured in Units. We should determine the system of units within the CAD system before creating the first geometric entities. (Fig 15)

1 In the menu bar select:

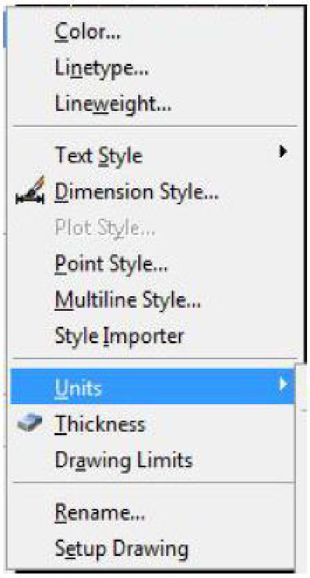
[Format] [Units]

The AutoCAD menu bar contains multiple pull down menus, where all of the AutoCAD commands can be accessed. Note that many of the menu items listed in

© NIMI NOT TO BE REPUBLISHED

the pull-down menus can also be accessed through the Quick Access toolbar and / or Ribbon panels.

Fig 15



2 Click on the length type option to display the different types of length units available. Confirm the length type is set to decimal.

3 On your own, examine the other settings that are available. (Figs 16, 17 & 18)

4 In the drawing Units dialog box, set the length type to decimal. This will set the measurement to the default English units, inches.

5 Set the precision to two digits after the decimal point as shown in the above Figure.

6 Pick ok to exit the drawing units dialog box.

Fig 16

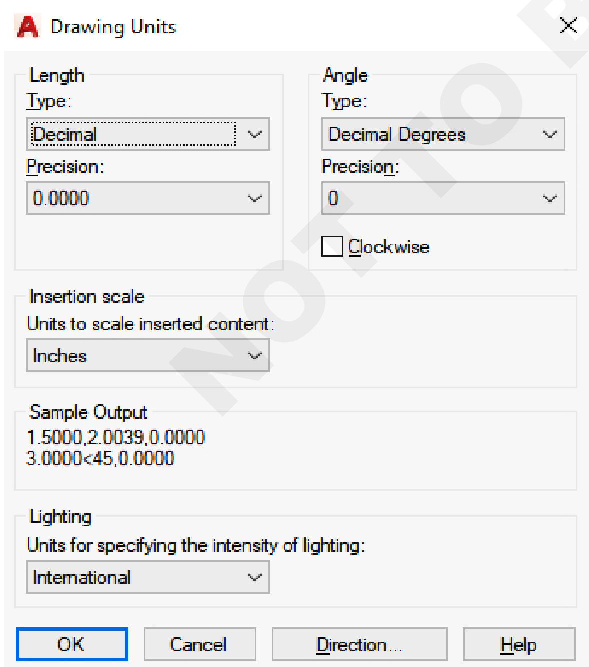


Fig 17

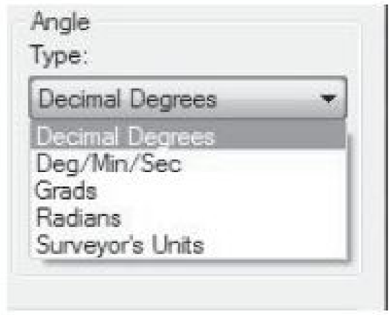
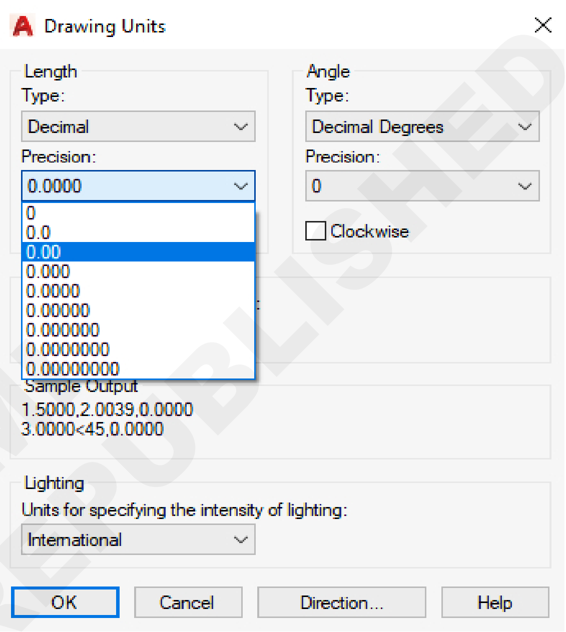


Fig 18



© NIMI NOT TO BE REPUBLISHED

Drawing area setup

Next, we will set up the **drawing limits** by entering a command in the command prompt area. Setting the Drawing Limits controls the extents of the display of the grid. It also serves as a visual reference that marks the working area. It can also be used to prevent construction outside the grid limits and as a plot option that defines an area to be plotted / printed. Note that this setting does not limit the region for geometry construction.

1 In the menu bar select:

[Format] [Drawing Limits] (Fig 19)

2 In the command prompt area, the message "Reset model space limits: Specify lower left corner or [on/off] <0.00,0.00>." is displayed. Press the **ENTER** key once to accept the default coordinates <**0.00,0.00**>. (Fig 20)

3 In the command prompt area, the message "specify upper right corner <12.00,9.00>" is displayed. Press the ENTER key again to accept the default coordinates <12.00,9.00>.

4 On your own, move the graphic cursor near the upper right corner inside the drawing area and note that the drawing area is unchanged. (The drawing limits

command is used to set the drawing area, but the display will not be adjusted until a display command is used.) (Fig 21)

Fig 19

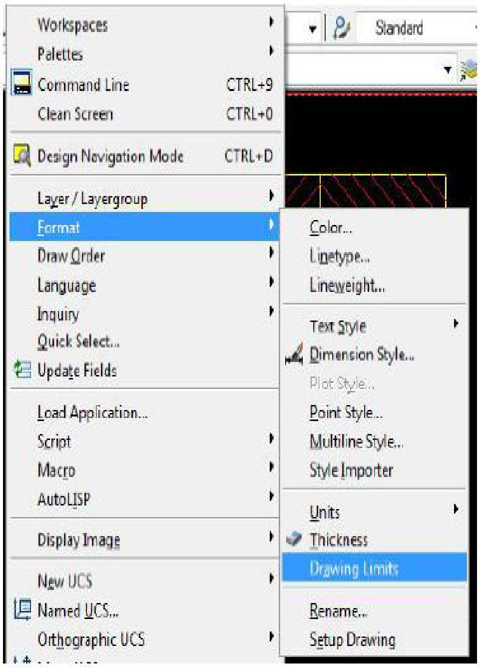


Fig 20

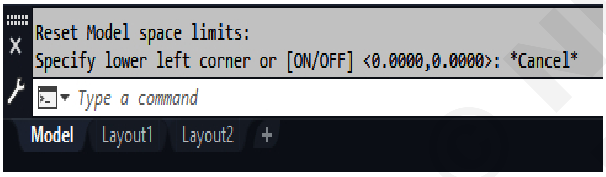
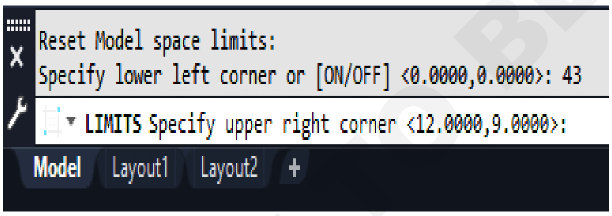


Fig 21



Setting limits of a drawing

In AutoCAD The drawing must be drawn in full scale. So limits are needed to size up a drawing area. The limits are determined by the following factor.

i Size of drawing.

ii Space needed for dimensions, notes and other details.

iii Space between different views.

iv Space for the border and a title block etc.

Limits

Pull down: Format, drawing limits.

Command: Limits.

The command **LIMITS** allows you to change the upper and lower limits of the drawing.

Example: Set the drawing screen to A4 size (210 x 297)

Command: LIMIT.

