INSTRUMENT MECHANIC

NSQF LEVEL - 4

1st Year

TRADE PRACTICAL

SECTOR : ELECTRONICS & HARDWARE

(As per revised syllabus July 2022 - 1200 of hrs)

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 : Electronics & Hardware

Duration : 2 Years

Trades : Instrument Mechanic - 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

First Edition: December 2022 Copies : 500

Rs.405/-

FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2022 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 **Instrument Mechanic - 1st Year - Trade Practical - NSQF Level - 4 (Revised 2022) in Electronics & Hardware Sector under** Annual 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 (Training)
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001

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 syllabi 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**

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 **Instrument Mechanic - 1st Year - NSQF Level - 4** (Revised 2022) under the **Electronics & Hardware** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Smt. S. Vijaya	-	Assistant Training Officer, Govt. I.T.I Women Selem.
Smt. D. Chitra	-	Training Officer, Govt. I.T.I Ambattur Chennai - 50.
Smt. S. Gomathy	-	Training Officer, Govt. I.T.I Guindy Chennai - 32.

NIMI - COORDINATORS

Shri. Nirmalya Nath	-	Deputy Director, NIMI, Chennai - 32.
Shri. S. Gopalakrishnan	-	Assistant 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.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the course. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 4 (Revised 2022) syllabus are covered.

The manual is divided into Fifteen modules.

Module 1	Basic Safety
Module 2	Basic Fitting
Module 3	Tube Joint and Fitting
Module 4	Basic Electricity & Passive Components
Module 5	Electrical Machine
Module 6	Transformer
Module 7	Electrical Measuring Instruments
Module 8	Semi Conductor, Transistors and Power Supply Circuit
Module 9	Oscillators
Module 10	Operational Amplifiers
Module 11	Logic Circuits
Module 12	A/D and D/A Converters
Module 13	Digital Meters and CRO
Module 14	Computers
Module 15	Microprocessor 8085

The skill training in the shop floor is planned through a series of practical exercises centered 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 **Instrument Mechanic** Trade Practical NSQF Level - 4 (Revised 2022) in **E & H**. The contents are sequenced according to the practical exercise contained in NSQF LEVEL - 4 (Revised 2022) syllabus on Trade Theory attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation 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 indications about the corresponding practical exercises are given in every sheet of this manual.

It will be preferable to teach/learn trade theory connected to each exercise at least 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 for the purpose of self-learning and should be considered as supplementary to class room instruction.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

Sl. No.	Learning Outcome	Ref.Ex.No
1	**Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check dimensional accuracy using precision instruments following safety precaution. [Basic fitting operation – marking, Hacksawing, Chiseling, Filing, Drilling,Taping and Grinding etc. Accuracy: ± 0.5mm] CSC/N0304**	**1.1.01 1.2.09**
2	**Apply a range of skills to execute tube joints, dismantle and assembles tubes and fittings of PI arc &ferrule and test for leakage. [range of skills- cutting, threading, flaring, bending and joining] ELE/N9410**	**1.3.20 1.3.23**
3	**Identify, test the cable and measure the electrical parameters. ELE/N9411**	**1.4.24 1.4.30**
4	**Test various electrical passive and active components using proper measuring instruments and compare the data using standard parameter. ELE/N9412**	**1.4.31 1.4.39**

5	**Identify, test and use of various types of switches, E.M. relays, Circuit breaker and construct electrical circuits. ELE/N9413**	**1.4.40 1.4.44**
6	**Estimate, Assemble, install and test wiring system. PSS/N6001**	**1.4.45-48**
7	**Test various electrical passive and active components using proper measuring instruments and compare the data using standard parameter. ELE/N9412**	**1.4.49-50**
8	**Verify characteristics of resonance circuits. ELE/N9413**	**1.4.51-54**
9	**Plan, execute commissioning, testing and evaluate performance of AC & DC motors and generators. ELE/N9402**	**1.5.55-61**
10	**Execute testing, evaluate performance and maintenance of transformer. PSS/N2406, PSS/N2407**	**1.6.62-65**
11	**Plan, select, and carry out measurement, extension of range, overhauling, testing and calibration of 'D' Arsonval meter, PMMC meter. ELE/N9414**	**1.7.66-70**
12	**Select, perform electrical/electronic measurement, earthing installation service and calibrate MI instruments, electro dynamometer instruments, Induction type and Special instruments- voltage tester, continuity tester, rotation tester, phase sequence indicator, synchronising, synchronous cope, frequency meter, thermocouple type ammeter. ELE/N9415**	**1.7.71-83**
13	**Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning. ELE/N9404**	**1.7.84-98**
14	**Detect the faults and troubleshoot SMPS, UPS, inverter, converter and Thyristor family. ELE/N7202**	**1.8.99- 1.8.105**
15	**Identify, place, solder and desolder and test different SMD, discrete components with due care and following safety norms using proper tools /setup. ELE/N5102**	**1.8.106 1.8.111**
16	**Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning. ELE/N9407**	**1.9.112 1.9.113**
17	**Construct and test different circuits using operational amplifiers circuits and execute the result. ELE/N9407**	**1.9.114 1.10.121**
18	**Identify, test and Verify all digital ICs. Assemble, test and troubleshoot various digital circuits and digital instruments. ELE/N9405**	**1.10.122 1.13.143**
19	**Measure the various parameters by CRO and execute the result with standard one. ELE/N9416**	**1.13.144 1.13.145**
20	**Install and setup operating system and related software in a computer & Practice with MS office and application software related to instruments. ELE/N9417**	**1.13.146 1.14.155**
21	**Identify various functional blocks of a microprocessor system, identify various I/O Ports, write and executive simple program and Interface a model application with the microprocessor kit and run the application. ELE/N9418**	**1.15.156 1.15.160**

SYLLABUS

Duration	Reference Learning outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 90 Hrs. Professional Knowledge 16 Hrs.	Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check dimensional accuracy using precision instruments following safety precaution. [Basic fitting operation – marking, Hacksawing, Chiseling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.5mm] CSC/N0304	1. Importance of trade training, List of tools & Machinery used in the trade. (01 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. (03 Hrs.) 5. Safety signs for Danger, Warning, caution & personal safety message. (03 Hrs.) 6. Preventive measures for electrical accidents & steps to be taken isuch accidents (04Hrs.) 7. Use of Fire extinguishers.(03Hrs.) 8. Practice and understan precautions to be followed while working in fitting jobs. (05 Hrs.) 9. Safe use of tools and equipmentsused in the trade (05 Hrs.)	Organization of the Institute, Departments various trades & functions. Types of work, responsibility to be undertaken, incentives and future planning of profession. Safely precautions to be observed in the trade both during 'theoretical Periods' and 'Practical hours/workshop hours' Elementary First Aid. Safety and hazards. Sign boards and types. Hazardous and non-hazardous. Environmental pollution related to the trade- caused, consequences, mitigation and control. (06 Hrs.)
		10. Demonstration and uses of hand tools- screwdrivers,pliers, spanners, tweezers, tester, wire stripper, electrician knife, steel rule, scriber, punches, hammer. (06 Hrs.) 11. Visual inspection of raw material for rusting, scaling, corrosion etc. (05 Hrs.) 12. Filing- flat & square (Rough finish). (05 Hrs.) 13. Filing practice, surface filing, side and checking 900 by try square. (05 Hrs.) 14. Marking out lines, filling and saving use of vice to given dimensions. (05 Hrs.) 15. Filing- Flat, square and Parallel to an accuracy of 0.5mm. (05 Hrs.)	Basic hand tools, types, classification use & metal cutting fundamentals. Filing- Flat, square and Parallel to an accuracy of 0.5mm. Measurement & measuring instruments, Marking tools, Fasteners & Fastening devices. (05 Hrs.)

		16. Measurement of Length, Height & Diameter by Vernier callipers and Micrometers. (05 Hrs.)	
		17. Select drill bits, reamers and tapes. (02 Hrs.) 18. Drill through holes and blind holes. (10 Hrs.) 19. Form external thread with dies to standard size. (10 Hrs.)	Precision Measuring Instruments, gauge blocks, sine bar, dial indicators, vernier calipers, micrometers, bevel protractor, thickness gauges. Element & types of screw threads used in instruments, Calculation of drill size for tapping. (05 Hrs.)
Professional Skill 25 Hrs. Professional Knowledge 04 Hrs.	Apply a range of skills to execute tube joints, dismantle and assembles tubes and fittings of PI arc &ferrule and test for leakage. [range of skills- cutting, threading, flaring, bending and joining] ELE/ N9410	20. Flaring of tube and tube joints. (06Hrs.) 21. Cutting and threading of tube length. (06 Hrs.) 22. Fitting of tube and per sketch observing conditions used for tube work. (06 Hrs.) 23. Fit and assemble tubes, PI arc and ferrule fittings. (07 Hrs.)	Types of tubes used for instrumentation. Tube cutter, Flaring tools, swedging tools, equipment's & fixture required for pipe bending, straightening, thread cutting, method of installation. (04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Identify, test the cable and measure the electrical parameters. ELE/N9411	24. Construct a test lamp and use it tocheckmains healthiness. (02Hrs.) 25. Measure the voltage between phase and ground and rectify earthing. (03 Hrs.) 26. Prepare terminations, skin the electrical wires /cables using wire stripper and cutter. (03 Hrs.) 27. Measure the gauge of the wire using SWG and outside micrometre. (03 Hrs.) 28. Refer table and find current carrying capacity of wires. (03Hrs.) 29. Measure AC and DC voltages using multi meter. (03 Hrs.) 30. Use the multi meter to measure the various functions (AC V, DC V, DC I, AC I, R). (03 Hrs.)	Electrical components-conductor, semiconductor & insulators. Standard wire gauge (SWG). Introduction of electricity- static electricity. Current, voltage, P.D, E.M.F, resistance. Electrical circuit - D.C & A.C circuit differences. Importance of grounding. (05 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Test various electrical passive and active components using proper measuring instruments and compare the data using standard parameter. ELE/ N9412	31. Measure the resistor value by colour code and verify the same by measuring with multi-meter. (02 Hrs.) 32. Practice soldering on IC bases and PCBs. (03 Hrs.) 33. Practice de-soldering using pump and wick. (02 Hrs.) 34. Join the broken PCB track and test. (02 Hrs.)	Uses of multimeter. Resistor, Resistivity and colour code, Types of resistors used in instrumentation. Definition and purpose of soldering and desoldering. Soft soldering. Types of soldering irons. Solder & flux. Care & precaution of soldering. De-soldering tools and method of use.

		35. Practice on measurement of parameters in combinational electrical circuit by applying Ohm's Law for different resistor values and voltage sources. (03Hrs.) 36. Measurement of current and voltage in electrical circuits to verify Kirchhoff's Law. (02 Hrs.) 37. Verify laws of series and parallel circuits with voltage source in different combinations. (02 Hrs.) 38. Measure the resistance, Voltage, Current through series and parallel connected networks using multi meter. (02 Hrs.) 39. Measure and test the voltages of the given cells/battery using analog/digital multi-meter. (02Hrs.)	Ohm's law & Kirchhoff s laws. Series & parallel circuits. Primary & secondary cells and batteries. {Liquid & dry). Maintenance free batteries construction-charging, efficiency-use, advantage.(05 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 04 Hrs.	Identify, test and use of various types of switches, E.M. relays, Circuit breaker and construct electrical circuits. ELE/N9413	40. Dismantle and identify the different parts of a relay. (04 Hrs.) 41. Connect a timer relay in a circuit and test for its working. (04 Hrs.) 42. Connect a contactor in a circuit and test for its working. (04 Hrs.) 43. Construct and test series and parallel resonance circuit. (04Hrs) 44. Make a panel board using different types of switches for a given application. (04 Hrs.)	Switches and types. Magnet and magnetism, magnetic properties. Magnetic campus and its uses. Explanation of Electro-magnetism, Advantages, disadvantages-application-types E.M. relays. (04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 04 Hrs.	Estimate, Assemble, install and test wiring system. PSS/N6001	45. Practice cutting, threading of different sizes & laying Installations. (05 Hrs.) 46. Draw layouts and practice in PVC Casing-capping, Conduit wiring with minimum to a greater number of points of minimum 15 mtrs. (05 Hrs.) length. (05 Hrs.) 47. Wire up PVC conduit wiring to control one lamp from two different places. (05 Hrs.) 48. Draw layouts and practice Wiring for instrument panel. (05Hrs.)	Principles of alternating current, A.C & DC electricity, types of wave forms, time period and frequency, peak to peak values, RMS values, Average values. (04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 04 Hrs.	Test various electrical passive and active components using proper measuring instruments and compare the data using standard parameter. ELE/ N9412	49. Measure the inductor value by written/colour code and verify the same by measuring with LCR meter. (10 Hrs.) 50. Measure charge, energy store of capacitor in series and parallel circuits with voltage source in different combination. (10 Hrs.)	Inductor and Inductance, types of inductors, Factors affecting the value of inductance, self-inductance (L), Capacitance, types of capacitor, unit of capacitance, factors affecting the value of capacitors, charge, energy stored in capacitors. Capacitors in series and parallel. Capacitors in DC circuit. (04 Hrs.)

Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Verify characteristics of resonance circuits. ELE/ N9413	51. Measure capacitive and inductive reactance with increase/ decrease the input frequency of the circuit. (05 Hrs.) 52. Measure current & voltage and determine the characteristics of RL, RC and RLC in AC series circuits. (05 Hrs.) 53. Measure the resonance frequency in AC series circuit and determine its effect on the circuit. (05 Hrs.) 54. Measure current & voltage and determine the characteristics of RL, RC and RLC in AC series circuits. (05 Hrs.)	A.C.-impedance, Inductive reactance, capacitive reactance. AC current through - R, L, C circuits. Resonance in RLC circuit. Importance - of series and parallel resonance. (05 Hrs.)
Professional Skill 46 Hrs. Professional Knowledge 10 Hrs.	Plan, execute commissioning, testing and evaluate performance of AC & DC motors and generators. ELE/N9402	55. Start, run and reverse the direction of rotation of singleˆphase AC motors. (07Hrs.) 56. Practice on speed control of single-phase AC motors. (06Hrs.) 57. Install, connect and determine performance of single-phase DC motors. (07 Hrs.) 58. Start, run and reverse the direction of rotation of singleˆphase DC motors. (06Hrs.) 59. Install an alternator, identify parts and terminals of alternator. (07Hrs.) 60. Perform speed control of DC motors - field and armature control method. (06 Hrs.) 61. Connect, start and run three phase induction motors by using DOL, star-delta and auto-transformer starters. (07 Hrs.)	Introduction of AC and DC generators working principles, construction. Operation, field magnets, armature windings, commutator and brushes, EMF equation. Faraday's Law, Lenz's Law, Fleming's left Hand and right-hand rules. DC motors working principles, construction, operation, types. Different speed controlling techniques of DC motors. AC motors, induction motors, three phase motors, stepper motors.(10 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Execute testing, evaluate performance and maintenance of transformer. PSS/N2406, PSS/N2407	62. Perform OC and SC test to determine and efficiency of single-phase transformer. (05Hrs.) 63. Determine voltage regulation of single-phase transformer at different loads and power factors. (05 Hrs.) 64. Verify and measure voltage regulation of auto transformer at different loads. (05 Hrs.) 65. Perform series and parallel operation of two single phase transformers. (05 Hrs.)	Transformer, types, transformation ratio. Open circuit test and short circuit test, regulation Auto transformer. Current measurement. Instrument transformer. Potential transformer and current transformer. (05 Hrs.)

Professional Skill 40 Hrs. Professional Knowledge 06 Hrs.	Select, perform electrical/ electronic measurement, earthing installation service and calibrate MI instruments, electro dynamometer instruments, Induction type and Special instruments- voltage tester, continuity tester, rotation tester, phase sequence indicator, synchronising, synchronouscope, frequency meter, thermocouple type ammeter. ELE/N9415	66. Overhaul, check, fault find, repair, test of voltmeter and ammeter. (07 Hrs.) 67. Study the construction circuit operation and adjustment for correct functioning of zero errors on voltmeter and ammeter. (06Hrs.) 68. Find the minimum and maximum measurable range of the meter. (07Hrs.) 69. Test the shunt and series resistance of various rangeof ammeter. (07 Hrs.) 70. Practice multipliers for different range extension of voltmeter and ammeter. (07 Hrs.)	**Basics of electrical measuring instruments-** Types - absolute and secondary instruments. Types of secondary instruments, DC instruments - 'D1 Arsonval meter, PMMC meter- working principle, method of working, moving coil operation. (FSD) full scale deflection reading, measurement value, meter sensitivity, accuracy. Meter resistance, maximum power, capability etc. **Meter range extension-** Converting galvanometer into ammeter, voltmeter. Range extension of voltmeter, ammeter. Shunt resistance and series resistance value calculation. Meter resistance, meter FSD identification techniques.(06 Hrs.)
Professional Skill 60 Hrs Professional Knowledge 10 Hrs.	Select, perform electrical/ electronic measurement, earthing installation service and calibrate MI instruments, electro dynamometer instruments, Induction type and Special instruments- voltage tester, continuity tester, rotation tester, phase sequence indicator, synchronising, synchronouscope, frequency meter, thermocouple type ammeter. ELE/N9415	71. Prepare plate earthing and measure earth resistanceby earth tester / megger. (05 Hrs.) 72. Test earth leakage by ELCB and relay. (05 Hrs.) 73. Measure the power using wattmeter. (05 Hrs.) 74. Test and calibrate wattmeter. (05Hrs.) 75. Familiar with the construction of energy meter and ampere hour meter. (03 Hrs.) 76. Overhaul, check and fault find of ampere hour meter. (05 Hrs.) 77. Test and calibrate ampere hour meter. (05 Hrs.) 78. Measure power in single and three phase circuit using voltmeter &ammeter. (05 Hrs.) 79. Overhaul and maintenance of KWH meter and energy meter. (05 Hrs.) 80. Test and calibrate KWH meter and energy meter. (05 Hrs.) 81. Measure power factor in three phase circuit by using power factor meter and verify the same with voltmeter, ammeter and wattmeter readings. (05 Hrs.) 82. Practice of use voltage tester to Test electrical power in circuit, to test for proper grounding, to	Ohm meters- measuring electrical resistance. Basic construction of Ohm meter, working method of ohmmeter. Types of Ohm meter - series and shunt type of ohm meters. Megger/insulation tester, earth tester - construction working advantages and disadvantages of various types of ohm meter. AC instruments - types of AC measuring instruments -MI, electro dynamometer type, Working principle, construction, advantages and disadvantages of MI instruments and electro dynamometer instruments. Various applications. Induction type meters -working principle construction and operation of induction type instruments. Construction and Applications - single phase and three phase energy meter, watt meter. Walt hour meter, Ampere Hour meter, power factor meter etc. Special instruments: voltage tester, continuity tester, rotation test, phase sequence indicator, synchronizing, the synchroscope, _ frequency meter. Thermocouple type ammeters.(10 hrs.)

		determine whether adequate voltage is present in a wire. (05Hrs.) 83. Determines the phase sequence of the threeˆphase supply system using Phase sequence indicator. (02 Hrs.)	
Professional Skill 80 Hrs. Professional Knowledge 16 Hrs.	Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning. ELE/ N9404	84. Test the power diode, Zener diode, tunnel diode, photo diode using multi meter and determine forward to reverse resistance ratio. (05 Hrs.) 85. Determine V-I characteristics of semiconductor diode. (05 Hrs.) 86. Measure the voltage and current through a diode in a circuit and verify its forward characteristic. (05 Hrs.) 87. Measure the voltage and current through a Zener diode in a circuit and verify its forward and reverse characteristic. (05 Hrs.) 88. Construct and test fixedˆbias, emitter-bias and voltage divider-bias transistor amplifier. (05Hrs.) 89. Construct and Test a common emitter amplifier with and without bypass capacitors 90. Construct a single stage amplifier and measure current gain, voltage gain & power gain. (05 Hrs.) 91. Construct and test a FET Amplifier. (04 Hrs.) 92. Construct and test a half wave, full wave and Bridge rectifier circuit. (05 Hrs.) 93. Construct and test different filter circuit used in rectifier and measure output voltage with load. (05 Hrs.) 94. Construct and test Zener based voltage regulator circuit. (03Hrs.) 95. Construct and test Zener and transistor-based series regulator. (03 Hrs.) 96 Construct and test a +12V fixed voltage regulator. (05 Hrs.) 97 Construct and test a fixed +15ve and –15ve voltage regulator using ICs. (05 Hrs.) 98 Construct and test a 1. (05Hrs.)2V 30V variable output regulated power supply using IC LM317T and its characteristics. (05 Hrs.)	Semiconductor, Covalent bond, Doping, Intrinsic and extrinsic semiconductor. PN junction diode, Forward and Reverse characteristics. Specification of diodes (data sheets). Applications of diode. Special semiconductor diode-Zener diode, tunnel diode, Photo diode. Transistors. Defining transistors, NPN& PNP transistor, Symbol, operation, Biasing of Transistor & mode of Application. Transistor CB, CC, CE Amplification, current gain, voltage gain, and power gain. Introduction to FET, MOSFET. Rectifiers: half wave rectifier, full wave (bridge & center tapped) rectifier. Voltage multipliers. Filters: Introduction, purpose and use of ripple filter. Types of filters. Capacitance filter, inductance filters, RC filters, LC filters, voltage dividers and bypass filters. Voltage regulators. Introduction & purpose Zener regulators, shunt regulators, series regulators, IC regulators, variable regulators. (16 hrs.)
Professional Skill 20 Hrs.	Detect the faults and troubleshoot SMPS,	99 List the defect and symptom in the faulty SMPS. (02 Hrs.)	

Professional Knowledge 04 Hrs.	UPS, inverter, converter and Thyristor family. ELE/N7202	100 Measure / Monitor major test points of computer SMPS. (02Hrs.) 101. Troubleshoot the fault in the given SMPS unit.Rectify the defect and verify the output with load. Record your procedure followed for trouble shooting the defects.(05Hrs.) 102. Open top cover of a UPS; identify its isolator transformers, the UPS transformer and various circuit boards in UPS.(03 Hrs.) 103. Perform load test to measure backup time. (03 Hrs.) 104. Install and test an inverter. (02Hrs.) 105. Troubleshoot the fault in the given inverter unit. Rectify the defects and verify the output with load. (03Hrs.)	**Power Supply units.** Introduction, purpose & use. UPS and SMPS, inverters and converters and their applications. (04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 04 Hrs.	Identify, place, solder and desolder and test different SMD, discrete components with due care and following safety norms using proper tools/setup. ELE/N5102	106. Measure and plot input and output characteristics of a CE amplifier. (05 Hrs.) 107. Check for cold continuity of PCB. (03 Hrs.) 108. Solder the SMD components from the given PCB. (04 Hrs.) 109. De-solder the SMD components in the same PCB. (04 Hrs.) 110. Repair solder mask and damage pad. (04 Hrs.)	General characteristics of an amplifier, Concept of amplification. PCB basic construction, applications. Lay outing circuit on PCB.(04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning. ELE/N9407	**Oscillators** 111. Demonstrate Colpitts oscillator, Hartley oscillator circuits and compare the output frequency of the oscillator by CRO. (08Hrs.) 112. Construct and test a RC phase shift oscillator circuits. (06 Hrs.) 113. Construct and test a crystal controlled oscillator circuit. (06Hrs.)	Oscillator's oscillations, oscillation frequency, basic working principle and working of Talk circuit, Crystal controlled oscillators, Phase shift oscillators, RC phase shift oscillators, Colpitt, Clapp, Hartley. (05 Hrs.)
Professional Skill 44 Hrs. Professional Knowledge 10 Hrs.	Construct and test different circuits using operational amplifiers circuits and execute the result. ELE/ N9407	114. Use analog IC tester to test the various analog ICs. (07Hrs.) 115. Construct and test various Op Amp circuits Inverting, Non inverting and Summing Amplifiers. (05 Hrs.) 116. Construct and test Differentiator and Integrator circuits. (05 Hrs.)	**Operational Amplifier.** Differential amplifier, ideal op-amp. Op-amp with feedback, advantages of feedback. Inverting and Non inverting and inverting amplifier, Op-amp as summer, differential amplifier. V to I converter and I to V converter, Instrumentation amplifier

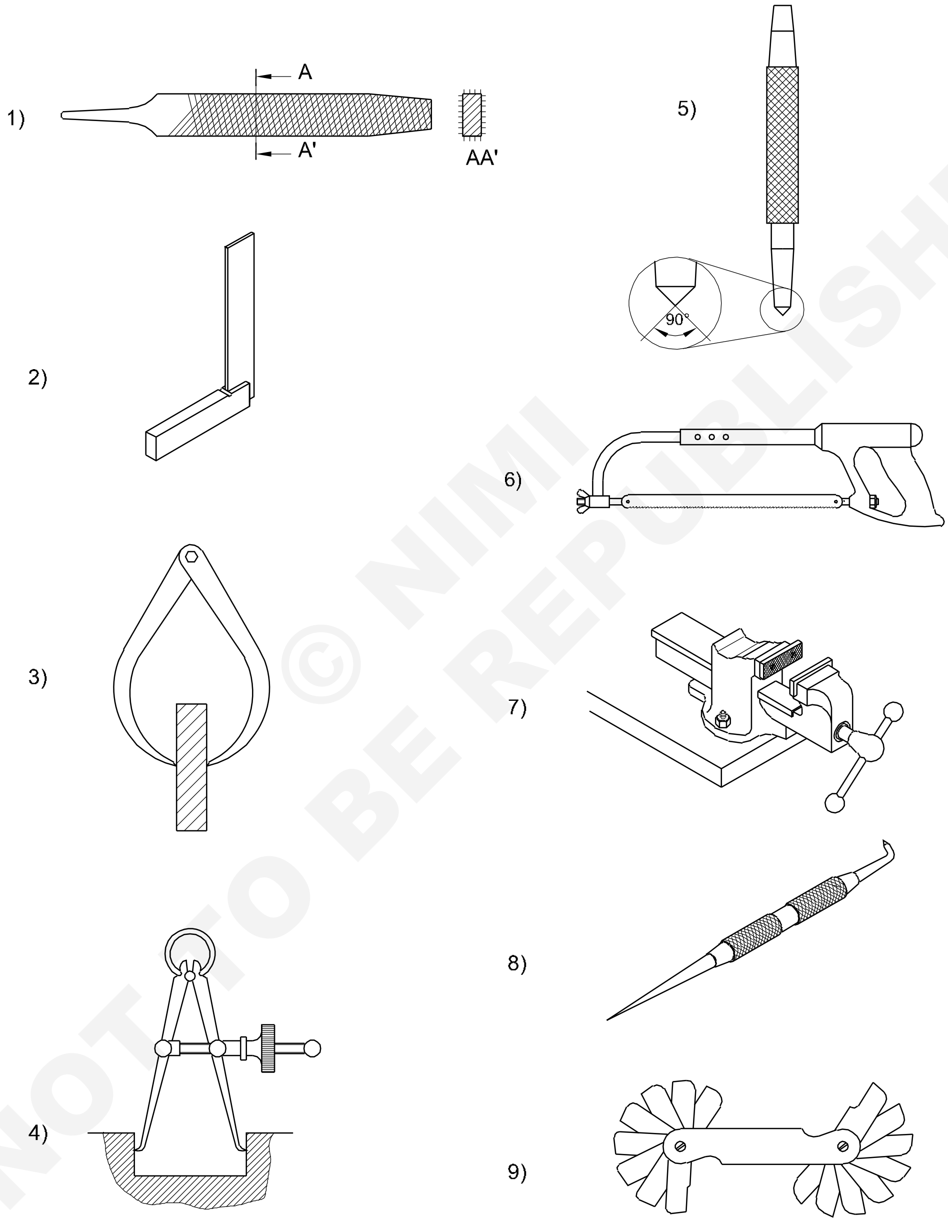
		117. Construct and test a voltage to current and current to voltage converter circuit using Op-amp. (05 Hrs.) 118. Construct and test Instrumentation amplifier (04 Hrs.) 119. Construct and test Astable timer circuit using IC 555. (06 Hrs.) 120. Construct and test mono stable timer circuit using IC 555. (06Hrs.) 121. Construct and test 555 timers as pulse width modulator. (06Hrs.)	Basics of op- amp applications - integrator, differentiator, Introduction of timers (555) and its applications. (10 Hrs.)
Professional Skill 125 Hrs. Professional Knowledge 20 Hrs.	Identify, test and Verify all digital ICs. Assemble, test and troubleshoot various digital circuits and digital instruments. ELE/N9405	122. Verify the truth tables of all Logic Gate ICs by connecting switches and LEDs. (05 Hrs.) 123. Construct and verify the truth table of all the gates using NAND and NOR gates. (05 Hrs.) 124. Use digital IC tester to test the various digital ICs (TTL and CMOS). (05 Hrs.) 125. Construct and verify the truth table of all the gates using DTL circuit. (05 Hrs.) 126. Construct Half Adder circuit using ICs and verify the truth table. (05 Hrs.) 127. Construct Full adder with two Half adder circuit using ICs and verify the truth table. (05 Hrs.) 128. Construct Half subtractor and full subtractor circuit using ICs and verify the truth table. (05 Hrs.) 129. Construct the adder cum subtractor circuit and verify the result. (05 Hrs.) 130. Construct and test R-S flip-flop using IC7400 with clock and without clock pulse. (06 Hrs.) 131. Verify the truth tables of JK Flip-Flop using ICs by connecting switches and LEDs. (06 Hrs.) 132. Construct and test 7493 as a modulus-12 counter. (06 Hrs.) 133. Construct and test seven segment LED display decoder with IC 7447. (06 Hrs.) 134. Measure current flowing through a resistor and display it on LED Module. (06 Hrs.)	**Number systems;** binary, octal, decimal and hexadecimal number system. Conversion of number systems. Boolean algebra, binary addition, subtraction, multiplication and division. 1's and 2's compliment, BCD code, ASCII code, gray code. Logic Circuits. Basic gates-AND, OR and NOT gates. De-Morgan \s Theorem. Universal gates - NAND and NOR gates. Special gates - Ex-OR, Ex -NOR gates and Buffer and its applications. Basic digital ICs, function, digital application, logic symbols. Adders - Half adder, full adder Subtractor - Half subtractor, full subtractor. Flip flops - RS flip flop, clocked RS flip flop, JK flip flop, Basics of Counters and registers. Multiplexer and de--multiplexer. Digital meters: displays: LED, 7 segment display, LCD, CRT, electro-luminescent displays, electro-phoretic image display, liquid vapor display, dot matrix display.(10 Hrs.)

		135. Construct and test Digital to Analog (D/A) Binary Weighted resistor converter by using op-amps. (06 Hrs.) 136. Construct and test Digital to Analog (D/A) converter using R-2R ladder network circuit. (06 Hrs.) 137. Perform the interfacing of IEEE 488.2 standard with a single controller can control up to 15 different instrument connected star topology. (06 Hrs.) 138. Perform the interfacing of RS232 to the PC. (06 Hrs.) 139. Convert RS-485 signals to RS-232 signals using RS-485 to RS-232 converter. (06 Hrs.)	**A/D and D/A converters,** Introduction, weighted register D / A converter, binary(R-2R) ladder D / A converter, specification for D / A converter, Ramp or counter type A/D converter, GPIB (general purpose interface bus) IEEE - 488, RS 232. (06 Hrs.)
		140. Display a word on a two-line LED. (05 Hrs.) 141. Measure/current flowing through a sensor and display it on a LED module (DPM). (05 Hrs.) 142. Practice on measuring instruments in single and three phase circuits e.g. (05 Hrs.) Phase sequence meter and Frequency meter etc. (05 Hrs.) 143. Practice on time measuring instrument to measure the time in different electrical control circuit. (05 Hrs.)	Digital meters: frequency meter, phase measuring meter, and time measuring instruments. Digital capacitance meter. (04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Measure the various parameters by CRO and execute the result with standard one. ELE/N9416	144.Measure the Amplitude, Frequency and time period of typical electronic signals using CRO. (10 Hrs.) 145. Take a print of a signal from DSO by connecting it to a printer and tally with applied signal. (10 Hrs.)	CRO: introduction and applications of CRO, functional block diagram of CRO, CRT power supply. Various types of probes. Applications of various types of CROs like dual beam CRO, Dual trace CRO, storage oscilloscope. (05 Hrs.)
Professional Skill 70 Hrs. Professional Knowledge 10 Hrs.	Install and setup operating system and related software in a computer &Practice with MS office and application software related to instruments. ELE/N9417	146. Practice on windows interface and navigating windows. (07 Hrs.) 147. Customize the desktop settings and manage user accounts. (07 Hrs.) 148. View system properties and control panel details. (07 Hrs.) 149. Install necessary application software for windows i.e. office package and media player. (07 Hrs.) 150. Burn data, video and audio files on CD/DVD using application software. (07 Hrs.)	Introduction to Computer, Block diagram of PC, software familiarization of Multimedia System consisting of CD ROMS, DVD ROMS, Sound Cards. (05 Hrs.)

		151. Dismantle and assemble the desktop computer system. (07 Hrs.) 152. Replace RAM and ROM from CPU. (07 Hrs.) 153. Identify different parts, its function and operation of modem. (07 Hrs.) 154. Install a modem to the computer to send and receive data over a telephone line or a cable or satellite connection. (07 Hrs.) 155. Construct and test DAC and ADC using computer network circuit. (07 Hrs.)	Computer Hardware, Computer systems, computer hardware, CPU, CPU operations, ROMs and RAMs, I/P and O/P and peripheral equipments, terminals, printers, MODEMS, Data interface, ADC and DAC. (05 Hrs.)
Professional Skill 40 Hrs Professional Knowledge 10 Hrs.	Identify various functional blocks of a microprocessor system, identify various I/O Ports, write and executive simple program and Interface a model application with the microprocessor kit and run the application. ELE/N9418	156. Measure the crystal frequency, connect it to the processor. (10 Hrs.) 158. Use 8085 microprocessor, connect 8 LED to the port, blink the LED with a switch. (10 Hrs.)	Introduction to microprocessor microcomputers, Memories Intel 8085. Architecture Instruction set of 8085, Microprocessor. 1. Data transfer group. 2. Arithmetic group. 3. Logic group. (05 Hrs.)
		159. Perform addition and subtraction of two 8-bit numbers using 8085 microprocessors. (10 Hrs.) 160 Demonstrate entering of simple programs, execute &monitor the results. (10 Hrs.)	Basic Programming of 8085 such as adding, subtraction of two 8-bit numbers, etc. Block diagram and pin' diagram 8255 and its operation. Microprocessor applications. (05 Hrs.)

Importance of trade training, list of tools & machinery used in the trade

Objectives: At the end of this exercise you shall be able to
- **identify the tools and equipments used in instrument mechanic section**
- **record the names of tools, do's and don't of each tool**
- **record the names of the industries where the instrument mechanics are employed.**



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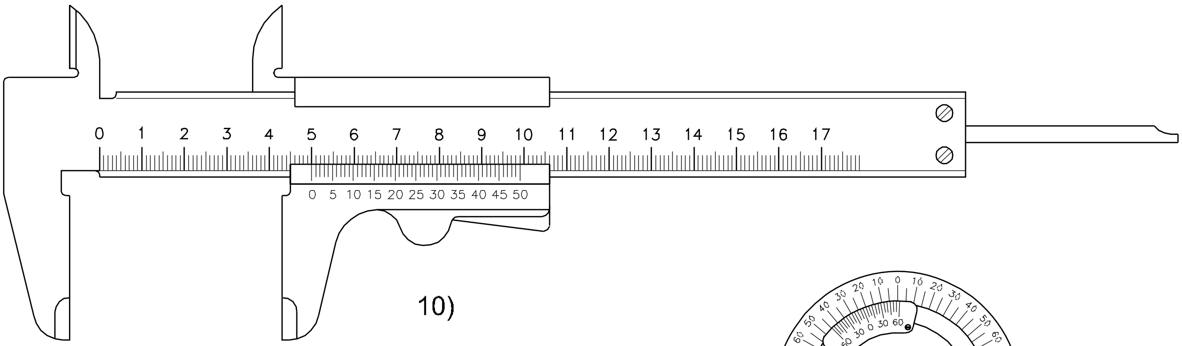
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE	**IDENTIFICATION OF TOOLS, AND EQUIPMENTS**				DEVIATIONS	TIME
					CODE NO. IM20N1101E1	



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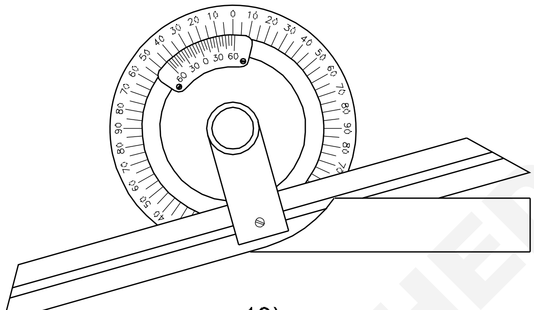

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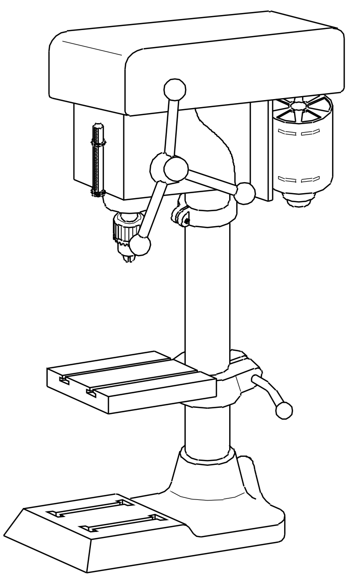

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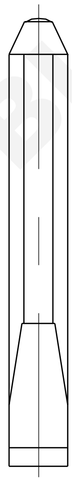

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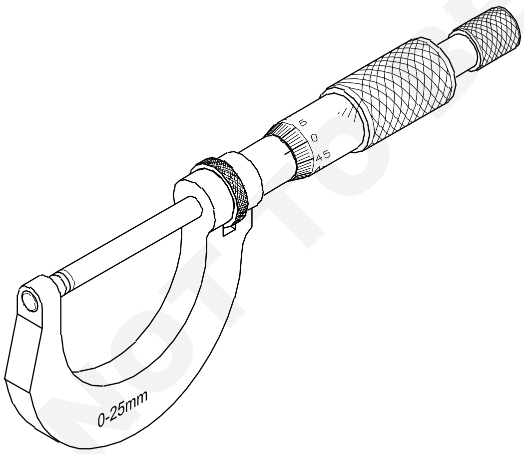

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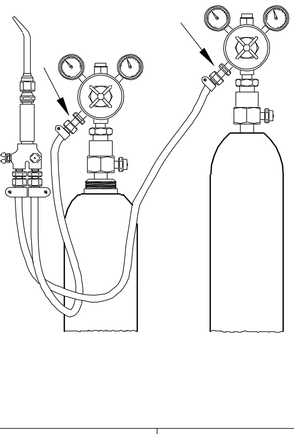

15)

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NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE	IDENTIFICATION OF TOOLS, AND EQUIPMENTS	DEVIATIONS	TIME:
		CODE NO. IM20N1101E2	

Job Sequence

Instructor shall display all the tools and equipments in the section and brief their names, uses and the safety point to be observed for each tool and equipment.

- Trainees will note down all the displayed tools names, uses and the precaution to be observed while working with each tool.
- Record it in Table 1.
- Get it checked by the instructor.

Table 1

Sl.No	Name of tool/equipment	Uses	Precaution to be observed (Do's and Don't)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Instructor shall brief the role of a instrument mechanic in industries. Emphasis more on the assembly shop by providing the names of the private and public sector industries, where the instrument mechanics are largely employed. Ask the trainees to note down the names of the industries.

Safety attitude development of the trainee by educating them to use personal protective equipment (PPE)

Objectives: At the end of this exercise, you shall be able to
- **identify personal protective devices**
- **interpret the different types of personal protective devices**
- **identify occupational hazards and the corresponding potential hazards.**

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NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE	IDENTIFY THE CATEGORIES OF THE SAFETY SIGN				DEVIATIONS	TIME
					CODE NO. IM20N1102E1	

Job Sequence

- Read and interpret the visuals of personal protective equipment on real devices or from the charts.
- Identify and select personal protective equipment used for different types of protection.
- Write the name of the PPE and the corresponding type of protection and the hazards in Table 1.

The instructor shall display the different types of personal protective equipments or charts and explain how to identify and select the PPE devices suitable for the work and ask the trainees to note down the hazards and type of protection in the Table 1.

— — — — — — — — —

TASK 1: **Interpret the different types of personal protective devices**

Table 1

S.No.	Name of the PPE	Hazards	Type of protection
1			
2			
3			
4			
5			
6			
7			
8			
9			

Get it checked by your instructor.

— — — — — — — — —

TASK 2: **Identify occupational hazards and the corresponding potential hazards.**

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

1 Identify the occupational hazard and the corresponding situation with the potential harm and record it in Table 2.

Table 2

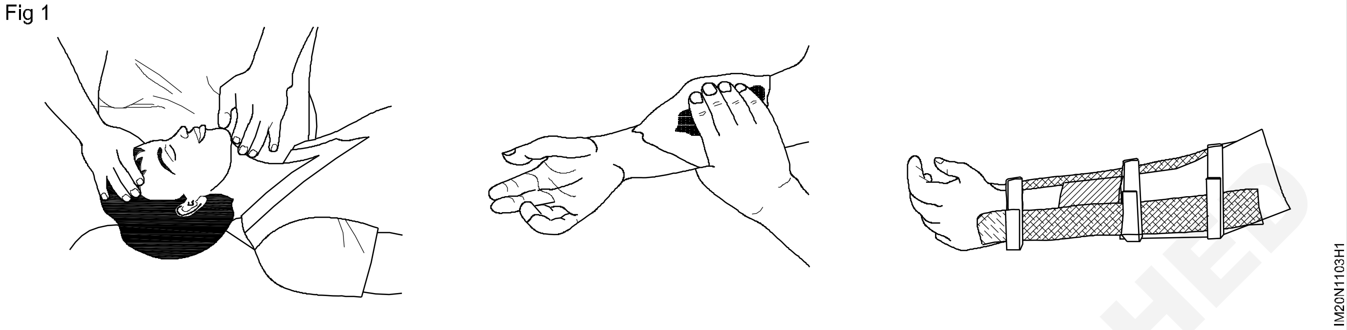
S.No.	Source or potential harm	Type of occupational hazards
1	Noise	
2	Explosive	
3	Virus	
4	Sickness	
5	Smoking	
6	Non control device	
7	No earthing	
8	Poor house keeping	

Fill up and get it checked by your instructor.

First aid method and basic training

Objectives: At the end of this exercise, you shall be able to
- **rescue breathing for an unconscious victim of different condition**
- **perform treatment for stopping of bleeding.**

Fig 1



Job Sequence

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

TASK1: **Prepare the victim to receive artificial respiration**

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

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

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

4 Start artificial respiration immediately without delay. Do not waste too much time in loosening the clothes or trying to open the tightly closed mouth.

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

6 Send word for a doctor immediately.

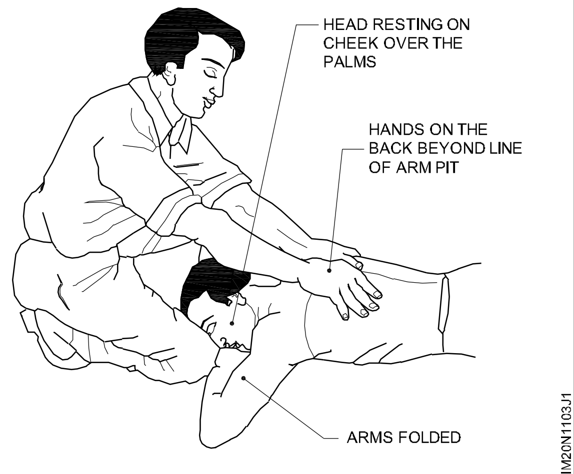
— — — — — — — —

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.**

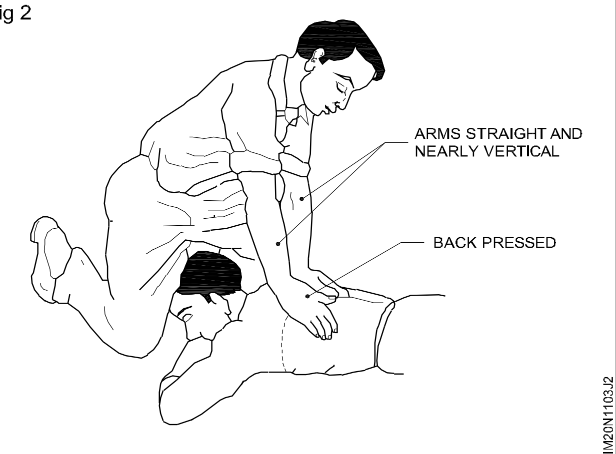
1 Place the victim prone (that is face down) with his arms folded with the palms one over the other and the head resting on his cheek over the palms. Kneel on one or both knees near the victim's hand. Place your hands on the victim's back beyond the line of the armpits, with your fingers spread outwards and downwards, thumbs just touching each other as in Fig 1.

Fig 1



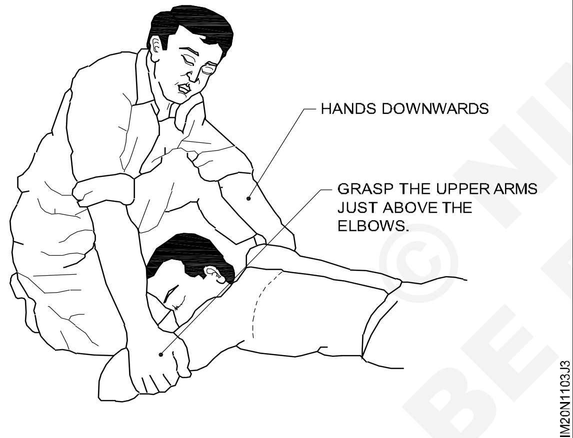
2 Gently rock forward keeping your arms straight until they are nearly vertical, and steadily pressing the victim's back as shown in Fig 2 to force the air out of the victim's lungs.

Fig 2



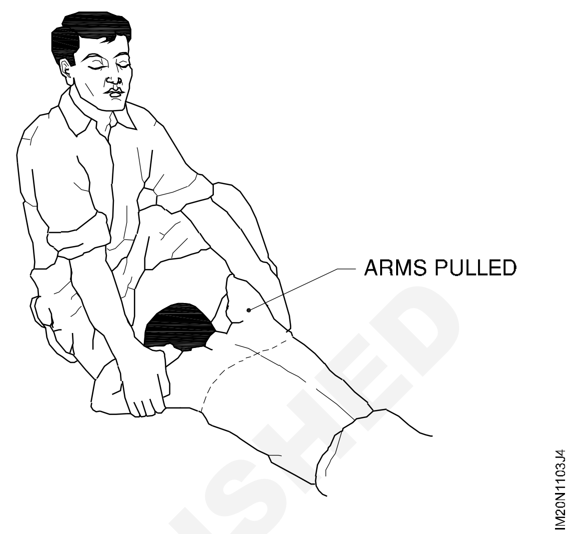
3 Synchronise the above movement of rocking backwards with your hands sliding downwards along the victim's arms, and grasp his upper arm just above the elbows as shown in Fig 3. Continue to rock backwards.

Fig 3



4 As you rock back, gently raise and pull the victim's arms towards you as shown in Fig 4 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.

Fig 4



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

6 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.

7 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.

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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.

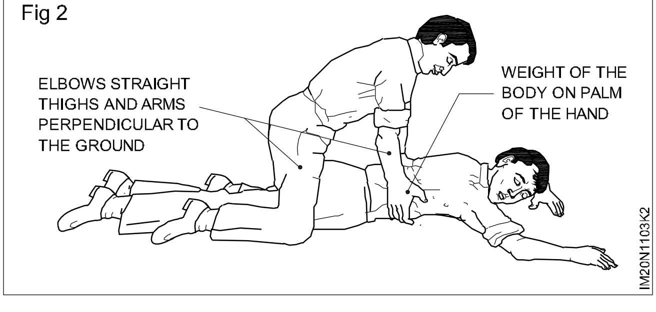
1 Lay the victim on his belly, one arm extended direct forward, the other arm bent at the elbow and with the face turned sideward and resting on the hand or forearm as shown in Fig 1.

Fig 1

2 Kneel astride the victim, so that his thighs are between your knees and with your fingers and thumbs positioned as in Fig 1.

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 2.

Fig 2

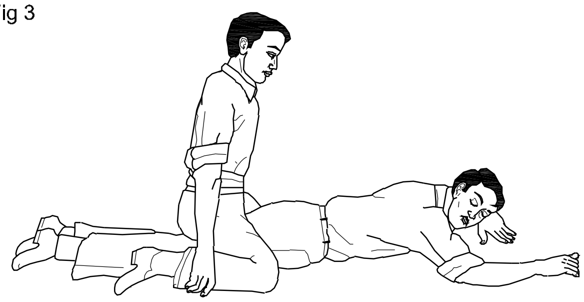


4 Now swing backward immediately removing all the pressure from the victim's body as shown in Fig 3, thereby, allowing the lungs to fill with air.

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

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

Fig 3



IM20N1103K3

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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 1)

Fig 1

IM20N1103S1

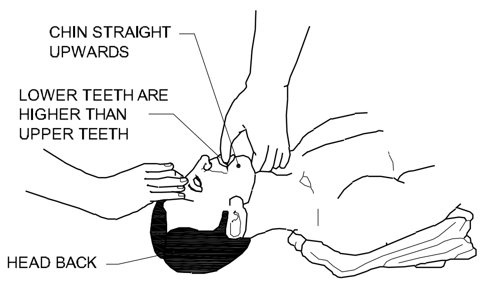
2 Tilt the victim's head back so that the chin points straight upward. (Fig 2)

Fig 2

IM20N1103S2

3 Grasp the victim's jaw as shown in Fig 3, 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 3



IM20N1103S3

4 Take a deep breath and place your mouth over the victim's mouth as shown in Fig 4 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 4

IM20N1103S4

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.

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 1)

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 1

— — — — — — — — —

TASK 6: **Resuscitate a victim who is under cardiac arrest by (CPR) cardio pulmonary resuscitation**

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

1 Check quickly whether the victim is under cardiac arrest.

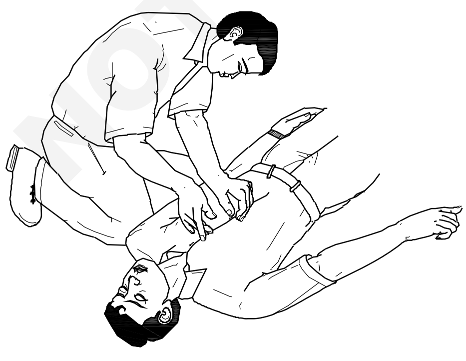
Cardiac arrest could be ascertained by the absence of the cardiac pulse in the neck (Fig 1), blue colour around lips and widely dilated pupil of the eyes.

Fig 1

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

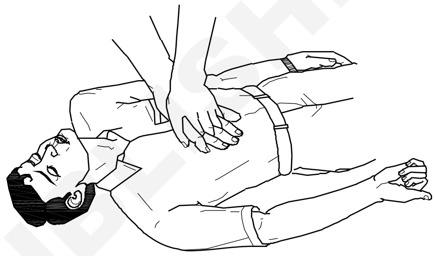
3 Kneel alongside facing the chest and locate the lower part of the breastbone. (Fig 2)

Fig 2



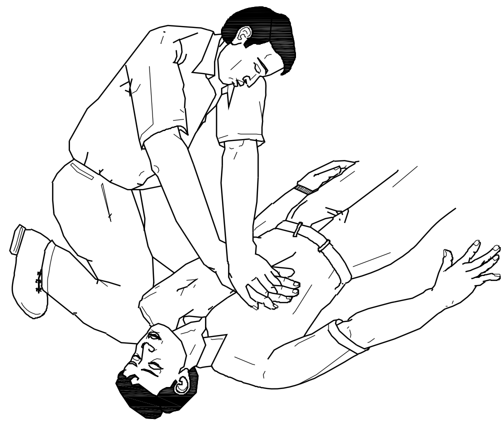
4 Place the palm of one hand on the centre of the lower part of the breastbone, keeping your fingers off the ribs. Cover the palm with your other hand and lock your fingers together as shown in Fig 3.

Fig 3



5 Keeping your arms straight, press sharply down on the lower part of the breastbone; then release the pressure. (Fig 4)

Fig 4



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

7 Check the cardiac pulse. (Fig 5)

8 Move back to the victim's mouth to give two breaths (mouth-to-mouth resuscitation). (Fig 6)

Fig 5

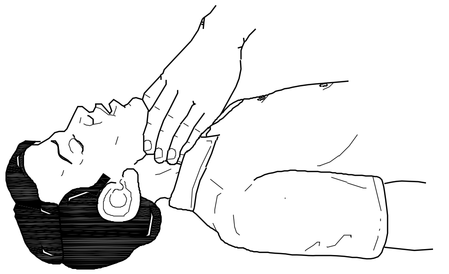


Fig 6

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.

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

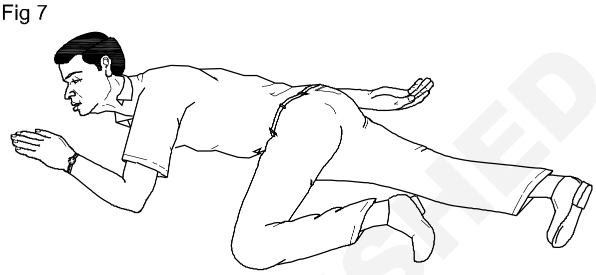
11 Place the victim in the recovery position as shown in Fig 7. Keep him warm and get medical help quickly.

Other steps

1 Send word 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 7



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TASK 7: **Treatment for bleeding victim**

1 Determine the location of the bleeding.

2 Elevate the injuried area above the heart if possible.

3 Apply direct pressure to the bleeding area with sterile cloth.

4 Keep the pressure on for 5 seconds.

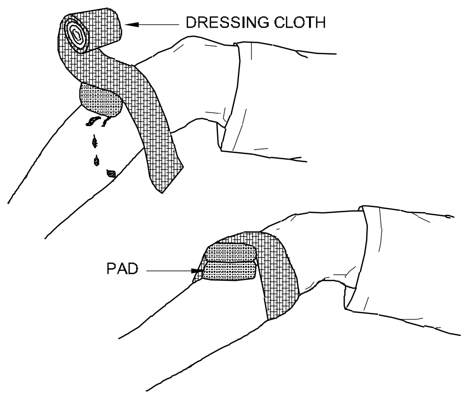
5 Check to see if the bleeding has stopped if not apply further pressure for 15 minutes.

6 Clean the wound.

7 Bandage the wound with pad of soft material. (Fig 1)

8 Advice victim to take treatment from doctor.

Fig 1



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Safe disposal of waste materials like cotton waste, metal chips / burrs etc.

Objectives: At the end of this exercise you shall be able to
- **identify and segregate the waste material in workshop**
- **arrange the waste material in different bins.**

Fig 1

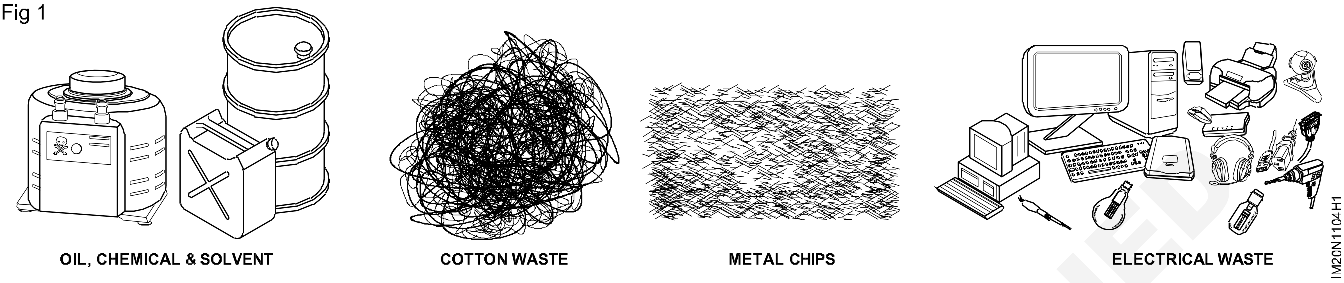
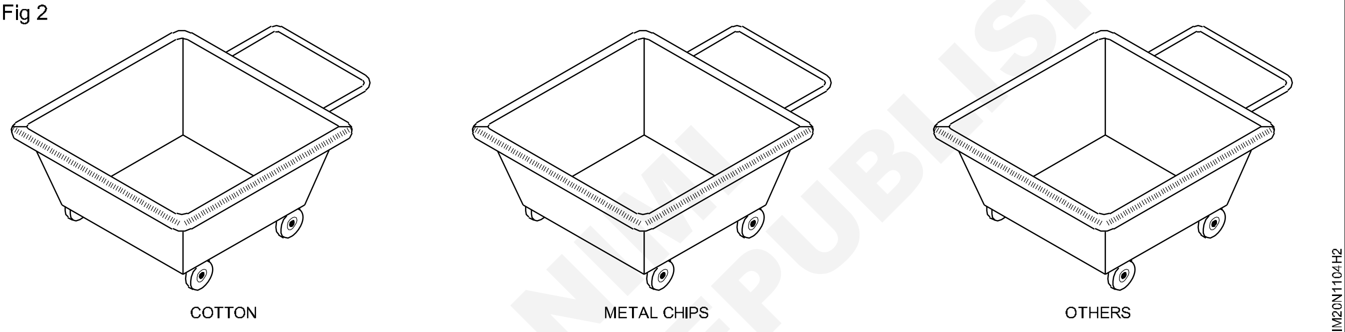


Fig 2



Job Sequence

- Separate the cotton waste.
- Collect the chips by hand shovel with the help of brush. (Fig 1).
- Clean the floor, if oil is spilled.

Do not handle the chip by bare hand

There may be different metal chips. So separate the chip according to metal.

- Separate the cotton waste material and store it in the bin provided to store the waste cotton material. (Fig 2)
- Similarly store the each category of metal chip in separate bins.

Each bin should have name of the material.

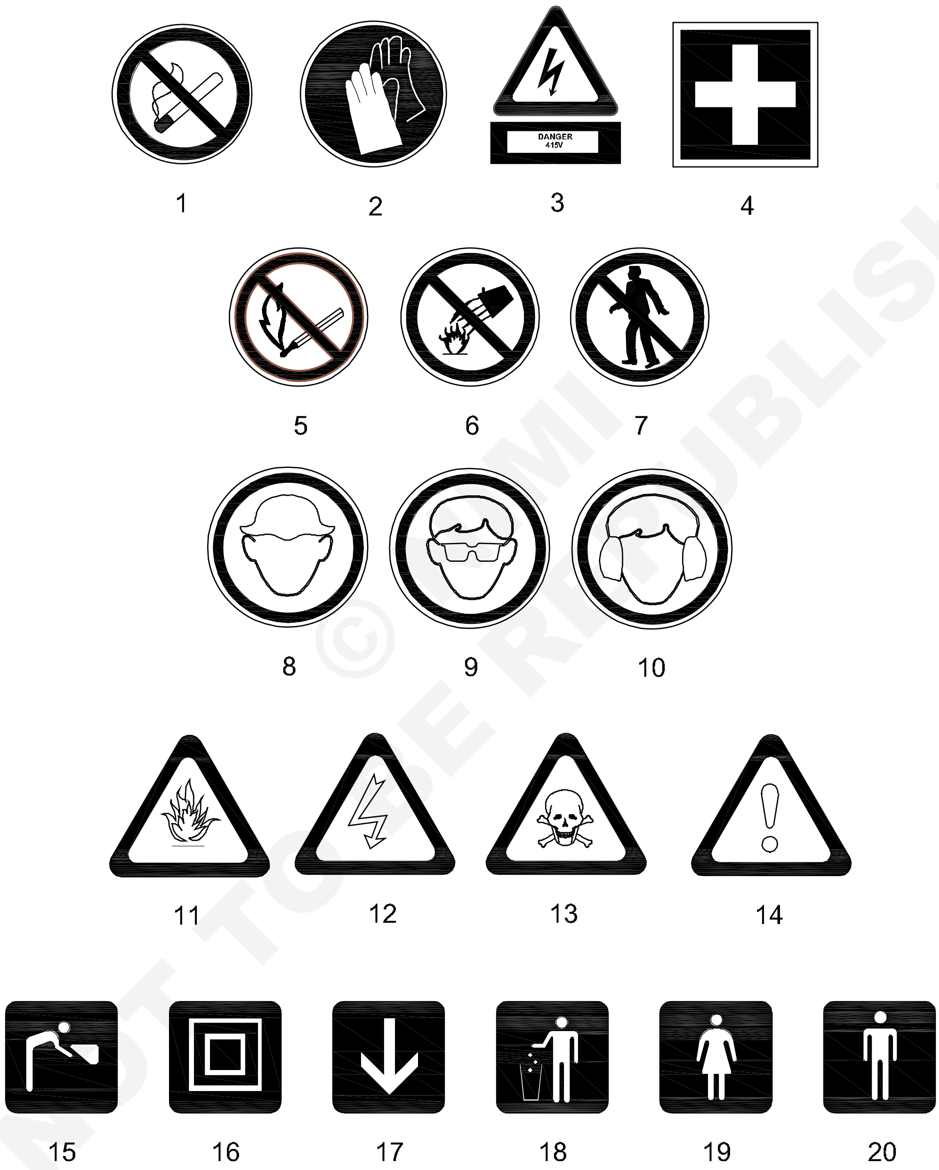
Identify the material given in fig 1 and fill in table 1

Table1

S. No.	Name of the material
1	
2	
3	
4	
5	

Safety sign for danger, warning, caution and personal safety message

Objectives: At the end of this exercise you shall be able to
- **identify the basic categories of safety sign**
- **record the meaning of safety sign in the table given.**



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NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE	**IDENTIFY THE CATEGORIES OF THE SAFETY SIGN**	DEVIATIONS	TIME: 1Hr
		CODE NO. IM20N1105E1	

Job Sequence

Instructor shall provide various safety signs, chart categories and explain their meaning, description. Ask the trainee to identify the sign and record in Table 1.

- Identify the safety sign from the chart.
- Record the name of the category in Table 2.
- Mention the meaning description of the safety sign in Table 1.

Table 1

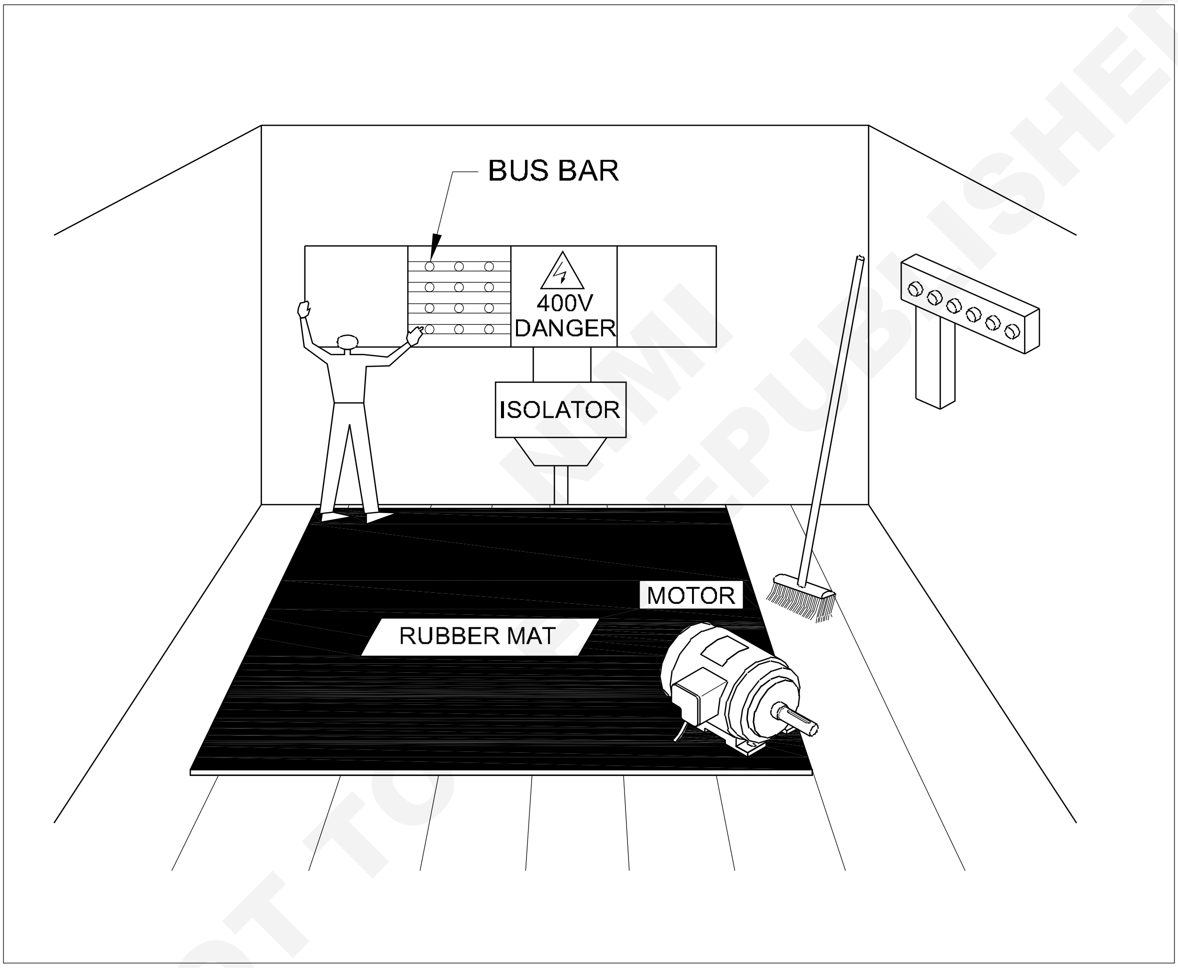
Fig. No.	Basic Categories/Safety sign	Meaning - description
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

- Get it checked by your instructor.

Preventive measures for electrical accidents and step to be taken in such accidents

Objective: At the end of this exercise you shall be able to
• **rescue a person from live wire.**

Before rescue a person from live wire, use a wooden piece or switch off the electric main



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NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE	**PREVENTIVE MEASURES FOR ELECTRICAL ACCIDENTS**	DEVIATIONS	TIME : 2 HOURS
		CODE NO. IM20N1106E1	

Job Sequence

Disconnecting a person (mock victim) from a live supply (simulated)

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

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

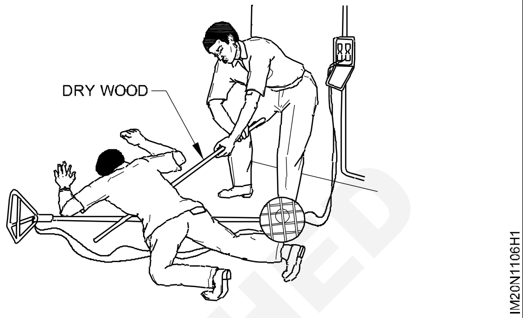
> **Do not run to switch off the supply that is far away.**
>
> **Do not touch the victim with bare hands until the circuit is made dead or the victim is moved away from the equipment.**
>
> **Push or pull the victim from the point of contact of the live equipment, without causing serious injury to the victim. (Fig 1)**

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.

Fig 1



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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 and extinguish the fire.**

--	--	--	--	--	--	1.1.07
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE	**PRACTICE ON FIRE EXTINGUISHER**	DEVIATIONS	TIME : 7 HOURS
		CODE NO. IM20N1107E1	

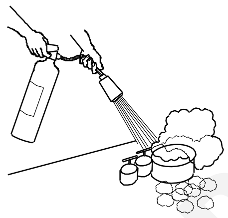
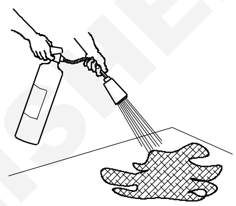
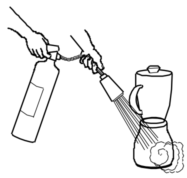
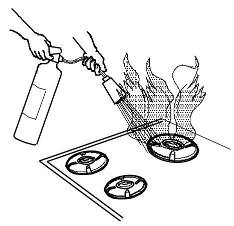
Job Sequence

- Alert people surrounding by shouting fire, fire, fire when observe fire.
- Inform fire service or arrange to inform immediately.
- Open emergency exist and ask them to go away.
- Put "Off" electrical power supply.

Do not allow people to go nearer to the fire

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

Table1

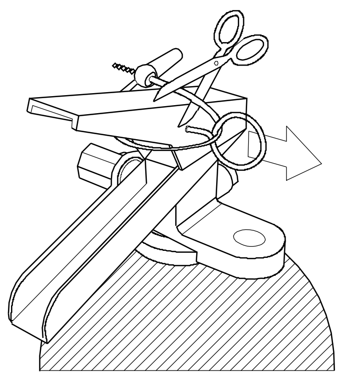
Class 'A'	Wood, paper, cloth, solid material	
Class 'B'	Oil based fire (grease, gasoline, oil) & liquefiable solids	
Class 'C'	Gas and liquefied gases	
Class 'D'	Metals and electrical equipment	

Assume the fire is 'B' type (flammable liquefiable solids)

- Select CO_2 (carbon dioxide) fire extinguisher
- Locate and pick up CO_2 fire extinguisher. Check for its expiry date.
- Break the seal. Fig1
- Pull the safety pin from the handle (Fig 2) (Pin located at the top of the fire extinguisher) (Fig 2)
- Aim the extinguisher nozzle or hose at the base of the fire (this will remove the source of fuel fire) (Fig 3)

Keep your self low

Fig 1



IM20N1107H1

Fig 2

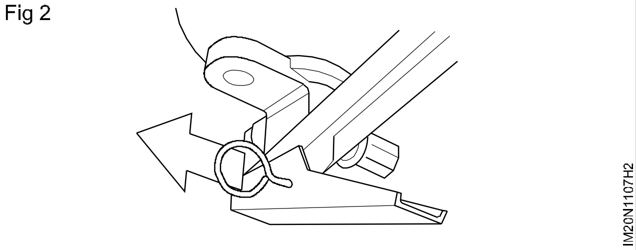
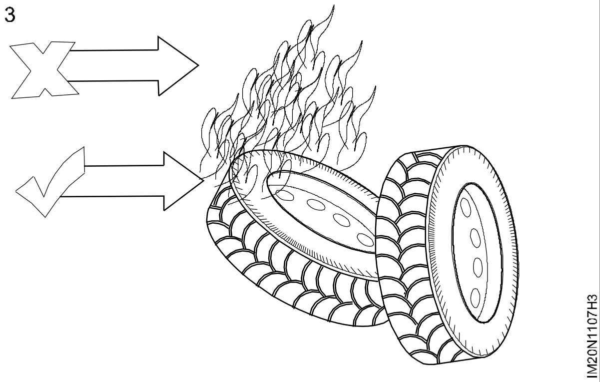


Fig 3



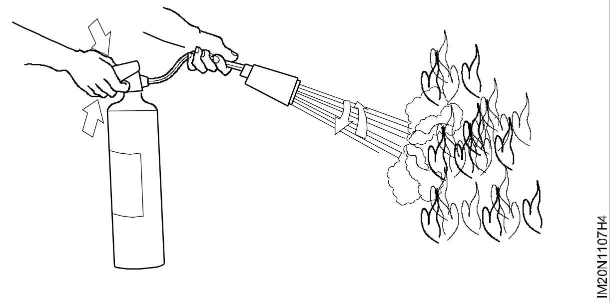
- Squeeze the handle lever slowly to discharge the agent (Fig 4)
- Sweep side to side approximately 15 cm over the fuel fire until the fire is put off. (Fig 4)

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 is put off promptly

Fig 4



- If the fire doesn't respond well after you have used up the fire extinguisher move 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

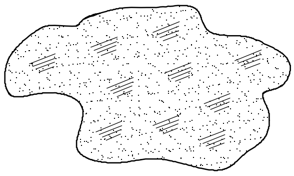
S for squeeze

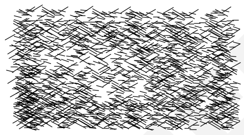
S for sweep

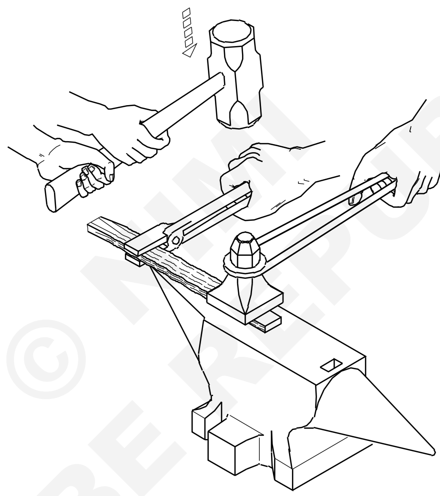
Practice and understand precautions to be followed while working in fitting jobs

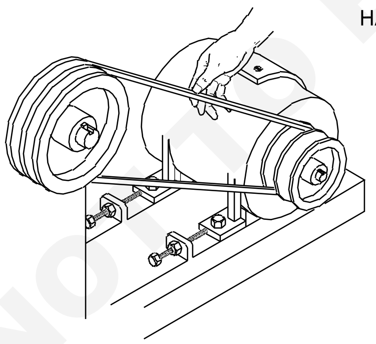
Objective: At the end of this exercise, you shall be able to
- **record the precaution to be followed while working in fitting jobs.**

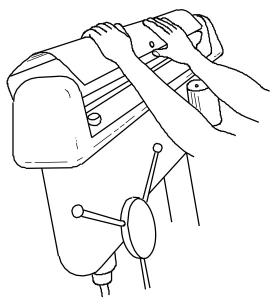
Set up the appropriate the safety rolls

1

OIL SPILLS ON SHOP FLOOR AND WORK TABLE

2

METAL CHIPS SPREAD ON SHOP FLOOR NEAR DRILLING MACHINE

3

HANDLING HOT JOBS WITHOUT GLOVES

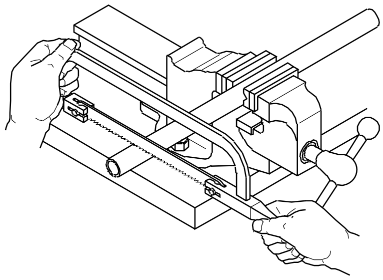
4

MACHINE RUNNING WITHOUT BELT GUARD

5

CHANGING THE BELT WHEN THE SPINDLE IS ROTATING

1	-	-	-	-	-	1.1.08
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

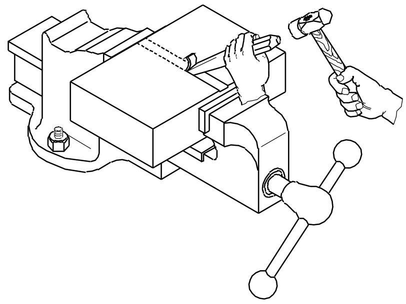
SCALE: NTS	PRECAUTIONS WHILE WORKING IN FITTING JOBS	TOLERANCE :	TIME : 2Hr
		CODE NO. IM20N1108E1	

6



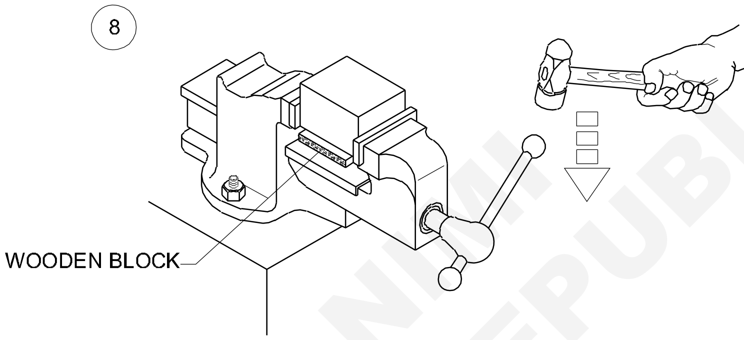
HACKSAWING WITHOUT HANDLE

7



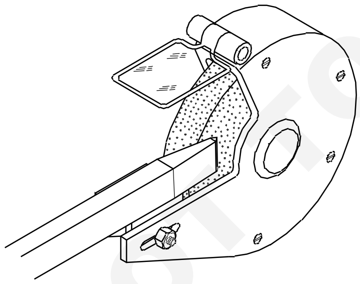
CHIPPING ON METAL WITHOUT CHIPPING SCREEN

8



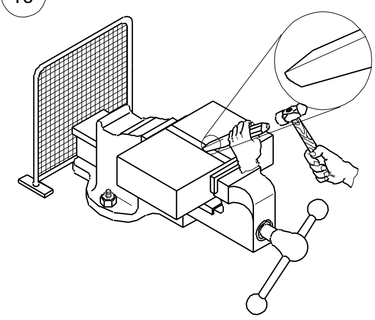
STRIKING ON VICE HANDLE WITH HAMMER TO GRIP THE WORK PIECE

9



GRINDING A FLAT CHISEL IN SIDE WAYS OF GRINDING WHEEL

10



CHIPPING WITH BLUNT CHISEL ON METAL SURFACE

1	-	-	-	-	-	1.1.08
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE: NTS	**PRECAUTIONS WHILE WORKING IN FITTING JOBS**	TOLERANCE :	TIME : 2Hrs
		CODE NO. IM20N1108E2	

Job Sequence

The instructor shall guide and demonstrate the students to practice and understand precautions to be followed while working in fitting jobs.

- Recrod the precautions to be followed while working in fitting job in Table 1.

Table 1

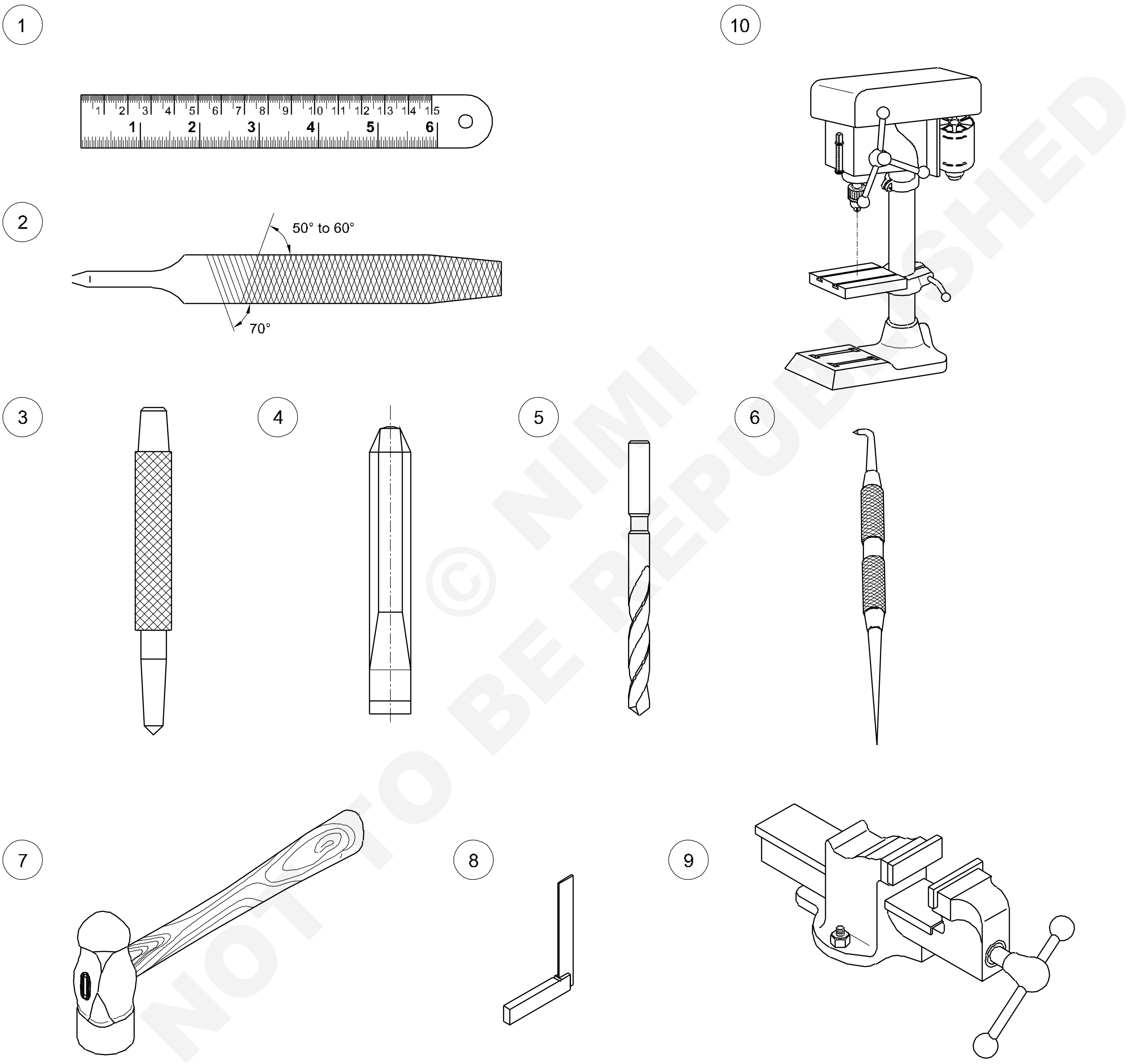
Fig. No.	Description	Record precautions to be followed while working in fitting job
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

- Fill up and get it checked by your instructor.

Safe use of tools and equipments used in the trade

Objective: At the end of this exercise, you shall be able to
- **record the safety points while using the instrument mechanic trade tool and equipments.**

Check the tools and equipment's and keep it in safety place



1	-	-	-	-	-	1.1.09
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE: NTS	FITTER TOOLS AND EQUIPMENTS	TOLERANCE :	TIME : 2Hrs
		CODE NO. IM20N1109E1	

Job Sequence

The instructor shall emphasise the students about the safe use of tools and equipmments used in trade and guide them to record the safety points

- Recrod the precautions to be followed while working in fitting job in Table 1

Table 1

Fig. No.	Description	Record precautions to be followed while working in fitting job
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

- Fill up and get it checked by your instructor.

Demonstration and uses of hand tools

Objectives: At the end of this exercise, you shall be able to
- **identify the tools**
- **identify the tools for its specification and uses.**

Requirement			
Tools		**Materials**	
Trainees tool kit	-1Set	Cotton waste	- as reqd

PROCEDURE

Identify the tools

Assumption: set of trainees toolkit as given in this exercise are displayed on the work bench. Trainees are required to identify the tool and its specification and draw the sketch of tools in the allotted column.

1 Draw a neat sketch against each item
2 Identify the specification of each item
3 Indentifying tools for specific uses

Write correct specification of the items given to you

Name of the tool	Specification	Sketch of tools	Uses
1 Screw driver			
2 Plier			
3 Spanner			
4 Tester			
5 Wire striper			
6 Electrician knife			
7 Steel rule			
8 Scriber			
9 Punch			
10 Hammer			

Electronics & Hardware
Instrument Mechanic - Basic Fitting **Exercise 1.2.11**

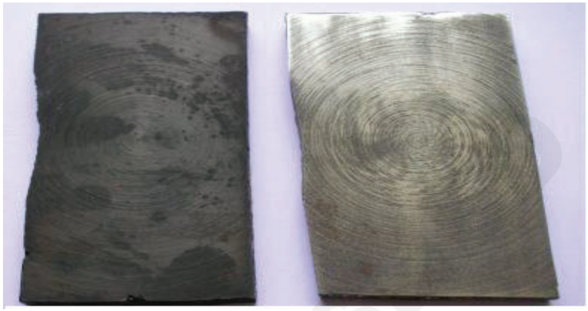
Visual inspection of raw material for rusting scaling corrosion etc.,

Objectives: At the end of this exercise, you shall be able to
- **visual inspection of raw material for rusting and scaling**
- **visual inspection of raw material for corrosion**

Fig 1

Rusted components

Fig 2



Scalled part

Fig 3

Corroded gears

Job Sequence

- Check the physical characteristics of the material and UC as colour, particle size, small and flow and any other characteristics
- Which com be assessed visually that are not covered by specific acceptances.
- This should be comparable to the reference sample retained in the QC lab and / or photographs
- Check the foreign matter
- Record the appearance of the defects in Table-1 get it checked by the instructor

Rusting

- Differentiate metals that can rust from metals the cannot rust
- Iron is typically dark in colour
- Galvanised steel has a duel appearance
- While stainless steel is shying and bright
- Copper has a bright reddish colour
- The only metals can rust are iron and allays that contain iron

Scaling

Scale is hard mineral coatings and correction deposits made up of solids and sediments

- 1mm thick scale cost add 7.5% to energy cost
- While 1.5mm adds 15% and 7mm can increase cost by over 70%

Corrosion

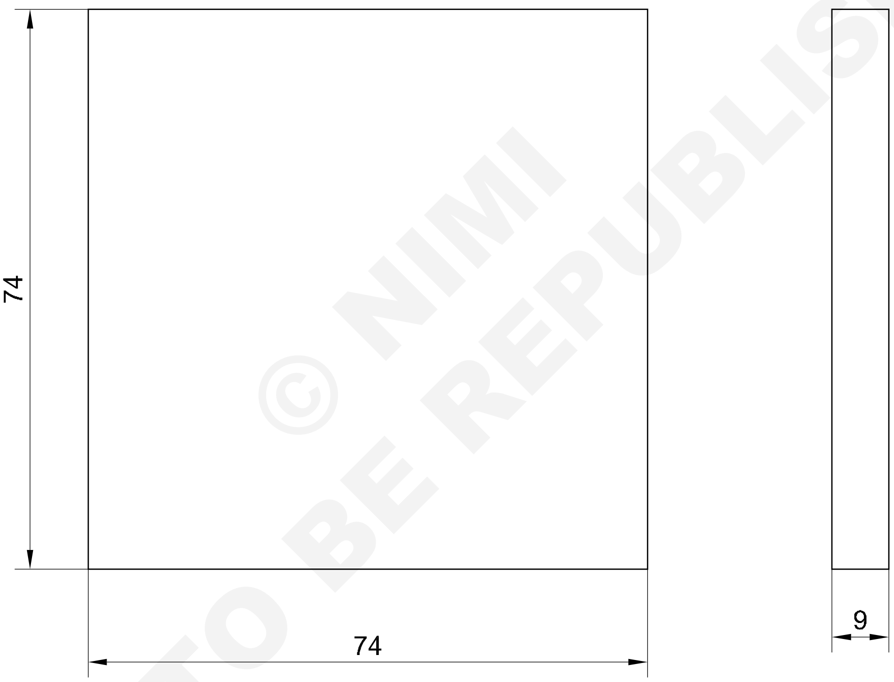
- All metals can corrode some like pure iron
- General attach caused by chemical or electro chemical

- Localized corrosion
- Pitting - the generation of small holes in the sure of metals
- Galvanic corrosion occur when different metals a located together to corrosion in only one of the two
- Fil form correction -occurs when water generate under a coating such as paint
- Environmental cracking when environmental conditions are stress full enable some metal can begin good crack fatigue or become brittle and weakened

SL. No	Defects on raw material	Brief the appearance
Rusted Scaling Corrosion		

Filing flat and square (rough finish)

Objectives: At the end of this exercise you shall be able to
- **hold the job in a bench vice horizontally for filing**
- **check the flatness of filed job using straight edge/try square blade**
- **check the squarness of the job with trysquare.**



1	75 ISF10 - 75	-	Fe310	-	-	1.2.12
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

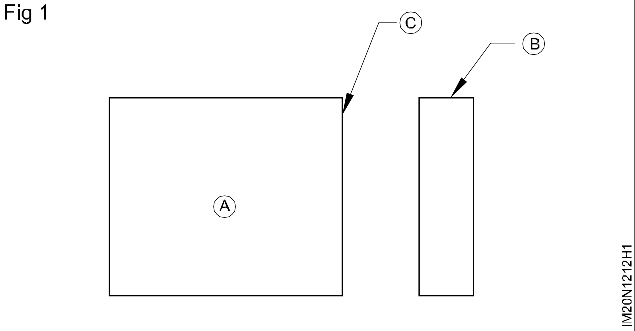
SCALE 1:1	**FILING FLAT AND SQUARE (ROUGH FINISH)**	TOLERANCE : ±0.5mm	TIME : 10Hrs
		CODE NO. IM20N1212E1	

Job Sequence

- Check the raw material size using steel rule.
- Remove the scaling by flat rough file.
- File side (A) with flat bastard file (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.