Specify lower left corner or (ON/OFF) <0.000,0.000>:

Specify upper right corner <12.000,9.000>: 210,297

Give ZOOM command with ALL option to view all the drawing

area (A4 size)

MVSETUP = Multi view Setup

MVSETUP offers two different setup options depending on whether you are in Model Space or in a Layout (Paper Space).

In model space- you set the units type, drawing scale factor, and paper size at the command prompt using MVSETUP. Using the settings you provide, a rectangular border is drawn at the grid limits.

In Paper Space - you can insert one of several predefined title blocks into the drawing and create a set of layout viewports within the title blocks. You can specify a global scale as the ratio between the scale of the title block in the layout and the drawing on the Model tab. The model tab is most useful for plotting multiple views of a drawing within a single border.

MVSETUP commands

No (to not create a new layout tab - we will do this in another lesson)

A (Metric units)

48 (Scale factor - common arch, scale factor is 1:1)

24 Width- see table below for paper size.

(example 210 x 297) Since we are printing in "land scape " mode, we enter the bigger number of the paper size first.

18 Length - Smaller number from the list below.

Once MVSETUP is finished, it will show a rectangle. This is the area where your grid will show up if you have the grid on. This box is pretty much useless so just erase it. You will not need it.

From here, set up dimensions styles, text styles. layer.

If these settings will used in other drawings here are two suggestions, the first of which is recommended because it is less error prone.

1 After creating the desired settings, do a save-as and save t as a . dwt. All of the settings that you created will be saved.

2 After using this drawing, open it and erase all objects. The settings will remain but you will have to hunt down the objects that need to be erased in layouts.

2 Setting units of a drawing

Every object you create is measured in drawing units. Before you start to draw, you must decide what one drawing unit will represent based on what you plan to draw. Then you create your drawing at actual size with that convention. For example, a distance of one drawing unit typically represents one millimeter, one centimeter, one inch, or one foot in real - world units.

UNITS Command is used to set the units of measure, angle measurement, direction and precision.Pull down Menu: Format, UNITS

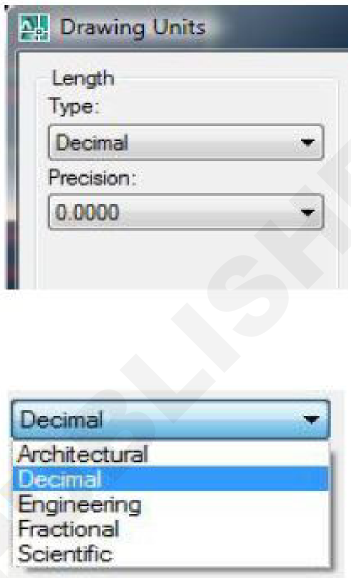
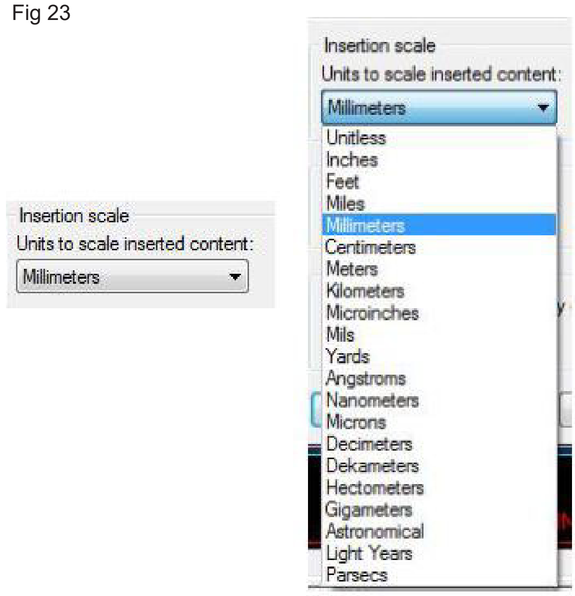
Command: UNITS

If you enter-units at the command prompt, UNITS displays prompts on the command line. There are five fundamental types of units i.e. Decimal, architectural, engineering, fractional & scientific.

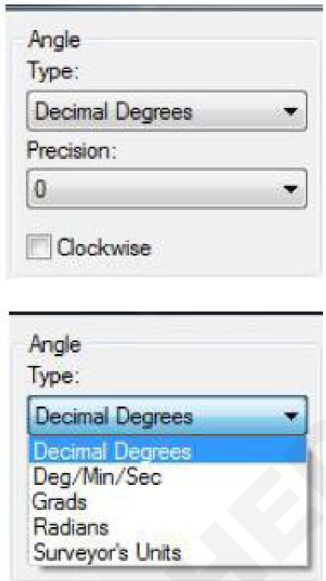
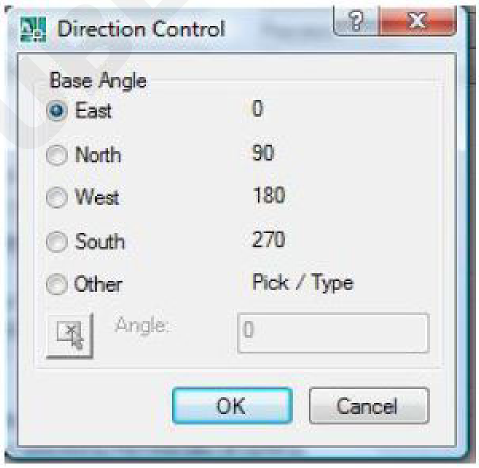
The text window displays the following prompt.

There are five fundamental types of units i.e. Decimal, architectural, engineering, fractional & scientific.

There are five fundamental types of units i.e.

Icon/Button	Description
Decimal, Architectural, Engineering, Fractional & Scientific. Report formats: (Examples) 1 Scientific (1.55E + 01) 2 Decimal (915.50) 3 Engineering 1'-3.50" 4 Architectural 1'-3 1/2" 5 Fractional 15 1/2 Enter choice, 1 to 5 <Current >: Enter a value (1-5) or press ENTER The following prompt for decimal precision is displayed if you specify the scientific, decimal, or engineering format. Enter number of digits to right of decimal point (0 to 8) <Current >: Enter a value (0-8) or press ENTER. The following prompt for the denominator of the smallest fraction is displayed if you specify the architectural or fraction format. Enter denominator of smallest fraction to display. (1,2,4,8,16,32,64,128,or 256) <current>: Enter a value (1,2,4,8,16,32,64,128,or 256) or press ENTER (Fig 22)	Fig 22 
Inserting scale Controls the units of measurement for blocks and drawings that are inserted into the current drawing. A block or a drawing that is created with units that are different from the units specified with this option is scaled when inserted. The insertion scale is the ratio of the units used in the source block or drawing and the units used in the target drawing and the units used in the target drawing. Select Unit less to insert the block without scaling it to match the specified units. (Fig 23)	Fig 23 

© NIMI NOT TO BE REPUBLISHED

Icon/Button	Description
The next prompts is for angle formats and precision. System of angle measure: (Example) 1 Decimal degree 45.000 2 Degree/minutes/seconds 45d0’0. 3 Grads 50.000g. 4 Radians 0.78454r. 5 Surveyor’s units N 45d0’0”E. Enter choice ,1 to 5< Current>:Enter a value (1-5) or press ENTER. Enter number of fractional places for display of angles (0-8) <Current>:Enter a value (0-8) or press ENTER. (Fig 24)	Fig 24 
The next prompt is for the direction for angle 0. **Direction for angle 0:** **East 3 o’clock = 0.** **North 12 o’clock = 90.** **West 9 o’ clock = 180.** **South 6 o’ clock = 270.** Enter direction for angle 0<current>: Enter a value or press ENTER. The default direction for 0 degrees is to the east quadrant, or 3 o’ clock. The default direction for positive angular measurement is counter clockwise. Measure angles clockwise? [Yes/No] <current>: Enter y or n or press ENTER. Select the unit you want from the dialogue box. This unit is used for dimensioning of the drawing. Input from the user accepted in this unit only. (Fig 25)	Fig 25 

© NIMI NOT TO BE REPUBLISHED

Drafting setting a display commands

Objective(s): At the end of this exercise you shall be able to
- **practice the drafting setting**
- **identify the visual reference**
- **practice esc, undo, redo commands**
- **practice display commands**
- **use modify command to erase.**