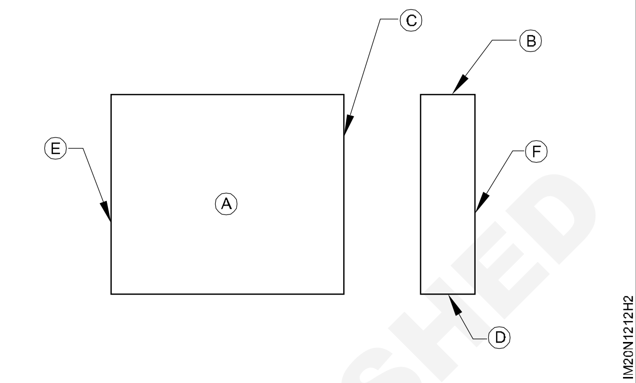
The side A,B and C are mutually perpendicular to each other (Fig 1)

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 74mm 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 steel rule and squareness with a try square
- File surface (F) and maintain the thickness of 9mm parallelism to side A.
- Remove sharp edges. Apply little amount of oil and preserve it for evaluation.

Filing practice, surface filing, side and checking 90° by try square

Objective: At the end of this exercise, you shall be able to
- **check file flat, flatness and squareness using try square and surface plate.**

Requirement

Tools/Equipments

- Bench vice
- Hack saw
- Roush fife
- Smooth file
- Try square
- Steel rule
- Dot punch
- Ball peen hammer
- Scriber

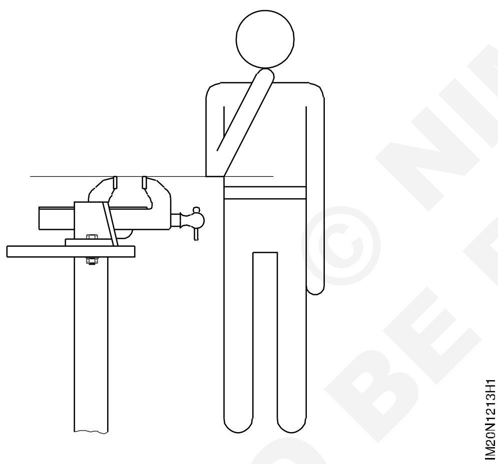
Materials

• Ms flat	- as reqd
• Cotton waste	- 250gm
• Hack saw blade	- as reqd.

PROCEDURE

Check the height of the bench vice. (Fig 1) If the height is more, use a platform and if it less, select and use another workbench.

Fig 1



Hold the job in the bench vice with a projection of 5 to 10 mm from the top of the vice jaw.

Select flat files of various grades and length according to the

– Size of the job

– Quantity of metal to be removed

– Material of the job.

Check whether the handle of the file fits tightly.Hold the handle of the file (Fig 2) and push the file forward using your right hand palm.

Hold the tip of the file according to the quantity of the metal to be removed.

For heavy filing. (Fig 3)

Fig 2

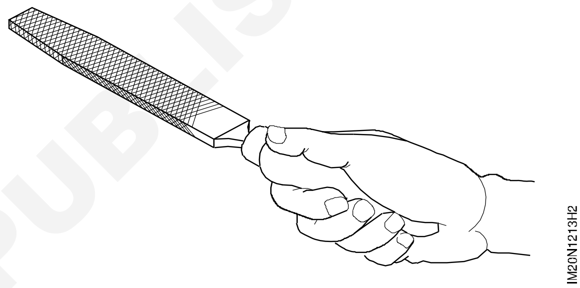
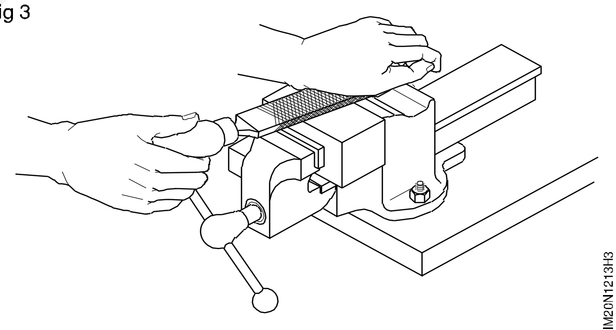
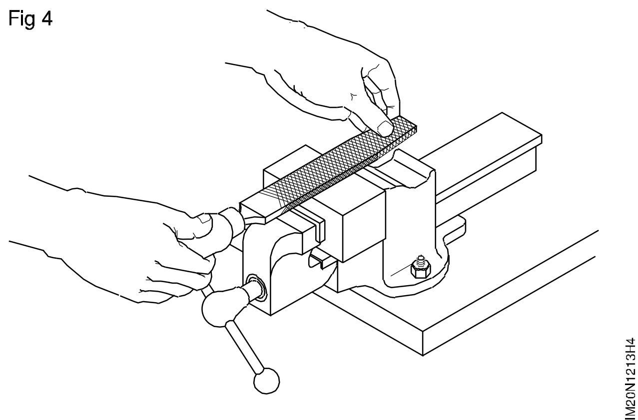


Fig 3



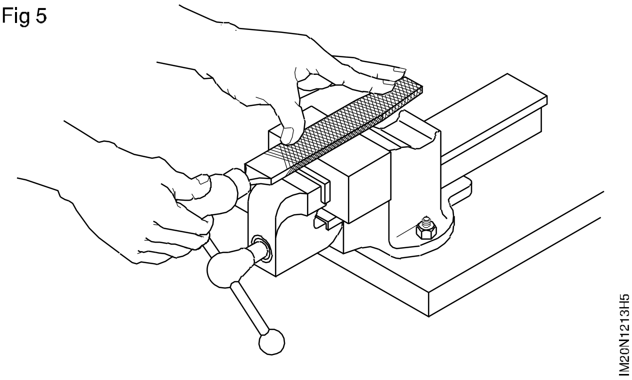
For light filing. (Fig 4)

Fig 4



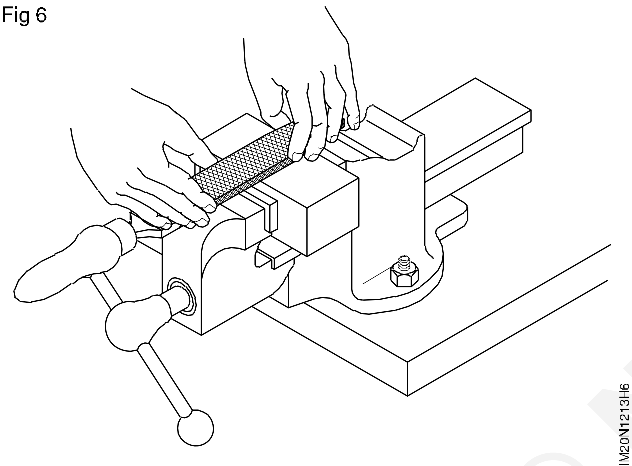
For removing local uneveness. (Fig 5)

Fig 5



For removing the local uneveness draw filing can also be done. (Fig 6) The same filing can also be done for fine finishing.

Fig 6



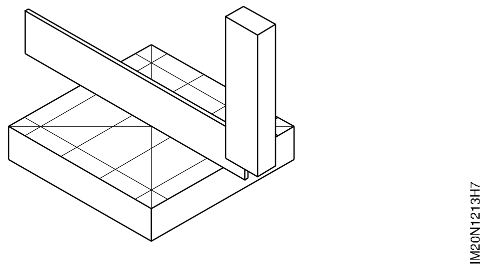
Start filing by pushing the file uniformly during the forward stroke and release the pressure during the return stroke.

Continue giving strokes. Balance the pressure of the file in such a way that the file always remains flat and straight over the surface to be filed.

Checking flatness (Fig 7)

Use the blade of the try square as a straight edge for checking flatness.

Fig 7



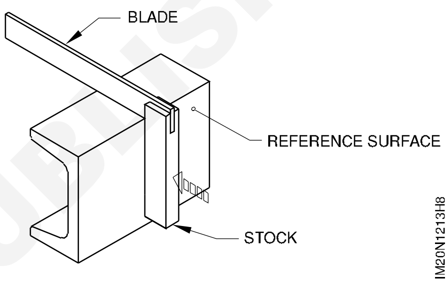
Place the blade of the try square on the surface to be checked in all directions so as to cover the entire surface.

Do the checking facing the light. Light gap will indicate high and low spots.

Checking squareness: Consider the large finished surface as the reference surface. Ensure that the reference surface is filed perfectly and is free from burrs.

Butt and press the stock against the reference surface. (Fig 8)

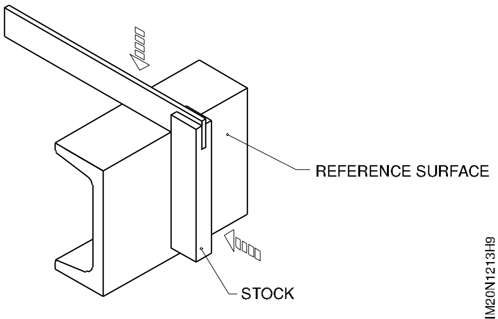
Fig 8



Bring down slowly (Fig 9) and make the blade touch the second surface with which the squareness is to be checked.

Light gap will indicate the high and low spots.

Fig 9



Marking out lines, filing and sawing using of vice to given dimension

Objectives: At the end of this exercise, you shall be able to
- **apply marking media evently**
- **perform operations of marking a straight line**
- **mark parallel lines to the given dimension using marking block how to using the scriber**
- **how to punch with the help of centre punch and ball peen hammer**

Requirements

Tools/Instruments

• Ball peen hammer	- 1 No.
• Steel rule 300mm	- 1 No.
• Marking block with scribber 150mm	- 1 No.
• Centre punch 100mm	- 1 No.

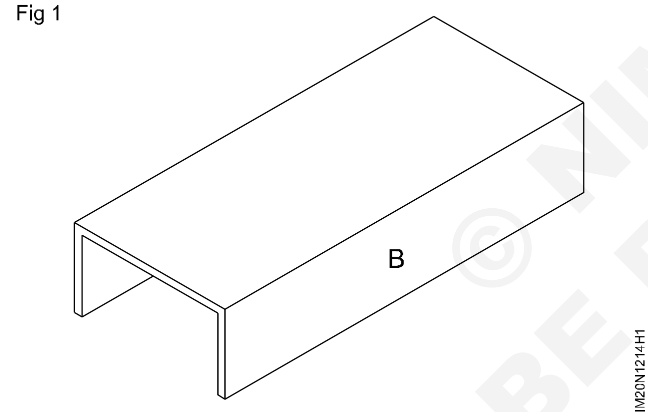
Equipment/Machines
- Anvil 300mm with stand 100 kg

Materials
- From Ex No.1.2.12 MS Flat 74 x 74 x 9mm.

PROCEDURE

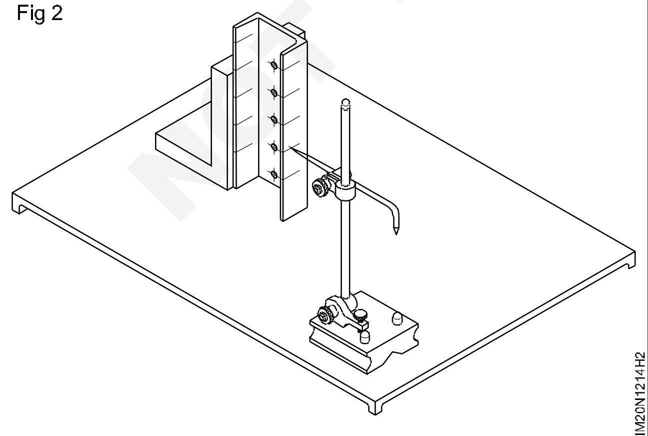
1 Apply marking media on B surface allow it to dry (Fig 1).

Fig 1



2 Place the job on surface plate and place with support of angle plate and mark on the side of the channel as figure.(Fig 2)

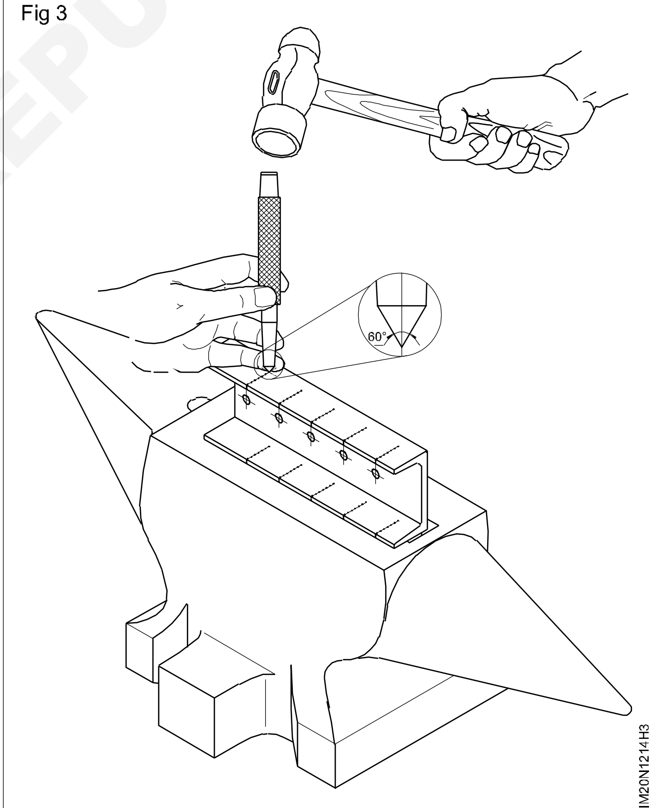
Fig 2



3 Take out the job and inspect

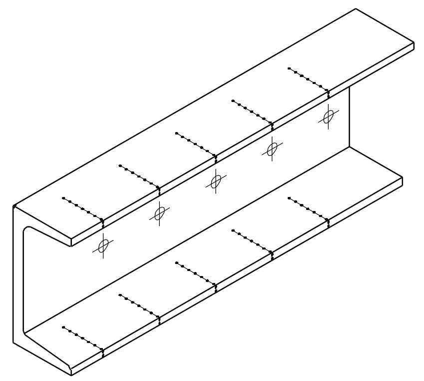
4 Place the job on anvil and mark punching on the line with help of dot punch and hammer (Fig 3)

Fig 3



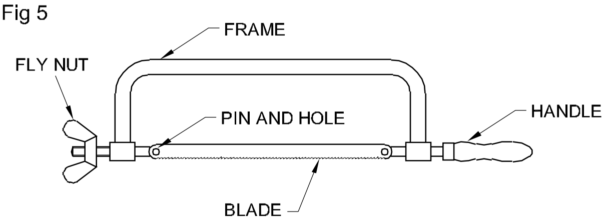
5 Check the channel punch all the point or not (Fig 4)

Fig 4



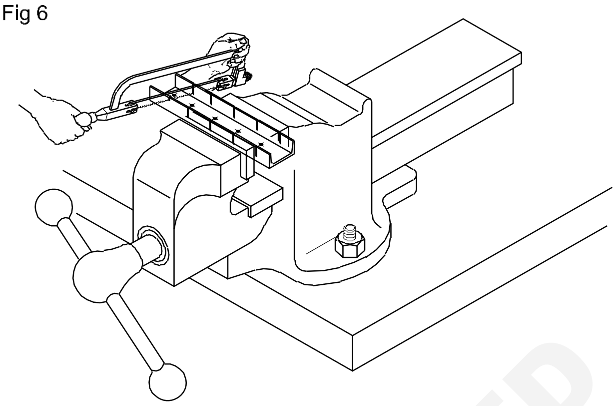
6 Fixing of hacksaw blade the teeth of the blade should be away pointing from the handle. Fix the blade to the frame in good tension.(Fig 5)

Fig 5



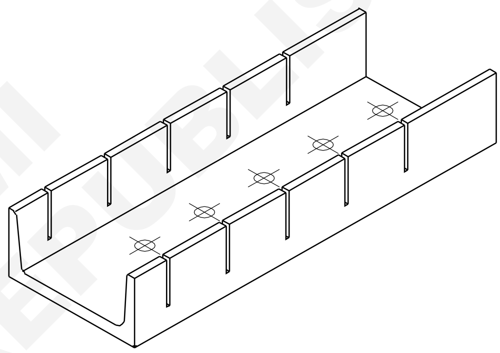
7 Set your thumb nail vertically to the location of the cut, and this location should be at least 10 mm from the vice. Hold and press the hacksaw straight forward. Do not use force when pulling it back. Apply cutting compound occasionally while cutting. Use the full length of the hacksaw blade. Make the last few cuts while holding the piece to be cut with your left hand. For this section use a fine grade blade. A minimum of two or three teeth should be in contact with the work. (Fig 6)

Fig 6



8 Open the vice and take out the job remove the burs (Fig 7)

Fig 7



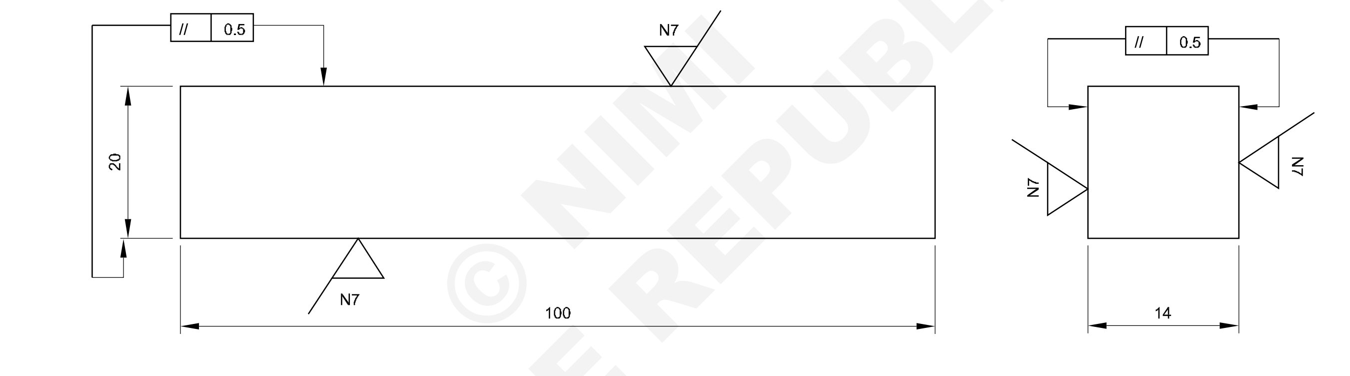
Filing flat, square and parallel to an accuracy of ±0 .5mm

Objectives: At the end of this exercise you shall be able to
- **file flat, parallel surfaces within an accuracy of ±0.5mm**
- **check dimensions with steel rule**
- **check parallelism with an outside caliper**
- **check right angle with try square.**

Requirement

Tools/Instruments
- Bastard file
- Flat second cut file
- Smooth file
- Try square
- Hacksaw with blade
- Steel rule 300mm
- Dot punch
- Ball peen hammer
- Calliper
- Angle plate 150mm
- Surface plate 300 x 300mm

Materials
- MS flat - available size in your lab
- Cotton waste - as reqd



1	25 ISF 15-105	-	Fe310	-	-	1.2.15
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	FILING FLAT AND SQUARE (PARALLEL BLOCK)				TOLERANCE : ±0.5mm	TIME : 10Hrs
					CODE NO. IM20N1215E1	

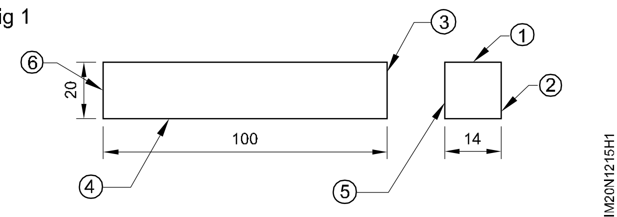
Job Sequence

- Remove burrs and check the size of the raw material.
- File diagonally (Fig.1) side 1 with a 350mm flat bastard file.
- Frequently check the flatness with a try square blade.
- File the same side with a flat second cut file and finish with a flat smooth file.
- File side 2, flat and at 90° to side 2 and side 1.
- File side 3, flat and at 90° to side 2 and side 1.
- Mark sizes as per drawing.
- File side 4 parallel to side 1. (use a caliper to check parallelism.
- File and finish side 5 parallel to side 2.
- File and finish side 6 parallel to side 3.
- Check the size with steel rule.

Remove the hard surface scale from the surface to be filed, using the edge of a flat bastard file.

- Clean, apply little oil and preserve it for evaluation.

Fig 1



Measurement length height and diameter by vernier caliper and micrometer

Objectives : This shall help you to
- **check the condition of the vernier caliper**
- **measure the outside and inside diameter of a bore**
- **measure the depth of a stepped bore.**
- **determine the diameter length and breath using micrometer**

Requirement

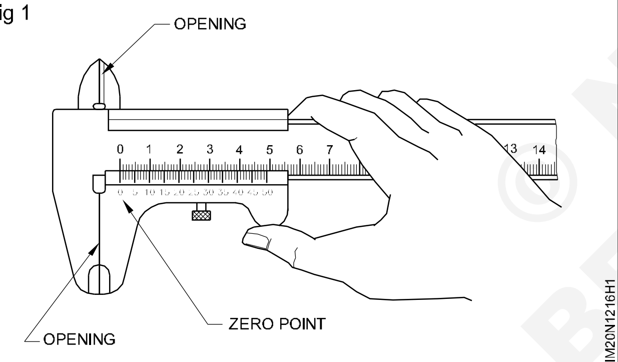
Tools/Equpments		Materials
• 0.25mm outside micrometer	- 1No.	• differens round and flat job
• 25.50mm outside micrometer	-1 No.	• cleaning cloth
• 25.50mm vernicaliper (0-150mm)	-1 No.	• white petrol

The sense of feeling is very important to judge the accuracy of the reading.

Checking the condition of the vernier callper

Fig 1 indicate the general instructions for different applications of the universal vernier caliper.

Fig 1



Check the vernier caliper

Confirm looseness of the locking screw

Clean every part of the caliper with rags

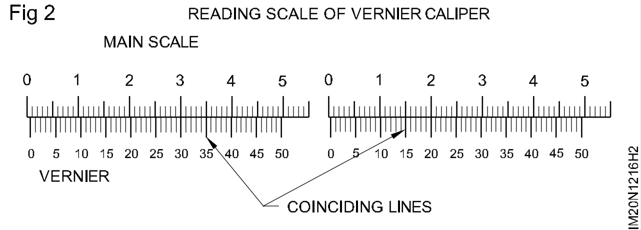
Close the jaws, and examine the opening through light

Check whether the zero points coincide.

Reading scale of a vernier caliper

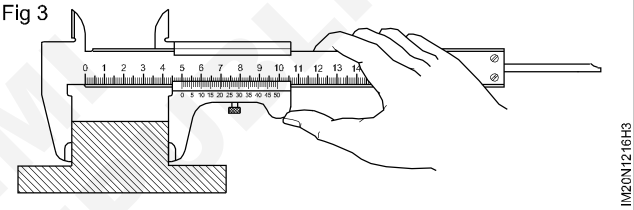
As for decimals, read the scale mark of the slide scale just where it lines up with the scale mark of the main scale. (Fig 2)

Fig 2



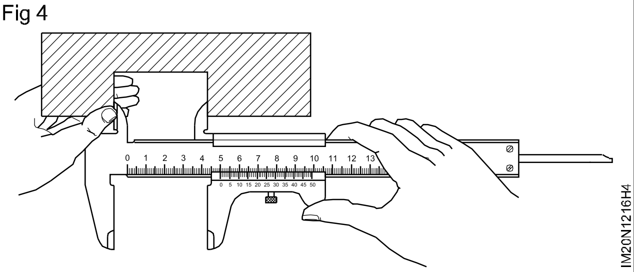
To measure the length of an object, (Fig 3) read the scale mark, keeping the workpiece firmly held between the jaws so that the workpiece and the jaw faces establish a satisfactory contact.

Fig 3



To measure the notch width of an object, (Fig 4) fit the main scale nib correctly to the face of the object to be measured, hold it lightly with the fingers of the left hand and read the scale mark (minimum value), after moving the sliding unit so that it is in contact with the other face of the notch.

Fig 4



To measure the depth of a notch, (Fig 5) fit the depth bar to the notch, hold it lightly with the fingers of the left hand, keep it upright and read the scale mark, while keeping the depth bar flush with the bottom of the notch and the depth reference surface in contact with the top of the notch.

Measuring the outside diameter

Open out the movable jaw slightly more than the measurable size. (Fig 6)

Place the jaws at right angle to the axis of the workpiece.

Close the jaw over the workpiece such that the nib of the jaws just slip from the point of contact.

Lock the nib and record the reading.

Fig 5

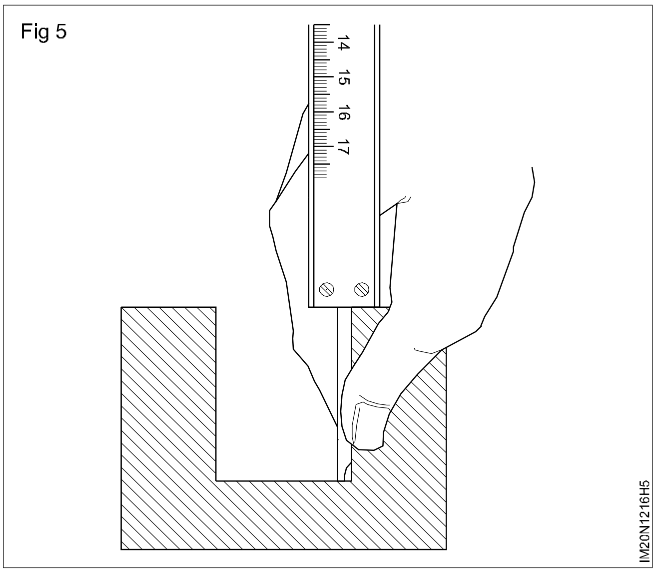
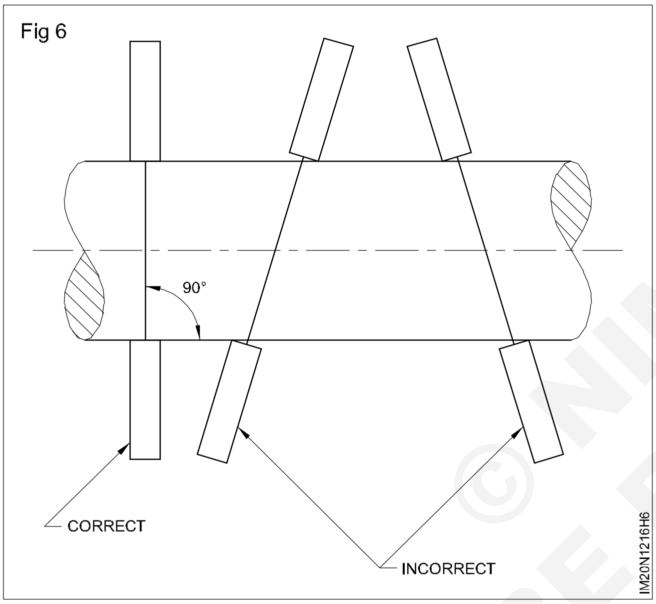


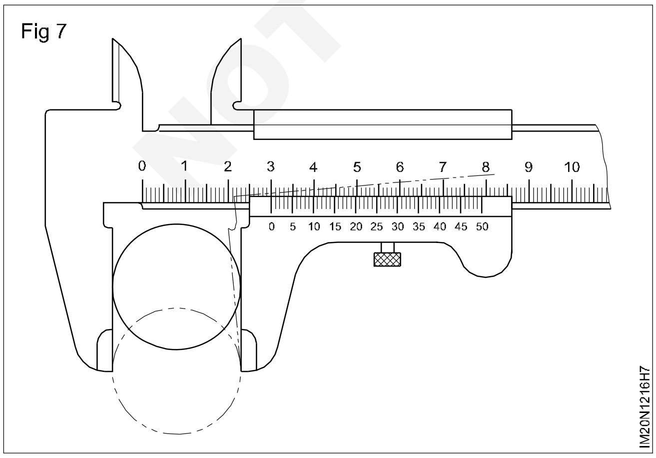
Fig 6



Measure the object with the vernier calipers, touching at right angles. (Fig 7)

Measure by using the base of the jaws. If a measurement is performed by using the tip of the jaws, a bend occurs in the jaws and the value read on the vernier calipers becomes smaller than the actual dimensions.

Fig 7



Measuring large diameters (Relationship between diameter D of the object to be measured and length 'a' of the jaws).

In the case of 'a' < ½ D the relationship of read value 'd' and diameter 'D' of the object being measured becomes as shown below. 'd' < 'D' and the measurement of diameter D is no longer possible.

In the above case, measure by letting the beam contact the ends of the object being measured.

The maximum measuring length of a caliper and dimension 'a' is given below for reference. (Fig 8 & 9)

Fig 8

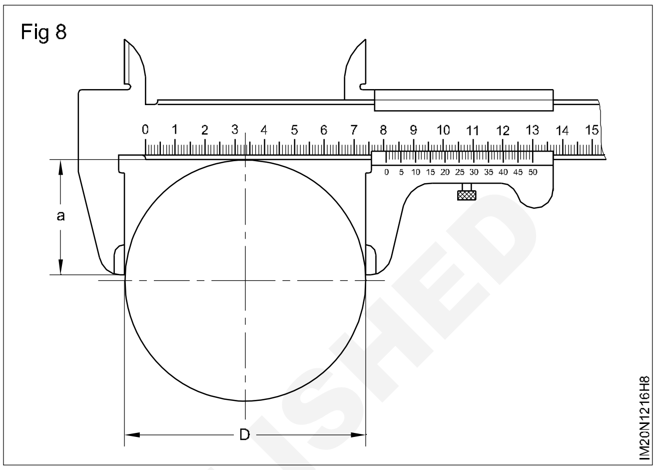
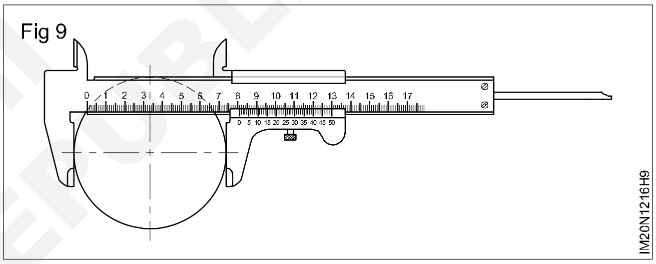


Fig 9



Maximum measuring length	a
150 200 300	38 50 60

Measuring the Inside diameter

Open out the nibs of the vernier caliper slightly less than the measurable size.

Place the nibs inside the bore surface such that the nibs are parallel to the axis of the workpiece and centre of the bore.

Open out the nibs so as to make contact on the bore surfaces, and swing the nibs to measure the maximum value of the bore size.

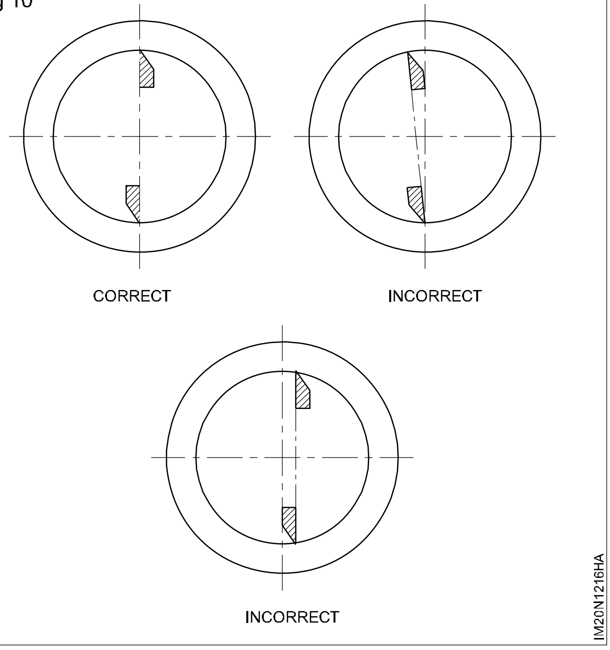
Lock the nib and record the reading.

It is not advisable to have the measurement at right angle to the axis of the work because it reduces the actual size of the bore.

Measurements of inside diameters

Measure by matching the nibs of the vernier caller to the dial centre. (Fig 10)

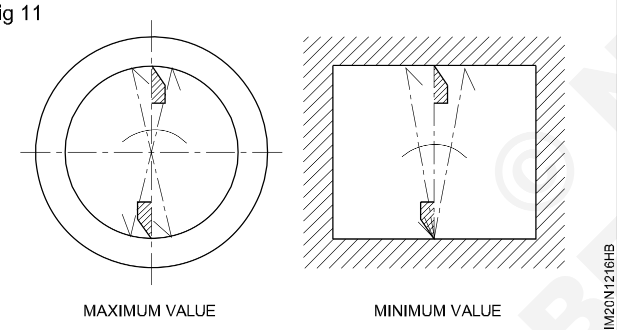
Fig 10



Measurements of inside diameters and square holes

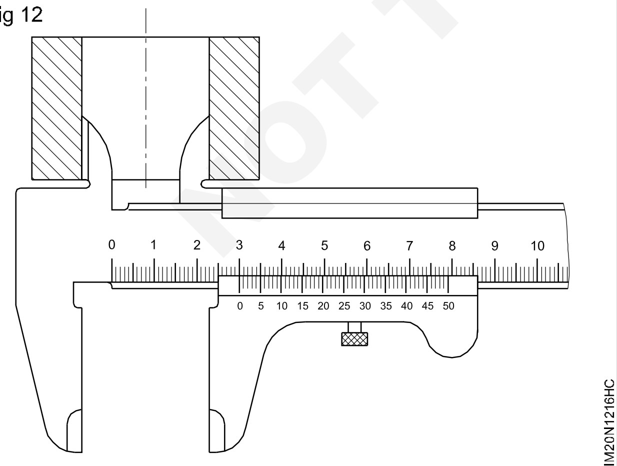
In the case of an inside diameter, the maximum measured value is the actual dimension. In the case of a square hole (Fig 11) the minimum measured value is the actual dimension.

Fig 11



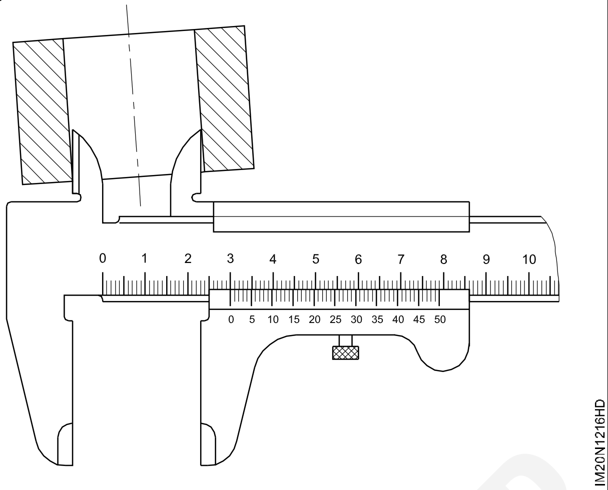
To have correct contact of nibs, insert nibs in the object as deeply as possible and let them be in contact. (Fig 12)

Fig 12



When the insertion is not sufficiently deep the measuring surface tilts off the vernier caliper and a correct measurement is not possible. (Fig 13)

Fig 13

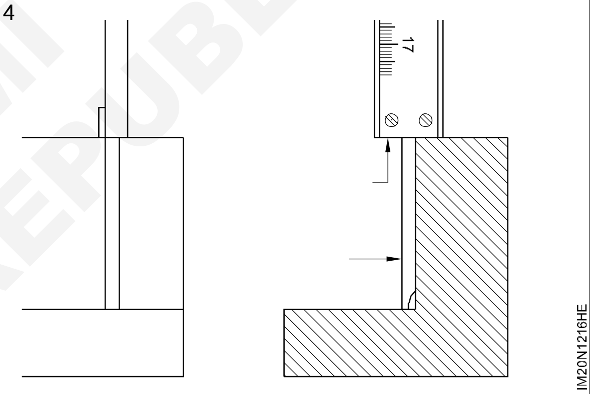


Measuring the depth of a step

To measure depth, put the depth reference surface of the vernier calipers in contact with the object to be measured.

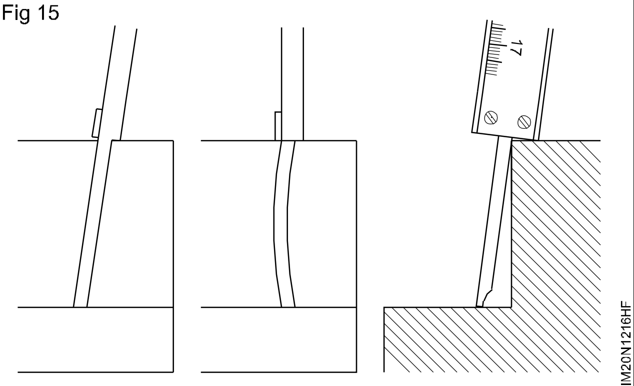
Be sure that the depth bar does not tilt with respect to the object being measured and that no measuring pressure higher than what is specified is applied. (Fig 14)

Fig 14



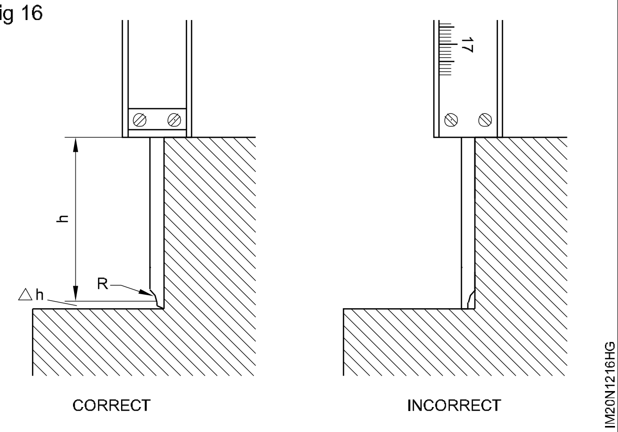
Connect the depth bar tip as shown in the drawing and make sure that it does not touch the corner R. (Fig 15)

Fig 15



Take the measurement without contacting corner R, or error h will occur. (Fig 16)

Fig 16



When measuring the depths of holes, (Fig 17) make the area where the depth level can touch the object that is being measured as large as possible.

When no direct measurement is possible, (Fig 18) bridge with an object which can be used as a reference for measurement.

Fig 17

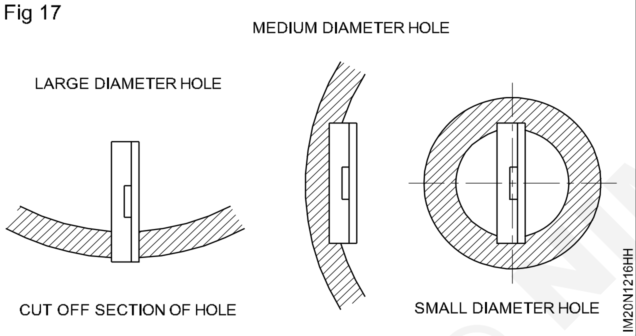
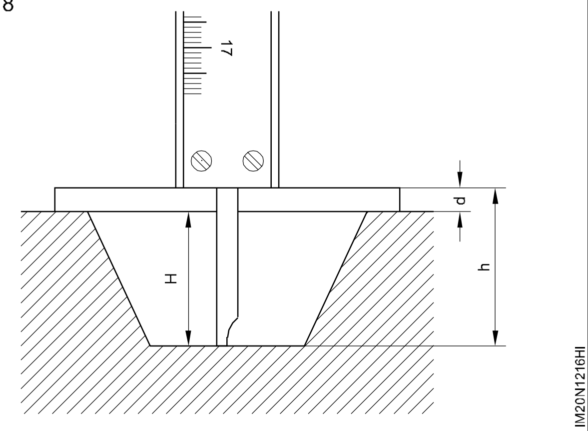


Fig 18



H = h-d

Place the base line of the main scale at right angles with the axis of the workpiece and move the depth bar so that it just makes contact over the other surface.

Lock the jaws and record the reading.

When it is not possible to measure the depth with this instrument, bridge the clearance with a flat object and take the reading.

While taking the measurement of a blind hole, hold the depth bar with the fingers lightly so that it is flush with the bottom surface.

Micrometer

Objectives: At the end of this exercise, you shall be able to
- **measure the diameter using micromerter**
- **measure the length and breadth of job using micrometer.**

Measure the diameter of the job with a micrometer and find the size of the shank.

1 Check the micrometer for its zero error by operating the ratchet

2 Record the error value with the tve or - ve sign in table

3 Determine the value of barrel divisions and thimble divisions (least count) in mm.

4 Place the cleaned straight portion of the job between the jaws (anvil and spindle) of the micrometer

5 Hold micrometer very nearly to the dimension of the work

6 Hold job in left hand and right hand with micrometer

7 Rotate the thimble feet the correct contact this may require the movement of micrometer over the work

Use ratchet drive avoid over heightening

8 Lock micrometer take it out and note reading

Fig 1

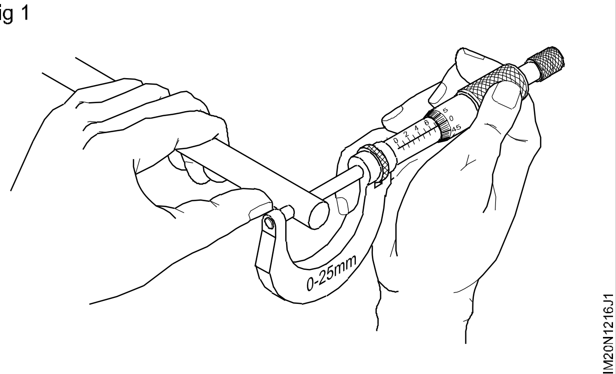
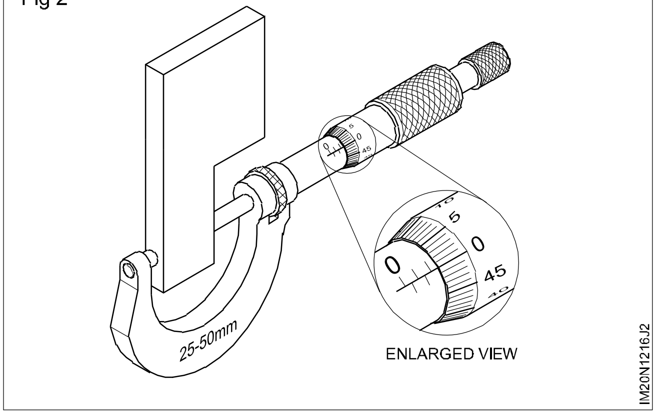


Fig 2

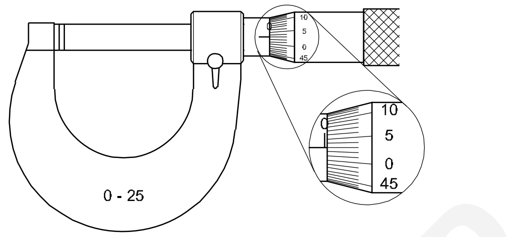


Example (refer to Fig 3)

Barrel reading whole mm= 13division	= 13.00mm
Barrel reading haft mm = 1 division	= 0.50mm
Thimble reading = divisions	= 0.13mm
Reading before correction	= 13.63mm
Error (positive)	= (-)0.01mm
Actual reading	= 13.62mm

9 Repeat the measurement

Fig 3



Select drill bits reamers and taps

Objectives: At the end of this exercise, you shall be able to
- **select the drill for reamers**
- **select the drill for taps**
- **record it in the table**

Requirement			
Tools/Materials			
• Drill bits	- various size.	• Taps (metric)	- various size.
• Reemer (metric)	- various size.		

Job Sequence

- Select the drill for hole size
- Select the drill for various sizes of reamers
- Select the drill for various sizes of laps
- Record in table 1 and 2
- Get it checked by the instructor

Reaming dill size = reamed size - (undersize + over size)

Under size:

under 5	0.1....0.2
5.......20	0.2....0.3
21.....50	0.3....0.5
over.,50	0.5....1

Table 1

Sl.No	Reamer size	size of drill
1	∅ 6	
2	∅ 8	
3	∅ 10	
4	∅ 12	
5	∅ 15	
6	∅ 16	
7	∅ 18	
8	∅ 20	
9	∅ 30	
10	∅ 40	

Tap drill size = major diameter - pitch

Tap drill size inch = major diameter

$$= \frac{1}{\text{No.of threads per inch}}$$

Table 2

Sl.No	Tab size	Threads per	Threads per
1	5	40	
2	5/8”	11	
3	3/8”	16	
4	1/4”	20	
5	7/8”	9	
6	M8	1mm	
7	M10	1.5mm	
8	M12	1.5mm	
9	m20	1.5mm	

Safety precaution

1 Before taping select the appropriate drill size

3 Using the formula to find the tap size

Drill through holes and blind holes

Objective : At the end of this exercise, you shall be able to
- **drill through hole to the required size.**
- **drill blind holes to the required depth using the depth stops.**

Requirement

Tools/Materials

• Bench drilling machine	- 1No.
• Drill bits (metric)	- as reqd.
• Machine vive	- as reqd.
• Coolant - oil	- as reqd.

PROCEDURE

TASK 1: **Drill through hole**

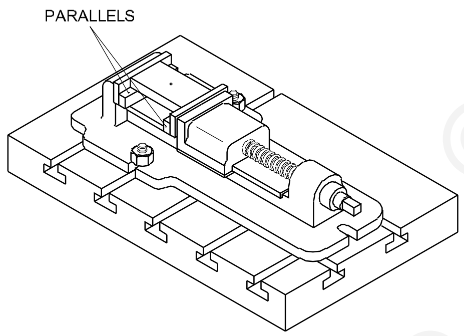
Method of Drilling

1 Check the given raw material for its size.

2 Mark and locate the centres for the hole to be drilled.

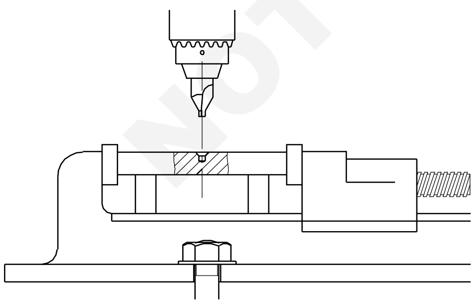
3 Mount the job in the machine vice on the parallels and clamp it securely to the drill-press-table. (Fig 1)

Fig 1



4 Set the work table (Fig 2) in such a manner that a drill can be fixed and removed without disturbing the vice or the job.

Fig 2



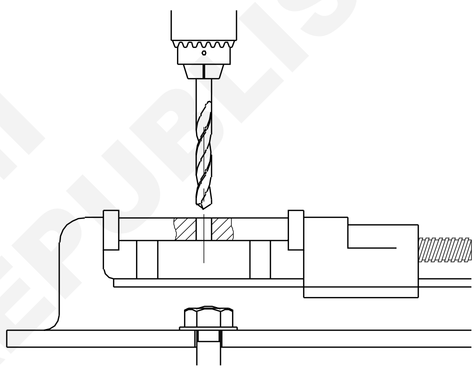
5 Fix the centre drill on the drilling machine spindle and align with the centre mark on the job.

6 Spot the hole location with a centre drill. Remove the centre drill and fix 8 mm drill for pilot hole.

7 Start the drilling machine.

8 Feed the drill and drill through hole. (Fig 3)

Fig 3



9 Set the spindle speed of the drilling machine to the nearest calculating r.p.m. $V = \frac{\pi d \times n}{1000}$

11 Remove drill from the machine without disturbing the set up.

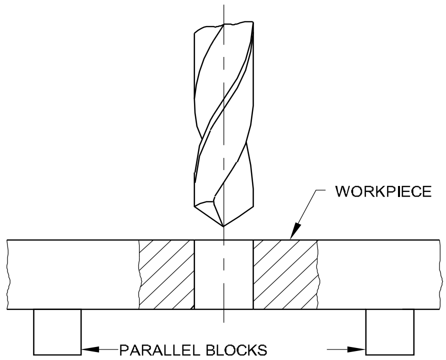
12 Fix 14.5 mm drill and drill through hole.

While drilling use cutting fluid.

13 Release the drill frequently from the hole for the chips to be flushed out by the cutting fluid.

14 Remove the drill and job from the machine. (Fig 4)

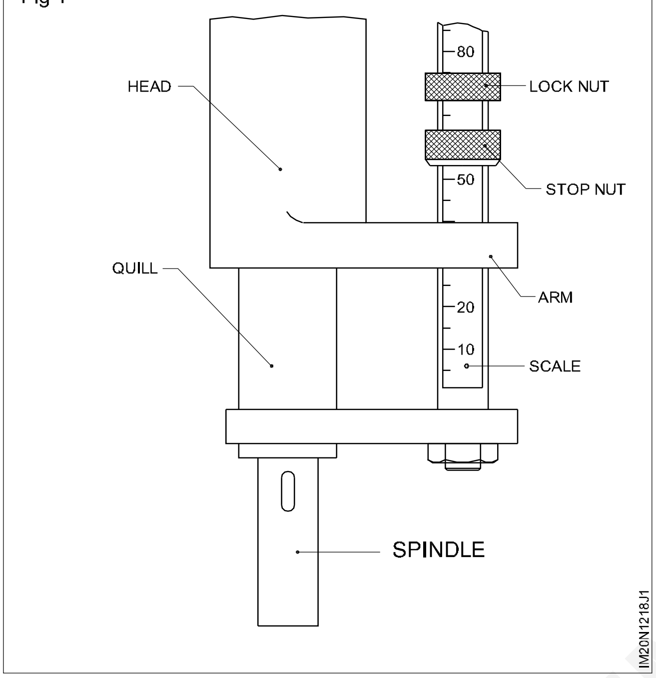
Fig 4



TASK 2: **Method of controlling depth of blind holes**

While drilling blind holes, it is necessary to control the feed of the drill. Most machines are provided with a depth stop arrangement by which the downward movement of the spindle can be controlled. (Fig 5)

Fig 1



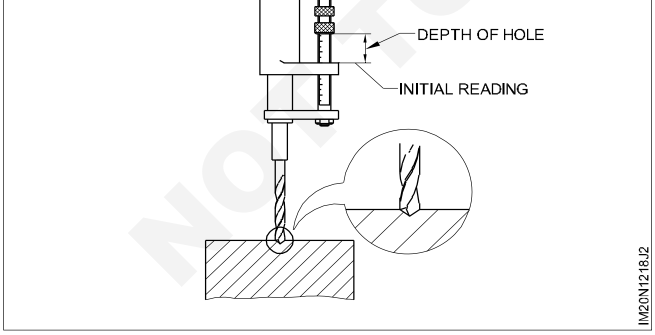
Most depth stop arrangements will have graduations by which the advancement of the spindle can be observed.

Generally the blind hole depth tolerances are given up to 0.5 mm accuracy.

Setting for drilling blind holes: For blind hole-depth setting, first the work is held on the machine and the hole is located correctly.

The drill is started, and it drills until the full diameter is formed. Note down the initial reading at this point. (Fig 6)

Fig 2



Add the initial reading to the depth of the blind hole to be drilled.

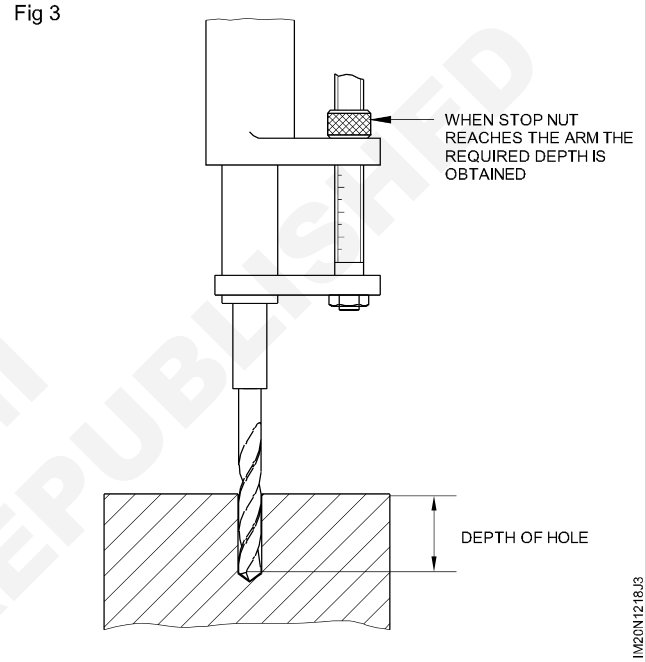
Initial Reading + Depth of Hole = Setting

Adjust the stop next to the required setting, using the scale.

Tighten the lock nut to prevent the setting from being disturbed.

Start the machine and feed the drill. When the stop nut reaches the arm the blind hole is drilled to the required depth. (Fig 7)

Fig 3



While drilling, release the drill frequently from the hole for the chips to be flushed out by the cutting fluid.

Do not drill on a light component without clamping. If not clamped, the job will rotate along with drill.

Form external thread with dies to standard size

Objectives: At the end of this exercise, you shall be able to
- **cut external threads using dies.**

Requirement

Tools/Materials

• Die stock	- as reqd.	• Machine vive	- as reqd.
• Dies	- as reqd.	• Coolant - oil	- as reqd.

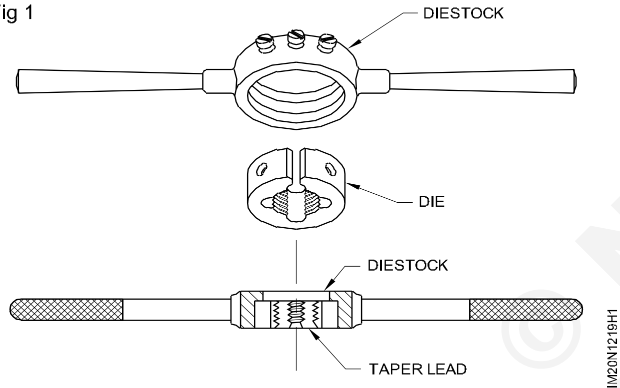
PROCEDURE

Check blank size

1 Blank size = thread size - 0.1 x pitch of thread

2 Fix the die in the die stock and place the leading side of the die opposite to the step of the die stock. (Fig 1)

Fig 1

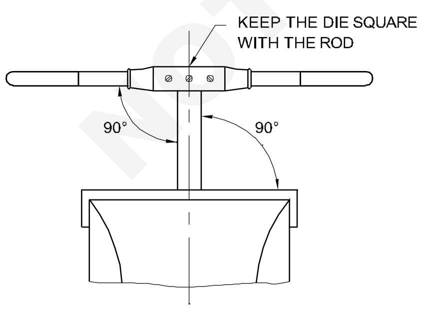


Use false jaws for ensuring a good grip in the vice.

Project the blank above the vice-just the required thread length only.

5 Place the leading side of the die on the chamfer of the work. (Fig 2 & Fig 3)

Fig 2



6 Make sure that the die is fully open by tightening the centre screw of the die stock. (Fig 4 & Fig 5)

7 Start the die, square to the bolt centre line.

8 Apply pressure on the die stock evenly and turn in the clockwise direction to advance the die on the bolt blank.

Fig 3

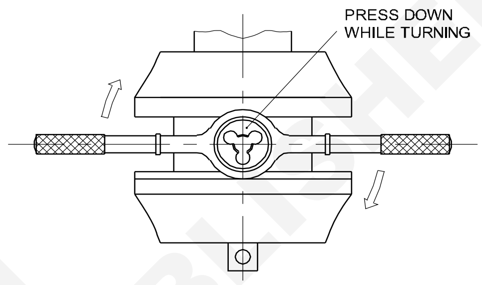


Fig 4

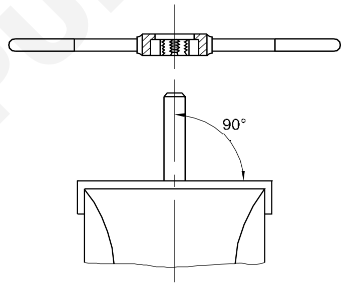
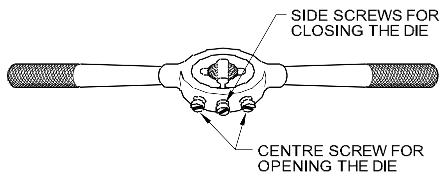


Fig 5



9 Cut slowly and reverse the die for a short distance in order to break the chips.

Use a cutting lubricant.

11 Increase the depth of the cut gradually by adjusting the outer screws.

12 Check the thread with a matching nut.

13 Repeat the cutting until the nut matches.

Too much depth of cut at one time will spoil the threads. It can also spoil the die.

Clean the die frequently to prevent the chips from clogging and spoiling the thread.

Flaring of tube and tube joints

Objectives: At the end of this exercise you shall be able to
- **make flaring at the end of the tube**
- **join the flare fittings**
- **test the flared and brazed joints.**

Requirements

Tool/Equipments/Instruments

- Flaring block with yoke - 1 No.
- Adjustable wrench 200mm - 1 No.
- Valve key 6mm (cylinder valve opener) - 1 No.
- Pressure gauge with adapter - 1 No.
- Flat file smooth 200mm - 1 No.
- Metal tape or steel rule - 1 No.
- Cylinder with pressure - 1 No.

Materials

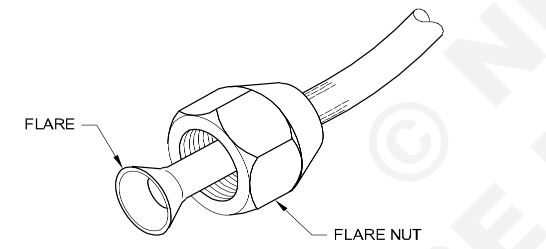
- Copper tubes
- Flare nut 6mm size
- Thread seal tape
- Soap solution with stirrer
- A small quantity of oil

PROCEDURE

1 Refrigerator pipes are sometimes joined to fittings by making a flared connection.

2 The end of the pipe is opened out to form a cone (Fig 1).

Fig 1



FLARE NUT

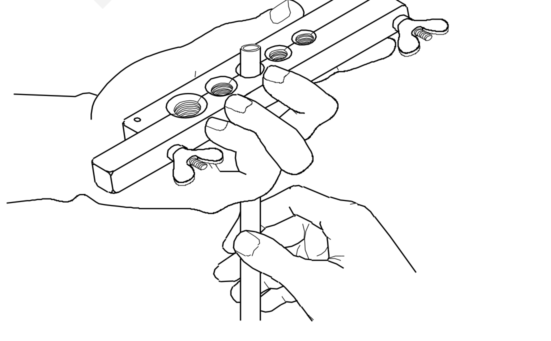
3 Always place the special flare nut on the pipe first before flaring.

4 Examine the pipe flaring tool. Make sure that you understand how it works before starting to flare the end of a pipe.

5 Make sure that the end of the pipe is free of rough edges before flaring.

6 Place the pipe in the tool (Fig 2). Make sure that you have:

Fig 2



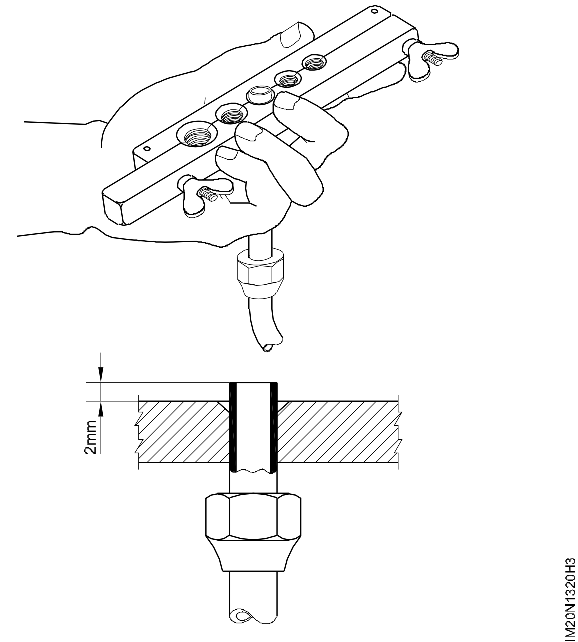
a Place the flare nut on the pipe.

b Chose the correct size hole in the flaring tool to fit the pipe; (there are 5 holes to fit different sizes of pipe.)

7 If the pipe is 1/4 inch (6 mm) in diameter, position the pipe so that the end is at least 2 mm above the top of the flaring block (Fig 3). (This distance is calculated as “pipe diameter divided by 3”; in this case, 6 mm divided by 3 = 2mm).

8 Tighten the nuts at each end of the flaring block. (Fig 3).

Fig 3

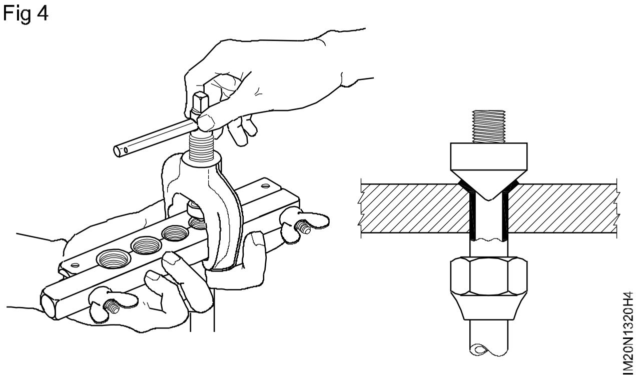


9 Fit the yoke to the flaring block. (Fig 4)

10 Oil the cone and slowly screw it into the end of the pipe.

11 The end of the pipe will be formed into a flare. (Fig 2)

Fig 4



12 Remove the flared pipe from the block.

13 Examine the flare. If it has cracked, the cone was screwed down too quickly.

14 Make sure that the flare is of the correct size. It should just fit inside the flare nut. If it is too loose, cut off the flare and start again at instruction 5.

At instruction 7, use 3 mm instead of 2 mm. Repeat until the flare is of correct size for the flare nut too much or do not tight too much.

Testing

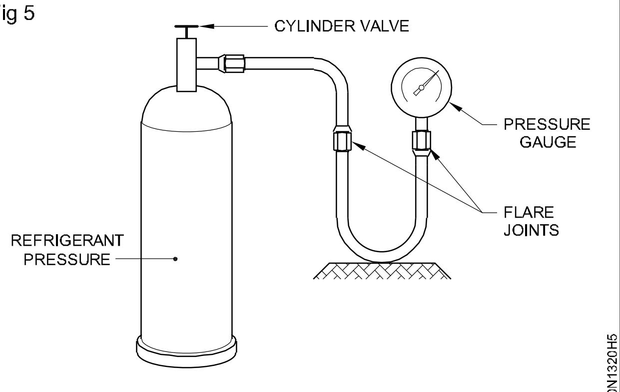
1 Put thread seal tape on the thread

Push back the flare nut and place the flared tube on the fitting, then tighten the nut using adjustable wrench or suitable double end spanner.

2 Tighten the one end of the tube to the cylinder with the flare nut. (Fig 5)

3 Connect a pressure gauge at the other end of the tube with flare nut.

Fig 5



PRESSURISED TESTING

Do not give more pressure while tightening since this will spoil flare.

Make sure that they should not be loose in the tube.

4 After joining the tube firmly, open the cylinder valve with the help of valve key or ratchet.

5 The pressure will be shown in the pressure gauge.

6 Then close the cylinder valve. Major leaks will make noise and that needs the nut to be tightened.

7 If there is no leak, the pressure in the pressure gauge will remain constant.

8 If it decreases, check the joints with soap solution foam. Leak will bubble, then tight the joints. If it stands still then there is no leak.

Cutting and threading of tube length

Objective: At the end of this exercise you shall be able to
- **cutting and threading of tube length**

Requirements

Tools/Instruments

- Steel rule - 1 No
- Triangular file 50mm - 1 No
- Ball pare hammer 220gm - 1 No
- Mallet - 1 No
- Tube cuter - 1 No
- Reaming tool - 1 No
- spring bender 6mm - 1 No
- Tube bender 6mm - 1 No

Materials/Components

- M.S tube 6mm - as reqd
- Cotton waste - as reqd

PROCEDURE

Cut the copper tube

1 Carefully measure the length of tube needs and mark the outside (where you are going to cut with the edge of a file.

2 Place the tube between the bottom rollers and the top cutting wheel.

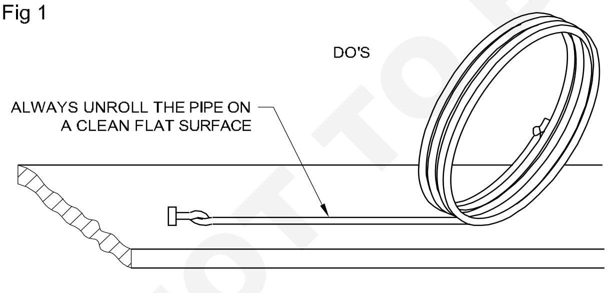
3 Position the tube so that the cutting wheel is in line with the mark that you made with the file.

4 Tighten the handscrew until the cutting wheel just touches the outside of the tube.

5 Turn the tube cutter slowly around the tube so that the cutting wheel cuts gradually into the outside.

6 Turn the handscrew to increase the pressure of the cutting wheel and then turn the cutter around the tube again. (See Fig 1).

Fig 1

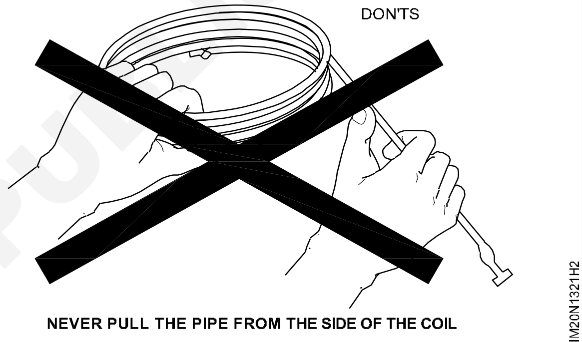


7 Continue the cutting by gradually increasing the pressure of the cutting wheel. Work slowly and carefully. Do not use too much pressure or you may damage the tube.

8 When the cut is complete seal the open end and roll the tube back into a coil.

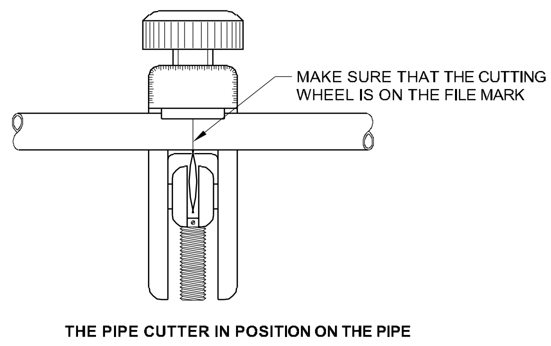
9 To remove all rough edges from the end of the tube, use the reaming tool. (Fig 2)

Fig 2



10 Hold the open end of the tube to be reamed down (so that pieces of copper will not get inside the tube). Turn the reaming tool until all rough edges have been removed from the inside of the tube. (Fig 3)

Fig 3



Observation Table

Sl.No.	Parameter	Remarks
1	Length of the tube cut	Excellent/good/average
2	Cleaned edges of the tube	Excellent/good/average
	Note : Repeat the exercises for various sizes of tubes.	

Fit and assemble tubes and ferrule fitting

Objectives: At the end of this exercise you shall be able to
- **cut the tube to given length**
- **cut threads on tube using die stock**
- **fit ferrules on the tube**
- **bend the tube using tube bender**
- **fit and assemble tubes and ferrule fitting.**

Requirements

Tools/Instruments

- Tube cutter - 1 No
- Tube bender - 1 No
- M10 die - 1 No
- Die stock - 1 No
- Bench vice 2½" - 1 No
- Spanner - 1 No

Materials/Components

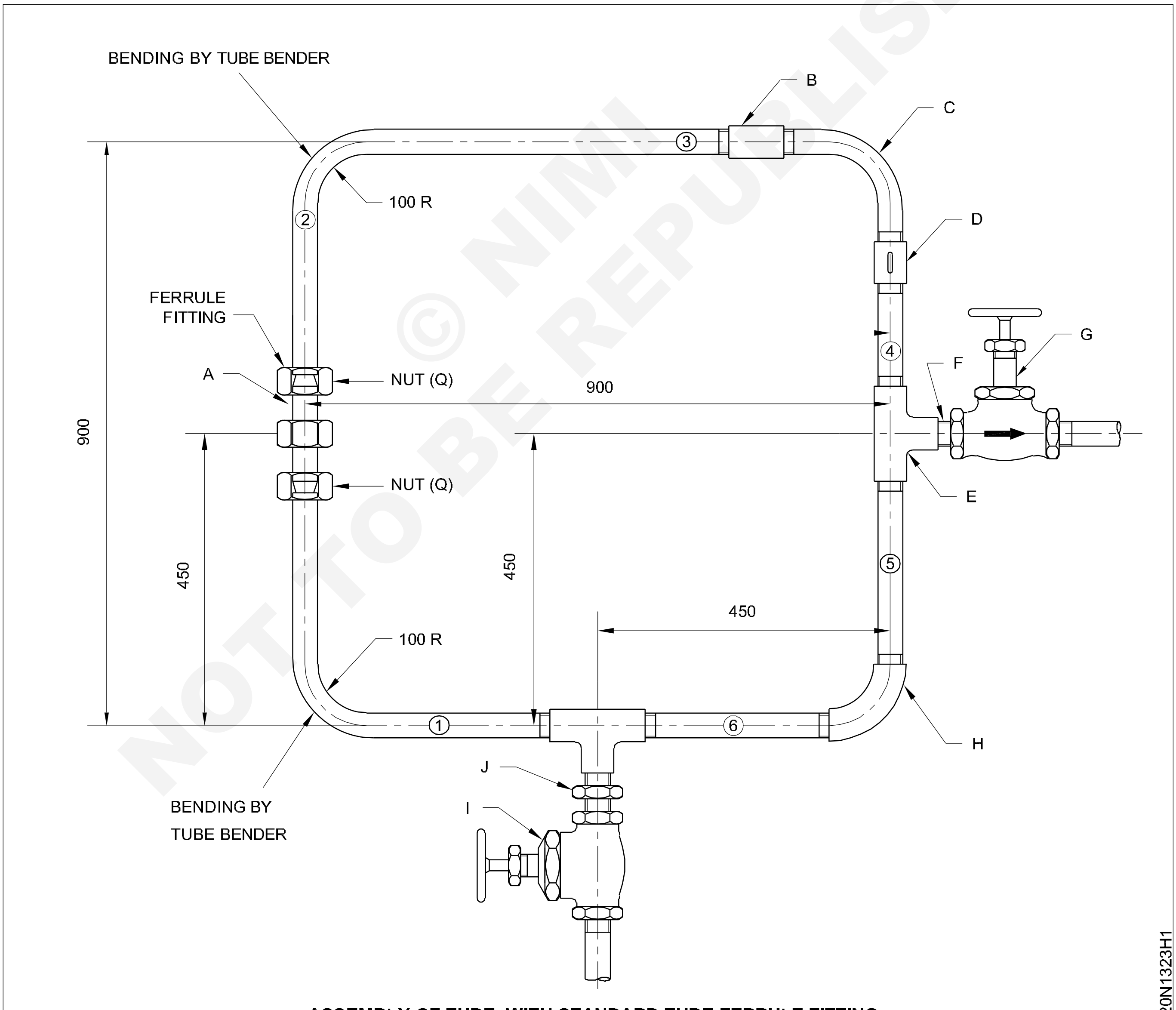
- SS tube dia 9mm X 4mm - 1 No each

NO.OFF	STOCK SIZE	DESCRIPTION	MATERIAL	DRG. NO. (ASSY)	PART NO.	EX. NO.
NUT - 1/4" -2NOS						
1	10 x 25 x 25 mm	HEXAGONAL NIPPLE	SS	J	J	-
1	10 mm	GATE VALVE	COPPER ALLOY	I	I	-
1	10 mm	ELBOW	SS	H	H	-
1	10 mm	GLOBE VALVE	COPPER ALLOY	G	G	-
1	10 x 100 mm	BARREL NIPPLE	SS	F	F	-
2	10 mm	TEE	SS	E	E	-
1	10 mm	RIBBED COUPLING	SS	D	D	-
1	10 mm	BEND 90°	SS	C	C	-
1	10 mm	PLAIN COUPLING	SS	B	B	-
1	10 mm	UNION (WITH WASHER)	SS	A	A	-
1	Ø9 x 4.05 - 405	TUBE (CLASS B)	SS	6	6	-
1	Ø9 x 4.05 - 410	TUBE (CLASS B)	SS	5	5	-
1	Ø9 x 4.05 - 290	TUBE (CLASS B)	SS	4	4	-
1	Ø9 x 4.05 - 300	TUBE (CLASS B)	SS	3	3	-
2	Ø9 x 4.5 - 820	TUBE (CLASS B)	SS	1 & 2	1 & 2	23

SCALE NTS	ASSEMBLY OF TUBE WITH STANDARD TUBE FITTING & FERRULE FITTING	DEVIATIONS	TIME
		CODE NO. IM20N1323E1	

Job Sequence

- Calculate the length of tubes required based on sketch.
- Cut the tubes as per calculated length using tube cutter.
- Cut threads using die & die stock
- Fit ferrules and nut in one end of tube (1) of (2) before fitting.
- Join tube No. 2 with the 4-way coupling. (B)
- Fit pipe No.3 wih the coupling tube.
- Join plain coupling (G) to the other end of the No. 3.
- Assemble tube bend (H) to the plain coupling.
- Fit the ribbed coupling (I) to the other end of the bend.
- Join pipe No. 5 to the opposite end of 'T'.
- Assemble elbow (M) with tube No. 5,
- Fit tube No. 6 with the other end of the elbow.
- Join 'T' with tube No. 6.
- Fit tube No. 1 with the opposite end of 'T'.
- Join tube Nos. 1 & 2 with union. (A)
- Fit 150mm barrel nipple (P) to the left side of the 'cross' and put cap (A) for it.
- Put another 100mm barrel nipple (C) to the right side of the cross.
- Join the reducer (E) to the barrel nipple.
- Assemble the bib-cock (F) to the other end of the reducer.
- Put the hexagonal nipple (0) to the left side 'T'.
- Assemble the gate-valve to the nipple.
- Test the joints for leakage.



ASSEMBLY OF TUBE WITH STANDARD TUBE FERRULE FITTING

Construct a test lamp and use it to check mains healthiness

Objectives: At the end of this exercise you shall be able to
- **construct a test lamp**
- **check mains healthiness by using the test lamp.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set
- Digital multimeter with probes - 1 No

Materials/Components

- PVC wire,Red colour, (5/20 gauge) - 1 m
  Black colour, (5/20 gauge) - 1 m
- Incandescent bulb 60W/250V - 1 No

PROCEDURE

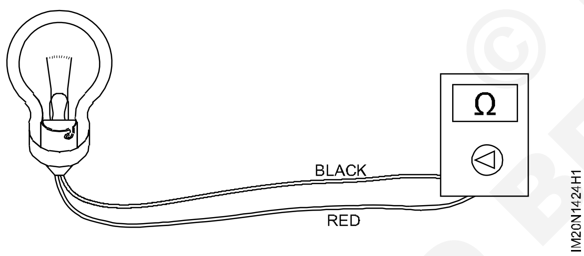
Safety precaution: Be cautious and your safety from electrical shock is your responsibility.

1 Skin the terminals of PVC wire and connect them into pendent lamp holder.

2 Fix the 60 watt bulb into the lamp holder.

3 Use ohm meter test and ensure continuity of the constructed test lamp as shown in Fig 1.

Fig 1



4 Connect the test lamp across live and neutral terminals of AC mains supply point.

5 Switch ON the mains supply and observe the brightness of lamp.

6 Record the observation of mains healthiness as good in Table - 1

Table - 1

Lamp brightness		Mains healthiness
OK	Not OK	

7 Get the work checked by the Instructor.

— — — — — — — —

Measure the voltage between phase and ground and rectify earthing

Objectives: At the end of this exercise you shall be able to
- **measure the voltage between neutral and ground rectify ear thing .**

Requirements

Tools/Instruments/Equipments

- Trainees kit - as reqd.
- Neon tester, 500V - 1 No.
- Multimeter - 1 No.

PROCEDURE

- Position the selector of digital multimeter in ACV position (above 200v)
- Measure voltage between phase and neutral (V_1) = ------------V
- Measure voltage between phase and grd (V_2) = ------------V
- IF $V_1 = V_2$ conclude earthing is prefer
- IF $V_1 = V_2$ earthing is not perfect rectify gushing

Earth system resistant is high to bring it down to a lower value

- Pour water in the earth pit
- Redig the earth pit and treat the surrounding alternate layers and salt and lock
- Provide one more earth electrode nearby (8m away from the main electrode) and connect it and parallel loathe the main electrode
- Replace the ECC wine (Earth continuity conductor) By a higher conductivity wire of the same size (or) a thick wire of the same material

Prepare termination skin the electrical wire cables using wire striper and cutter

Objectives : At the end of this exercise you shall be able to
- **skin the cable insulation using manual stripper**
- **skin the cable insulation using an auto - stripper**
- **terminating skinned cable to a two-pin main plug**
- **terminating skinned cable to three pin mains plug**

Requirements

Tools/Instruments/Equipments

- Wire stripper manual & auto
- Diagonal cutting pliers 150mm

Materials/Components

- PVC wire,
  Red colour, (5/20 gauge)
  Black colour, (5/20 gauge) - 1 m.
- Incandescent bulb,25 watts (per batch) - 1 No.
- Bulb holder - 1 No.
- Lamp grill
- Copper and aluminium cables of the following size
- PVC single strand 1.5 sq.mm - 3 m.
- PVC single strand 2.5 sq.mm - 3 m.
- PVC cable 14/0.2mm - 3 m.
- PVC cable 21/0.2mm - 3 m.
- PVC cable 40/0.2mm - 3 m.
- Two core PVC cable (240 V,5 A rating) - 1 m.
- Two pin electrical mains plug (240V, 5 amps rating) - 1 No.
- Three core PVC cable (240V, 5A rating) - 1 m.
- Three pin electrical mains plug (240 V, 5 A rating) - 1 No.

PROCEDURE

TASK 1: **Skin the cable insulation using manual striper**

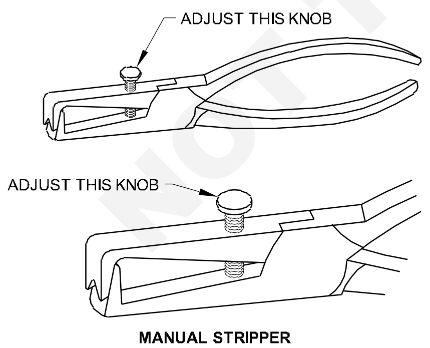
1 Mark and cut the length of the cable to be trimmed off.

2 Straighten the ends at which insulation is to be skinned.

3 Mark the point from which the insulation is to be skinned.

4 Adjust the jaws of the manual stripper and set them to suit the gap equivalent to the size of the conductor core. (Fig 1)

Fig 1



The jaws have V shaped notches to cut the insulation.

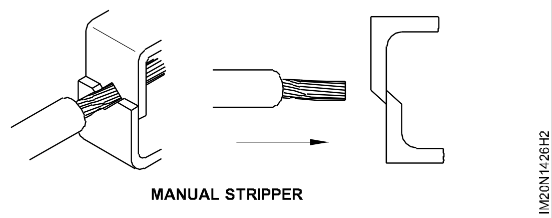
The adjustment screw operates as a stop to allow for a wide range of wire diameters. (Figs 1 & 2)

5 Set the jaws at the mark, press the handle of the stripper and turn to cut the insulation.

Exercise care not to nick the conductor. For better practice try on small waste pieces.

6 Pull the stripper to remove the insulation. (Fig 2)

Fig 2

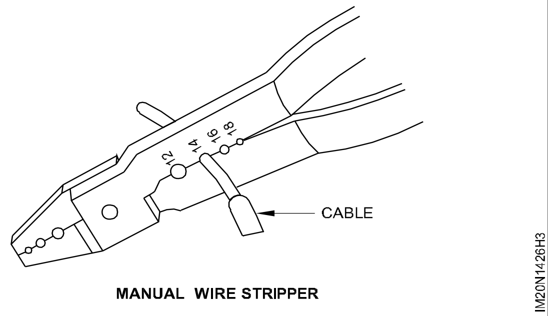


Partially cut insulation needs excessive force to remove. Excessive force, if required, indicates improper cutting of insulation.

7 Repeat the skinning of the wire insulation with another type of manual wire stripper, shown in Fig 3.

8 Exercise additional care in the case of flexible cables so as not to cut even a single strand.

Fig 3



MANUAL WIRE STRIPPER

When using this tool, make sure that it is correctly adjusted before trying to strip the insulation from the cable without damaging the conductor.

Do not use this tool to cut metallic conductors.

— — — — — — — —

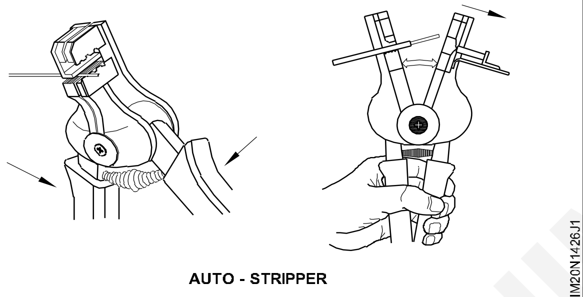
TASK 2: **Skin the cable insulation using an auto-stripper**.

1 Mark the length of insulation to be removed from the ends.

2 Straighten the cable ends.

3 Study the stripper and its working. (Fig 1)

Fig 1



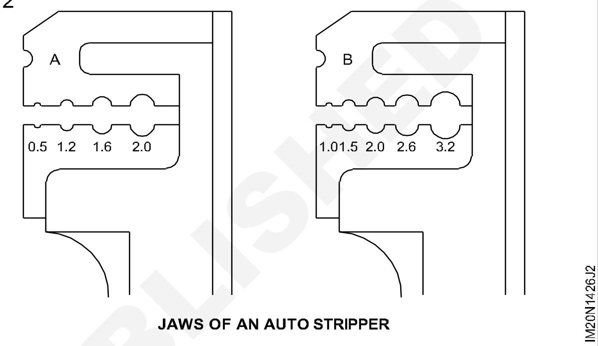
AUTO - STRIPPER

4 Select a slot in the jaws whose diameter is equal to the conductor core diameter. (Fig 2)

5 Locate the jaws of the stripper exactly at the mark.

6 Press the stripper.

Fig 2



JAWS OF AN AUTO STRIPPER

7 Further pressing makes the required length of insulation cut from the cable end .

8 Check for nicking of the cable conductor.

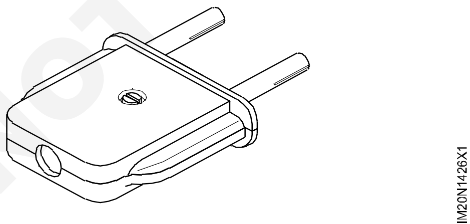
While using this stripper the cable insulation should be put in the proper slot to avoid damage to the conductor.

— — — — — — — —

TASK 3: **Terminating skinned cable to a two-pin mains plug**

The procedure given below is for the most common type of two pin PLUG shown in Fig 1. For other types of plugs the procedure may vary slightly. Consult Instructor in case of difficulty.

Fig 1



1 Keep ready the tinned wires.

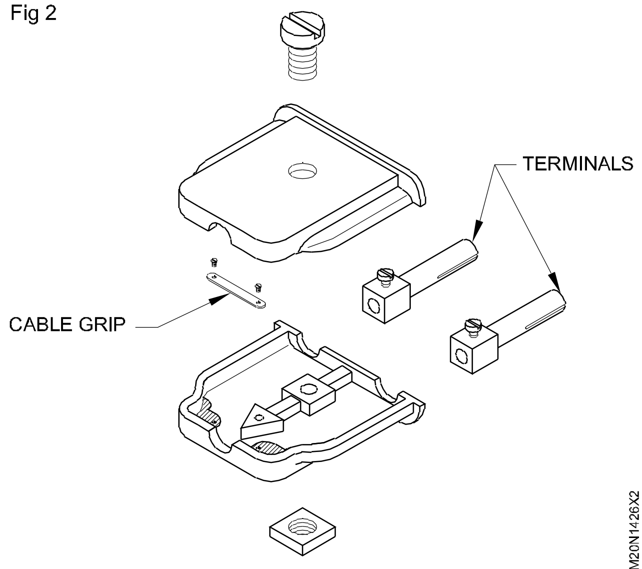
2 Unscrew the screws on the two-pin plug and keep them safe. (Use an empty matchbox or a tray.)

3 Remove the top cover and terminals of the plug as shown in Fig 2 and keep them safely in a tray.

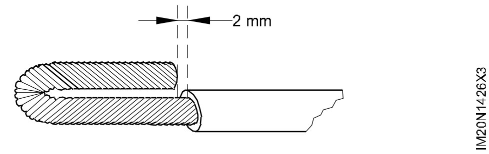
4 Remove the cable grip inside the plug and keep it safely along with its screws.

Some two-pin plugs may not have cable grips. In such cases skip this step.

Fig 2

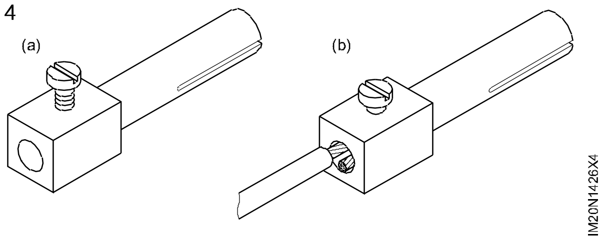


5 Bend the tinned conductors at one end of the two cable into a loop as shown in Fig 3.

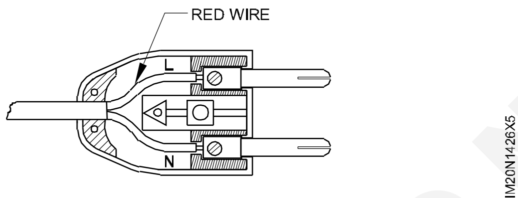
Fig 3


6 Unscrew the screw on the terminals of the plug till the end, but do not remove from the terminal. (Fig 4a)

7 Insert the tinned, looped conductors into the terminals and tighten the screws firmly as shown in Fig 4b.

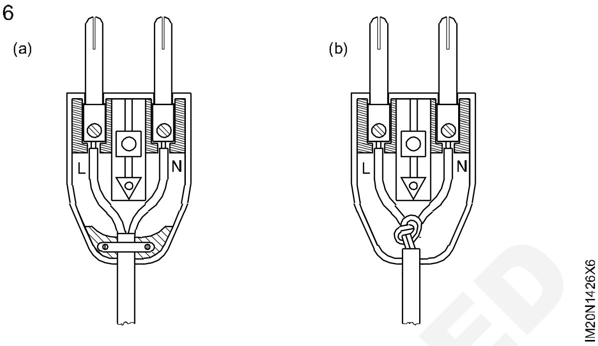
Fig 4


8 Place the terminal connected with the red wire at the place marked L in the plug and the other terminal in the other position of the plug as shown in Fig 5.