Drafting Settings

Drafting settings includes the commands for initial setting of a drawing. Some of the drafting settings are **snap, grid, polar tracking, osnap.**

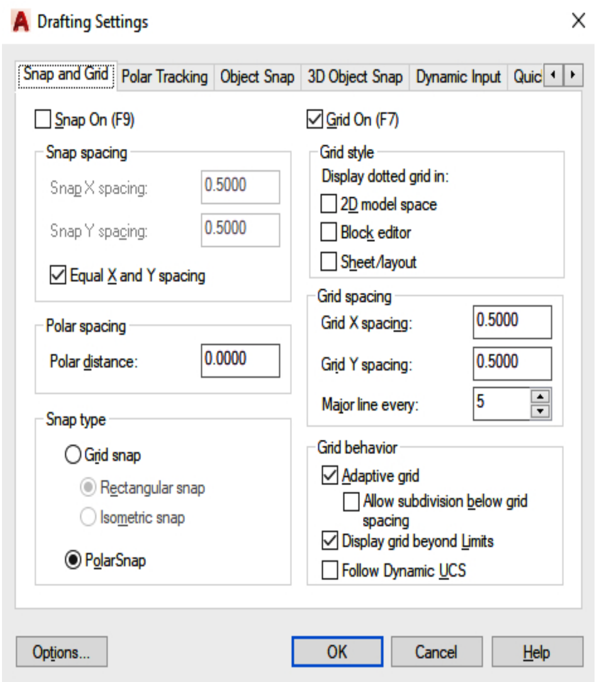
Switches the grid on/off

Set the size of the grid in the current drawing units

Snap: Snap is used to move the cursor at a defined value. This will set a position on the drawing quickly and accurately. The snap mode can be switched ON / OFF by pressing function key F9. (Fig 26)

Grid: Grid command is used to display dots, which is easy for us to fix the points. But these dots were not printed. Grid points have default spacing of one unit. We can change the spacing too. This mode can be ON / OFF by using the function key F7.

Fig 26



Object snap settings

Object snap settings are used to pick a geometric point on an object. Object snap mode can be ON / OFF by using the function key F3 or by clicking O snap button on the status bar. There are various options for object snap settings such as end point, mid point, centre, quadrant etc. (Fig 27)

Ortho: Ortho command forces lines to be drawn exactly perpendicular directions. While using this command we have to turn ortho ON/OFF (otherwise press F8 according to our need

The grid and snap mode option can be turned ON or OFF through the status bar. The status bar area is located at the bottom left of the AutoCAD drawing screen, next to the cursor coordinates. (Fig 28)

The second button in the status bar is the snap mode option and the third button is the grid display option. Note that the buttons in the status bar area serve two functions: (1) the status of the specific option, and (2) as toggle switches that can be used to turn these special options on and off. When the corresponding button is highlighted, the specific option is turned on. Using the buttons is quick and easy way to make changes to these drawing aid options. Another aspect of the buttons in the Status Bar is these options can be switched on and off in the middle of another command. (Fig 29)

Grid on

1 Left-click the grid button in the status bar to turn on the **grid display** option. (Notice in the command prompt area, on the massage “<Grid on>” is also displayed.)

2 Move the cursor inside the graphics window, and estimate the distance in between the grid lines by watching the coordinates display at the bottom of the screen. (Figs 30 & 31)

Fig 27

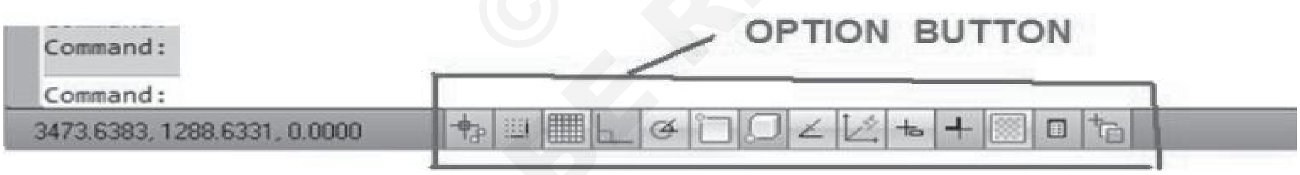


Fig 28

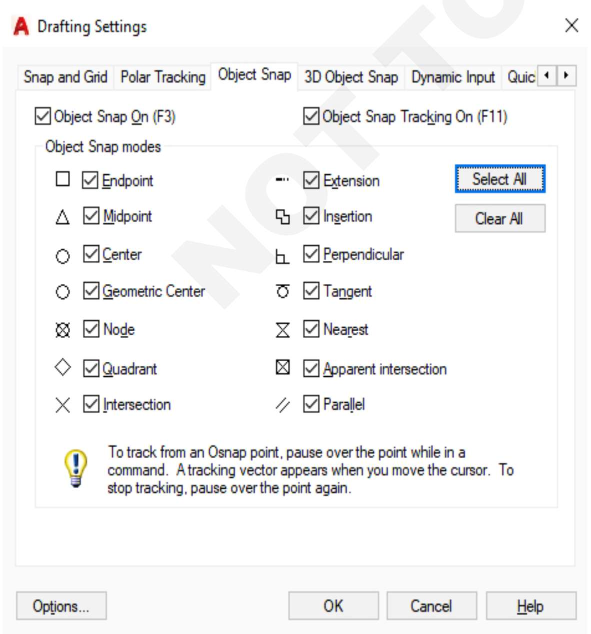


Fig 29

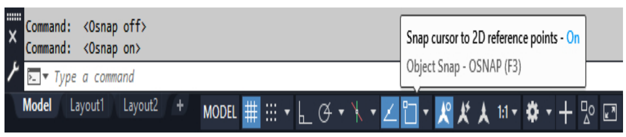


Fig 30

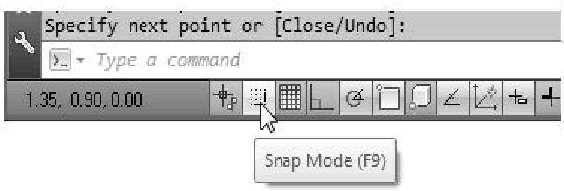
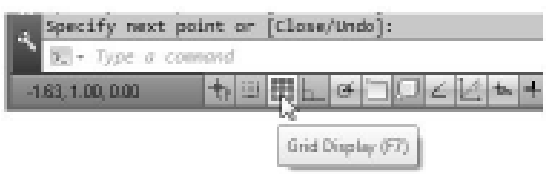


Fig 31



© NIMI NOT TO BE REPUBLISHED

The grid option creates a pattern of lines that extends over an area on the screen. Using the grid is similar to placing a sheet of grid paper under a drawing. The grid helps you align objects and visualize the distance between them. The grid is not displayed in the plotted drawing.

The default grid spacing. Which means the distance in between two lines in the screen, is 0.5 inches. We can see that the sketched horizontal line in the sketch is about 4.5 inches long. (Figs 32, 33 & 34)

Snap mode on

1 Left- click the snap mode button in the status bar to turn on the snap option. (Fig 35)

2 Move the cursor inside the graphics window, and move the cursor diagonally on the screen. Observe the movement of the cursor and watch the coordinates display at the bottom of the screen.

Fig 32

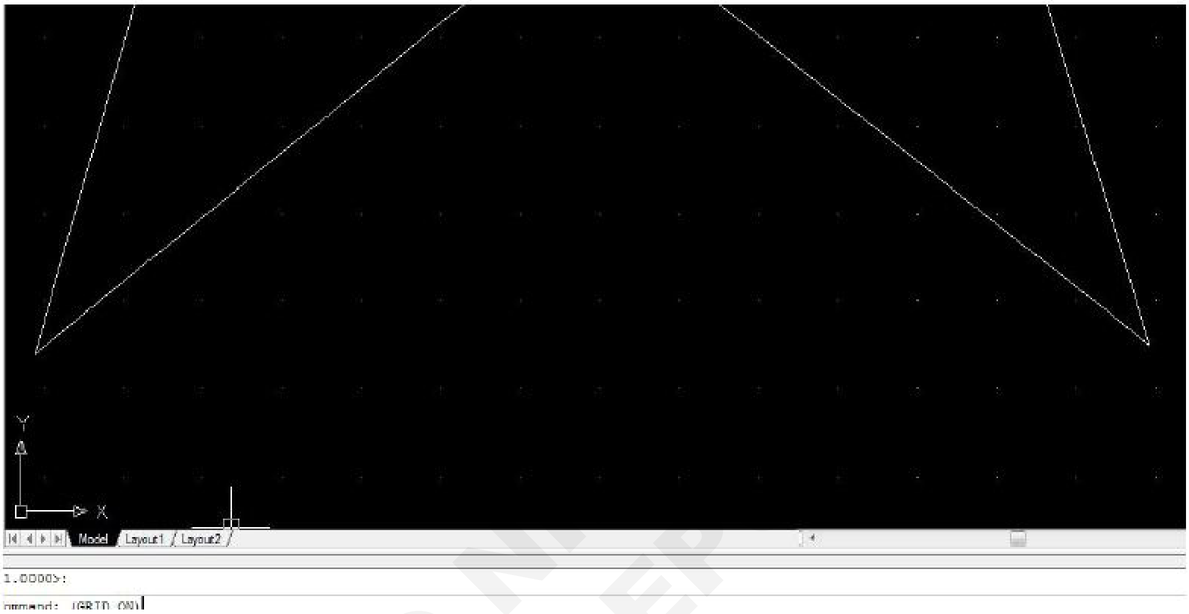


Fig 33

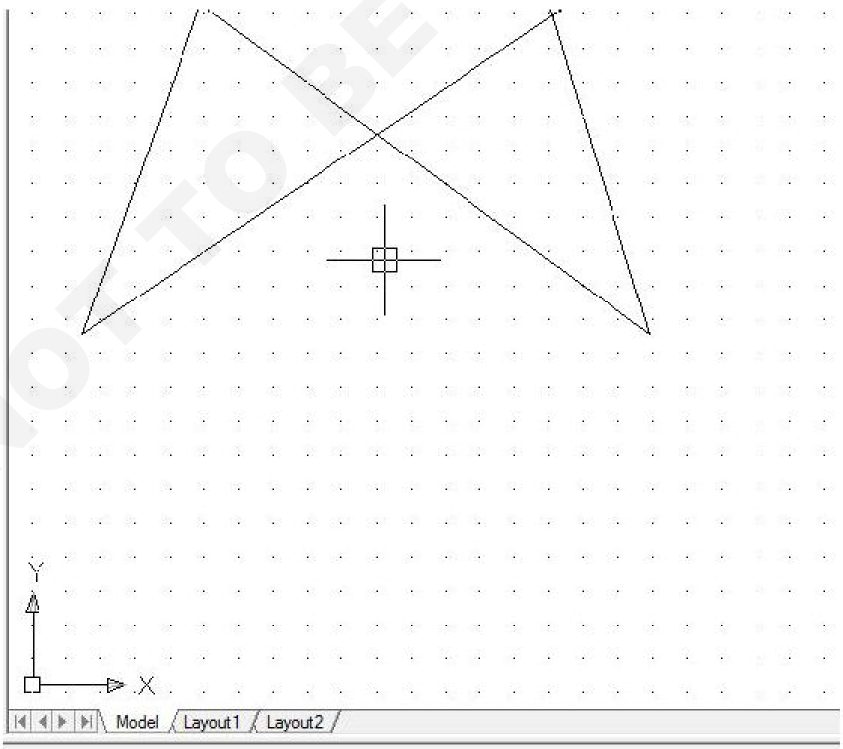


Fig 34

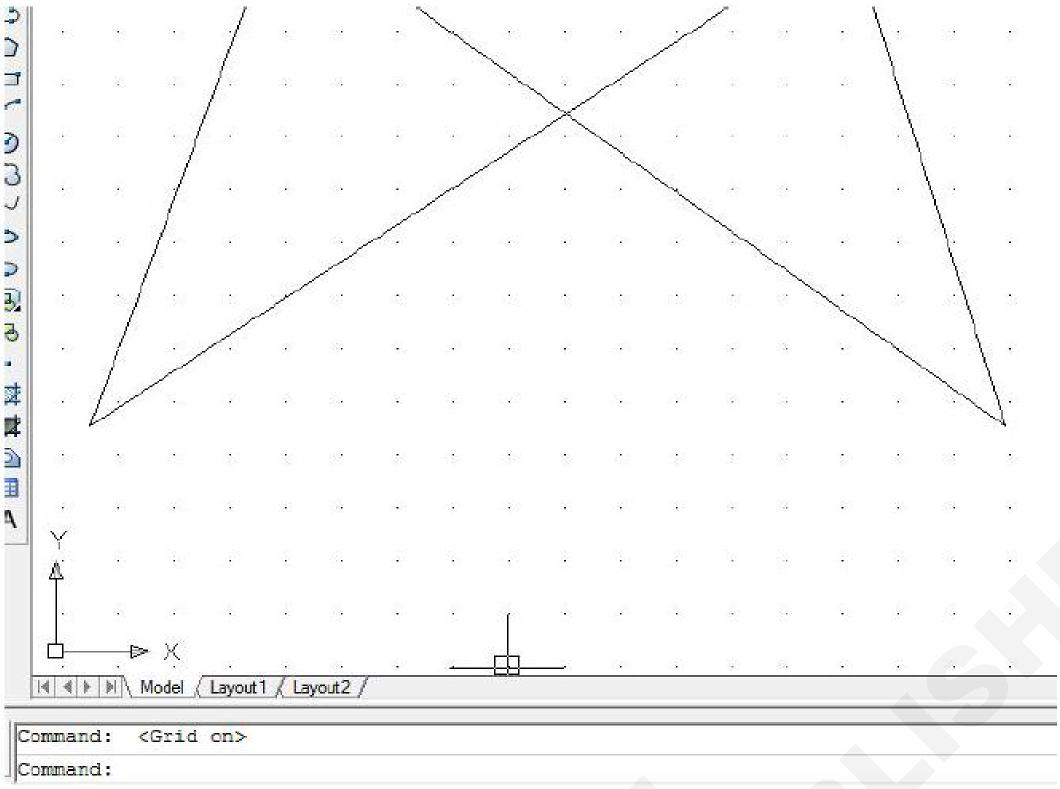
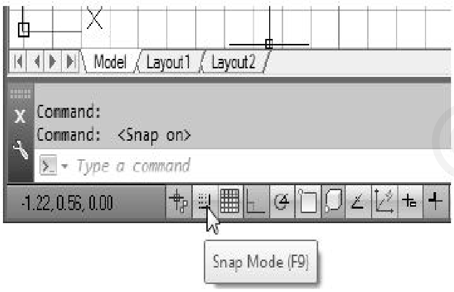


Fig 35



SNAP mode is on, the screen cursor and all input coordinates are snapped to the nearest point on the grid. The default snap interval is 0.5 inches, and aligned to the grid points on the screen.

In case of any mistake

Pressing the ESC key

The Esc key at the top of the key board will get you out of most problems you encounter using AutoCAD. Here are some examples of the times you would press Esc key.

- If a command is not responding the way you expect.
- If you want to cancel a command you started.
- If you clicked a point on the screen unintentionally.
- If a dialogue box appears on the screen accidently.

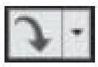
In all these cases above, pressing Esc once will free the command line.

Example

Issue the line command, click a point on the screen and then press the esc key to cancel the command.

Using undo

You can undo the last command by typing U at the command line and pressing the enter key, or by clicking on the Undo icon on the tool bar.

Using redo 

The Redo command will reinstate the last command you applied undo to. You may undo as may commands as like you, but you may only redo once.