Fig 5


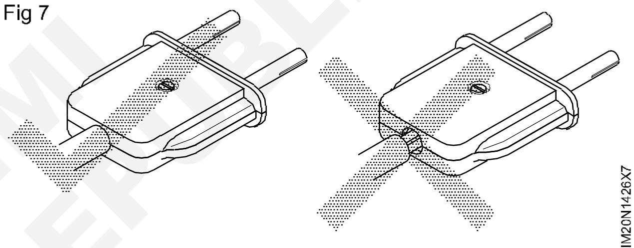
9 Spread the wires inside the plug. Place the cable grip and put back the cable grip screws firmly as shown in Fig 6a. Get it checked by your instructor.

Some plugs may not have cable grip. In such case put a simple knot at the entry of the plug as shown in Fig 6b.

Fig 6


10 Reassemble the plug cover and put back the screw(s). The finished work should look as shown in Fig 7.

11 Get your work checked by your instructor and his remarks entered in O&T sheet.

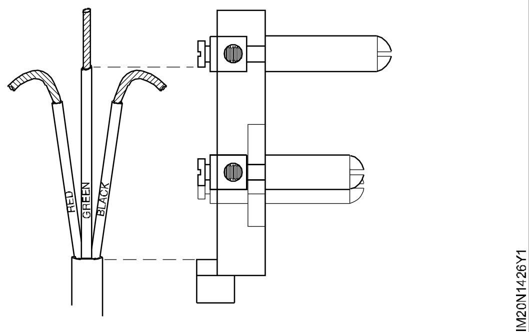
Fig 7


TASK 4 :- **Terminating skinned Cable to three pin mains plug**

The steps given below are for the most common type of three-pin PLUGS. For other types the steps may be vary slightly. Consult your instructor in case of difficulty.

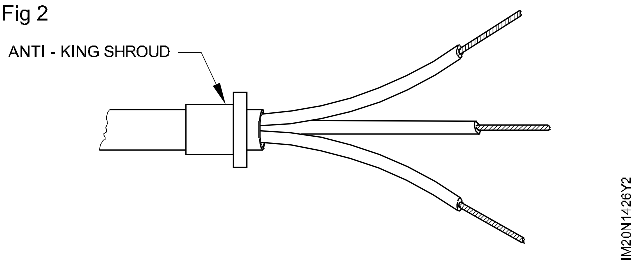
1 Open the outer plastic casing of the 3 pin plug. Remove the cable grip and place them safely in a tray or screw box.

2 Check if the length of the outer sheath skinned is equal to the distance between the earth terminal and the cable grip as shown in Fig 1. If found less, remove the required extra length of cable sheath.

Fig 1


3 Unscrew the screws on the terminal till the end but do not remove from the terminal.

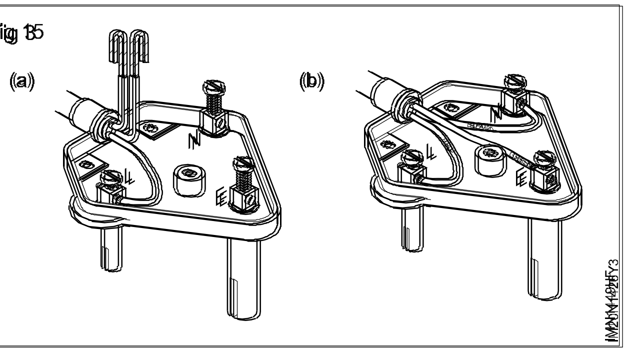
4 Remove the anti-kink shroud(anti-kink ring) from the plug and take the cable through it as shown in Fig 2.

Fig 2


5 Make loops of the tinned conductor end of wires. Insert the red wire loop into terminal marked L or Live as shown in Fig 3a and tighten the terminal screw.

6 Insert the black/blue wire loop into the terminal marked N or Neutral and the green wire loop to the earth terminal as shown in Fig 3b and tighten screws.

Fig 3

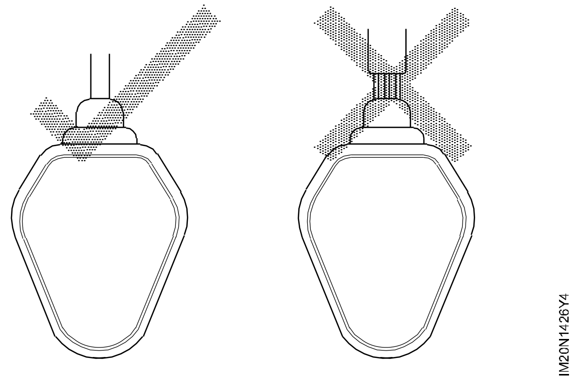


7 Position the anti-kink shroud,reassemble the cable grip rubber and its screws.

8 Get your work checked by your instructor and his remarks entered in O&T sheet.

9 Reassemble the top cover of the plug. The finished work should look as shown in Fig 4.

Fig 4



The cables terminated with 2 pin mains plug and 3 pin main plug made in this exercise will be used in further exercises. Trainees should preserve these power cords in their custody.

— — — — — — — —

Measure the gauge of the wire using SWG and outside micrometer

Objectives : At the end of this exercise you shall be able to
- **measure wire sizes using SWG**
- **measure wire using micrometers**

Requirements

Tools/Instruments/Equipments

- Standard wire gauge (SWG 0-36) - 1 No.
- Micrometer (0-25) - 1 No.
- Electrician's knife - 1 No.
- Manual wire stripper 150mm - 1 No.
- Combination pliers 150mm - 1 No.

Materials

- Wires (assorted size) - as reqd
- Cables (underground armoured and unarmoured cable) - as reqd
- Wire/cable specification data book - 1 No

PROCEDURE

TASK 1: **Measuring the wire sizes by SWG in gauge number**

1 Take any one wire from the table, note down its alphabet in Table 1.

2 Identify the type of insulation, type of conductor material and size of wires. Note it down in Table.

3 Identify the type of insulation, type of conductor material and size of wires. Note it down in table 1.

4 Identify the type of cable (unarmoured and armoured cable) and note down in table 1.

5 Identify the type of insulation, core and record in Table 1.

6 Skin the insulation of the cable.

Exercise care to prevent from nicking

7 Clean the surface of the wire with a cotton cloth remove insulation particles and any adhesive coating from the surface of the conductor

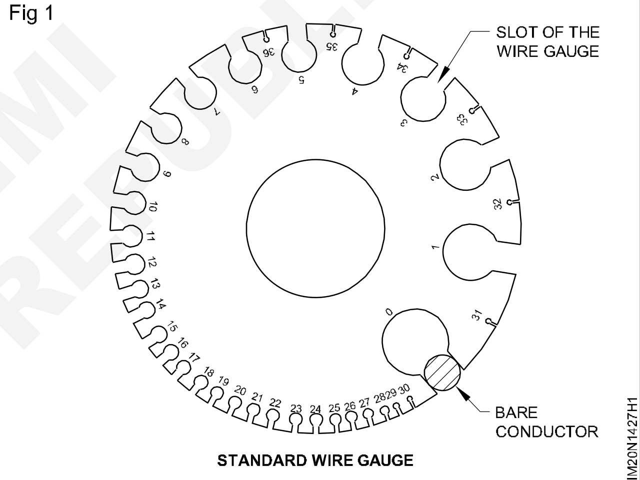
Do not use abrasives to clean the conductor use of abrasive material, reduces the size of the conductor

8 Straighten the end of the conductor to be measured.

Do not straighten conductors by directly using hand tools on them.

9 Insert the conductor in the slot of the wire gauge and determine its close fit. (Fig 1)

Fig 1



10 Read the making at the slot, Fig 2 it gives the wire size in SWG. The other side will give you the diameter. Of the wire in mm

11 Record the measured size in table 1

12 Repeat steps 1 to 10 for various wire and note the data in table 1.

Fig 2

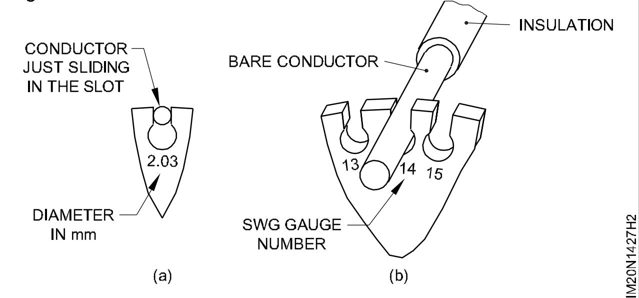


Table 1

Sl.No	Alphabet	Type of insulation	Type of conductor	Type of cable		Type of core single/3/31/2	Core size in mm
				armoured	unarmoured		
1							
2							
3							
4							
5							

— — — — — — — —

TASK 2: **Measuring the wire size, using micrometer**

1 Repeat steps 1-3 of TASK 2.

2 Check the micrometer for zero error by operating the spindle.

3 Record the error value with the sign +ve or -ve

4 Place the cleaned, straight portion of the conductor between the jaws (anvil and spindle)of the micrometer (Fig 1)

5 Close the spindle of the micrometer by turning the thimble.

Use the ratchet drive to avoid over tightening

6 Read and record the diameter in table 1 after computing zero error.

7 Refer to the conversion table (Table 2) to get the size of the conductor in the standard wire gauge.

8 Repeat the steps to find the measurement for the given cables.

Fig 3

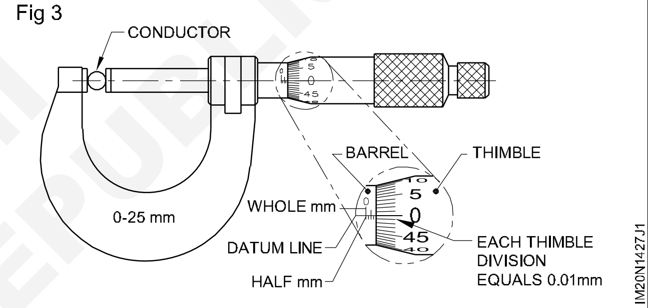


Table 2

Conversion table : SWG to inch/mm

No	Inch	mm
7/0	0.500	12.7
6/0	0.464	11.38
5/0	0.432	10.92
4/0	0.400	10.16
3/0	0.372	9.44
2/0	0.348	8.83
0	0.324	8.23
1	0.300	7.62
2	0.276	7.01

No	Inch	mm
3	0.252	6.40
4	0.234	5.89
5	0.212	5.38
6	0.192	4.88
7	0.176	4.47
8	0.160	4.06
9	0.144	3.66

No	Inch	mm
10	0.128	3.25
11	0.116	3.95
12	0.104	2.64
13	0.092	2.34
14	0.080	2.03
15	0.072	1.83
16	0.064	1.63
17	0.056	1.42
18	0.048	1.22
19	0.040	1.02
20	0.036	0.91
21	0.032	0.81
22	0.028	0.71
23	0.024	0.61
24	0.022	0.56
25	0.020	0.51
26	0.018	0.46
27	0.0164	0.42
28	0.0148	0.38
29	0.0136	0.34
30	0.0124	0.31

No	Inch	mm
31	0.0116	0.29
32	0.0108	0.27
33	0.0100	0.25
34	0.0092	0.23
35	0.0084	0.21
36	0.0076	0.19
37	0.0068	0.17
38	0.0060	0.15
39	0.0052	0.13
40	0.0048	0.12
41	0.0044	0.11
42	0.0040	0.10
43	0.0036	0.09
44	0.0032	0.08
45	0.0028	0.07
46	0.0024	0.06
47	0.0020	0.05
48	0.0016	0.04
49	0.0012	0.03
50	0.0010	0.02

Refer table and find current carrying capacity of wires

Objectives : At the end of this exercise you shall be able to
- **notice the cross sectional area of the cable**
- **indentify the material of the cable**
- **find the current carrying capacity of wire**

Requirements

Materials

- waire (asserted size) - as reqd.
- waire cable specification data book - 1 No.

PROCEDURE

- Note the cross sectional area of the cable (printed on the insulation of area)
- Skin the cable insulation, visualise and identify the mater
- Note the current carrying capacity from the table below

Current for single core PVC insulated sheathed copper and aluminium conductor cables of size 1 to 50 Sq.mm at ambient temperature of 40°c (Refer to IS 694 part1 1064) cables provided with coarse excess current protection)

Nominal cross sectional area	Number and diameter of wires	Bunched and enclosed in conduit or trucking			
		2 cables single phase AC or DC		3 or 4 cables 3-phases AC	
MM2	Number of strands dia. In mm	Copper Amps	Aluminium Amps	Copper Amps	Aluminium Amps
1	1/1.12	11	-	9	-
1.5	1/1.40	13	8	11	7
2.5	1/1.80	18	11	16	10
4	1/2.24	24	15	20	13
6	1/2.80	31	19	25	16
10	1/1.40	42	26	35	22
16	1/1.70	57	36	48	38
25	7/2.24	71	45	60	38
35	7/2.50	91	55	77	47
50	79/1.80	120	69	100	59

S.No	Cross sectional area in mm2	Material the cable	Current carrying capacity in AMP

Measure AC and DC voltage using multimeter

Objectives : At the end of this exercise you shall be able to
- **identify the different terminals of the digital multimeter and select the required range and function**
- **measure the unknown AC/DC voltage in a circuit**

Requirements

Tools & Instruments

- Available digital multimeter with test probes - 1 No.
- Operation instruction booklets - 2 Nos.
- AC power supply 415/240 volts 50Hz - 1 No.
- DC power supply 24V 1A - 1 No.

Materials

- Unknown resistors (wire wound or carbon) - assorted Values
- Suitable connecting leads - 1set.
- Incandescent lamps, 25W, 40W 60W & 100W of 240V rating -1No each

PROCEDURE

TASK 1: **Study the digital multimeter**

1 Collect the digital multimeter from you instructor.

2 Study the various symbols given on the meter, by referring to the symbols given in Table 1.

3 Observe the rotary selector switch functions and record you observations in you practical note book.

a The minimum and maximum AC voltage ranges of the meter are ____________ and _____________ volt.

B The minimum and maximum DC voltage ranges of the meter are _____________ and ______________ volt.

C The minimum and maximum alternating current ranges of the meter are ___________ and _________ amp.

D The minimum and maximum Direct current ranges of the meter are ____________ and ____________ amp.

E The minimum and maximum Resistance measurement ranges of the meter are ___________ and __________ ohm.

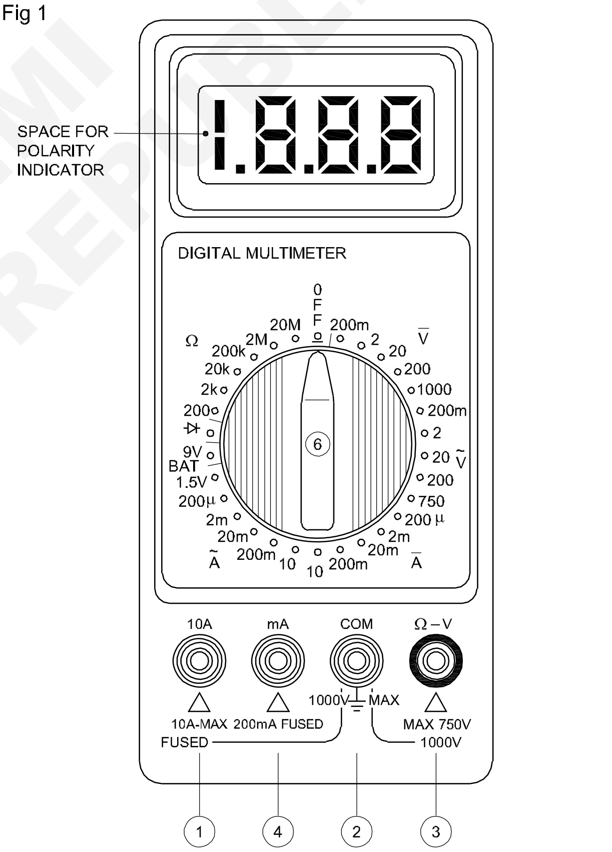
4 Identify the various input terminals of the meter. (Refer Fig 1)

A 10A input terminal for current measurements (AC or DC) upto 10A continuous when the function selector switch is in 10A position.

B COM Common terminal (black colour), return terminal for all measurements.

C Volt, ohm continuity, battery and diode test input terminal (red colour).

Fig 1



D mA Milliampere input terminals (AC/DC) upto 200mA continuous when the function selector switch is in A or mA position.

TABLE - 1

$\tilde{V}$	VOLTS AC	$\overline{V}$	VOLTS DC
$\tilde{A}$	AMPERES AC	$\overline{A}$	AMPERES DC
Ω	RESISTANCE	BAT	BATTERY TEST
⇥	DIODE TEST	·ı))	BEEPER SOUND CONTINUITY TEST
⚠	SEE MANUAL FOR EXPLANATION	ϟ	DANGEROUS VOLTAGES
⏚	GROUND		

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— — — — — — — —

TASK 2: **Measurement of DC voltage**

Select proper function and range for DC voltage measurement.

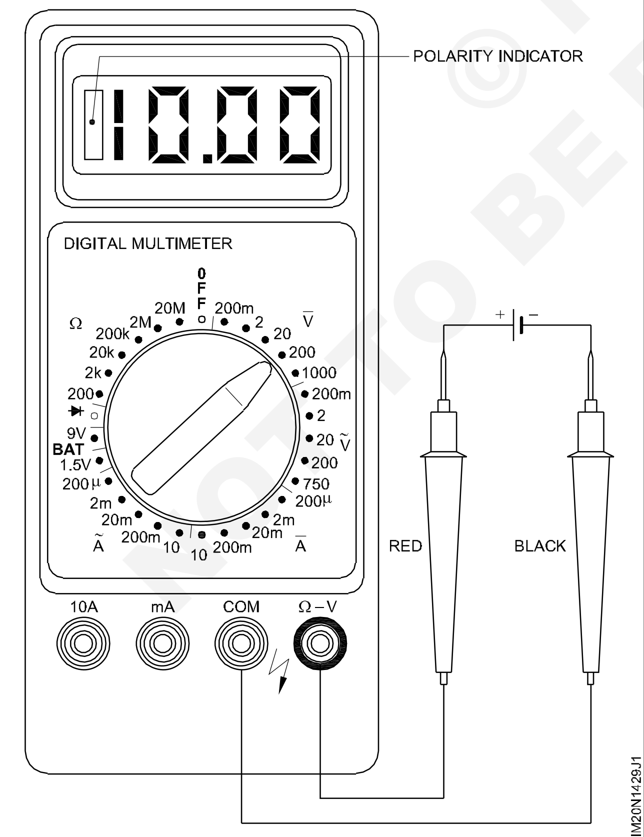
1 Set the function selector rotary switch to DC voltage (V) function and 200d V range as shown in Fig 2

Inspect the test leads for damaged insulation.

2 Connect the black lead to common terminal and the red lead to ?-V terminal.

3 Connect the test leads across the source as follows. Connect red lead to +ve' terminal and black lead to -ve terminal as shown in Fig 2.

Fig 2



Connect the multimeter selected as a voltmeter in parallel with the source voltage.

4 Read the value of DC voltage from the display and enter in the Table 2.

5 Measure atleast two more DC source voltage, and enter in Table 2.

Table 2

SI.No.	DC source	Measured Voltage
1		________volt.
2		________volt.
3		________volt.

If the measured value of voltage is very less with high range elected, then, repeat the measurement by selecting the suitable low range.

If higher voltage is measured with low range selection, the over range will be indicated by DIGIT '1' in display. So suitably select a higher range.

If '-ve' sign preceeds the reading, I indicates negative input to meter terminals.

TASK 3: **Measurement of AC voltage**

1 Turn the rotary selector switch to AC voltage (V) function. To measure unknown AC voltage select the highest possible range as shown in Fig 3.

2 Repeat the steps 2 to 4 of Task 2.

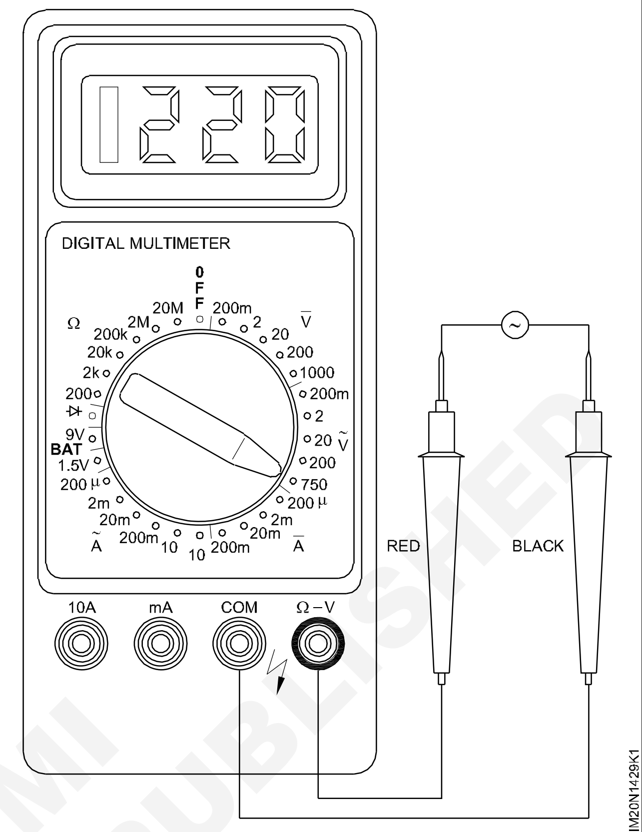
3 Measure atleast two more AC voltage and enter in table.

> **If higher voltage is measured with low range selection, the over range will be indicated by DIGIT '1' in display. So suitably select a higher range.**

Table 2

Sl.No.	DC source	Measured Voltage
1		_________volt.
2		_________volt.
3		_________volt.

Fig 3



Use the multimeter to measure the various function (AC V, DC V, DC I, AC I, R)

Objectives : At the end of this exercise you shall be able to
- **measure the resistance of the given unknown resistor**
- **measure the unknown AC/DC voltage and current in a circuit**

Requirements

Tools/Instruments

- Available digital multimeter with test probes - 1 No.
- Operation instruction booklets - 2 No.
- AC power supply 415/240 volts 50 Hz. - 1 No.
- DC power supply 24V 1A - 1 each.

Materials

- Unknown resistors (wire wound orcarbon) - assorted values
- Suitable connecting leads - 1 No.
- Incandescent lamps, 25W, 40W, 60W & 100W of 240V rating - 1 No each.

PROCEDURE

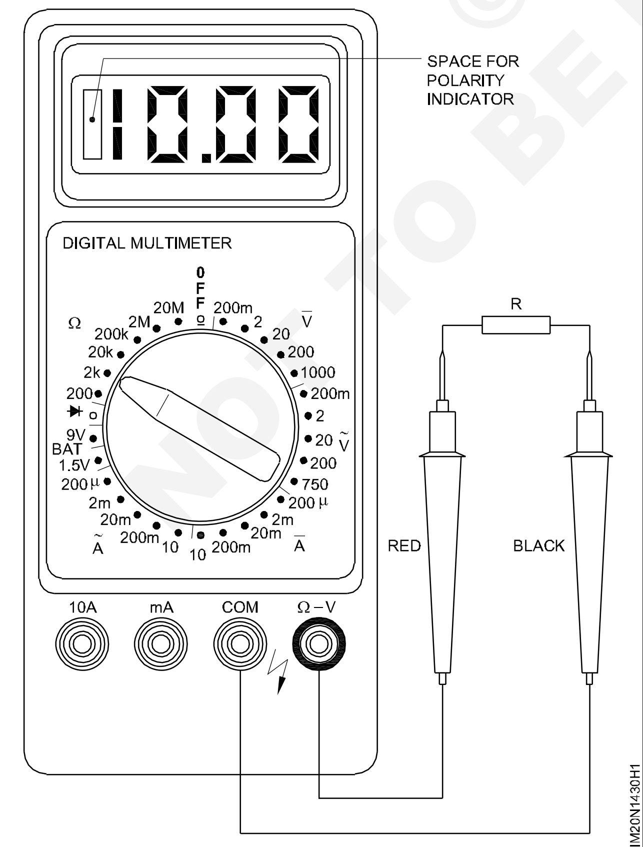
TASK 1: **Measure the resistance of an unknown resistor**

Select proper function and range for resistance measurement.

1 Set the function selector rotary switch to CHM (W) function and any one ohmic range as shown in

Inspect the test leads for damaged insulation if found replace them.

Fig 1



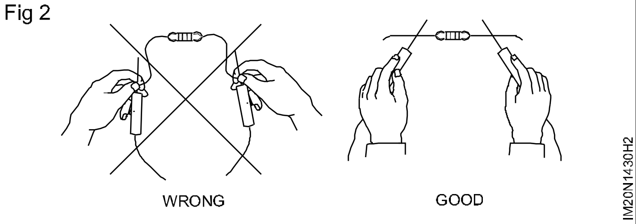
2 Connect the black lead to common terminal and red lead to Never use the ?-V terminal.

Never use the ohmmeter section on a live circuit.

3 Connect firmly the test leads across the resistance under measurement.

While connecting the test leads to resistor leads keep your finger tips off the probes. (Fig 2).

Fig 2



4 Read the value of resistance directly from the digital display and either in Table 1

Table 1

Sl.No	Resistance under measurement	Measured values
1		
2		
3		
4		
5		

5 Repeat the measurements for four more resistors.

If the measured value of resistance is very less with high range selected then repeat the measurement by selecting a suitable lower range.

If a higher value resistance is measured at a lower range setting the over range will be indicated by DIGIT '1' in display with other digits blanked.

So suitable select a higher range, for accurate measurement purpose.

— — — — — — — —

TASK 2: **Measurement of DC voltage**

Select proper function and range for DC voltage measurement.

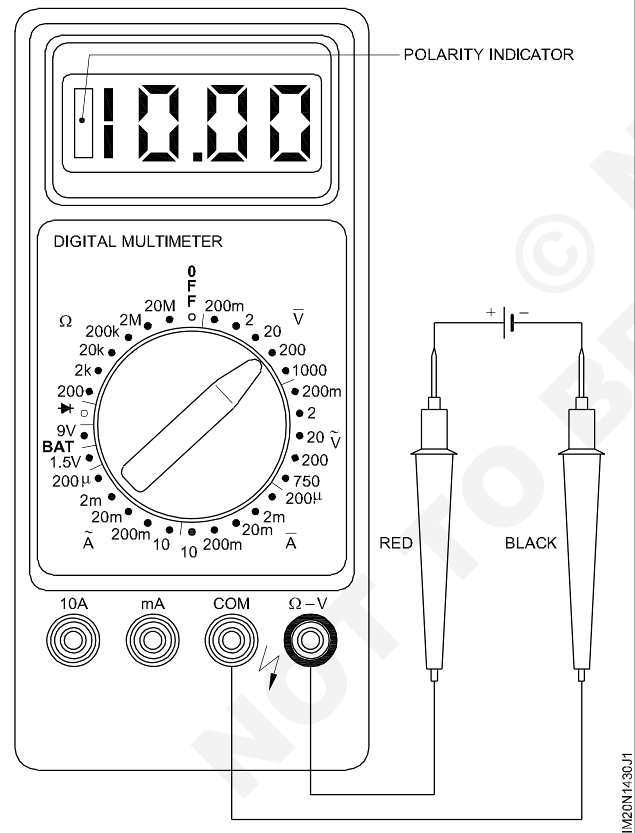
1 Set the function selector rotary switch to DC voltage (V) function and 200 V range as shown in Fig 3.

Inspect the test leads for damaged insulation.

2 Connect the black lead to common terminal and the red lead to V terminal.

3 Connect the test leads across the source as follows. Connect red lead to + ve terminal and black lead to -ve terminal as shown in Fig 3.

Fig 1



Connect the multimeter selected as a voltmeter in parallel with the source voltage.

4 Read the valve of DC voltage from the display and entire in the Table2.

5 Measure at least two more DC source voltage, an enter in Table 2.

Table 2

Sl.No.	DC source	Measured voltage
1	___________volt.	
2	___________volt.	
3	___________volt.	

If the measured value of voltage is very less with high range selected, then, repeat the measurement by selecting the suitable low range.

If higher voltage is measured with how range selection, the over range will be indicated by DIGIT 'I' in display. So suitable select a higher range.

If -ve' sign proceeds the reading, it indicates negative input to meter terminals.

— — — — — — — —

TASK 3: **Measurement of AC voltage.**

1 Turn the rotary select switch to AC voltage (V) function. To measure unknown AC voltage select the highest possible range as shown in Fig 4.

2 Repeat the steps 2 to 4 of Task 2.

If higher voltage is measured with low range selection, the over range will be indicated by DIGIT 'I' in display. So suitable select a higher range.

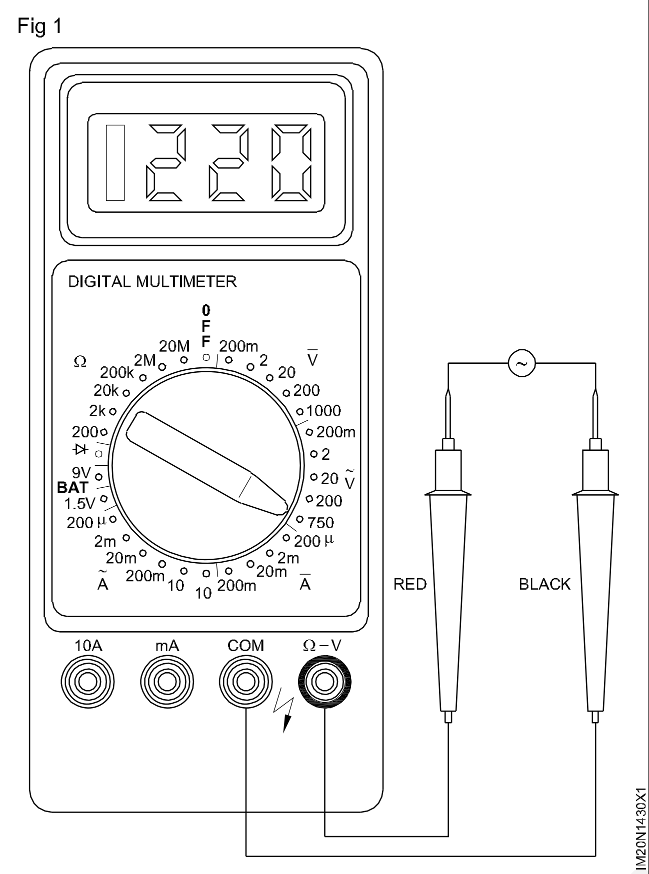


Table 3

Sl.No.	AC source	Measured voltage
1		__________volt.
2		__________volt.
3		__________volt.

— — — — — — — — —

TASK 4: **Measurement of direct current**

Select proper function and range for direct current measurement.

1 Turn the rotary selector switch to DC amperes (A) Function. To measure unknown DC current, select the highest possible range i.e., 10A

Inspect the test leads for damaged insulation. If found replace them.

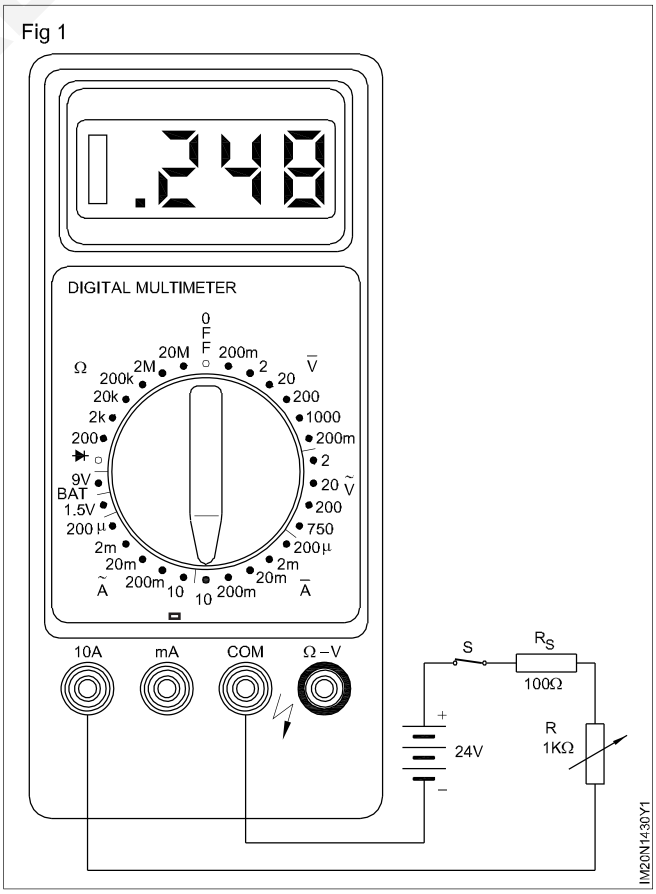
2 Connect the black lead to the common terminal and the red lead to 10A input terminal

3 Wire up a circuit as shown in the circuit diagram (Fig 5) and connect the meter test leads in series with the circuit.

Insert the meter in series with the circuit.

4 Close switch's and measure the current by reading the display and enter in table 4

5 Alter the resistance of the circuit by adjusting the rheostat and note down the corresponding current drawn by the circuit.



If the measured current is less than 200mA then connect the red probe to MA input terminal and turn the rotary switch to (A) function and range to 200mA or lower accordingly.

If higher current is measured with low range selection, the over range will be indicated by DIGIT '1' in display. So suitably select a higher range.

Connecting probes may be written in the text as probes. Also both words could be used alternatively.

Table 4

Sl.No.	Measured voltage
1	
2	
3	

— — — — — — — —

TASK 5: **Measurement of alternating current.**

Select proper function and range for alternating current measurement.

1 Turn the rotary selector switch to AC amperes (A) function. To measure unknown AC current, select the highest possible range i.e. 10A.

2 Connect the black lead to common terminal and the red lead to 10 A input terminal

When making current measurement, turn the circuit power off before connecting the meter in circuit.

3 Wire up a circuit as shown in the circuit diagram (Fig 6) and connect the meter test leads in series with the circuit

4 Close switch's and measure current by reading the display directly and enter in table 5.

5 Connect different wattage lamps in the circuit and measure the corresponding current drawn

Fig 1

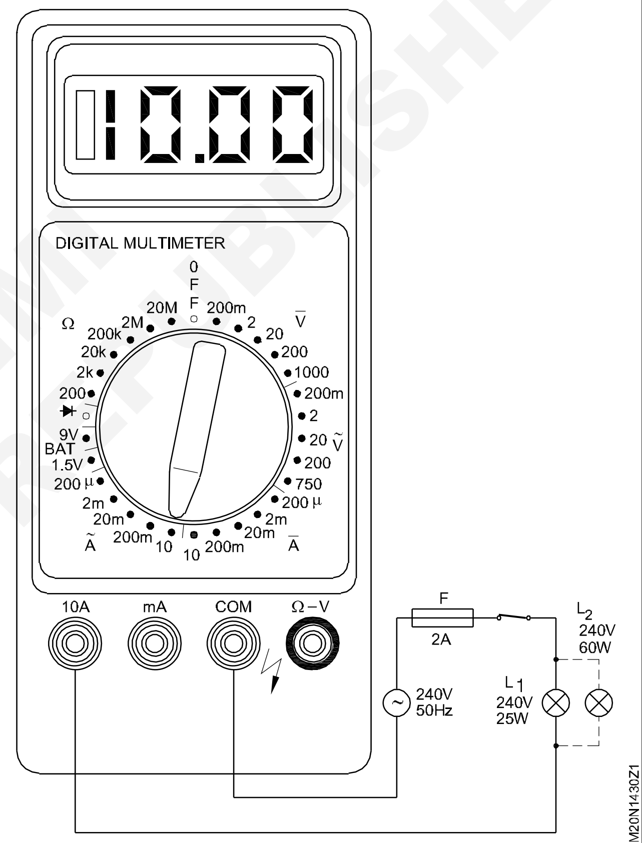


Table 5

Wattage of lamp	Measured current

If the measured current is less than 200mA then connect the red probe to mA input terminal and select range 200mA accordingly

If higher current is measured with low range selection, the over range will be indicated by DIGIT '1' in display, so suitably select a higher range.

— — — — — — — —

Measure the resistor value by colour code and verity the same by measuring with multimeter

Objectives : At the end of this exercise you shall be able to
- **determine resistance value by colour code using the chart**
- **measure the resister value by multimeter**

Requirements

Tools/Equipments		**Materials/Components**	
• Mutimeter /cementer	- 1 No.	• Assortocl types and values of fixed value resisters	- as reqd.

PROCEDURE

1 Take a colour coded resistor from the given lot and identify the colour of bands starting from one end of the resistor as shown in fig 1. Record the colour of the bands in table 2 of O & T sheet.

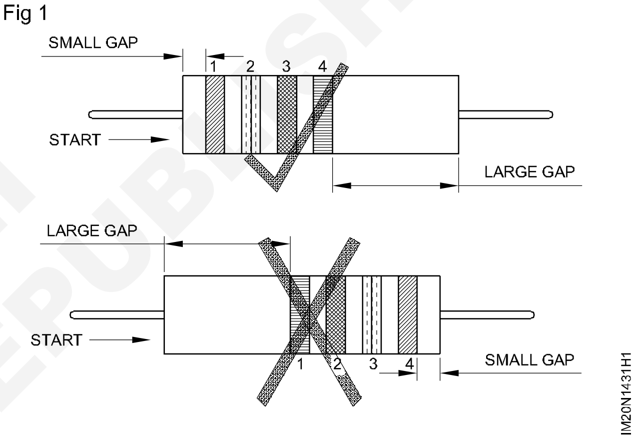
2 Refer table nos 7,8 and 9 of pocket table book and calculate the nominal, minimum, maximum value of the resistor. Record values in table 1 of O&T sheet.

3 Measure the resistance value of same resister by using multimeter

4 Record the multimeter reading in table 1 and compare

5 Repeat steps 1 & 4 for the remaining colour coded resistors and get your work checked by your instructor

Fig 1



Observation and tabulation sheet

Resistor label number	Colour of 1st Band	Colour of 2nd Band	Colour of 3rd Band	Colour of 4th Band	Percentage tolerance	Standard Value of resistor	Minimum Valus of resistor	Maximum valus of resistor	Measured valume (multi meter)	value Moct yes/ No
Sample	yellow	violet	red	silver	10%	4.7k Ω	4230 Ω	5170 Ω	Reading	

IPractice soldering on IC bases and PCB

Objectives : At the end of this exercise you shall be able to
- **clean the PCB, IC base properly and dry**
- **solder the IC base by appropriate soldering iron**
- **identify cold joint and rectify**

Requirements

Tools/Instruments/Equipments

- solder
- PCB board
- IC base

Materials/Components

- Industrial and catch brite pads impregnated with cleaner/500
- Acetone rethy hydrate (remove link)
- Fine emery sheet/knife

PROCEDURE

1 Clean the PCB board with pad and IC base with fine emery paper.

2 Clean the PCB board with solvent (acetone)

3 Dry with compressed air

4 place the IC bare in the apocopate location

5 Place the tip and the soldering iron on the solder pad and allow the ping bare and solder pad to heat up

6 Youch the tip of the strand and solder to the pin and IC of the iron

7 When you see the and LUX liquidity continue to add solder to the joint until the solder ferns a small mound with concave sides

8 Stop adding solder and remove the soldering iron

9 Do not move the joint for a few seconds as the solder needs time to cool and re-solidify otherwise you will get a cold

10 Check for cold joint (appears dull and grainy)

11 Reheat and apply a small amount of solder

Practice de-soldering using pump and wick

Objectives: At the end of this exercise you shall be able to
- **de- soldering using pump**
- **de-soldering using wick.**

Requirements

Tools/Equipment/Instruments

- Trainees tool kit - 1 Set.
- Magnifier with lamp - 1 No.
- Digital multimeter with probes - 1 No.
- De-soldering tool with vacuum pump - 1 Set.

Materials

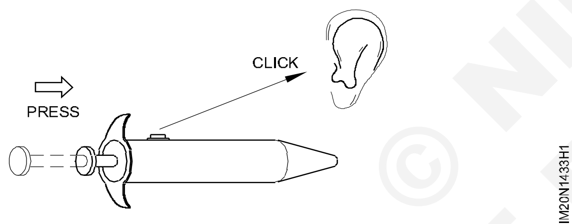
- Solder wick - as reqd
- IPA cleaning solution - as reqd
- Solder flux pen/liquid flux - as reqd
- Cleaning brush - 1 No.
- Vacuum pen - 1 No.
- Kapton tape - 1 No.
- Syringe-5 ml - 1 No.
- SMD leaded LC assembled PCB - 1 No.

PROCEDURE

TASK 1**: De-soldering using hand held de-soldering pump**

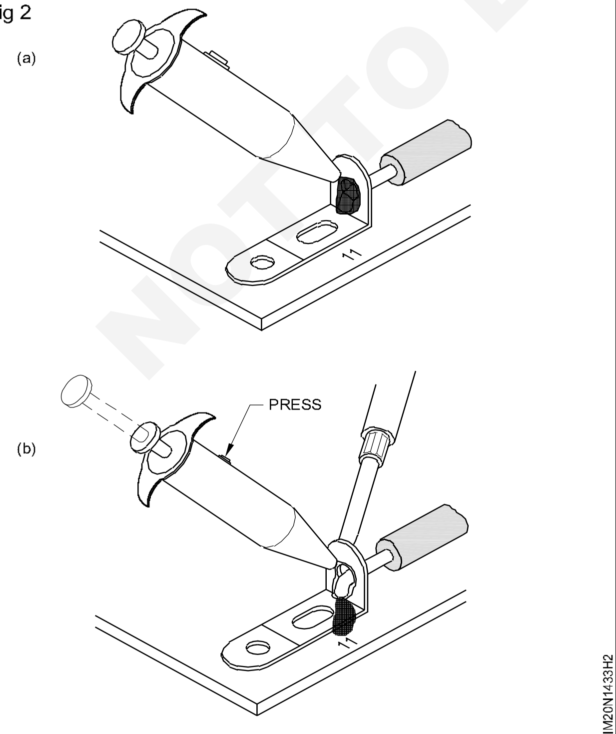
1 Press the handle of the de-soldering pump fully as shown in Fig 1 till it makes a click sound, and release the handle.

Fig 1



2 Hold the pump nozzle at lug no.11 of lug board as shown in Fig 2a

Fig 2



3 Hold the heated tip of the iron at the inner face of lug as shown in fig 2b till the solder melts. With the pump nozzle touching the melting solder at joint press the pump button.

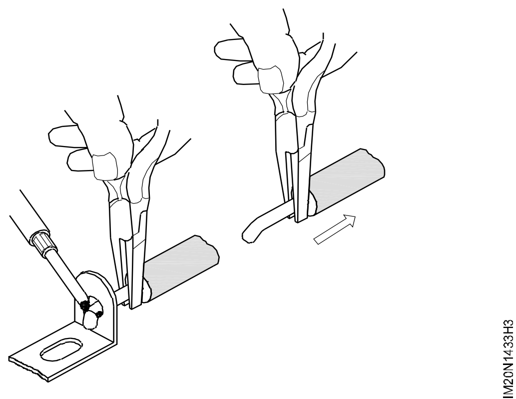
The pump sucks the molten solder.

4 Take away the iron and pump from the lug, check if the solder at the joint sucked off and the lug hole is clear, if not repeat steps 1 to 3 till the hole is almost cleat.

5 Clean the tip of iron and hold at the outer face of the lug pull out the wire from the lug as shown in Fig 3.

Do not force the wire out as the wire may get cut. If the wire is not coming out easily, repeat steps 1 to 5.

Fig 3



6 Get the de-soldered point checked by your instructor.

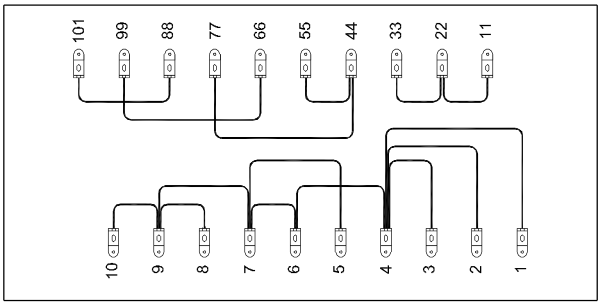
7 Repeat steps 1 to 5 de-solder wire at lug no 11 to 101.

8 Get your work checked by your instructor.

LAB Assignment

As a practice of soldering solder back the de-soldered wires on the lug board as show in Fig 4 after getting it checked de-solder the wires and get it checked.

Fig 4



CODE NO: 103 - 06 - LB

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Observation and tabulation sheet

1 Instructors remarks on

[] De-soldered wire from lug board :

(using soldering iron and nose player)

V.Good ☐ **Good** ☐ **Satisfactory** ☐ **poor** ☐

[] De-soldered wire from lug board :

(using soldering iron and de-soldering pump)

V.Good ☐ **Good** ☐ **Satisfactory** ☐ **Poor** ☐

2 Additional marks for the optional lab assignment, if done /10

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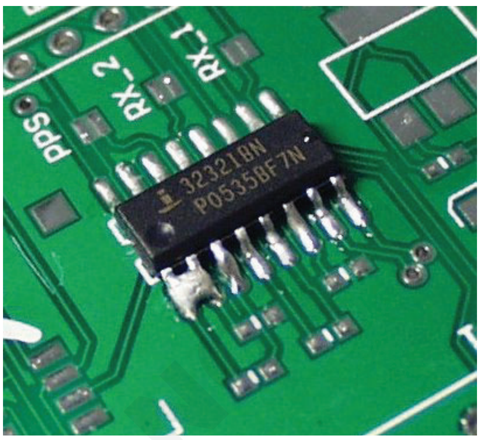
TASK 2**: Removal of surface mount solder joint using solder wick**

1 Collect the defective SMD-PCB from the instructor and identify the component to be removed

2 Use magnifying glass and inspect the size of the solder joint on the components to be removed as shown in the Fig 5

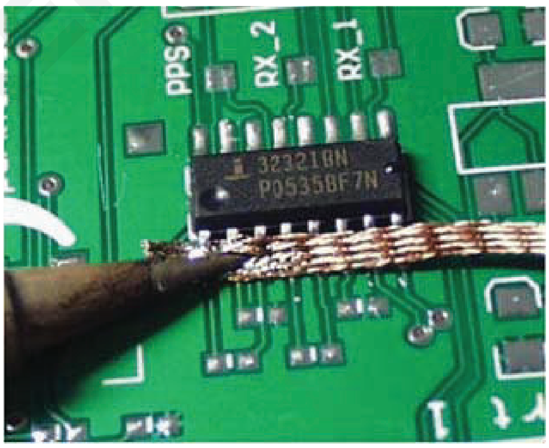


3 Apply a small quantity of flux and solder to the joints of the surface mount components to be removed

4 Place the end of solder wicking braid on the component lead side and the tip of the hot soldering iron over it as shown in Fig 6

5 Allow time for the solder to melt and the solder wick to draw the molten solder into the braid by capillary action.

Fig 6



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6 After the molten solder has been extracted from the joint, remove the wick and the soldering iron tip from the component lead

7 Use the unused portion of the wick for removing excess solder

8 Repeat the steps 3 to 7 for removing other terminals of the surface mount components.

9 Remove the components from the PCB and clean the surface with IPA solution

10 Get the work checked by the instructor.

— — — — — — — —

Join the broken PCB track and test

Objectives: At the end of this exercise you shall be able to
- **repair the damaged tracks on graphics board, hard disk drive, mobile phone etc.**
- **Check the physical inspection of the given PCB.**

Requirements

Tools/Instruments

- Cleaning solvent (IAP)
- Magnifying glass with lamp
- Soldering Iron
- Tweezer
- ESD-safe surface
- Defective SMD PCB with broken track

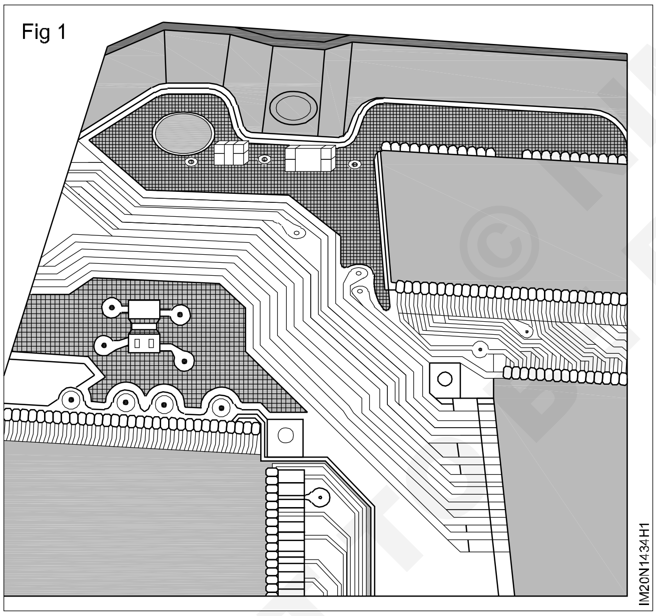
Materials

- Flux
- Solder
- Wipes

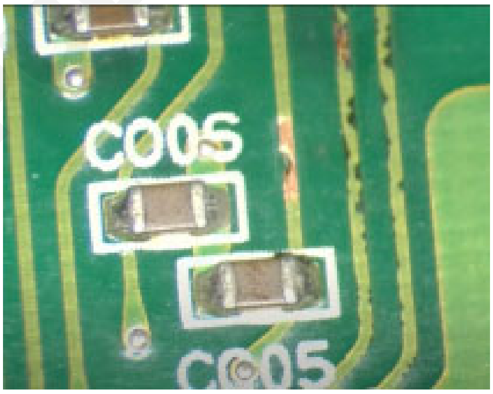
PROCEDURE

1 Identify the broken track on the PCB using magnifying glass as shown in Fig 1 & 2.

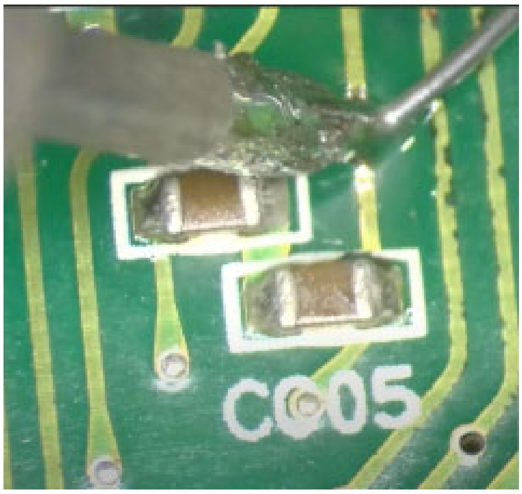
Fig 1



2 Use a jeweler's flat head screw driver and gently scrap both sides of the break until the bare copper visible as shown in Fig 3

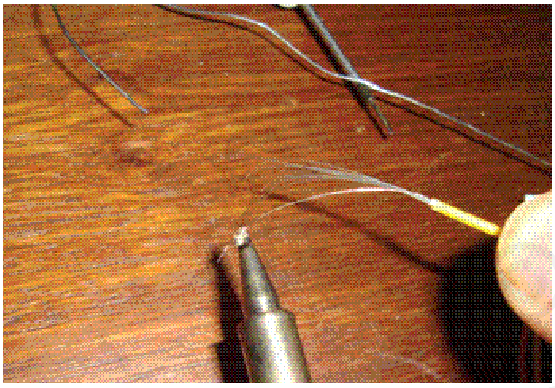


3 Melt a blob of solder using soldering iron to tin the bare copper track as shown in Fig 4.



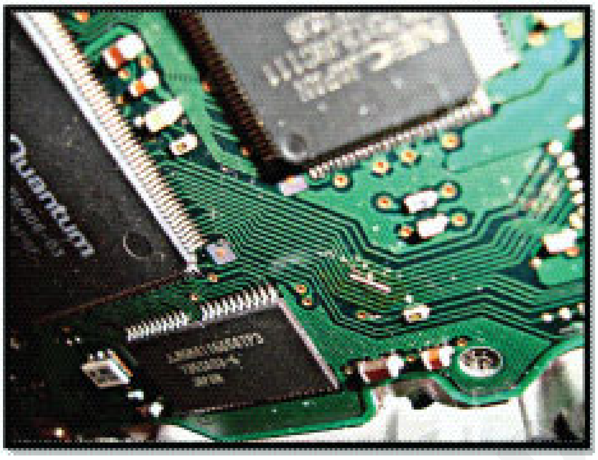
4 Remove any excess lead on the track. Now you can see the tinned track as shown in Fig 5.

5 Take a multistrand wire. In that tin only one single strand wire as shown in Fig 6.

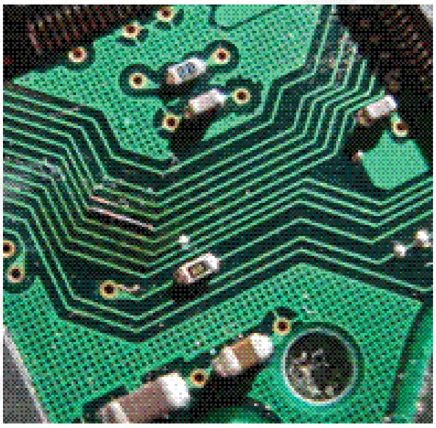


6 Cut the required length of tinned wire as shown in Fig 7.

7 Place the tinned wire on the top of break carefully using tweezers as shown in Fig 8.



8 Keep the soldering iron with the blob of solder for few seconds to solder it as shown in Fig 9.



9 Clean the surface using cleaning solvent and get the work checked by your instructor.

Practice on measurement of parameters in combinational electrical circuit by applying ohm's law for different resistor values and voltage sources

Objectives: At the end of this exercise you shall be able to
- **verify the relation between voltage and current when resistance is constant**
- **verify the relation between current and resistance when keeping voltage is constant**
- **plot the graph in both conditions illustrating the behaviour of current with respect to resistor.**

Requirements

Tools/Instruments
- Screwdriver 150 mm - 1 No.
- MC Ammeter 0 to 500 mA - 1 No.
- MI Ammeter 0 to 1A - 1 No.
- MC Voltmeter 0 15 V - 1 No.

Equipment/Machines
- 12 Volts battery 60 AH capacity OR - 1 No.
- DC variable power supply 0 - 30 V 2 amperes - 1 No.
- Rheostat 20 ohms - 3.7A - 1 No.

Materials
- S.P.Switch, 6A, 250V - 1 No.
- Resistors 10, 20, 50 Ohms 5 watts - 1 each.
- Resistor 20 ohms,2W - 1 No.
- Connecting leads 14/0.2 mm - 1 No.
- P.V.C. insulated copper wires of assorted length - 8 Nos.
- Graph sheet - 1 No.

PROCEDURE

TASK 1**: Verify the relation between current and voltage when resistance is constant**

1 Check the voltmeter from the dial marking 'V'.

2 Check the ammeter from the dial marking 'A'.

3 Identify the fixed and variable terminals of the rheostat.

4 Connect the circuit elements as shown in Fig 1.

Fig 1

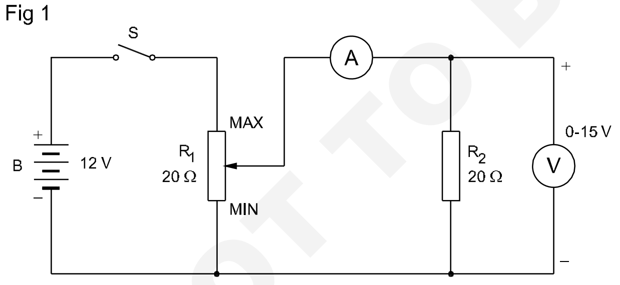


TABLE 1

No.	VOLTAGE (VOLTS)	CURRENT (AMPS)	RELATION BETWEEN I AND V

IM20N1435H1

5 Check the value of each major division and minor division of the scales of the meters.

6 Close the switch keeping the variable rheostat at the minimum value of output.

7 Apply different voltages by varying the rheostat arm of the potential divider in succession across the resistance.

8 Measure the voltage and the corresponding current from the instruments.

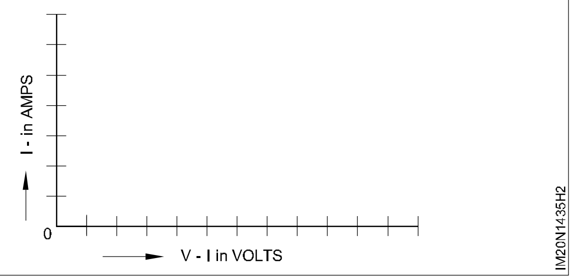
9 Record the measured values in Table 1.

> **To avoid parallax error:**
>
> **Position your eye in line with the pointer and also in front level of the instrument**
>
> **Position your eye to coincide with the mirror image of the pointer in instruments having anti-parallax mirror.**

10 Refer the recorded value and plot a graph. Write your conclusion considering the calculated R values.

V in Y Axis; I in X axis as shown in Fig 2.

Fig 2



Conclusion

Write your findings and conclusion by interpreting the current and voltage

____

____

— — — — — — — — —

TASK 2: **Verify the relation between current and resistance: Voltage is constant and resistance is variable.**

1 Connect the circuit elements as shown in Fig 3 with 0 -1A ammeter. Adjust V at 10 volts keep it constant.

Fig 1

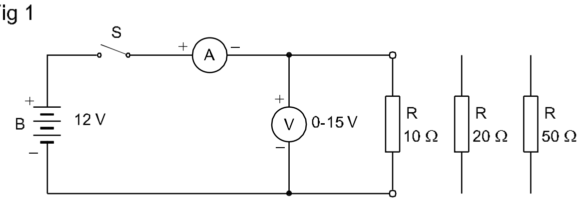


TABLE 2

No.	VOLTAGE (VOLTS)	RESISTANCE (OHMS)	CURRENT (AMPS)	RELATION--BETWEEN I AND R

IM20N1435J1

2 Close the switch 'S' and measure the current and voltage.

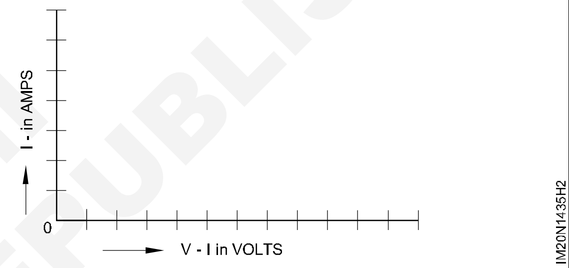
3 Read and record values in the given Table 2.

4 Open the switch (OFF). Change the ammeter to 0-500 mA and repeat steps 2 and 3 by replacing 10 - ohm resistance by 20 and 50 ohms.

5 Refer the recorded value and plot the graph. Write your conclusion considering the calculated I values.

R in Y Axis; V in X Axis as shown in Fig 4.

Fig 2



Write your findings and conclusion by interpreting the current and resistance.

Conclusion

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Measurement of current and voltage in electrical circuits to verify Kirchhoff's Law

Objectives: At the end of this exercise you shall be able to
- **verify Kirchhoff's current Law in two and three branch currents**
- **verify Kirchoff's voltage Law with one voltage and two voltage source.**

Requirements

Tools/Instruments/Equipment

• Trainees kit	- 1 No.
• Variable DC power supply unit 0-30V/1A	- 2 Nos.
• Milliammeters 0 - 500 mA	- 3 Nos.
• Milliammeters 0 - 30 mA	- 1 No.
• Power supply unit 0 - 30 V	- 1 No.

Materials

• Resistors 1K	- 4 Nos.
• Resistors 2.2K, resistors 3.3K	- 1 No.
• Resistors 4.7K	- 1 No.
• Lug board	- 1 No.
• Toggle switch, SPST, 1amp.	- 2 Nos.
• Patch cords	-as required.
• SPST switch 6A, 250V	-as required.

PROCEDURE

TASK 1: **Verify the Kirchhoff's current law with two branch currents**

1 Connect the PSU, milliammeters, SPST switch and resistors as illustrated in the schematic circuit and the layout diagram as shown in Fig 1.

> **Keep the SPST and PSU in the OFF position while making circuit connections.**

2 Switch 'ON' PSU and set output to 12 volts.

3 Simplify the circuit in Fig 1 and calculate the theoretical total circuit current and branch currents of the circuit for a set DC supply of 12 volts. Record values in Table 1.

> **Check if the connected ammeters can measure the calculated current. Change the meter, if necessary.**

4 Get the circuit connections checked by your instructor.

5 Switch ON SPST.

6 Measure and record the total circuit current (I_T) and branch currents I_{S1} and I_{S2} in Table 1.

7 Switch OFF the SPST.

8 Set the output of the RPSU to 9 volts.

9 Calculate the theoretical circuit currents for the set supply voltage of 9V.

10 Record values in Table 1.

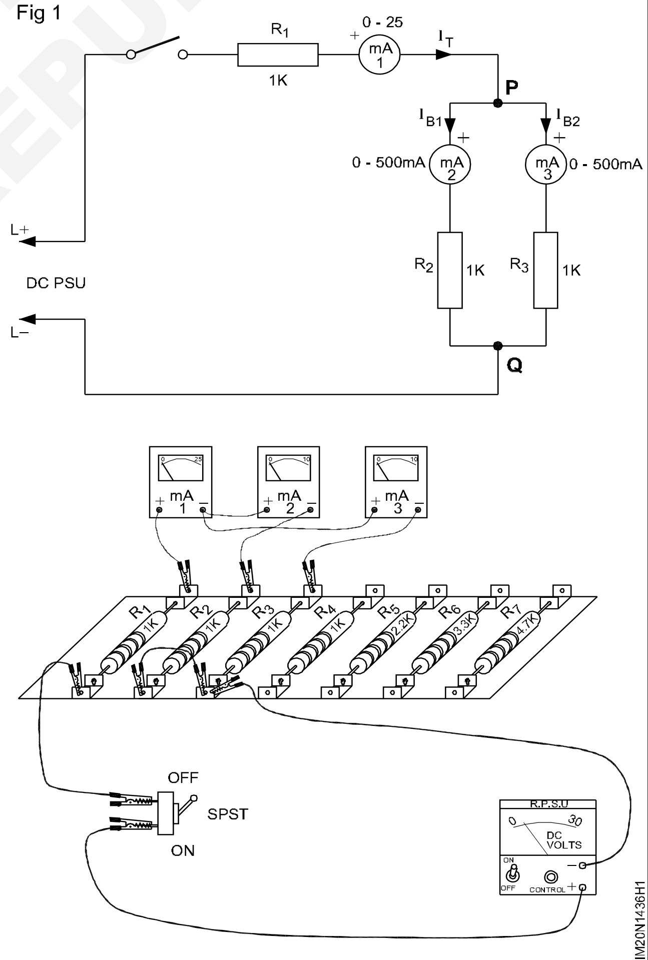
11 Repeat steps 4 and 6.

12 Switch OFF SPST and PSU.

13 Write Kirchhoff's current equations for the nodes P and Q.

14 Verify the equation substituting the measured current values.

Fig 1



15 Get the readings and equations checked by your instructor.

Table 1

Set circuit voltage	Calculated values of circuit current			Measured values of circuit currents		
	Total circuit current (I_T) $I_T = I_{B1} + I_{B2}$	I_{B1}	I_{B2}	Total circuit current (I_T) $I_T = I_{B1} + I_{B2}$	I_{B1}	I_{B2}
12V						
9V						

— — — — — — — — — —

TASK 2 : **Verify the Kirchhoff's current Law with three branch currents**

1 Make circuit connections on the lug board as per the schematic circuit in Fig 1.

> **Make it a practice to keep the SPST and PSU switches in the OFF position while making circuit connections.**

2 Get the wired circuit checked by your instructor.

3 With the SPST in OFF position, set the output of PSU to 12 volts.

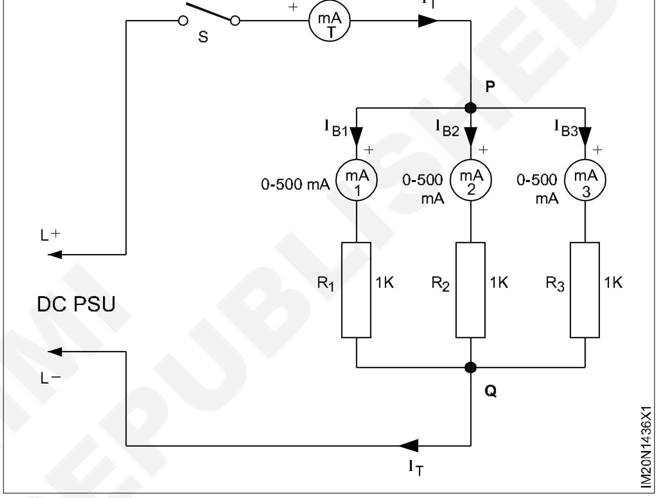
4 Switch ON the SPST switch. Measure and record currents I_T, I_{B1}, I_{B2} and I_{B3} in Table 1.

5 Switch OFF SPST and PSU.

6 Write Kirchhoff's current equations at nodes P and Q. Verify the equation using measured current values.

7 Get the readings and equations checked by your instructor.

Fig 1



8 Record your findings and conclusions after verifying the recorded and calculated values and check if it is same as per the theoretical conclusions.

Table 1

Set circuit voltage	Total circuit current (I_T) $I_T = I_{B1} + I_{B2} + I_{B3}$	Branch currents		
		I_{B1}	I_{B2}	I_{B3}
12 V				

— — — — — — — — — —

TASK 3: **Verify the Kirchhoff's voltage Law with one voltage source**

1 Measure and record in Table 1, values of resistors R_4, R_5 and R_6 soldered on the lug board.

2 Make the circuit connections as shown in Fig 1.

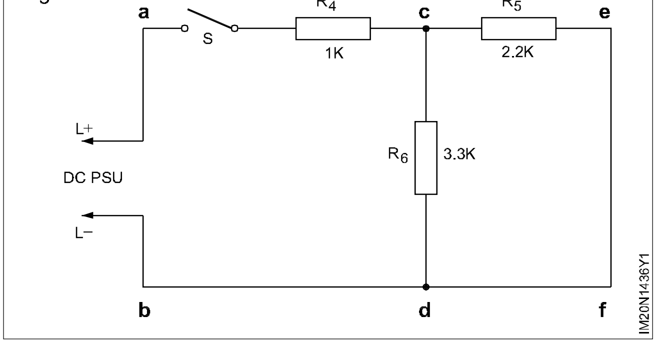
3 Mark the polarity of the voltage drops across resistors R_4, R_5 and R_6 in the copy of Fig 1.

4 Get the circuit connections and polarities marked and checked by your instructor.

5 Switch ON PSU and set output to 12V. Switch ON SPST. Following the voltage polarities marked across the resistors, measure and record the drop in voltage across resistors R_4, R_5 & R_6 in Table 1.

6 Switch OFF SPST and PSU.

Fig 1



7 Write Kirchhoff's loop equations for the closed paths a-c-d-b-a, a-e-f-b-a and c-e-f-d-c. Substitute the voltage readings recorded in Table 1 in the equations for verification.

8 Get your readings and equations checked by your instructor.

Table 1

Set circuit voltage	Measured values of			Voltage measured across		
	R_4	R_5	R_6	V_{R4}	V_{R5}	V_{R6}

— — — — — — — — —

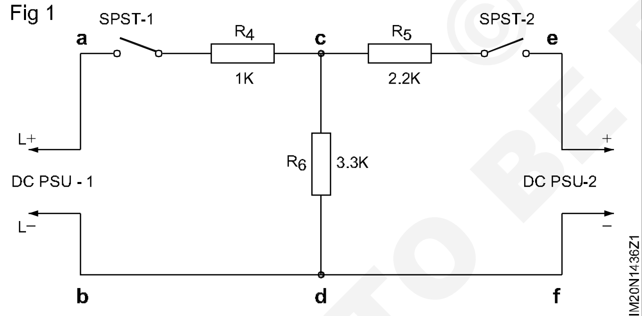
TASK 4: **Verify the Kirchhoff's voltage Law with two voltage sources**

1 Modify the circuit connections made in TASK 1, to obtain a circuit as shown in Fig 1.

Keep both the PSU's and the two SPST's in the OFF position while making circuit connections.

2 Mark the polarity of the voltage drops across the resistors R_4, R_5 and R_6 in the copy of Fig 1.

Fig 1



3 Set the output of PSU-1 to 12 volts and PSU-2 to 6 volts.

4 Switch ON both SPSTs. Following the voltage polarities marked across the resistors, measure and record the voltage drop across the resistors R_4, R_5 & R_6 in Table 1.

Note: While measuring voltage across resistors, if the meter deflects below zero, recheck the polarity marked at step 2 and repeat step 4.

5 Switch OFF the SPSTs and PSUs.

6 Write Kirchhoff's voltage equations for the closed paths a-c-d-b-a, a-e-f-b-a and c-e-f-d-c.

7 Get your readings and equations checked by your instructor.

8 Record your findings and conclusion after verifying the recorded and calculated values and check if it is same as per the theoretical conclusions.

Table 1

Set output of RPSU 1	Set output of RPSU 2	Voltage measured across		
		V_{R4}	V_{R5}	V_{R6}

— — — — — — — — —

Verify laws of series and parallel circuits with voltage source in different combinations

Objectives: At the end of this exercise you shall be able to
- **verify the laws of series circuits**
- **verify the laws of parallel circuits**

Requirements

Tools/ Instruments

•	Electrician tool kit	- 1 Set
•	Ammeter MC 0-500 mA	- 3 Nos.
•	Rheostat - 100 ohms, 1A	- 1 No.
•	Voltmeter MC 0-15V	- 1 No.
•	Multimeter	- 1 No.
•	Rheostat 0 - 25 ohm, 2A	- 2 Nos.
•	Potentiometer 60 ohm, 1A	- 1 No.
•	Rheostat 0 - 300 ohm, 2A	- 2 Nos.
•	Rheostat 0 - 10 ohm,5A	- 2 Nos.

Equipment/ Machines

•	DC source, 0 - 6V/30AH (battery), Battery 12V, 90AH - 1 No. OR DC 0-30V variable voltage supply source with current limiting facility 0-1 ampere	- 1 No.

Materials

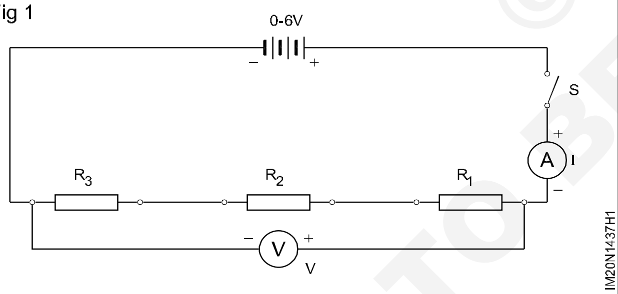
•	Switch SPT 6A 250V	- 1 No.
•	Resistor 10 ohm 1 W	- 2 Nos.
•	Resistor 20, 30, 40 & 60 ohm 1 W	- 1 No. each
•	Connecting cables	- as required.

PROCEDURE

TASK 1: **Verify the characteristics of series circuits**

1 Construct/ assemble the circuit as shown in Fig 1. (R_1 = 10 Ω, R_2 = 20 Ω , R_3 = 10 Ω)

Fig 1

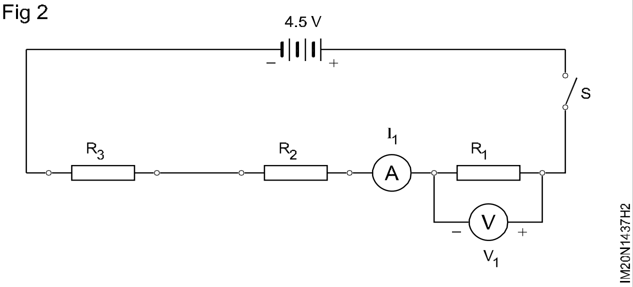


2 Close the switch 'S', measure the current (I) and voltage (V).

3 Enter the measured value in Table 1.

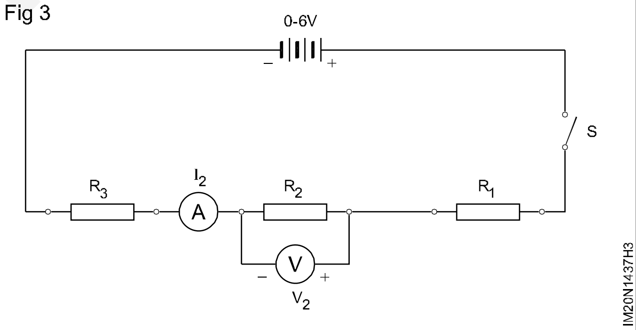
4 Switch OFF the supply. Reconnect the ammeter and voltmeter as shown in Fig 2 and measure voltage (V_1) and current I_1 through R_1.

Fig 2



5 Switch OFF the supply. Reconnect the voltmeter and ammeter as shown in Fig 3 and measure the voltage (V_2) and current (I_2) in R_2.

Fig 3



6 Draw the circuit diagram showing the position of A and V in the circuit to measure the current (I_3) and voltage (V_3) across R_3.

7 Connect and measure the I_3 and V_3 across R_3.

8 Enter the measured values in Table 1.

9 Record the relationship between I_1, I_2, I_3 and I.

10 Write down the mathematical form of current law of a series circuit.

13 Calculate resistance from the measured values, record the results with the values indicated on the resistors.

14 Record the relationship between R and R_1, R_2, R_3.

11 Record the relationship between V_1, V_2, V_3 and V.

12 Write down the mathematical form of voltage law of a series circuit.

V =

15 Write down the mathematical form of resistance law of a series circuit.

R =

16 Get it checked by the instructor

Table 1

Values	Total	R_1=10	R_2=20	R_3=10
Current	I =	I_1 =	I_2 =	I_3 =
Voltage	V=	V_1 =	V_2 =	V_3 =
Resistance	R = ______ =	R_1=______ =	R_2=______ =	R_3=______ =

TASK 2 : **Verify the characteristics of parallel circuits**

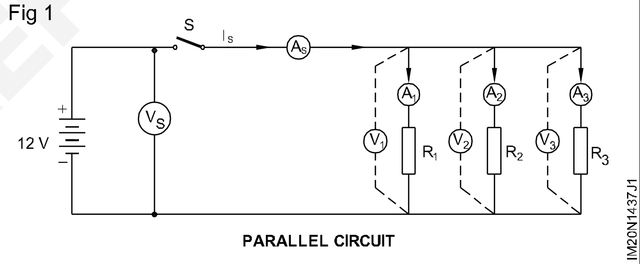
1 Use an Ohm meter to set the values of a rheostat or resistor R_1 = 40 ohms, R_2 = 60 ohms and R_3 = 30 ohms.

While using multimeter to measure resistance values see that the supply is OFF and the supply source is disconnected from the circuit.

2 Connect the resistors (Rheostats) in parallel with the switch S, ammeter A, voltmeter V and battery B as in Fig 1 and measure the current I_s and V_s. Record the valuesin Table 2.

3.Get it checked by the instructor

Fig 1



PARALLEL CIRCUIT

Table 1 Measured Value of R_T = ----------Ohms

Sl.No.	R_1	R_2	R_3	Calculated $R_T = \dfrac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}$	I_s	V_s	$R_T = \dfrac{V_S}{I_S}$

4 Measure the voltages V_S, V_1, V_2 & V_3 and record them in Table 3.

5 Calculate the current through each resistor taking into consideration V_S, applying Ohm's law and enter the values in Table 3.

6 Measure the currents I_S, I_1, I_2 & I_3 and record them in Table 1.

7 Compare the calculated values with the measured values. Record your observation. ______________

Table 1

V_s	V_1 Measured	V_2 Measured	V_3 Measured	Calculated				Measured			
				I_S	I_1	I_2	I_3	I_S	I_1	I_2	I_3

7 Calculate the value of total resistance R_T, from the above measured values.

8 Compare the measured and calculated values of total resistance R_T.

Verification

Current Characteristics $I_S = I_1 + I_2 + I_3$

Voltage Characteristics $V_S = V_1 = V_2 = V_3$

Total Resistance $R_T = \dfrac{1}{\dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}}$

Conclusion

___

___

9 Get the work checked by the instructor

Measure resistance, voltage current through series and parallel connected network using multimeter

Objectives : At the end of this exercise you shall be able to
- **measure voltage through series and parrallel circut**
- **measure current through series and parrallel circut**
- **measure resstance in series and parrallel circut**

Requirements

Tools/Instruments/Equipments

- Multimeter with test probes - 1 No.
- Long nose pliers 150mm - 1 No.
- Tweezer 150mm - 1 No.
- Sodlering iron 25W, 230V - 1 No.
- NIpper pliers 150mm - 1 No.
- Combination pliers 200mm - 1 No.
- Solder sucker - 1 No.

Materials

- D.P.S.T knife switch 16A 250V - 1 No.
- Tag board - 1 Nos.
- Resistor 1/2 watt 200, 680 ohms, 1.5K, 3.3k, 4.7K and 330K (5/20 gauge) - 1 No
- Rosin cored solder 60/40 - 20 gms.
- SPST knife switch 16A with fuse arrangement - 2 Nos.
- Crocodile clips 16 amps - 2 Nos..
  Resistors 1/2 watt 330 1k 10k - 1 No

TASK 1: **Measure voltage through senes and parrallel cirut**

1 Use the resistance board and connect the same with DC supply as shown in Fig 1.

2 Set the function swich to Dc postion.

> **Remember that the multimeter function switch should be set to match the type of source to be measured**

3 set the range selector at the highest range of DC voltage

4 Make connections to the mulimeter and resistance board as shown in Fig 1, collect a multimeter

> **Connect the common test prod (black) to the near ground terminal and positice lead (red) to the higher voltage terminal of the circuit**

5 Repeat the working steps 1 to 4 for other resistors and enter the values in Table 1

Fig 1

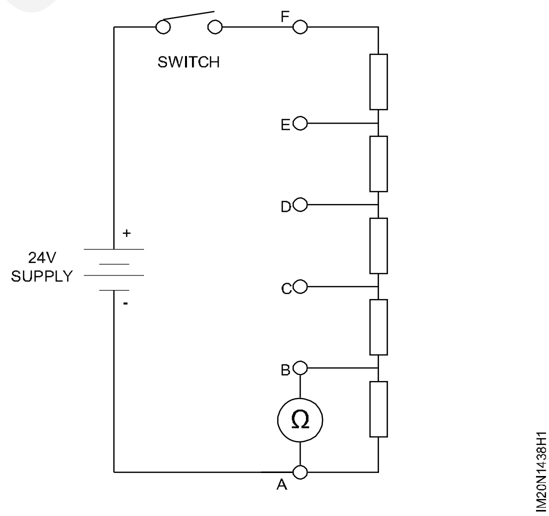


Table1

DC voltage measurement

Sl.No	Measuring Points	Selected voltage range	Multiplication Factor (M.F)	Measured value (M.Value)	Actual Voltage M.Value x MF
1	O-A				
2	O-B				
3	O-C				
4	O-D				
5	O-E				
6	O-F				

Measuring voltage using multimeter

- Prepare a circuit as shown in Fig 2
- Let the multimeter at DC voltage position
- Connect the multimeter in the circuit
- Switch on the power supply and watch the reading a cross cash resistor and hole down realign's in table 2.
- Must the voltage take few readings and note down
- Set your work checked by your instructor.

Fig 2

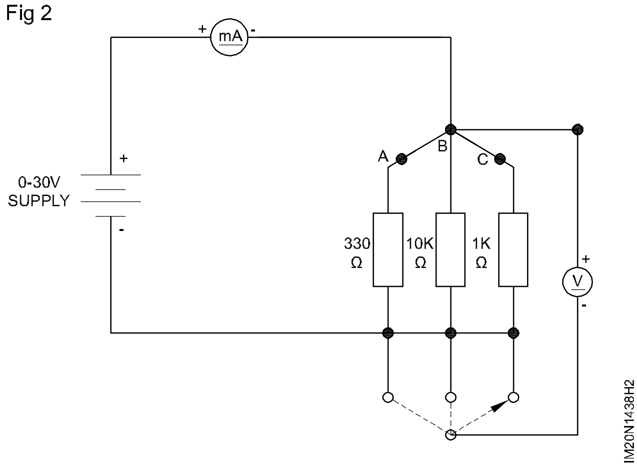


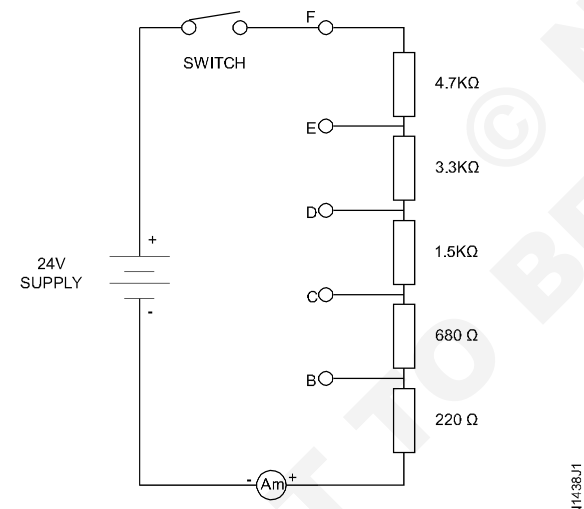
Table 2

S.no.	Resistance value (R)	Voltage (V)	current (I)
1 330			
2 1k			
3 10k			

— — — — — — — —

TASK 2: **Current through series and parralld crcuit.**

Fig 1



SERIES CIRCUIT

Fig 3

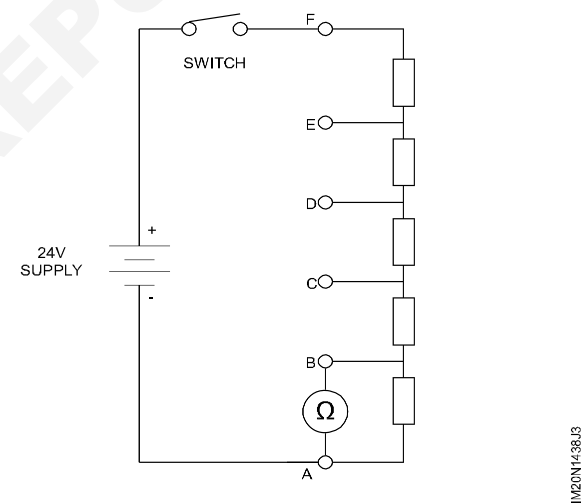
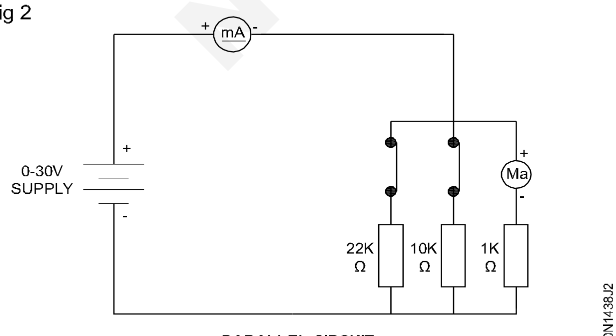
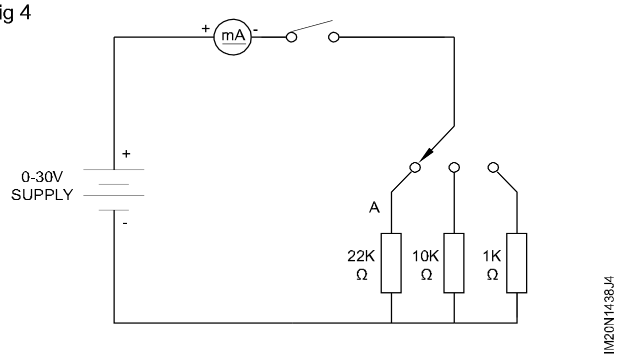


Fig 2



PARALLEL CIRCUIT

Fig 4



Measure the voltages of the given cells/battery using analog/digital multimeter

Objectives: At the end of this exercise you shall be able to
- **measure the voltage of given cell/battery using analog multimeter**
- **measure the voltage of given cell/battery using digital multimeter.**

Requirements			
Tools/Equipments/Instruments		**Materials/Components**	
• Digital multimeter with probes	- 1 No	• Lead acid battery 6V/12V any AH rating	- 1 No
• Analog multimeter with probes	- 1 No	• 1.5V/3V/9V battery	- 1 No each

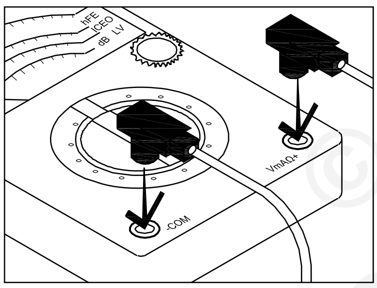
Note: The instructor has to label the cells and batteries used for this exercise /Task

PROCEDURE

TASK 1 : **Measurement of cell/battery voltage using analog multimeter**

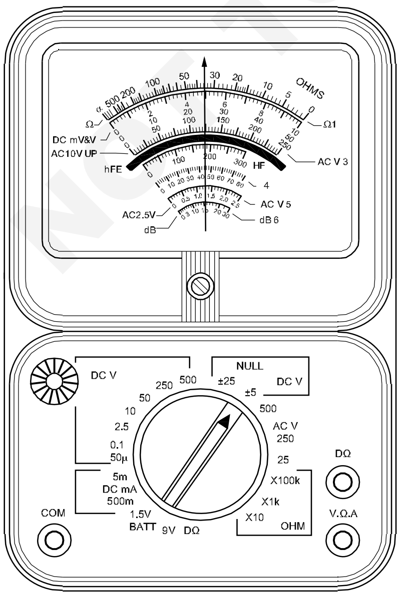
1 Observe the front panel and insert the black colour probe "COM" socket of analog multimeter and insert the red colour probe into the V mA Ω socket as shown in Fig 1.

Fig 1



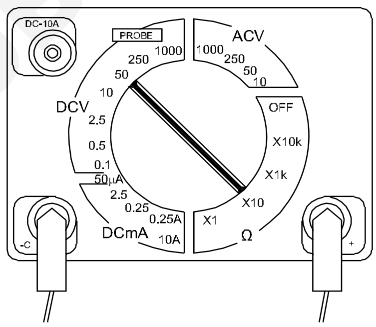
2 Set the range selector knob of multimeter to DCV, as shown in Fig 2.

Fig 2



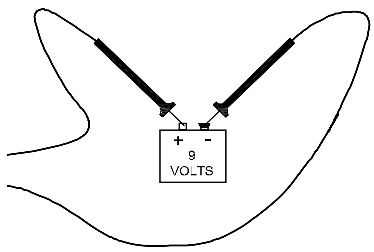
3 Set the voltage range nearest to the cell / battery voltage as shown in Fig 3.

Fig 3



4 Pick the 9V battery, place the black probe on the negative (-) terminal and red probe on the positive (+) terminal of the battery as shown in Fig 4.