Display commands

Zoom

Zoom command enlarges or reduces the view of the drawing. When we are working on a drawing it is always required to bring the area of our interest to focus on to the screen. The zoom tool bar may be accessed from the standard tool bar at the top of the screen or from the dropdown menu > view >Tool bars....> Zoom. The icons are

NOT TO BE REPUBLISHED © NIMI

Icon	Function
Realtime	This allow you to select a window or box around the area you want to magnify.
Dynamic	This is both zoom and pan. When the command is issued a view box will be displayed with the drawing inside. The view box can be resized (Zoom) and moved around pan.
Scale	The drawing is at a scale of 1.A zoom scale of 2 doubles the magnification of the drawing, while 0.5 halves it.
Center	Allows you to pick a point which will be the center of the zoom area.
In	Just click on it zoom in on the drawing. You may preset the amount it zooms in a the command line.
Out	Just click on it zoom out from the drawing. You may preset the amount it zooms out at the command line.
All	This zooms to show the complete electronic page you set up. It zooms out to the electronic sheet limits.
Extents	This will zoom to fit the complete drawing on the screen.
Previous	This displays the last view created by zoom, pan or view command.

Pan

Pull down menu: view, pan.

The cursor changes to a hand cursor.

By holding down the pick button on the pointing device, you lock the cursor to its current location relative to the view port coordinate system. Graphics within the window are moved in the same direction as the cursor.

when you reach a logical extent (edge of the drawing space), bar is displayed on the hand cursor on the side where the extend has been reached. Also a message is displayed in the status bar as “already bottom most extent”. Depending upon whether the logical extent is at the top, bottom, or side of the drawing, the bar is either horizontal (top or bottom) or vertical (left or right side).

When you release the pick button, panning stops. You can release the pick button move the cursor to another location in the drawing, and the press the pick button again to pan the display from that location.

On your own, move the graphic cursor near the upper-right comer inside the drawing area and note that the drawing area is unchanged. (The Drawing Limits command is used to set the drawing area, but the display will not be adjusted until a display command is used.)

Inside the Menu Bar area

Select: **[View] [Zoom] [All]**

Zoom All command will adjust the display so that all objects in the drawing are displayed to be as large as possible. If no objects are constructed, the Drawing Limits are used to adjust the current viewport.

Move the graphic cursor near the upper - right comer inside the drawing area and note that the display area is updated.

In the menu bar area select: [View] [pan] [Realtime]

The available pan commands enable us tomove the view to a different position. The pan - realtime function acts as if you are using a video camera.

Move the cursor, which appears as a hand inside the graphics window, near the center of the drawing window, then push down the left - mouse - button and drag the display toward the right and top side until we can see the sketched line. (Notice the scroll bars can also be used to adjust viewing of the display.) (Figs 36 & 37)

© NIMI NOT TO BE REPUBLISHED

Fig 36

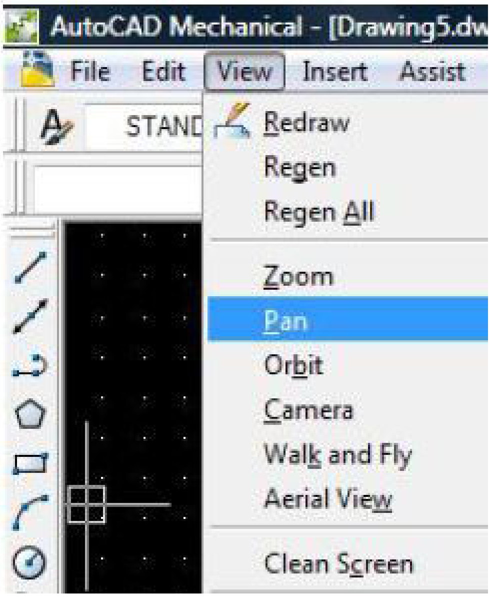
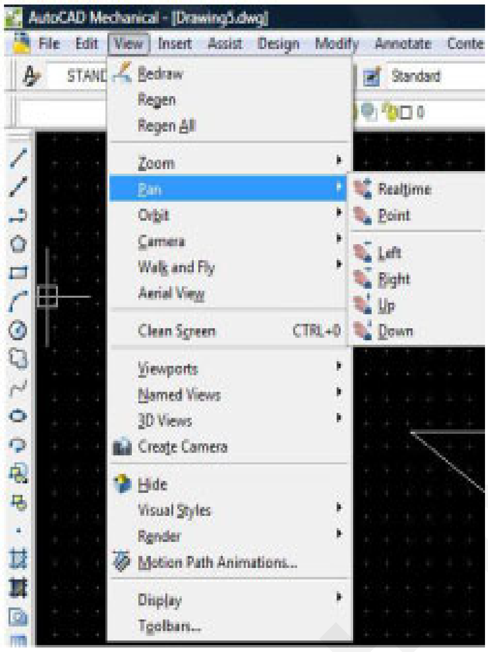


Fig 37



Co-ordinates system in AutoCAD

Objective(s): At the end of this exercise you shall be able to

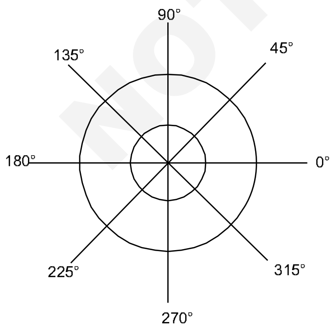
- **know absolute co-ordinates system**
- **polar co-ordinates system**
- **prepare simple profiles using polar co-ordinate system**
- **prepare simple profiles using absolute co-ordinate system.**

You can use absolute delete relative polar coordinates (distance and angle) to locate points when creating objects.

To use polar coordinates to specify a point, enter a distance and an angle separated by an angle bracket (<).

By default, angles increase in the counterclockwise direction and decrease in the clockwise direction. To specify a clockwise direction, enter a negative value for the angle. For example, entering 1<315 locates the same point as entering 1<-45. You can change the angle conventions for the current drawing with the UNITS command. (Fig 1)

Fig 1



DMN2790J1

Absolute Polar Coordinates

Absolute polar coordinates are measured from the UCS origin (0,0), which is the intersection of the X and Y axis.

Use absolute polar coordinates when you know the precise distance and angle coordinates of the point.

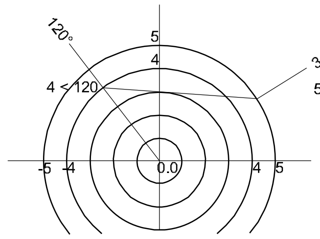
With dynamic input, you can specify absolute coordinates with the # prefix. If you enter coordinates on the command line instead of in the tooltip, the # prefix is not used. For example, entering #3<45 specifies a point 3 units from the origin at an angle of 45 degrees from the X axis.

The following example shows two lines drawn with absolute polar coordinates using the default angle direction setting. Enter the following in the tooltip:

Command: line

From point: #0,0

Fig 2



DMN2790J2

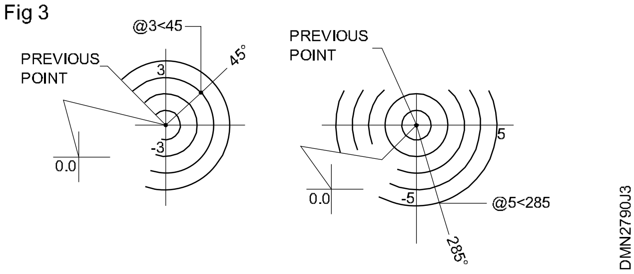
To point: #4<120

To point: #5<30 (Fig 2)

Relative coordinates are based on the last point entered. Use relative coordinates when you know the location of a point in relation to the previous point. (Fig 3)

© NIMI NOT TO BE REPUBLISHED

Fig 3



To specify relative coordinates, precede the coordinate values with an @ sign. For example, entering @1<45 specifies a point at a distance of 1 unit from the last point specified at an angle of 45 degrees from the X axis.

The following example shows two lines drawn with relative polar coordinates. In each illustration, the line begins at the location labeled as the previous point.

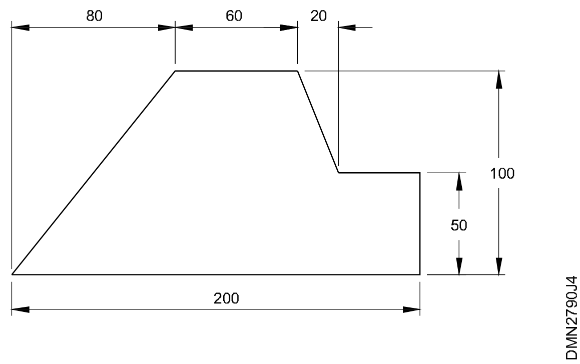
Command: line

From point: @3<45

To point: @5<285

Draw in absolute and polar co-ordinates system (Fig 4)

Fig 4

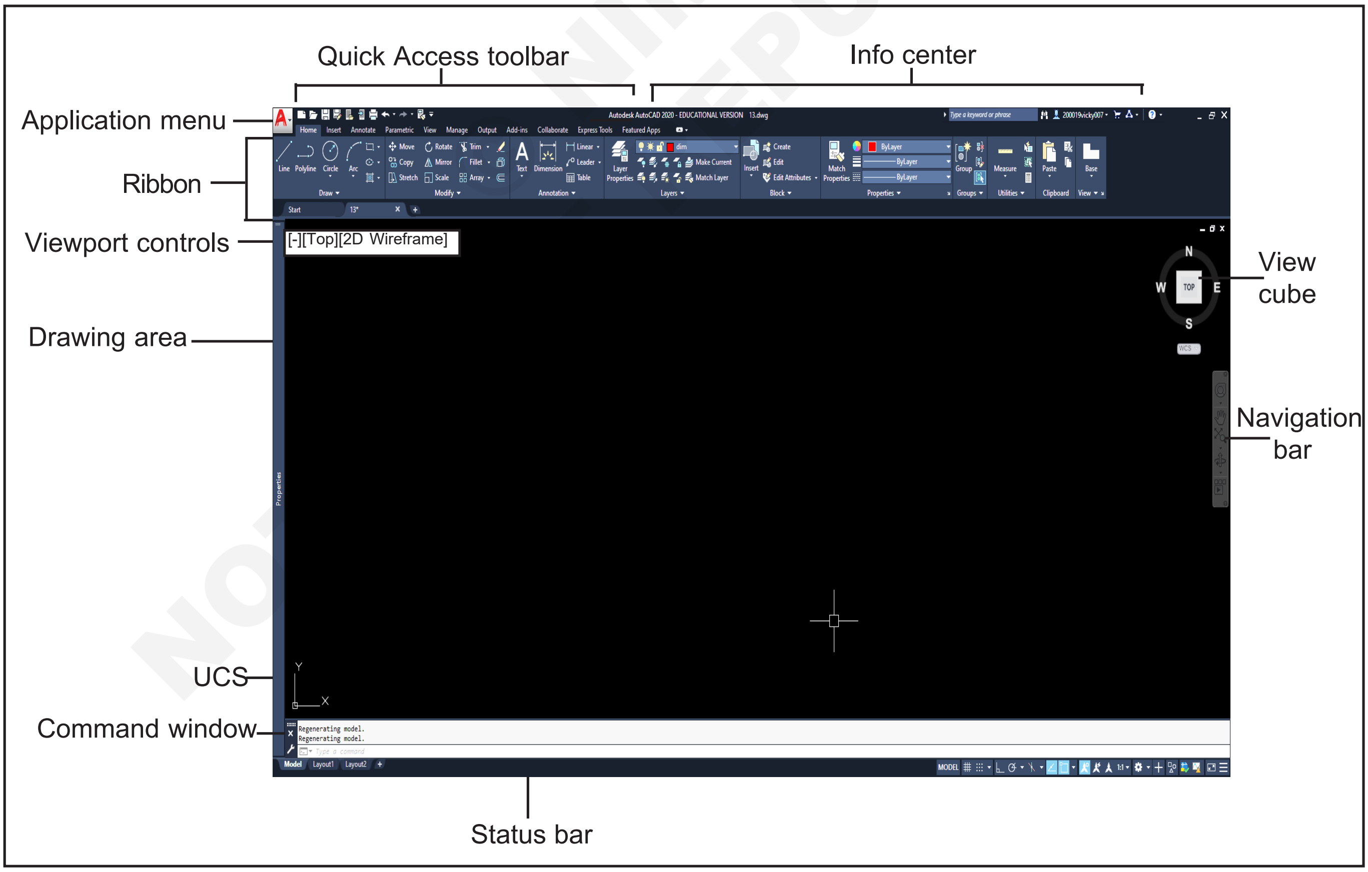


Introduction to AutoCAD

Objective(s): At the end of this exercise you shall be able to

- **know fundamental aspects of computer aided design and drafting.**

Knowing AutoCAD Environments



AutoCAD drafting & annotation environment is shown. AutoCAD classic, 3D Basics, 3D modeling are the other environments you can choose for your convenient and necessity.

NIMI
REPUBLISHED

TASK 1: **Draw the figure in AutoCAD using Relative co ordinate system (Fig 1)**

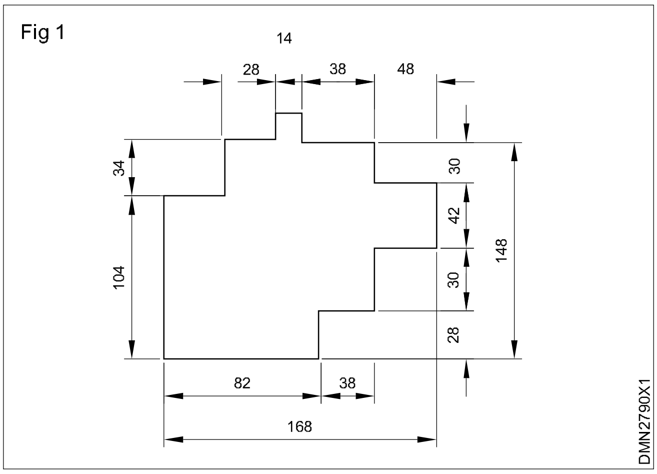


Fig 1

Command: L

LINE

Specify first point:
Specify next point or [Undo]: @82,0
Specify next point or [Undo]: @0,28
Specify next point or [Close/Undo]: @38,0
Specify next point or [Close/Undo]: @0,30
Specify next point or [Close/Undo]: @@48,0
Specify next point or [Close/Undo]: @48,0
Specify next point or [Close/Undo]: @0,42
Specify next point or [Close/Undo]: @-48,0
Specify next point or [Close/Undo]: @0,30
Specify next point or [Close/Undo]: @-38,0
Specify next point or [Close/Undo]: @0,18
Specify next point or [Close/Undo]: @-14,0
Specify next point or [Close/Undo]: @0,-10
Specify next point or [Close/Undo]: @-28,0
Specify next point or [Close/Undo]: @0,-34
Specify next point or [Close/Undo]: @-40,0
Specify next point or [Close/Undo]: c

— — — — — — — —

TASK 2 : **Draw the figure in AutoCAD using Polar Co-ordinate system (Fig 2)**

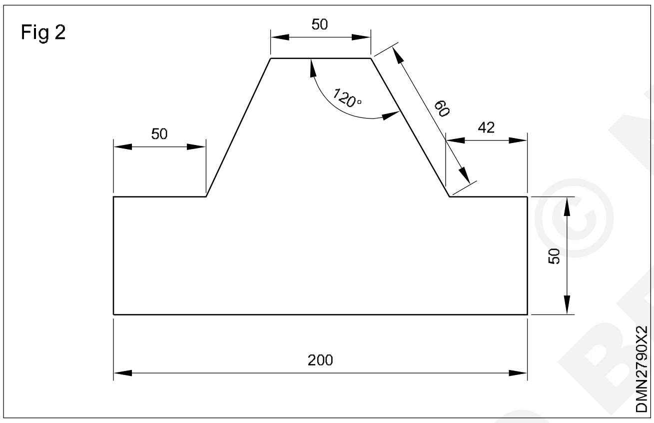


Fig 2

Command: L

LINE

Specify first point:
Specify next point or [Undo]: @200<0
Specify next point or [Undo]: @50<90
Specify next point or [Close/Undo]: @40<180
Specify next point or [Close/Undo]: @60<120
Specify next point or [Close/Undo]: @50<180
Specify next point or [Close/Undo]: @60<240
Specify next point or [Close/Undo]: @50<180
Specify next point or [Close/Undo]: c