Fig 4



5 Check the Analog voltmeter reading as shown in Fig 5 and record the reading in Table 1.

6 Repeat step 4 and 5 for the remaining labelled cells/ battery.

7 Get the work checked by the Instructor

Fig 5

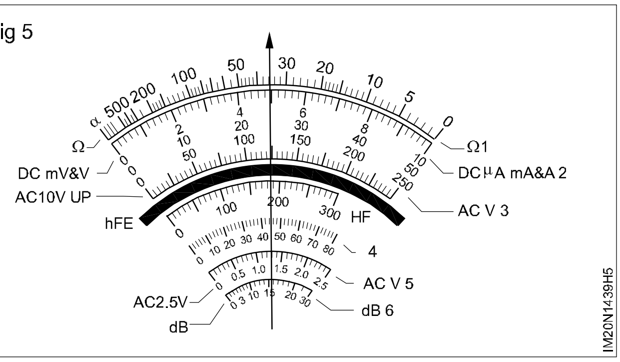


Table 1

Label No	Voltage marked on the cell/ battery	Meter range selected	Measured reading

Note: Readjust the voltage selector knob of the analog meter suitably measure the cell/battery voltage with accuracy of deflection of the pointer on the calibrated scale.

— — — — — — — —

TASK 2 : **Measurement of cell/battery voltage using Digital Multimeter**

1 Plug the black colour probe into the COM socket on the digital multimeter and red colour probe into the V Ω mA socket.

2 Turn the multi meter knob to the DC Voltage selection as shown in Fig 6a and b.

Fig 6a

Fig 6b

Note: Most digital multimeter power up in Auto range mode. This automatically selects a measurement range based on voltage present.

3 Pick one of the labelled battery and measure the terminal voltage as shown in Fig 7a and b.

Fig 7a

4 Observe the reading displayed on the digital meter and record it in Table 2.

Table 2

Label No	Voltage marked on the cell/ battery	Meter range selected	Measured reading

5 Repeat step 3 and 4 for other labelled batteries also.

Note: For accurate measurement, the voltage range selector of digital meter may be readjusted suitably.

6 Get the work checked by the Instructor.

— — — — — — — —

Dismantle and identify the different parts of a relay

Objectives : At the end of this exercise you shall be able to
- **identify the parts of relay and trace the wiring diagram of the relay**
- **test and verify the operation of the Relay.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set
- Regulated DC Power Supply, 0-30V/2A - 1 No
- Multimeter/Ohmmeter - 1 No
- DC Ammeter, 0-1A - 1 No
- DC Voltmeter, 0-30V - 1 No

Materials/Components

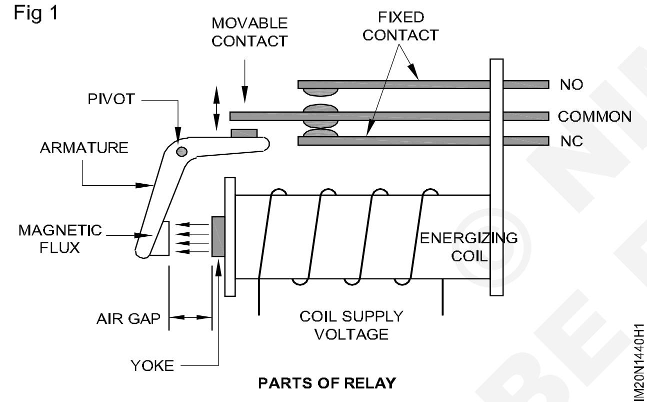
- Hook-up wire - 5 m
- 12V Relay - 1 No

PROCEDURE

TASK 1: **Identification of Relay Parts**

1 Collect the relays along with the instruction booklet. (Refer Fig 1)

Fig 1



PARTS OF RELAY

2 Inspect and determine the terminal connection of the coil and the number of contacts.

3 Identify the normally open and closed contacts by using Ohmmeter/multimeter.

4 Record the relay and contact terminal number.

5 Draw the connection diagram of the relay in the record.

6 Measure the coil resistance and record.

7 Record all the details in Table 1.

Table 1

1	Type of Relay	: …………	
2	Coil Voltage	: …………	
3	Number of terminals	: …………	
4	Number of NO contact	: …………	
5	Number of NC contact	: …………	
6	Coil Resistance	: …………	Ohm
7	Pickup Current	: …………	mA
8	Reset Current	: …………	mA

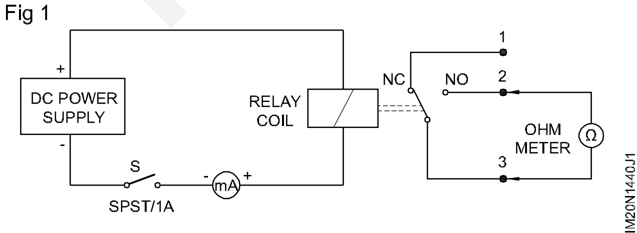
8 Get the work checked by the Instructor.

— — — — — — — —

TASK 2: **Testing of a Relay**

1 Connect the supply as per the diagram.(Fig 1)

Fig 1



2 Adjust the power supply voltage to minimum.

3 Switch ON the Switch 'S'.

4 Slowly increase the DC Voltage till the ohmmeter/ multimeter connected across the normally open contact shows deflection or makes sound.

5 Observe the minimum current (Pick up Current) required to activate the relay and enter the value.

6 Slowly reduce the voltage of the power supply till the ohmmeter/multimeter connected across the normally open contact shows infinity deflection or sound gets OFF.

7 Observe the minimum current (Reset current) required to deactivate the relay and enter the value.

8 Get the work checked by the Instructor.

— — — — — — — —

Connect a timer relay in a circuit and test for its working

Objectives : At the end of this exercise you shall be able to
- **identify the terminals of timer relay**
- **test relay for it's working**

Requirements

Tools/Instruments/Equipments

- Timer relay 230u/1A - 1 No
- NCON tester 230u/1A - 1 No.

Materials

- Main charges
- Twp Pin Plug with wire
- Screw driver
- 40W bulb folder
- Insulation tape
- Plier

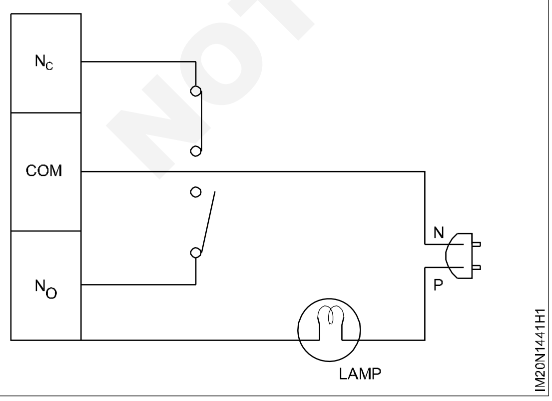
PROCEDURE

1 Identify the terminals Table 1

S.No	Terminal No.	Description

2 Identify the terminals
3 Connect mains chord to the terminal No.
4 Take a two pin plug connected with wire
5 Give neutral to common terminal No
6 Connect a how bulb between 'NO' Terminal and plug
7 The Number of 'NO' terminal is
8 Set the Time
9 Switch on the supply to the timer relay and also the supply to the 40 w bulb

Fig 1



10 Observe
11 Note down the working as an Table 2

Table 2

S.No	Set time in min/sec/min	Nature of the bulb after the set time bulb glows

- Connections should be correct and tight
- Provide proper insulation

Connect a contactor in a circuit and test for it's working

Objectives : At the end of this exercise you shall be able to
- **identify the parts of contactor**
- **connect the contactor in a circuit & test for its working.**

Requirements

Tools/Instruments

- Combination pliers 200mm - 1 No.
- Screwdriver 150mm - 1 No.
- Connector screwdriver 100mm - 1 No.
- Electricians knife - 1 No.
- Round nose pliers 150mm - 1 No.
- Multimeter - 1 No.
- Voltmeter 300V, AC - 1 No.
- Ammeter 500mA AC - 1 No.
- Electrical drilling machine 6mm - 1 No.
- Capacity with 2, 3 and 4mm drill bits - 1 No.

Equipment/Machines

- Dimmerstat/auto-transformer/variac 230V/0-270V - 1 No.
- NIMI electrical machine bench - 1 No.

Materials

- PVC insulated cable, 2.5 sq.mm
- 650V grade - 10 m.
- Magnectic contactor, 3-phase
- 20A, 230V - 1 No.
- 'ON' and 'OFF' push button stations, having one (normally closed) and one (normally open) contacts in each set - 1 No.
- Test lamp 40W, 230V - 2 Nos.
- Laminated boards of size
- 200mm. (L) X 150mm. (B) X 3mm. (T) - 3 Nos. Machine screws 2 BA 25mm long with two washers and nuts - 10 Nos.

PROCEDURE

TASK 1: **Identify the parts of the contactor and their operation**

1 Inspect visually the given contactor.

2 Identify the mounting holes for fixing screws.

3 Dismantle the contactor carefully.

4 Identify the parts like protective housing, contact supports, main and auxiliary contacts, no-volt coil, armature, yoke, springs etc.

5 After a careful study, draw the schematic diagram for the given contactor in Table 1 in the space available just below the sample schematic diagram.

6 Identify the incoming and outgoing terminals of the power circuit. Note down the same in Table 1.

7 Assemble the contactor and check the operation of the moving magnetic core and the moving contacts by using hand pressure.

8 Trace and check the terminal connections to the fixed contacts.

9 Check the continuity between incoming and outgoing terminals, when the contactor is open and when closed manually, and write in the Table 1.

10 Identify the no-volt coil and its connecting terminal. Enter the details in Table 1.

11 Measure the resistance of a no-volt coil by the multimeter and write in Table 1.

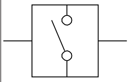
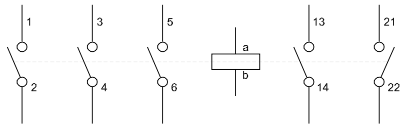
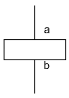
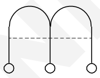
> **Schematic diagram given in Table 1 is for a particular contactor. The contactor given to you may have different identification marks. If so, strike off the given numbers and incorporate the new numbers/letters by the side of the given numbers or otherwise draw a new schematic diagram as implied in working step 5 of Task 1. Likewise change the identification given in the column 'Conditions between terminals as ' in Table 1.**

12 To determine the minimum voltage required for the operation of the no-volt coil, first position the contactor on the laminated board and mark the fixing holes.

13 Drill holes in the marked places with the help of an electrical drilling machine.

14 Fix the contactor on the laminated board with the help of machine screws.

TABLE 1

Sl. No.	Device	Symbol	Schematic diagram	Conditions between terminals	Write whether open or close
1	Contactor		Sample	under open (normal) condition	
	Identification Incoming terminals ______ ______			1 & 2.... 3 & 4.... 5 & 6....	______ ______ ______
	Outgoing terminals ______ ______			21 & 22 13 & 14	______ ______
				Under manually closed condition 1 & 2.... 3 & 4.... 5 & 6.... 21 & 22... 13 & 14...	______ ______ ______ ______ ______
2	No-volt coil			a & b Resistance value____ ohm	
3	Terminals of 'No' volt coil ______ ______				Voltage rating ______ volt.

Steps 12-14 are not required if the NIMI electrical machine bench is available as the devices are already fixed on the laminated boards.

15 Fix the laminated board with the contactor in a vertical position on a wooden board of the working bench.

16 Connect the no-volt coil circuit through an ammeter push-button, ON switch and a dimmerstat as shown in Fig 1.

17 Connect the two lamps L_1 and L_2 with the auxiliary terminals 21,22,13 and 14 as shown in Fig 1.

18 Connect a voltmeter as shown in Fig 1.

19 Keep the knob of the auto-transformer (dimmerstat variac) in a low position such that the output is approximately zero.

20 Switch on the supply and slowly increase the voltage to 100V by turning the auto-transformer knob.

Now the no-volt coil is connected across 100 V AC though the operating voltage written on the no-volt coil is 230V or any other rating given in your starter no-volt coil.

If the contactor is not closed then the indication lamp L_1 will be on and lamp L_2 will be off.

21 Push the 'ON' button. See whether the no-volt coil holds the movable contacts down.

If the magnetic coil holds (operates), this will be indicated by L_1 off and L_2 on.

22 write your observation in Table 2.

23 If the magnetic contact does not hold, increase the applied voltage in steps of 25V upto the rated voltage of the no-volt coil and observe the operation by pushing the

Construct and test series and parallel resonance circuit

Objectives : At the end of this exercise you shall be able to
- **determine the resonance frequency of a given LC series circuit**
- **determine the circuit current at different frequencies**
- **plot a graph of frequency versus circuit current.**
- **determine the resonance frequency of a given LC parallel circuit.**

Requirements

Tools/ Equipment/ Instruments

- Trainees tool kit - 1 Set
- Dual trace CRO, 0-20 MHz with manual - 1 No
- Function generator with manual - 1 No
- Milli Ammeter 0-30mA - 1 No

Materials/ Components

- General purpose Lug board - 1 No
- Capacitor 0.1 µF - 1 No
- Inductor coil, around 40mH (Use the solenoid coil made in unit 5) - 1 No
- Unknown value Inductor - 1 No
- LED with holder - 1 No
- Hook-up wires - as reqd

PROCEDURE

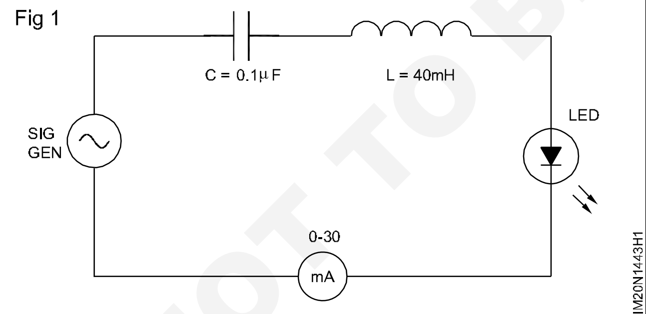
TASK 1 : **Determine the resonance frequency of a given LC series circuit**

1 Measure and record the inductance of the coil.

2 Solder the components as shown Fig 1 to obtain a simple series resonance circuit. Connect instruments as shown in Fig 1

The LED in the circuit is to get a visual indication of the current through the circuit at different frequencies.

Fig 1



3 Knowing the values of L and C, calculate and record the resonance frequency of the series resonance circuit.

4 Set the output of the signal generator to $10V_{rms}$ and frequency to 1 kHz. Record the current, I through the circuit.

LED may not be glow or may be very dim, because the set frequency of 1 kHz may not be the resonance frequency of the circuit.

5 Increase the frequency gradually and record the resonance frequency for at which the circuit current becomes maximum (LED glows brightly)

This is the resonance frequency of the series resonance circuit because at series resonance current I through the LC circuit will be maximum.

6 Compare and record the difference in the resonance frequency calculated at step 3 and that measured in step 5.

7 Vary the input frequency in steps of 500 Hz around the resonance frequency and in each step record the value of circuit current.

8 From the recorded readings of current in step 6, plot a graph of frequency versus current and mark the resonance frequency of the LC series circuit.

9 Get the working of the circuit, recorded readings and the graph checked by the instructor.

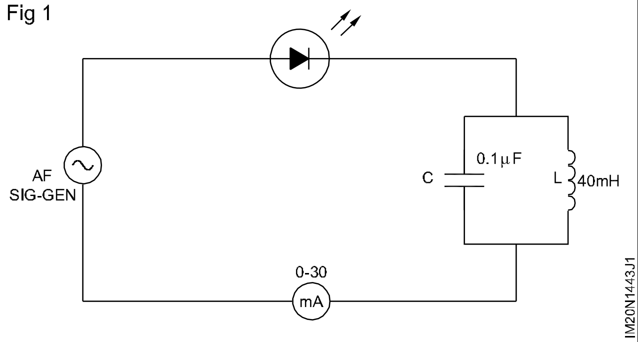
— — — — — — — —

TASK 2 : **Determine the resonance frequency of a given LC parallel circuit**

1 Measure and record the inductance of the coil.

2 Solder the component as shown Fig 2 to obtain a simple parallel resonance circuit. Connect components as shown in Fig 1.

Fig 1



> **The LED in the circuit is to get a visual indication of the current through the circuit at different frequencies.**

3 Knowing the values of L and C, calculate and record the resonance frequency of the parallel resonance circuit.

4 Set the output of the signal generator to $4V_{rms}$ and frequency to 1 kHz. Record the current I through the circuit.

> **Ensure that the current through the circuit is around 10 to 12 mA and not more. If more current is flowing, reduce the output level of the signal generator. LED will glow at all frequencies other than at the resonant frequency.**

5 Increase the frequency gradually and record the resonance frequency f at which the circuit current becomes minimum (LED does not glows or glows very dim).

> **This is the resonance frequency of the parallel resonance circuit because at parallel resonance, current (I) through the parallel LC circuit will be minimum.**

6 Compare and record the difference in the resonance frequency calculated at step 3 and that measured in step 5.

7 Vary the input frequency in steps of 500 Hz around the resonance frequency and in each step record the value of circuit current.

8 From the recorded readings of current in step 6, plot a graph of frequency verses current and mark the resonance frequency of the LC parallel circuit.

9 Get the working of the circuit, recorded readings and the graph checked by the instructor.

Make a panel board using different types of switches for a given application

Objectives: At the end of this exercise you shall be able to
- **fix the accessories on the board**
- **wire the cable on the panel board according to the wiring diagram**
- **terminate the cable in accessories**
- **test the circuit.**

Requirements

Tools/Instruments

- Hacksaw - 1 No.
- Screw driver - 1 No.
- Electrician knife - 1 No.
- Drill bit - 1 No.
- Side cutting plier - 1 No.

Materials

- Wooden panel board - 1 No.
- Wood screws - 1 No.
- T.W wooden block - 1 No.
- Two way switch (SPDT) - 1 No.
- Bakellie pattern - 1 No.
- Lamp 100 W - 1 No.
- Fuse & Fuse holder - 1 No.
- Two way switch cspot - 1 No.
- Bulb Holder - 1 No.

PROCEDURE

TASK 1 : **Preparation of panel board**

1 Collect the accessories and materials for the exercise.

2 Identify the mode of connections to the terminals with respect to the position of the knob and the draw the connection diagram in your record book.

3 Keeping the above connections as the base draw a schematic diagram to control one lamp and one switch.

4 Show the connections to your instructor and get this approval.

— — — — — — — —

TASK 2 : **Form the circuit on a panel board**

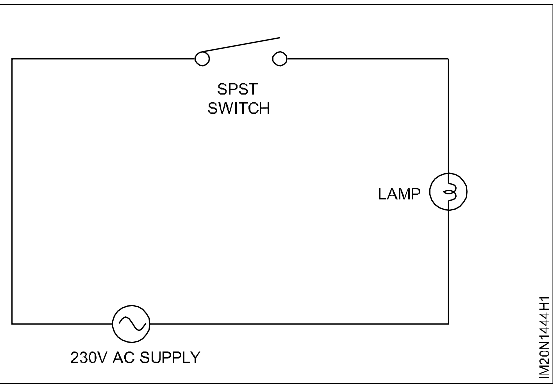
1 Fix the wooden blocks, switches, fuse holder on the wooden panel as shown in the figure.

2 Wire the circuit according to the approved diagram.

3 Operate the switch and note down the result.

4. Get the work checked by your instrcutor

Fig 1



Result :

Switch (SW)	Lamp Condition	Remarks
Closed		
Open		

TASK 3: **Ascertain the connection of a two way switch**

1 Collect the accessories and materials for the exercise.

2 Identify the mode of connection to the terminals with respect to the position of the knob and draw the connection.

3 Show the connections to the instructor and get this approved.

— — — — — — — —

TASK 4: **Form the circuit on a panel board**

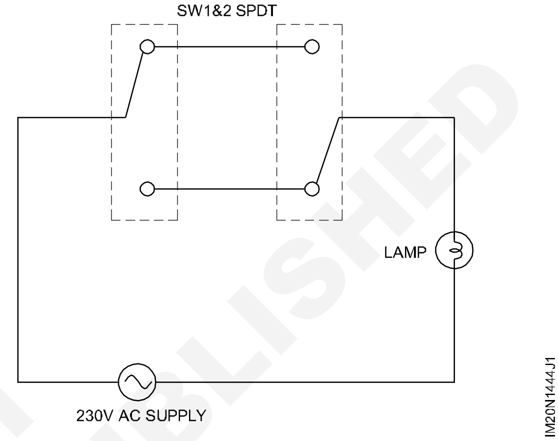
1 Fix the wooden blocks, switches, fuse holder on the wooden panel as shown in the figure.

2 Wire the circuit according to the approved diagram.

3 Operate the switch and note down the result.

4 Get the work checked by your instructor.

Fig 1



Result :

SW-1	SW -2	Lamp Condition	Remarks
UP	UP		
UP	Down		
Down	UP		
Down	Down		

Practice cutting threading of different sizes and laying installations

Objectives : At the end of this exercise you shall be able to
- **measure and cut the conduit pipe according to requirement**
- **prepare the conduit pipe ends for threading and fastening in a pipe vice**
- **cut the threads on heavy gauge metal conduit according to requirement using a conduit die set.**

Requirements

Tools/Instruments

- Pipe vice 50mm - 1 No.
- Steel rule 600mm - 1 No.
- Hacksaw with a blade of 24 teeth per 25mm (25 TPI) - 1 No.
- Blowlamp, 1 litre with kerosene - 1 No.
- Flat file bastard 200mm - 1 No.
- Half round file bastard 200mm - 1 No.
- Reamer 16mm - 1 No.
- Oil can 200ml - 1 No.
- Conduit stock and dies for 18 mm conduit - 1 set.
- Wire brush 50mm - 1 No.
- Conduit bending machine (bench type) with 18mm collet and guide - 1 set.

Materials

- Conduit pipe 19 mm dia. 3m long - 1 No.
- Lubricant - coconut oil (for a batch of 16 trainees) -100 ml
- Chalk piece - 1 No.
- Cotton waste - as reqd.
- Matchbox (For a batch of 16 trainees) - 1 No.
- Wooden plugs suitable to plug 16mm holes - 2 Nos.
- River sand (For a batch of 16 trainees) - 2 litres.

PROCEDURE

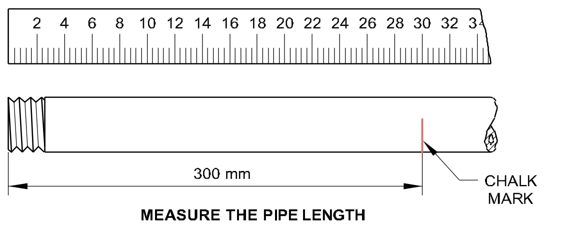
TASK 1: **Preparation of conduit pipe for cutting.**

Assume the job needs a 300 mm long conduit drop but a standard length pipe of 3000 mm is only available. Normally both the ends of a standard length pipe will have threads. To make the required conduit drop, the standard length 3000 mm pipe is to be cut for a length of 300 mm and threaded again at one end.

Cutting could be done either by pipe cutters or with hacksaws. In practice, cutting with a hack-saw is popular, and the method is explained below

1 Measure 300mm from the threaded end of the pipe and mark it with chalk as shown in Fig 1.

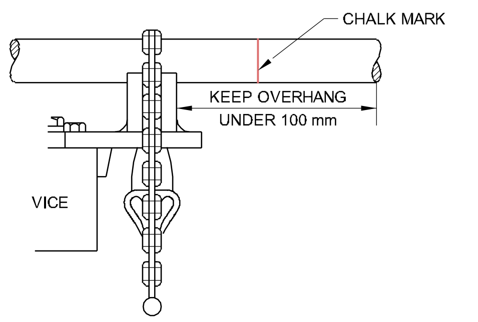
Fig 1



2 Open the jaw of the vice and insert the pipe so that it is horizontal and parallel to the jaw serrations.

3 Keep the chalk mark of the pipe within 100 mm of the vice as shown in Fig 2.

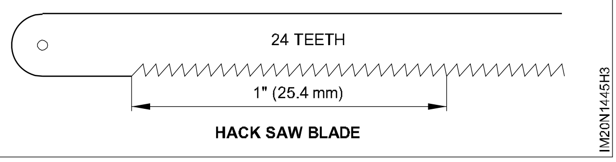
Fig 2



4 Close and tighten the vice jaw.

5 Select a hacksaw with a blade having 24 teeth per 25mm (25 TPI), as shown in Fig 3.

Fig 3

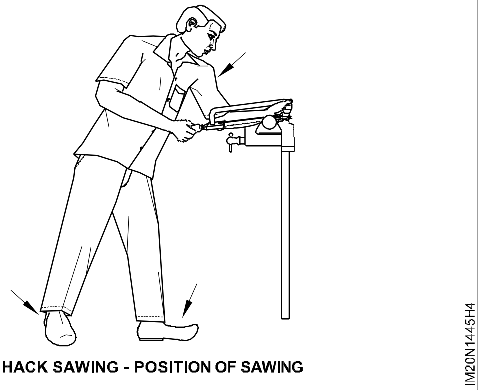


HACK SAW BLADE

Ensure that the hacksaw blade is firmly tightened in the frame and that the teeth point in the forward direction.

6 Take up the hacksaw and position yourself, as shown in Fig 4, with your left shoulder pointing in the direction of the cut. Note the position of the feet, which allows for free and controlled movement of the body when cutting.

Fig 4

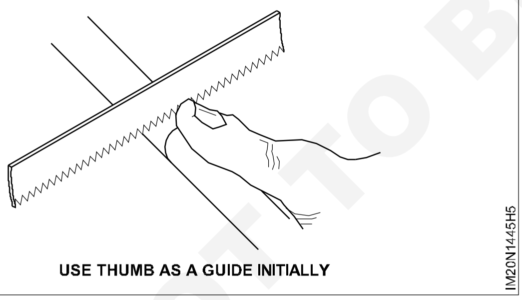


HACK SAWING - POSITION OF SAWING

7 Grip the hacksaw handle with the right hand and position the hacksaw blade on top of the cutting line.

8 Prepare to cut by guiding the blade with the thumb of your left hand exactly on the cutting line against the saw blade as shown in Fig 5.

Fig 5



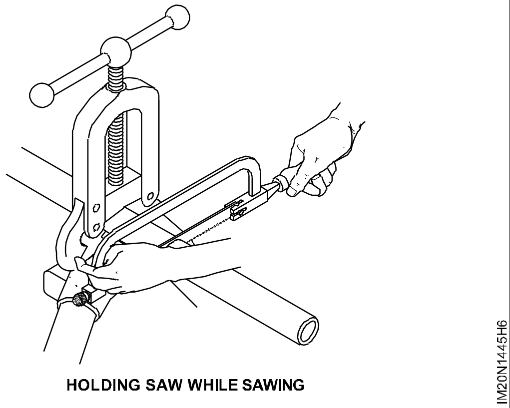
USE THUMB AS A GUIDE INITIALLY

9 When the initial cut has been made, move the left hand to the front end of the hacksaw frame and use both hands for the cutting operation as shown in Fig 6.

10 When sawing, use the full length of the blade, increasing gradually the pressure on the forward stroke, and releasing the pressure as the blade is drawn back. (Fig 6)

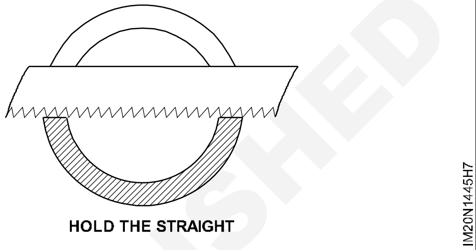
11 Saw with steady, even strokes, keeping the blade upright and square to the cut as shown in Fig 7.

Fig 6



HOLDING SAW WHILE SAWING

Fig 7

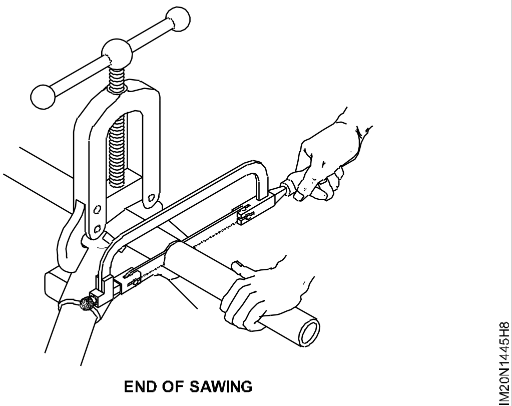


HOLD THE STRAIGHT

12 When getting near to the end of the cut, the conduit must be supported with your left hand as shown in Fig 8. Finish the cut.

Support the free end of the conduit to prevent the blade of the hacksaw from being damaged.

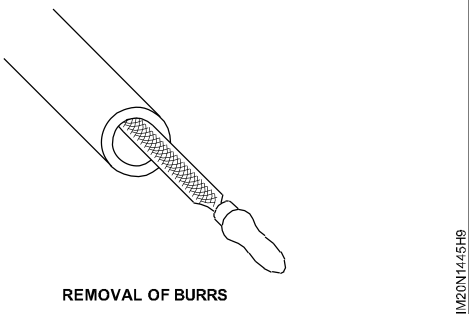
Fig 8



END OF SAWING

13 Use a reamer or half round file to remove the inside burrs as shown in Fig 9.

Fig 9

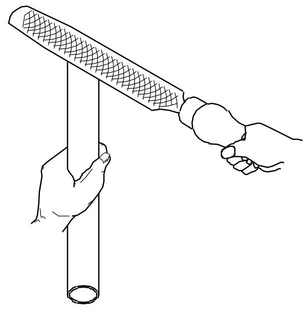


REMOVAL OF BURRS

14 Use the flat portion of the half round file to smoothen the sharp edges. (Fig 10)

15 Clean the hacksaw and vice after the end of the work and keep them in their respective places.

Fig 10



REMOVAL OF SHARP EDGES

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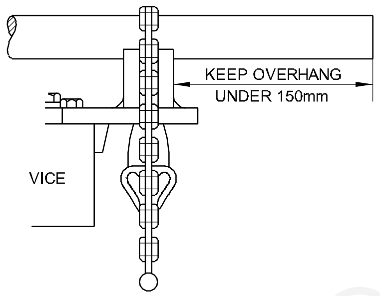
TASK 2: **Preparation of conduit pipe for threading.**

1 Open the jaw of the vice and insert the pipe so that it is horizontal and parallel to the jaw serrations.

2 Keep the end of the tube within 150 mm of the vice.

3 Close and tighten the vice as shown in Fig 1.

Fig 1

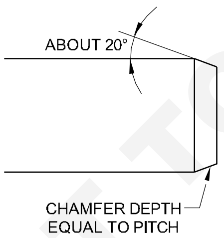


HOLD THE PIPE IN THE PIPE VICE FOR THREADING OPERATION

IM20N1445J1

4 File the end of the tube flat and chamfer the outer edge to an angle of about 20^{o} as shown in Fig 2.

Fig 2



BEFORE THREADING, CHAMFER THE EDGE OF THE PIPE

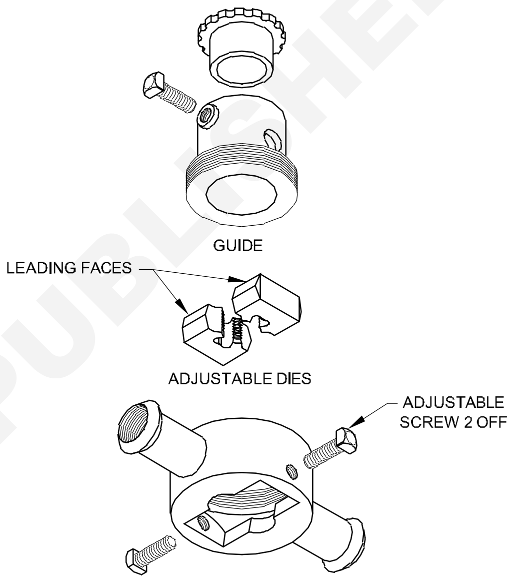
IM20N1445J2

Make the depth of the chamfer equal to the pitch of the thread (1.5 mm for conduit).

5 Choose the correct dies and stock suitable for the pipe to be threaded.

Assembly drawing for the quick cut stock and dies is given in Fig 13. The die size is engraved on the die itself. Check the size with that of the pipe. The handle of the stock is not shown in the picture for clarity.

Fig 3



DIE SET (HANDLE NOT SHOWN)

IM20N1445J3

6 Insert each half of the die in the cap(stock) with the chamferred threads(leading faces) being adjacent to the guide.

7 Screw the guide into position.

8 Adjust each adjusting screw equally to make the die halves centralized to the pipe axis.

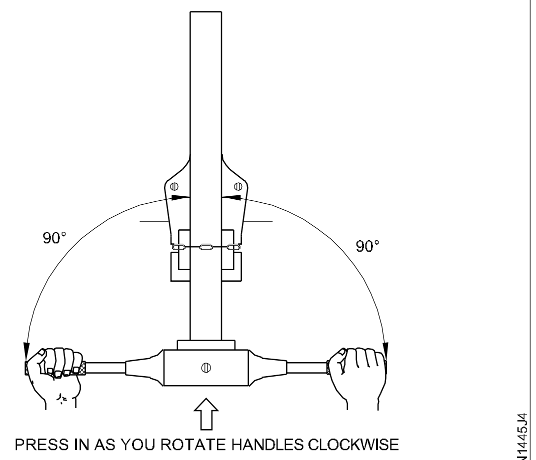
9 Slide the stock guide over the end of pipe, adjust the adjusting screws such that the dies just grip the pipe evenly on both sides.

10 Apply pressure to the stock and keep the handles at right angles to the pipe as shown in Fig 4.

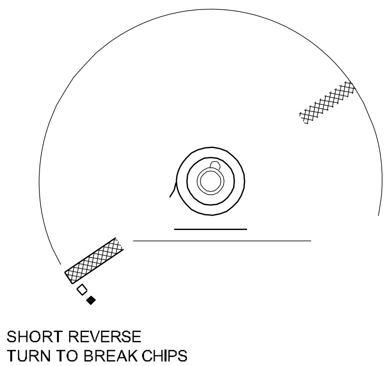
11 Rotate the handles clockwise in a plane at right angles to the pipe axis as shown in Fig 5.

12 Apply the lubricant to the part to be threaded after the thread has been started.

Fig 4



MOUNTING THE DIE SET IN THE CONDUIT



THREADING PROCESS

The lubricant allows the die to cool off the heat developed and thereby helps the edges to stay sharp and to produce a better thread finish.

13 Make one or two complete turns in a clockwise direction.

Check whether the stock is at right angle to the pipe axis.

14 As indicated by the increased resistance of rotation, ease the handle as frequenly as necessary, back in an anticlockwise direction for half a turn.

Reverse turning is necessary to break off long cuttings and to clear the cutting edges of the die.

15 Apply the lubricant at frequent intervals.

Use a brush to remove the metal burrs from the die.

16 Remove the stock. Check the length and fit of the thread by screwing on the female fittings (coupling etc.).

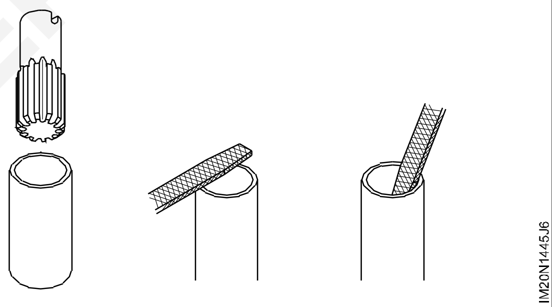
The length of the thread should be sufficient to fit half way into the couplings and fully into the other fittings.

17 If the thread is not smooth (i.e.tight in the fittings) mount the stock and tighten the adjusting screws by half turn evenly and repeat working steps 10 to 6.

18 Remove any burrs or sharp edges from inside the end of the pipe with a reamer or half round file as shown in Fig 6, and file off the sharp edges, if any.

19 Clean the die stock and vice. Keep them in their respective places.

Fig 6



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Draw layout and practice in PVC casing-capping conduit wiring with minimum to a greater number of points of minimum 15mtrs length

Objectives: At the end of this exercise you shall be able to
- **draw the plan diagram for the given work station**
- **draw the circuit diagram**
- **mark the layout on the work station/location**
- **prepare the PVC channel as per the marked layout**
- **fix the PVC channel and other PVC accessories**
- **run the cable as per the circuit diagram**
- **fix the PVC top cover over the casing**
- **prepare and fix the terminals**
- **mount the switches socket outlets, and other accessories**
- **connect the wire leads as per the circuit diagram and test the circuit.**

Requirements

Tools/ Instruments

- Combination pliers 200mm - 1 No.
- Screwdriver 200mm with 4mm blade - 1 No.
- Side cutting pliers 150mm - 1 No.
- Electrician's knife - 1 No.
- Bradawl 150mm - 1 No.
- Ball peen hammer 250 grams - 1 No.
- Hacksaw with 24 TPI blade - 1 No.
- Firmer chisel 10mm - 1 No.
- Round file rasp 150mm - 1 No.
- Flat file rasp 200mm - 1 No.
- Neon tester 500V - 1 No.
- Drill bits 6mm, 3mm - 1 each.
- Hand drilling machine 6mm capacity - 1 No.
- Gimlet 4mm dia. - 1 No.

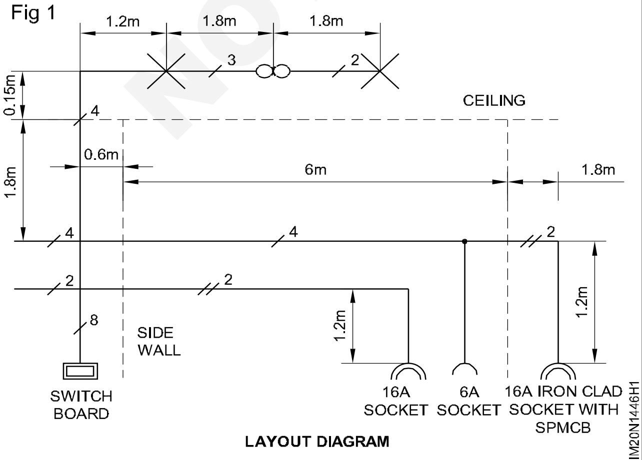
Materials

- 3/4” PVC pipe 15mt
- 3/4” elbow - as reqd
- 3/4” Tee - as reqd
- PVC cable 1.5/2.5 sq.mm - 2 coil each
- PVC casing & capping 25 mm - 5 length
- 16 A 3 pin 240V socket - 2 Nos.
- 6 A 3 pin 240V socket - 2 Nos.
- 2 plate ceiling 240V - 1 No.
- TW box 8" x 6" with laminated top - 3 Nos.
- 1 ϕ industrial socket 16A 240V with S.P. & MCB - 1 No.
- SPT 16A 240V switch - 2 Nos.
- Wooden screws 8 x 45 mm - 20 Nos.
- Wood screws No. 6 x 35 mm - 1 box
- Wood screws No. 5 x 15 mm - 1 box
- TW round block 25 x 45 mm - 3 Nos.
- PVC 25 mm casing & capping 4 way - 1 No.
- PVC 25 mm casing & capping 3 way - 1 No.
- PVC 25 mm casing & capping elbow - 1 No.

PROCEDURE

1 Trace the layout diagram and the cable route, distance, location of fittings and other accessories. (Fig 1)

Fig 1



2 Draw the wiring diagram for the given load as per the layout plan.

3 Check your wiring diagram with the wiring diagram given by your instructor.

4 List out the materials required for this wiring.

5 Compare your material list with the list given by your instructor.

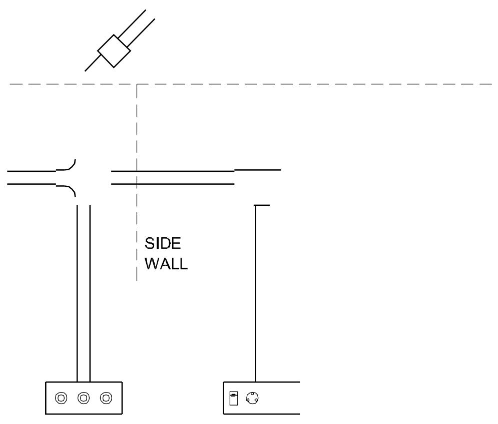
6 Collect the materials as per the approved list.

7 Mark the layout points on the building as per the installation plan. (Fig 2)

8 Drill holes in the PVC channel for fixing at a distance of 60cm using drilling machine.

9 Place the channel on the marked route and mark for jumper holes for fixing.

Fig 2



CHANNEL WIRING INSTALLATION PLAN

10 Prepare the joints on the PVC channel (refer layout).

Whenever the cable is to be bent cut and remove the side wall of the PVC channel.

11 Fix the PVC channel on the walls and ceiling as per the layout.

12 Run the cable in the PVC channel as per the wiring diagram.

13 Fix the top cover on the channel.

14 Mark and cut the PVC boxes/meter box for the casing entry.

15 Drill holes in the PVC boxes for cable entry and for fixing holes and take out the end terminals of cables.

16 Fix the PVC box/Metal box in the marked position.

17 Terminate the cable in the accessories and fix them.

18 Mount the switches, fan regulator and other fittings in the PVC box/metal box.

19 Fix the PVC box/metal box using wood screws.

20 Test the circuit for insulation value, earth continuity and polarity test.

21 Test the circuit with supply after getting approval from the instructor.

Wire up PVC conduit wiring to control one lamp from two different places

Objectives: At the end of this exercise you shall be able to
- **form the circuit using two-way switches to control one lamp from two different places**
- **cut the profiles in a wooden board according to marking for flush-type accessories (R)**
- **wire up a circuit in PVC cassing and capping to control one lamp from two different places.**

Requirements

Tools/Instruments

- Trainees tool kit - 1 No.
- C.P. hammer 250 gms - 1 No.
- Screwdriver 200 mm with 5 mm blade - 1 No.
- Screwdriver 150 mm with 3 mm blade - 1 No.
- Electrician's knife (100 mm) - 1 No.
- Connector screwdriver 100 mm - 1 No.
- Mallet 5 cm dia. - 1 No.
- Gimlet 5 mm dia. 200 mm long - 1 No.
- Hand drilling machine 6 mm capacity - 1 No.
- Drill bit 3 mm to 5 mm - 1 each
- Try square 150 mm - 1 No.
- Brawdal 150 mm - 1 No.
- Combination pliers 200 mm - 1 No.
- Hacksaw frame with balde (24 TPI) - 1 No.
- Steel rule (300 mm) - 1 No.

Materials

- PVC casting and capping (30 mm x 10 mm) - 2 Nos.
- PVC terminal box - 1 No.
- Wood screws No.6x12 mm - 3 Nos.
- Wood screws No.6x20 mm - 4 Nos.
- PVC-sheathed aluminium cable 1.5 sq mm. 250V grade - 6 m.
- Flush mounting two-way switch 6A, 250V - 2 Nos.
- Batten lamp-holder, brass 6A, 250V - 1 No.
- Terminal plate 2-way - 1 No.
- Bulb 40W, 250V, BC type - 1 No.
- PVC round block (90mm x 40 mm) - 1 No.
- PVC swich 180 mm x 100 mm with sunmica cover - 1 No.
- PVC 'Tee' bends and elbow (Each) - 2 Nos.
- Marking Pen/Pencil/Chalk - as reqd.
- Marking thread - as reqd.
- PVC Insulation tape - 1 Roll.
- Self tapping screw (20 mm) - as reqd.

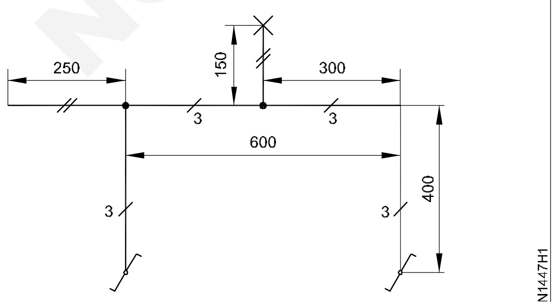
PROCEDURE

1 Estimate the tools and materials required for the job according to the layout (Fig 1) and the wiring diagram. (Fig 3) Compare the list with the given list. Discuss with your co-trainees/instructor about the variations between the two lists.

2 Collect materials as per the list.

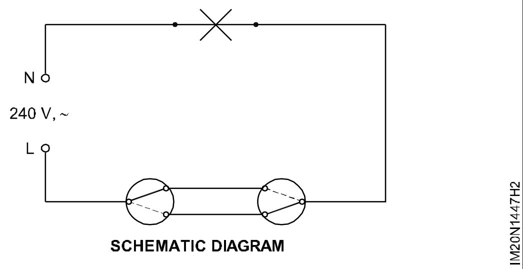
3 Identify and confirm the switches received are two-way switches only.

Fig 1



LAYOUT DIAGRAM

Fig 2



SCHEMATIC DIAGRAM

4 Identify the terminal points, cable entry holes and fixing holes of the switches and batten lamp-holders.

5 Form the circuit as per the schematic diagram shown in Fig 2.

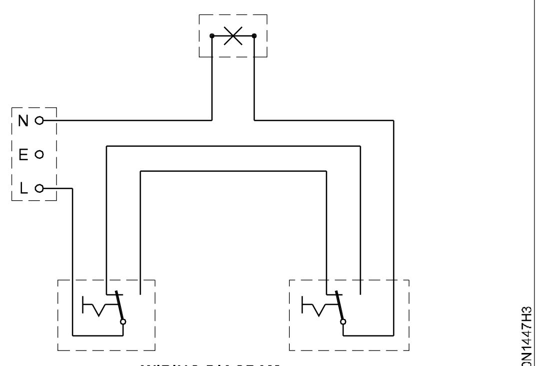
Get the approval of the instructor. If necessary, make alterations in the connections.

6 Connect the supply, check the function of the circuit and note the results in Table 1.

Table 1

S_1,S_2 position up	____________
S_1,S_2 position down	____________
S_1 up and S_2 down	____________
S_1 down and S_2 up	____________

Fig 3



WIRING DIAGRAM

7 Mark the layout points on the building as per the installation plan (Fig 4)

8 Drill holes in the PVC casing for fixing at a diameter of 60 cm using drilling machine

9 Place the casing on the worked route and mark for jumber holes for fixing

10 Prepare the joints on the PVC casing

Whenever, the cable is to tbe bent, cut and remove the side wall of the PVC casing

11 Fix the PVC casing, on the walls and ceiling as per the layout

12 Run the cable in the PVC casing as per the wiring diagram

13 Fix the top cover on the casing

14 Mark and cut the PVC boxes for the casing entry

15 Fix the PVC box in the marked position

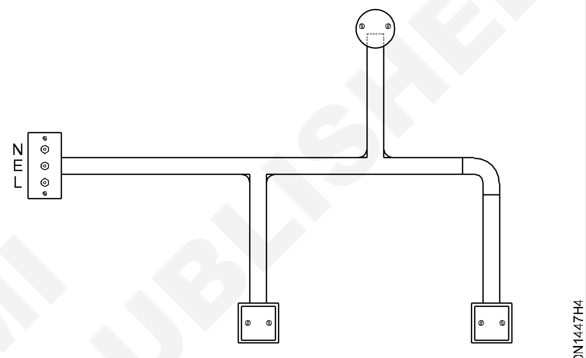
16 Terminate the cable in the accessories and fix them.

17 Mount the switches in their respective places and give connection to it.

18 Test the circuit with the supply

19 Get it checked with you instructor

Fig 4



INSTALLATION PLAN

Draw layouts and practice wiring for instrument panel

Objectives : At the end of this exercise you shall be able to
- **mark the layout on the panel board for proper position of the accessories**
- **make drill points and drill holes on the panel board**
- **cut and fix the accessories in the panel**
- **use the crimping tool to crimp the lugs at the cable**
- **connect the wires and complete the wiring as per the wiring diagrams**

Requirements

Tools/Instruments/Equipments

- Steel rule 300mm - 1 No.
- Round nose plier 200mm - 1 No.
- Round nose plier 150mm - 1 No.
- Screw driver 100mm, 150mm - 1 No each.
- Crimping tool 200mm - 1 No.
- Scriber 100mm - 1 No.
- Smooth file, half round, 150mm - 1 No.
- Hand drilling machine 6mm capacity - 1 No.
- HSS drill bit 4mm - 1 No.
- Ammeter MI o-5A - 1 No.
- Voltmeter MI 0-300v -1no - 1 No.
- Wattmeter 250v, 5A, 700 watts - 1 No.

Materials/Components

- Control panel (blank) - 1 No.
- S.P switch one way flush type 6A, 250V - 1 No.,
- Kit-kat fuse carrier with base flush type, 6A, 250V - 1 No.
- Neon Indi-later, flush type, 6A, 250v - 1 No.
- Grommet - as reqd
- lugs - as reqd
- sleeves - as reqd
- PVC insulated copper cable 2.5 Sq.mm - as reqd

PROCEDURE

1 Draw the layout and circuit diagram for the control panel

2 Select and check the accessories required

> **If any accessories found to be defective repair or replace with approval of instructor**

3 Mark the layout on the control panel by using steel rule and scriber

4 Make the chain drills on the control panel for indicator, kit-kat fuse, switch ammeter, voltmeter and wattmeter

5 Chip the chain drills

6 File and finish the slot using half round file

7 Mark the fixing holes for indicator, kit-kat of switch and holder as per the layout diagram.

8 Mark the drills on the panel to fix the accessories

9 Mount all the accessories of the control panel as per the layout diagram

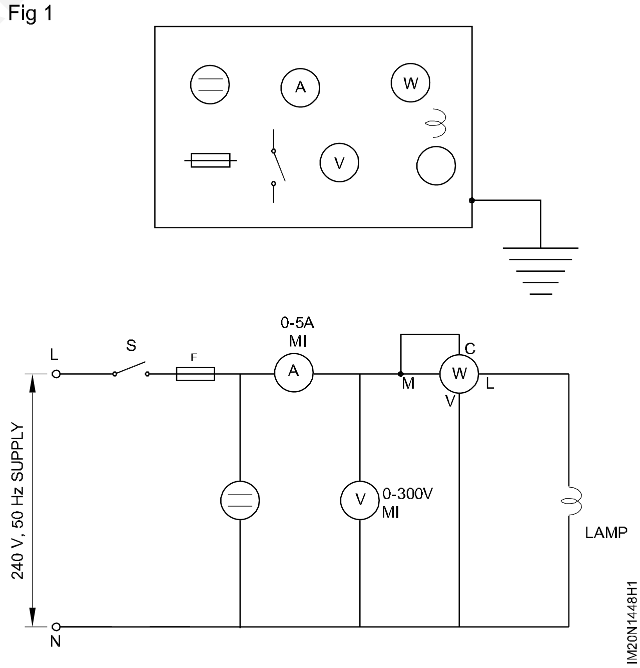
10 Skin the wire ends and crimp the lugs

11 Connects as per the circuit diagram

> **Use the grommets to avoid the strain in the cable**

12 Complete the wiring and test for its operation.

Fig 1



Measure the inductor value by written/colour code and verity the same by measuring with LCR meter

Objectives : At the end of this exercise you shall be able to
- **identify different types of inductor**
- **check the physical condition of inductor**
- **measure the value of inductance using digital LCR**
- **determine the inductance value by colour code**

Requirements

Tools/Instruments/Equipments

- Digital LCR meter

Materials/Components

- Assorted types and Values of inductor

PROCEDURE

IIdentify inductors by their appearance and check physical defects

1 Take anyone inductor from the given asserter

2 Check for any of the physical defects or per lot the exercise No. given in the book.

Measure the value of inductance using digital LCR meter

1 Larry out necessary settings on the given LCR meter to measure the inductance of unknown inductor

2 Take any one of the inductor and connect across the test terminal of LCR meter

3 Record the measured value in table 1 of record sheet.

Calculate the inductance value from colour ba

1 Take a colour coded inductor from the given tool and indentify the colours of bands starting from one and of inductor as shown in fig

2 Record the colour of the bands in table -1 of record sheet

Five band military standard inductor colour code

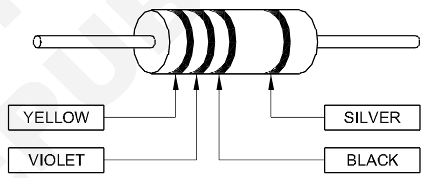
Fig 1

Silver	Red	Violet	Brown	Gold
Military Ident Firebrand	2	7	0	± 5%

- 5 band inductor colour code
- Militancy standard inductor colour code)

- Values equal (or) higher then 10MH
- Wide seller band-military RF indictor

Fig 2



Four inductor colour code

Band yellow - 4

Band violet -7

Band black - X1

Band sillier - ± 10%

Inductance value = 47MH ± 10%

1	2	3	4	5
Silver	**Red**	**Gold**	**Red**	**Silver**

1 Silver - Military identifier

2 Red - 2

3 Gold - Decimal point

4 Red - 2

5 Silver - ± 10%

The inductor value is 2.2 MH ±10%

Inductance value written method. Printing method

1 Consist of 3 or 4 letters (Including alphabets and numerical digit)

2 First 2 digit indicate the value

3 Third digit in the power to be applied for the first 2.

4 Four deter (or) alphabet represents the tolerance value.

K – ± 10%

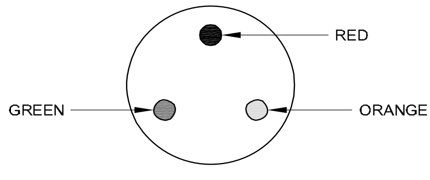
J - ± 5%

M - ± 20%

SMD (surface mount device) or chip inductor coder

> **While correcting venires at the at the terminals of Ind. Use minimum lead length for connection as lead length will add up inductance value.**

Fig 3



INDUCTOR CODES

Colour code table

Band Meaning	1 Mil spce	2 Dig it (or) DCC point	3 Dig it (or) DCC point	4 Multi plier	5 Tolerance
Gold					±
Silver	Always slier double			x1	±10%
Black		0	0	x 10^0	± 20%
Brown		1	1	x10^1	± 1%
Red		2	2	x10^2	± 2%
Orange		3	3	x10^3	± 3%
Yellow		4	4	x 10^4	±4%
Green		5	5	x 10^5	
Blue		6	6	x 10^5	
Violet		7	7	x 10^7	
Gray		8	8	x 10^8	
White		9	9	10^9	

1 For inductance values less than 10 the second (or) third band in gold which represents the decimal point than remaining bands indicates 2 sign if car

2 Calculate the inductor value in clock rise

Green red - Inductance value

Orange - Multiplier

Inductance value = 52000nh

=52nH

3 For values lower than 10nH the third dot will not act like a multiplier

(EG) black orange black 3.0nH

4 Compare the measured value of the inductor using LCR meter and colour base

5 Record the difference in table 1

Discuses seasons for difference in reading (if any) with your instructor

6 Repeat above steps and measure inductance of at least five different types of inductor and get your work checked by your ins true

Table 1

S.No	Type/name Of inductor	Symbol	Physical defects Noticed	Inductance value using LCR meter	Inductance value using Colour bands	Difference in reading

Measure charge, energy store of capacitor in series and parallel circuits with voltage sources in different combination and calculate capacity reactance.

Objectives: At the end of this exercise, you shall be able to
- **measure charge, energy store of capacitor in series circuit.**
- **measure charge, energy store of capacitor in parallel circuit**
- **calculate capacitive reactance.**

Requirements

Tools/Instruments

- Voltmeter MI 0 to 300V - 3 Nos.
- Ammeter MI 0 to 500mA - 1 No.
- Rheostat, about 300 ohms 2A - 1 No.
- 230V AC source

Materials

- Switch SPT 6A 250V - as required.
- 2 MFD 230V/400V - 2 Nos.
- 4 MFD 230V/400V - 1 No.
- Connecting leads - 1 No.

PROCEDURE

TASK 1: **Measuring charge, energy stone of capacitor in series circuit**

1 Form the circuit with two capacitors in series as shown in fig 1 (2 MF, 2MF)

2 Determine the Xc value for the seires combination performing steps 2 to 5 of TASK 1. Fill up Xc values in table 2 under the appropriate columns.

3 Calculate the total capacitance C_{total} as $\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2}$

4 Measure the voltage across each capacitor and record it in table 1

5 Repeat steps 1 to 5 for series grouping of capacitors

a) 2 & 4 MFD b) 4 & 8 MFD

7 Calculate the charge of capacitor using the formula of Q = Cv

8 Calculate the energy stored in capacitor E = ½ Cv2

Fig 1

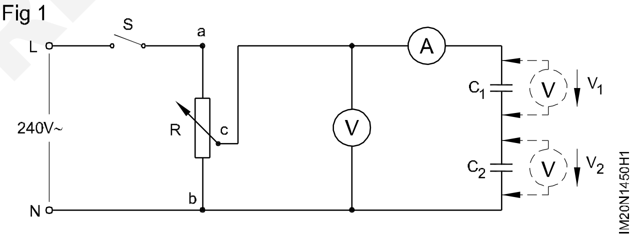


Table1

DC voltage measurement

Sl.No	Value of Capacitor C_1 in µf	Value of Capacitor C_2 in µf	Voltage across C_1	Voltage across C_2	Current in mA	Voltage V	Total $x_C = \frac{V}{I}$	Total $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$
			V1	V2				
1	2	2						
2	2	4						
3	4	8						

TASK 2: **Measure charge energy store in capacitor in parallel circuit**

1 Form the circuit with two capacitors in parallel as shown in fig 2 (2 MF, 2MF)

2 Determine the reactance Xc of the parallel combination performing steps 2 to 5 of Task 2 Fill up X_c in Table.

3 Calculate the total capacitance Ctotal = C1 + C2 Record ctotal in table 2

4 Calculate the C_{total} from X_c. Check for its confimity.

5 Calculate charge in capacitor Q = Cv

6 Calculate energy in capacitor E = ½ Cv2

Discharge the capacitors at the end of each experiment / test.

Fig 1

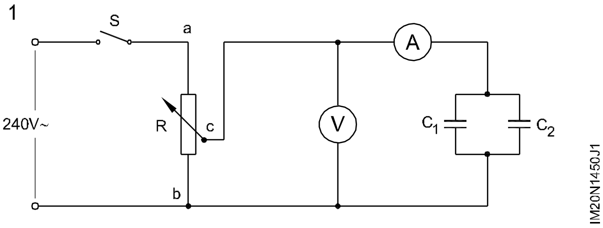


Table1

DC voltage measurement

Sl.No	Value of Capacitor C_1 in µf	Value of Capacitor C_2 in µf	Voltage across C_1	Voltage across C_2	Current in mA	Voltage V	Total $X_C = \frac{V}{I}$	Total Ctotal=$C_1 + C_2$
			V1	V2				
1	2	2						
2	2	4						
3	4	8						

— — — — — — — — —

TASK 3: **Measure capacitive reactance.**

1 Form the circuit as shown in fig 3 with a 2 - F capacitor. (Fig 3)

Discharge the capacitor before handling.

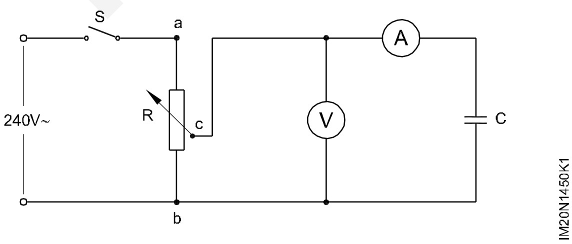
2 Close the switch S and adjust the potential divider for the reted voltage of the capacitor (230V).

3 Read voltmeter and ammeter and record in table 3.

4 Calculate the reactance $X_C = \frac{V}{I}$ and record the result in table 3

$$X_C = \frac{1}{2\pi FC}$$

Fig 1



6 Compare the calculate value using the formula

7 Find the capacitive value for 4µ F repeating steps 1 to 5.

Table 3

Sl.No	Value of capacitor	Voltage	Current	

Measure inductive reactance with increase/decrease the input frequency of the circuit

Objective: At the end of this exercise you shall be able to
- **measure inductive reactance**

Requirements

Tools /Equipment/Instruments

- Trainees kit - 1 No
- Multimeter - 1 Nos.
- AF signal generator - 1 KH_Z/2V

Materials

- Inductor650mH - 1 No.
- Connecting wires - as reqd.

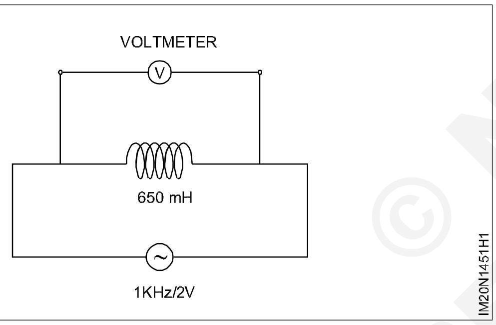
PROCEDURE

1 Connect the circuit diagram as shown in Fig 1

2 Set IV in signal generator and note down voltage across inductor with increased frequency using signal generator

3 set IV in signal generator and note down voltage across inductor with decreased file acuency.

Fig 1



4 Note and record the reading in table-1

5 Calculate X_L

$$X_L = 2\pi f L$$

6 Get the work checked by the instructor.

Table 1

I/P = IV	
Frequency in HZ	**Output voltage in volt**

Measure current and voltage and determine the characteristics of the RL, R-C, R-L-C in AC series circuits

Objectives: At the end of this exercise, you shall be able to
- measure the current, voltage, power and P.F in R-L series circuits
- measure the current voltage, power and P.F in R-C, series circuits
- measure the current voltage, P.F in R-L-C series circuits
- measure the power and P.F. in R-L-C series circuits

Requirements

Tools/Instruments

- MI voltmeter 0 - 300 V - 3 Nos.
- MI ammeter 0 - 1.5 A - 1 No.
- Wattmeter 250 V, 2.5 amps - 1 No.
- Power factor meter (0.5 lag to 0.5 lead) 250 volts, 2.5 amps - 1 No.

Equipment/Machines

- Auto transformer 0-270V/8A - 1 No.

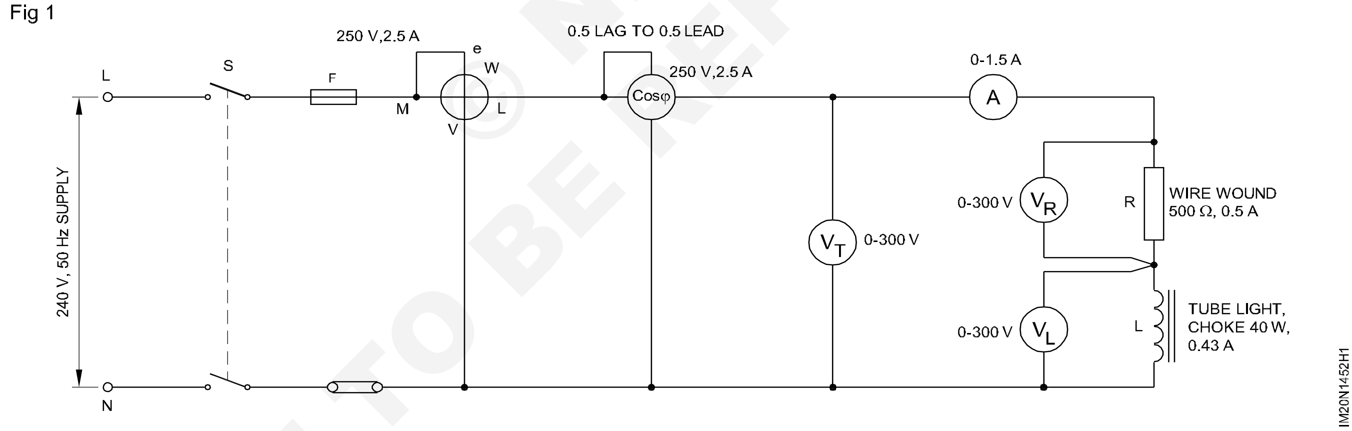
Materials

- Connecting cables - as required.
- Choke (tube light) 40 W, 0.43 A, 250 V - 1 No.
- I.C.D.P. switch - 16 amps, 250 volts - 1 No.
- Wire wound resistor 500Ω/0.5A - 1 No.
- Wire wound resistor 100Ω/1.5A - 1 No.
- Electrolytic capacitor 8μFd/400V - 1 No.
- Electrolytic 1μFd, 2μFd, 4μFd/400V - 1 each

PROCEDURE

TASK 1: **Measure the current, voltage, power and P.F in R-L series circuit**

Fig 1



1 Assemble the circuit by connecting instruments, resistor R, inductor L as in Fig 1. Switch ON the supply.

2 Measure the voltage V_R, V_L, supply voltage V_T and the circuit current and record in Table 1.

3 Read power (W_1) and power factor (cos ϕ) and record it in Table 1.

4 Calculate the apparent and the true power consumed in the circuit and compare them.

5 Calculate the power factor and compare it with the measured power factor.

6 Draw the vector diagram to add the voltage drops across R and L.

- Keep current as the reference vector.
- Select a suitable scale for the voltage.
- Draw the voltage vector (V_R) in-phase with current (I).
- Draw the voltage vector V_L leading-current I by 90°.
- Add vector V_R and V_L to get V_{T1}

7 Compare the above with the measured supply voltage.

8 Calculate the power factor from the true power and apparent power $\text{Cos }\phi_2 = \frac{W}{V_T \times I}$ = ...W

9 Compare the calculated power factor with the measured power factor.

10 Repeat the steps changing two values for the resistor and inductor and record them in Table 1 in columns 2 and 3.

11 Get it checked by the instructor.

Table 1

Measured value							Calculated value			
Sl. No.	Circuit current	Supply voltage	Power consumed (Wattmeter reading)	Voltage across resis-tance	Voltage across induc-tance	Power factor (reading of P.F. meter)	Vector addition of VR and VL	Difference in VT_1 and VT_2	Power consumed in circuit	Difference between measured & calculated power factor
	I	V_{T1}	W_1	V_R	V_L	Cos ϕ_1	V_{T1}	$V_T - V_{T1}$	W2= $V_T \times I \times \cos\phi_1$	Cos $\phi_1 -$ Cos ϕ_2
1										
	Resistance =					Inductance =				
2										
	Resistance =					Inductance =				
3										
	Resistance =					Inductance =				

Conclusion

The difference between vector addition of V_R and V_L with respect to V_T is due to ________________________

____

— — — — — — — —

TASK 2: **Measure the current voltage, power and P.F in R-C series circuit**

1 Test the capacitor with an ohmmeter for its condition.

Discharge the capacitor before testing.

2 Check the value of the given resistance with a digital multimeter for its value.

Check the suitability of the selected wattmeter and P.F. meter with respect to the circuit specifications.

3 Construct the circuit as per diagram. (Fig 1) Keep the switch 'S' open.

Set the auto-transformer output to zero voltage.

4 Close switch 'S' and adjust the auto-transformer output voltage to 100V.

5 Measure the circuit current, voltage power consumed and power factor and note the readings in Table 2.

6 Calculate cosϕ and impedance.

7 Compare the calculated P.F with measured P.F.

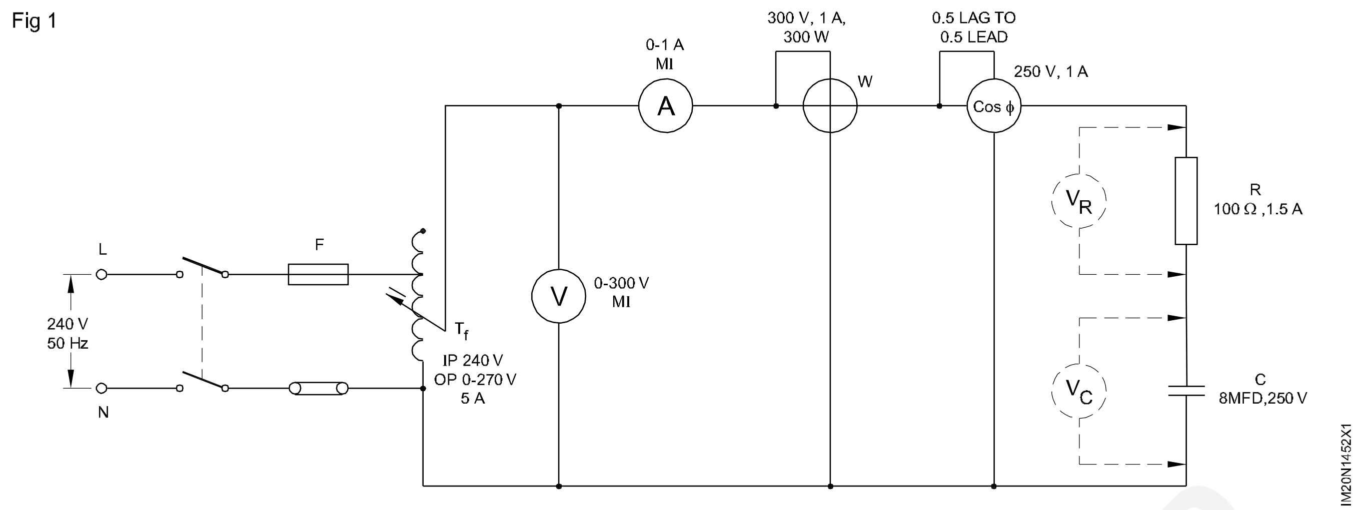
8 Measure the voltages across R and C and note in Table 3.

9 Compare the arithmetical sum of V_R and V_C with the supply voltage and observe that this is a wrong procedure.

10 Add V_R and V_C by the vector method (graphically) selecting a suitable scale and compare with the measured supply voltage.

11 Adjust the output voltage to 200 V and repeat steps 5 to 10.

Fig 1



12 Get it checked by the instructor.

Table 2

Measured				Calculated	
V supply	I	W	PF	$PF = \frac{W}{VI}$	$Z = \frac{V}{I}$
100 V					
200 V					

Conclusion

____

____

____

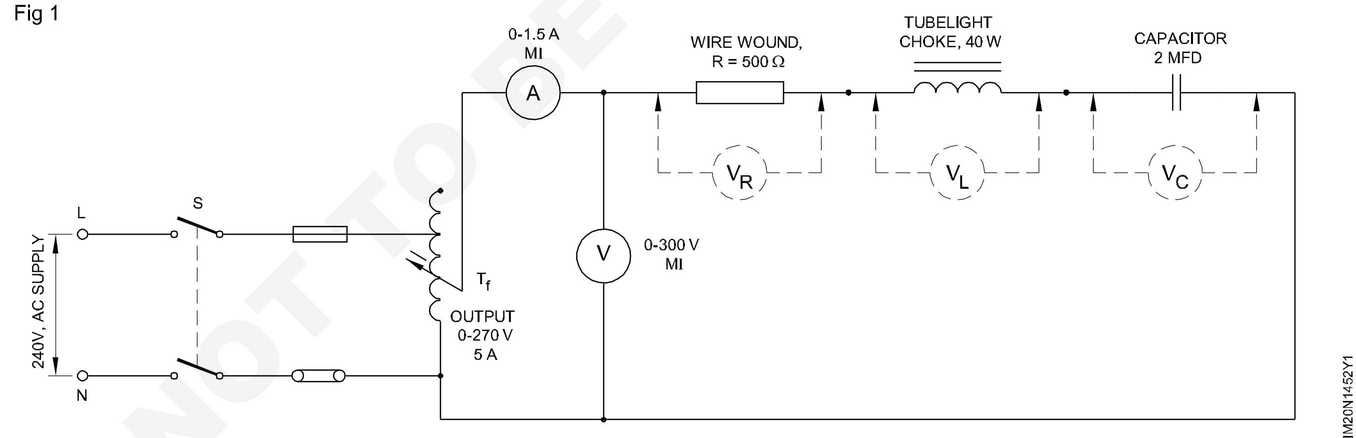
Table 3

V supply	V_R	V_C	$V_R + V_C$ (Arithmetic)	$V_R + V_C$ (Vector)
100 V				
200 V				

— — — — — — — — —

TASK 3: **Measure the current voltage, P.F, in R-L-C series circuit**

Fig 1



1 Assemble the circuit as per circuit diagram (Fig 1) with the instruments and components collected.

Before forming the circuit, confirm that the capacitor is discharged.

2 Switch 'ON' the supply and adjust the auto-transformer until the voltmeter indicates 240 volts.

3 Measure the voltage across each element and note it in the Table 4.

Table 4

Supply	V_R	V_L	V_C	I
240 v				

4 Measure the current and note the same in Table 4. Switch off the circuit.

5 Draw the vector diagram (say 1cm = 50 V and 1cm = 0.1A) taking the current as the reference vector.

6 Determine the supply voltage from the vector diagram.

Supply voltage (vector sum) =.................V

Assumption: The resistance of the choke is negligible in this case.

7 Compare the value of the resultant vector voltage with reading of the voltmeter across the mains.

If the vector sum of voltages V_R V_C V_L is not exactly equal to the measured supply voltage, it may be due to---

- **observation error**
- **drawing of the vector diagram incorrectly**
- **assumptions made.**

8 Replace the capacitor with another value, say 8.0 MFD and repeat the steps 2 to 7.

9 Replace the capacitor with another value, say 1.0 MFD and repeat the steps 2 to 7.

10 **Result:** Total measured voltage is________________

____

11 Get it checked by the instructor.

Conclusion

A The voltage across individual component and total supply voltage________________

____

B The circuit current________________

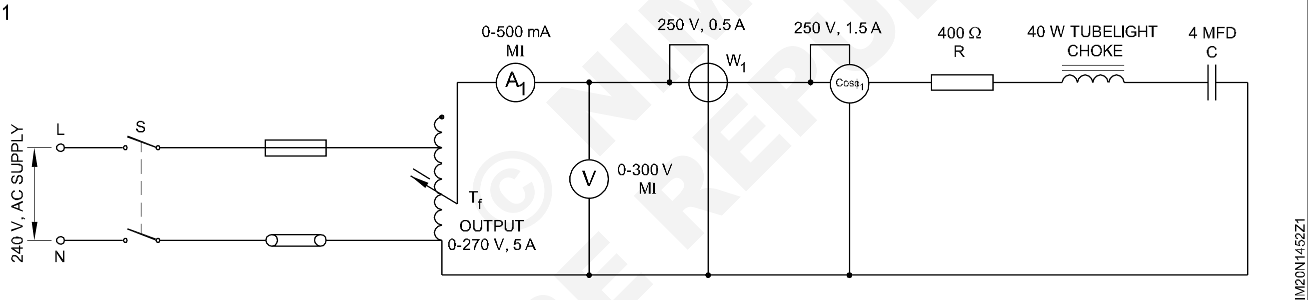
____

C The phase angle of current with supply voltage (from voltage vector)________________

— — — — — — — —

TASK 4: **Measure the power and P.F. in R-L-C series circuit**

Fig 1



1 Form the circuit as shown in Fig 4.

Discharge the capacitor. With an ohmmeter check the resistance for its value, the inductor for its continuity and the capacitor for leakage.

2 Set the auto-transformer to have zero output. Switch 'ON' the supply.

3 Gradually increase the output voltage until it is 100V.

4 Measure the corresponding current. Note down the readings in Table 5. Also read the Wattmeter and the power factor meter and record it in Table 5.

5 Calculate the apparent power from voltmeter and ammeter reading.

Apparent power = V x I in volt amp (VA)

6 Determine the power factor by using the formula and record it in Table 5.

$$\cos \Phi = \frac{\text{True power}}{\text{Apparent power}}$$

7 Verify the measured power factor with the calculated power factor.

8 Increase the voltage to 200 volts and repeat steps 4 to 7.

Do not increase the voltage beyond 200V for this circuit.

9 Reduce the output voltage back to zero and switch off the supply.

10 Repeat the experiment (steps 2 to 9) with

i) the capacitor removed

ii) a 2 micro-farad capacitor connected

iii) a 8 micro-farad capacitor connected keeping the voltage at 200 V.

11 Compare the readings of the power factor in all the four cases. Record your observation.

12 **Result**

The change of the capacitor in the R-L-C series circuit for given R-L (value)

____

____

____

13 Get it checked by the instructor.

Table 5

Sl. No.	V Volt	I Amp.	Wattmeter reading True power True power	AP = V xI in VA Voltmeter and ammeter reading Apparent power	$\cos\phi = \frac{W}{AF}$	P.F. Meter reading	Capacitor value in MFD
1	100 V						4
2	200 V						4
3	200 V						0
4	200 V						2
5	200 V						3

— — — — — — — —

Measure the resonance frequency in AC series circuit and determine its effect on the circuit

Objectives: At the end of this exercise you shall be able to
- **determine the resonance frequency of a given LC series circuit and circuit current**
- **plot a graph of frequency versus circuit current**
- **test the working of a series LC as a wave trap**
- **determine the effect of the resonance on the circuit.**

Requirements

Materials/Components

- General purpose Lug board - 1 No.
- Capacitor 0.1 μF - 1 No.
- Inductor coil, around 40mH (Use the solenoid coil made in Ex. 1.5.46) - 1 No.
- LED with holder - 1 No.
- Hook-up wires - as reqd.

Tools/Equipments/Instruments

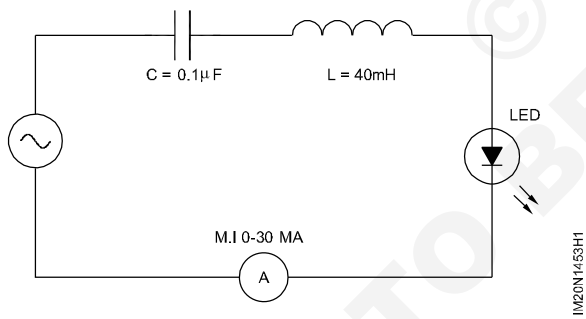
- Trainees kit - 1 No.
- CRO, 20 MHz - 1 No./batch
- Function generator - 1 No./batch
- MI Ammeter 0 - 30 mA - 1 No.

PROCEDURE

TASK 1: **Finding Resonance frequency and circuit current**

1 Solder the components as shown Fig 1 to obtain a simple series resonance circuit. Connect instruments as shown in Fig 1.

Fig 1



> **The LED in the circuit is to get a visual indication of the current through the circuit at different frequencies.**

3 Calculate and record the resonance frequency of the series resonance circuit with known values of L and C

4 Set the output of the signal generator to $10V_{rms}$ and frequency to 1KHz. Record the current, I through the circuit in Table 1.

> **LED may not be glow or may be very dim, because the set frequency of 1 KHz may not be the resonance frequency of the circuit.**

5 Gradually increase the frequency and record the resonance frequency f_r at which the circuit current becomes maximum (LED glows brightly).

> **This is the resonance frequency of the series resonance circuit because at series resonance, current I through the LC circuit will be maximum.**

6 Compare and record the difference in the resonance frequency calculated in step 3 and that measured in step 5.

7 Vary the input frequency in steps of 500 Hz around the resonance frequency and in each step record the value of circuit current in Table 1.

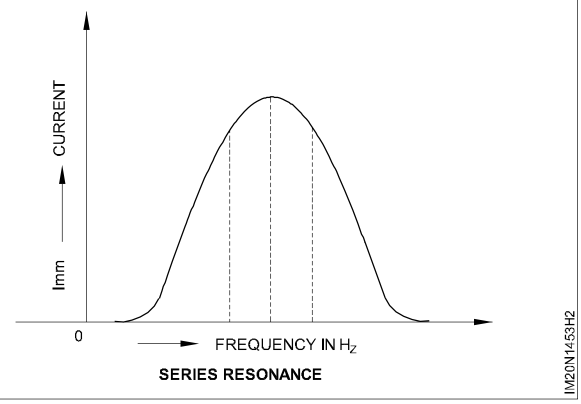
8 From the recorded readings of current in step 6, plot a graph of frequency versus current and mark the resonance frequency of the LC series circuit. (Fig 2)

9 It may appear as in Fig 2 working of the circuit, Record readings and plot the graph and get it checked by the instructor.

Table 1

Frequency	+500HZ	+1KHZ	+1.5KHZ	+2KHZ
Sine wave				

Fig 2



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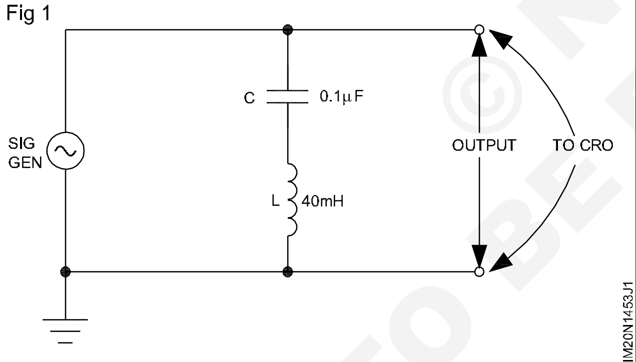
TASK 2: **To use series LC circuit as wave-trap to determine the effect on the circuit**

1 Using known values of L and C, make the circuit connections as in Fig 3.

Fig 1



2 Set the output of the signal generator to 3 volts, 50KHz, sine wave.

3 Increase the frequency till the output of the trap circuit is minimum. Record this frequency as the trap frequency and its the effect on the circuit.

At trap frequency, which is the resonance frequency of the Shunt connected LC circuit, the impedance of the circuit will be minimum and hence the voltage across the circuit will be minimum. Ideally, this should be zero. But, because of the internal resistance of the coil, the output voltage will not be zero but, will be minimum.

4 Get your work checked by the instructor.

LAB ASSIGNMENT: Change the value of the capacitor used in the LC circuit to 0.01µF and redo TASK 2 to find the new wave-trap frequency.

— — — — — — — —

Measure current and voltage and determine the charactertics of R-L, R-C and R-L-C in AC parallel circuits

Objectives: At the end of this exercise you shall be able to
- **measure the current, voltage in R-L parallel circuit**
- **measure the current and voltage in each branch circuit of R-C parallel circuits**
- **determine the characteristics of R-L-C in parallel circuits.**

Requirements

Tools/Instruments

- Digital multimeter - 1 No.
- MI Ammeter 0 to 2 ampere (0-5A) - 2 Nos.
- MI Ammeter 0 to 3 amperes (0-5A) - 1 No.
- MI Voltmeter 0-250 V - 1 No.
- Frequency meter 50Hz/±5 - 1 No.

Equipment/Machines

- Auto-transformer - input 240 V - output 0 to 270 V, 8 amps - 1 No.
- Rheostar 400Ω/1A - 1 No.

Materials

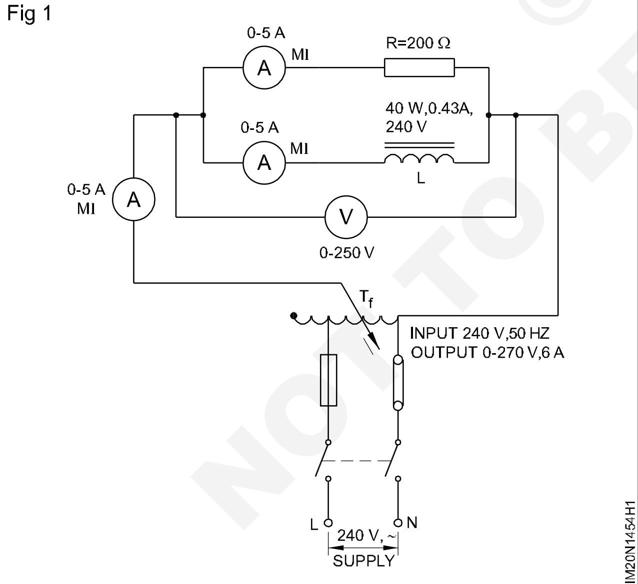
- Connecting cables - as reqd.
- I.C.D.P switch 250V, 16 A - 1 No.
- Wire wound resistor - 200 ohms - 1 No.
- Choke coil of 40 watts, 240V 50 Hz. tube light - 1 No.
- E.capacitor 8μFd/4μFd/400V - 1 each.
- E.capacitor 2μFd/400V - 1 each.

PROCEDURE

TASK 1: **Measure the current, voltage in R-L parallel circuit**

1 Assemble the circuit with the instruments, inductance coil and resistance. (Fig 1)

Fig 1



2 Set the auto-transformer output at zero position.

3 Switch 'ON' the supply and gradually increase the output voltage to 50V.

4 Measure the branch and total currents and record in Table 1. Repeat this step for different voltages say 100V, 125V, 150V, and 175V.

Table 1

Sl.No.	Measured				Graphical
	V	I_R	I_L	I_T	I_T Value
1	50				
2	100				
3	125				
4	150				
5	175				

5 Draw the vector diagram with suitable scale for currents taking voltage as reference vector in your practical record.

6 Determine the total current graphically.

The calculated values of total current and the actual measured value of current may vary due to instrument error, observational error and non-availability of pure inductance. Hence, about 5% error is permissible.

7 Compare the total current measured with the calculated value entered in table 2.

TABLE 2

Sl.No.	Measured value		Calculated value	
	V	I_T	$I_T = \sqrt{(I^2_R + I^2_L)}$	$Z = \frac{V}{I_T}$
1	50			
2	100			
3	125			
4	150			
5	175			

8 Find the Impedance of the circuit from the supply voltage and measured current. Calculate $Z = \frac{V}{I_T}$

Conclusion

Total current in an AC parallel circuit is the vector ____________ of $\mathbf{I_R}$ and $\mathbf{I_L}$ and not ____________ addition.

— — — — — — — —

TASK 2: **Measure the current and voltage in each branch circuits of R-C parallel circuits**

1 Test the capacitor with an ohmmeter for its condition.

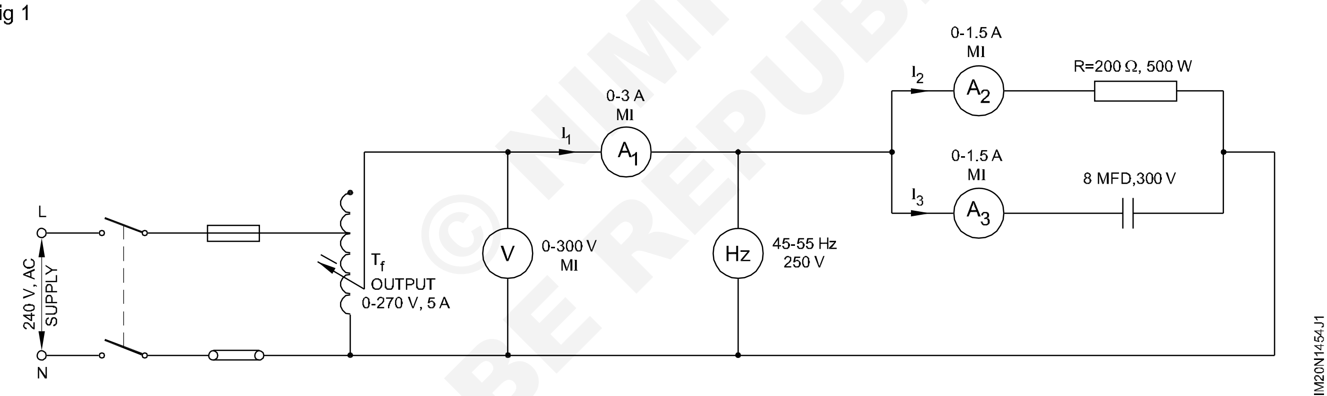
Discharge the capacitor before testing.

2 Test the resistor with an ohmmeter for its value.

6 Calculate the impedance 'Z' and record in Table 3.

7 Calculate the capacitive reactance ($X_c = V/I_3$) and record your result in Table 3.

Fig 1



3 Build the circuit as per diagram. (Fig 1) Keep the switch open. Set the auto-transformer to the minimum output voltage.

4 Switch ON the supply. Adjust the auto-transformer for an output voltage of 200V.

5 Record the frequency, voltage and the three ammeter readings in Table 3.

8 Calculate the capacitance from the values recorded in Table 3.

9 Establish that the arithmetical sum of the branch current is not equal to the main circuit current.

10 Graphically add the currents I_2 and I_3 and determine the value of I_1. Compare this value with the measured value.

11 Calculate the power factor from the recorded readings and enter the value in the space given below.

Table 3

Sl.No.	V	f	I_1	I_2	I_3	$Z = \frac{V}{I_1}$	$X_C = \frac{V}{I_3}$	$C = \frac{1}{2\pi f X_C}$

12 Adjust the supply voltage to about 100 V and repeat steps 5 to 10.

Discharge the capacitor after the experiment.

13 Repeat the exercise for changed values of R and C in the circuit.

Conclusions

i The calculated value and the indicated value of the capacitor

____

____

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ii The arithmetic sum of the branch current and the measured value of total current.

____

____

____

iii The vectorial sum of the branch currents and the measured value of the total current.

____

____

____

iv The determination of PF from the vector diagram

____

____

____

$$\text{Cos}\ \phi = \frac{I_2}{I_1} = \ldots\ldots\ldots\ldots\ldots\ldots\ldots =$$

— — — — — — — —

TASK 3 : **Determine the characteristics of R-L-C in parallel circuits**

1 Form the circuit as shown in Fig 1.

2 Repeat steps 2 to 13 of TASK 2 and record the readings in Table 4.

3 Compare the readings of the power factor in all the cases. Record your observations.

Conclusion

i Effect of change of supply voltage in R-L-C parallel circuit as regards power factor of circuit

____

____

ii Effect of change in capacitance in RLC parallel circuit.

____

Fig 1

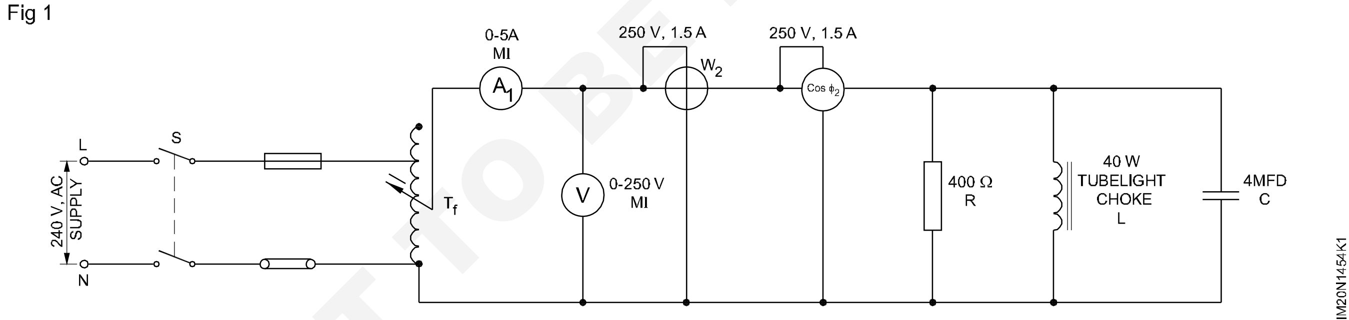


Table 4

Sl. No.	V Volt	I Amp.	W True power in Watt	AP = V xI Apparent power in VA	$\cos\phi = \frac{W}{AP}$	P.F. Meter reading	Capacitor value in μFD
1	100 V						4
2	200 V						4
3	200 V						0
4	200 V						2
5	200 V						3

Start run and reverse the directions and rotation of single phase AC motors

Objectives: At the end of this exercise you shall be able to
- **read and interpret the name-plate details of an AC single phase, capacitor-start, capacitor-run motor**
- **test and identify the terminals of an AC single phase, capacitor-start, capacitor-run motor**
- **connect, start and run an AC single phase, capacitor-start, capacitor-run motor**
- **reverse the direction of rotation of an AC single phase, capacitor-start, capacitor-run motor.**

Requirements

Tools/Instruments
- Insulated cutting pliers 200mm - 1 No.
- Screwdriver 250 mm - 1 No.
- Electrician's knife 100 mm - 1 No.
- Megger/insulation tester 500 V - 1 No.
- Ohmmeter - 1 No.

Equipment/Machines
- AC single phase, capacitor-start, capacitor -run motor 240V, 0.5HP 50 cycles - 1 No.
- Single phase, D.O.L starter 240 V 10 amps with overload relay - 1 No.

Materials
- P.V.C insulated stranded copper cable (3/20) 3/0.914 mm - 6 m.
- Fused I.C.D.P switch, 240V, 16A - 1 No.

PROCEDURE

TASK 1: **Connect, start and run an AC single phase, capacitor-start, capacitor-run motor.**

1 Read and record the name-plate details of the given single phase, capacitor-start and capacitor-run motor in Table 1. (as per exercise 3.1.18)

2 If the motor is connected to the supply, switch off the I.C.D.P, remove the fuse-carriers and disconnect it from supply.

3 Open the terminal box and identify the terminal markings.

4 Using a Megger/insulation tester, find out the continuity between the winding terminals.

5 Measure the resistance between the terminals of the same winding with the help of an ohmmeter, and identify the starting and running windings. Enter the value of resistance in Table 1.

TABLE 1

Sl.No.	Terminal pairs	Resistance	Remarks
1			Running/Starting
2			Running/Starting

In a four-terminal machine, the pairs of terminals which give low resistance are the running winding terminals. During ohmmeter testing, the pairs of terminals in which the meter pointer shows a short initially and gradually moves to resistance value are identified as starting/auxiliary winding terminals. The change in reading is due to the capacitor connected in the starting winding. Normally the connection diagram is pasted inside the terminal box for reference.

6 Measure the insulation resistance between the starting and running windings and also between the winding and body with the help of a Megger, and enter the values in Table 2.

7 Show the readings to your instructor and get his approval.

8 Select suitable sizes of switch, starter, cables, fuse etc. according to the motor rating.

TABLE 2

Sl.No.	Terminals	Insulation resistance	Remarks
1	Body to starting winding		Good/bad
2	Body to running winding		Good/bad
3	Between windings		Good/bad

Fig 1

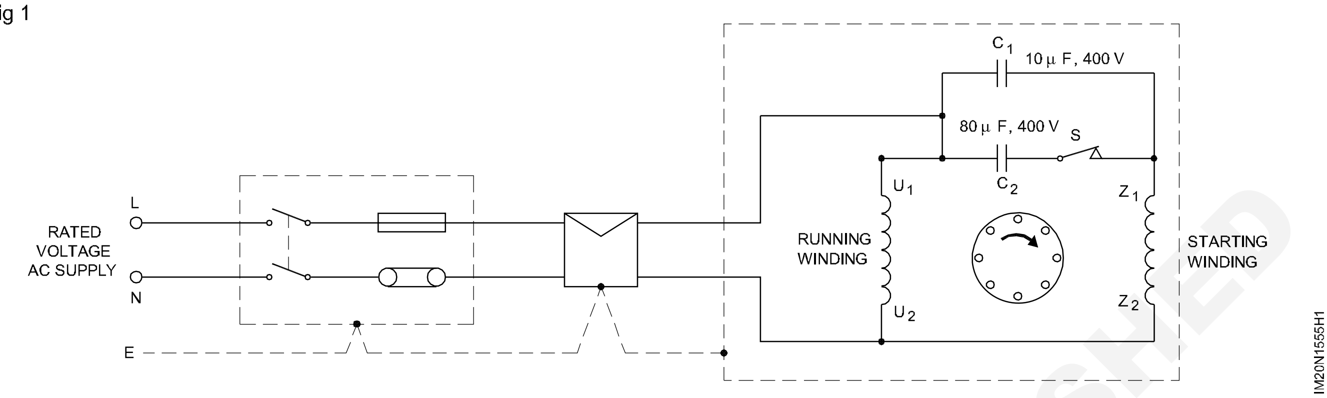


TABLE 3

Sl.No.	Component part	Type	Value in micro-farad	Voltage		Duty cycle	Condition
				working	maximum		
1	Running condenser						
2	Starting condenser						

9 Identify the starting and running condensers and check their condition and data. Enter them in Table 4. Also compare and analyse the data relating to the starting and running condensers.

10 Show the readings to your instructor and get his approval.

11 Check the condition of the centrifugal switch, and ensure it is working.

12 Connect the motor to the 240V AC supply through the switch and starter as per the circuit diagram. (Fig 1)

13 Insert a suitable size of fuse in the I.C.D.P. switch, and set the overload relay according to the rating of the motor.

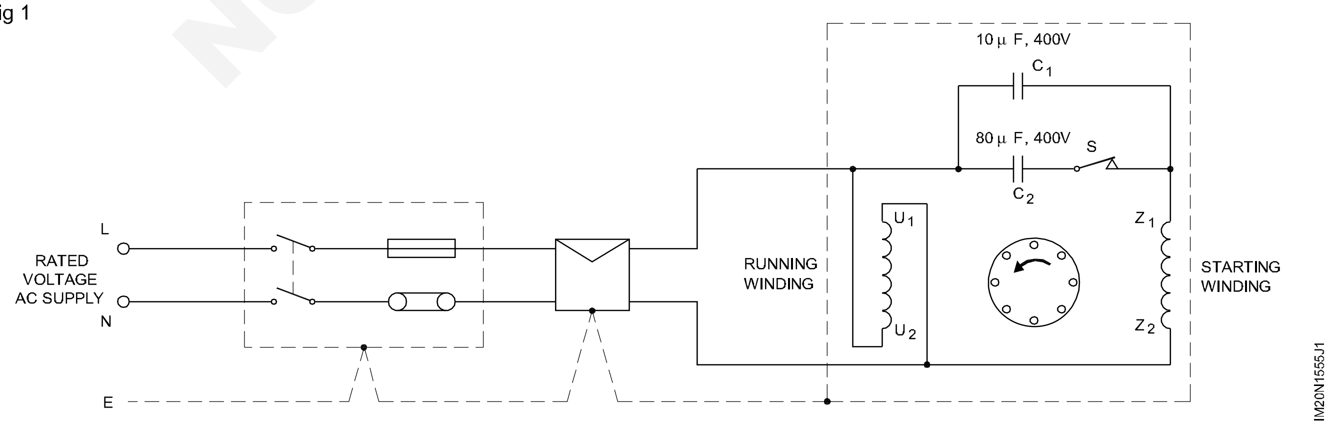
14 Get the approval of your instructor for starting. Switch on the I.C.D.P, and start the motor by pressing the start-button of the starter.

15 Observe the direction of rotation and record the D.O.R below. Direction of rotation - clockwise/anticlockwise.

TASK 2: **Change the direction of rotation of an AC single-phase capacitor, start capacitor-run motor**

1 Stop the motor, switch off the I.C.D.P. Remove the fuse and interchange the running winding terminals as shown in Fig 1.

Fig 1



2 Repeat the steps 14 and 15 of task 1.

The D.O.R is clockwise/anticlockwise.

The direction of rotation could be changed either by changing the running winding terminal connections or by changing the starting winding terminal connections whichever is easier. The schematic diagram shown in Fig 2 is for a four-terminal machine. For a ten-terminal machine only the terminals U_1 and U_2 can be changed easily.

3 Stop the motor, interchange the starting winding terminal connections as shown in Fig 3 keeping the running winding connection as in Fig 1 and repeat the steps 14 and 15 of task 1.

The D.O.R. is clockwise/anticlockwise.

4 Stop the motor, reconnect the starting and running winding as in Fig 1. Only interchange the supply terminal connections at the starter outgoing side as shown in Fig 4 and repeat the steps 14 and 15 of Task 1.

Fig 2

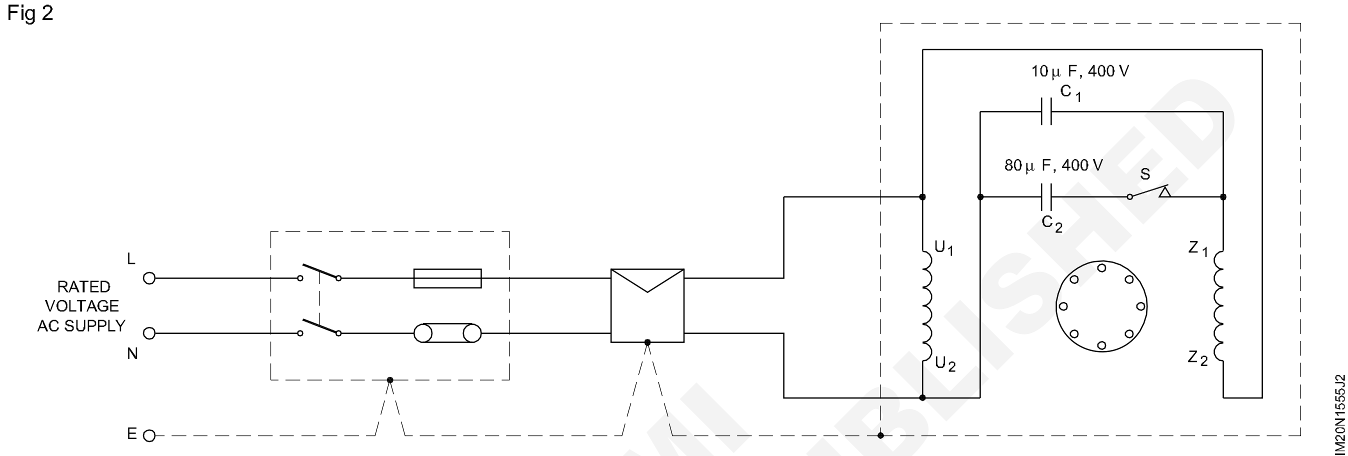
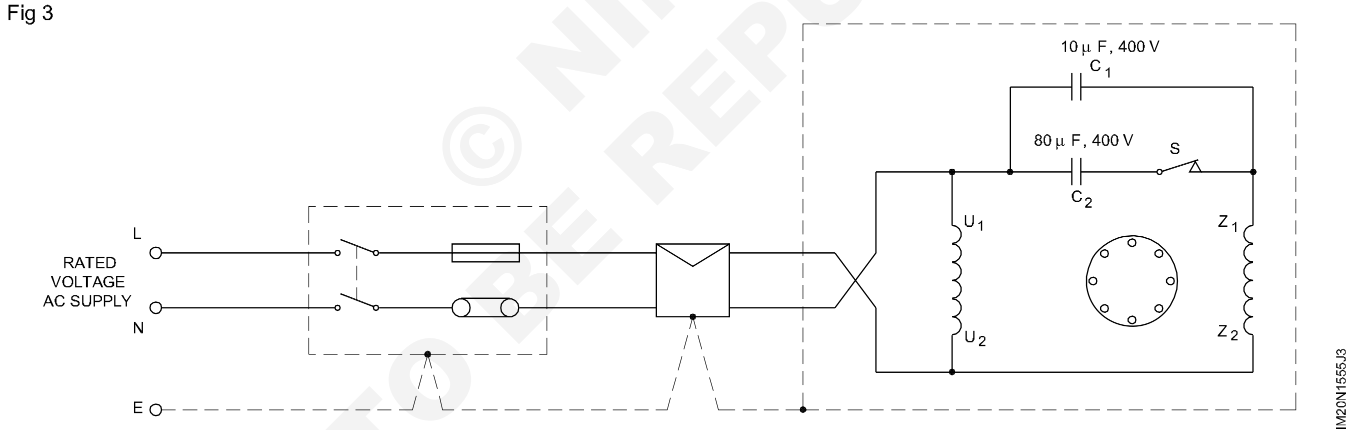


Fig 3



6 The D.O.R. is clockwise/anticlockwise.

7 Stop the motor. Switch off the ICDP. Remove the fuses. Disconnect the cables. Write your observation regarding the method of changing the direction of rotation and show to your instructor.

CONCLUSION

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Practice on speed control of a single phase AC motors

Objectives: At the end of this exercise you shall be able to
- **interpret the name-plate details of an ac series motor and determine full load current**
- **select a suitable variable resistor**
- **connect, run and measure the speed for different settings of the resistor.**

Requirements

Tools/Instruments

- Electrician tool Kit - 1 No.
- Voltmeter 0-300 V - 2 Nos.
- Ammeter 0 - 5A - 1 No.
- Tachometer 3000 rpm - 1 No.

Equipments/Machines

- AC series motor 240V 1/2 HP - 1 No.
- Rotary switch 6A, 250.4 position - 1 No.

Materials

- Connecting cable - as reqd.
- ICDP switch 16A 250V - 1 No.
- Wire wound enamel insulated resistor 10 ohms 100 W - 2 Nos.

PROCEDURE

TASK 1 : **Connect, run and control speed at a AC single phase motors**

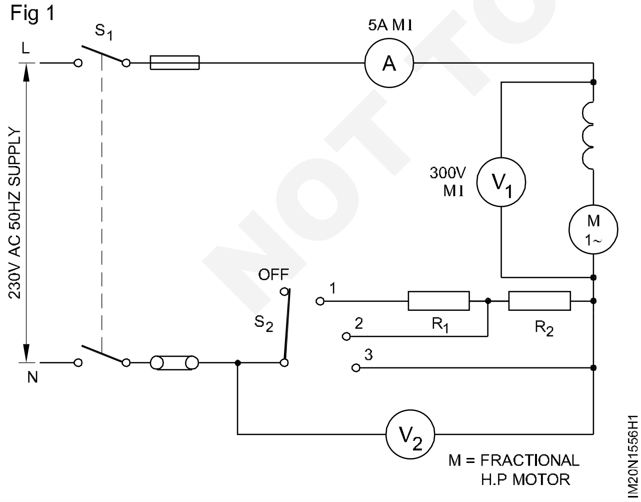
1 Read the name-plate details and record in Table 1.

2 Determine the load current from the name plate

To drop 80 V at position 1 and to drop 40 V at position 2. Calculate the required series resistors R_1 and R_2 and also determine their wattage (see example given)

3 Make the connections as per diagram (Fig 1) and make necessary arrangements to load the motor through prony brake.

Fig 1



4 Close the switch S_1.

5 Set the switch S_2 in position 1 and observe the starting of the motor.

6 Measure the current, voltages V_1 & V_2 and the speed. Record the values in Table 2.

7 Set the switch S_2, in position 2 and repeat the step 6.

8 Set the switch in position 3 and repeat the step 6.

Table 1

Mnufacturer's name	
HP/KW	R.P.M.
Current	Voltage
Type	
Sl.No.	Insulation

Table 2

Switch S_2 Position	Current	V_1	V_2	Speed

9 Write the conclusion based on the following questions.

a What is the relation between V1 and the speed of the motor?

____

____

b V_2 is the drop across series resistance. What happens to the speed if it increases when the supply voltage is constant ?

____

____

____

c Can you find some approximate relation between V2 and fall in speed ?

____

____

____

d Calculate the value of resistance R_1 and R_2 by repeating V_1 & V_2 measurement at the loaded condition of the series motor.

____

____

____

Example

Calculation steps

Motor voltage V_1 = 175 V

Supply voltage V = 230 V

Voltage to be dropped V_2 = V - V_1 = 55 V.

Full load current of motor = I = ________

Resistance value = $R = \frac{V_2}{I} = \frac{55}{I}$

Calculated resistance= ______________ ohms.

Nearest standard resistance value is ___________

The resistance should carry full load current, I = _________________ A.

Therefore resistor selected is ______________ ohms ___________ amps ____________ watts.

— — — — — — — —

Conduct performance analysis of single phase DC series shunt and compound motors

Objectives: At the end of this exercise you shall be able to
- **read and interpret the name-plate details of a DC series motor**
- **test and identify the terminals of a DC series motor**
- **measure the armature resistance**
- **measure the series field resistance**
- **connect the two-point starter for series and 3 point & 4 point starter for shunt and compound motor**
- **measure the speed of the motors**
- **vary the load of a DC series motor**
- **determine the performance characteristic of a DC series motor shunt motor and compound motor and draw the following curves**
  - speed versus load
  - torque versus load
  - speed versus torque.
- **determine the efficiency of the DC shunt motor at different loads.**

Requirements

Tools/Instruments

- Insulated cutting pliers 150mm - 1 No.
- Screwdriver 150mm - 1 No.
- D.E. spanner set 5mm to 20mm - 1 No.
- 500V Megger - 1 No.
- Multimeter/ohmmeter 0 to 2 K ohms - 1 No.
- M.C.ammeter 0-15A - 1 No.
- M.C. volmeter 0-300V - 1 No.
- Tachometer 300-3000 r.p.m - 1 No.

Equipment/Machines

- D.C. series motor 220V 3 H.P - 1 No.
- ICDP switch 250V 16A - 1 No.
- 2- Point starter - 1 No.
- Dial type spring balance 25kg capacity - 1 No.
- Prony brake system complete - 1 No.
- DC shunt motor 220V 2/3 HP - 1 No.
- 220V 4 - point starter - 1 No.
- Rheostat 100 ohms 2 amps - 1 No.
- Brake test arrangement with two spring balances of 25 and 50 kg rating - 1 Set
- 220V DC compound motor 2 or 3 with prony brake loading arrangment - 1 Set

Materials

- 2.5 sqmm PVC insulated multi-strand copper cable - 6 m.
- Fuse wire 5A &10A. - as reqd.
- Test lamp - 1 No.

PROCEDURE

TASK 1: **Conduct the load performance test on a DC series motor**

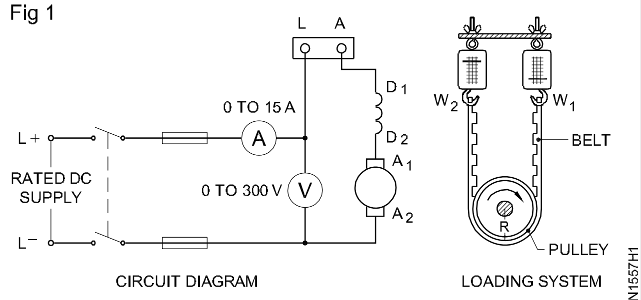
1 Note down the name-plate details.

2 Identify the terminals of the given DC series motor and test for insulation and ground.

3 Select and collect the required equipment, apparatus and cables, and connect the motor as per the circuit diagram. (Fig 1)

The DC series motor should not be started or made to run without load.

Fig 1



DC SERIES MOTOR

4 Start the DC series motor slowly by moving the starter handle to the 'ON' position.

5 Check the speed, load current and input voltage. Adjust the load current to 1/4th of the F.L. value by adjusting the load.

6 Measure the speed, load current, voltage and read the spring balance and record in Table 1.

7 Slowly increase the load in steps up to full load. Record the measurement for 1/2, 3/4 and full load.

8 Tabulate all the readings in the tabular columns provided in Table 1.

9 Stop the motor by switching it off after taking all the readings.

Do not remove the mechanical load before switching off.

10 Measure the radius of the pulley and calculate the torque, horsepower and efficiency.

11 Draw the following characteristic curves.

- Speed versus load
- Torque versus load
- Speed versus torque

12 Write your conclusion about the relationship between speed and load, torque and load, speed and torque and efficiency and load.

CONCLUSION

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Table 1

Sl. No.	Load	Applied voltage (volts)	Line current (amps)	Spring balance W_1 kg	Spring balance W_2 kg	Radius of pulley (metre)	T_1 Torque in Kilogram metre	T Torque in N.M NM= 1 kg mx9.81	N Speed in r.p.m.	OP = $\frac{(2\pi NT)}{60}$ (where N is the speed in r.p.m. & T is the torque in newton metre)	Efficiency = $\frac{(OP \times 100)}{IP}$
	1/2										
	3/4										
	Full load										

— — — — — — — —

TASK 2: **Conduct the load performance test on a DC shunt motor**

1 Read and interpret the name-plate details and record it.

2 Switch `OFF' the mains and remove the fuses.

3 Determine the terminals of the DC shunt motor.

4 Test the shunt motor for continuity, short circuit and insulation resistance between

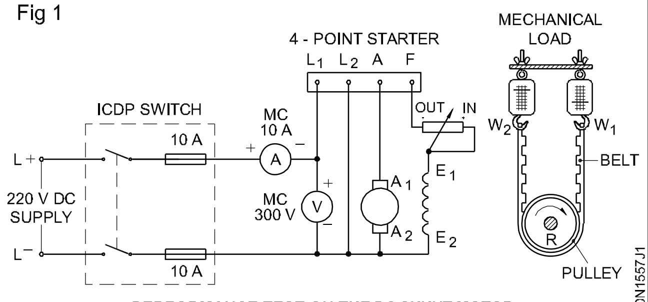
- the windings
- the windings and the earth.

5 Select a proper rating of I.C.D.P. switch, cables, fuse wire and 4-point starter according to the rating of the given DC shunt motor.

The rating given here for the switch, fuse, cable and 4-point starter is for 220 V, 3 HP motor only.

6 Connect the DC shunt motor as per the circuit diagram.(Fig 2) Keep the shunt regulator rheostat in the cut out position, and the mechanical load applied through the brake to zero value.

Fig 1



PERFORMANCE TEST ON THE DC SHUNT MOTOR

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TASK 3: **Determine the relation between load current, speed and torque**

1 Switch on and move the 4-point starter handle, gradually up to `ON' position.

2 Measure the speed, and if necessary, adjust the speed to the rated value by adjusting the shunt regulator rheostat and note down the reading in Table 1.

3 Increase the load step by step by tightening the wing-nut.

4 Measure the speed each step read the meters and the spring balances and record them in Table 2. Load the motor up to its full load value.

5 Reduce the load gradually and switch `OFF' the motor.

6 Measure the radius of the pulley in metres and calculate the torque in kg. metres.

Torque in kg.m = (W_1 – W_2)kg x radius of pulley in meters where W_1 is the reading of the tight side spring balance and W_2 is the reading of the slack side of the spring balance in kilograms.

7 Draw the speed load characteristic curve, keeping the load (line) current in the X-axis and the speed in the Y-axis.

8 Draw the torque-load characteristic in the same graph sheet, keeping the load (line) current in the X-axis and torque in the Y-axis.

9 Draw the torque-speed characteristic in the same graph sheet, keeping the torque in the X-axis and the speed in the Y-axis.

Use different colours for each curve.

10 Write the conclusion by highlighting the relation between

- speed and load
- torque and load
- torque and speed.

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11 Calculate the efficiency of the given DC shunt motor by applying the following formula and record it in Table 2.

Output = $\frac{2\pi NT}{60}$ newton metres/sec. or watts

where N is the speed in r.p.m.

T is the torque in newton metres.

(To convert the torque in Kg metre to newton metre multiply Kg M by 9.81.)

Input = VI

where V is the applied voltage, I is the line current.

Hence efficiency = $\frac{\text{output}}{\text{input}}$x100

$= \frac{2\pi NT \times 100}{60 \times VI}$ percentage.

Table 1

Sl. No.	Applied voltage (volts)	Line current (amps)	Spring balance W_1 (kg)	W_2 (kg)	Radius of pulley (metre)	T_1 Torque in Kilogram metre	T Torque in N.M NM= 1 kg mx9.81	N Speed in r.p.m.	OP = (2πNT) / 60 (where N is the speed in r.p.m. & T is the torque in newton metre)	Efficiency = (OP x 100) / IP

— — — — — — — —

TASK 4: **Conduct the load performance test of a DC compound motor**

a Identify the terminals and test the condition of the DC compound motor

1 Identify the terminals of the given DC compound motor.

2 Test the given DC compound motor for continuity, insulation and ground faults, and make sure the machine is in good condition.

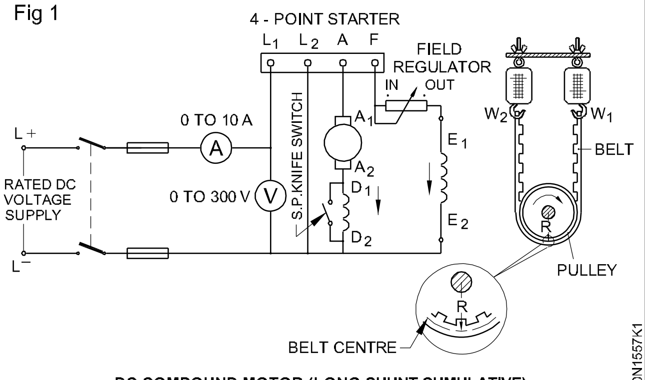
3 Select suitable size of cables, I.C.D.P switch and loading arrangements, according to the machine rating.

The rating of the switch, fuse cable and 4-point starter should be changed according to the rating of the given DC compound motor.

b Connect the machine as a long shunt cumulative compound motor and test it for its performance

1 Connect the machine as a long shunt (cumulative) compound motor with the switches, fuses and meters and starter.(Fig 3)

Fig 1



DC COMPOUND MOTOR (LONG SHUNT CUMULATIVE)

2 Arrange the prony brake for loading the motor.

3 Keep the series field shorted by the S.P.S.T. knife switch.

This will enable the motor to start normally, even if it is connected as a differential compound motor.

4 Keep the field regulator in the `cut out' position. Switch on the supply and move the 4-point starter handle gradually up to the `ON' position.

5 Open the series field shorting switch.

6 Measure the speed and adjust it to the rated value and note down the readings in Table 3.

7 Increase the load step by step up to the full load following the instructions contained in step 8.

When applying the load, the speed may increase, if it is differential. Then stop the motor and interchange the connections of the series field for cumulative compounding Accordingly modify the connection diagram. (Fig 3)

8 Measure the speed for each step read the meters and spring balances and record them in Table 1. Increase the load up to the full load value.

9 Reduce the load gradually, switch off the motor.

10 Measure the pulley radius for calculating the torque.

The torque = (W_1 - W_2) in Kgs x radius in meters,

T=Kg metre, where W_1 is the tight side spring balance reading and W_2 is the slack side spring balance reading in kgs.

11 Calculate the torque in newton-metre = Kg. metre x 9.81.

12 Calculate the input = V x I in watts.

Calculate the output = $\frac{(2\pi NT)}{60}$ NW – metres or watts.

Calculate the percentage efficiency using the formula

= (OPx100) / IP = $\frac{2\pi NT}{60 \times VI}$ x 100 percent.

13 Enter the values of efficiency for various load currents in Table 3.

14 Draw the speed-load characteristic curve keeping the load current in the X-axis and speed in the Y-axis.

15 Draw the torque-load characteristic in the same graph sheet, keeping the load current in the X-axis and the torque in the Y-axis. Use different colours.

16 Draw the torque-speed characteristic in the same graph sheet, using a different colour and keeping the torque in the X-axis, and the speed in the Y-axis.

17 Write your conclusion by highlighting the relation between – speed vs load

- torque vs load
- speed vs torque.

CONCLUSION

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18 Draw the curve showing the relation between load and efficiency of the DC compound motor in a separate graph sheet keeping the load in the `X' axis and the efficiency in the 'Y' axis.

Table 1

Sl. No.	Applied voltage (volts)	Line current (amps)	Spring balance		Radius of pulley (metre)	T_1 Torque in Kilogram metre	T Torque in N.M NM= 1 kg mx9.81	NSpeed in r.p.m.	OP= $\frac{(2\pi NT)}{60}$ (where N is the speed in r.p.m. & T is the torque in newton metre)	Efficiency = (OP x 100) / IP
			W_1 (kg)	W_2 (kg)						
1										
2										
3										
4										
5										

c Connect the machine as a long shunt differential compound motor and test it for its performance.

Tasks c to e to be carried out by the trainees under the direct supervision of the instructor.

1 Complete the circuit (Fig 4) for the long shunt differential compound motor and get the approval of your instructor.

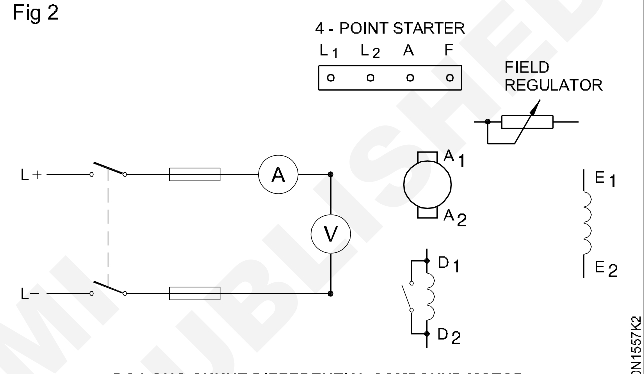
2 Connect the machine as a long shunt, differential compound motor with the switches, meters and starter as per the approved diagram. (Fig 4)

3 Repeat the steps 2 to 7 of Task 4 b and enter the readings in Table 1.

If the connections are correct, the speed may increase with the increased load.

4 Repeat the steps 8 to 18 of Task 4b, and write the conclusions.

Fig 2



DC LONG SHUNT DIFFERENTIAL COMPOUND MOTOR

Conclusion

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Table 1

Sl.No.	Applied voltage (volts)	Line current (amps)	Spring balance		Radius of pulley (metre)	T_1 Torque in Kilogram metre	T Torque in N.M NM= 1 kg mx9.81	N Speed in r.p.m.	OP= $\frac{(2\pi NT)}{60}$ (where N is the speed in r.p.m. & T is the torque in newton metre)	Efficiency = (OP x 100) / IP
			W_1 (kg)	W_2 (kg)						
1										
2										
3										
4										
5										
6										

d Connect the machine as a short shunt, cumulative compound motor and test it for its performance.

1 Complete the circuit given in Fig 5 for the short shunt, cumulative compound motor and get the approval of your instructor.

2 Connect the machine as a short shunt cumulative compound motor as per the approved diagram. (Fig 5)

3 Repeat the steps 2 to 7 of Task 4 b and enter the readings in Table 1.

If the connections are correct, the speed may fall or remain constant at the increased load.

4 Repeat the steps 8 to 18 of Task b, and write the conclusions.

Conclusion

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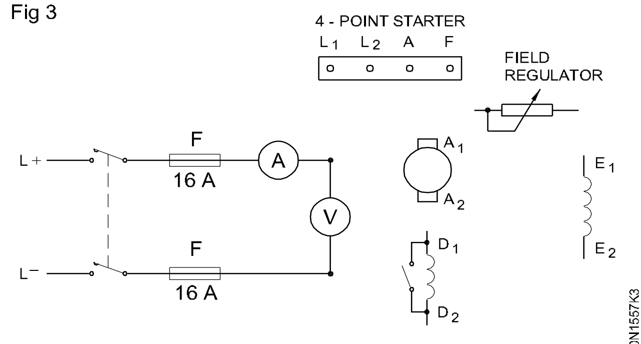
Fig 3



DC SHORT SHUNT CUMULATIVE COMPOUND MOTOR

Table 1

Sl.No.	Applied voltage (volts)	Line current (amps)	Spring balance W1 (kg)	Spring balance W2 (kg)	Radius of pulley (metre)	T_1 Torque in Kilogram metre	T Torque in N.M NM= 1 kg mx9.81	N Speed in r.p.m.	OP= $\frac{(2\pi NT)}{60}$ (where N is the speed in r.p.m. & T is the torque in newton metre)	Efficiency = (OP x 100) / IP
1										
2										
3										
4										
5										

e Connect the machine as a short shunt, differential compound motor and test it for its performance

5 Complete the circuit (Fig 6) for the short shunt differential compound motor and get the approval of your instructor.

6 Connect the machine as a short shunt differential compound motor as per the approved diagram. (Fig 6)

7 Repeat the steps 2 to 7 of Task 4b and enter the reading in Table 2.

If the connections are correct the speed will increase at the increased load.

8 Repeat the steps 8 to 18 of Task 4, and write the conclusions.

Conclusion

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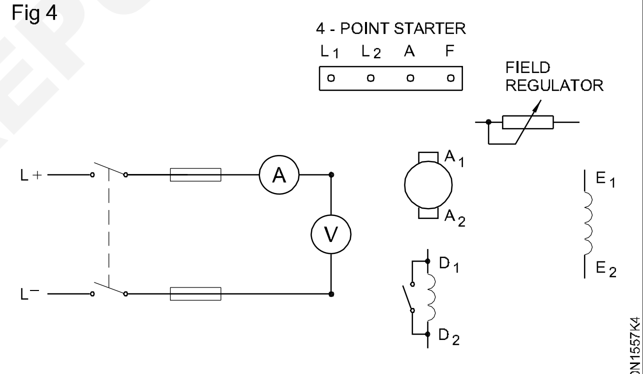
Fig 4



D.C SHORT SHUNT DIFFERENTIAL COMPOUND MOTOR

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Table 2

Sl.No.	Applied voltage (volts)	Line current (amps)	Spring balance W1 (kg)	Spring balance W2 (kg)	Radius of pulley (metre)	T_1 Torque in Kilogram metre	T Torque in N.M NM= 1 kg mx9.81	N Speed in r.p.m.	OP= $\frac{(2\pi NT)}{60}$ (where N is the speed in r.p.m. & T is the torque in newton metre)	Efficiency = (OP x 100) / IP
1										
2										
3										
4										
5										

Start run and reverse the direction of rotation of single phase DC motors

Objectives: At the end of this exercise you shall be able to
- **read and interpret the name-plate details of a DC machine (R)**
- **test and identify the terminals of a DC series motor**
- **identify the parts of a 2-point starter**
- **connect a 2-point starter and start the motor**
- **measure the speed of the machine by a tachometer (R)**
- **reverse the direction of rotation of a DC series motor**
  - **by changing the armature terminals**
  - **by changing the field terminals.**

Requirements

Tools/Instruments

• Insulated cutting pliers 150mm	- 1 No.
• Megger 500 V	- 1 No.
• Screwdriver 150mm	- 1 No.
• D.E. spanner set 5mm to 20mm	- 1 No.

Equipment/Machines

• DC series motor 220V 3 H.P.	- 1 No.
• 2-point starter for 220V 3 H.P. DC series motor	- 1 No.
• Loading arrangement or complete brake test arrangement	- 1 set.

Materials

• 2.5sq mm P.V.C. copper multi-strand cable	- 6 m.
• Fuse wire 15 amps	- as reqd.
• 250V 16A I.C.D.P.switch	- 1 No.

PROCEDURE

1 Read and interpret the name-plate details of the given DC series motor and enter them in Table 1 (Refer Exercise 2.3.03).

2 Switch off the mains and remove the fuse-carriers of the given DC series motor.

3 Identify the terminals of the DC series motor.

4 Measure the insulation resistance between (a) the windings and (b) the windings and the body.

Insulation value should not be less than 1 Megaohm.

TASK 1: **Connect, start and run the DC series motor.**

1 Fix and arrange a suitable load for the series motor.

The series motor should not start or run without a load. A flat belt drive, which might slip, while running should not be used. Fig 1 shows the loading through brake arrangement. The belt over the pulley should be marginally tightened to apply a certain load on the motor.

2 Select a proper rating of the I.C.D.P. switch, cables, fuse wire and 2-point starter, according to the rating of the given DC series motor.

The rating of the switch, fuse, cable and 2-point starter given here is for a 220V 3 HP DC series motor.

3 Open the 2-point starter, identify the parts, trace the connection and draw the connection diagram.

4 Connect the motor as per the circuit diagram shown in Fig 1 and get it approved by the instructor.

Check whether the belt is in position for loading the pulley.

5 Switch `ON' the I.C.D.P.and move the 2-point starter gradually in the clockwise direction, till the `ON' position is reached and observe the direction of rotation.

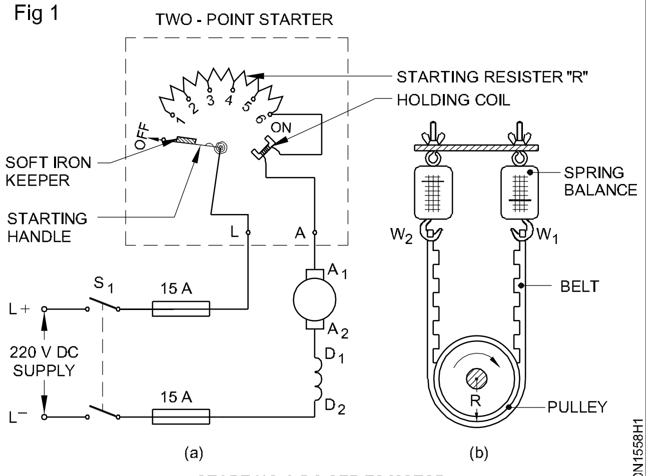
6 Record the direction of rotation in Table 2.

7 Measure the speed with a tachometer and enter the value in Table 1.

8 Stop the motor by switching off the I.C.D.P. and wait till the starter handle comes to the `OFF' position. Remove the fuse.

If the 2-point starter provided to you is without the hold on coil and spring-loaded handle, then the starter handle needs to be brought to the `OFF' position manually after switching `OFF' the supply.

Fig 1



STARTING A DC SERIES MOTOR

When reversing any motor, we should allow it to come to a dead stop and then operate it in the opposite direction.

Table 1

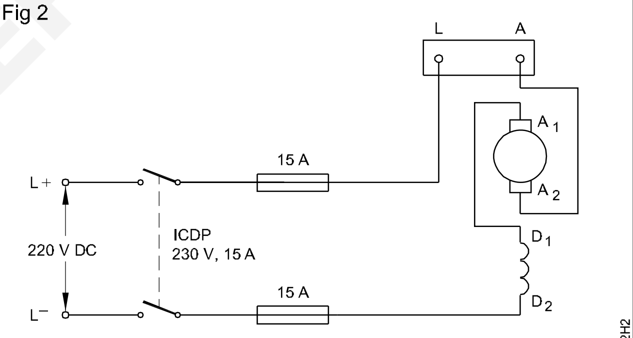
Sl. No.	Figure	Direction of rotation	Speed in r.p.m.
1	Fig 1		
2	Fig 2		
3	Fig 3		
4	Fig 4		

TASK 2: **Reverse the direction of rotation of a DC series motor**

Method 1 : Reverse the direction of rotation by changing the armature terminals.

1 Connect the motor as shown in Fig 2 and check the loading arrangement for the correctness. Repeat steps 5 to 8 of Task 1.

Fig 2



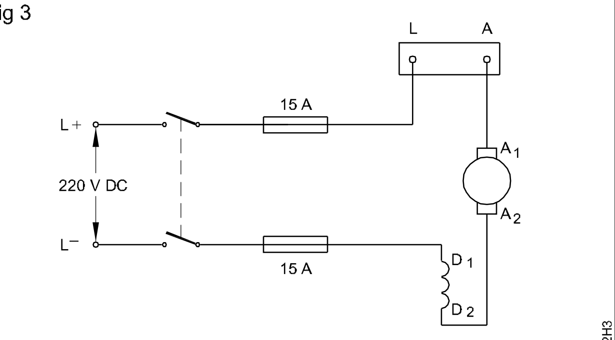
REVERSING THE DIRECTION OF ROTATION OF A DC SERIES MOTOR BY CHANGING ARMATURE CONNECTION

Method 2: Reverse the direction of rotation by changing the field terminals.

1 Connect the motor as shown in Fig 3 and check the loading arrangements for its correctness. Repeat steps 5 to 8 of Task 1.

2 The effect of changing the supply terminals on the direction of rotation could be checked by connecting the DC series motor as shown in Fig 4. Check the loading arrangements for correctness. Repeat steps 5 to 8 of Task 1.

Fig 3



REVERSING THE DIRECTION OF ROTATION OF THE DC SERIES MOTOR BY CHANGING FIELD CONNECTION

3 Compare the connections in Fig 1 and Fig 4. Check the direction of rotation in both the cases.

4 Write the conclusion based on this experiment in the space given below.

CONCLUSION

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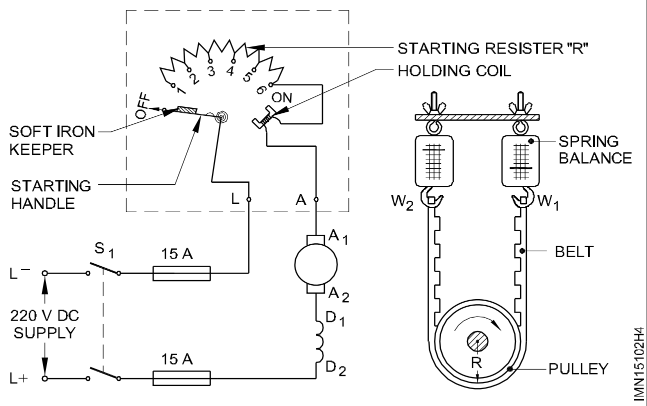
Fig 4



DC shunt motor

Objectives: At the end of this exercise you shall be able to
- **identify the parts and trace the connections of a 3-point starter**
- **connect a 3-point starter to a DC shunt motor, start and run the motor**
- **reverse the direction of rotation of a DC shunt motor**
  - **by changing the armature terminals**
  - **by changing the field terminals.**

Requirements

Tools/Instruments

- Insulated cutting pliers 200mm - 1 No.
- Screwdriver 150mm - 1 No.
- D.E. spanner set 5mm - 20mm - 1 Set.
- Megger 500V - 1 No.
- Shunt type ohmmeter 0-2K or multimeter - 1 No.

Materials

- PVC insulated stranded copper cable 2.5 sq.mm. - 6 m
- Fuse wire 15 amperes - 0.2 m

Equipment/Machines

- DC shunt motor 220V 3 Hp - 1 No.
- ICDP switch 250V 16A - 1 No.
- 3-point starter suitable for 220V, 3Hp, DC shunt motor - 1 No.

PROCEDURE

1 Read and interpret the name-plate details of the given DC shunt motor and record it.

2 Identify the terminals of the DC shunt motor from the markings.

3 Test the DC shunt motor for continuity, insulation and earth.

There should be continuity between the armature terminals A1 and A2, and also between the shunt field terminals E1 and E2. The insulation resistance between the armature and shunt field windings and between the windings and the frame should not be less than one megohm.

TASK 1: **Connect, start and run a DC shunt motor.**

1 Select the ICDP switch, 3-point starter, fuse wire and cable according to the given specification.

The specification here is for DC shunt motor 220v,3HP rating. If the available DC shunt motor in the shop floor is not of the same rating, the specification will have to be changed.

2 Open the 3-point starter, trace the connections and sketch the internal parts.

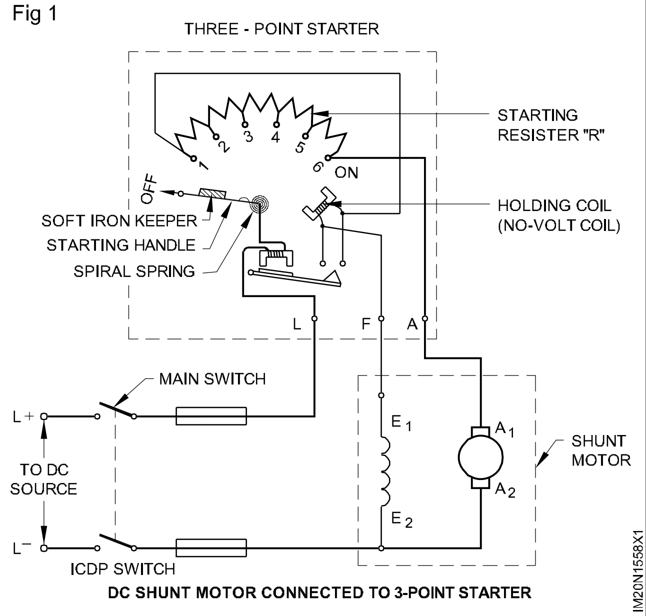
3 Measure the resistance of the series resistor and the no-volt coil of the starter. Enter these values in Table 1.

4 Connect the DC shunt motor as shown in Fig 1.

5 Check the supply voltage and confirm by verifying with the data given in the name-plate.

6 Check the rating of the fuses in the main switch. If required, change it in accordance with the motor rating.

Fig 1



7 Switch `ON' the ICDP and gradually move the starter handle to the `ON' position.

8 Observe the direction of rotation and enter it in Table 2.

9 Stop the motor by switching `OFF' the ICDP Wait until the shaft comes to a standstill position.

10 Remove the fuse-carriers from the ICDP.

Table 1

Resistance of the series resistor (in ohms)	Resistance of the no-volt coil(in ohms)

TABLE 2

Sl.No	Description	Direction of rotation
1	Normal connection as in Fig 1	
2	By changing armature terminals as in Fig 2	
3	By changing shunt field terminals as in Fig 3	

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TASK 2**: Reverse the direction of rotation of a DC shunt motor**

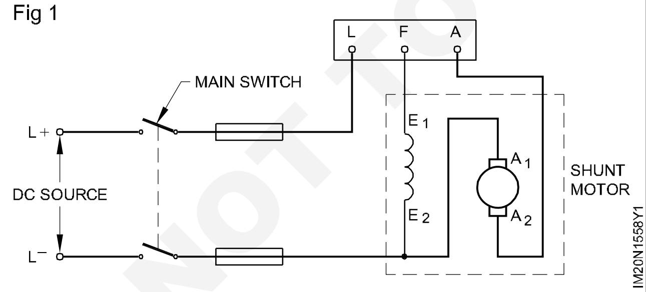
Method 1 : Change the direction of rotation by changing the armature terminals.

1 Reconnect the DC shunt motor as shown in Fig 2.

2 Replace the fuse-carriers.

3 Repeat the working steps 7 to 10 of Task 1.

Fig 1



Method 2 : Change the direction of rotation by changing the shunt field terminals.

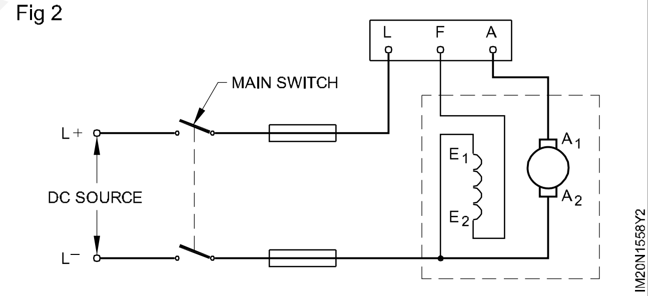
1 Reconnect the DC shunt motor as shown in Fig 3.

2 Replace the fuse-carriers.

3 Repeat the working steps 7 to 10 of Task 1.

Only one pair of terminals, either armature or shunt field, should be changed. If both the armature and shunt field terminals are changed, the direction of rotation will not change.

Fig 2



Write the conclusion:

a Necessity of starter

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b method of changing the direction of rotation in a DC shunt motor based on fleming’s left hand rule

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Install an alternator identify parts and terminals of alternator

Objectives: At the end of this exercise you shall be able to
- **read and interpret the name-plate details of an alternator**
- **identify the terminals of a single phase alternator**
- **determine the DC excitation/field winding terminals**
- **identify the terminals of a 3-phase, star-connected alternator.**

Requirements

Tools/Instruments

- Combination pliers 200mm - 1 No.
- Round nose pliers 150mm - 1 No.
- Screwdriver 200mm - 1 No.
- Electrician's knife 100mm - 1 No.
- Shunt type ohmmeter 0 to 25 ohms - 1 No.

Equipment/Machines

- Single-phase alternator 240V 1kVA - 1 No.
- Three-phase alternator 415V 5kVA - 1 No.

Materials

- Test prods - 1 set.
- PVC insulated copper cable 2.5 sq mm - 5 m.

PROCEDURE

1 Note down the name-plate details of the given alternator in Table 1.

TABLE 1

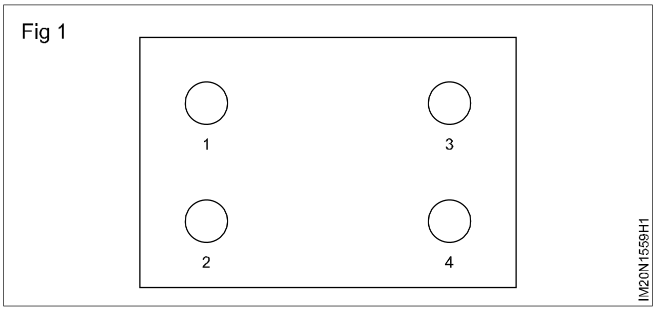
Name-plate details

Manufacturer, Trade Mark	:__________		
Type, model or list number	:__________		
Type of current	:__________	Fabrication or serial number	:__________
Function	:__________ Alternator		
Type of connection	:__________	P.F.	:__________
Rated voltage	:__________ Volts	Rated current	:__________ amps
Frequency	:__________ Hz	Rated speed	:__________ r.p.m.
Rated power	:__________ kVA	Rated exc.current	:__________ amps
Rated exc.voltage	:__________ Volts	Direction of rotation	:__________
Rating class	:__________	Protection class	:__________
Insulation class	:__________		

2 Remove the terminal cover and note the position of the terminals in your note book.

3 If there is any marking on the terminals note it down also. If not, give your own making as 1, 2, 3 etc. as shown in Fig 1.

If there are only four terminals in the terminal block, it may be a single phase alternator or a three-phase, star-connected alternator with the field winding internally connected with rectifiers. If all the four terminals show continuity between one other, it is a three-phase alternator. Otherwise it is a single phase alternator. However, the details in the name-plate will give you the clue.



4 Take the ohmmeter and adjust it for zero reading by shorting its prods.

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TASK 1: **Identify the terminals of a single phase alternator**

1 Connect Prod 1 of the ohmmeter to any one of the terminals of the terminal plate and go on touching the other terminals with Prod 2, one by one as shown in Fig 1 until the ohmmeter shows some value. The pair of terminals where the ohmmeter shows some value belongs to one winding.

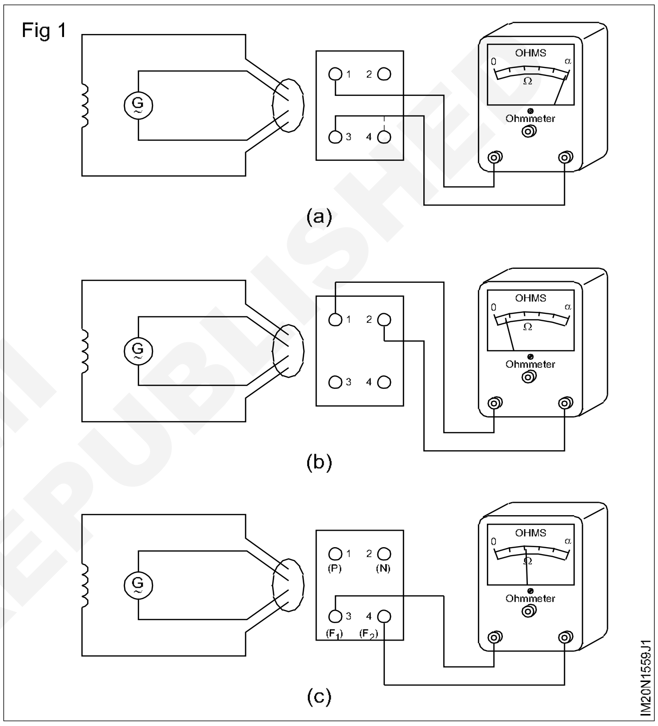
2 Similarly identify the other pairs of terminals.

In the case of a single phase alternator having only two pairs of terminals, one pair belongs to AC winding and the other pair belongs to DC excitation. Mark the AC winding terminals as P and N.

3 Measure the value of resistance of each pair of terminals accurately and record in Table 1.

TABLE 1

Sl. No.	Between pairs	Resistance value in ohms	Remarks
1			
2			



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TASK 2: **Identify the field terminals**

1 Find out the pair of terminals which shows a higher resistance compared to the other pairs (TASK 2 as shown in Fig 1c). These are the field terminals. Mark them as F_1 and F_2.

The value of DC field winding resistance depends on the rating of the excitation voltage. Some machines are excited with a low voltage of 24 to 40 volts and some others are excited with a higher voltage. Accordingly the value of the field resistance changes. Hence, depending upon the available alternator, select an ohmmeter of a proper range. The ohmmeter specified here is for low resistance measurement.

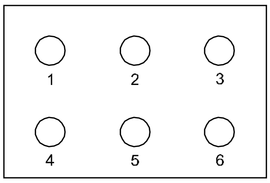
— — — — — — — —

TASK 3: **Identify the terminals of a 3-phase, star-connected alternator**

In a 3-phase, star-connected alternator three windings are internally connected in the star and four terminals are brought out to the terminal block. These four terminals consist of three beginning ends of the 3-phase winding and one neutral.

1 If there is any marking on the terminals note it down also. If not, give your own marking as 1,2,3 etc as shown in Fig 1.

Fig 3

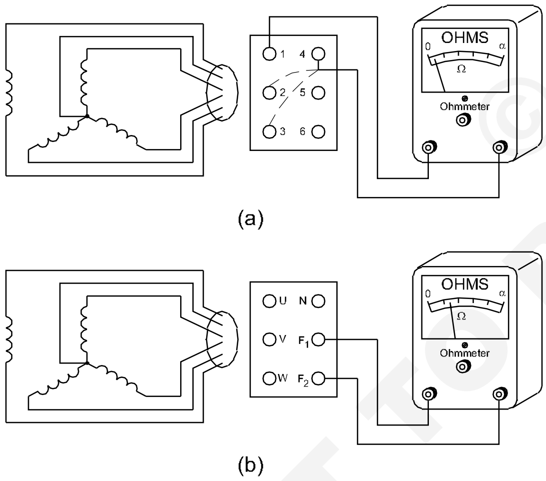


IMN15103H3

2 Identify the terminals which show the internal connection, following the procedure stated in the above working steps and also as shown in Fig 1a. Measure the resistance in between them and record the readings in Table 1.

3 Identify the field winding from the terminal block. (Fig 1b)

Fig 4



(a)

(b)

IMN15103H4

Only one pair will be independent with marginally high resistance. This pair belongs to the field winding. The other four terminals which show continuity between them belong to the star-connected, main winding terminals.

Out of the four terminals, three terminals will give comparatively high resistances between them. These are the ends of the three coils called UVW terminals. However, the left out terminal out of the four will give half the value of resistance when measured between any one terminal of UVW and that terminal. This terminal is the neutral and has to be marked as `N'. The marking of the 3-phase terminals as UVW is tentative. The correct phase sequence is to be checked with the help of a phase-sequence meter, and then only the terminals could be marked as UVW.

4 Mark the terminals accordingly.

5 Show your marking to your instructor and get his approval.

TABLE 1

Sl.No.	Between	Resistance value in ohms	Remarks
1	1 - 2		
2	2 - 3		
3	3 - 4		
4	1 - 3		
5	1 - 4		
6	2-4		
7	5 - 6		

Perform speed control of DC motors - field and armature control method

Objectives: At the end of this exercise you shall be able to
- **read and interpret the name-plate details of a DC machine**
- **identify the terminals of a DC machine**
- **connect the DC shunt motor through a 4-point starter and a shunt field regulator**
- **start and run a DC shunt motor**
- **measure the speed of a DC motor**
- **vary the speed of a DC motor with the help of the shunt field control regulator, and find the relationship between the field current and speed.**

Requirements

Tools/Instruments

- Insulated cutting pliers 200mm - 1 No.
- Screwdriver 200mm - 1 No.
- Electrician's knife (100 mm) - 1 No.
- M.C. ammeter 0-1A - 1 No.
- M.C. voltmeter 0-300V - 1 No.
- Tachometer 300-3000 r.p.m. - 1 No.
- Megger - 500V - 1 No.
- Test lamp - 1 No.

Equipment/Machines

- DC shunt motor 220V 3HP - 1 No.
- Rheostat 220 ohms 1 amp - 1 No.
- 4-point starter 15A 220V - 1 No.

Materials

- P.V.C. insulated multi-strand copper cable 2.5 sq mm 600V grade - 10 metres.
- Fuse wire 15 Amps - as reqd.

PROCEDURE

TASK 1: **DC motor speed control by field control method**

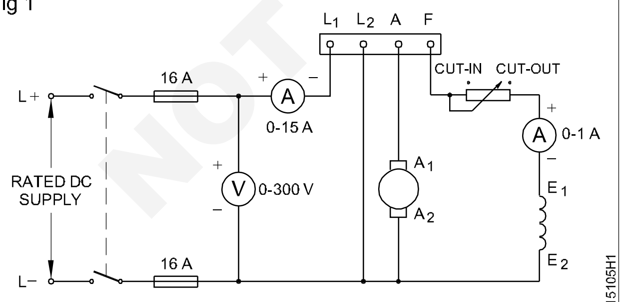
1 Note the name-plate details of the given DC shunt motor and record it.

2 Identify the terminals of the given DC shunt motor and test for insulation and ground.

3 Select a suitable range of rheostat, ammeter, voltmeter, switch and fuse according to the specification of the given DC shunt motor.

4 Make the connections as per the circuit diagram shown in Fig 1.

Fig 1



SPEED CONTROL OF THE DC SHUNT MOTOR BY FIELD CONTROL METHOD

5 Keep the field rheostat in the cut out position to have minimum resistance in the shunt field circuit.

> **The rheostat position must be in the cut out postion at the time of starting to have a low starting speed.**

6 Apply the rated supply voltage through the switch and start the motor by the 4-point starter.

7 Measure the speed, field current, voltage and enter them in Table 1.

8 Decrease the field current by increasing the field control resistance in steps.

> **Calculate 130% of the speed value from the name-plate details. The speed should not be more than 30% of the rated value.**

9 For each step, measure the speed, field current, and the applied voltage and enter these values in Table 2.

10 Switch OFF the supply of motor.

11 Draw the speed versus field current curve in a graph sheet, keeping the field current in the X-axis and the speed in the Y-axis.

12 Write your observation highlighting the relation between speed, field current and field flux.

Observation

____

____

____

____

TABLE 2

Sl.No.	Voltage	Line current	Field current	Speed
1				
2				
3				
4				
5				
6				

— — — — — — — —

TASK 2: **Speed control of DC motor, armature control**

1 Note the name-plate details of the given shunt motor and record it.

2 Identify the terminals of the given DC shunt motor and test for insulation and ground.

3 Select the 3-point starter, rheostat, ammeter and voltmeter according to the rating of the given DC shunt motor.

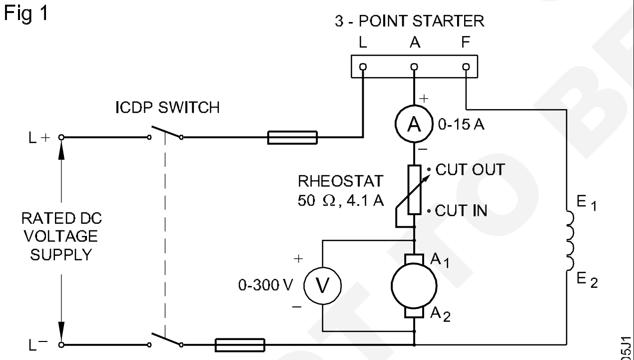
4 Make the connections as per the circuit diagram shown in Fig 1.

5 Keep the armature circuit rheostat in the cut out position.

6 Apply the rated voltage and start the motor by using the 3- point starter.

7 Measure the speed, armature, current, voltage across the armature and enter them in Table 1.

Fig 1



SPEED CONTROL OF THE DC SHUNT MOTOR BY ARMATURE CONTROL METHOD

8 Gradually increase the armature circuit resistance and observe the speed and coressponding armature current and voltage across the armature.

9 For each variation, repeat step No 7.

10 Switch `OFF' the supply to the motor.

11 Draw the speed and armature voltage characteristic curve in the graph sheet, keeping voltage in the X-axis and speed in the Y-axis.

12 Write your conclusion highlighting the relationship between the voltage across the armature and speed.

Note: Back emf = E_b = Applied voltage

– Total armature circuit voltage drop

$= E - I_a R_T$

$= E - I_a (R_a + R_{ar})$

E_b = Applied voltage – (Internal Armature Resistance drop + External armature rheostat drop)

Assuming the internal armature resistance drop is negligible, we can also assume voltage across the armature = back emf E_b.

Conclusion

____

____

____

Table 1

S.No.	Armature current (I_a)	Voltage across armature	Speed r.p.m.	Remarks

Connect start and run three-phase induction motors by using D.O.L, star delta and auto transformer starter

Objectives: At the end of this exercise you shall be able to
- **identify and collect the parts of a D.O.L starter**
- **assemble the D.O.L starter when contactor overload relay, push-button stations and single-strand cables are given in semi-knocked out condition**
- **connect and harness the hook-up cable for control circuit**
- **mount the D.O.L starter, the main ICTP switch and connect the 3-phase induction motor**
- **earth the motor, the starter and the switch**
- **set the overload relay**
- **replace correct capacity backup fuses**
- **start and stop the 3-phase induction motor through D.O.L starter**
- **measure the starting and the running currents of the 3-phase squirrel cage motor**
- **measure the actual speed of the 3-phase squirrel cage motor**
- **determine synchronous speed.**

Requirements

Tools and Instruments

- Combination pliers 200mm - 1 No.
- Screwdriver 300mm with 4mm blade - 1 No.
- Connector screwdriver 100mm - 1 No.
- Side cutting pliers 200mm - 1 No.
- Electricians knife 100mm - 1 No.
- Ammeter MI 0-20 amp - 1 No.
- Voltmeter MI 0-500V - 1 No.
- Plumb bob with thread - 1 No.
- Spirit level - 1 No.
- Tachometer 0-3000 rpm - 1 No.

Equipment/Machines

- 3-phase squirrel cage motor 3 HP 415V, 50Hz - 1 No.
- D.O.L starter 10 amp 415V with overload relay, no-volt coil & push-button station - 1 No.
(The instructor is requested to dismantle the contactor, overload relay and the internal connecting hook-up cables before giving the equipment to the trainees)

Materials

- PVC insulated, single strand copper cable 16 SWG - 0.5m
- PVC insulated, single strand copper cable 18 SWG - 0.5m
- Machine screws 2 BA, 30mm long with 2 washers and one nut - 4 Nos.
- I.C.T.P switch 16A 415V - 1 No.

PROCEDURE

1 Note down the name-plate details of the given AC 3-phase squirrel cage induction motor in Table 1.

2 Collect the contactor unit, overload relay unit, start/stop push-button unit, the necessary fixing screws,

Table 1
Name-plate details

Manufacturer, Trade Mark.............................	Rated frequency.......................
Type, model or list number............................	Rated power.............k.w/HP
Type of current..	Rating class.......................
Function...........................	Insulation class..................
Fabrication or serial number..........................	Rated current......... amps
Type of connection.....sep/shunt/series/compound	Rated speed...........r.p.m
Rated voltage... volts	Protection class............

Start, run and reverse an AC 3-phase squirrel cage induction motor by manual star/delta starter

Objectives: At the end of this exercise you shall be able to
- **identify the parts of a manual star-delta starter and trace the connection**
- **draw the star/delta connection of motor winding through starter-handle operation**
- **connect the manual star-delta starter with 3-phase squirrel cage induction motor**
- **adjust the overload relay according to the motor current rating**
- **start the 3-phase squirrel cage induction motor through the manual star-delta starter**
- **stop the 3-phase squirrel cage induction motor through the manual star-delta starter**
- **reverse the direction of rotation of the squirrel cage motor.**

Requirements

Tools and Instruments

- Insulated cutting pliers 200mm - 1 No.
- Screwdriver 200mm, 300mm - 1 No.
- Side cutter 150mm - 1 No.
- Wire stripper 150mm - 1 No.
- M.I ammeter 0-10 amp - 1 No.
- M.I voltmeter 0-500V - 1 No.

Equipment/Machines

- 3-phase squirrel cage induction motor 415V, 5 HP - 1 No.
- Manual star-delta starter 16A, 415V with overload relay and no-volt coil - 1 No.

Materials

- PVC insulated, stranded aluminium, cable 2.5 sq.mm 650V grade - 25 m
- Fuse wire 10 amps - as reqd.
- Black insulation tape- - as reqd.
- ICDP switch 16A 415V - 1 No.

PROCEDURE

1 Read and interpret the name-plate details of the given 3-phase induction motor and starter and enter in Table 1 & Table 2 .

2 Switch 'off' the mains, remove the fuse-carriers and keep them in safe custody.

3 Remove the terminal cover of the motor and the front cover of the starter.

Table 1

Starter : Name Plate details

____
____
____
____
____

TABLE 2

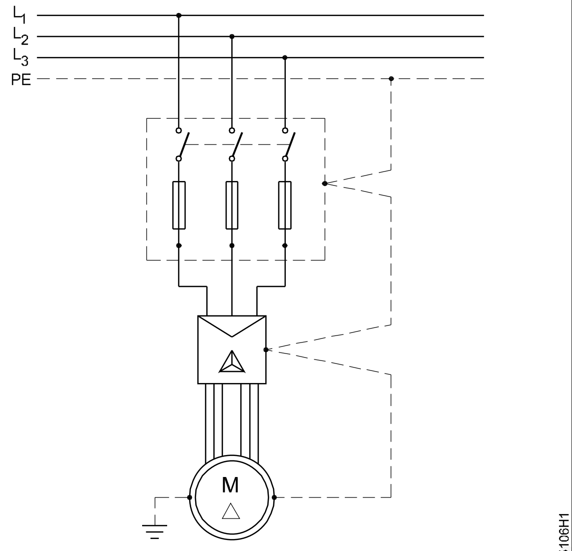
Name-plate details

Manufacturer, Trade Mark..............................	Rated frequency.......................
Type, model or list number............................	Rated power............................kW/HP
Type of current...	Rating class............................
Function...........................	Insulation class........................
Fabrication or serial number..........................	Rated current.......................... amps
Type of connection.....sep/shunt/series/compound	Rated speed.............................r.p.m
Rated voltage.. volts	Protection class.......................

To connect a star-delta starter, the squirrel cage induction motor must have six terminals, which are normally marked as U_1, V_1, W_1 & U_2, V_2, W_2.

4 Identify the parts of the given star-delta starter, trace the connections and verify its operation. Draw the traced out circuit and get it approved by the instructor.

Fig 1



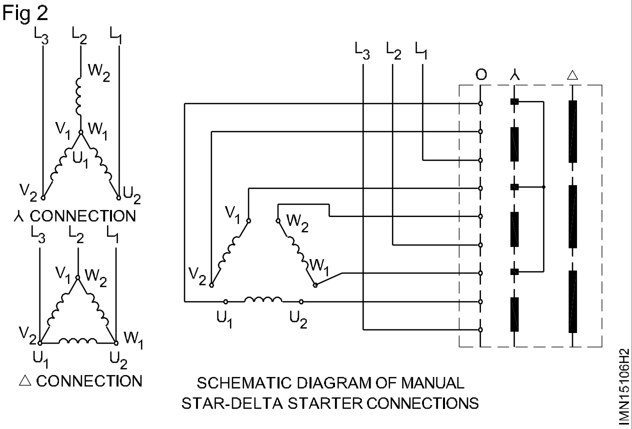
LAYOUT DIAGRAM OF STAR - DELTA STARTER CONNECTED TO THE MOTOR

The layout diagram in Fig 1, the schematic diagram of a star-delta starter in Fig 2 and two types of practical circuits in Figs 3 and 4 are all given for your guidance only.

5 Draw the complete connection diagram incorporating the ICTP switch, the given star-delta starter and motor and get it approved by your instructor.

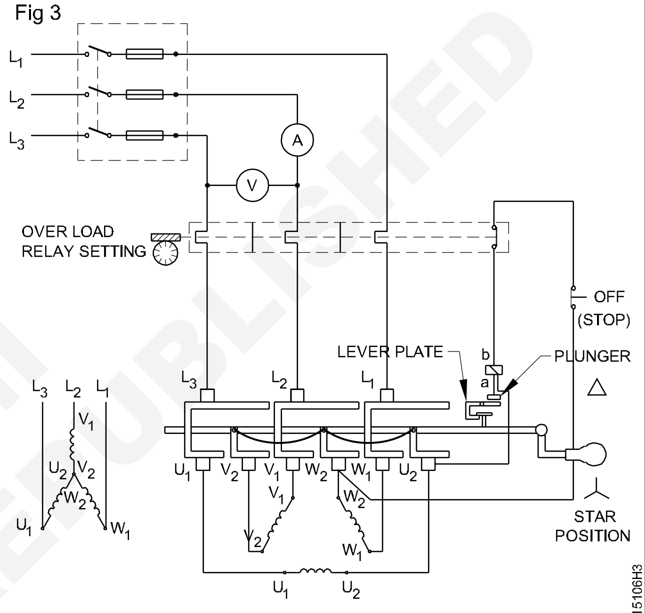
6 Make the connections of the motor, starter and the ICTP switch as per the approved diagram.

Fig 2



SCHEMATIC DIAGRAM OF MANUAL STAR-DELTA STARTER CONNECTIONS

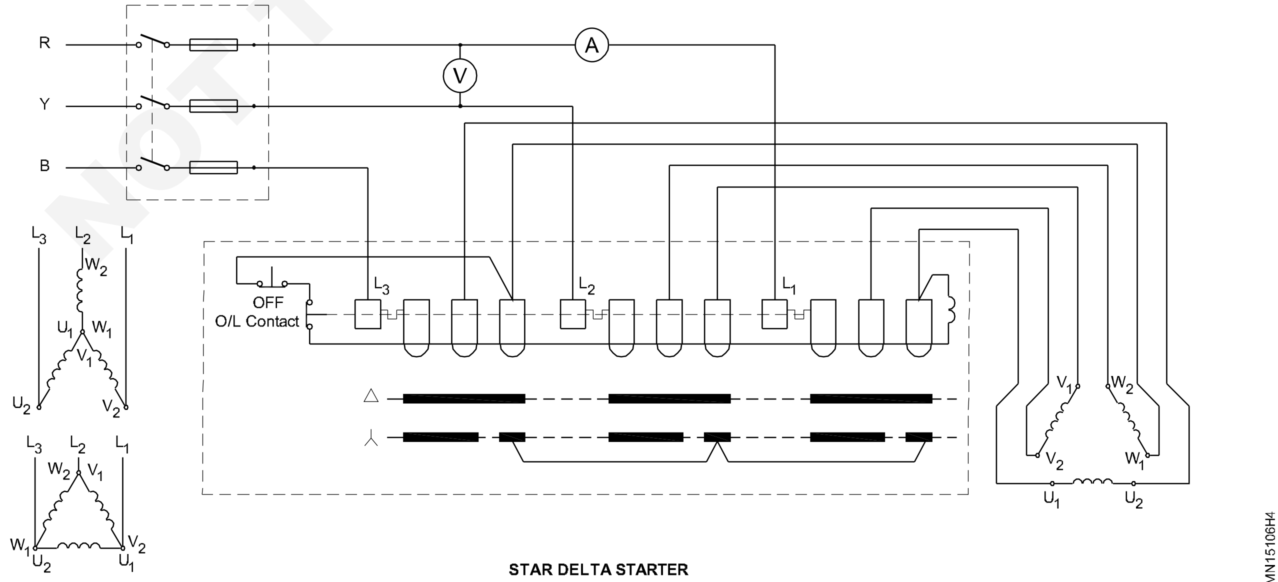
Fig 3



STAR - DELTA SWITCH IN STAR POSITION

7 Connect three cables from supply $L_1 L_2$ & L_3 to the main switch as shown in Fig 3 or Fig 4.

Fig 4



STAR DELTA STARTER

Connect and run 3-phase induction motor through auto-transformer starter operated by contactors

Objectives: At the end of this exercise you shall be able to
- **connect a 3-phase induction motor with an auto-transformer and contactors as starter**
- **start and run a 3-phase induction motor by auto-transformer and contactors.**

Requirements

Tools and Instruments

- Multimeter - 1 No.
- Megger 500V - 1 No.

Equipment/Machines

- Auto-transformer starter 3-phase 415V with tapping - 1 No.
- AC 3-phase squirrel cage induction motor 415V, 3KW/5HP - 1 No.

Materials

- Contactors 415V, AC with 240V operating coil having 16A - 3 power circuit contacts 2A - 4 auxiliary change over contacts - 4 Nos.
- Delay time relay, 24V, AC operating coil with 1 or 2 normally open contacts - 3 Nos.
- Connecting cable copper 1.5mm^2 for control circuit - 10m
- Power cable single strand 2.5mm^2 copper - as reqd.

PROCEDURE

1 Check the insulation and continuity of three-phase induction motor.

2 Check the earthing connection for its effectiveness.

3 Trace the diagrams Fig 1 and 2.

Fig 1

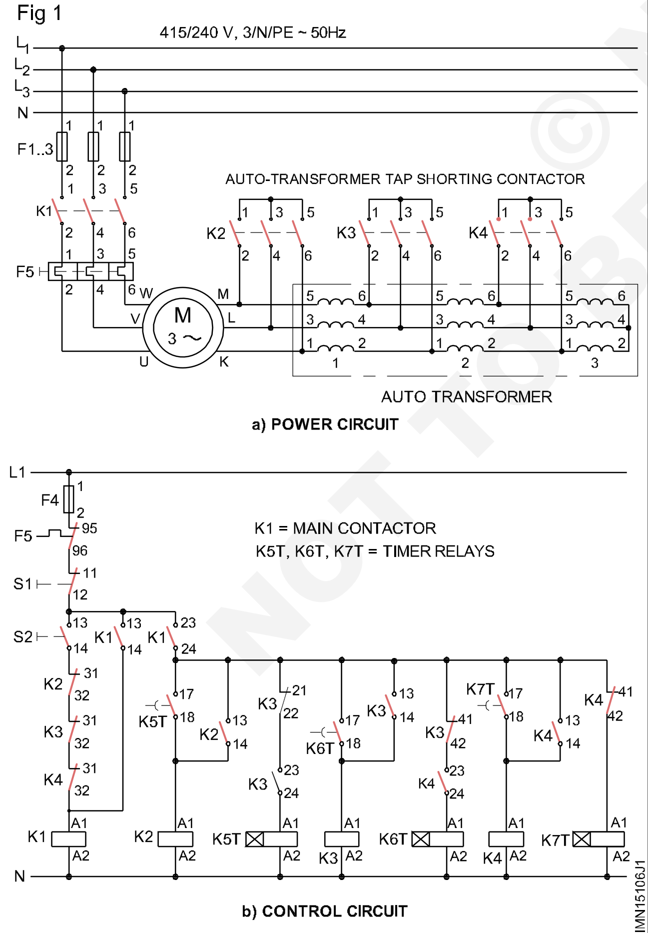
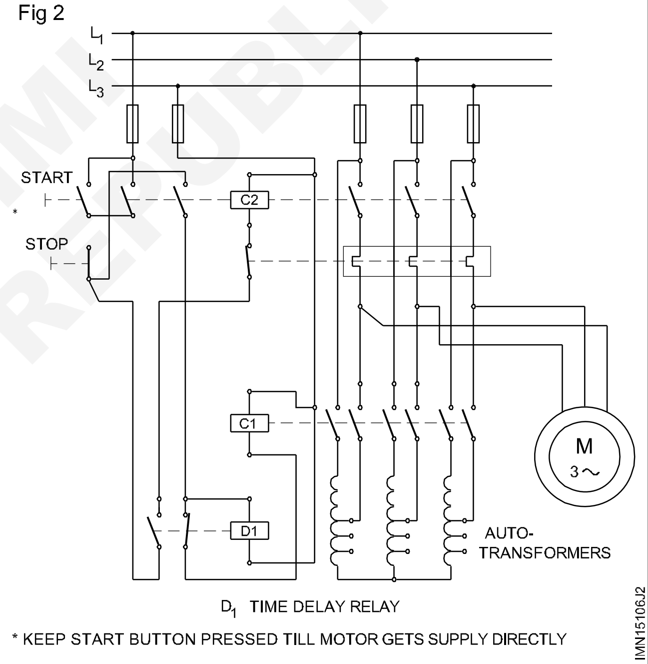


Fig 2



4 Draw the power lines connecting the contactors, auto-transformer and motor for sequential operation as in Fig 3.

5 Mark the different terminals of contactors corresponding to the actual panel provided.

6 Draw the control circuit connections including timer and overload trip for sequential operation in Fig 3.

7 Complete the connections external to the panel in Fig 3.

Get the circuit checked by the instructor before proceeding.

8 Make connections as per diagram.

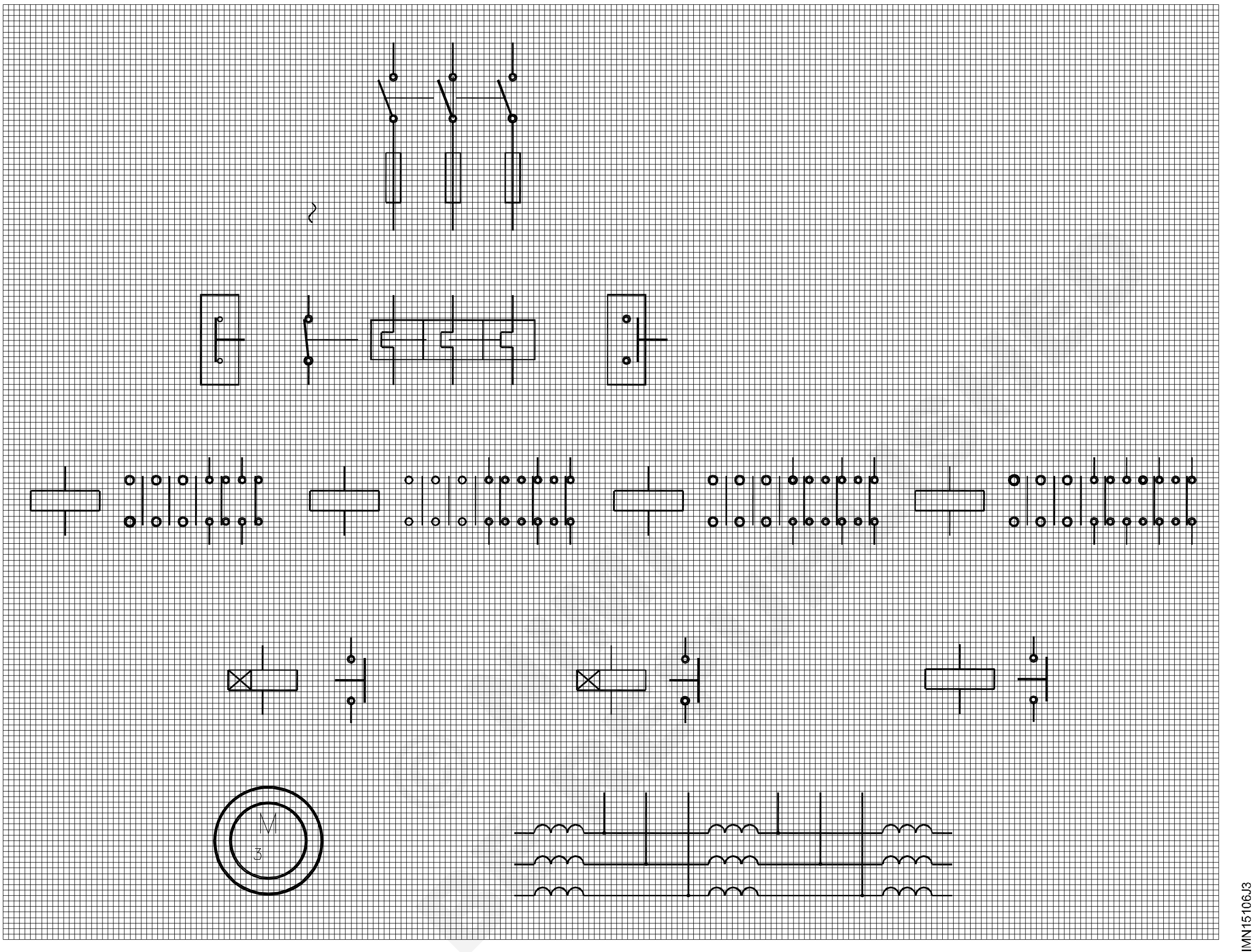
9 Switch on S1. Switch on the contactor.

10 Check when the full voltage to the induction motor is given by the auto-transformer.

11 Measure rpm of the induction motor.

12 Switch 'OFF' the contactor and then the S_1.

Fig 3



Perform OC and SC test to determine the efficiency of single phase transformer

Objectives : At the end of this exercise you shall be able to
- **find the transformation ratio of any given transformer**
- **find the iron loss of the transformer**
- **find the copper loss of the transformer**
- **find the efficiency of the transformer.**

Requirements

Tools/Instruments

- Trainees kit
- AC milliammeter, 0-500 mA - 1 No./batch.
- AC ammeter, 0-5A - 2 Nos./batch.
- Wattmeter 250V, 1A, 250 watts - 1 No./batch.
- Auto transformer,0-270V,5A - 1 No./batch.

Materials

- Transformer 240:12V, 3A (36VA) - 1 No.
- Patch cords - as reqd.

PROCEDURE

TASK 1 : **Finding transformation ratio and iron loss of the transformer**

This test is popularly known as OPEN CIRCUIT or OC TEST

1 Record the specifications/rating of the given transformer in O&T sheet.

2 Measure and record the ohmic resistance of primary and secondary windings in O&T sheet.

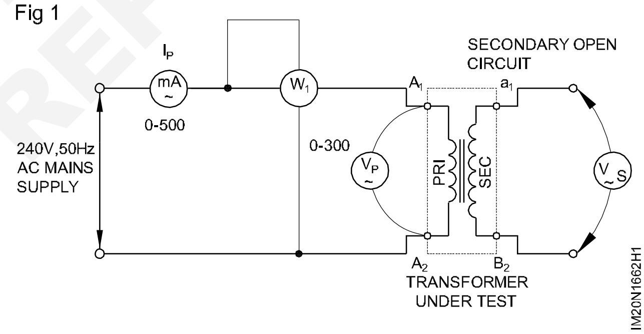
3 Connect the test set-up for OC-test as shown in Fig 1. Get it checked by your instructor.

4 Switch ON mains. Measure and record primary power (W_I), primary voltage(V_p), primary current (I_P) and secondary voltage (V_S) in Table 1 of O&T sheet.

5 From the recorded values, calculate and record the transformation ratio K of the transformer and power factor cosø.

6 Get your work checked by your instructor.

Fig 1



Observation & Tabulation Sheet

1. Transformer specifications:

(i) Type of transformer : Single phase/Three phase

(ii) Rated primary voltage : ________ Frequency : ________

(iii) Rated secondary voltage : ________ volts

(iv) Rated secondary current : ________ Amps

(v) VA rating of transformer : ________ VA

2.

(i) Resistance of primary winding : ________ Ohms

(ii) Resistance of secondary winding : ________ Ohms

3.