— — — — — — — —

TASK 3: **Draw the figure in AutoCAD using Ortho Method (Fig 3)**

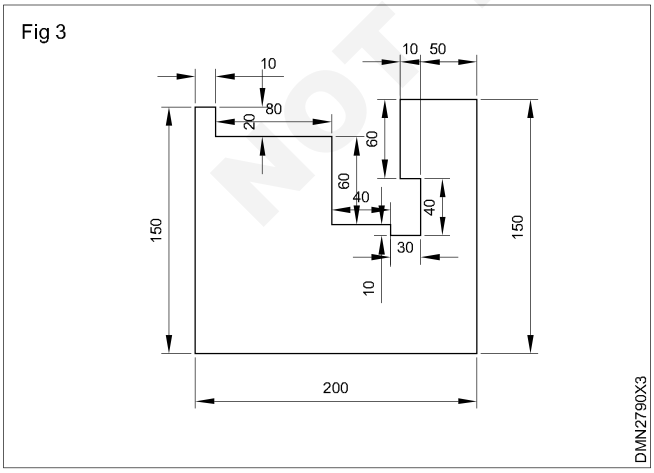


Fig 3

Command: L

LINE

Specify first point: <Ortho on> click and Press F8 for Ortho ON or OFF

Keep the cursor towards the direction line while using Ortho method.

Specify next point or [Undo]: 200
Specify next point or [Undo]: 160
Specify next point or [Close/Undo]: 50
Specify next point or [Close/Undo]: 60
Specify next point or [Close/Undo]: 10
Specify next point or [Close/Undo]: 40
Specify next point or [Close/Undo]: 30
Specify next point or [Close/Undo]: 10

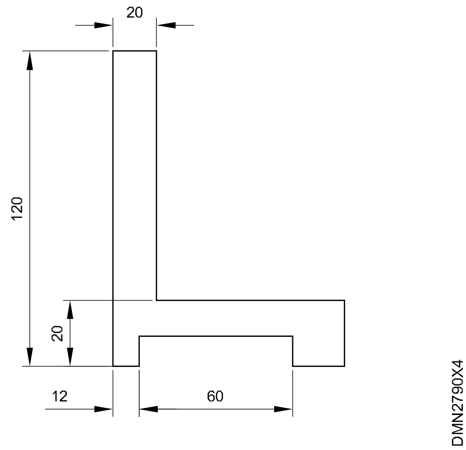
NOT TO BE REPUBLISHED © NIMI

Specify next point or [Close/Undo]: 40
Specify next point or [Close/Undo]: 60
Specify next point or [Close/Undo]: 80
Specify next point or [Close/Undo]: 20
Specify next point or [Close/Undo]: 10
Specify next point or [Close/Undo]: c

— — — — — — — —

TASK 4: **Draw the figure in AutoCAD using commands line, offset, trim, erase (Fig 4)**

Fig 4



Command: L
LINE
Specify first point:
Specify next point or [Undo]:
Specify next point or [Undo]: <Ortho on>
Specify next point or [Undo]: 250
Specify next point or [Undo]: 200
Specify next point or [Close/Undo]: 250
Specify next point or [Close/Undo]: c
Command: O OFFSET
Current settings: Erase source=No Layer=Source OFFSETGAPTYPE=0
Specify offset distance or [Through/Erase/Layer] <Through>: 30
Select object to offset or [Exit/Undo] <Exit>: **select**
Specify point on side to offset or [Exit/Multiple/Undo] <Exit>: **Click on side to offset**

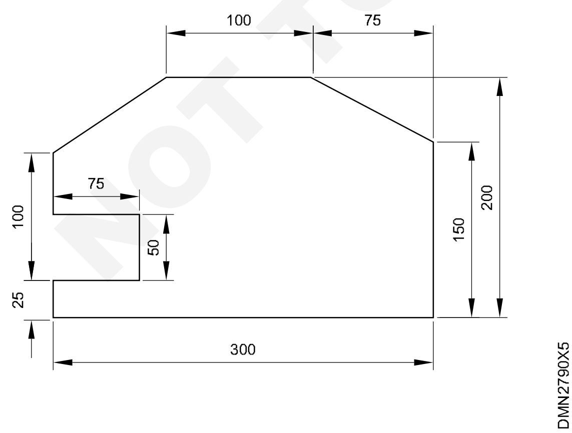
Repeat the OFFSET Command for different parallel lines
Command: tr TRIM
Current settings: Projection=UCS, Edge=None
Select cutting edges ...
Select objects or <select all>: Enter to select all
Select object to trim or shift-select to extend or [Fence/Crossing/Project/Edge/Erase/Undo]:

Repeat the Trim Command for removing unwanted lines
Command: **E**
ERASE
Select objects: 1 found
Select objects: ? (Enter for erase)
Repeat the Erase Command for removing unwanted lines.

— — — — — — — —

TASK 5 : **i) PRACTICE YOURSELF (Fig 5)**

Fig 5

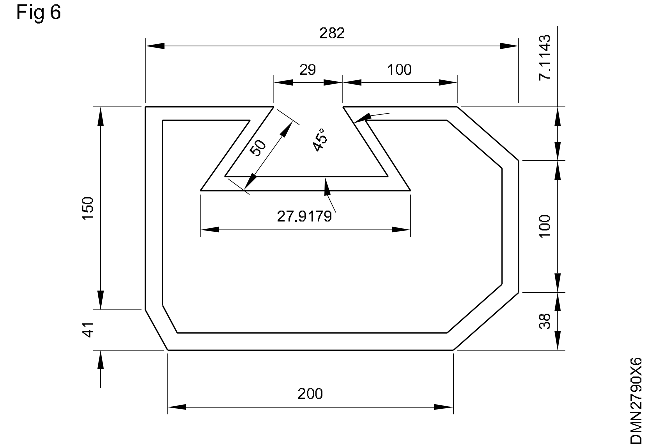


Command: _line
Specify first point:
Specify next point or [Undo]: <Ortho on> 300
Specify next point or [Undo]: 150
Specify next point or [Close/Undo]: @-75,50
Specify next point or [Close/Undo]: 100
Specify next point or [Close/Undo]: @-125,-75
Specify next point or [Close/Undo]: 50
Specify next point or [Close/Undo]: 75
Specify next point or [Close/Undo]: 50
Specify next point or [Close/Undo]: 75
Specify next point or [Close/Undo]: C

© NIMI NOT TO BE REPUBLISHED

ii) PRACTICE YOURSELF (Fig 6)

Fig 6



Command: _line
Specify first point:
Specify next point or [Undo]: 200
Specify next point or [Undo]: @75<30
Specify next point or [Undo]: 100
Specify next point or [Undo]: @75<135
Specify next point or [Close/Undo]: 100
Specify next point or [Close/Undo]: @50<-45
Specify next point or [Close/Undo]: 100
Specify next point or [Close/Undo]: @50<45
Specify next point or [Close/Undo]: 100
Specify next point or [Close/Undo]: 150
Specify next point or [Close/Undo]:c
Command: O
OFFSET
Current settings: Erase source=No Layer=Source OFFSETGAPTYPE=0
Specify offset distance or [Through/Erase/Layer] <10.0000>:
Select object to offset or [Exit/Undo] <Exit>: **SELECT**
Specify point on side to offset or [Exit/Multiple/Undo] <Exit>: **Click the side**
Repeat the Erase Command for number of parallel lines
Command: **TR /EX**
TRIM/EXTEND
Current settings: Projection=UCS, Edge=None
Select cutting edges ...
Select objects or <select all>:
Select object to trim or shift-select to extend or [Fence/Crossing/Project/Edge/eRase/Undo]:
Repeat the Command for removing unwanted lines.
Command: **E**
ERASE
Select objects: 1 found
Select objects: **Enter for erase**
Repeat the Command for removing unwanted lines.