Table - 1

(Results of OC-test)

V_P	I_P	Iron loss W_1	V_S	Transformation ratio K $K = \frac{V_s}{V_p}$	Power factor $\text{Cos } \phi = \frac{W_I}{V_p \cdot I_p}$
Rated primary Voltage (230 V_{rms})					

— — — — — — — —

TASK 2: **Finding transformation ratio and copper loss of transformer**

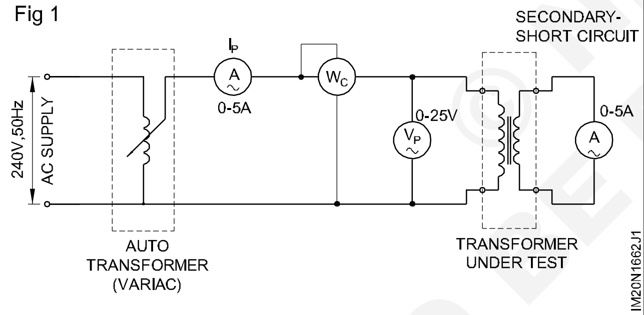
[This test is popularly known as SHORT CIRCUIT or SC TEST]

1 Connect the test set-up for SC-test as shown in Fig 2 and get it checked by your instructor.

> **Make sure that the auto-transformer (VARIAC) is at zero volt output position otherwise the transformer under test may get damaged permanently.**

2 Slowly increase the output of VARIAC till 50% of rated secondary current(I_S) flows in the secondary winding.

Fig 1



> **Rated secondary current will flow at a very low primary voltage (V_p) itself. Hence take care not to increase the output of auto transformer abruptly. This will damage the transformer permanently.**

3 Record readings of W_c, I_P, V_P and I_S in Table 1.

4 Increase the output voltage of VARIAC till 100% rated secondary current flows through the secondary winding.

5 Record readings of W_c, I_P, V_P and I_S in Table 1.

6 Switch OFF mains and disconnect the set-up.

7 Calculate and record the current transformation ratio using the recorded values of I_P and I_S.

8 From the readings recorded in Table 1 and 2. Calculate and record

(i) Total transformer losses

(ii) Efficiency of the transformer at 50% of rated load

(iii) Efficiency of the transformer at 100% of rated load

9 Get your work checked by your instructor.

Table 1

(Results of SC-test)

Secondary winding current I_S	Primary winding current I_P	Copper loss W_C	Transformation ratio $\frac{I_p}{I_s}$	Total transformer losses $W = W_I + W_C$ (W)
[50% of rated current] ______ Amps				
[100% of rated current] ______ Amps				

5 Efficiency h of the transformer

(i) At 50% of rated load: ____________________

(ii) At 100% of rated load: ____________________

Determine voltage regulation of single phase transformer at different loads and power factor

Objectives: At the end of this exercise you shall be able to
- **measure power output using single phase wattmeter**
- **measure power factor of single phase transformer with load using power factor meter**
- **adjust load to the required power factor**
- **calculate the voltage requlation of the transformer at different loads.**

Requirements

Tools/Instruments

- Ammeter MI - 0 to 10 A - 1 No.
- Ammeter MI - 0 to 5 A - 1 No.
- Voltmeter MI - 0 to 150V - 1 No.
- Voltmeter MI - 0 to 300 V - 1 No.
- Dynamometer wattmeter - 5A, 250 V, 1250 W - 1 No.
- Power factor meter 0.5 lag - 1 - 0.5 lead 250 V rating - 1 No.

Equipment/Machines

- Auto-transformer input 240V, output 0 to 270V, 5A - 1 No.
- Transformer single phase 115/230V 1 KVA - 1 No.
- Lamp bank 240V, 1KVA - 1 No.

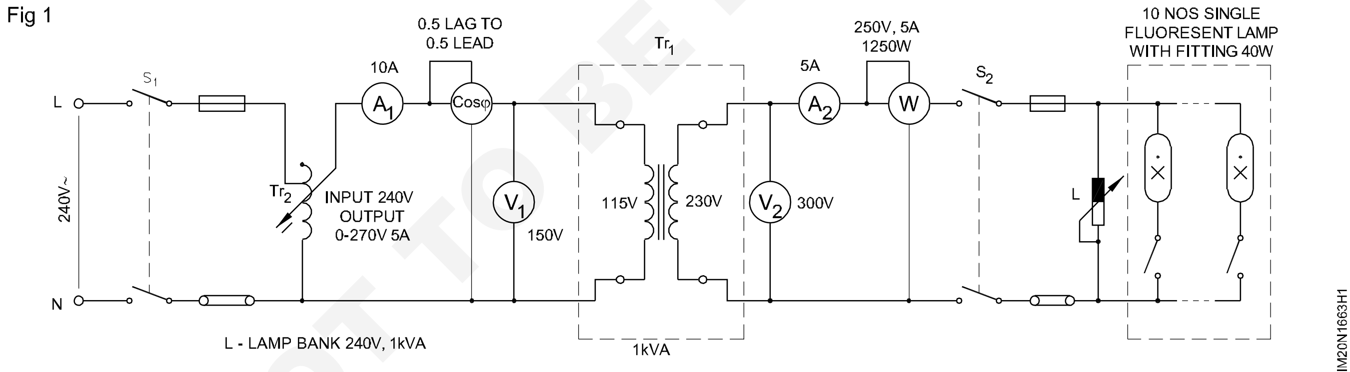
Materials

- Connecting cables - as reqd.
- SPT switches 6A 250V - 10 Nos.
- DPST switch 250V, 16A - 2 Nos.
- Single fluorescent lamps with fitting 240V, 40 W - 10 Nos.

PROCEDURE

1 Connect the equipment, meters etc. as per Fig 1.

Fig 1



Keep the switches s_1 and s_2 open. Set the auto-transformer for zero volt output.

2 Close switch S_1 and adjust (increase) the output of auto-transformer gradually to reach 115V.

Keep all the switches in the lamp bank in 'off' position.

3 Close switch S_2 and switch 'on' the incandescent lamps one by one till A_2 reads 25% of the load i.e. say 1A.

4 Adjust the auto-transformer Tr_2 if necessary to keep the primary voltage constant i.e. 115V.

5 Record the readings of the instruments in Table 1.

6 Increase the incandescent lamp load to 50% of the full load i.e. 2 A, 75% of the full load 3.A and 100% of the full load i.e. 4.0 A and record the reading in each case as in step 5.

7 Repeat steps 3 and 5, switching on the tube lights to get a power factor of about 0.9, 0.8 and 0.7 and enter the readings in Table 2.

Voltage regulation = $\frac{v_1 - v_2}{V_2} \times 100\%$

TABLE 1
(Unity P.F)

Sl. No.	Load	V_1	A_1	P.F.Cos ϕ	V_2	A_2	W	Voltage regulation $= \frac{v_1 - v_2}{V_2} \times 100\%$

TABLE 2
(Different P.Fs)

Sl. No.	Load	V_1	A_1	P.F.Cos ϕ	V_2	A_2	W	Voltage regulation $= \frac{v_1 - v_2}{V_2} \times 100\%$

Verify and measure voltage regulation of auto transformer at different loads

Objectives: At the end of this exercise you shall be able to
- **measure winding resistance**
- **test single phase auto transformer**
- **measure voltage regulation of auto transformer.**

Requirements

Tools/Instruments

- Ring spanner set of 6 to 12mm - 1 No.
- Spanner DE set of 6 to 12mm - 1 No.
- Low range ohm meter 0-25Ω - 1 No.
- Voltmeter MI multi-range 0-75-150V-300V-600V - 1 No.
- Ammeter MI multi range 0-2/10A - 3 Nos
- Multi range watt meter 600V/10A - 4 Nos
- Megger 500V - 1 No.

Equipments/Machines

- Auto transformer single phase I/P 240V O/P - 0-270V, 50Hz, 8A - 1 No.
- Auto transformer 3-phase I/P 415V, 50Hz, Star connected O/P 0-440V, 16amp - 1 No.
- Single phase load, 1kW - 1 No.
- 3-phase load 5kW - 1 No.

Materials

- Connecting leads -as reqd.

PROCEDURE

TASK 1: **Test on single phase auto- transformer**

1 Read, interpret and record the name plate details of the given single phase auto transformer, in Table 1.

TABLE 1

Single phase auto-transformer details

Input voltage	V
Output voltage	V
Current rating	...........Amp
VA/KVA rating	...........KVA
Number of phases and frequency	...........ϕ ....Hz
Serial Number	....
Manufacturer's name	....

2 Trace and draw the connection diagram of the auto-transformer.

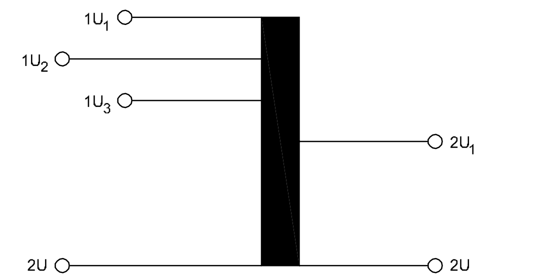
Typical markings of terminals of a single phase auto-transformer is given below for your reference in Fig 1.

3 Identify the primary, secondary of auto transformer and record the terminal markings.

a) Primary Terminal markings ....

b) Secondary Terminal markings ....

Fig 1



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TASK 2: **Measurement of winding resistance**

1 Measure the resistance of the primary winding and secondary winding at zero position and maximum position of the knob by using ohm meter, and record the readings as in Fig 2.

a Resistance of Primary windings (1U to 2U) ....

b Resistance of Secondary winding when the setting is at zero (2U to 2U1) ....

c Resistance of Secondary winding when the setting is at

maximum (2U to 2U1) ......

1 Measure voltage regulation of auto transformer with different loads.

Perform series and parallel operation of two single phase transformer

Objectives : At the end of this exercise you shall be able to
- **connect two single phase transformer in parallel**
- **connect two single phase transformer in series.**

Requirements

Tools/Instruments/Equipments

- Insulated combination plier 200mm - 1 No.
- Side cutting plier 150mm - 1 No.
- Screw driver 150mm - 1 No.
- Connector screw driver 75mm - 1 No.
- Electricians knife - 1 No.
- Test lamp - 1 No.
- Transformer 2kVA 230 v/115V - 2 Nos

Materials/Components

- Voltmeter MI type (0-300v) - 3 Nos
- Ammeter MI type (0-10A) - 2 Nos
- Varian 230/0-270 V , 20A - 1 No.
- PVC cable 1.5mm2 650 V gneds - 5mt
- Insulation tape - 1 No.

TASK 1: **conect two single transformers in parallel**

1 Indentify the primary and secondary of the transformers
2 Connect as per the circuit diagram
3 Connect the load (resistive lood)
4 Switch on the supply and set the variac at 230 V
5 Note the ammeter and voltmeter reading
6 Change the load
7 Note the ammater and voltmeter reading in table 1

Fig 1

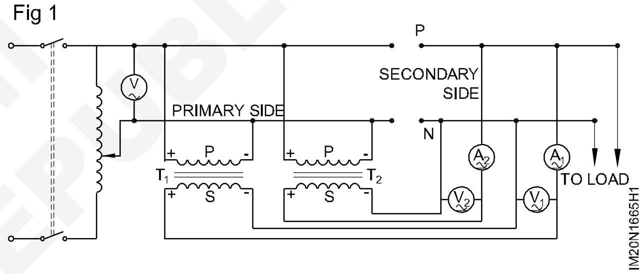


Table 1

Resistive	Secondary side and T_1		Secondary side and T_2	
Load in Walts	Voltmeterreading V_1 in volt	Ammeter reading I_1 in AMS	Voltmeter Reading V_2 in volt	Ammeter Reading I_3 in AMP

TASK 2: **Two single phase transformers connected in series**

1 Indentify the primary and seconded of the transformer
2 Connect as per the circuit diagram
3 Switch on the supply and set variac at 115V
4 Note the voltmeter reading Table 2

Fig 1

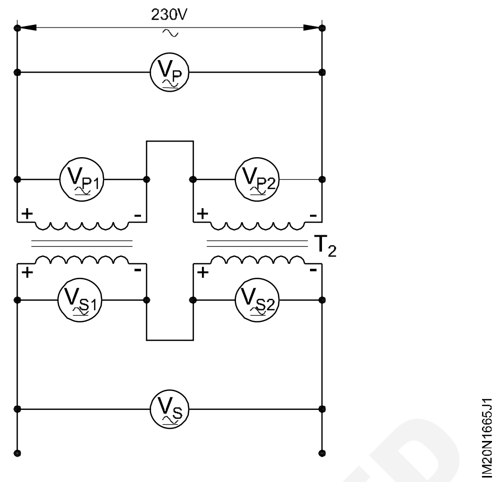


Table 2

Sl.No	Primary side voltmeter Reading in volt			Secondary side voltmeter reading in volt		
	VP	VP1	VP2	VPs	VS1	VS2

- **Connections should be correct and tight**
- **Voltage ratio and % impede of both the transformers must be same**
- **Same polarities must be connected together**
- **Give the rated voltage to the primary side**

Identify the type of measuring instruments specification internal construction

Objectives : At the end of this exercise you shall be able to
- **identify the type of instruments (AC/DC) and their function from the dial markings**
- **finding internal construction.**

Requirements

Tools and Instruments

- Voltmeter 0 - 300 V MC - 1 No.
- Ammeter MI 0-15 A panel board type - 1 No.
- Ammeter 0 - 5A MC - 1 No.
- Ohmmeter-shunt and series type - 1 each.
- Multimeter - 1 No.
- Multi-range voltmeter MC 0-75, 150, 300 & 600 V - 1 No.
- Multi-range voltmeter MI 0-150, 300 and 600 V - 1 No.

PROCEDURE

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 1. 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.

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

IM20N1766H1

TABLE 1

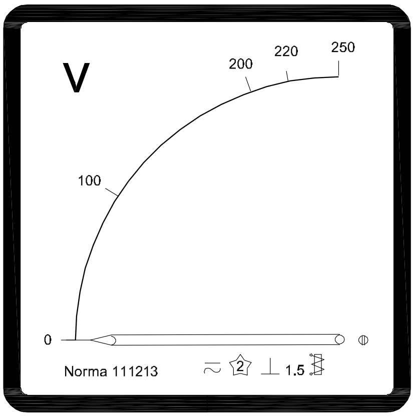
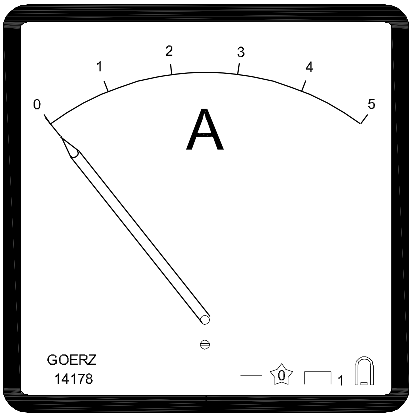
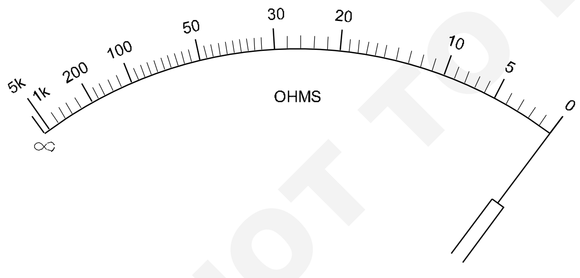
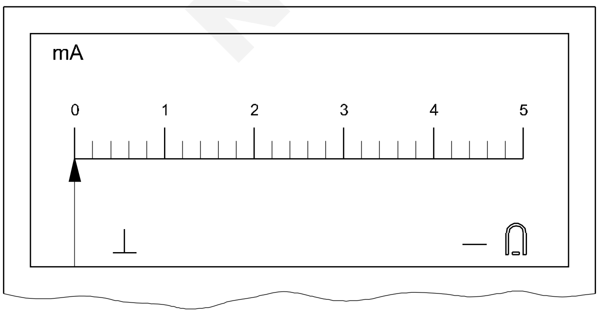
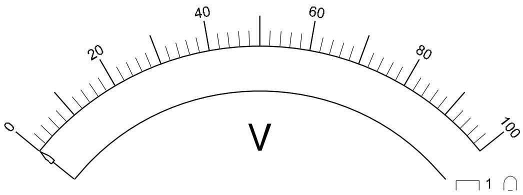
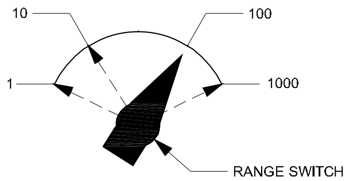
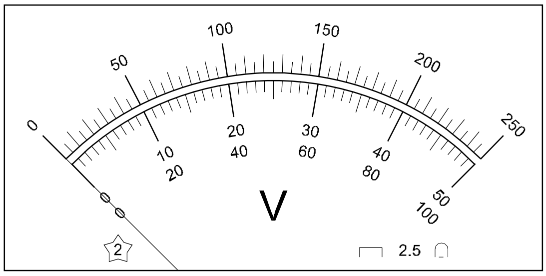
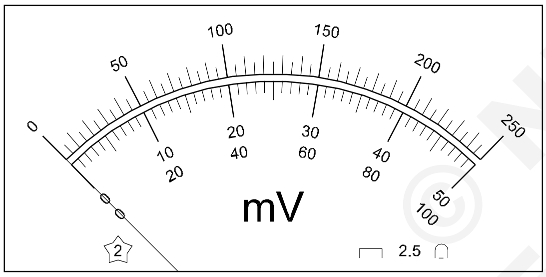
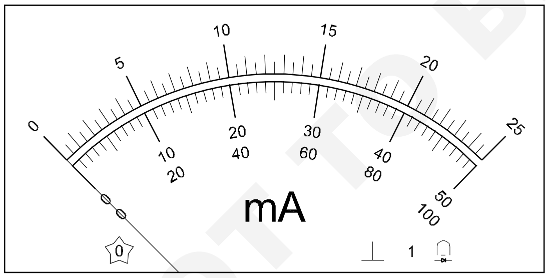
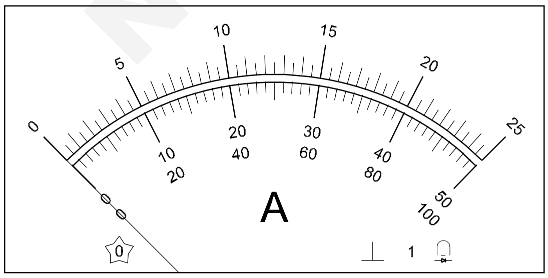
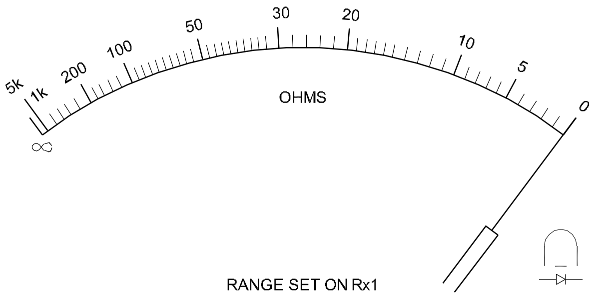
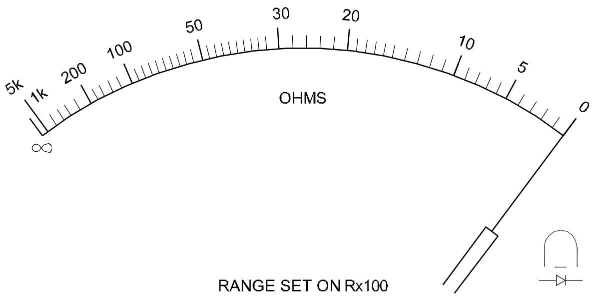
Instrument	Symbol	Type AC/DC	Function
Fig 1 			
Fig 2 			

TABLE 2

Instrument	Range:single or multi-range	Scale single or multi-scale	Function V or A or ohms
 			

Instrument	Range:single or multi-range	Scale single or multi-scale	Function V or A or ohms
   RANGE SET ON 250 (a)  RANGE SET ON 100 (b)  RANGE SET ON 5  RANGE SET ON 2.5			

Instrument	Range:single or multi-range	Scale single or multi-scale	Function V or A or ohms
 			

4 Identify the working position, accuracy (error of indication), type and function of the instruments in Figs 1 & 2 and record in Table 3.

5 Open the meter

6 Identify and record the type of clamping and controlling system

7 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.

— — — — — — — —

Overhaul check fault find repair and test of and voltmeter and ammeter

Objectives: At the end of this exercise you shall be able to
- **overhaul check fault find repair and test of MI voltmeter**
- **overhaul check fault find repair and lest of MI ammeter.**

Requirements

Tools/Equipments/Instruments		Materials/Components	
• MI Ammeter (suitable range)	- 1 No.	• 60:40 solder	- as reqd.
• Screw driver 100 mm	- 1 No.	• Soldering flux	- as reqd.
• Tweezer - 100 mm	- 1 No.	• Benzene	- as reqd.
• Eye glass	- 1 No.	• Cleaning brush	- as reqd.
• Nose plier - 100 mm	- 1 No.	• Pith wood	- as reqd.
• Soldering iron - 12W	- 1 No.	• connecting wires	- as reqd.

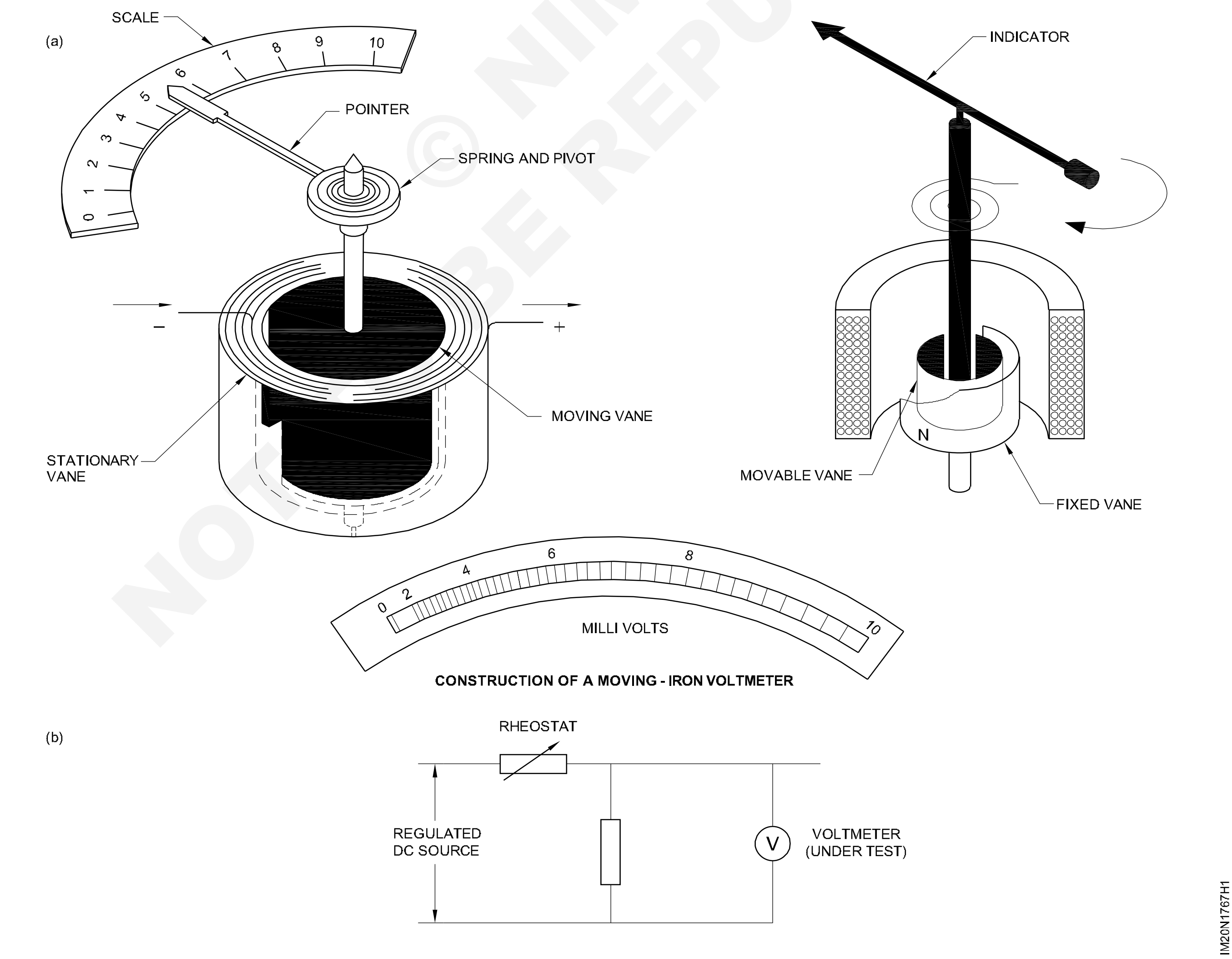
PROCEDURE

TASK 1 : **Overhaul check fault find repair and test of MI voltmeter**

1 Check the moving iron voltmeter for physical and electrical defects.

2 Note down the defects.

Fig 1



3 Remove the outer cover.

4 Remove the dial.

5 Check the coil and multiplier for continuity using a multimeter.

6 Check the terminals for proper soldering.

7 Desolder the hair-spring from the bridge plate end.

8 Remove the top cover of the air damping chamber.

9 Remove the top bridge plate.

10 Remove the pointer and spindle from the position.

11 Clean the jewels, pivot with benzene and cleaning brush.

12 Clean the spindle and check.

13 Assemble all the parts in the following sequence, first fix pointer spindle, resolver the hair spring, close the air damping chamber, fix the bridge plate and fix the dial.

Finally check the pointer movement after completing the assembly.

14 Get your work checked by the instructor

15 Test meter as per the circuit diagram (Fig 2) for its propre functioning.

With the guidance of instructor calibrate, the above meter

— — — — — — — —

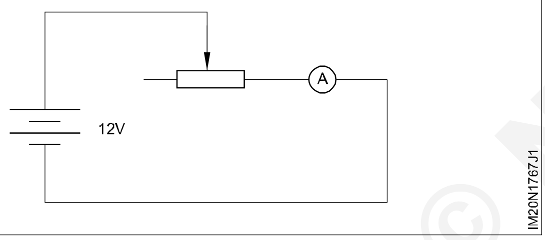
TASK 2 : **Dismantling the moving iron Ammeter**

1 Inspect the moving iron Ammeter and note down the defects as shown in Fig 1.

2 Open the moving iron ammeter.

3 Remove the dial and stoppers.

Fig 1



4 Check the coil for its continuity and the terminals for correct soldering.

5 By de-soldering the outer end of the hair spring and remove the bridge plate.

6 Take out the top cover of air damping chamber.

7 Remove the assembly of pointer moving iron and spindle from the coil.

8 Check the jewel and pivot and clean perfectly with benzene, peg wood.

9 Assemble all the parts in the same sequence.

10 Get your work checked by the instructor.

11 Test the meter as per the circuit (Fig 4) diagram for is proper functioning.

12 With the guidance of instructor calibrate the above meter

— — — — — — — —

Calibration of MI ammeter and Voltmeter

Objectives: At the end of this exercise you shall be able to
- **calibrate the ammeter using standard meter find out error and reclify**
- **calibrate the volmeter using standard meter, find out error and rectify**
- **find out error and rectify.**

Requirements

Tools/Equipments/Instruments

- MI Ammeter (suitable range) - 1 No.
- Calibrator or master meter - 1 No.
- Potentiometer wire wound type, 1kohm, 5W - 1 No.
- MI volmeter (suitable range) -1 No.
- Power supply (0-30)V -1 No.
- Screw driver 6" long - 1 No.
- Nose plier 4" dia - 1 No.

Materials/Components

- Connecting leads - as reqd.

PROCEDURE

TASK 1 : **Calibrate the ammeter with standard meter find out error and rectify.**

Ensure whether repaired meter (MC/MI type) would match the specifications of the calibrator and connect as shown in Fig 1.

OR

Connect the meter as per diagram with standard meter and ensure polarities are connected properly as per Fig 1.

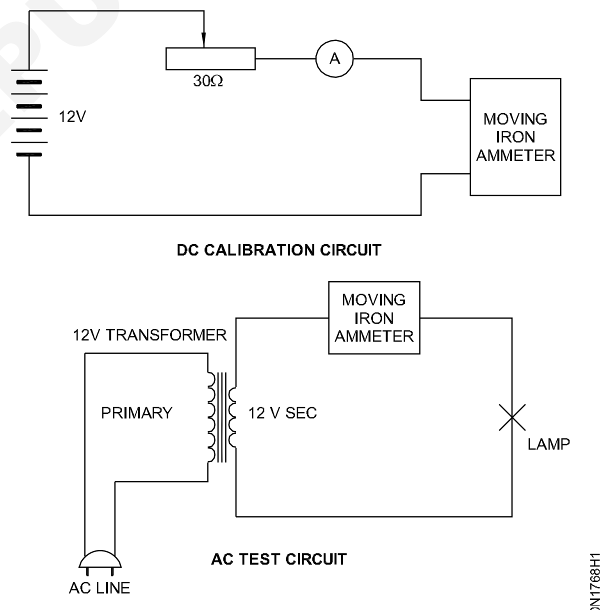
Keep the Rheostat or Variable resistor in the maximum position and apply variable DC voltage in steps and observe the readings in both the meters and note down in Table 1.

Note down the readings and find out the error of the instrument under test.

$$\%\ \text{error} = \frac{\text{difference between calibrator} - \text{Meter under test}}{\text{Reading of the calibrator}} \times 100\%$$

Observe the errors for various inputs and if the % of error is too much, carry out necessary servicing of the instrument and redo the calibration procedures.

Fig 1



CALIBRATION OF MOVING - IRON AMMETER

TABLE 1

Sl. No.	Standard meter readings	Under test meter reading	% Error
1			
2			
3			
4			

TASK 2: **Calibrate the voltmeter with standard meter find out error and rectify.**

1 Select the suitable range standard voltmeter instead of ammeter.

2 Connect the standard voltmeter in parallel with the instrument under test with multiplier resistance included in the instrument as shown in Fig 1.

3 Take the readings in small steps of voltage and find out the error of the instrument in Table 1.

4 If the error is too much, necessary repairs and servicing should be carried out and should be recalibrated once again.

Fig 1

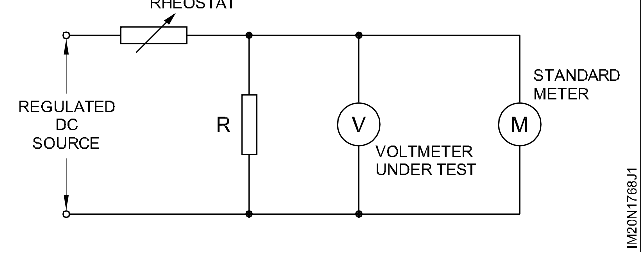


TABLE 1

Sl. No.	Standard meter readings	Under test meter reading	% Error
1			
2			
3			

— — — — — — — —

Find the minimum and maximum measurable range of the meter

Objectives: At the end of this exercise you shall be able to
- **determine the minimum and maximum measurable range of the meter.**

Requirements

Tools/Equipments/Instruments

• Trainees tool kit	- 1 Set
• MC ammeter 0-500 mA	- 1 No
• MC voltmeter 0-10V	- 1 No

Materials/Components

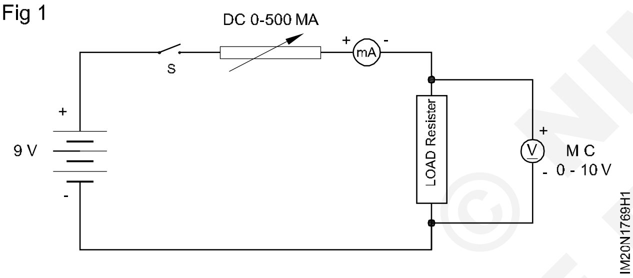
• Connecting cable copper 1.5sq.mm	- as reqd
• Cotton cloth	- as reqd
• Variable resistor/Rheostat 0-1kΩ	- 2 Nos
• SP Switch 6A, 240V	- 1 No
• 9V Battery	- 1 No

PROCEDURE

1 Collect ammeter, voltmeter, variable resistance battery and SP switch.

2 Assemble the circuit as shown in Fig 1.

Fig 1



3 Set the variable resistance to have zero out put.

4 Close the switch 'S'.

5 Note down the minimum measurable range of milliammeter and voltmeter and record in the Table 1.

6 Gradually increase load to 500 mA by varying variable resistance.

7 Also adjust the voltage across load resistor to 10 volts.

8 Note down the maximum measurable range of m i l - liammeter and voltmeter and record it in Table 1.

Table -1

1	**Minimum range of milli ammeter __________**
2	**Minimum range of volt meter _____________**
3	**Maximum range of milliammeter___________**
4	**Maximum range of voltmeter _____________**

9 Get the work checked by the Instructor.

— — — — — — — —

Test the shunt and series resistance of various ranges of ammeter and voltmeter

Objectives: At the end of this exercise you shall be able to
- **test the shunt resistance of various range ammeter**
- **test the series resistance of various range of voltmete.**

Requirements

Tools/Equipments/Instruments

- Ammeter (Varian ranges available in your lab)
- Voltmeter (Varian ranges available in your lab)
- Multimeter - (Analog) - 1 No
- Screw driver 100mm/150mm - each 1No

Materials/Components

- Cleaning cloth - as reqd

PROCEDURE

TASK 1: **Test the shunt resistance of various range of ammeter.**

1 Take analog multimeter Fig 1
2 Open the back cover of multimeter
3 Observe the various ranges of ammeter with the help of instructor
4 Test measure and record (Table 1) the resistance of shunt resistors in the multimeter (Ammeter) Fig 2
5 Observe the various ranges of voltmeter in the multimeter with the help of instructor.
6 Test, measure and record (Table 1) the resistance of series resistors in the multimeter (Voltmeter)

Fig 2

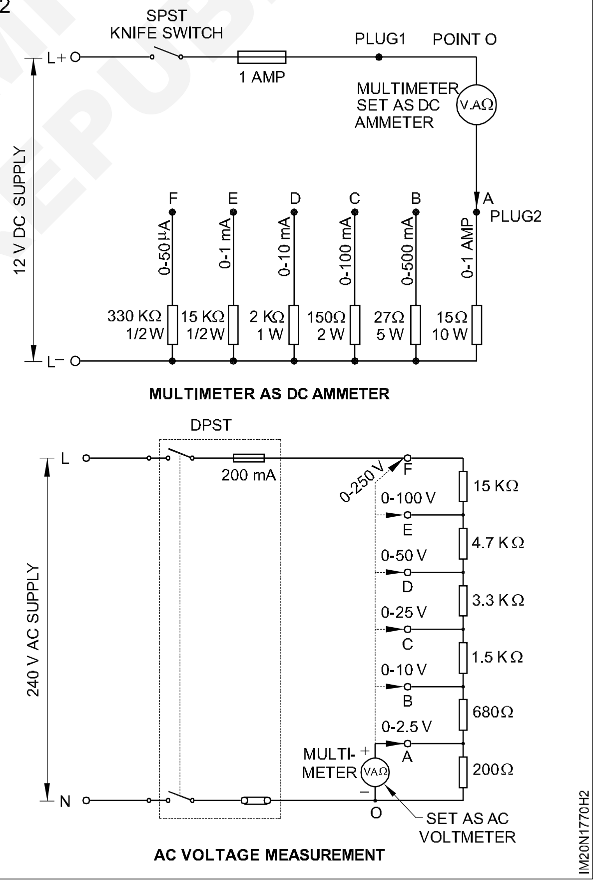


Fig 1

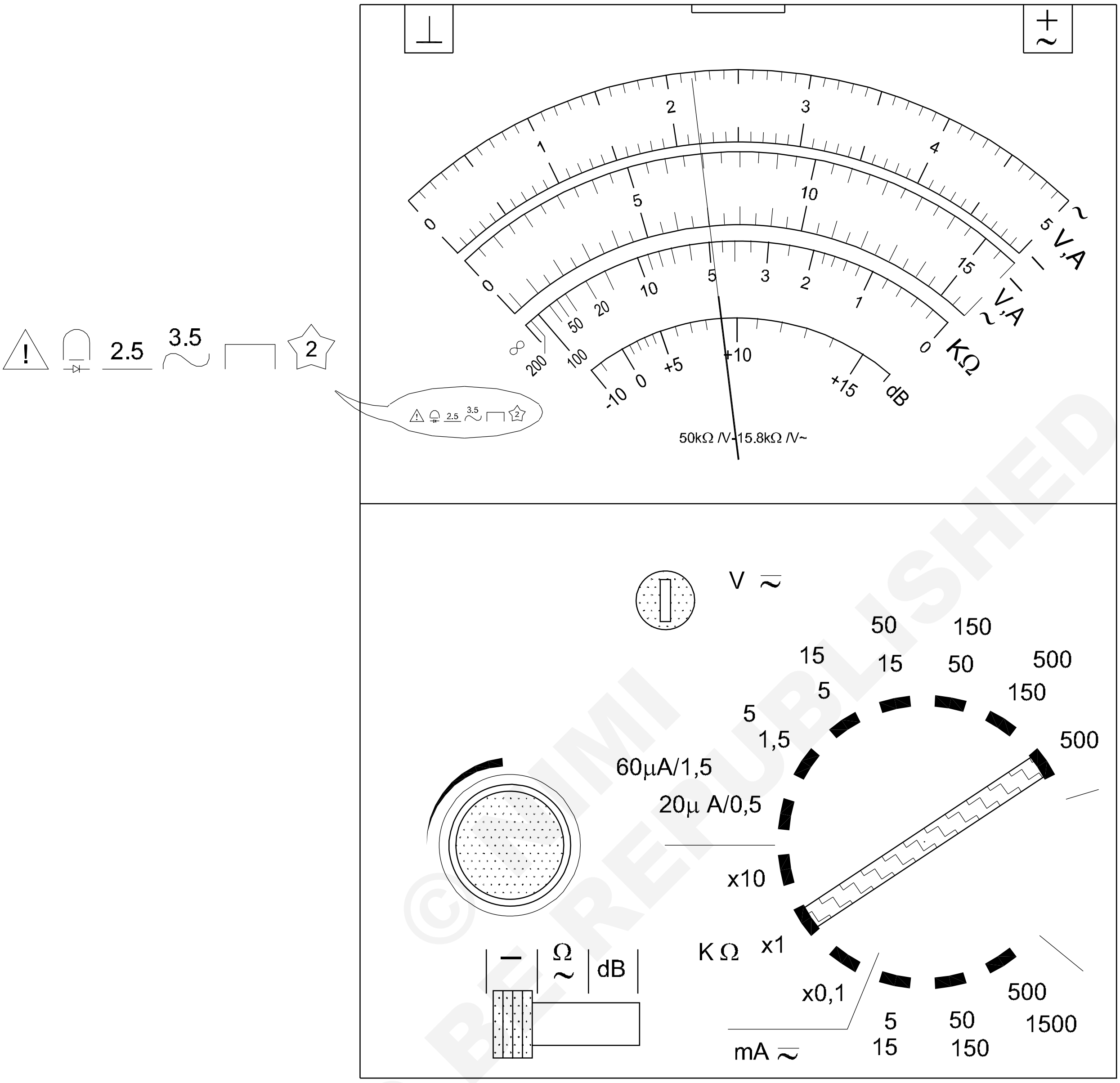


Table 1

Sl.No.	Range of ammeter	Value of shunt resistor	Range of voltmeter	Value of series resistor

Practice multipliers for different range extension of voltmeter and ammeter

Objectives: At the end of this exercise you shall be able to
- **measure the resistance of the measuring element (moving coil of the meter)**
- **measure the full scale deflection current of the measuring element**
- **connect the additional resistance with the measuring element to produce full scale deflection current at the extended range of the voltmeter**
- **check the voltmeter with a standard voltmeter.**

Requirements

Tools/Instruments

- Combination pliers 150mm - 1 No.
- Wire stripper 150 mm - 1 No.
- Electric soldering iron 250V 35W - 1 No.
- Milli voltmeter 0-50mV - 2 Nos.
- Milliammeter 0-10mA - 1 No.
- M C Voltmeter 0-15V - 1 No.
- Wheatstone bridge - 1 No.
- Cutting pliers 150mm - 1 No.
- Ammeter 0-500mA - 1 No.
- Voltmeter 0-100mV - 1 No.
- Voltmeter 0-1V - 1 No.
- Ohmmeter (or) multimeter - 1 No.

Equipment/Machines

- Variable D.C. power supply 0-30V - 1 No.
- Standard resistors for multipliers (Decade resistance box in 5 decades 1, 10, 100, 1000,10000) OR Variable tubular wire wounded resistors - 1 No.
- Battery 12V, 100AH - 1 No.
- Variable wire-wound resistor 10 ohms 5.2A - 2 Nos.
- Extension range of Voltmeter

Materials

- Potentiometer 10K 2W - 1 No.
- Resistor 1K 2W - 1 No.
- Resin core solder - as reqd.
- Connecting leads - as reqd.
- Copper wire 18 SWG - as reqd.
- Nichrome wire 18 SWG - 1/2m.

PROCEDURE

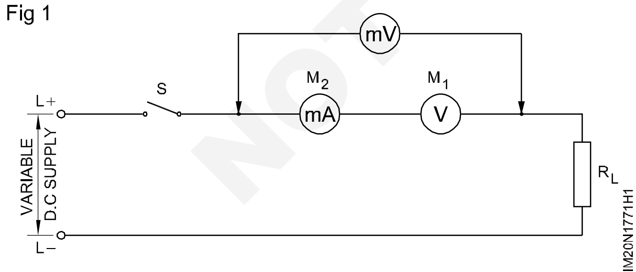
TASK 1: **Extension range of voltmeter**

1 Remove the cover of the MC 0-15V voltmeter, examine and disconnect the series resistance, if any.

2 Connect the moving coil ends to the meter terminals and close the cover.

3 Form the circuits as shown in Fig 1.

Fig 1



Keep the switch open and the variable DC supply at minimum level.

4 Close the switch; gradually increase the DC voltage until full scale deflection is achieved in M_1 (voltmeter under test).

5 Record the reading of M_2 and then the voltage drop across M_1 at full scale deflection in Table 1.

TABLE 1

Reading of M_2 at f.s.d. of M_1	Voltage drops across M_1 at f.s.d	Resistance of MCof M_1

6 Open the switch and disconnect the circuit.

7 Calculate the M C resistance of M_1 using Ohm's Law and record in Table 1.

8 Calculate the resistance of the multiplier for the proposed range (say 0-30V) using the formula

$$\text{Multiplier resistance} = \frac{\begin{pmatrix}\text{Proposed range}\\ \text{of voltage}\end{pmatrix} - \begin{pmatrix}\text{Voltatage drop}\\ \text{across MC at FS}\end{pmatrix}}{\text{MC current at FSD}}$$

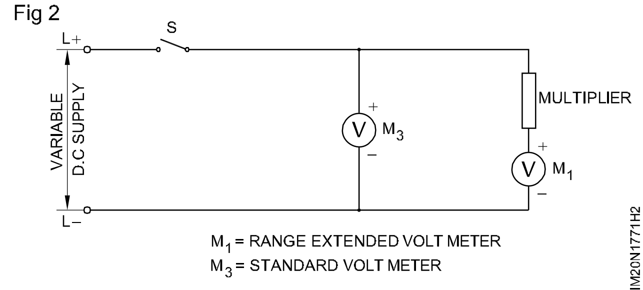
9 Calculate the multiplying factor (M.F.) by the formula

$$M.F. = \frac{\text{Proposed voltmeter range}}{\text{Voltage drop across MC at FSD}}$$

10 Select the standard resistance suitable for the value of the multiplier resistance calculated in step 8 and connect them all in series with meter M_1.

11 Form the circuit as shown in Fig 2, keeping the switch open.

Fig 2



Keep the variable D C Supply at minimum level.

12 Close the switch and increase the voltage gradually to get exact divisions in standard voltmeter M_3.

13 Record the readings of M_1 and M_3 in Table 2 for each setting (in M_3) until M_1 reaches the full scale deflection.

14 Open the switch and disconnect the circuit.

15 Calculate the actual voltage using `$M_1$ reading' and the `Multiplying factor' of the multiplier connected.

16 Calculate the error using the formula given below and record in Table 2.

Error = standard meter reading – calculated voltage from the readings of M_1

In case of non-availability of wire-wound resistors of different values of suitable wattage to form the multiplier resistance, you may make use of wire-wound tubular variable resistance for laboratory use and verify the working of the instrument in the extended range.

Set the value of variable wire-wound resistance exactly equal to the multiplier resistance using the Wheatstone bridge.

TABLE 2

Sl. No.	**Reading of** M_3	**Reading of** M_1	**Multiplying factor** M.F.	**Voltage** = M_1 x MF	**Error** (Col.2)-(Col.5)
1	2	3	4	5	6

— — — — — — — —

TASK 2: **Extension of 500 milliammeter range to 2.5 amperes.**

1 Connect the 0-500mA range milliammeter as shown in Fig 3 to the variable DC power supply. If a variable DC power supply is not available, make connections to a battery as shown in the circuit. (Fig 4)

2 Set the output voltage to the circuit at the minimum and close the switch S.

3 Gradually increase the voltage until the milliammeter reads full scale deflection.

4 Observe and record the reading of the voltmeter and ammeter in Table 1. The measuring element indicates full scale deflection at V_i = ___ V

I_i = ___ A.

5 Open the switch S and disconnect the circuit elements.

6 Calculate the shunt resistance R_{sh}.

$$R_{sh} = \frac{V_i}{I_{sh}}.$$

The voltage across the shunt resistance is then equal to V_i. The current I_{sh} in the shunt resistance is the difference between the end value of the measuring rangeI = 2.5A and the current in the measuring element I_i. ie. I_{sh} = I– I_i.

Fig 1

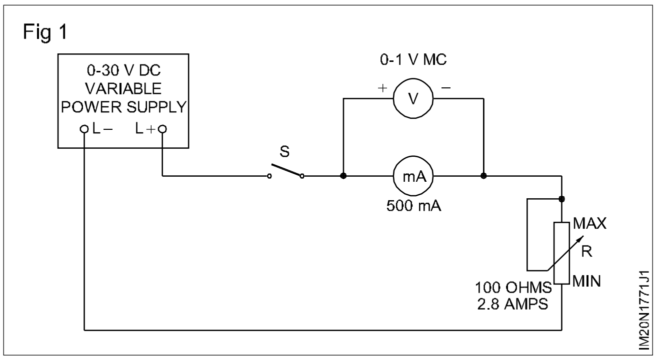
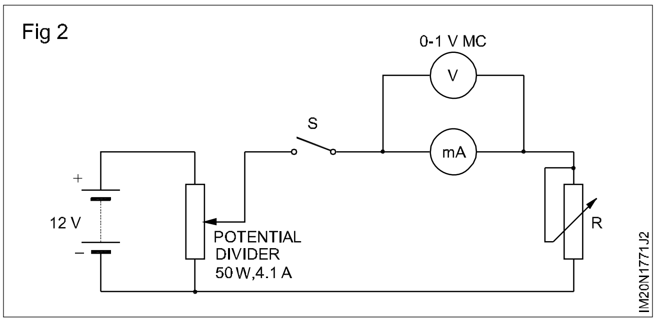
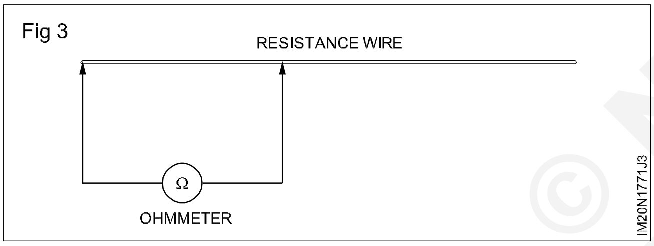


Fig 2



7 Measure the exact length of the Nichrome wire that has a resistance equal to R_{sh} as shown in Fig 5, using an ohmmeter and go to step 9. If a Wheatstone bridge is used, go to step 8.

Fig 3

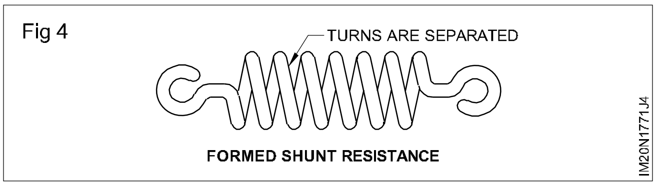


8 Set the ratio arm and variable resistance to the value which causes balance of the bridge when the unknown resistance value equals R_{sh}. Connect one lead from the instrument to the end of the wire, and with the other lead touch and move to cause null deflection. The point at which null deflection occurs indicates the length of wire.

9 Cut the wire 1 cm greater in length than measured.

10 Coil the wire with eye formation at both ends. Exercise care to see the excess length of 1 cm is used for eye formation at the ends. (Fig 6)

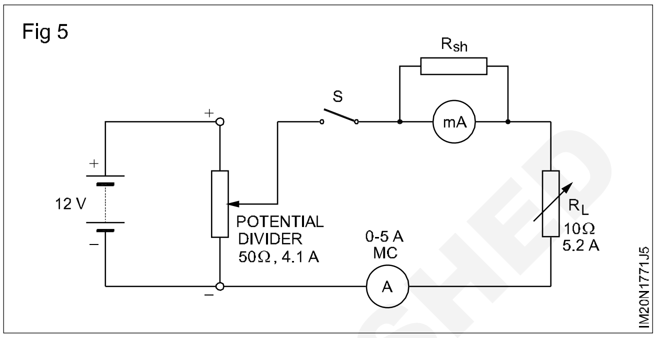
Fig 4



11 Connect the coiled wire as shunt across the terminals of the milliammeter.

12 Set up the circuit according to the circuit diagram. (Fig 7)

Fig 5



13 Adjust the variable load resistance R_L to 4 ohms.

14 Switch on the power and adjust the output voltage to circuit, equal to 10V. Observe the ammeter deflection.

15 Read the value of current 'I'.

16 Verify that the readings shown are in amperes by inserting a 5A ammeter in series.

Extension of 500 milliamperes ammeter range to 5 amperes

1 Calculate the shunt resistance R_{sh} following the instruction in step 6 of Task 1.

2 Repeat the steps 7 and 15 of Task 1.

Extension of 100 milliampere ammeter range to 1 ampere

1 Follow the steps 1 to 15 under Task 1 for 100 milliampere ammeter to extend its range to 1 ampere.

2 Consider the 100 milliampere ammeter with its range extended to 1.0A by external shunt as a single instrument.

— — — — — — — —

Prepare plate earthing and measure earth resistance by earth tester / megger

Objectives: At the end of this exercise you shall be able to
- **prepare the plate for earthing according to ISI standard**
- **prepare the earthing pit in ground according to required standard**
- **install the plate in earthing pit**
- **test the earthing and measure the earth resistance using earth tester / Megger.**

Requirements

Tools/Instruments

- G.I. die stock with 12.7 mm, 19mm and 38mm die - 1 Set
- D.E. spanner set 6mm to 25mm - 1 Set
- Blowlamp, 1 Pint - 1 No.
- Crowbar38mmx 1800mm long - 1 No.
- Spade 300mm x150mm - 1 No.
- Cement mortar tray - 1 No.
- Tongs 300mm - 1 No.
- Hacksaw frame with 24 TPI blade - 1 No.
- Pipe wrench 50mm - 1 No.
- Soldering pot with ladle - 1 No.
- Combination pliers 200mm - 1 No.
- Measuring tape 5m - 1 No.
- Sledge Hammer 2 Kg. - 1 No.

Equipment/Machines

- Earth tester with spikes and connecting lead - 1 Set

Materials

- G.I. plate 600mmx600mmx63mm - 1 No.
- G.I. pipe 12.7mm dia. - 5 m.
- G.I. pipe 19mm dia. - 1 m.
- C.I.cover hinged to C.I. frame 300mm square - 1 No.
- Funnel with 19mm dia. sleeve & wire mesh - 1 No.
- G.I.nut for 19mm dia. sleeve & wire mesh - 2 Nos.
- G.I. check-nuts for 19mm dia. G.I.pipe - 2 Nos.
- G.I.washer 40mm with 19mm hole - 2 No.
- G.I. wire No.8 SWG - 10 m
- Copper lug 200 amps with 19mm dia. hole - 1 m
- Solder 60x40 - 100gms.
- Soldering paste - 10 gms.
- Matchbox - 1 No.
- Cement - 10 kgs.
- Blue metal chips 6mm size - 40 kgs.
- River sand - 80 kgs.
- Charcoal or coke - 5 kgs.
- CommonSalt - 5 Kgs.

PROCEDURE

TASK 1: **Prepare the plate for earthing according to ISI standard**

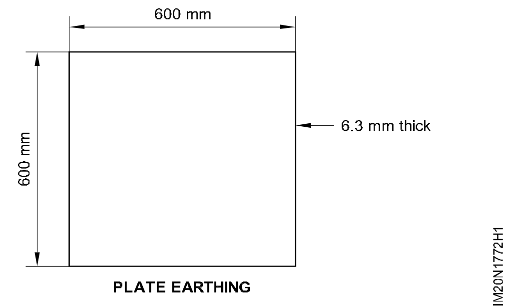
1 Collect G.I plate and accessories for earthing

2 Mark thread on one side of 19mm dia GI pipes to a length of 25mm

3 Fabricate GI plate as shown in Fig 1 600mmx600mm square plate with a thickness of 63mm

4 Fabricate 19mm dia G.I pipe as shown in TASK 2 Fig 1

Fig 1



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TASK 2 : **Prepare the earthing pit in ground as per standard**

1 Select an earth pit site atleast 1.5meters away from the building foundation

An earth electrode should not be installed is proximity to a metal fence to avoid the possibility of the fence becoming live. If the metal fence is un avoidable it should be earthed

2 Dig an earth pit of dimensions 1m width x 1m breadth x2.5m depth

The depth given here is the minimum recommended. However the depth may be increased till moist soil is reached

3 Fabricate G.I pipe 12.7mm diameter with GI bonds in proper position and insert the G.I wire missing through GI pipe by soldering lug at external and fix GI plate with bolt and nut as shown in TASK 2 Fig 1

Fig 1

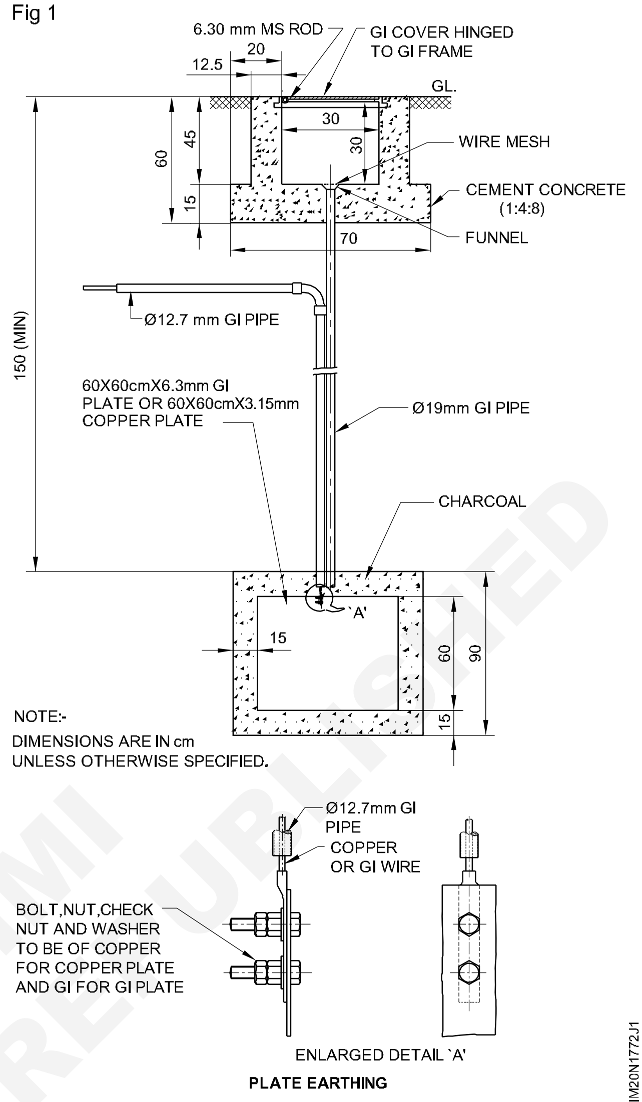


PLATE EARTHING

— — — — — — — —

TASK 3 : **Install the plate in earthing pit already prepared**

1 Place the fabricated 19mm GI plate in an upright position as shown in fig 2 and position the pipe with the helps bamboo sticks

2 Place the wooden box around the plate and fill it to a height of about 15cm with charcoal and fill the surrounding outer space of the box with soil.

It is difficult to dig a pit 150mm square .A pit of dimension 1 meter square is therefore suggested to be dig. The area sufficient to be filled with salt and charcoal is about 150mm square. Hence fill the surrounding area with the soil which was taken out earlier

3 Lift and place the wooden box above the coke layer and fill up with salt to a height of about 15cm and to an area of 150x 150mm area around the pipe.

Fill up the surrounding area with soil.

4 Prepare the concrete mixture and build the strcuture as shown in figure 2.

5 Fix the GI core with the plates

At least allow one day for curing the concrete structure. Pour water every 2 hours (A wetted gunny is a act will hold the moisture for several times.

6 Pour three or four buckets of water through the funnel to the earth pit

Allow an hour for the water to be obsorbed in the earth.

— — — — — — — —

TASK 4 : **Test the earthing and measure the earth resistance using earth tester**

1 Test the earth electrode resistance with an earth tester.

2 Record the earth electrode resistance.

> **If the earth resistance is found higher than the acceptable value, make one more plate earth electrode at a distance of 8 meters from the earth in one and connect both of them in parallel**

3 Measure the resistance of earth electrode value and record

> **The second reading with two electrodes will be approximately half the first reading which was taken with one electrode. The measured value should be with in the recommended value. If not have an another earth electrode may be distance of 8 meters from the other electrodes.**

— — — — — — — — —

Test earth leakage by ELCB and relay

Objectives: At the end of this exercise you shall be able to
- **identify the terminals of ELCB**
- **connect the ELCB in an Power circuit and test its functioning**
- **measure the leakage current at which ELCB trips off.**

Requirements

Tools/Instruments

- Cutting plier 150mm - 1 No.
- Screw driver 150mm - 1 No.
- Electrician's knife 100 mm - 1 No.
- Wire stripper 150 mm - 1 No.
- Ammeter MI (0 - 10A) - 1 No.
- Ammeter MI (0 - 100mA) - 1 No.
- Philips star screw driver 100 mm - 1 No.

Equipments

- ELCB 240V, 25A, 2 pole with Tripping leakage current 30mA - 1 No.
- MCB 240V, 10A, 2 pole - 1 No.

Materials

- 10KW 1W wire wound variable resistor - 1 No.
- 5KW 1W fixed resistor - 1 No.
- Pushbutton switch 250V, 6A - 1 No.
- Water rheostat - 1 No.

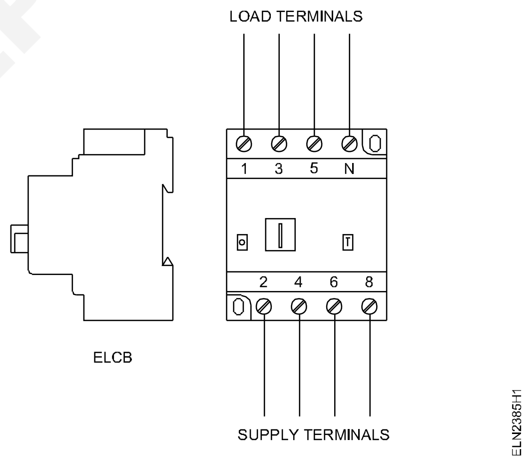
PROCEDURE

TASK 1 : **Identify the terminals of ELCB**

1 Collect the ELCB from your instructor and read the specification given on it.

Identify the supply terminals and load terminals referring the marking on the unit as given in Figure 1.

Fig 1



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TASK 2 **: Connect and test the operation of ELCB**

1 Wire up the circuit as shown in the circuit diagram. (Fig 2)

2 Switch on the main supply keeping the MCB and ELCB in ON position.

3 Close switch S_1 and operate the water rheostat till the ammeter 'A' reads about 5 A current.

Keep variable resistance in full cut in position.

4 Press the test switch and vary the variable resistance and note the leakage current and record

____

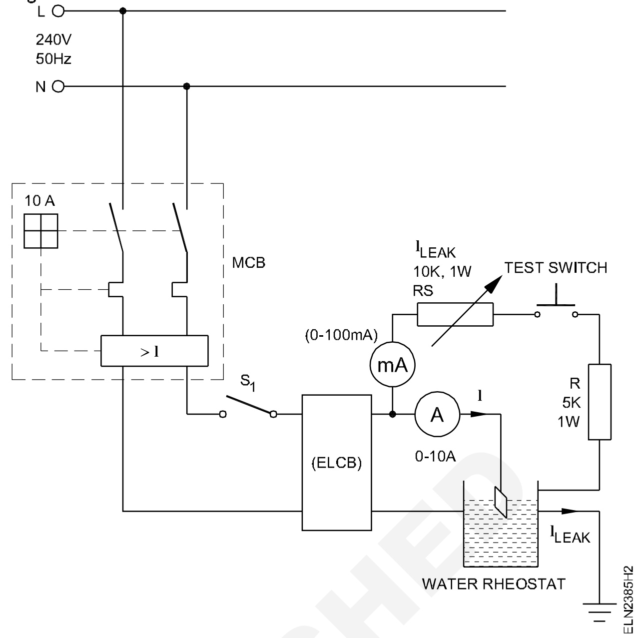
5 Record the leakage current at which the ELCB trips off

____

6 Open the external test switch and reset the ELCB.

7 Test ELCB for 'Trip function' by operating the 'Test button'. In this case the ELCB must trip off when the button is pressed.

Fig 2



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Measure the power using wattmeter

Objective: At the end of this exercise you shall be able to
- **measure power consumed using a wattmeter**

Requirements

Tools/Instruments/Equipments

- Cutting pliers 150mm - 1 Nos.
- Knife/wire stripper - 1 No.
- Wattmeter 250V, 5A, 1250W (Dynamometer type) - 1 No.
- Voltmeter 0-300V M.C - 1 No.
- Ammeter 0-5A M,C - 1 No.
- Heater 230V - 1000W - 1 No.
- Rheostat 5A, 10 0hms - 1 No.

Materials/Components

- Lamps 500W, 230/250V - 1 No.
- Lamps 200W, 230/250V - 1 No.
- Lamp-holder BC & Goliatic type - 2 Nos. each
- Flexible cable 80/0.2 of 250V grade - as reqd.
- SPT switches 6A 250V - 1 No.

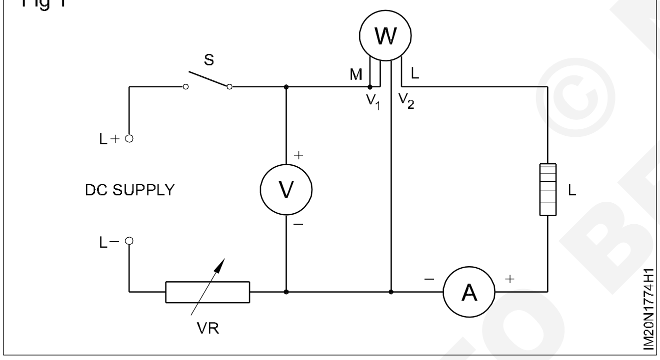
PROCEDURE

TASK 1: **Direct method of power measurement**

1 Identify the terminals of a wattmeter

2 Connect the wattmeter, voltmeter, ammeter rheostat and load as shown in Fig 1

Fig 1



3 Close the switch and adjust the variable resistance to set the voltage across load L (indicated by voltmeter) equal to value recorded in the indirect method.

4 Results

5 Read the wattmeter and record the value in the table

6 Open the switch and disconnect the circuit

7 Compare the power calculated by the indirect method with the wattmeter reading.

8 Repeat the experiment for 500W and 200W lamps loads and note down the values in Table 1

Table 1

Reading of V	Reading of A	Calculated power in welts	Reading of wattmeter

Test and Calibrate wattmeter

Objectives: At the end of this exercise you shall be able to
- **calibrate wattmeter using voltmeter and ammeter**
- **calibrate wattmeter using standard wattmeter.**

Requirements

Tools/Instruments

- Cutting plier 150mm - 1 No.
- Nose plier 100mm - 1 No.
- Electrician screw driver 100mm - 1 No.
- Line tester - 1 No.
- Instrument/watch maker screw drivers - 1 set.

Materials

- Connecting leads assorted length - as reqd.
- Insulation tape roll - 1 No.
- Bulbs 250V AC assorter power range - as reqd.
- Load base (i.e. 12" x 8" board fitted with pattern holders - 1 No.

PROCEDURE

TASK 1 : **Using Voltmeter and Ammeter**

1 Connect the instruments Wattmeter, Voltmeter and Ammeter as shown in Fig 1.

2 Connect the bulb loads as shown in Fig 1.

3 Provide fuse 5Amps at both the input terminals i.e. Phase and Neutral as shown in Fig 1.

4 Switch `ON' the supply and switch `ON' the loads.

5 Take reading by changing different load in voltmeter, ammeter and wattmeter and record it in Table 1.

Fig 1

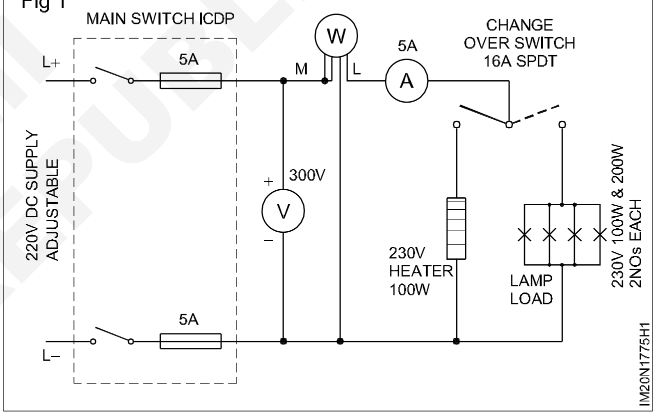


TABLE 1

Sl. No.	Voltmeter reading	Ammeter reading	Power calculated V x I	Wattmeter reading	Error
1					
2					
3					
4					

Calculate % error taking V x I as true value.

— — — — — — — —

TASK 2 : **Using two wattmeter**

1 Connect the wattmeter to be tested and the master wattmeter as shown in Fig 2.

2 Connect the lamp load as per Fig 2.

3 Check the circuit before connecting supply.

4 Switch ON the supply and note down the reading.

5 Record the readings in Table 2.

Fig 1

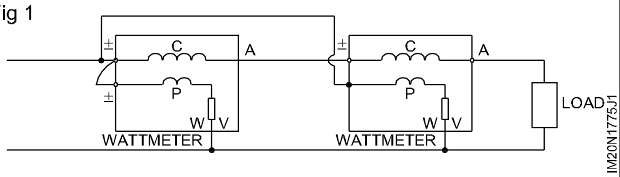


TABLE 2

Sl.No.	Wattmeter reading to be tested	Standard meter reading	Difference	Error
1				
2				
3				
4				

Familiar with the construction of energy meter and ampere hour meter

Objectives: At the end of this exercise you shall be able to
- **familiar with the construction of energy meter**
- **familiar with the construction of ampere hour meter.**

Requirements

Tools/Instruments

- Energy meter Sϕ - 1 No.
- Ampere hour meter 230V - 1 No.

Materials

- Screwdriver 150mm - as reqd.
- Cleaning cloth - 1 No.

PROCEDURE

TASK 1 : **Familiar with the construction of energy meter**

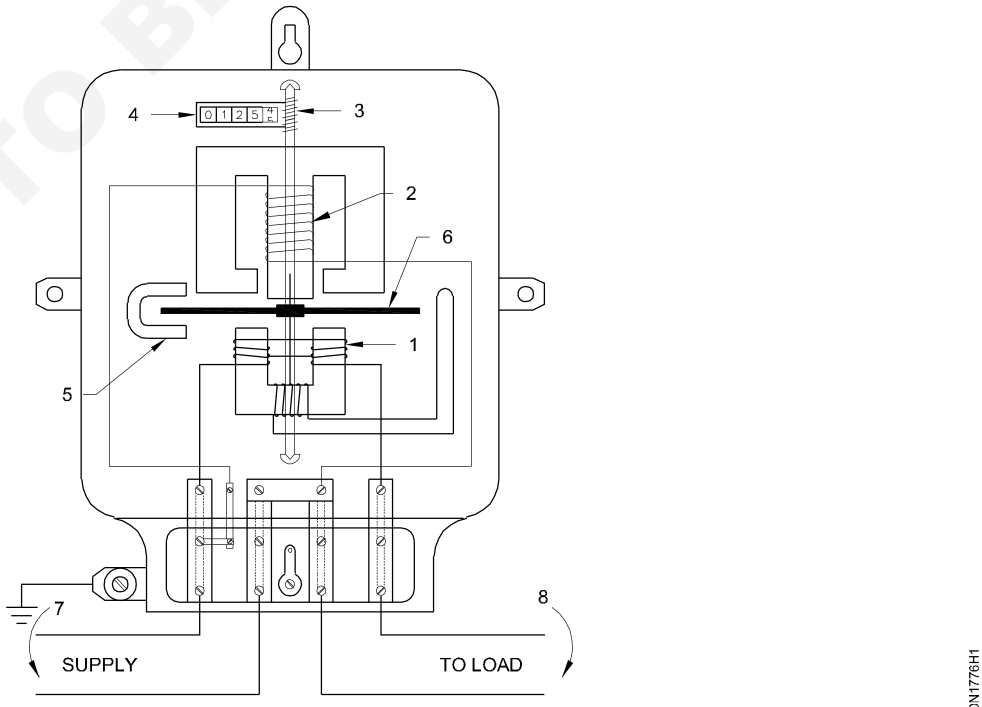
1 Remove the top cover of energy meter

2 Identify the parts of fig 1 and note the parts in table 1 with help of instructor

Table 1

Sl.No	Name of the parts
1	
2	
3	
4	
5	
6	
7	
8	

Fig 1



INDUCTION TYPE ENERGY METER

TASK 2: **Familiar with the construction of ampere hour meter**

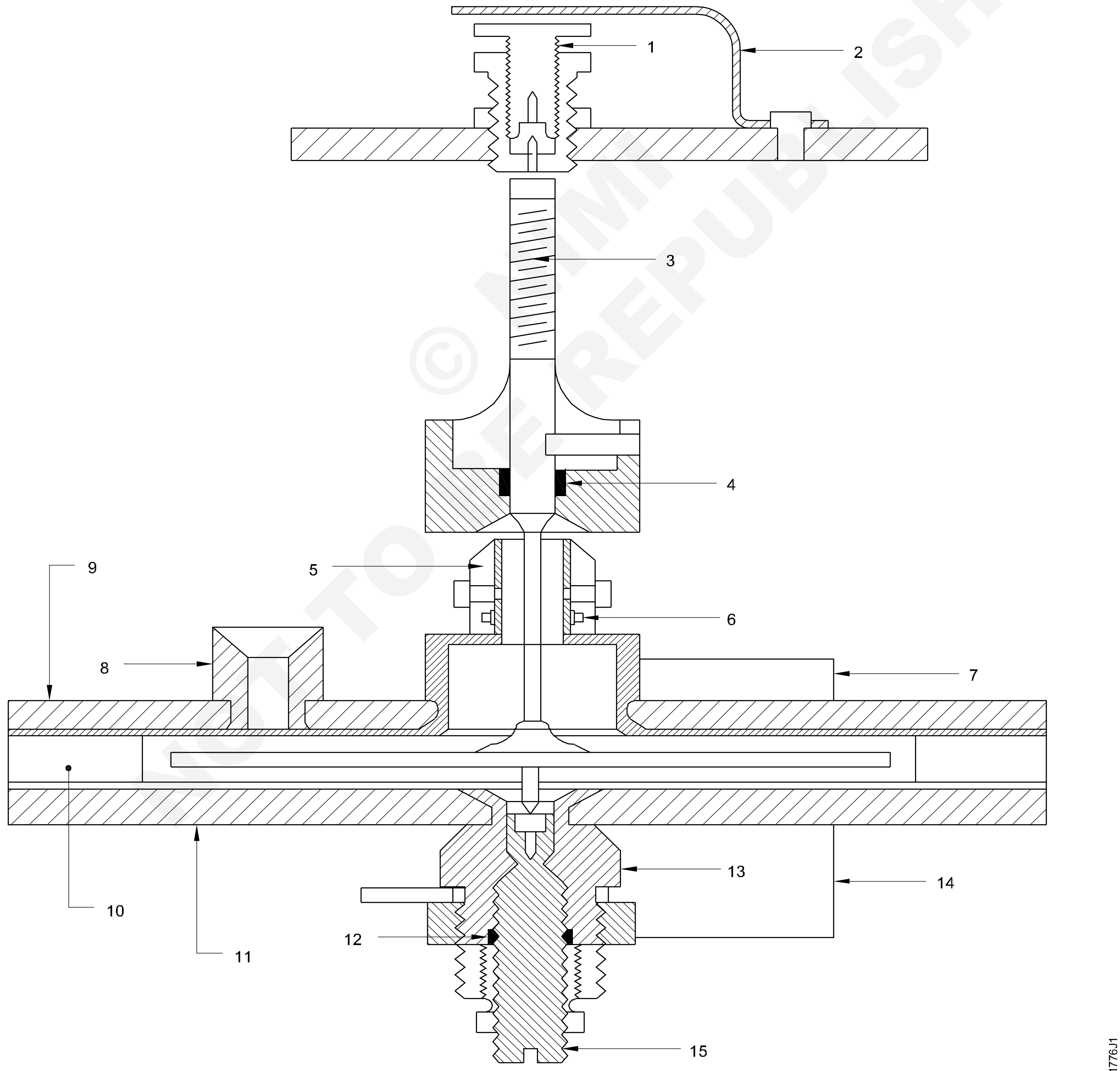
1 Remove the top cover of ampere hour meter

2 Identify the parts of Fig 1 and tabulate the parts in table 2 with the help of your instructor

Table 1

SI.No	Name of the parts
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Fig 1



MERCURY MOTOR TYPE AMPERE - HOUR METER

Overhaul check and fault find of ampere-hour meter

Objectives: At the end of this exercise you shall be able to
- **dismantle and assemble the mercury motor type ampere-hour meter**
- **identify parts of the instrument.**

Requirements

Tools/Instruments/Equipments

- 100mm nose plier - 1 No.
- 100mm fine point tweezer - 1 No.
- Watch maker screw driver set - 1 No.
- 100mm Electrician screw driver - 1 No.
- Eye glass 4 x - 1 No.
- Pegwood and pith wood - 1 each

Materials

- Unserviceable mercury motor type ampere hour meter - 1 No.
- Cleaning brush - 1 No.
- Cleaning lotion - 1 No.

PROCEDURE

1 Keep service table clean and spread a white paper on the table in your right hand side.

2 Remove the top cover by unscrewing to the side screw of the top cover and keep it over the table in your left hand side.

3 Remove the top jewel ratining spring and remove top jewel and keep it on the white paper

4 Then remove the bottom jewel by unscrewing the jewel screw and keep on the white paper in sequence

5 Remove the aluminum disc attached with worm and keep it on table in sequence.

6 Now identify parts referred with the given fig and write down the name of the parts.

7 Show the record which you recorded while identifying and get approv from your instructor.

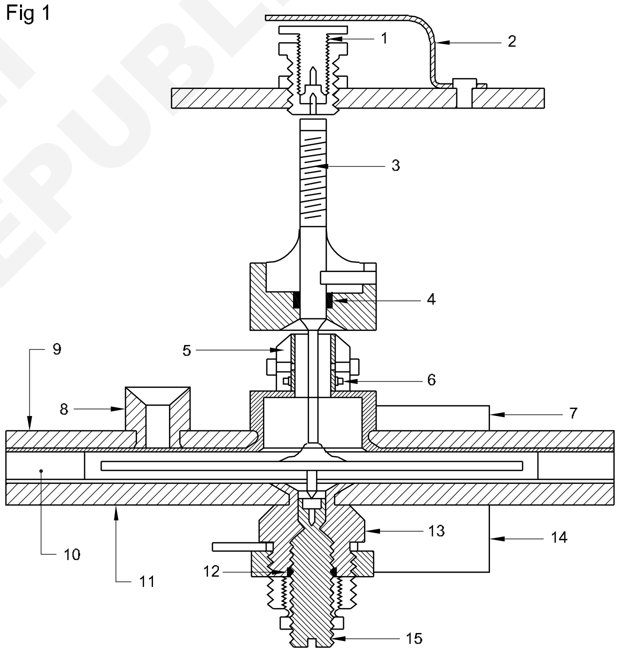
8 Clean the jewel and pivoted points of the spindle of the disc.

9 Cleaning the worm with cleaning lotion and apply petroleum jelly over the worm as lubricant for free running.

10 Reassemble the meter in reversal sequence

11 Check for its working condition and get approval from your instructor and record it.

Fig 1



1. TOP JEWEL
2. TOP JEWEL RETAINING SPRING
3. WORM
4. 6. 12. SEALING GLANDS
5. SEALING COLLET
7,14. POLE PIECES
8. MERCURY FILLER
9. TOP BATH PLATE
10. BATH RING
11. BOTTOM BATH PLATE
13. CENTRE CONTACT
15. BOTTOM JEWEL SCREW

MERCURY MOTOR TYPE AMPERE - HOUR METER

IM20N1777H1

Test and calibrate ampere hour meter

Objectives: At the end of this exercise you shall be able to
- **test ampere hour meter**
- **calibrate ampere hour meter.**

Requirements

Tools/Instruments/Equipments
- Battery 12V DC - 1 No.
- Ammeter -10A MI - 1 No.
- Timer - 1 No.
- Relay 12 Vdc - 1 No.
- Incandescent lamp (12V) - 1 No.

Materials
- Connecting wires - 1 No.

PROCEDURE

Test and calibrate the given ampere hour meter

1 Connect the circuit as per diagram.

2 Note ampere hour meter reading and record in Table 1

3 Note the reading of ammeter, timer and record in Table 1

4 Compare the value calculate the error

Fig 1

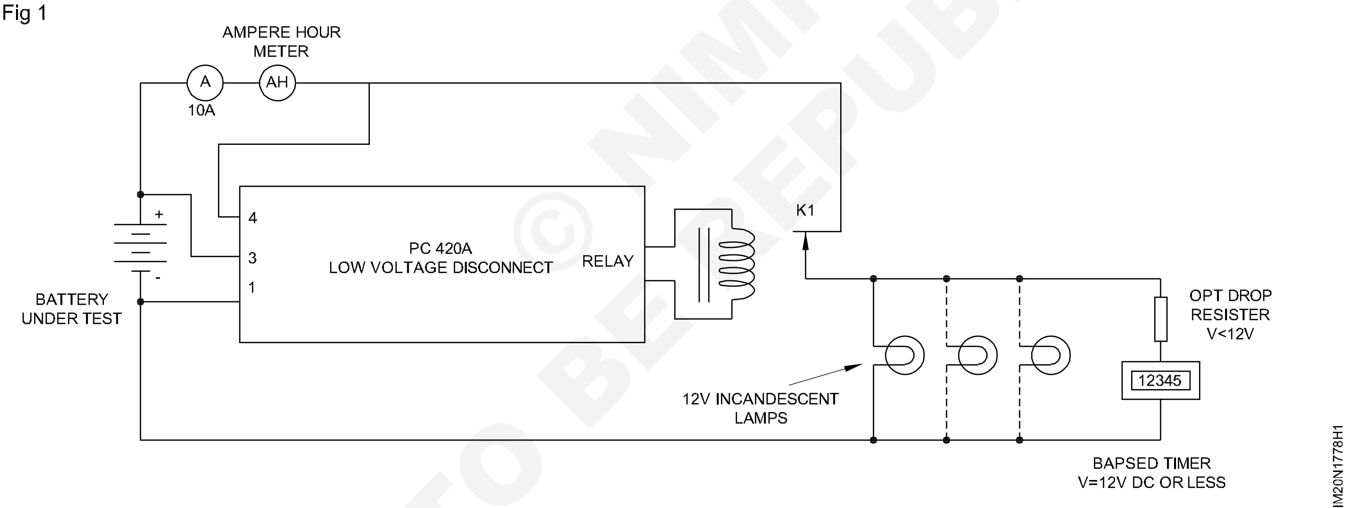


Table 1

SI No	Ammeter reading in A	Time in sec	Ampere hour meter reading in Ah

Measure power in single and three phase circuit using voltmeter and ammeter

Objectives: At the end of this exercise you shall be able to
- **measure power in single phase using voltmeter and ammeter**
- **calculate power in phase with availed reading using formula P = V x I.**
- **measure power in three phase using voltmeter and ammeter**
- **calculate power in phase with availed reading using formula P = V x I.**

Requirements

Tools/Instruments

- 0 to 500 V MI Voltmeter - 1 No.
- 0 to 5 Amp MI Voltmeter - 1 No.
- 100mm cutting plier - 1 No.
- 100mm Nose plier - 1 No.
- 100mm end cutter - 1 No.
- Sleeve remover - 1 No.
- 100mm Nose plier - 1 No.

Materials

- Lamp load box with single phase connection- 1 No.
- Assorted length 1/18 piece wires - as reqd.
- Insulation tape roll - 1 No.
- Lamp load box with three phase connection - 1 No.
- Assorted length 1/18 piece wires - as reqd.
- Insulation tape roll - 1 No.

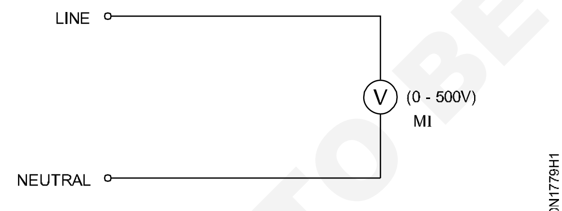
PROCEDURE

TASK 1: **Measure power in single phase using voltmeter and ammeter**

1 Connect M1 voltmeter range 0 - 500V as shown in Fig 1 and insert plug into single phase supply.

Be sure that it is in 'off' position.

Fig 1



VOLTMETER CONNECTION FOR SINGLE PHASE POWER MEASUREMENT

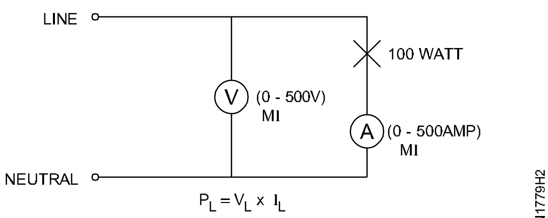
2 Switch 'ON' the supply and note down the reading of each meter and record the readings.

Do not touch the meters and connected the loads and the connectors while taking reading to avoid electric shock.

3 Then switch 'off' the supply and disconnect and remove all voltmeter.

4 Connect the lamp load box and 0-5 A MI ammeter in series as shown in Fig 2 and voltmeter in parallel, check the circuit.

Fig 2



LOAD AND AMMETER CONNECTIONS

5 Insert plug into single phase supply and switch 'ON' the supply note down the reading and record Volt (V) and current (I).

6 Switch 'off' supply and disconnect load and ammeter.

7 Calculate the power mathematically with availed readings using formula P = V x I.

8 Show your recorded readings of power calculation to your instructor and get it approved.

Note:

1 Insulate the open connection with insulation tape.

2 Avoid parallel error while taking readings.

3 Take quick and correct reading as soon as possible.

4 Switch 'Off' the circuit immediately after taking readings

5 Use insulated tools.

TASK 2 : **Measure power in three phase using volt meter and ammeter**

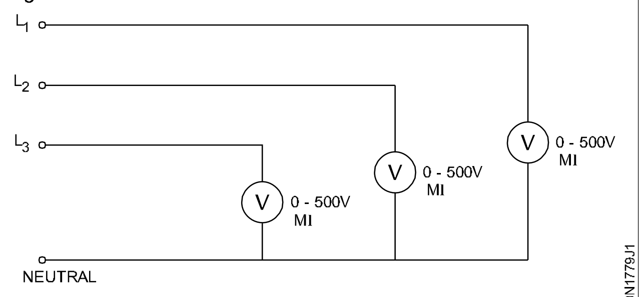
1 Connect M1 three voltmeters range 0 - 500V as shown in Fig 3 and insert plug into three phase supply.

Be sure that it is in 'off' position.

2 Switch 'ON' the supply and note down the reading of each meter and record the readings.

Do not touch the meters and connected the loads and the connectors while taking reading to avoid electric shock.

Fig 1



VOLTMETER CONNECTIONS WITH FOUR WIRE SYSTEM

3 Then switch 'off' the supply and disconnect and remove all voltmeter.

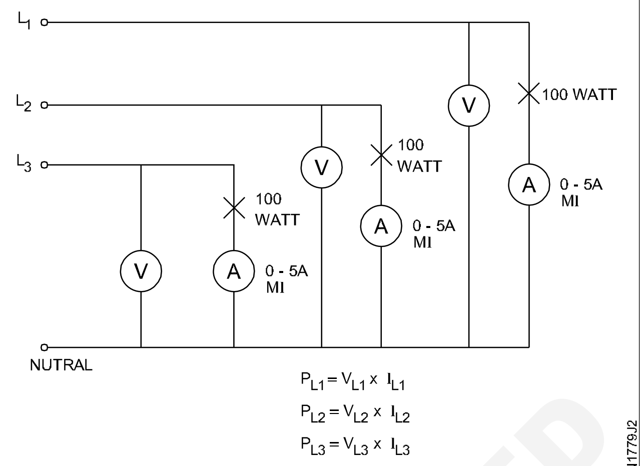
4 Connect the lamp load box and 0-5 A MI ammeters as shown in Fig 4 and connect the three voltmeters, check the circuit.

5 Insert plug into three phase supply and switch 'ON' the supply note down the reading and record it.

6 Switch 'off' supply and disconnect loads and ammeter

7 Calculate the power mathematically with availed readings using formula P = V x I

Fig 2



LOAD AND AMMETER CONNECTION

Phase 1 = P = availed line voltage x availed load current

Phase 2 = P = availed line voltage x availed load current

Phase 3 = P = availed line voltage x availed load current

8 Show your recorded readings and power calculation to your instructor and get it approved.

Note:

1 Insulate the open connection with insulation tape

2 Avoid parallel error while taking readings

3 Take quick and correct reading as soon as possible

4 Switch 'Off' the circuit immediately after taking readings

5 Use insulated tools.

Overhaul and of maintenance of KWH meter and energy meter

Objectives: At the end of this exercise you shall be able to
- **dismantling of single phase kwh meter**
- **identification of parts**
- **checking, cleaning of parts**
- **assembling of meter.**

Requirements

Tools/Instruments

• Screw driver 100mm	- 1 No.
• Long nose plier 100mm	- 1 No.
• Soldering iron 25W 230V	- 1 No.
• Multimeter	- 1 No.
• Oilstone pithwood	- 1 No.
• Pegwood watch maker	- 1 No.
• Screw driver set (instrument)	- 1 No.
• Energy meter 250 volts 10 amps	- 1 No.

Materials

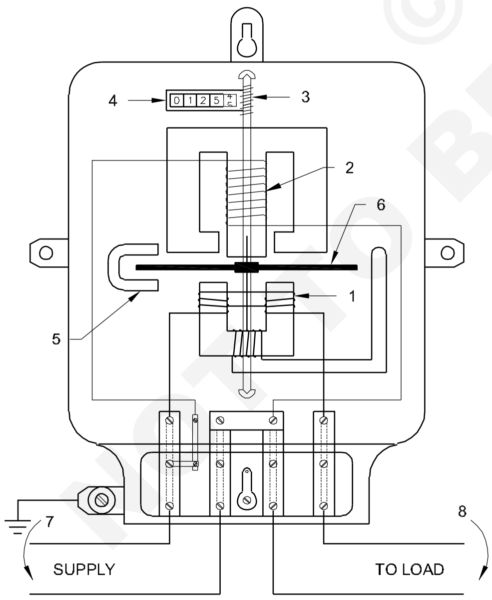
• Solder	- 1 No.
• Benzene or white petrol	- as reqd.
• Cleaning cloth	- as reqd.
• Lubricating oil	- as reqd.

PROCEDURE

1 Take the single phase kwh meter and note down its name plate specifications.

2 Open the bottom connection plate. Note down bottom connection. It is two types as shown below in Fig 1.

Fig 1



1. CURRENT COIL
2. VOLTAGE COIL
3. WORM GEAR
4. REGISTERING MECHANISM
5. BREAK MAGNET
6. ALUMINIUM DISC
7. SUPPLY TERMINALS
8. LOAD TERMINALS

KILOWATT HOUR METER

IM20N1780H1

3 Open the side screws and remove the front cover. Identify the following parts.

4 PC - pressure coil or voltage coil (Thin wire)

5 CC - Current coil (Thick copper wire)

6 Break magnet.

7 Rotating aluminum disc counter.

8 Shading rings.

9 Train of gears.

10 Note down the connection of PC & CC coils.

11 Take a multimeter and check the continuity of coils.

12 Remove the break magnet by loosening the bottom screw.

13 Slowly pull the magnet.

14 Cut and keep it on magnetic shunt.

15 Using watch maker screw drive loosen the counter and take it away and keep properly.

16 With screw driver/plier loosen the top and bottom pivot bearings lift them up and down and make disc free.

17 Take out the disc and keep in safe place. Extreme care is to be taken so that the dist should not bend.

18 With the help of petrol clean pivot and bearings. Use pitch and peg wood.

19 Carefully dismantle the counter note down the sequence of dismantling.

20 Keep all wheels sequentially.

21 Clean the wheels with petrol.

22 Assemble the counter, while assembling use a drop of lubricating oil.

23 Take the aluminum disc and fix it between top and bottom bearings.

24 Adjust bearing screws so that the disc can move freely between air gap of PC and CC.

25 Put the counter in its place. See that the worm wheel on disc shaft properly meshes with counter wheel.

26 Rotate the disc with hand see that first dig it of counter is moving.

27 Put the break magnet in its place. Tight the break magnet screw and adjust it properly so that it should not touch to aluminum disc. Rotate the disc with hand and see that it freely rotate in the air gap of magnet.

28 If it touches to magnet adjust top and bottom bearing screws.

29 Take the cover of meter. Clean its glass with cloth and fix it. Tight the both side screws. Put the bottom cover. Keep the kwh meter for calibration.

Test and calibrate KWH meter and energy meter

Objectives: At the end of this exercise you shall be able to
- **identify the single phase energy meter terminals**
- **connect energy meter terminals to line and load**
- **determine the energy in single phase circuit by the indirect method (load remaining constant over a period).**

Requirements

Tools/Instruments

• Voltmeter MI, 250V	- 1 No.
• Ammeter MI, 0 - 5 A	- 1 No.
• Isolator 30 A	- 1 No.
• Lamp load 1000W, 240V.	- 1 No.
• Energy meter 5A, 240V, 50 Hz	- 1 No.
• Stopwatch	- 1 No.

Materials

• Connecting leads	- as reqd.

TASK 1: **Test for starting current error in energy meter**

1 Connect low load (5 W lamp) as shown in Fig 1.

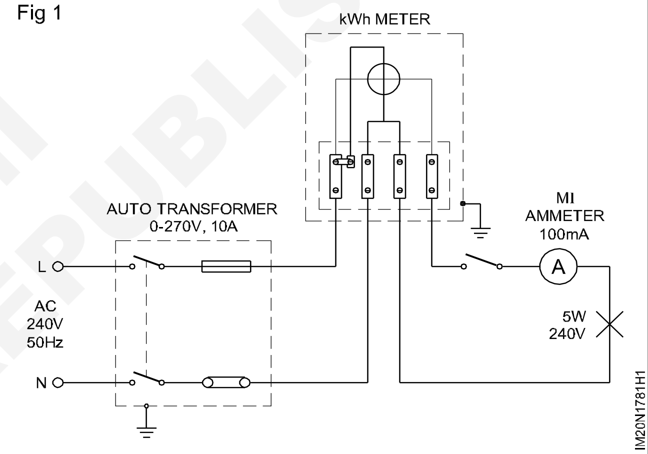
2 Switch on the load and observe the meter rotation.

3 Write your observation correlating your finding from the above experiment with the recommendation given in IS 722 (Part II and Part III).

Observation

As per I.S. 722 (Part II) 1977 the starting current shall be 0.5% of the rated basic current at Cosq = 1 for dial and pointer type register. Whereas for drum type register it will be 0.75%. For meters provided with reverse stop the values will be 1% and 1.5% respectively.

Fig 1



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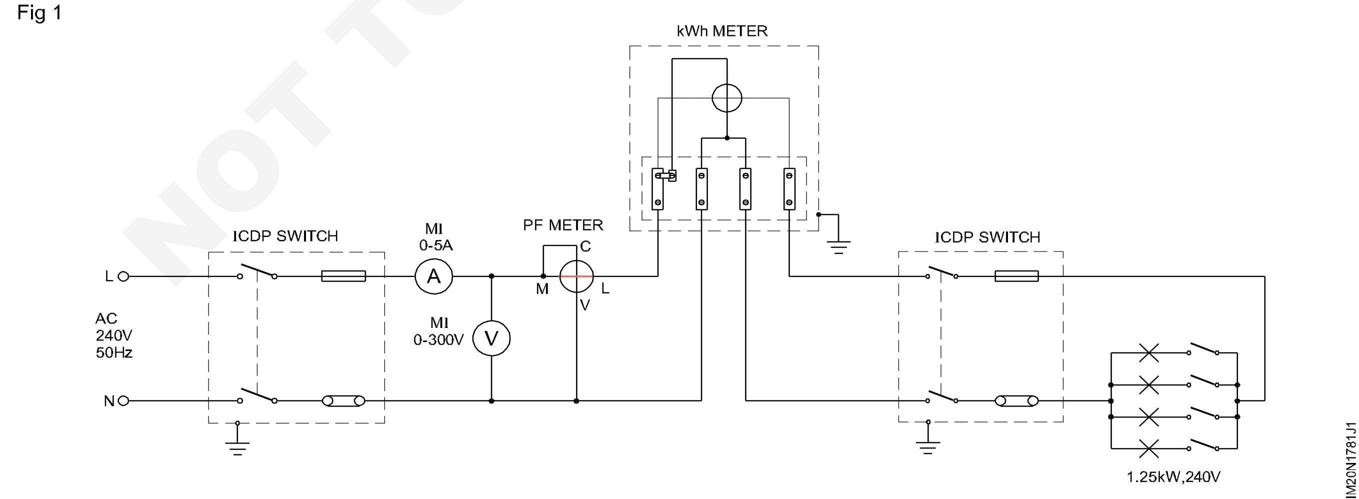
TASK 2: **Test for percentage error in single phase energy meter**

Fig 1



1 Make the connections as shown in Fig. 3 with the lamp load.

2 Switch 'ON' the lamps so that 25% of the rated current of energy meter flows in the circuit.

3 Tabulate the voltmeter, ammeter and P.F. meter readings in Table-1.

4 Keeping the load constant, count the number of revolutions of the energy meter disc for 2 minutes (120 seconds) and record the same in Table-1.

5 Calculate the true energy by using the formula.

$$\text{True energy} = \frac{E \times I \times \cos\theta \times t}{1000 \times 3600} \text{ kWh}$$

where 't' is the time in seconds.

6 Calculate the energy registered (recorded) by the meter using the formula

7 Find the error using the formula

Error = Recorded energy (R) - True energy (A).

8 Calculate the percentage error, using the formula

where R = Energy registered by the meter

A = True energy.

9 Repeat the working steps from 2 to 8 for 50% 75%, 100% resistive and inductive load and enter in Table 1.

— — — — — — — —

TASK 3: **Measurement of energy by the direct method**

1 Identify the energy meter terminals - line and load, after removing the terminal cover.

Always mount the meter vertically.

2 Associate the circuit diagram (inside) with the terminal markings of the instrument.

3 Connect the energy meter terminals (line & load) in the circuit as shown in Fig 1.

4 Note the meter constant from the name-plate of the energy meter. (Fig 2)

Fig 1

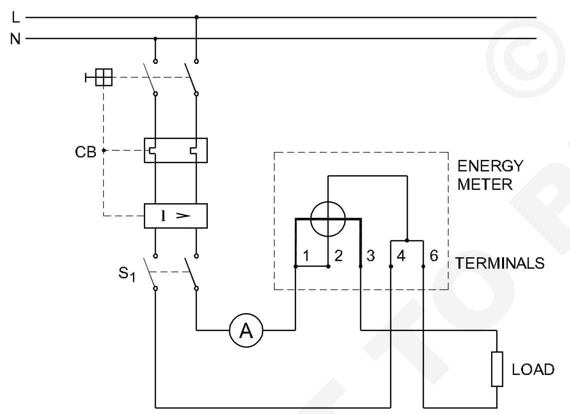
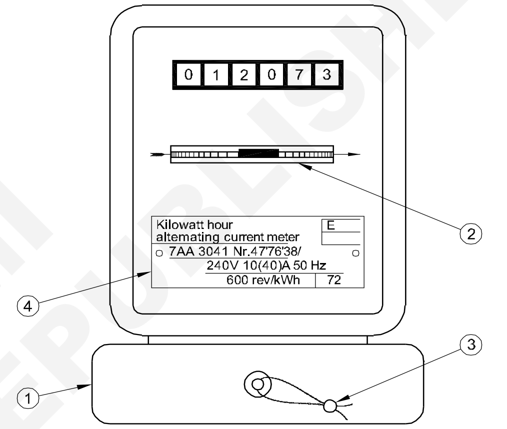


Fig 2



1 TERMINAL COVER 3 METAL SEAL
2 DISC 4 NAME-PLATE

5 Record the initial meter reading.

6 Switch ON the circuit with load.

7 Record the reading after 30 minutes.

8 Calculate the energy consumed which is the difference between the current and previous reading.

9 Repeat the steps 5 to 8 for changed load condition.

10 Repeat step 9 atleast 3 times.

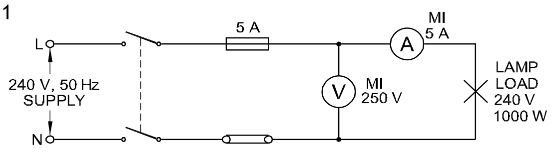
— — — — — — — —

TASK 4 **Measurement of energy by the indirect method**

1 Select a suitable range of voltmeter and ammeter.

2 Connect the ammeter and the voltmeter to the line and load as shown in Figure 1.

Fig 1



3 Close the switch S of the circuit.

4 Start the stopwatch.

5 Observe the readings of the voltmeter and ammeter.

Watch the instruments constantly. No change in the reading should take place during the period of measurement.

6 Record the reading and time in the tabulation form (Table 1) after 30 seconds.

Table 1

Voltage (V)	Current (I)	Time(s)	Energy(Ws)

7 Calculate the energy with the given formula.

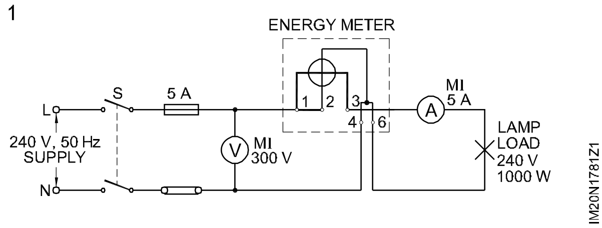
8 Repeat the steps 3 to 7 for 60 seconds and 90 seconds time and record the values of the ammeter and the voltmeter. Calculate the energy consumption.

— — — — — — — —

TASK 5: **Verify the calculated energy with the meter reading** (with disc rotation).

1 Connect the instruments as per circuit diagram in Fig 1.

Fig 1



2 Close the switch S.

3 Observe that the voltmeter and ammeter indicate steadily while the bulb is glowing.

4 Watch the rotation of the disc in the energy meter.

5 Record the meter constant (i.e.the number of revoulutions per KWH) from the dial mark on the meter.

If the meter constant i.e. rev.per kwh is very high, say in the order of 1000 and above, reduce the load suitably.

6 When the red mark on the disc passes the window, start the stopwatch to count the time.

7 Start counting the number of revolutions of the energy meter disc.

Watch there is no change in the readings of the voltmeter and ammeter.

8 On completion of 1/10 of the meter constant or equivalent to the whole number of revolutions, stop the stopwatch and switch OFF the supply.

9 Record the number of revolutions in Table 2. Record the time also in Table 2.

10 Energy recorded

$$= \frac{\text{No. of revolution s counted}}{\text{Meter constant}} \text{ kWh}$$

$$\text{i.e. Energy} = \frac{N}{\text{Meter constant}} \text{ kWh}$$

(kWh = 1000 x 3600 watt.second.)

11 Calculate energy from the formula

$$\text{Energy} = \frac{V \times I \times t}{1000 \times 3600} = \text{kWh.}$$

12 Compare the direct reading of energy with the indirectly measured energy.

13 Repeat the steps 10 to 20 for the following value of N.

N = 1/5 of meter contstant

N = 1/4 of meter constant

N = 1/3 of meter constant

The value of N calculated from the meter constant is rounded off to the next higher value.

Table 2

Sl. No.	Voltmeter reading	Ammeter I	Rev. counted, N	Time in Seconds t	Energy	
					ws measured	ws calculated

Measure power factor in three phase circuit by using power factor meter and verify the same with voltmeter, ammeter, wattmeter readings

Objectives: At the end of this exercise you shall be able to
- **connect a single phase P.F. meter in 3-phase balanced load and read the P.F**
- **verify the P.F. by voltmeter, ammeter and wattmeter readings and determine the error**
- **connect the capacitor bank in the 3-phase circuit and measure the P.F.**

Requirements

Tools / Instruments
- Single phase P.F. meter 250V/ 500V; 5A/ 10A - 1 Set
- Wattmeter 250/500V, 5A/10A 1500W - 1 Nos.
- M.I Ammeter 0-5 A/ 10A - 1 No.
- M.I Voltmeter 0-300V/ 600V - 1 No.
- Insulated combination plier 200mm - 1 No.
- Insulated screwdriver 200mm - 1 No.

Equipment / Machines
- 3-phase induction motor 415V 2.25 KW (with loading arrangement) - 1 No.
- Power factor improving capacitor bank single phase 250V, 50 Hz 1kvar - 1 Set
- 3 Phase lamp load 3 KW 415 V 50 Hz - 1 No.

Materials
- PVC insulated copper cable 2.5 sq. mm 650 V - grade - 20 m
- T.P.I.C. switch 16A, 500V - 2 Nos.

PROCEDURE

1 Collect the meters and the 3-phase lamp load.

The lamp load should have equal wattage in all the three phases.

2 Make necessary connections of the meters and load as per circuit diagram - Fig 1.

Connect the current coils of wattmeter and P.F. meter in series with load.

3 Get the circuit approved by the instructor.

4 Switch 'ON' the power supply momentarily observe deflections of all the meters. Keep the switch closed if nothing is abnormal.

5 Equally load all the three phases and note down the meter readings and enter in Table 1.

6 Switch 'OFF' the power supply.

Fig 1

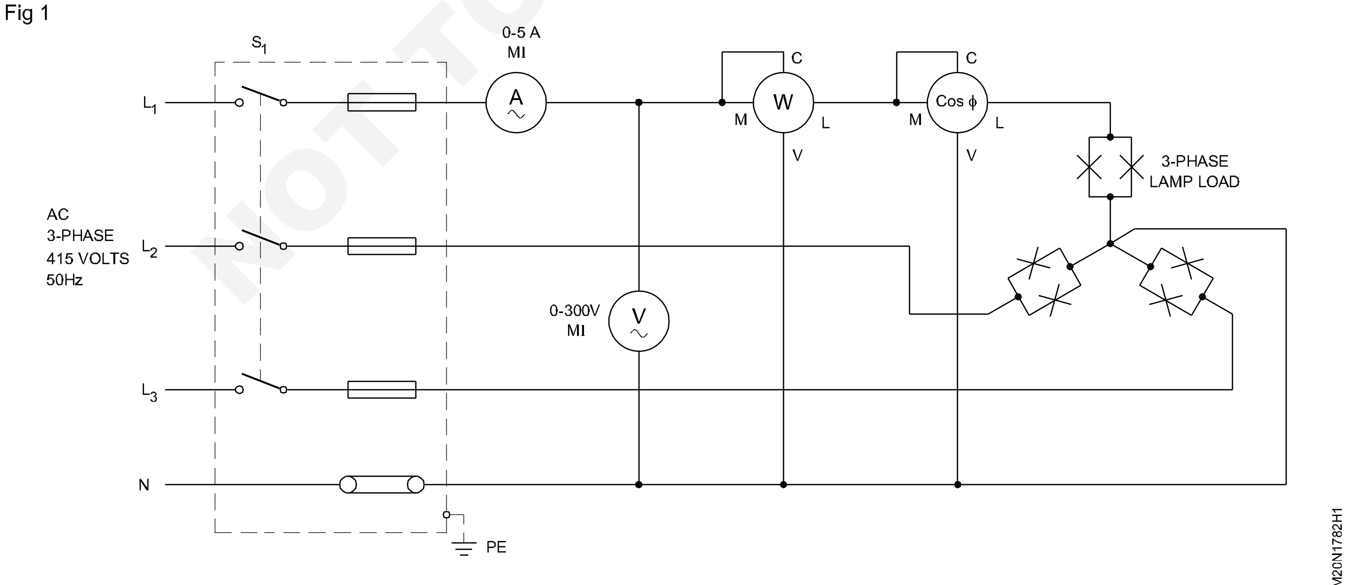


Table 1

Load condition	Ammeter reading in Amps. (I_{ph})	Volt-meter reading in Volts (E_{ph})	3-phase apparent power in watts $3xE_{ph}xI_{ph}$	Wattmeter reading in Watts W	3-phase power W x 3	Calculated value of P.F. $P.F.=\frac{W\times3}{3\times E_{Ph}\times I_{ph}}$	P.F. measured value	Remarks
Resistive load								
Motor without load								
Motor without load but with capacitor								
Motor with load								
Motor with load and with capactior								

If P.F. meter shows leading P.F. for inductive load, switch 'off' the supply and interchange current coil connections of the P.F. meter.

7 Determine the power factor by using the formula,

$$P.F.=\frac{W\times3}{3\times E_{Ph}\times I_{ph}}$$

Where W- Wattmeter reading (power in one phase)

E_{ph}- Phase voltage

I_{ph}- Phase current (Also equal to line current)

8 Compare the calculated power factor and power factor meter reading and write your observation.

Observation ____________________

____

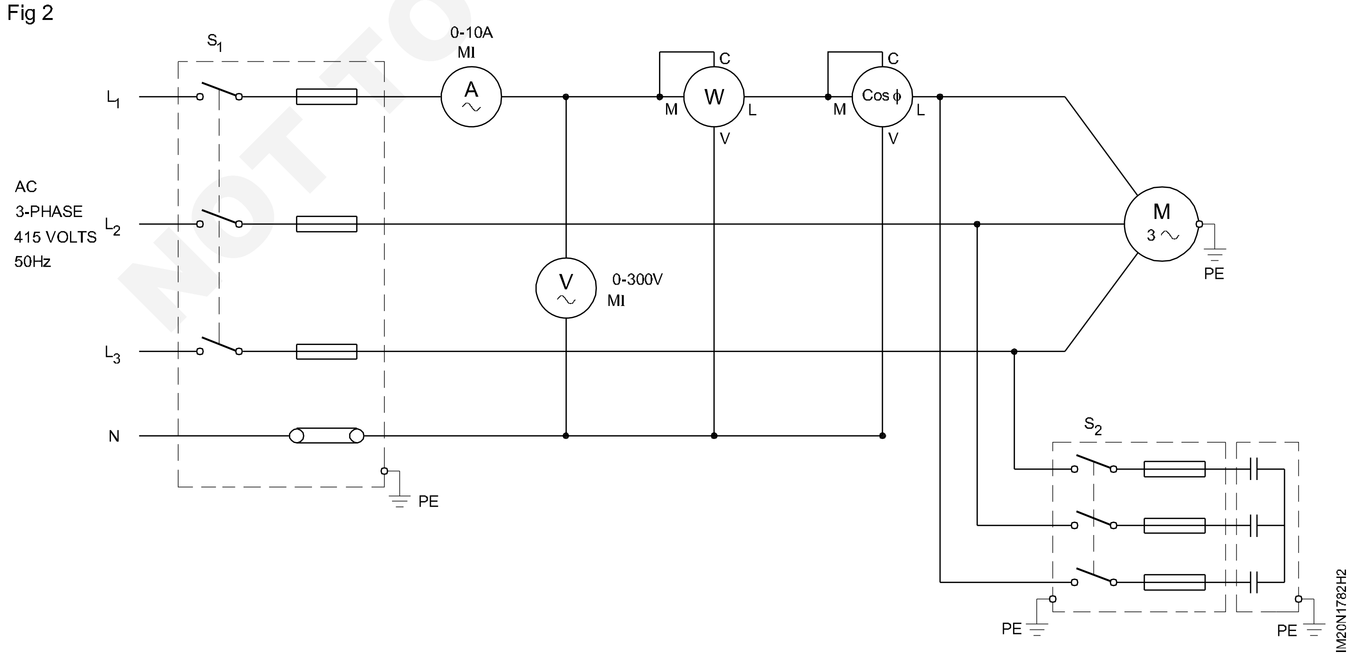
____

9 Show the readings to your instructor for approval.

10 Disconnect the lamp load and connect the 3 phase induction motor with P.F. improving capacitor as shown in Fig 2.

11 Ensure that the range of current coil in wattmeter and P.F. meter are well higher than the load current of the connected load.

Fig 2



12 Keep the capacitor switch in OFF condition. Switch ON the power supply and observe the deflection of the meters.

13 Record the meter readings in Table 1 for the load conditions shown in Table 1.

14 Switch 'OFF' the power supply and disconnect the connection.

15 Calculate the power factor in each case and compare with the measured P.F.

> **Consider the multiplying factor of the wattmeter which depends on the range of watt meter with respect to current and voltage ranges and C.C. and P.C. range selected. The reading of the wattmeter should be multiplied with the multiplying factor to get the actual power.**

16 Observe the P.F. each load condition and write your observations.

Observation ______________________________

____

____

17 Show the readings and observation to your instructor for approval.

— — — — — — — —

Practice use of voltage tester to test electrical power in circuit to test for proper grounding to determine whether adequate voltage present in a wire

Objectives: At the end of this exercise you shall be able to
- **practice of use voltage tester to test electrical power**
- **to test for proper grounding**
- **determine whether adequate voltage is present in a wire.**

Requirements

Tools /Equipment/Instruments

- Voltage tester 90 V to 1000V - 1 No
- Supply source/power socket/ fuses - available in your lab

PROCEDURE

1 Identify and check the given voltage tester

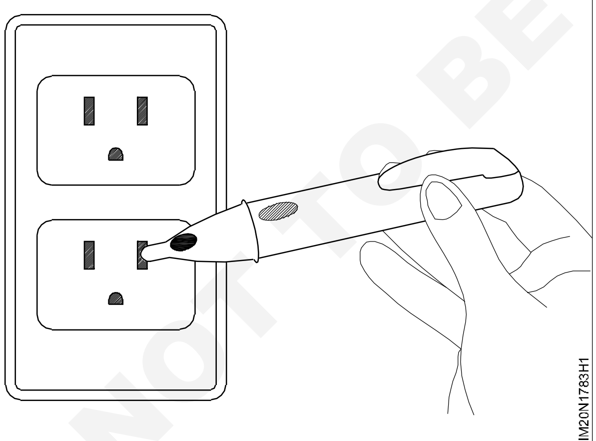
2 Observe the parts modes and lighting of voltage tester

3 To use voltage tester insert as shown in (Fig 1,2) on socket/holder with the help of power

4 Note the following steps

5 **Correct:** if both yellow lights are lit up and the red light is dark. This indicate that the outlet is working in most cases. If either the hot or neutral lights are dim, this indicates that the wire is in poor condition.

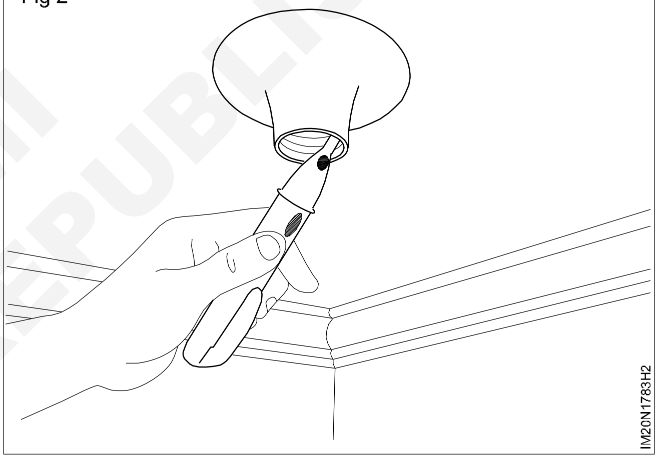
Fig 1



6 **Open hot:** if all lights are dark this indicates that there is no electricity coming from the hot (black) wire. Electricity may be shut off, or the wire may be disconnected, or bad.

7 **Open neutral:** if the second yellow light is lit. but the red and first yellow lights are dark. This indicates that the neutral wire is not getting any electricity. The neutral (white) wire may be disconnected or need to be replaced.

Fig 2



8 **Reversed polarity:** if the red light and the first yellow light are lit, this indicates that the hot and neutral wires are reversed. The outlet needs to be re-wired so that the hot and neutral wires are switched, the hot wire wired to the ground could also give this reading.

10 **Hot and ground reversed:** if the red light and second yellow light is lit but the first yellow light is dark this indicates that the hot and ground wires are reversed. It could also indicate that the neutral wire is bad and the polarity is reversed if you get this reading the entire outlet needs to be re-wired.

11 Get your work checked by the instructor.

Determine the phase sequence of the 3-phase supply system using a phase sequence indicator

Objectives: At the end of this exercise you shall be able to
- **connect the phase sequence meter and identify the sequence.**

Requirements

Tools and Instruments		Materials	
• Phase sequence meter	- 1 No.	• Connecting leads	- 3 Nos.

PROCEDURE

1 Read the marking on the phase sequence indicator and record the direction for – RYB sequence
– RBY sequence.

PHASE SEQUENCE

In the direction of arrow on disc: _______________

Opposite to the direction of arrow on disc: _______________________

2 Switch OFF the supply and connect the 3 phases of the supply to the sequence indicator. (Fig 1)

Mark the leads as I, II, III. Connect them, such that I is connected to R, II to Y, III to B.

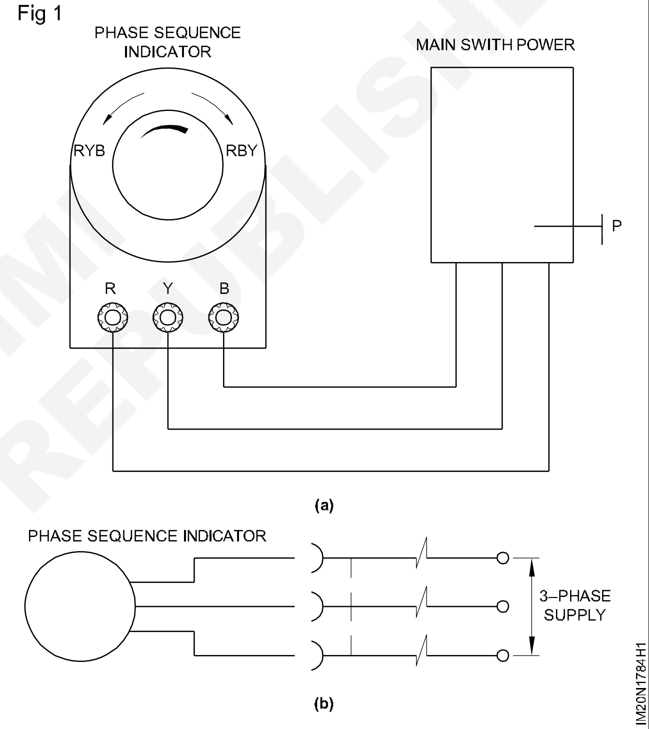
> **You can connect any lead (phase) to any terminal in the sequence indicator.**

3 Switch ON the supply and observe the direction of the disc movement.

4 Record the direction by a tick mark.

Rotation	
Same as the arrow on disc	
Opposite to the arrow on disc	

Fig 1



5 If the rotation is opposite, switch off the supply and interchange the leads II & III connected to the terminals Y and B. Switch on the supply.

6 Now the disc will rotate in the direction of the arrow.

7 Mark the leads corresponding to the letters on the phase sequence indicator.

— — — — — — — —

Test power diode, zener diode tunnel diode and photo diode

Objectives: At the end of this exercise you shall be able to
- **test the diode using multimeter observe the voltage**
- **determine the forward to reverse resistance ratio.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set
- Multimeter with probes - 1 No
- Semi conductor data manual - 1 No

Materials

- Assorted type of (Tunnel, Zener & Photo) Diodes - 10 Nos
- Red colour Sleeve Wire - 1 No
- Patch Cords - 10 Nos

PROCEDURE

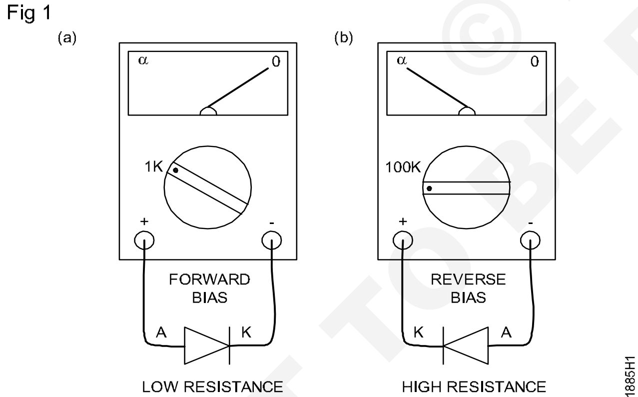
The instructor has to label the different types of diodes used for this exercise.

1 Pick one of the labelled diode from the given assorted lot.

2 Set the multimeter to x100Ω range. Carry out resistance zero setting of the meter.

3 Connect the multimeter probes across the diode terminals as shown in the Fig 1a. Record the resistance reading shown by the meter in Table-1.

Fig 1



DIODE TESTING USING ANALOG MULTI-METER

4 Reverse the meter probe connected to the diode as shown in the Fig 1b and record the reading shown by the meter in Table-1.

5 From the readings noted in step-3 and step-4 calculate and record the ratio between Forward resistance (R_F) to Reverse resistance (R_R).

6 From the recorded information given conclusion of diode.

- In good diodes, resistance will be less than 100Ω in one direction and very high or almost infinity/open in the other direction.
- In most cases the ratio between low to high resistance would be at 1:1000.
- If get zero both ways, the diode is shorted.
- If get INFINITY both ways, the diode is open.

7 Repeat step-3 to step-6 for all the remaining diodes, and record in Table 1.

8 Get the work checked by the Instructor.

Table 1

Label No.	Code No.of Diode	Forward Resistance (F_R)	Reverse Resistance (R_R)	Ratio of F_R/R_R	Servicable/ UnServicable
1	Power diode				
2	Zener diode				
3	Tunnel diode				
4	Photo diode				

— — — — — —

Determine V-I characteristics of semiconductor diode

Objective: At the end of this exercise you shall be able to
- **determine V-I characteristics of semi conductor diode in forward bias and reverse bias.**

Requirements

Tools/Equipment/Instrument

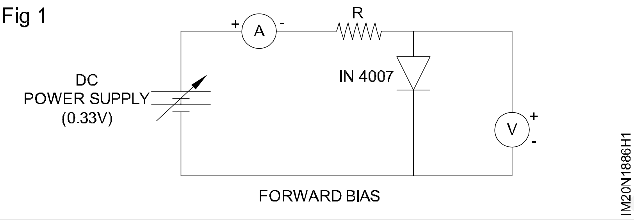
- PN Junction diodes - as reqd.
- RPS (0-30V) - 1No.
- Resistor
- Volt meter (0-50V) - 1No.
- Ammeter (0-50mA) - 1No.
- Bread board, connecting wires.

PROCEDURE

TASK 1: **Construct and measure VI characteristics of PN junction diode**

Collect all the required components, test and assemble as in Fig 1.

Fig 1



Forward Bias: Positive terminal of the octernal pattern is connected to the "P" region and negative terminal is connected to "N" region as shown in figure No-1 and list the reading in the table.

Fig 2

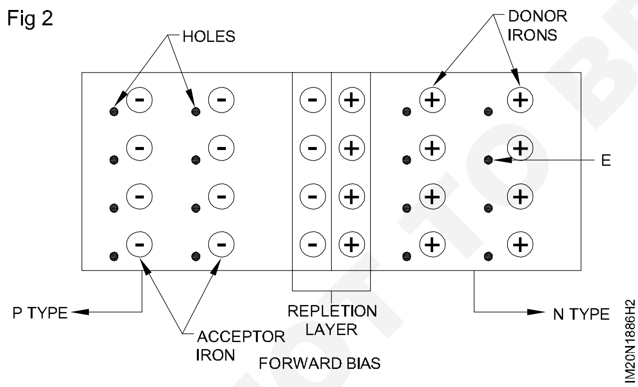


Table 1

S.No	Voltage (V)	ammeted (I) (ma)
1		
2		
3		

Reverse bias: The negative terminals of the external battery is connected to positive terminal is connected to the "N" region.

Fig 3

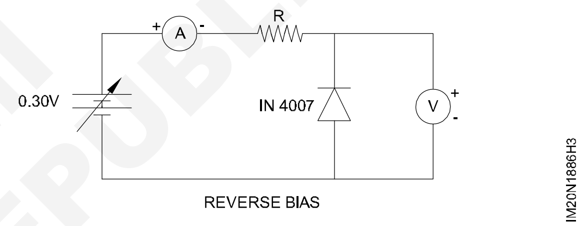


Table 2

S.No	Voltage	ammeted (ma)
1		
2		
3		

Precautions : Connecting must be tight. Handle the components carefully

Measure the voltage and current through a diode

Objectives: At the end of this exercise you shall be able to
- **find and plot the forward characteristics of a diode.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set
- Regulated DC power supply, 0-30V/2A - 1 No
- DC milli-ammeter, 0-500mA - 1 No
- DC milli-Voltmeter, 0-1000mV - 1 No
- DMM with probes - 1 No

Materials

- Lugboard - 1 No
- Semiconductor diode, 1N4007 or BY127 - 1 No
- Resistor, 470Ω/½ watt CR25 - 1 No
- Hook up Wire - 2 m
- Patch Cords - 10 Nos

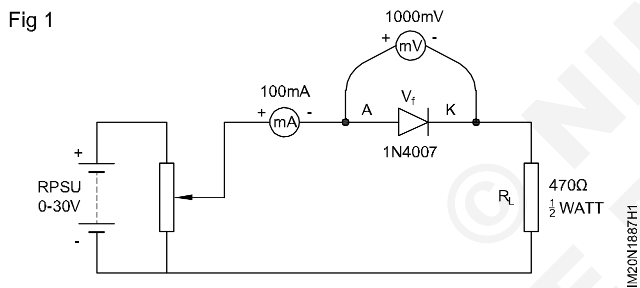
PROCEDURE

1 Check to confirm the good physical and electrical working condition of the given diode.

2 Identify the Anode and Cathode terminals of the diode.

3 Construct the circuit as shown in Fig 1.

Fig 1



4 Switch ON the Regulated Power Supply and increase the output voltage of the RPSU such that the diode drop V_f varies from 0 to 1V in steps as given in Table-1.

5 At each step record the values of I_F.

6 Switch OFF the RPSU. From the recorded values of V_f and I_f, calculate and the forward resistance R_f of the diode.

7 From the recorded readings in Table-1, plot a graph of V_f and I_f as in fig 2.

8 Take the different reading and put in the tabular coloumn.

9 Get the work checked by the Instructor.

Table 1

Forward diode voltage in (mV)	Forward current I_f in mA	Forward (R_F) Resistance Ω
100mV		
200mV		
300mV		
400mV		
500mV		
600mV		
700mV		
800mV		
900mV		
1 Volt (1000mV)		

Measure the voltage and current through a zener diode and verify its forward. Reverse cahracteristics

Objectives: At the end of this exercise you shall be able to
- **find the forward characteristics of zener diode**
- **find the reverse characteristics of a zener diode**

Requirements

Tools/Equipments/Instruments

- Trainees kit - 1 No
- Power supply, 0-30V, 1A - 1 No
- DC milliammeter, 0-50mA - 1 No

Materials

- Assorted types of zener diodes - 20 Nos
- 12V, 400mw, Zener diode - 1 No
- Resistor 47Ω, 1/2Ω - 1 No
- Resistors, 2.2K, 1K, 820Ω, 560Ω, 1/4 W - 1 each
- Patch cords - as reqd
- Lug board (end product of Unit-2) - 1 No
- Wire sleeve, yellow - 5 cms.

PROCEDURE

TASK 1: **Find forward characteristics of zener diode**

1 Take one of the given zener diodes. Record its label number and the component code number in Table 1.

2 Check and record the working condition of teh zener in a similar way as you test a rectifier diode.

If you don't know which terminal (+ve or -ve) of multimeter is connected to the +ve of the internal battery, Check using another voltmeter and make a mark on your meter.

3 From the polarity marking on the body of the zener and from the test carried out at step 2, identify and put a yellow sleeve to the cathode terminal of the zener.

4 Refer diode data manual and record the following specifications of the zener diode under test;

– Nominal zener voltage, V_z

– % tolerance

– Maximum power dissipation, $P_{z(max)}$

– Zener curent, I_Z

– Resistance of zener in zener mode, Rz

– Type of package

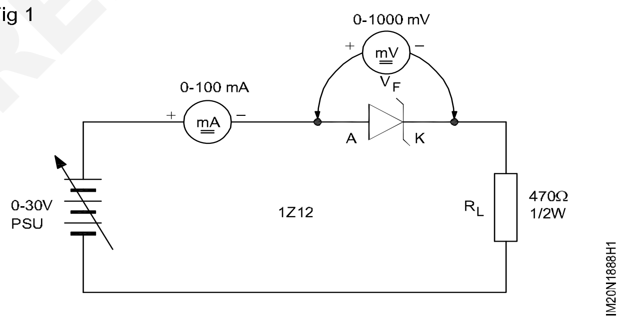
5 Get the work checked by your instructor

6 Repeat steps 1 to 5 for atleast five different types of zener diodes in the given lot.

7 Collect a 12 volt, 400mw (min) zener. Diode, identify and put a yellow sleeve to its cathode. Refer data manual and record its specifications in Table 2 of O & T Sheet.

8 Connect the circuit as shown in Fig 1

Fig 1



9 Get the connections of your check with by instructor.

10 Switch ON PSU and increase the output voltage of the PSU such that the diode drop V_f varies from 0 to 1V in step as given in Table 3. At each step record the values of I_f.

11 Switch OFF the PSU. For each set of recorded values of V_f and I_f, calculate and record the forward resistance R_f of the zener diode.

12 From the recorded readings in Table 2, plot a graph of V_f and I_f in O&T sheet.

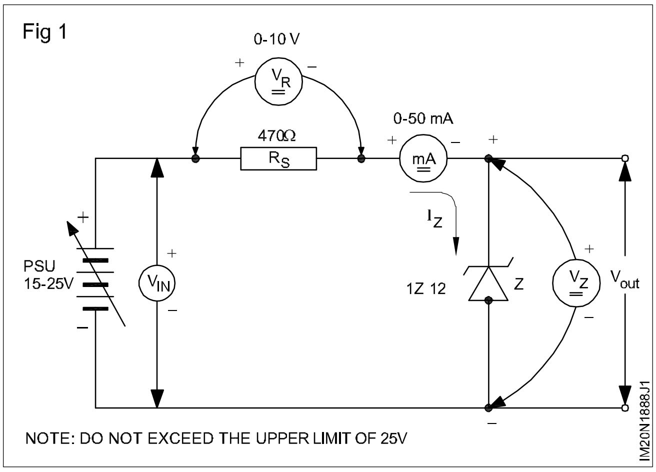
13 Get your work checked by your instructor.

— — — — — —

TASK 2: **Find Reverse characteristics of zener diode**

1 Wire a test circuit as shown in Fig 2 on a general purpose lug board.

2 Vary the input to zener V_{IN} in steps as given in Table 3 and at each step record the values of V_R, V_z and I_z in Table 3. After taking readings, switch OFF PSU.



3 From the recorded readings in Table 4 calculate and record the resistance R_z of the zener, and power dissipated P_z for each set of reading taken.

4 Get the recorded readings checked by your instructor.

Table - 1

Label No.	Zener code-number	Condition from quick test	Specifications					Types of package
			Nominal zener voltage V_z	% tolerance	Max.power P_z	Zener curent I_z	Zener resistance R_z	

Table - 2

Code No.	Condition	Zener code number	Condition from quick test	Specifications					Types of package
				Nominal zener voltage V_z	% tolerance	Max.power P_z	Zener curent I_z	Zener resistance R_z	

Table - 3

				Calculated value of	
V_{in} dc volts	V_R volts	I_z mA	V_z volts	R_z P_z	

Table - 4

				volts	
V_{in} d c	volts V_R	volts I_z	mA V_z	Calculated	value of R_z P_z

Construct and test fixed bias, emitter bias, and voltage divider bias transistor amplifier

Objectives: At the end of this exercise you shall be able to
- **construct and test fixed bias arrangement to transistor amplifier circuit**
- **construct and test emitter bias arrangement to transistor amplifier circuit**
- **construct and test voltage divider bias arrangement to transistor amplifier circuit.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Digital multimeter with probes - 1 No
- CRO, 20 MHz, Dual Trace - 1 No
- Regulated DC Power Supply, 0- 30V/2A - 1 No
- AF signal generator - 1 No
- DC micro ammeter 0-500 μA - 1 No
- DC miliammeter 0-30 mA - 1 No

Materials

- Breadboard - 1 No
- Transistor BC 107, SL100 - 1 No each
- Capacitor
  - 1 mF/25V - 1 No
  - 10kpf - 2 Nos
  - 25mF/25V - 2 Nos
- Resistor/¼ W/CR25
  - 220kΩ - 1 No
  - 5.1kΩ - 1 No
  - 1.5kΩ - 2 Nos
  - 5.6kΩ - 1 No
  - 12kΩ - 1 No
  - 120Ω - 1 No
  - 470Ω - 1 No
  - 1kΩ - 3 Nos
- Hook up wires - as reqd

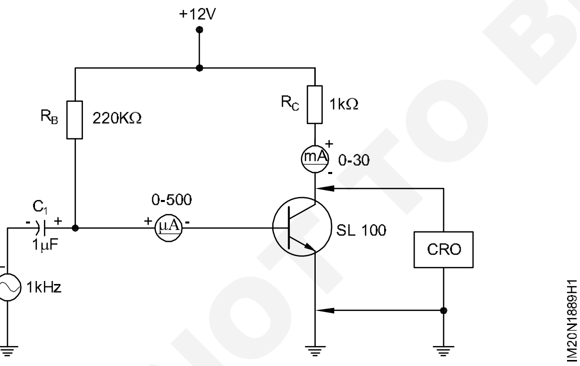
PROCEDURE

TASK 1 : **Construction and testing of fixed bias arrangement for transistor amplifier circuit using BJT**

1 Collect all the components required and check them for good working condition using multimeter.

2 Assemble the circuit as shown in Fig 1.

Fig 1



3 Calculate base current 'I_B' using the formula.

$$I_B = \frac{V_{CC} - V_{BE}}{R_B}$$

4 Now switch - ON the DC supply to the circuit and record readings in Table 1 without signal.

5 Prepare CRO for measurement and apply AF signal 1kHz/20mV sine wave from AF signal generator as input.

6 Observe and record the values of I_B, I_C and V_{CE} for the fixed bias amplifier circuit in Table-1.

7 Compare the calculated values with the observed values.

8 Get the values checked by the Instructor.

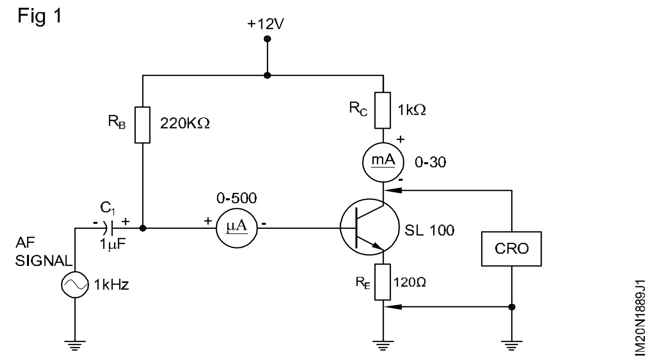
Table 1

Input condition	**Base Current I_B**	**Collector current I_C**	**V_{CE}**	**Voltage**	**Current gain $A_i = I_C / I_B$**	**$A_v = \frac{V_C}{V_{in}}$**
Without signal						
With input Signal						

TASK 2 : **Construction and testing of emitter feedback bias amplifier circuit using BJT**

1 Modify the circuit as shown in Fig 2.

Fig 1



2 Calculate the values of I_B, I_C b_{dc} and V_{CE} by using the formula given in the note and record the values in Table 2.

3 Switch ON the 12V DC supply and AF signal generator input to the circuit assembled and measure base current I_B, collector current I_C,V_{BE} (forwad bias of transistor) and the voltage drops across base resistor R_B the emitter resistor R_E, collector resistor R_C and V_{CE} record the observed values in Table 3.

Table 2

Calculated Observed values	**Collector Current I_C**	**Base current I_B**	**V_{CE}**	**Current gain Ai (β_{dc})**	**Volatage gain A_V**
Calculated values					
Observed values					

4 Prepeare CRO for measurements, connect and observe the peak-to-peak AC signal input from AF signal generators at CH1 and amplified AC signal output of the emitter feedback bias amplifier circuit at CH-2 and record the readings.

5 Increase the input A/C signal voltage applied to emitter feedback amplifier gradually and repeat the observations of the parameters given in step 3.

6 Note that the collector current 'I_C' remains stable to maintain constant 'Q' - operating point of the amplifier.

7 Calculate and record the I_C (sat) of the emitter-bias circuit

8 Get the values checked by the Instructor

Table 3

AF Signal Generator - AC input = Sinewave 1kHz/20mV

Value/ signal condition	**Base Current I_B**	**Collector current I_C**	**Current gain $\beta = \frac{I_C}{I_B}$**	**V_{BE}**	**V_{CE}**	**DRB**	**Drop across R_E**	**Drop across R_C**
Calculated Value								
Measured Values								
Without Signal								
With signal								

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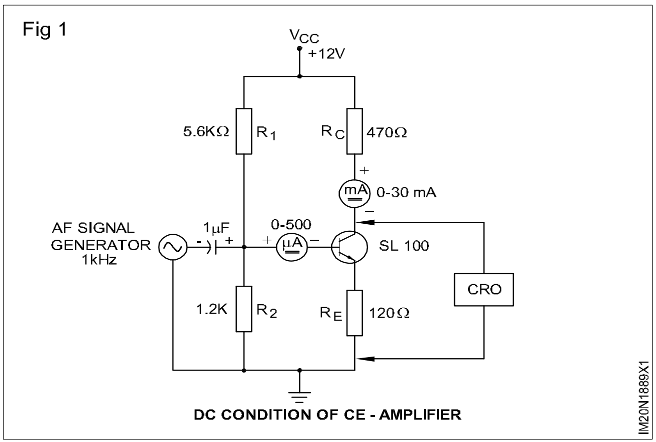
TASK 3 : **Construction and testing of voltage divider biased transistor CE amplifier**

1 Check all the components and assemble the circuit as shown in Fig 3.

Fig 1



DC CONDITION OF CE - AMPLIFIER

2 Get the assembled circuit checked by the Instructor.

3 Measure and record I_B and I_C in Table 4, calculate current gain βdc and record it. in table 4

4 Apply AC input signal of 1 kHz, 20 mV from AF signal generator to the voltage divder biased CE amplifier.

Table 4

Collector current I_C	Base current I_B	Current gain A_i β_{dc}

5 Prepare the CRO for measurements connect CRO to observe/measure AC signal input to amplifier from AF signal generator to CH-1 and amplified AC signal output of voltage divider bias to CH-2.

6 Measure and record the observed values as required in Table 5. Calculate & record Ai and Av of the amplifier observe and record the Input/Output waveforms available on the CRO.

7 Get the work checked by the instructer.

Table 5

Signal Condition	Base current I_B	Collector current I_C	β_{dc}	Voltage drop Across				V_{BE}	V_{CE}	Voltage gain
				R_1	R_2	R_C	R_E			$A_V = \frac{V_{out}}{V_{in}}$
Without signal										
With signal										

7 Get the work checked by the Instructor.

— — — — — —

Construct and test a CE amplifier with and without bypass capacitors

Objectives: At the end of this exercise you shall be able to
- **construct and test CE amplifier with by pass capacitor and without by pass capaciter.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- CRO, 20 MHz Dual trace - 1 No
- AF Signal generator - 1 No
- Regulated DC power supply, 30V/2A - 1 No
- Digital multimeter with probes - 1 No

Materials

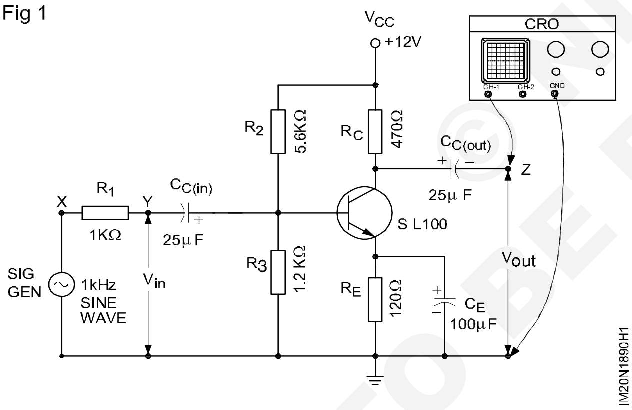
- Hook-up wires - as reqd
- Breadboard - as reqd

- Resistor/¼W/CR25
  1kW,1.2 kΩ, 5.6 kΩ
  120W, 470Ω - 1 No each
- Capacitors
  25 mF/25V - 2 Nos
  4.7 mF/25V - 1 No
  100 mF/25V - 1 No
  470 mF/25V - 1 No

PROCEDURE

1 Collect all the components, test them assemble the circuit as shown in Fig 1 on breadboard. Capacitor C_E is the emitter by pass capacitor.

Fig 1



2 Get the circuit connections checked by the Instructor.

3 Preapare the CRO for measurements and switch 'ON' 12V DC supply to the circuit, adjust the output of the signal generator at 1kHz such that V_{out} is large enough and undistorted.

4 Record the peak to peak values of input V_{in} and output V_{out} in Table 1; Calculate and record the voltage gain A_v of the amplifer.

5 Find the input impedance Z_{in} and output impedance Z_{out} of the amplifier using the same procedure and Record values in Table 1.

6 Measure and record the AC and DC voltages at various points of the amplifier in Fig 2 and Fig 3.

7 Switch off DC supply to the circuit. Disconnect 100 mF capacitor connected across the 120Ω emitter resistor.

Now the input V_{in} may show higher value due to increased Z_{in} without the bypass capacitor. Do not alter the output level / frequency of the signal generator.

8 Switch 'ON' DC supply to the circuit, repeat steps 4 and record readings in Table 1.

9 Measure and record the AC and DC levels at various points of the amplifier without the bypass capacitor in Fig 3.

10 Switch-OFF DC supply to the circuit and from the recorded readings, complete the sentences given in record sheet.

11 Get the work checked by the Instructor.

Table - 1

Condition	$V_{in(peak-to-peak)}$	$V_{out(peak-to-peak)}$	A_v	Z_{in}	Z_{out}
With bypass capacitor C_E connected across R_E					
Without bypass capacitor C_E					

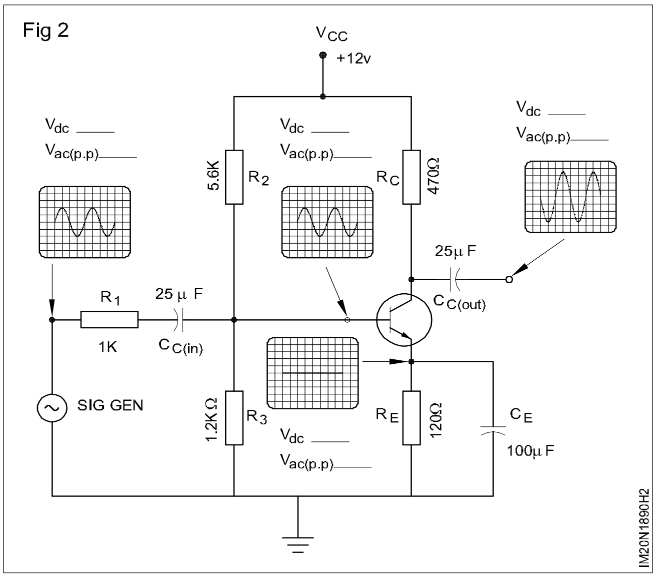


Fig 2
VCC
+12v
Vdc
Vac(p.p)
5.6K
R2
RC
470Ω
25μ F
R1
25 μ F
CC(out)
1K
CC(in)
SIG GEN
1.2KΩ
R3
RE
120Ω
CE
100μ F
IM20N1890H2

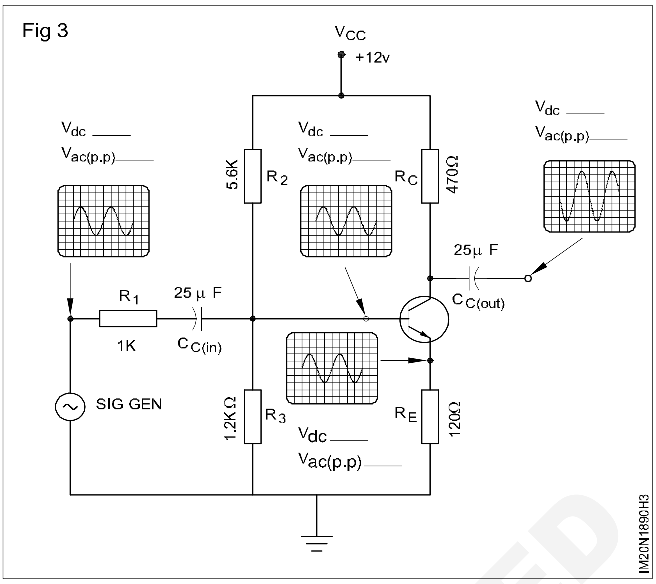


Fig 3
VCC
+12v
Vdc
Vac(p.p)
5.6K
R2
RC
470Ω
25μ F
R1
25 μ F
CC(out)
1K
CC(in)
SIG GEN
1.2KΩ
R3
RE
120Ω
IM20N1890H3

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Construct a single stage amplifier and measure current gain, voltage gain and power gain

Objectives: At the end of this exercise you shall be able to
- **measure curent gain of a single stage amplifier**
- **measure voltage gain of a single stage amplifier**
- **measure the power gain of a single stage amplifier.**

Requirements

Tools/Equipments/Instruments

- Tag board code no. 110-03-TB - 1 Set
- Transistor, SL100 or equivalent - 1 No
- Diode IN914/OA79 - 1 No
- Capacitor, 100 µF/25 V, electrolytic, axial- 1 No
- Potentiometer, 10 Kµ, carbon - 1 No
- Resistors 1/4W, carbon
  - 120Ω - 1 No
  - 470Ω - 1 No
  - 1 KΩ - 1 No
  - 1.2KΩ - 1 No
  - 5.6KΩ - 1 No
- Hook-up wires - 1 No
- Rosin-cored solder, 22 gauge - 1 No

Materials

- Trainees kit
- Oscilloscope, 20 MHz, Dual trace - 1 No
- AF Signal generator
- Regulated DC power supply (End product of Ex.9.13) - 1 No
- DC microammeter, 0-500µA - 2 Nos
- DC millammeter, 0-30mA - 2 Nos

PROCEDURE

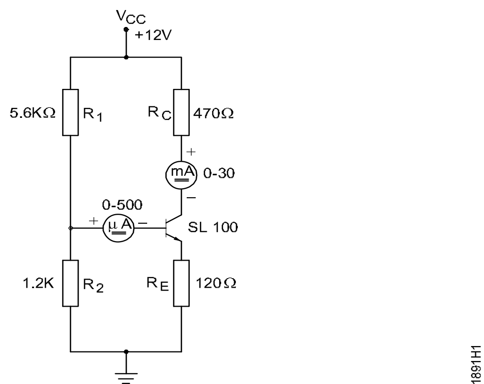
TASK 1: **Current gain A_i of CE amplifier**

1 Construct the circuit of a CE amplifier as shown in Fig 1.

2 Apply V_{CC}. Measure and Record I_c and I_B in Table 1 of O & T sheet.

3 Calculate and record the values of current gain A_i of the amplifier. Get the work checked by your instructor.

Fig 1



DC CONDITION OF CE - AMPLIFIER

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TASK 2: **Voltage gain A_v of the amplifier**

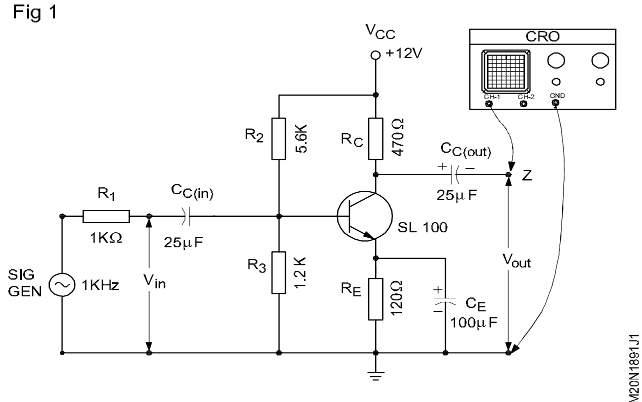
1 Construct a CE amplifier as shown in the schematic diagram at Fig 2.

2 Get the wired circuit checked by your instructor before applying voltage to the circuit.

3 Set the output of the Signal Generator to 1 KHz, sine wave. Adjust the signal generator output level such that the output wave-form seen on CRO is maximum and is undistorted. Get the work checked by your instructor.

4 Measure the peak-to-peak values of input ac V_{in} and output ac V_{out} of the circuit. Record your readings in O & T sheet.

Fig 1



5 From the recorded readings, calculate and record the voltage gain A_v of the amplifier.

6 Get the readings checked by your instructor.

— — — — — — —

TASK 3: **Calculating power gain A_p of the amplifier**

1 Using CRO, measure the input voltage (peak) V_x at point X and V_Y at point Y. Record your readings in the O & T sheet.

2 Find the input current i_{in} using Ohm's law as given below,

$$i_{in} = \frac{Vx - VY}{R_1}$$

3 Calculate and record the input imedance Z_{in} of the amplifier using the formula.

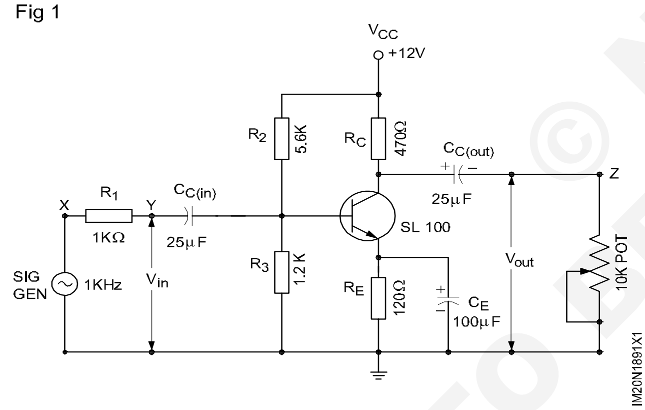
input impedance, $Z_{in} = \frac{Vin}{i_{in}}$

V_{in} is nothing but the voltage V_Y measured at step 1.

4 Measure the value of amplified ac $V_{out\,(p\text{-}p)}$ at the output of the amplifier and record in the O & T sheet.

5 Connect temporarily a 10K pot across the output of the amplifier as shown in Fig 3.

Fig 1



At this stage DON'T change the input signal level V_{in} to the amplifier.

6 Adjust 10K pot such that the output level V_{out} seen on CRO, shows half the value of V_{out} measured and recorded at step 4.

7 Switch OFF DC supply to the circuit. Remove the pot from the circuit without disturbing the adjusted value of the pot. Measure the adjusted resistance value of the pot. Record this value as the out put impedance Z_{out} of the amplifier in the O & T sheet.

8 From the recorded readings, calculate the power gain of the CE amplifier using the formulae.

Input power to the amplifier, $Pin = \frac{V_{in}^2}{Z_{in}}$

Output power of the amplifier, $P_{out} = \frac{V_{out}^2}{Z_{out}}$

Amplifier power gain A_P in $= \frac{P_{out}}{P_{in}}$

Amplifier power gain A_P in decibels (dB) $= 10 \log \frac{P_{out}}{P_{in}}$

9 Calculate amplifier power gain Ap from the calculated values of Ai and Av at tasks 1 and 2. Record the power gain Ap of the amplifier.

10 Get your work checked by your instructor.

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Construct and test a FET amplifier

Objective: At the end of this exercise you shall be able to
- **construct and test voltage amplifier using a JFET.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Regulated DC power supply 0-30V/2A - 1 No
- Function generator - 1 No
- Soldering iron 25W/240VAC - 1 No
- Oscilloscope 0-20 MHz Dual trace - 1 No
- Digital multimeter with probes - 1 No

Materials

- Assorted types of N-channel JFET - 4 Nos
- Plastic sleeves
  Red, Green, Yellow, Black - 4 Nos
  (each of 10mm length)

Aids: Semiconductor data manual/ data sheet of the FET - as reqd

- Capacitors
  5.6 nF/25V DC - 1 No
  270 nF/25V DC - 1 No
  6.8 μF/25V - 1 No
- Resistors, ¼ W/CR25
  10 kΩ - 1 No
  12 kΩ - 1 No
  47 kΩ - 1 No
  1 MΩ - 1 No
- Solder, flux - as reqd
- Hook up wires - as reqd

One of the given JFET should be a BF 245B or BFW 10 or equivalent.

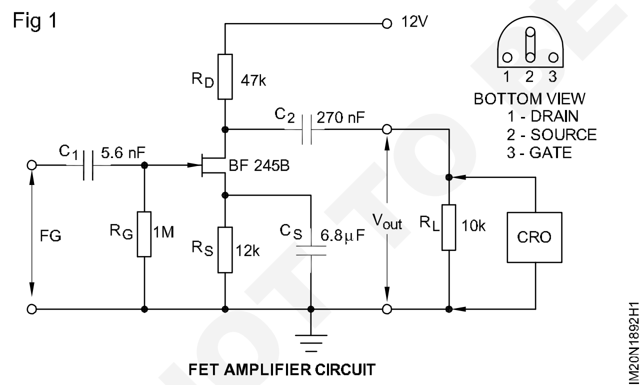
PROCEDURE

TASK 1 : **Construction and testing of FET amplifier**

1 Collect the required components, test and assemble the FET amplifier as shown in Fig 1.

Construct the circuit on a bread board or on a GPCB.

Fig 1



FET AMPLIFIER CIRCUIT

2 Get the assembled circuit checked by the instructor.

3 Switch ON the 12 VDC to the circuit.

4 Set the function generator output with sinewave at 10 kHz, 100 mV_{p-p} as the input to the FET amplifier.

5 Prepare the CRO for measurements and observe the output across the R_L.

6 Record the output reading in Table 1.

Table 1

Input frequency : 10 kHz			$\text{Gain} = \frac{\text{Output voltage}}{\text{Input voltage}}$
Sl. No.	Input voltage (mV)	Output voltage (mV)	
1	100		
2	200		
3	300		
4	400		
5	500		
6	600		
7	700		
8	800		
9	900		
10	1000		

7 Increase the input voltage in steps of 100 mV upto 1V, record the observation in Table 1.

8 Calculate gain for each setting of input and record them.

9 Get the work checked by the Instructor.

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TASK 2 : **Measurement of gain of FET amplifier at different frequencies**

1 Set the function generator output with sinewave at 20 kHz- 400 mV, switch ON the FET amplifier

2 Measure the output across R_L using CRO and record the readings.

Construct and test a Half-wave, Full wave and Bridge rectifier circuit

Objectives: At the end of this exercise you shall be able to
- **construct and test a half-wave rectifier**
- **construct and test a two diode full-wave rectifier**
- **construct and test a full-wave bridge rectifier.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Oscilloscope 0-30MHz, Dual Trace with probe kit - 1 No
- Multimeter with probes - 1 No

Materials

- Lug Board/PCB - 1 No
- Semiconductor diode, 1N4007 or By127 - 4 Nos
- Step-down Transformer, 230V/12V/500mA - 1 No
- Centre tapped Step-down Transformer, 230V/12-0-12V/500mA - 1 No
- Main cord with Three Pin Plug - 1 No
- Resistor, 470Ω/1Ω CR25 - 1 No
- Hook up Wire - 5 m

PROCEDURE

TASK 1: **Construct and Test a Half-Wave rectifier**

1 Check to confirm the good condition of the given components.

2 Using Lug board/PCB, construct the Half-wave rectifier as shown in Fig 1.

3 Connect AC mains to the Transformer and switch ON mains.

4 Measure and record the mains voltage and transformer secondary AC voltage $V_{S(rms)}$ to the rectifier in the Table-1.

5 Calculate the expected DC voltage V_{dc} across the load resistor R_L using the formula,

$V_{dc} = 0.45V_{S(rms)}$

Where, $VS_{(rms)}$ is the AC input to the rectifier.

6 Measure and record the rectifier output DC voltage V_{dc} across R_L using multimeter/Voltmeter.

7 Record the difference in the calculated and measured values.

8 Connect the two channel input probes of the CRO. Set the Volt/div and Time/div of CH-1 and CH-2 such that the two waveforms are seen clearly.

9 From the displayed waveforms on the screen, measure and record the following parameters;

a Peak value of Source Voltage V_S (Input Volt to Rectifier).

b Frequency of Source Voltage V_S.

c Peak value of pulsating DC - V_{dc}.

10 Frequency of Pulsating DC - V_{dc}.

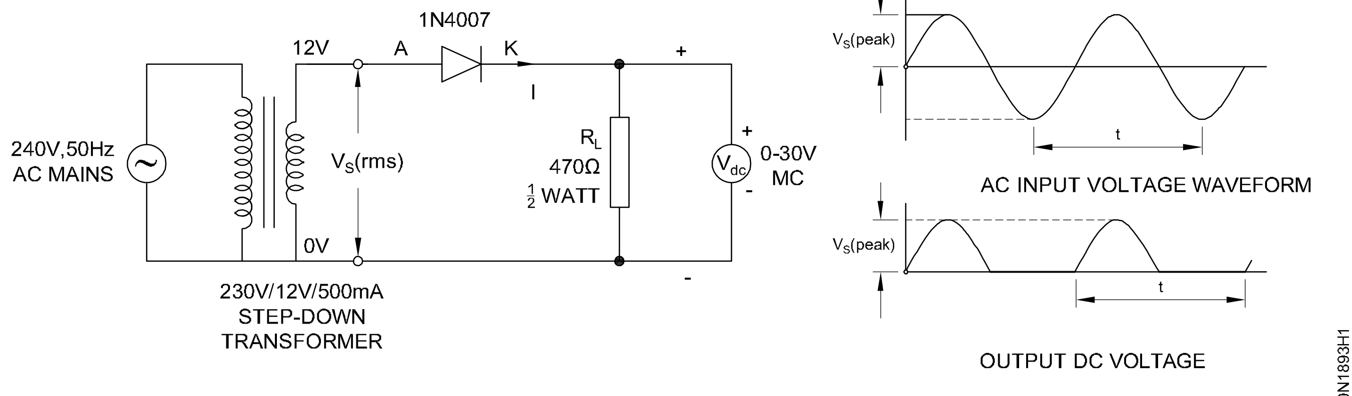
11 Get the work checked by the Instructor.

Table 1

- Type of Transformer :
- Rated Primary Voltage :
- Rated Secondary Voltage :

Mains supply voltage	Secondary voltage $V_{S(rms)}$	Calculated V_{dc}	Measured V_{dc}	Difference between (3) and (4)	Peak value V_S	Frequency of V_S	Peak Value of pulsa ting V_{dc}	Frequency of pulsating V_{dc}

Fig 1



HALF-WAVE RECTIFIER **HALF-WAVE RECTIFIER WAVEFORMS**

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TASK 2: **Construct and Test a two diode Full-Wave rectifier**

1 Construct the two diode Full-wave rectifier as shown in Fig 2.

2 Connect AC mains to the centre tapped Transformer and switch ON mains.

3 Measure and record the mains voltage and transformer secondary AC voltage $V_{S(rms)}$ to the rectifier in the Table-2.

4 Calculate the expected DC voltage V_{dc} across the load resistor R_L using the formula,

$V_{dc}=0.9V_{S(rms)}$

Where, $V_{S(rms)}$ is the AC input to the rectifier.

5 Measure and record the rectifier output DC voltage V_{dc} across R_L using multimeter/Voltmeter.

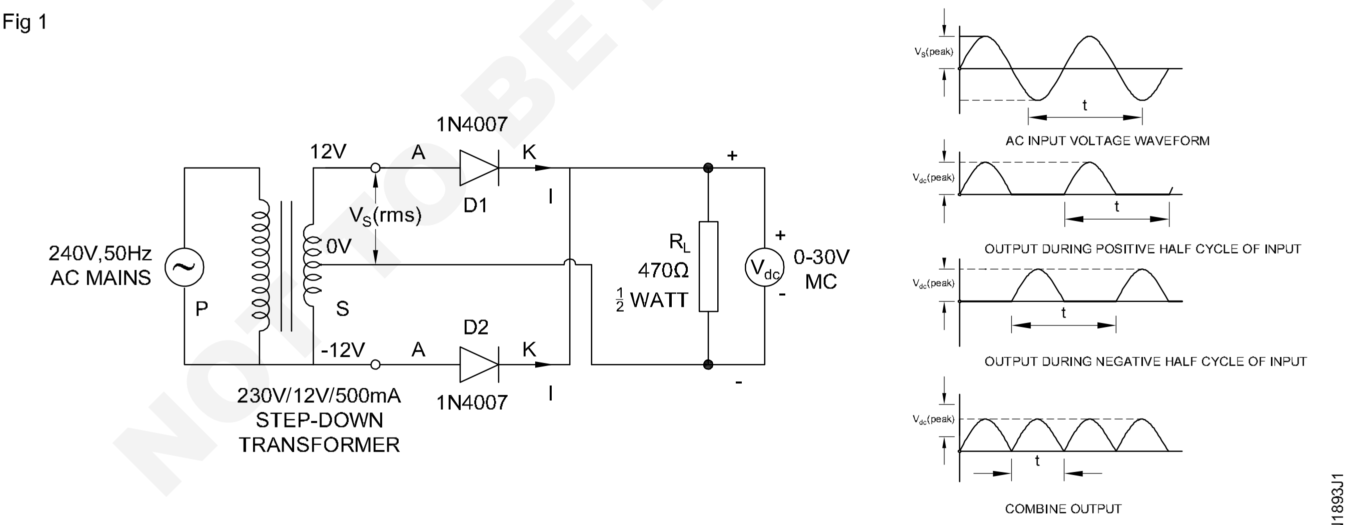
6 Record the difference in the calculated and measured values in Table 2.

7 Connect the two channel input probes of the CRO. Set the Volt/div and Time/div of CH-1 and CH-2 such that the two waveforms are seen clearly.

8 From the displayed waveforms on the screen, measure and record peak value of Source Voltage V_S (Input Volt to Rectifier), frequency of Source, Voltage V_S, peak value of pulsating DC - V_{dc}, frequency of Pulsating DC - V_{dc}.

9 Get the work checked by the Instructor.

Fig 1



CENTRE TAPPED FULL-WAVE RECTIFIER **FULL-WAVE RECTIFIER WAVEFORMS**

Table 2

- Type of Transformer :
- Rated Primary Voltage :
- Rated Secondary Voltage :

Mains supply voltage	Secondary voltage $V_{S(rms)}$	Calculated V_{dc}	Measured V_{dc}	Difference between (3) and (4)	Peak value V_S	Frequency of V_S	Peak Value of pulsa ting V_{dc}	Frequency of pulsating V_{dc}

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TASK 3: **Construction and Testing of four diode full wave bridge rectifier**

1 Construct the Full-wave Bridge rectifier as shown in Fig 3.

2 Connect AC mains to the Transformer and switch ON mains.

3 Measure and record the mains voltage and transformer secondary AC voltage $V_{S(rms)}$ to the rectifier in the Table-3.

4 Calculate the expected DC voltage Vdc across the load resistor RL using the formula,

$V_{dc}=0.9V_{S(rms)}$

Where, $V_{S(rms)}$ is the AC input to the rectifier.

5 Measure and record the rectifier output DC voltage V_{dc} across R_L using multi-meter/Voltmeter.

6 Record the difference in the calculated and measured values.

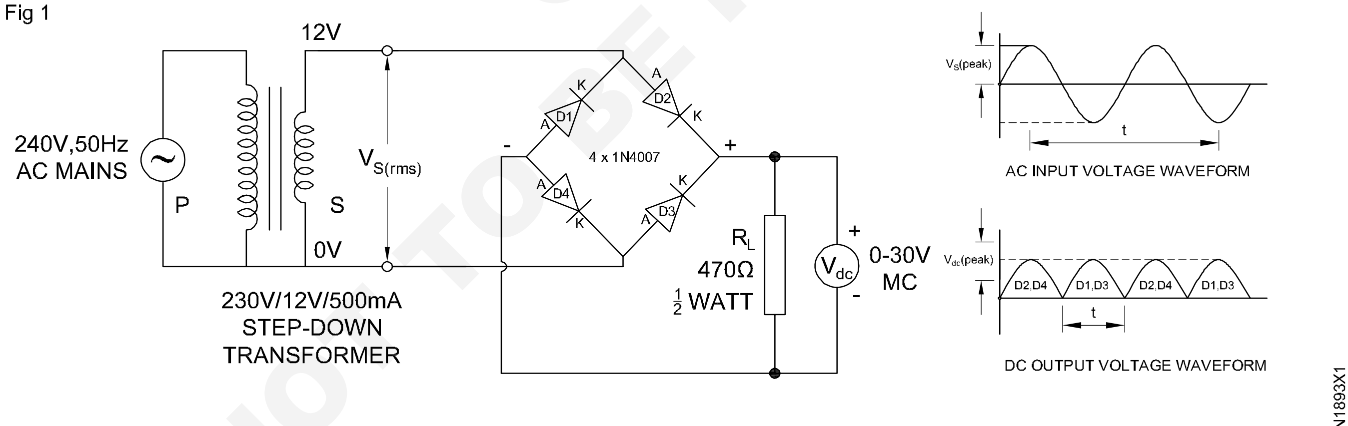
7 Connect the two channel input probes of the CRO. Set the Volt/div and Time/div of CH-1 and CH-2 such that the two waveforms are seen clearly.

8 From the displayed waveforms on the screen, measure and record the following parameters;

- Peak value of Source Voltage V_S (Input Volt to Rectifier).
- Frequency of Source Voltage V_S.
- Peak value of pulsating DC - V_{dc}.
- Frequency of Pulsating DC - V_{dc}.

9 Get the work checked by the Instructor.

Fig 1



FULL-WAVE BRIDGE RECTIFIER FULL-WAVE BRIDGE RECTIFIER WAVEFORMS

Table 3

- Type of Transformer :
- Rated Primary Voltage :
- Rated Secondary Voltage :

Mains supply voltage	Secondary voltage $V_{S(rms)}$	Calculated V_{dc}	Measured V_{dc}	Difference between (3) and (4)	Peak value V_S	Frequency of V_S	Peak Value of pulsa ting V_{dc}	Frequency of pulsating V_{dc}

Construct and test different filter circuit used in rectifier and measure output voltage with load

Objectives: At the end of this exercise you shall be able to
- **construct and test different filter circuit in rectifier.**

Requirements

Tools/Instruments

- Trainee's kit - 1 No
- CRO, dual trace, 20 MHz - 1 No

Materials

- Lugboard with wired bridge rectifier at Ex 1.1.93 - 1 No
- Hook up wire (red, black) - as reqd.
- Resistors, 470Ω, 5Ω and 220Ω, 5Ω - 1 each.
- Electrolytic capacitor (see note) - as reqd.

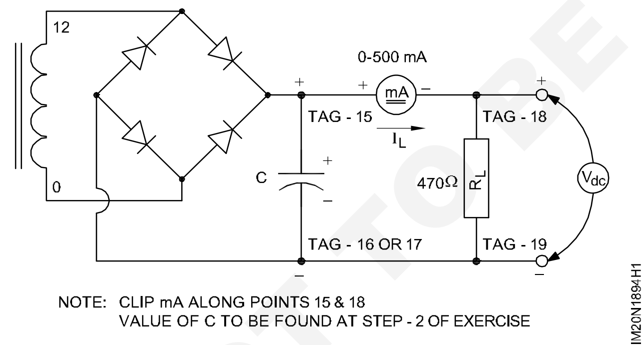
PROCEDURE

1 To the constructed bridge rectifier in Ex.1.8.93 assuming a load current, I_L of 80mA, calculate and record the value of filter capacitor to be connected. Assme 10% of rule ripple.

2 Choose a standard value capacitor value close to the calculated value of C in step 1. Get it checked and approved by your instructor. Record the chosen standard value capacitor.

3 Collect the capacitor and solder it on the tag board as shown in Fig 1. Connect a DC 0-500mA as shown in Fig 1.

Fig 1



4 From the values of RL and C used calculate and record the theoretical value of ripple factor r, using the formula,

$$r = \frac{1}{4\sqrt{3} f R_L C} \text{ (For full-wave rectifier) or } r = \frac{2887}{R_L C}$$

where, f is the supply frequency in Hz, 50Hz

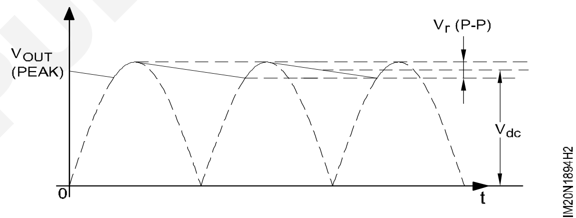
C is capacitance in Farads

R_L is resistance in ohms

To find% ripple factor (%r), multiply calculated r by 100.

5 Power ON circuit. Measure and record values of V_{dc} and I_L in O&T sheet. From the measured value of I_L, recalculate and record the peak-to-peak ripple $V_{r(p-p)}$ using the formula, $V_{r(p-p)} \le \frac{I}{fC}$

Fig 2



6 Using CRO, referring Fig 2, measure and record the following parameters in Table 1;

- Peak value of pulsating Dc, $V_{out(peak)}$

- Peak-to-peak value of ripple $V_{r(peak-peak)}$

7 Compare and record the difference in Vdc measured using meter (at step-5) with the calculated value of Vdc using Vout(peak) and Vr(p-p) (at step 7).

8 Get the readings checked by your instructor.

9 Change the value of load resistor RL from 470Ω to 220Ω, 5Ω and repeat steps 1 to 9.

10 Construct and test the same circuit for different filter with the help of Instructor.

Note: When 220Ω is connected as load, the load current will be approximately, 34V/220Ω = 154mA. Hence, at step 1, take 160mA as load current to calculate the value of C.

Construct and test zener based voltage regulator circuit

Objectives: At the end of this exercise you shall be able to
- **construct and test the Zener based voltage regulator circuit.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Regulated DC power Supply 0-30V/2A - 1 No
- Multimeter with probes - 1 No
- Ammeter, 0-300mA MC - 1 No
- Voltmeter, 0-30V, MC - 2 Nos
- Voltmeter, 0-10V, MC - 1 No

Materials

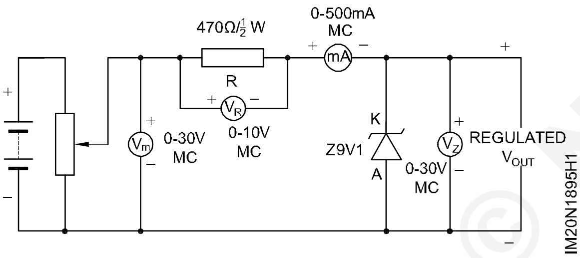
- Lug Board/PCB - 1 No
- Zener Diode, 5.6V - 1 No
- Resistor, 470Ω/1/2Ω - 1 No
- Hook up wire - 3 m
- Patch cords - 10 Nos

PROCEDURE

1 Collect the equipments and components and check the items for its good working condition.

2 Connect them as in the circuit diagram-1.

Fig 1



3 Switch ON the input supply.

4 Measure and record the values of V_R, V_Z and I_Z in the Table-1.

5 After observing readings, switch "OFF" PSU and from the recorded readings, calculate the Zener resistance R_Z and power dissipated P_Z for each set of readings.

6 Get the work checked by the Instructor.

Table 1

Sl. No.	Unregulated Input voltage,	Voltage Drop across series V_{in}	Zener voltage Resistor V_R	Zener current, V_Z	Calculated: Zener Resistance, I_Z	Calculated: Zener Power, R_Z P_Z

Formula

- Zener Resistance = $K = \frac{V_s}{V_p}$
- Zener Power = $P_Z = V_Z.I_Z$

— — — — — — —

Construct and test zener and transistor based series regulator

Objectives: At the end of this exercise you shall be able to
- **construct and test zener and transistor series regulator.**

Requirements

Tools/equipments/instruments

- Trainees tool kit - 1 set
- Regulated power supply (0-20) v/ 2A - 1 No
- Multimeter with probes - 1 No
- Volt meter (0-30) VMC - 1 No

Materials

- Lug board / PCB 180Ω - 2 Nos
- Zener diode 5.6 v 330Ω - 2 Nos
- Resistor 220Ω - 3 Nos
- Hookup wire 100Ω - 3m
- Patch cords - 10 nos

PROCEDURE

TASK 1: **Construct and test a zener based regulator circuit**

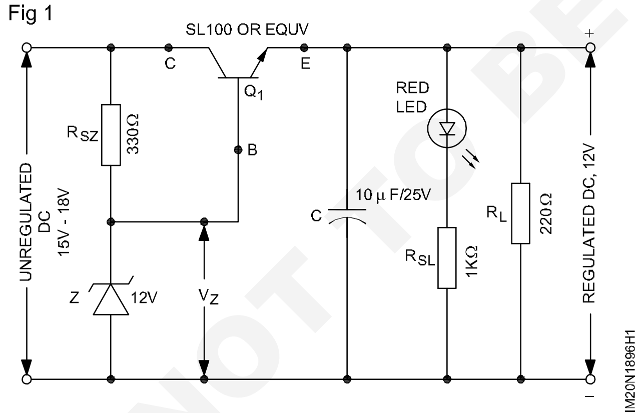
1 Refer data book and record the required details of the given transistor(SL 100 or equivalent) in record sheet.

2 Test to conform good working condition of the given transistor and other circuit components.

3 Solder the components on the given Tag board as per the schematic diagram and layout shown in Fig 1 and 2 respectively. Get the wired circuit checked by your instructor.

Note that the tag board is already wired with bridge rectifier with filter in earlier exercises.

Fig 1



4 Connect an unregulated dc voltage of 17V to the input terminals of the wired series regulator board.

5 Get the interconnections made checked by your instructor.

6 Switch-on the ac mains supply to the unregulated dc supply.

7 Measure and record the input voltage and output voltage of the series regulator.

8 Measure and record the following voltage levels in record Sheet.

a) Voltage across zener, V_Z

b) V_{CE} of the transistor Q_1

c) V_{BE} of the transistor Q_1.

9 Using a CRO, measure and record the peak - peak ripple voltage at the input and output of the regulator.

10 Switch off mains supply. Replace the 220 Ω load resistor R_L by a 180 Ω resistor.

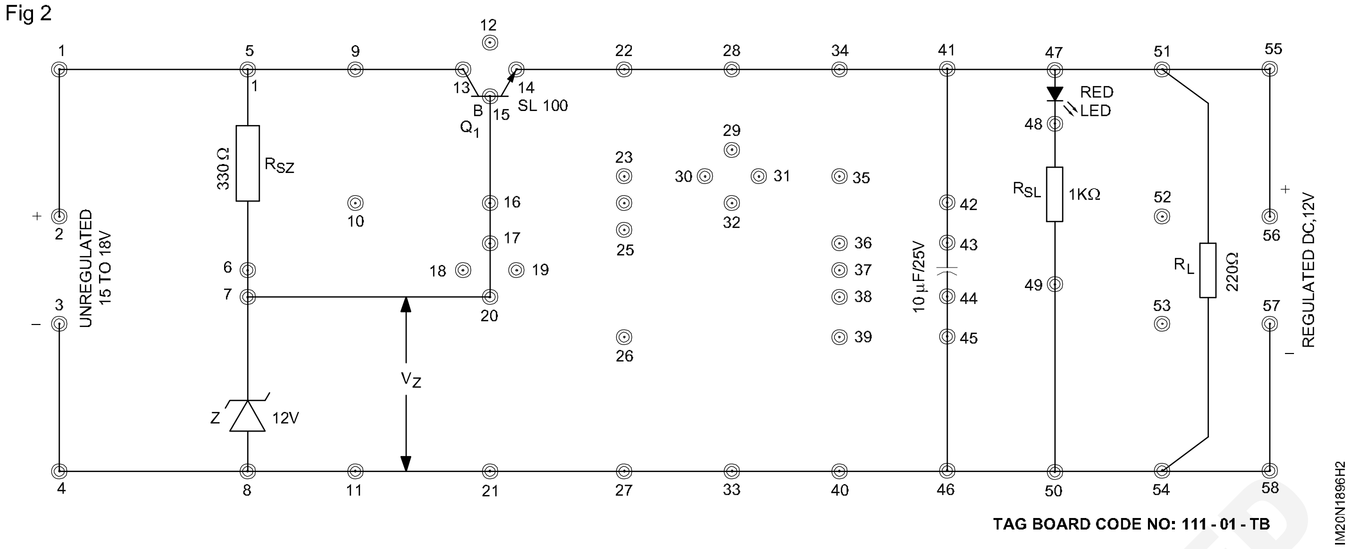
With R_L = 180 Ω, the load current will increase from the earlier 55mA to 66mA. This results in a total load of 10.3mA through LED, plus, 66mA through R_L (10.3mA + 66mA = 76.3mA). By doing this, you are still in safe loading the regulator because the regulator was designed for a load of <100mA.

Do not use R_L of value lower than 180Ω, this will load the regulator beyond is designed load current which will damage the pass transistor.

11 With increased load current, repeat steps 7, 8 and 9.

12 Get your work and recorded readings checked by your instructor.

Fig 2



TASK 2: **Construct and test series regular with voltage feedback**

1 Collect the components required to carry out task 1. Test to confirm good working condition of the components. Identify and put sleeves to the transistor leads.

2 Test the ouput of the unregulated power supply to confirm its good working condition.

> **The expected unregulated power supply output voltage is 17 to 18V.**

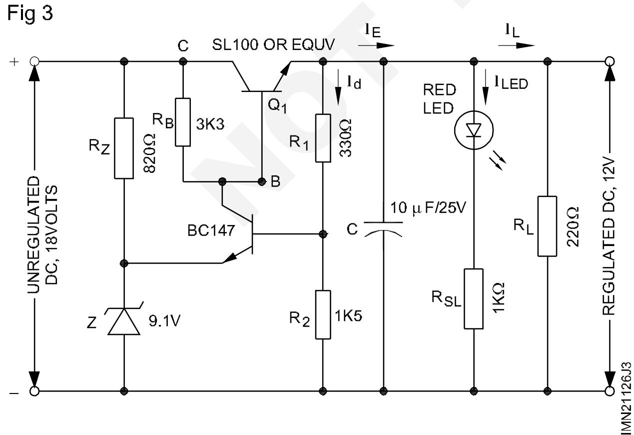
3 Referring to the schematic and layout diagram of the series regulator with voltage-feedback shown in Fig 3 and Fig 4 respectively, modify the wired simple series regulator circuit wired in task 1.