— — — — — — — —

© NIMI NOT TO BE REPUBLISHED

Create geometrical figuresand tools

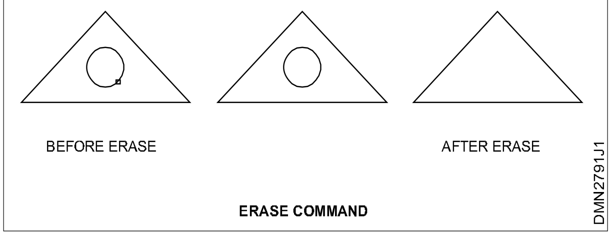
Objective(s): At the end of this exercise you shall be able to
- **practice erase, oops, extend, mirror, stretch, lengthen, explode.**

Modifying commands

Modifying commands are used for modifying the existing drawings. Thus it helps to prepare a final drawing incorporating the necessary changes and a lot of time is saved. Modifying commands are properties, erase, oops, extend, mirror, stretch, lengthen, explode

1 Erase (Fig 1)

Fig 1



ERASE COMMAND

This command allows the user to specify entities permanently removed from the drawing. The selection can be made with any of the standard SELECT OBJECT method.

Tool bar : Modify, Erase.

Pull down : Modify, Erase.

Command : Erase./ E.

Example

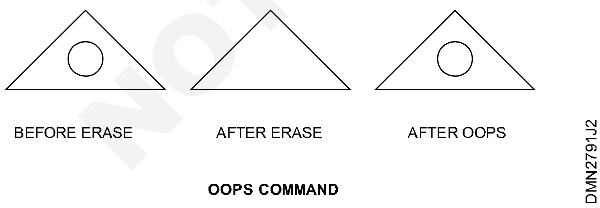
Command : Erase or E.

Select objects : Select the objects using mouse.

Select objects :

2 Oops (Fig 2)

Fig 2



OOPS COMMAND

This command restore objects that have been unexpectedly erased by the previous ERASE command

Example

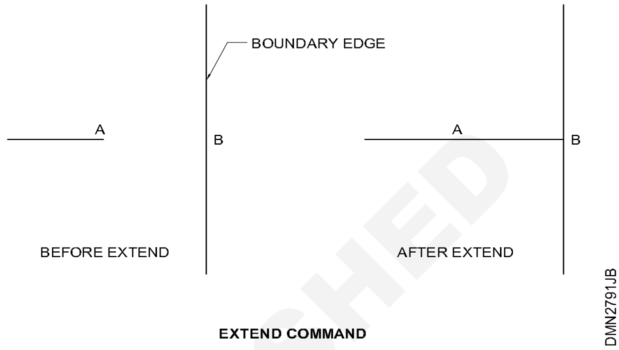
Command : Erase or E

Select objects : Select the objects using mouse

Command : Oops

3 Extend (Fig 3)

Fig 3



EXTEND COMMAND

This command is used to extend the shorter lines to meet another object.

Tool bar : Modify, Extend.

Pull down : Modify, Extend.

Command : Extend or EX.

Example

Command : Extend or EX.

Select boundary edges.

Select objects or <Select all> : Select A, 1 found.

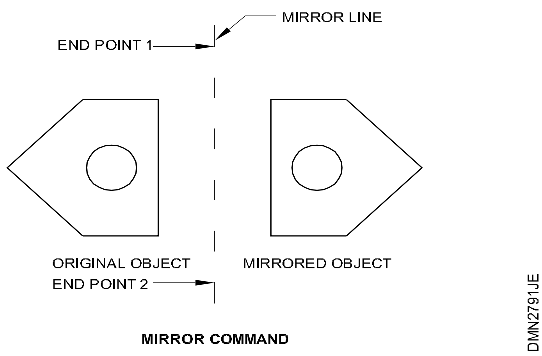
Select objects:

Select object to extend or shift - select to trim or [Fence/ Crossing/Project/Edge/Undo]:Select B.

Select object to extend or shift - select to trim or [Fence/ Crossing/Project/Edge/Undo]:

4 Mirror (Fig 4)

Fig 4



MIRROR COMMAND

Tool bar : Modify, Mirror.

Pull down : Modify, Mirror.

Command : Mirror or MI.

© NIMI NOT TO BE REPUBLISHED

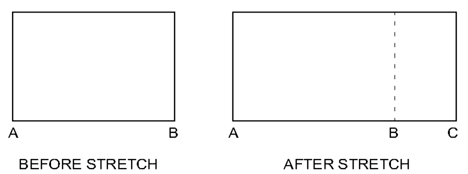
This command is used to create a mirror image of the select objects. After selecting the objects the beginning point and end point of a mirror line is entered.

Example

Command	: Mirror.
Select object	: Select the object.
Select object	:
First point of mirror line	: Specify the first point.
Second point	: Specify the second point.
Delete old object ?	: Enter Y for deletion, N for retraining <N> the previous object.

5 Stretch (Fig 5)

Fig 5



STRETCH COMMAND

Tool bar	: Modify, Stretch.
Pull down	: Modify, Stretch.
Command	: Stretch or S.

This command is used to lengthen or shorten the line or objects.

Example : 1

Command : STRETCH.

Select objects to stretch by crossing - window

Select objects : Select A and B by crossing - window.

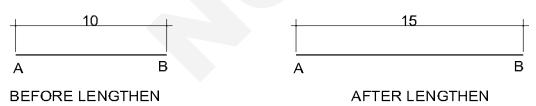
Select objects :

Specify base point or [Displacement] <Displacement>.

Specify second point: Mouse click at C.

6 Lengthen (Fig 6)

Fig 6



LENGTHEN COMMAND

Tool bar	: Modify, Lengthen.
Pull down	: Modify, Lengthen.
Command	: Lengthen or LEN.

This command is used to lengthen or shorten a line.

Example : 1

Command : LEN or LENGTHEN.

Select an object or [DElta/Percent/Total/Dynamic]: T

(Current length: 10).

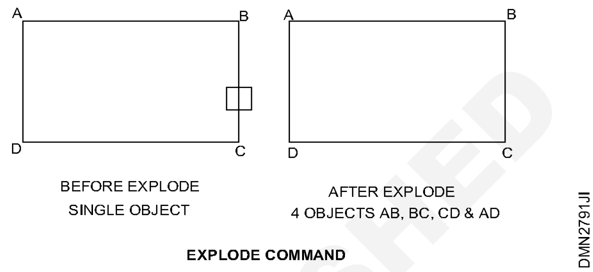
Specify total length of [Angle] <1.0000)>:15.

Select an object to change or [Undo]: Select line AB

Select an object to change or [Undo]

7 Explode (Fig 7)

Fig 7



EXPLODE COMMAND

Tool bar	: Modify, Explode.
Pull down	: Modify, Explode.
Command	: Explode or X.

This command will split the component objects such as blocks, polylines, regions etc. If you explode a polyline the result will be ordinary lines or arcs.

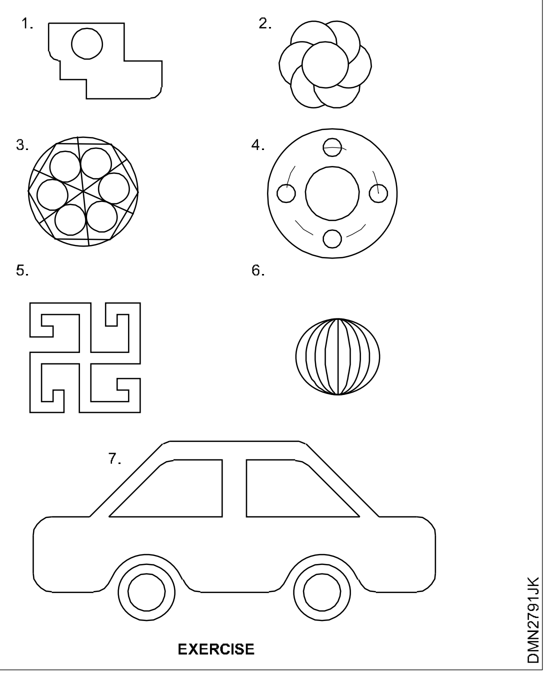
Example 1:

Command: EXPLODE or X.

Select an object: Select the rectangle.

Editing multiline (Fig 8)

Fig 8



EXERCISE

© NIMI NOT TO BE REPUBLISHED