4 Get the modified circuit checked by your instructor.

5 Connect the output of unregulated dc power supply to the input of the wired regulator circuit board.

6 Measure and record the unregulated DC input voltage, and the regulated dc output voltage.

Fig 3



i) V_Z

ii) V_F

iii) V_{CQ1}

iv) V_{CEQ2}

9 Switch-off mains supply. Connect a 180W resistor in place of the existing 220W load resistor R_L.

> **This reduced R_L increases the load current to 67mA. Hence the total current through the pass transistor will be a 6.5mA of I_d + 10.3mA of I_{LED} + 67mA of I_L.**
>
> **Do not use a resistor of less than 180W as R_L.**

10 With increased load (R_L = 180W), repeat steps 6, 7 and 8.

11 From the recorded readings in record sheet, calculate and record,

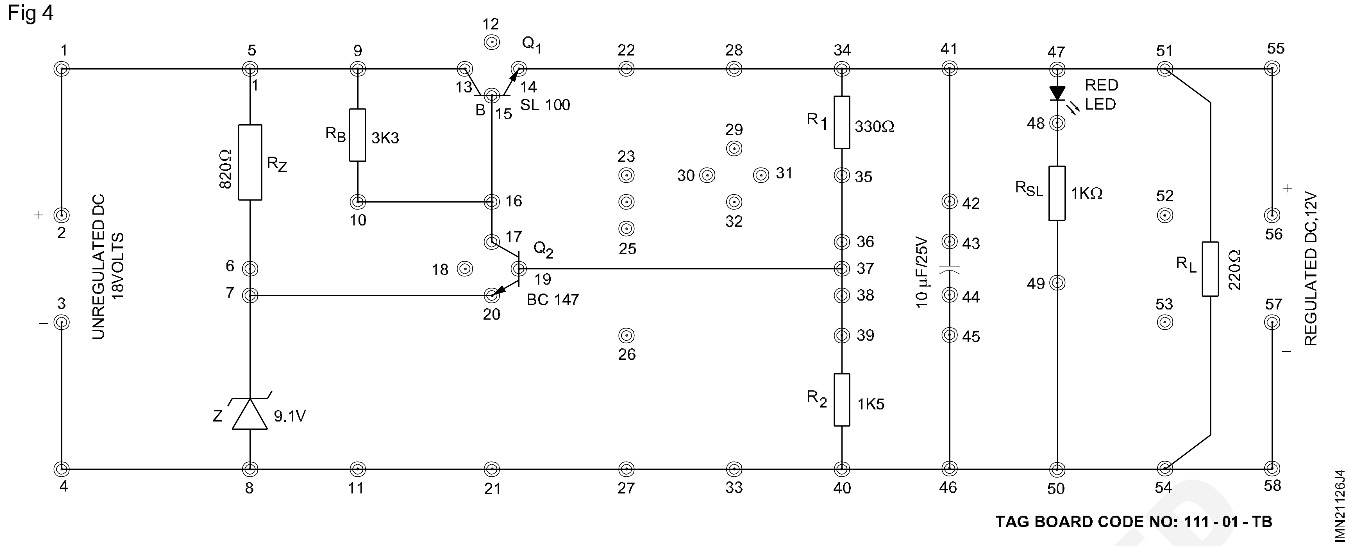
i) Percentage load regulation

ii) Ripple rejection ratio

> **To get $V_{out(No\ load)}$, temporarily open R_L and measure. Measure $V_{out(full\ load)}$ with R_L as 180W.**

12 Get your work checked by your instructor.

Fig 4



UNREGULATED DC 18VOLTS
REGULATED DC,12V
Q1
SL 100
Q2
BC 147
RB
3K3
RZ
820Ω
Z
9.1V
R1
330Ω
R2
1K5
10 µF/25V
RED LED
RSL
1KΩ
RL
220Ω
TAG BOARD CODE NO: 111 - 01 - TB
IMN21126J4

— — — — — —

Construct and test +12V fixed voltage regulator

Objectives: At the end of this exercise you shall be able to
- **construct and test a +12V regulator using IC 7812.**

Requirements

Tools/Equipments/Instruments

- DC Regulated power supply 0-30 V/2A - 1 No
- Trainees tool kit - 1 Set
- DC ammeter, 0-1A - 1 No
- Digital multimeter with probes - 1 No
- Rheostat 500Ω - 1 No

Materials

- Breadboard - 1 No
- Three-pin voltage regulator IC 7812 or equivalent - 1 No
- Suitable heat sink for IC 7812 - 1 No
- Capacitor 270 nF, disc/25V - 1 No
- 10 mF/25 V, electrolytic - 1 No
- Red LED/5mm - 1 No
- Resistor 820Ω, ¼W CR25 - 1 No
- Hook up wires (red and black colour) - 1 cm each
- Wire sleeves (R,Y,G) - 2 cm each
- Rosin cored solder - 10 gm

PROCEDURE

1 From the type code marked on the given 3 pin regulator IC. Identify the terminals of IC 7812.

2 Insert sleeves to the termi-nals using colour coding scheme given below;

Input - Yellow/Orange sleeve.

Common - Green/Black sleeve.

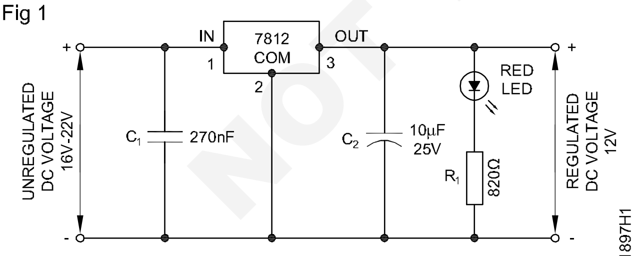
Output - Red sleeve.

3 Get the work done in steps 1 and 2 checked by the instructor.

4 Fix the suitable aluminium heat sink for IC 7812 on the bread board Refer Fig 2 for the position of heat sink on the breadboard.

5 Construct the voltage regulator circuit referring to the schematic and layout diagram shown in Fig 1 & Fig 2.

Fig 1

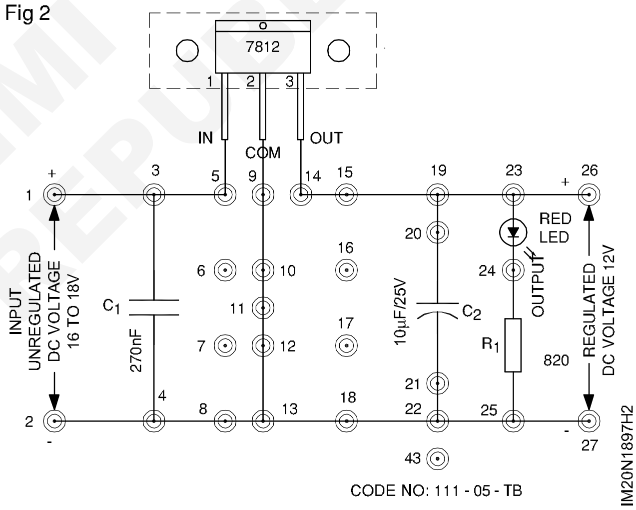


+12V FIXED OUTPUT VOLTAGE REGULATOR CIRCUIT
SPEC:OUTPUT DC:12V,RATED MAX LOAD 800mA

6 Get the neatness and correctness of your wiring checked by your instructor.

7 Apply 16 to 20 volts unregulated dc voltage to the input of the wired 12V regulator. Record the unregulated input voltage and no-load output voltage of the regulator in O & T sheet.

Fig 2



The unregulated dc voltage to the regulator should not be more than 24 volts; otherwise the IC may get damaged.

8 Using loading rheostat, load the regulator in steps of 200 mA upto 800mA and at each step measure and record,

- Regulated dc output voltage
- Input and output ripple.

Loading is limited to 80% of its rated maximum of 1A. This is because the heat sink used with IC 7812 may not be very effective in transferring away the heat.

9 From the recorded readings, calculate the

– output voltage regulation at each step of loading.

– ripple rejection at each step of loading.

10 Get the work checked by the Instructor.

O & T Sheet

1 Neatness and correctness of wiring: Very good Good Satisfactory Poor Continue Exercise

2 Level of unregulated input voltage to the regulator : ____________

		Load - Current			
	No-load	**200 mA**	**400 mA**	**600 mA**	**800 mA**
Output voltage					
Input ripple (P-P)					
Output ripple					
Ripple rejection					
Output regulation					

— — — — — —

Construct and test fixed +15V and -15V Voltage regulator using ICs

Objectives: At the end of this exercise you shall be able to
- **construct and test a fixed +15 volts regulator using a 7815 three-pin IC**
- **construct and test a fixed -15 volts regulator using 7915 three pin IC**

Requirements

Tools/Equipments/Instruments

- Trainees kit
- Rheostat 100Ω, 50Ω - 1 No./each.
- CRO, 20MHz - 1 No./each.
- DC ammeter, 0-1A - 1 No./each.
- 12V power supply - 1 No.

Materials

Component list for Tag board power supply
- Tag board Code No. - 1 No.
- Three-pin voltage regulator IC7812 or equivalent, IC7915 - 1 No.
- Heat sink for 7812, 7915 (use suitable heat sink) - 1 No.
- Zener diode 6.1 V, 1/4 W - 1 No.
- Capacitor 270nf, disc, μf - 1 each.
- 10μf/25 V, electrolytic - 1 No.
- Preset/Potentiometer, 470Ω - 1 No.
- Red LED - 1 No.
- Resistor 820Ω, 1/4 Ω and 1KΩ, 1/4Ω - 1 each.
- Hook up wires (red and black colour) - 1 Mtr.
- Rosin cored solder -10 cms
- Wire sleeve (R,Y,G) each - 2 cm

PROCEDURE

TASK 1: **Construct and test a fixed + 15V regulator using IC7815**

1 From the type code marked on the given 3 pin regulator IC, identify and record the IC's specifications in record sheet.

2 Identify the terminals of 7815 and put sleeves to the termi-nals using colour coding scheme given below;

Input - Yellow/Orange sleeve.

Common - Green/Black sleeve.

Output - Red sleeve.

3 Get the work done in steps 1 and 2 checked by your instructor.

4 Fix the heat sink on IC 7815 as demonstrated by your instructor. Refer Fig 2 for the position of heat sink on the tag board.

5 Construct the voltage regulator circuit referring to the schematic and layout diagram shown in Fig 1 and Fig 2.

Fig 1

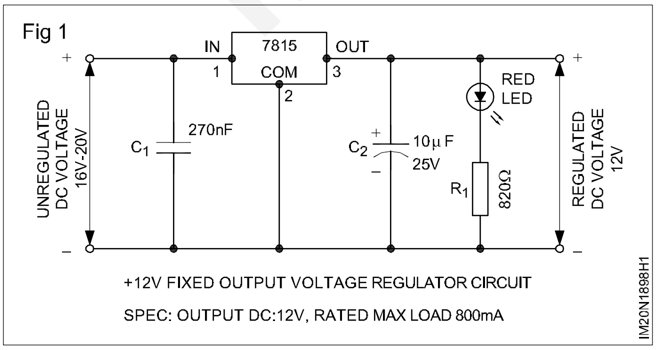
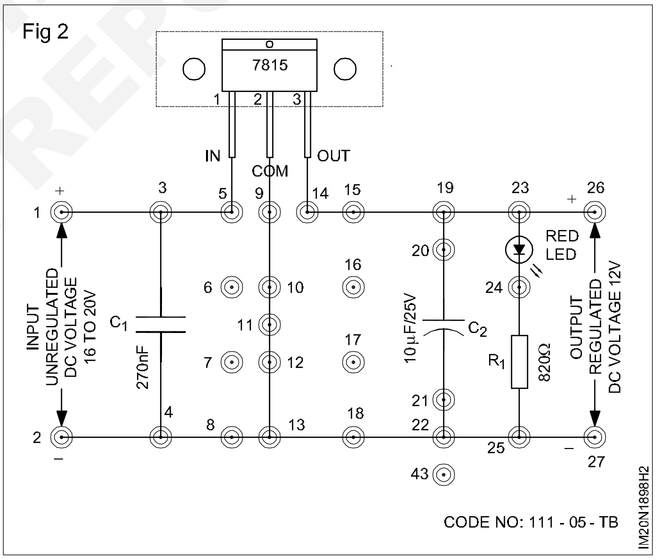


Fig 2



6 Get the neatness and correctness of your wiring checked by your instructor.

7 Apply 16 to 20 volts unregulated dc voltage to the input of the wired 15V regulator. Record the unregulated input voltage and no-load output voltage of the regulator in record sheet.

> **The unregulated dc voltage to the regulator should not be more than 24 volts; otherwise the IC may get damaged.**

The unregulated dc voltage to the regulator should be atleast 20 volts, otherwise the regulator may not work satisfactorily.

8 Using loading rheostat, load the regulator in steps of 200 mA upto 800mA and at each step measure and record,

– Regulated dc output voltage

– Input and output ripple.

Loading is limited to 80% of its rated maximum of 1A. This is because the heat sink used with 7812 may not be very effective in taking away the heat.

9 From the recorded readings, calculate the

– output voltage regulation at each step of loading.

– ripple rejection at each step of loading.

10 Get your work checked by your instructor.

1 IC specifications from marke code

Type code	Manufacturer	Type of regulator positive/Negative	Output voltage	Rated max. load current	Package type

1 Neatness and correctness of wiring:

Very good	Good	Satisfactory	Poor	Continue Exercise

2 Level of unregulated input voltage to the regulator : ____________

		Load - Current			
	No-load	**200 mA**	**400 mA**	**600 mA**	**800 mA**
Output voltage					
Input ripple (P-P)					
Output ripple					
Ripple rejection					
Output regulation					

— — — — — — —

TASK 2: **Construct and test a fixed -15 volts regulator using a 7915 IC**

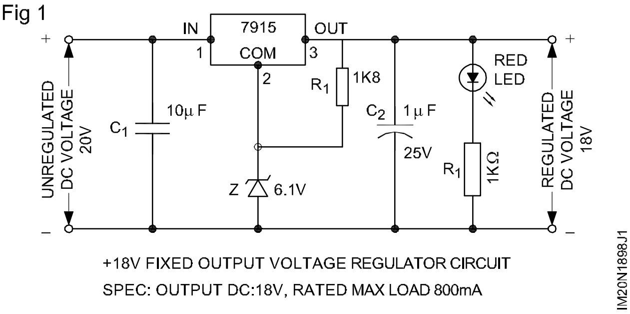
1 Identify the terminals of 7915 and put sleeves to the terminal using colour coding scheme given below.
Input – yellow/ orange sleeve
Common – green / black sleeve
Output – Red sleeve

2 Construct the voltage regulator circuit referring to the schematic lay out diagram shown in Fig 3.

3 Get the neatness and correctness of your wiring checked by your instructor.

4 Apply 16 to 18V unregulated dc voltage to the input of the wired -15v regulator. Record the unregulated input voltage and no load output voltage of the regulator in record sheet.

Fig 1



+18V FIXED OUTPUT VOLTAGE REGULATOR CIRCUIT
SPEC: OUTPUT DC:18V, RATED MAX LOAD 800mA

1 IC specifications from marke code

Type code	Manufacturer	Type of regulator positive/Negative	Output voltage	Rated max. load current	Package type

1 Neatness and correctness of wiring: Very good ☐ Good ☐ Satisfactory ☐ Poor ☐ Continue Exercise ☐

2 Level of unregulated input voltage to the regulator : ____________

		Load - Current			
	No-load	200 mA	400 mA	600 mA	800 mA
Output voltage					
Input ripple (P-P)					
Output ripple					
Ripple rejection					
Output regulation					

— — — — — — —

Construct and test 1.2V to 30V variable output regulated power supply using IC LM317T and its characteristics

Objectives: At the end of this exercise you shall be able to
- **construct and test 1.2 V to 30 V variable output regulated power supply.**
- **plot its characteristics.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Soldering Iron 25W/230V - 1 No
- Digital multimeter with probes - 1 No
- Rheostat 100Ω/1A - 1 No

Materials

- Breadboard/PCB - 1 No
- Step down transformer, 240V/24V or 12-0-12/24V - 1 No
- Diodes, 1N4002 or BY127 or Eqv - 6 Nos
- Capacitors 2200 μF/50V electrolytic - 1 No
  25 μF/50V, electrolytic - 1 No
  10 μF/50V, electrolytic - 1 No
  100 nF, ceramic disc - 1 No
- LED, Red, 5mm - 1 No
- Resistors
  4K7, potentiometer, carbon, rotary - 1 No
  2K2, carbon, ½Ω - 1 No
  220Ω, carbon, ¼Ω - 1 No
- 3-terminal voltage regulator, LM317T, TO-220 - 1 No each
- 1A, slow blow fuse with fuse holder - 1 No.
- Hook up wires - as reqd
- Rosin cored solder - 20 gm
- Heat sink for TO-220 package - 1 No

PROCEDURE

1 Test all the components to confirm their good working condition. Record the specifications of IC LM317T in O&T sheet, refer with semi conductor data manual.

2 Check the given bread board.

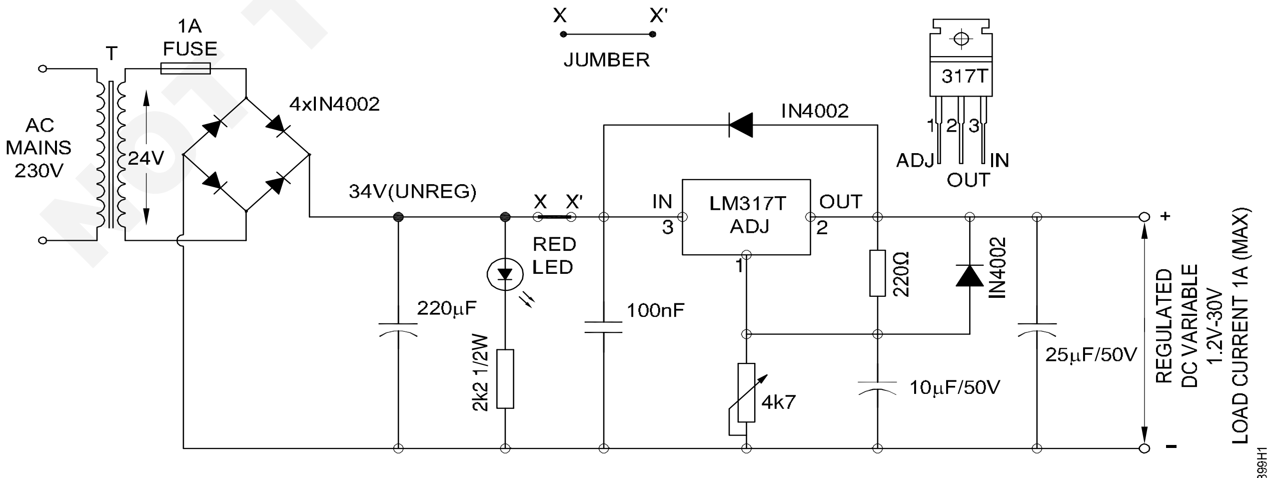
3 Construct a variable regulated output power supply on the given bread board referring to the schematic shown in Fig 1.

All components except the transformer to be mounted on bread board. Use suitable heatsink with IC 317 T.

5 Get the correctness and neatness of wiring checked by the instructor.

6 Diagram connect the secondary of (230/24V) transformer to the assembled circuit. Switch ON mains supply.

Fig 1



NOTE: INSERT ALL COMPONENTS EXCEPT THE FUSE & TRANSFORMER ON THE BEARD BOARD

Switch OFF main supply immediately if burning, smoking overheating, sparks are observed in any of the components, and report to the instructor. Check the IC and ensure that it is not heated-up

7 Measure and record the unregulated dc input and the minimum, maximum variable voltage of the regulator under no-load condi-tion.

8 Set the output to +15 volts and load the output using a loading rheostat in steps of 200 mA up to 600 mA. In each step measure and record the output voltage and the ripple voltages.

Load current is restricted to 600mA as heat-sink is provid-ed to the IC may not be the ideal one.

9 Calculate and record the output regulation and ripple rejection of the regulator.

10 Using a dc current meter (0-1A range) short the load termi-nals momentarily and record the short circuit fold back protec-tion current level.

11 Get the readings checked by the instructor.

Lab Assignment: Mount the regulator IC on a good aluminium heat-sink (available in market). If a good heat-sink is used with the IC, you can draw upto 1Amps easily. Mount the transformer and the wired PCB in a metallic box of suitable size. Mount the POT on the front panel of the box made. Mount output terminal sockets (Red and black) on the front panel of the box from which DC volt-age can be taken. This will serve you as a 1.2V to 30V, 1A rating variable power supply for servicing circuits in forthcoming exercises as well for the hobby gadgets and general servicing.

12 Plot the VI characteristics using readings.

Table 1

Type No.	Package type	Output voltage		Max. output current
		Min.	Max.	

1 **Specification of the given 3-terminal regulator IC.**

2 **Neatness and correctness of wiring:** **Very good** ☐ **Good** ☐ **Satisfactory** ☐ **Poor** ☐ **Continue Exercise** ☐

3 Unregulated dc input to regulator : ____________________

Minimum adjustable output voltage (No-load) : ____________________

Maximum adjustable output voltage (No-load) : ____________________

4 **Set output voltage : 15 volts**

Load current	200mA	300mA	400mA	500mA	600mA
Output voltage Output ripple (p-p) Input ripple Output regulation					

— — — — — — —

List the defect and symptom in the faulty SMPS

Objectives: At the end of this exercise you shall be able to
- **observe the symptom in the faulty slips.**
- **list the defects in the faulty SMPS.**

Requirements

Tools / Equipments/ Instruments

- Trainees tool kit - 1 Set.
- Multimeter with probes - 1 No.
- Adjustable type table lamp - 1 No.
- Magnifying Lens - 1 No.
- A faulty SMPS kit - 1 No.
- Oscilloscope, 20 MHZ - 1 No.

Materials

- Spare components - as reqd.
- Rosincored solder - as reqd.

Safety precautions

1 **Disconnect the SMPS unit from the mains before remvoing from the PC.**

2 **Do not touch the PCB with bear hand without discharging the DC storage electroytic capacitor.**

3 **Discharge the storage capacitor by using an incandescent-bulb connected with wires across the capacitor**

4 **Do not use screw drivers to short the capacitor terminals for discharging static charge.**

5 **Measure the voltage and make sure it is zero before proceeding for test.**

PROCEDURE

TASK 1: **Observe symptoms of the given faulty SMPS**

1 Observe the symptoms noticed on the defective SMPS in ON condition and determine which section or junction could be faulty.

2 Ref to the list of symptoms and remedy given in Table-1 and prepare a list symptoms noticed in your faulty SMPS units.

— — — — — — —

TASK 2: **List the defect in the faulty SMPS**

1 Record the specifications on the cover of SMPS.

2 Verify whether mains supply voltage is disconnected from the SMPS.

3 Initially perfrom cold check by keeping SMPS in OFF condition (components on PCB of the defective)

Observe the SMPS and list out the physical defects noticed as shown below:

- Charred/smoke smell on PCB
- Any component like resistor, diode, black (or) charred/ damage.
- Capacitor top bulged (or) not.
- PCB board darkened due to short
- Wire broken
- PCB track cut
- Connector broken
- Dry soldering
- Switching transistor blown
- Fuse blown.

4 Perform warm check of SMPS and measure output voltages

- Observe whether the SMPS fan is working or not.
- Observe the voltages at the connectors and various test points and record the observations in Table 1 & Table 2.

Probable faults and remedy

Sl. No.	Faults	Cause	Remedy
1	SMPS dead, fuse blown	Shorted switching transistor or semiconductors, power cord defective, or switch , open fusible resistor, other bad parts. Actual cause of failure may be power surge/brownout/lightning strikes, random failure, or primary side electrolytic capacitor (s) with greatly reduced capacity or entirely open	Test the switching transistor or semiconductor switch. If it fails replace it. If the semiconductor switch is good, check and replace the primary diodes. Replace the fusible resistor.
2	Supply dead, fuse not blown	Bad startup circuit - open startup resistors or open fusible resistors due to shorted semicondutors, bed controller components.	Test the switching transistor or semiconductor switch. If it fails replace it. Replace the fusible resistor
3	Supply mostly dead or takes a long time to come alive	Bad electrolytic capacitors. Visually inspect for capacitors with bulging tops or that have leaked.	If any one bad capacitors are found replace all electrolytic capacitors.
4	More ripple at the line frequency (50/60 Hz) or twice the line frequency (100/120 Hz)	Dried up main filter capacitor(s) on rectified AC input	Check the filter capacitor and replace it
5	No output supply and 300V persists in the filter capacitor after switching OFF the supply	Switching transistor or semiconductor switch short and fusible resistor or starting resistor open.	Test the switching transistor or semiconductor switch. If it fails replace it.
6	SMPS output is low	If SMPS givess low voltage output then the fault is mostly in the error amplifier, and oscillator stage. Ouput loading may also affect the output voltage some time	Measure voltages and compare them with normal voltage given the circuit diagram. Probable parts may be faulty zener diode in the error amp, faulty control circuit parts, transistor, IC, opto-coupler faulty.
7	SMPS output is high	If SMPS output is high first shut down set. Fault in the error amplifier, IC, oscillator section of SMPS.	Check fauult either in switch off condition or by giving input supply through a variac or low voltage transformer. Disonnect TV/computer other sections by diconnecting base or output transistor. Never keep on in this fault it may danage other parts also. Check for - error amp circuit, zener diode, opto-couoler, filters on error amplifier line, transistor, IC, oscillator. Replace the faulty components.

Sl. No.	Faults	Cause	Remedy
8	Combusted coil	A winding coil is present on the board which sometimes gets burnt due to excessive flow of current.	This problem can be identified esaily by the smell or you can identify through the burnt marks located on the external section of the winding coil. It may be possible that internal loop is damaged.

Note: In all cases, bad solder connections are a possibility as well since there are usually large components in these supplies and soldering to their pins may not always be perfect. An excessive load can also result in most of these symptoms or may be the original cause of the failure.

3 Get the work checked by the instructor.

— — — — — —

Measure/ Monitor at major test points of computer SMPS unit

Objectives: At the end of this exercise you shall be able to
- **prepare the computer SMPS unit for voltage measurements**
- **measure/monitor voltages at various test points of the SMPS unit.**

Requirements

Tools/Equipments/Instruments

- Computer SMPS working - 1 No.
- Trainees tool kit - 1 Set.
- Digital multimeter with probes - 1 No.

Materials

- AIDS: Chart showing various voltages of connects in smps unit of PC
- Computer power cord - 1 No.
- Hook-up wire - as reqd.

Safety precatutions

Make sure you conduct this test on a table with yourself standing a rubber that any insulated material to avoid static electricity destroying the computer components

PROCEDURE

TASK 1: **Preparation of computer SMPS unit for voltage measurements**

1 Remove the SMPS from the computer cabinet by follow the procedure.

2 Identify the green colour wire (power good signal test point) from the bunch of wires on the 24 pin molex connector as shown in Fig 1.

3 Use a piece of hookup wire, bend it as 'U' shape, connect it across the green and black wire terminals as shown in Fig 2.

4 Connect the power cord to the SMPS unit and switch ON power.

5 Observe the fan is running to confirm the working of SMPS unit.

6 Remove the hook up wire and re-insert if the fan is not rotating.

7 Get the work checked by the instructor.

Fig 1

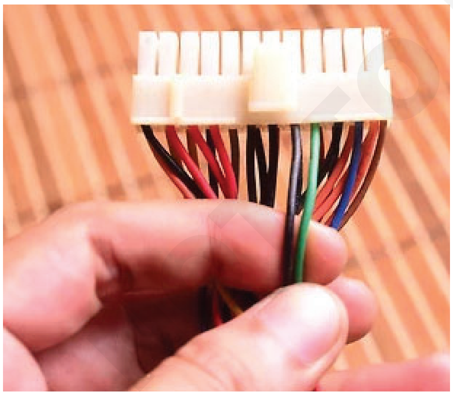
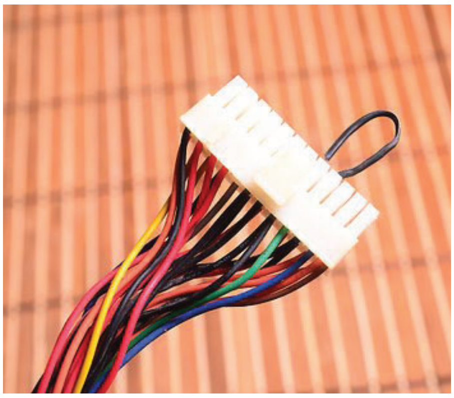


Fig 2



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TASK 2: **Measurement/monitoring voltages at various test points.**

1 Start measurement of AC voltage across the three terminal mains cord and record the readings in Table-1.

Table-1

Sl. No.	Parameter to measure	Voltage (AC)	Remarks
1	Phase to Neutral	-------------------	
2	Phase to Earth	-------------------	
3	Neutral to Earth	-------------------	

2 Switch OFF supply and plug the mains cord into SMPS unit, and select the P-4 power cable connector used for CPU cooler fan.

3 Switch ON SMPS supply and measure the DC voltage across the P-4 cable connector and record the readings in Table-2.

Table -2

Sl. No.	Description	Wire colour	Measured voltage
1	Ground	Black	
2	Ground	Black	
3	+12 VDC	Yellow	
4	+12 VDC	Yellow	

4 Refer to the chart showing voltages at various test points on power cable connector and record the observations in Table-3.

Table-3

Sl. No.	Wire colour	Description	Measured voltage	Remarks
1				
2				
3				
.				
.				
.				
.				
24				

5 Refer to the chart details and measure test point voltage at the 4 pin molex peripheral connector and record observation in Table-4.

Table-4

Sl. No.	Wire colour	Description	Measured voltage	Remarks
1	Yellow			
2	Black			
3	Black			
4	Red			

6 Get the work checked by the instructor.

Note: The instructor has to guide the trainees to measure voltage at additional connectors for SATA, Aux power connector etc. with preparation of suitable tables to record measurements according to the SMPS model available in the section.

Chart showing voltages at various connectors of SMPS units of personal computer system Fig 3

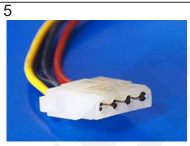
PIN DESCRIPTION OF THE 24-PIN POWER CABLE CONNECTOR

Pin	Name	Colour	Description/voltage level	Measured voltage
1	3.3V	Orange	+3.3 VDC	
2	3.3V	Orange	+3.3 VDC	
3	COM	Black	Ground	
4	5V	Red	+5 VDC	
5	COM	Black	Ground	
6	5V	Red	+5 VDC	
7	COM	Black	Ground	
8	PWR_OK	Grey	Power Ok is a status signal generated by the power supply ON, disconnect from GND to switch OFF.	Fig 3 
9	5VSB	Purple	+5 VDC Standby voltage (max 10mA)	
10	12V	Yellow	+12 VDC	
11	12V	Yellow	+12 VDC	
12	3.3V	Orange	+3.3 VDC	
13	3.3V	Orange	+3.3 VDC	
14	-12V	Blue	-12 VDC	
15	COM	Black	Ground	
16	PS_ON	Green	Power supply on (active low), short this pin to GND to switch power supply ON, disconnect from GND to switch OFF.	
17	COM	Black	Ground	
18	COM	Black	Ground	
19	COM	Black	Ground	
20	-5 V	White	Ground	
21	+5V	Red	+5 VDC	
22	+5V	Red	+5 VDC	
23	+5V	Red	+5 VDC	
24	COM	Black	Ground	

PIN description of the P-4 power cable connector

Pin	Name	Colour	Description/Voltage Level	Measured Voltage	
1	GND	Black	Ground		Fig 4 
2	GND	Black	Ground		
3	12V DC	Yellow	+12 VDC		
4	12V DC	Yellow	+12 VDC		

PIN description of the 4-PIN molex peripheral connector

Pin	Name	Colour	Description/Voltage Level	Measured Voltage	
1	12V DC	Yellow	+12 VDC		Fig 5 
2	GND	Black	Ground		
3	GND	Black	Ground		
4	+5V	Red	+5 VDC		

Ac input voltage measurement (at the mains socket)

Table - 5

Sl. No	Parameters to measure	Voltage (AC)	Remarks
1	Phase to neutral voltage		
2	Phase to earth		
3	Neutral to earth		

Pin Number	Pin Name	Description
1	+5V	
2	GND	
3	+5V	
4	GND	
5	PG	+5V When power good
6	+5V STB	Stand-by power
7	+12V	
8	-12V	
9	GND	
10	GND	
11	PWR_ON	Connect to ground to power on
12	GND	
13	GND	
14	GND	
15	-5V	
16	+5V	
17	+5V	
18	+5V	
19	TFSC	Thermal Fan speed control.
20	+5V	

Fig 6

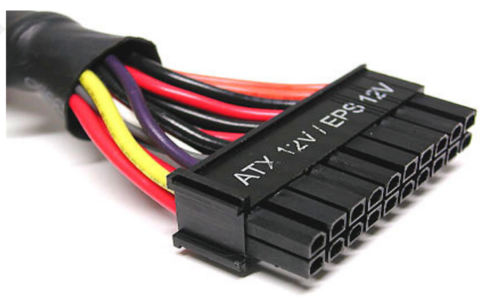


Fig 7

Another type of 20 Pin power connector used in new PCs.

Cable colors may differ between power supplies.

TFSC mainboard puts 0.7-1.4V there to control voltage supplied to power supply's fan

(Fan voltage increases when TFSC increases).

Troubleshoot the fault in the given SMPS unit, rectify the defect and verify the output with load

Objectives: At the end of this exercise you shall be able to
- **discharge the filter capacitor of SMPS unit**
- **identify the physical faulty component and replace it and test the output with load.**
- **identification of short circuited components connection of SMPS to the circuit for performy hoed ten**

Requirements

Tools/Equipments/Instruments

- ESD work bench - 1 No.
- Safety gloves - 1 No.
- Trainees tool kit - 1 set.
- Digital multimeter with probes - 1 set.
- LCR Meter - 1 No.

Materials

- 100 watt/230V bulb with holder - 1 No.
- Wire wound resistor (1.8kW or 2.2kW/10W) - 1 No.

Safety precaution

1 **Keep the place dry and clean**

2 **Make sure you conduct this test test on a table with yourself standing on a rubber mat or any insulated material to avoid static electricity destroying the computer peripherals.**

3 **Please note that some connections of the SMPS connectors contain a clip attached to it. Make sure to remove the clips before removing the connection.**

PROCEDURE

TASK 1: **Discharging the filter capacitor**

1 Discharge using bulb method

Make sure the power cord is removed from the SMPS to avoid Electrical shock.

i Dismantle the SMPS by referring to the procedure given in the previous exercises.

ii Connect 100 watt bulb wire across the leads of the capacitor as shown in Fig 1 & 2. Filter capacitors will be discharged.

Fig 1

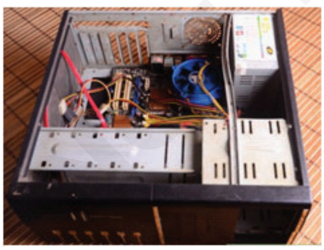


Fig 2

iii Connect 100 watt bulb wire across the leads of the capacitor as shown in Fig 1 & 2. Filter capacitors will be discharged.

2 Discharge using resistor Method

i Take a High wattage Low ohms wire wound resistor with proper insulated lead.

ii Use the resistor lead to short the capacitor to discharge as shown in Fig 3.

iii Use either a 1.8 K or a 2.2 K ohm 5 to 10 watt resistor to discharge the high voltage capacitor.

iv Get the work checked by the instructor.

Fig 3

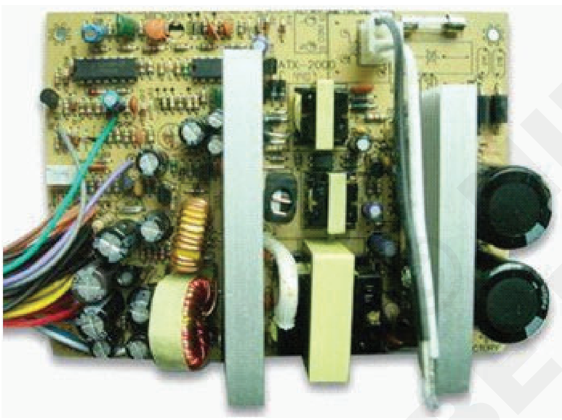
TASK 2 : **Identification of the physical fault (fuse blown) in SMPS and replace it and test the output with load.**

1 Take the dismantled SMPS as shown in Fig 4.

Fig 4

2 The board from the SMPS cabinet is similar to as shown in Fig 5.

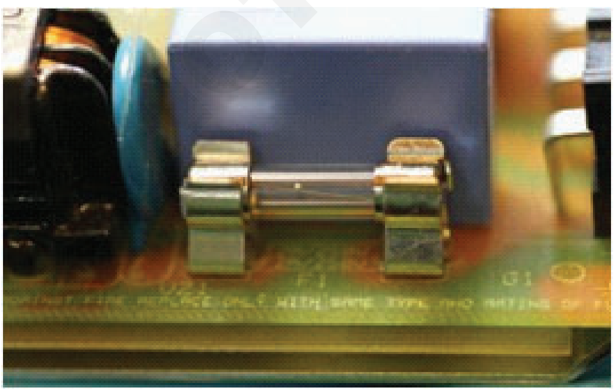
Fig 5



3 Disconnect the SMPS and make sure all electrolytic capacitors are discharged.

4 Remove the fuse from its holder as shown in Fig 6.

Fig 6



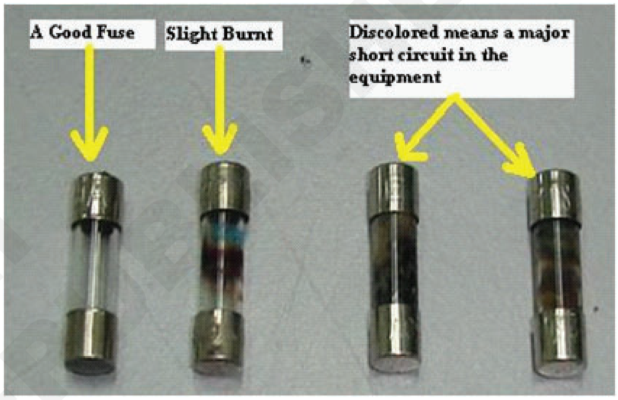
5 Look the fuse wire if there is a visible gap in the wire as shown in Fig 7.

Fig 7

6 Look the fuse carefully any dark or metallic smear inside the glass as shown in Fig 8.

7 If any above faults found in the fuse then the fuse is blown and needs to be replaced.

Fig 8

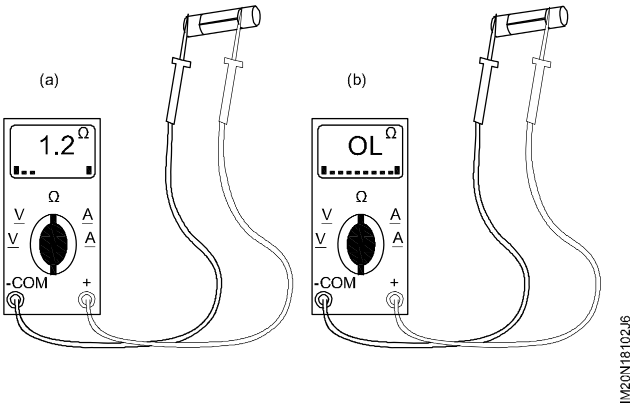


8 If there is no physical fault observed in fuse then use multimeter to check it.

9 Set a multimeter (Fig 9) to the continuity setting.

10 Place one of the multimeter leads on one end of the fuse. Place the other lead on the other end of the fuse as shown in the Fig 9.

Fig 6



11 If the meter shows continuity, as shown in Fig 9(a) then the fuse is good.

12 If the multimeter reading is OL(Over Limit) as shown in Fig 9(b), then the fuse is blown. If the fuse is blown, replace the fuse with one that is exactly having the same current rating.

13 Record the observation in TABLE 1.

14 Get the work checked by the instructor.

Table 1

Measured output voltage

Without capacitor	With capacitor

— — — — — — — —

TASK 3: **Identification of the short circuited components**

Capacitor checking

1 Disconnect the power card.

2 Discharge the main(large) capacitor.

Fig 10

3 Test the healthyness of diodes and capacitors at secondary section using multimeter.

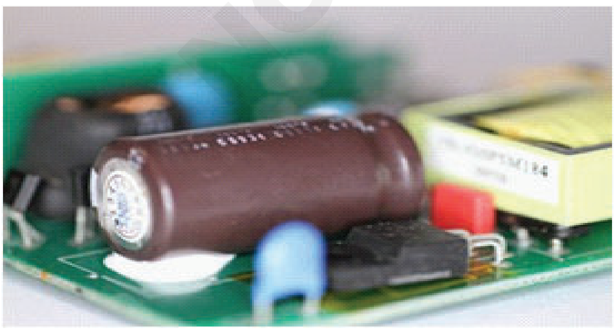
4 Open the lead of capacitor and measure capacitance using LCR meter.

5 Apply the supply to board and check the output voltage with out capacitor.

6 If the output voltage is less (or) no output measured, then fault may be in capacitor.

7 Switch OFF the supply and replace the capacitor.

Fig 12



8 Switch ON the supply and check the output voltage.

9 Record the observation in TABLE 4.

Fig 11

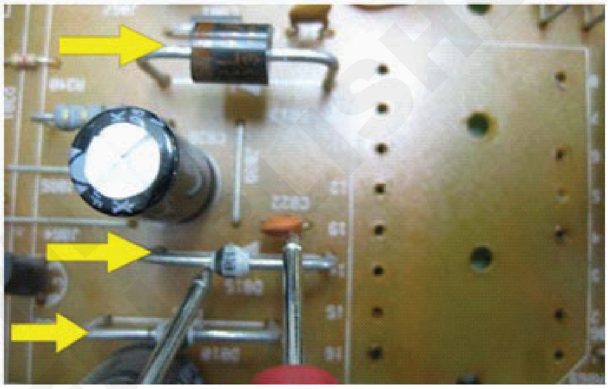


Table 4

Measured output voltage	
Without capacitor	**With capacitor**

Note: To confirm fault with switching transistor check the charge voltage across big filter capacitor in the input section. (after switching OFF the SMPS).

a) If the capacitor shows voltage considerably then the fault could be in the switching transistor.

b) If the capacitor shows No voltage then the fault could be in some other components/ section.

10 Get the work checked by the instructor.

— — — — —

TASK 4 : **Connection of SMPS to the circuit for performing load test**

1 Connect the circuit as shown in Fig 13 across 5V terminals.

2 Keep the rheostat in max resistance position.

3 Power ON the circuit.

4 Increase the current in steps of 200mA, note down the corresponding voltage and tabulate the reading in the TABLE 4.

5 Observe that even when the current is varied by the load, the output of SMPS remains constant at the rated voltage.

6 Get the work checked by the instructor.

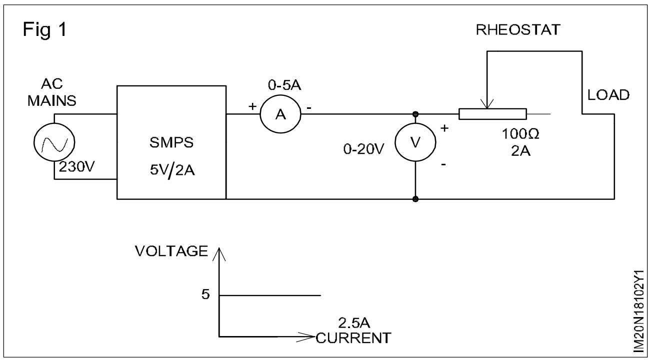


Table 4

Sl.No.	Load current(mA)	Voltage(V)

— — — — — — — —

Identify front panel controls, indicators, various circuit board and transformers of ups

Objectives: At the end of this exercise you shall be able to
- **identify front panel indicators of UPS**
- **identify the major section in UPS and components used in UPS**
- **identify different sockets and connectors on the rear panel of UPS.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Single phase UPS, 6KVA with manual - 1 No.

Materials

- Cotton waste - as reqd.

Safety precaution

Keep the place dry and clean

PROCEDURE

TASK 1 : **Identification of different controls and indicators on front panel of UPS**

1 Note down and record the specifications of the UPS.

2 Draw the sketch of front panel of the UPS with all indicators and switches

3 Identify each indicator and control on the front panel by referring to Fig 1/ Operating manual.

4 Record the observations in Table-1

5 Repeat the above steps for all indicators and controls on the front panel and record them.

6 Referring to the manual, record a brief function of the switches and the indicators.

Fig 1

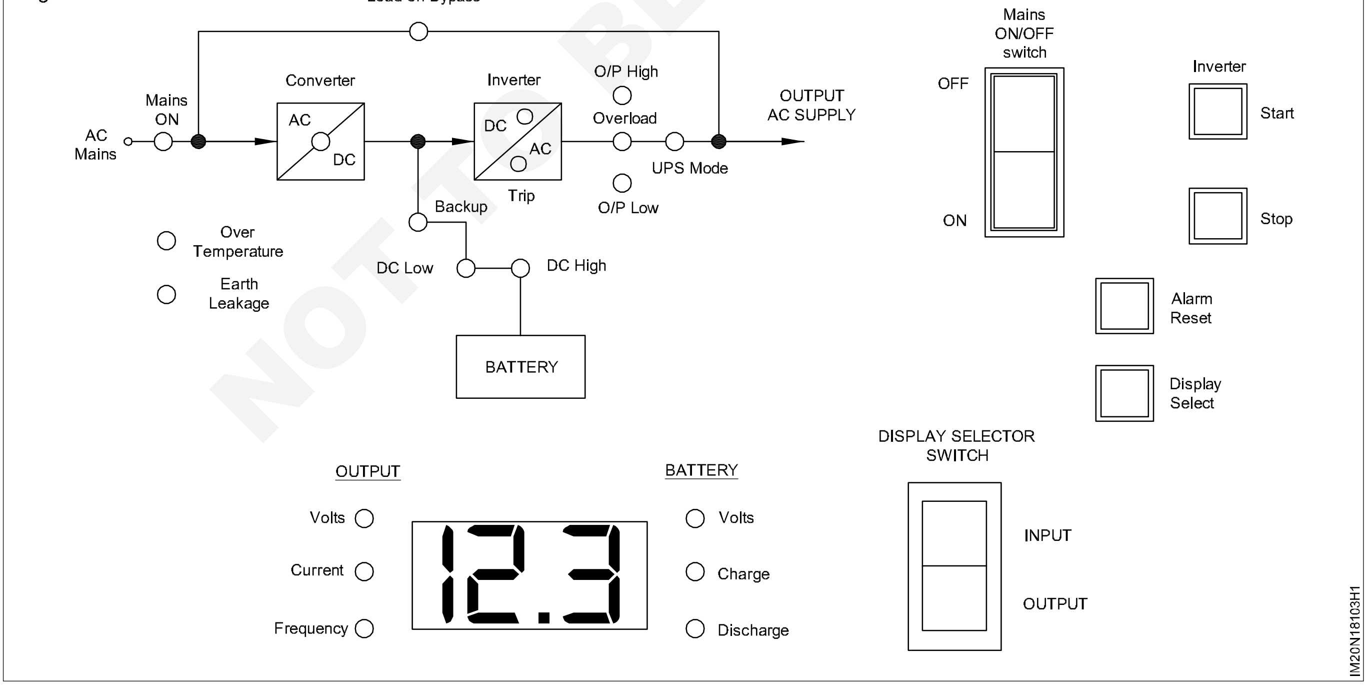


Table 1

Sl.No.	Name of the indicator/control	Purpose
1		
2		
3		
4		
5		

— — — — — — —

TASK 2: **Identification of different sockets and connectors on the rear panel of UPS**

1 Turn the rear panel of the UPS and identify the name of unit, record its socket and connector available in rear panel with the help of operation/Instruction manual.

2 Find out each socket in the UPS, note down in the Table-2.

3 Repeat the above steps for all sockets and connectors and note down in Table-2.

Fig 1

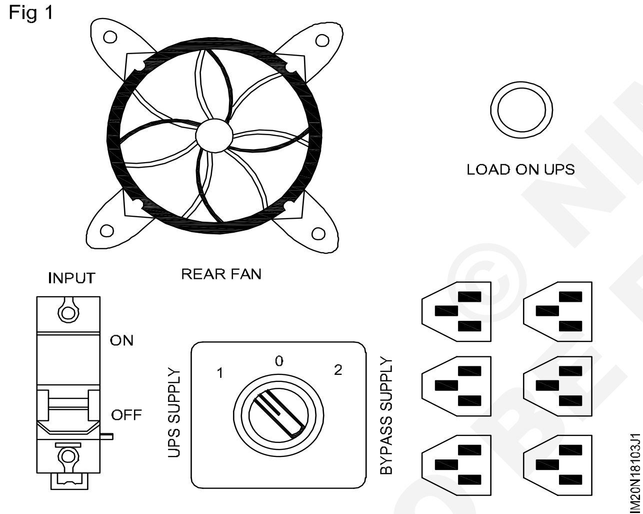


Table - 2

Sl.No.	Name of the Sockets/Connectors	Purpose

— — — — — — — —

TASK 3 : **Identification of major sections in computer UPS**

1 Disconnect the power cable from the mains supply. Remove the screws that are present in the side panel and open the UPS unit as demonstrated by the instructor as shown in Fig 1.

2 Unscrew the battery clamp pull out/ remove the battery terminal connectors and take out the battery.

Before opening CPU case touch cabinet outer cover to discharge ESD power.

3 Note down the wirings and carefully lift the circuit board. Remove from its position.

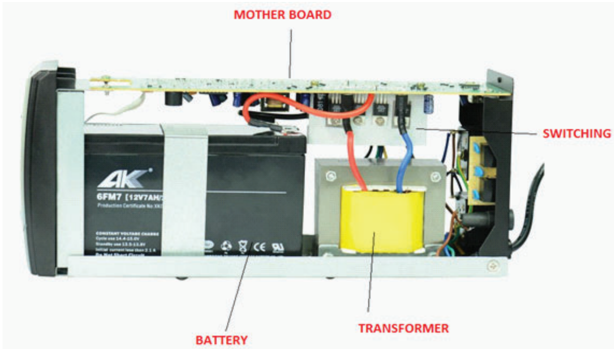
Fig 1

4 Find out the major section in UPS as shown in Fig 2. Note down your observations in TABLE 1.

Table 1

Sl.No.	Major section in UPS
1	
2	
4	
5	
6	

Fig 2



5 Get the work checked by the instructor.

— — — — — — —

TASK 4: **Identification of components used in computer UPS**

1 Remove the circuit board(PCB) from the UPS cabinet.

2 Identify the listed components in the circuit board as shown in Fig 3. Record the label of the identified components in TABLE 2 by referring to related theory

3 Repeat steps for all the other major components.

Fig 3

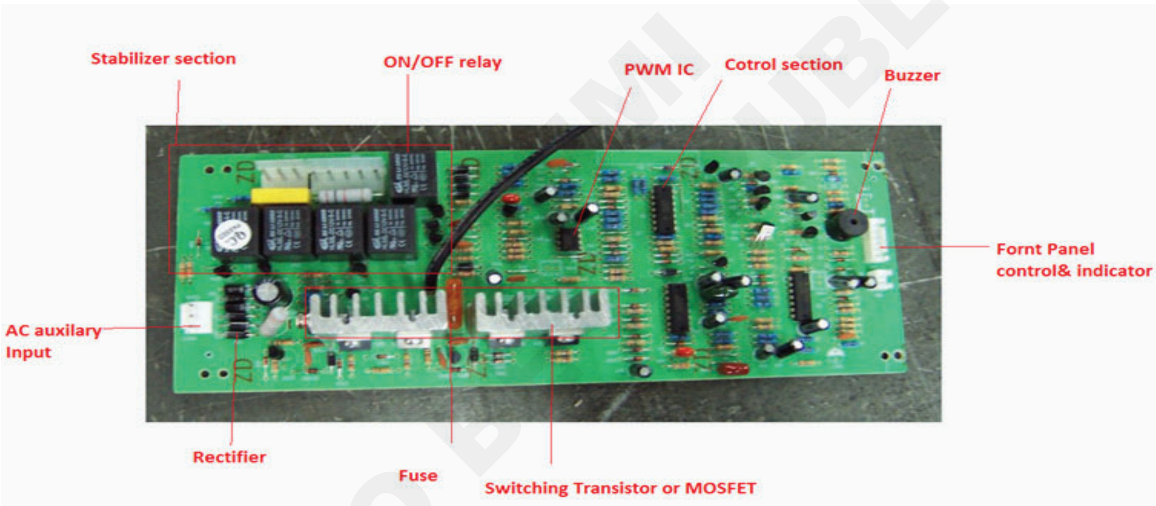


Table 2

Sl.No.	Name of sections	Components/Parts/Devices	Remarks
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

4 Get the work checked by the instructor.

Perform load test to measure backup time

Objectives: At the end of this exercise you shall be able to
- **perform load test of battery using UPS**
- **measure the back-up time of the UPS with battery.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Computer UPS (around 600VA) with operating instruction manual - 1 No.
- DMM with probes - 1 Set.
- Voltmeter 0-30VDC - 1 No.
- Safety gloves - 1 Pair.
- Stop watch - 1 No.

Materials

- 100W/240V incandescent lamp (Test lamp) - 1 No.
- 12V/7AH, maintenance free rechargeable battery - 1 No.

Safety precaution

1 **Before connecting the battery to UPS, in spect the electrode terminals for symbols colour codes on the battery.**

2 **Ensure that the UPS is kept in switched OFF condition**

3 **Connect the leads with correct polarity and tighten them.**

PROCEDURE

1 Use Dc voltmeter measure the terminal voltage and verify with the specification on the battery.

2 Take out the terminals of the battery cable from the UPS.

3 Observe the colour code of the cables and tightly connect the battery with correct polarity.

4 Connect the DC voltmeter across the battery, measure the voltage and record the observation in Table-1 as no load voltage.

5 Connect the lamp load to the UPS output as shown in Fig 1.

6 Reset the stop watch at starting point.

7 Start the stop watch and switch ON the UPS simulataneously, with voltmeter probes kept across the battery terminals.

8 Observe the readings on the meter and terminals record in Table-1.

9 Observe the lamp glow with beep sound carefully and stop the clock immediately when the lamp goes off.

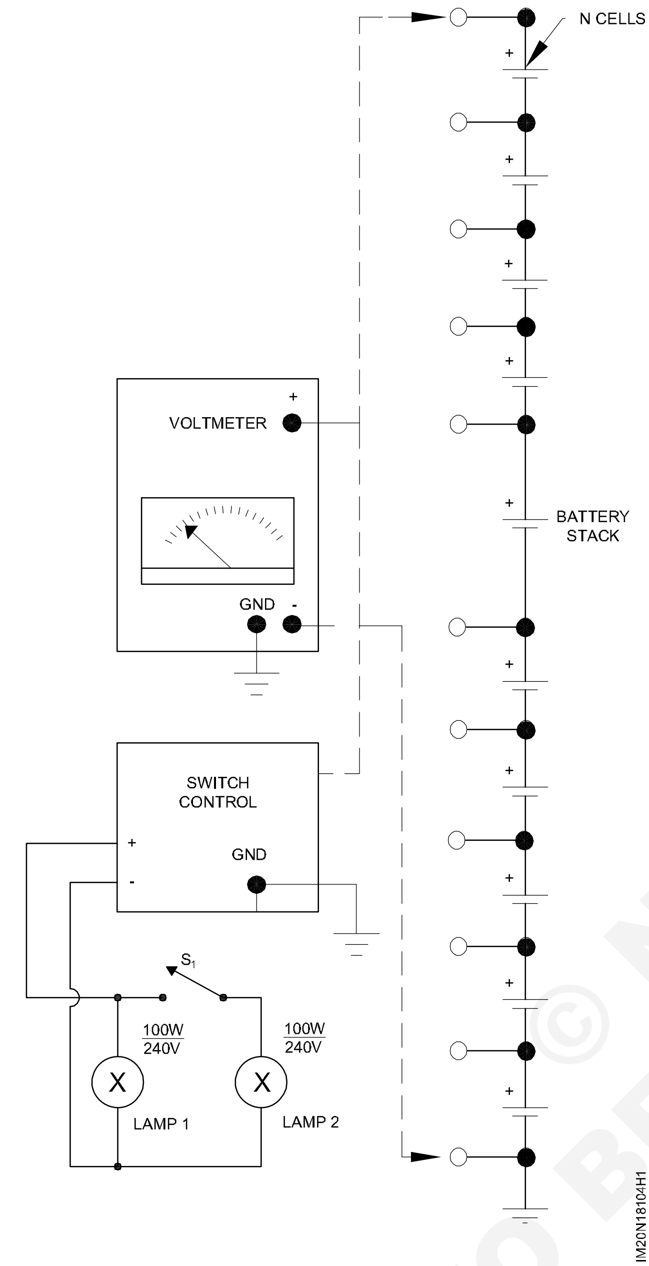
10 Note down the readings on the voltmeter and stop watch in Table-1.

Table 1

Status of UPS	Battery voltage		Full load
	No load	Light load	
UPS OFF			
UPS ON			

11 Get the work checked by the Instructor.

Fig 1


N CELLS
VOLTMETER
+
GND
-
BATTERY
STACK
SWITCH
CONTROL
+
-
GND
S_1
100W
240V
100W
240V
X
X
LAMP 1
LAMP 2
IM20N18104H1

Install and test an inverter

Objectives: At the end of this exercise you shall be able to
- **connect the external battery to inverter unit**
- **test the inverter by connecting to mains power.**

Requirements

Tools / Equipments/ Instruments

• Trainees tool kit	- 1 Set
• Digital Multimeter with probes	- 1 No.
• Line tester	- 1 No.
• Hand gloves	- 1 Set.
• Double ended spanner	- as reqd.
• Inverter	- 1 No.
• Battery, 12V, 150AH	- 1 No.

Materials

• 240V/16A, SPST switch	- 2 Nos.
• 240V/16A, 3Pin scoket	- 2 Nos.
• Connecting wires	- as reqd.
• 100W/240V Test lamp	- 1 No.

Safety precaution

- **Do not make contact with both the battery terminals simultaneously with metal parts like screw driver, spanners and bare hand**
- **Sparking may occur during connection of battery cables to battery terminals.**
- **Use only the battery cables provided with the inverter unit to connect the external battery.**

PROCEDURE

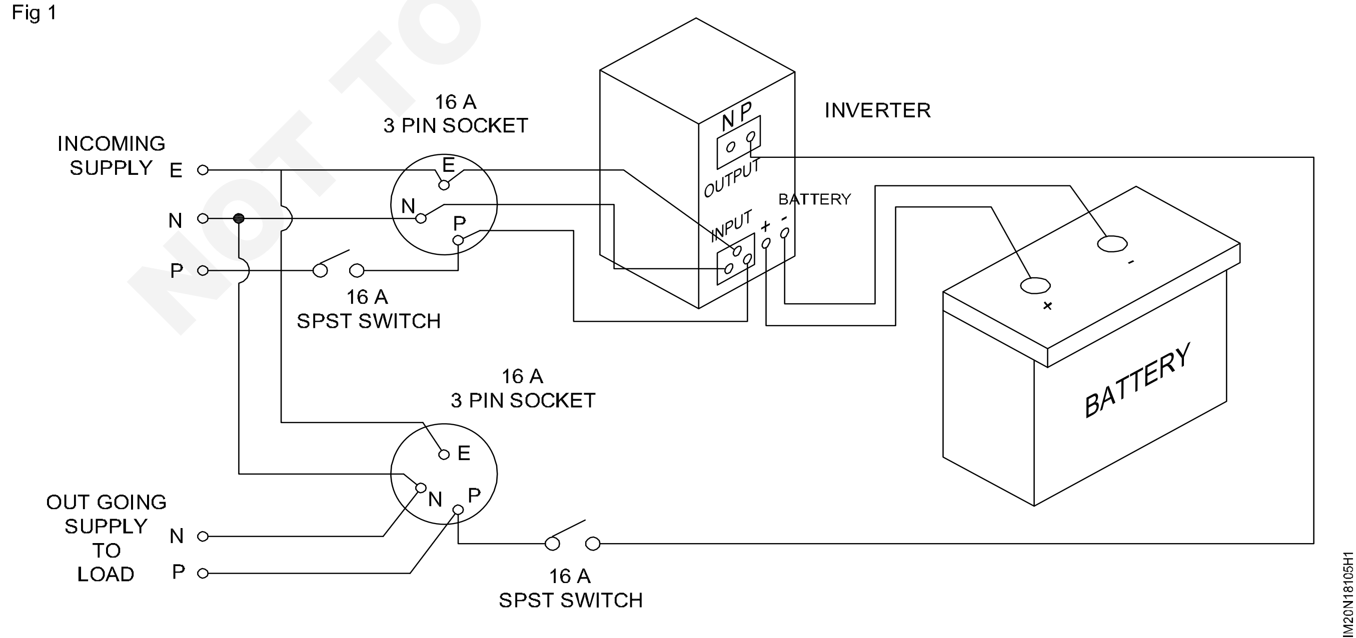
TASK 1: **Connection of the external battery to the inverter unit**

1 Read the user manual of the given inverter unit and check the capacity of battery given for inverter.

2 Identify the colour code used for the battery cables and polarity marked on the terminals of the battery.

3 Select the ref colour cable and terminals of the battery to the +Ve terminals of the UPS using bolt & nuts as shown in Fig 1.

Fig 1



4 Take the black colour cable from the UPS, connect it to the battery using bolt & nut as shown in Fig 1.

5 Use double ended spanners, tighten the bolt & nuts with correct force.

6 Get the connections checked by the Instructor.

— — — — — — —

TASK 2: **Testing the inverter by connecting to mains power and load**

1 Measure the voltage across the battery terminals, record the readings in Table-1.

> **Note: Take care while handling 230V AC mains voltage.**
>
> **Ensure that the inverter start/Run switch is in OFF condition before doing output connection.**

2 Connect the AC mains supply to the inverter unit through 16A, switch & socket by referring Fig.1

3 Connect the power cord of the inverter to the AC mains supply, switch ON and measure the DC voltage across battery terminals; record the readings in Table-1.

4 Connect the test lamp across the output terminals, switch ON the UPS and observe the lamp is glowing.

5 Measure the AC voltage across the output of UPS, the DC voltage across the battery and record the readings in Table.

6 Switch OFF AC mains and measure output voltage battery voltage and record the readings in Table - 1

Table-1

AC input supply			AC output supply			Battery voltage			
P-N	P-E	N-E	P-N	P-E	N-E	UPS OFF AC OFF	UPS OFF AC ON	Load ON AC ON	Load ON AC OFF

7 Get the work checked by the Instructor and Switch OFF the UPS.

— — — — — — —

Troubleshoot the fault in inverter unit, rectify defects and verify the output with load

Objectives: At the end of this exercise you shall be able to
- **identify the faulty components/section in the inverter**
- **rectify the defects in the inverter unit**
- **verify the output with load.**

Requirements

Tools / Equipments/ Instruments

- Trainees tool kit - 1 Set
- Digital multimeter with probes - 1 No.
- Line tester - 1 No.
- Magnifying glass - 1 No.
- Oscilloscope, 100MHz - 1 No.

Materials

- Defective inverter with battery - 1 No.
- Test lamp with 230V, 100W bulb - 1 No.
- Sketch pen - 1 No.

PROCEDURE

TASK 1 : **Identification of the faulty components/section in the inverter**

1 Open the inverter cover and carry out the visual inspection of the board and connectors with the help of magnifying glass.

2 Identify if any damaged components or connectors are seen.

3 Remove the damaged component and check the condition

4 Trace the circuit by referring the circuit diagram (Fig 1) and identify the sections

5 Mark the different test points by using sketch pen.

6 Apply supply to the inverter unit and measure voltage at marked test points.

7 Observe the waveforms using CRO at switching device input/ouput

8 Record the measured readings in the table-1

Table - 1

Section	Test point	Description	Voltage
Battery	TP1	Battery voltage	
Inverter	TP2 TP3	Inverter feedback voltage from inverter output transformer Rectified feedback DC voltage	
PWM section	TP3 TP5	Sensed DC Voltage to PWM section Trigger pulse from PWM IC to upper switching device (AC)	
Switching section	TP7 TP8	Output AC waveform of upper switching device (AC) Output AC waveform of lower switching device (AC)	
Inverter output	TP9	Inverter output voltage (also observe output waveform)	

9 Get the work checked by the Instructor.

— — — — — — —

TASK 2: **Rectification of the defects in the inverter unit**

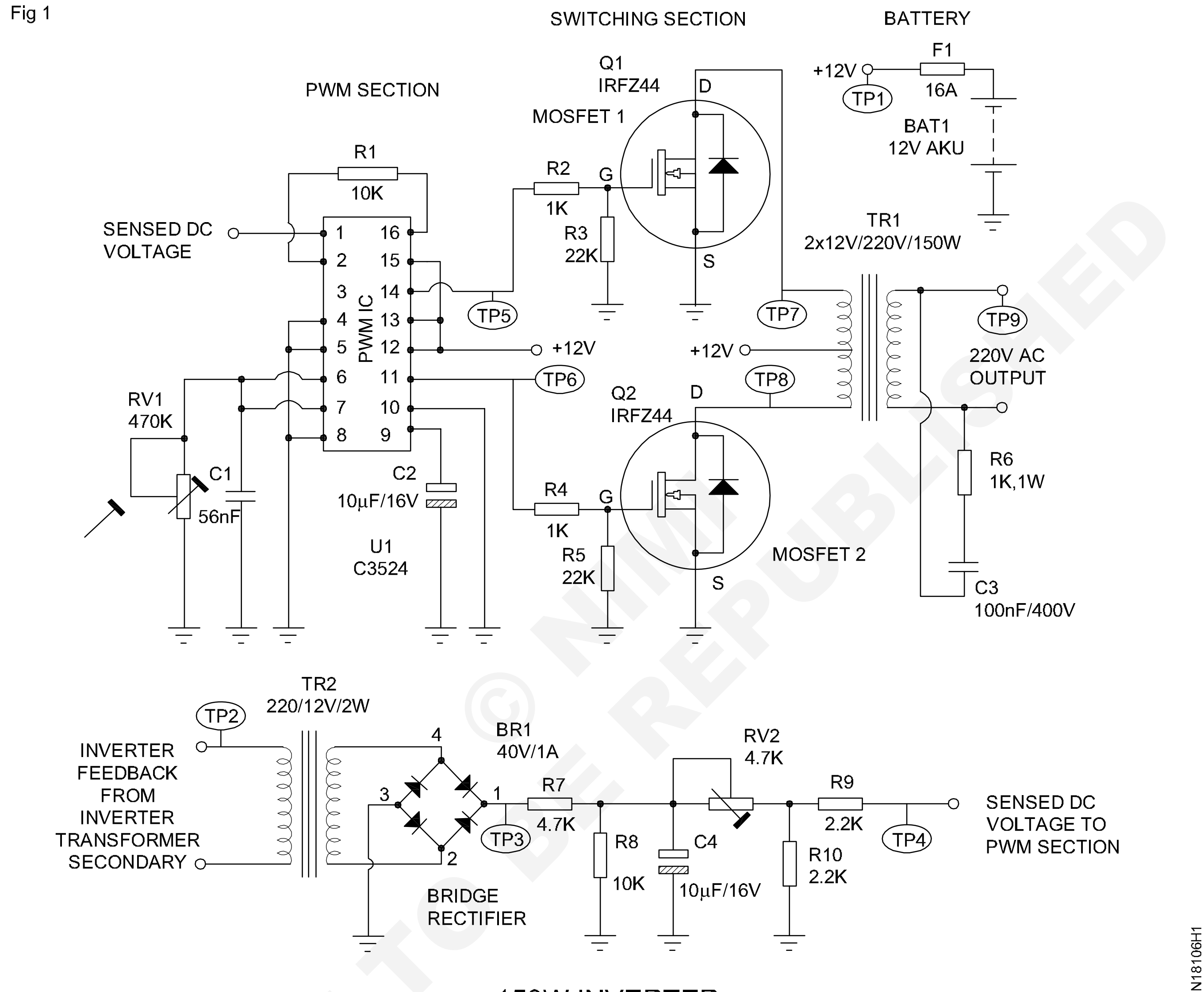
1 Based on the observed readings obtained from the marked test points and waveforms, identify the faulty section/component in the inverter.

2 Remove the suspected component from PCB and test it.

3 Replace the defective components.

4 Get the work checked by the Instructor.

Fig 1



150W INVERTER

— — — — — — —

TASK 3: **Verification of the output terminal with lamp load**

1 Connect a 240V, 100W lamp load at the output terminal

2 Switch ON the inverter, observe the lamp light

3 Measure the output AC voltage and confirm that it remains constant.

4 Get the work checked by the instructor.

— — — — — — —

Measure and plot input and output characteristics of a CE amplifier

Objectives: At the end of this exercise you shall be able to
- **measure and plot the input characteristics of a transistor in CE configuraton**
- **measure and plot the output characteristics of a transistor in CE configuration.**

Requirements

Tools/Equipments/Instruments

• Trainees tool kit	
• DC milliammeter, 0-100mA	- 1 Set
• DC microammeter, 0-500mA	- 1 No
• DC millivoltmeter, 0-1000mV	- 1 No
• Regulated DC dual power supply 0-30V/2A	- 1 No
• Semiconductor data manual	- 1 No

Materials

• Tag board	- 1 No
• Transistors, SL 100,	- 1 No
• Resistors	
120W, ¼ W	- 1 No
10kW, ¼ W	- 1 No
3.3kW, ¼ W	- 1 No
1 kW, POT, linear	- 1 No
• Hook up wires and patch cords	- as reqd

PROCEDURE

TASK 1: **Measurement and plotting of input characteristics (V_{BE} versus I_B) of given transistor as CE amplifier**

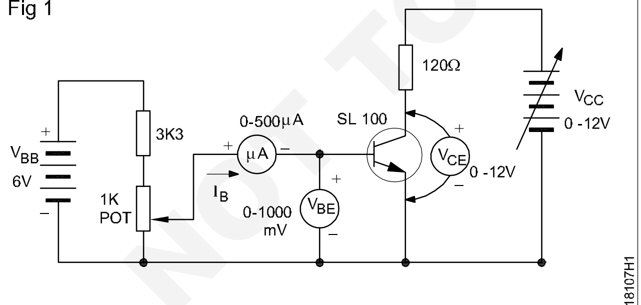
1 Collect the transistor, identify the number, refer the data book and record the details and condition of the transistor in Table 1.

Table - 1

Label No	Transistor No and type	β or h_{FE} (typical)	Condition from quick tests

2 Construct the circuit as shown in Fig 1.

Fig 1



INPUT CHARACTERISTICS OF CE AMPLIFIER

3 Switch ON 6V DC supply V_{BB} and adjust 1 K pot such that V_{BE} = 0V.

4 Adjust the DC supply for V_{CC} to 0 volt such that V_{CE} = 0 volt.

5 Increase V_{BE} from zero volt, in steps of 100 mV upto 700 mV; At each setting record value of base current I_B in Table 2.

Table - 2

V_{CE} set at 0 volts, constant							
V_{BE} in mV	0	200 mV	300 mV	400 mV	500 mV	600 mV	700 mV
I_B in µA							

6 Set V_{BE} = 0 volts by adjusting the pot; Set V_{CE} = 6 volts, repeat step 5 and record readings in Table 3.

Table - 3

V_{CE} set at 6 volts constant							
V_{BE} in mV	0	200 mV	300 mV	400 mV	500 mV	600 mV	700 mV
I_B µA							

7 Set V_{BE} = 0 volts; Set V_{CE} = 12 volts, repeat step 6 and record the readings in Table 4.

Table - 4

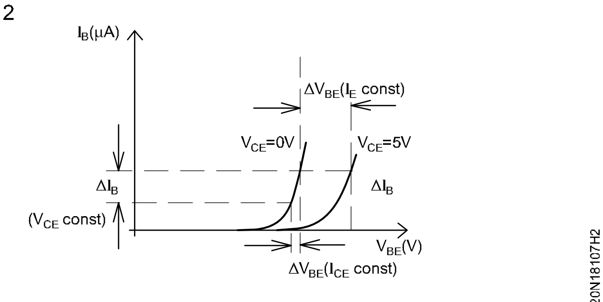
V_{CE} set at 12 volts constant							
V_{BE}	0	200 mV	300 mV	400 mV	500 mV	600 mV	700 mV
I_B µA							

8 Get the recorded readings checked by the instructor.

9 Draw the graph of input characteristics of given transistor in CE configuration by taking the readings recorded in Tables 2,3 and 4 shown in Fig 2. (Mark V_{BE} in X-axis and I_B in Y-axis).

10 Get the plotted graph checked by the Instructor.

Fig 2



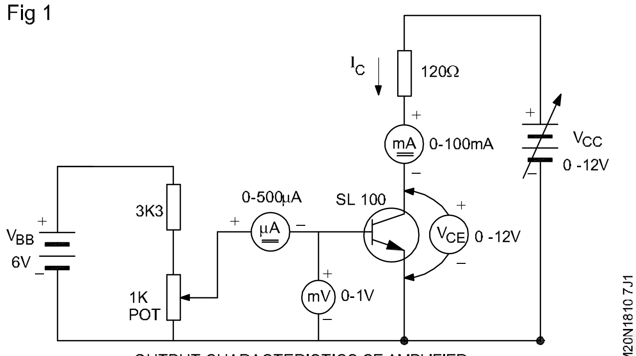
INPUT CHARACTERISTICS OF V_{BE} VS I_B

— — — — — —

TASK 2: **Measurement and plotting of output characteristics of given transistor as CE amplifier.**

1 Modify the circuit connections of Task 1 to make variations in V_{CE} and observe/measure I_C at different values of I_B as shown in Fig 3.

Fig 1



OUTPUT CHARACTERISTICS CE AMPLIFIER

2 Set V_{CC} to 0V such that V_{CE} = 0V and adjust the supply V_{BB} such that I_B = 100 µA.

3 Vary V_{CC} such that V_{CE} is increased in steps of 0.2V upto 1V and continue as per the Table 5; observe the output current I_C at each step of V_{CE} and record the readings in Table 5.

4 Increase I_B to values 200 µA, 300 µA, 500 µA and at each setting repeat step 3; Record the readings in Table 6, 7 and 8 respectively.

5 Get your recorded readings checked by the Instructor.

6 Draw the graph of output characteristics of given transistor in CE configuration by taking, plotting the readings recorded in Tables 5,6,7 and 8 as shown in Fig 4.

7 Get the plotted graph and get it checked by the instructor.

Table - 5

I_B set at 100 µA microAmps constant												
V_{CE}	**0.2V**	**0.4V**	**0.6V**	**0.8V**	**1V**	**2V**	**3V**	**4V**	**5V**	**6V**	**7V**	**8V**
I_C												

Table - 6

I_B set at 200 µA constant												
V_{CE}	**0.2V**	**0.4V**	**0.6V**	**0.8V**	**1V**	**2V**	**3V**	**4V**	**5V**	**6V**	**7V**	**8V**
I_C												

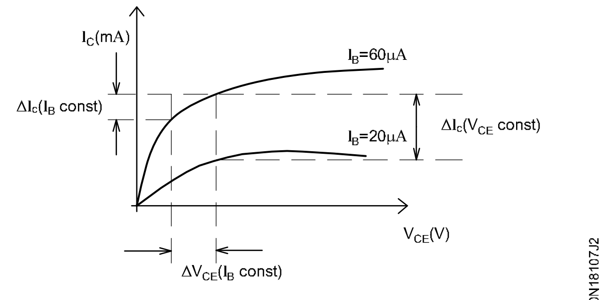
Table - 7

I_B set at 300 µA constant												
V_{CE}	**0.2V**	**0.4V**	**0.6V**	**0.8V**	**1V**	**2V**	**3V**	**4V**	**5V**	**6V**	**7V**	**8V**
I_C												

Table - 8

I_B set at 500 μA constant												
V_{CE}	0.2V	0.4V	0.6V	0.8V	1V	2V	3V	4V	5V	6V	7V	8V
I_C												

Fig 2



OUTPUT CHARACTERISTIC

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Check for cold continuity of PCB

Objectives: At the end of this exercise you shall be able to
- **inspect and identify any probable defect on the given circuit board**
- **record the observed defect/fault on the given circuit board.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Magnifier with lamp - 1 No
- Digital multimeter with probes - 1 No.
- Soldering workstation/hot air temperature/flow controller (with instruction manual) - 1 Set

Materials

- Rosin cored solder and flux - as reqd.
- IPA cleaning solution - as reqd.
- Solder flux pen/liquid flux - as reqd.
- Cleaning brush - 1 No

PROCEDURE

TASK 1: **Identification of any defect/dry solder/short circuit on the given circuit board.**

Note: The instructor has to simulate faults necessary in the circuit board to be given for this exercise/task.

1 Collect the defective circuit board from the Instructor.

2 Clean the board using the brush (Use IPA solution if needed).

3 Visually inspect for any physical damages like cracks/ burnt/dry soldered leads of all the major components on the PCB.

4 Use magnifier and carefully observe for any broken tracks on the board.

5 Use Ohm meter and check for any short/open circuit between tracks.

6 Record the observations in Table 1.

7 Get the work checked by the Instructor

Table - 1

Sl.No	Details of fault/defect identified		Types of defect Open/short circuit	Remarks
	Dry Solder	Loose connecion		
1				
2				
3				
4				
5				
6				
7				

— — — — — —

Solder the SMD components in the given PCB

Objectives: At the end of this exercise you shall be able to
- **solder the SMD components on the PCB.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Magnifier with lamp - 1 No.
- SMD soldering work station (hot air temperature/flow controller) with all accessories (and instruction manual) - 1 Set
- Vacuum pick up tool - 1 No.

Materials

- Rosin cored solder wire - as reqd.
- Flux pen/Liquid flux - as reqd.
- IFA cleaning solution - 1 bottle
- Piece of medium density fiber board - 1 No.
- Crocodile clips holder (MDF borad) - 2 Nos.
- Solder paste tube/syringe - 1 No.
- Cleaning brush - 1 No.

PROCEDURE

1 Choose and fit the appropriate tip for the soldering iron suitable to the SMD component onto the PCB.

2 Use crocodile clips to hold the PCB firmly on the work-bench.

3 Select the SMD components and note down the location/direction on the PCB to be soldered.

4 Switch ON the soldering workstation and adjust the temperature setting knob around 275°C.

5 Keep the SMD component over the pads on the printed circuit at its position correctly.

6 Use flux pen and apply a little quantity on the places where soldering has to be done.

7 Cut the solder wire into small pieces and place them on SMD component leads.

8 Hold the component using tweezers and apply the hot soldering iron tip over the solder pieces to melt.

9 Remove the soldering iron tip and allow the molten solder to set on the pin.

Caution: To avoid thermal buildup, solder the terminals alternately with little time interval between pins

10 Repeat steps to solder the other end of the SMD component .

11 Use magnifier and inspect the soldered joints are free from any solder bridges

12 Clean the board using IPA solution with brush

13 Get the work checked by the Instructor.

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De-solder the SMD Components in the same PCB

Objectives: At the end of this exercise you shall be able to
- **desolder the SMD Components from the PCB following different methods.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Magnifier with lamp - 1 No
- SMD rework station with hot air nozzles/temperature/flow controller with Instruction Manual - 1 Set
- DMM with Probes - 1 No.

Materials

- Desoldering wick - as reqd.
- Solder flux pen/Liquid flux - as reqd.
- IPA Cleaning solution - 1 bottle
- Piece of Medium Density Fiberborad (MDF) - 1 No

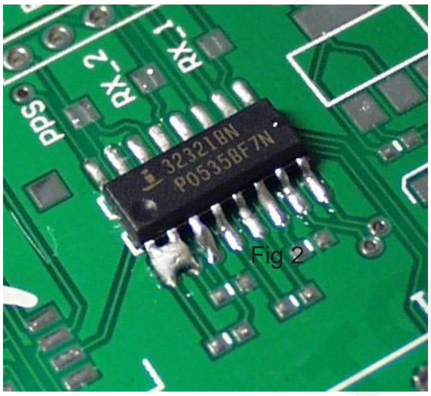
PROCEDURE

TASK 1 : **Desolder the SMD component from the PCB**

1 Collect the defective SMD-PCB from the Instructor and identify the components to be removed.

2 Use magnifying glass and inspect the size of solder joints on the components to be removed as shown in the Fig 1.

Fig 1

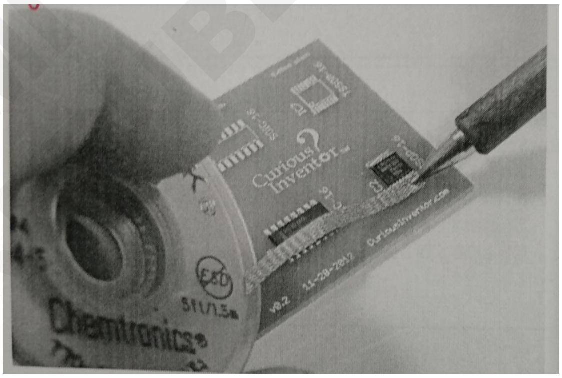


3 Apply a small quantity of flux and solder to the joints of the surface mount components to be removed.

4 Place one end of solder wicking braid on the component lead side and the tip of the soldering iron over it as shown in Fig 2.

5 Allow time for the solder to melt and the solder wick to draw the molten solder into the braid by capillary action.

Fig 2



6 After the molten solder has been extracted from the joint, remove the wick and the soldering iron tip from the component lead.

7 Use the unused portion of the wick for removing excess solder.

8 Repeat the steps 3 to 7 for removing other terminals of the surface mount components.

9 Remove the components from the PCB and clean the surface, using IPA solution.

10 Get the work checked by the Instructor.

— — — — — — —

TASK 2 : **Desolder SMD components using hot air**

Note: Use the MDF board to avoid damage to the Workbench or any surface made of plastic by the hot air.

1 Choose the appropriate hot air nozzle tip for the desoldering work attach and tighten it using screw driver.

2 Power ON the soldering rework station and adjust the hot air and temperature knobs to suit the work.

Note: It is recommended to set the air flow and temperature knobs at the middle and test on a small component, then readjust them to the required level around 275°C.

3 Aim the hot air nozzle at the SMD component and move it slightly back and forth until the solder begins to melt.

4 Use tweezers and carefully grab/lift the SMD component from the board.

Caution:

1 Aim the hot air gun at the same point will melt the board after a certain period of time

2 Make sure to keep the hot air gun moving to prevent any damage to the heat sensitive component/PCB burning.

5 Adjust the air flow and temperature setting knobs back to zero position after finished the SMD component desoldering work.

6 Switch OFF the soldering rework station and allow it to cool down.

7 Clean the board using IPA solution with brush.

8 Get the work checked by the Instructor.

— — — — — — — —

Repair solder mask and damaged pad

Objectives: At the end of this exercise you shall be able to
- **repair the damaged pad on the PCB**
- **repair the solder mask on circuit board.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Soldering workstation - 1 Set

Materials

- IPA cleaning solution - 1 Bottle
- Cleaning brushes - 1 No.
- Copper oil - as reqd.
- Circuit bond packs (2 gram prepackaged Epoxy containers) syringe type - as reqd
- Wipes/Foam swabs - as reqd.
- Glass/plastic bowls to mix the epoxy - 1 No.
- Kapton tape - as reqd.
- PCB with damage - as reqd.
- PCB repair Kit - 1 Set

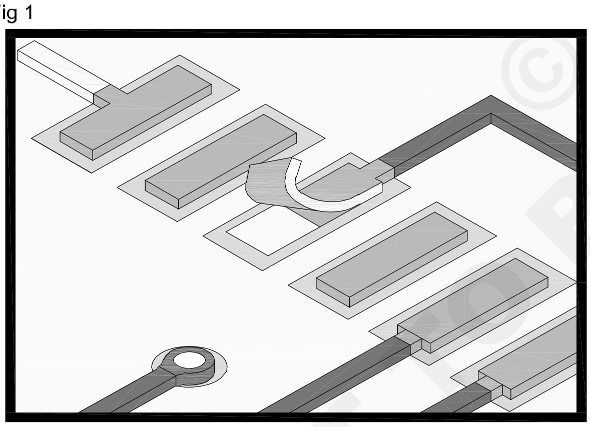
PROCEDURE

TASK 1 : **Repair the damaged pads on the circuit board**

1 Identify the damaged pad and clean the surface with cleaning solvent using a brush.

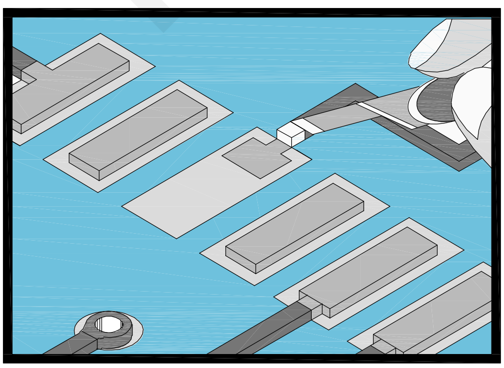
2 Use a dull knife and remove the damaged surface mount pad and a short length of the connecting track as shown in Fig 1.

Fig 1



3 Use a Knife to scrape any epoxy residue, contamination or burnt material from the board surface as shown in Fig 2.

Fig 2



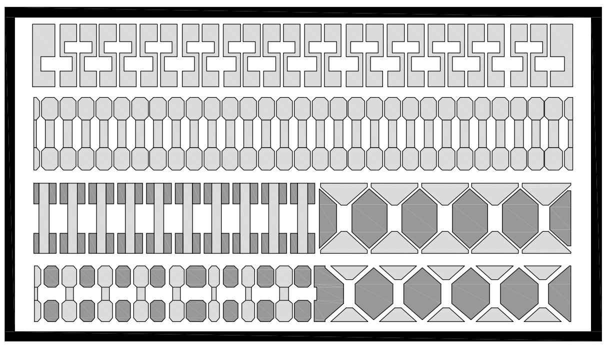
4 Tin the connecting track on the board surface using liquid flux and solder & clean the area.

The length of the overlap solder connection should be minimum 2 times of the circuit width. The area for the new pad on the board surface must be smooth and flat.

5 Select a new surface mount pad from a new strip as shown in Fig 3, which closely matches the surface mount pad to be replaced.

Note: PCB repair hit for circuit boards must contain eyelets & setting tools, pads, lands, tracks, tracks for damaged circuit traces, adhesive, and colour agents for solder mask and board repair, dry film, adhesive backed circuit frames.

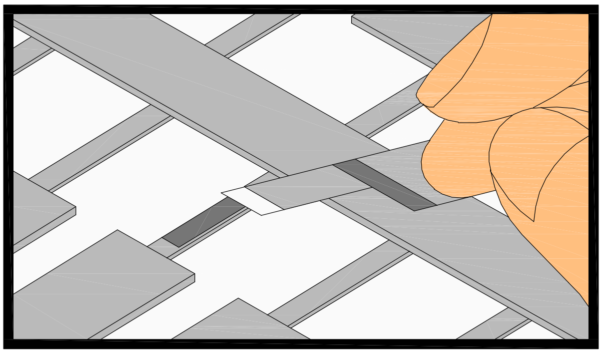
Fig 3



Note: New surface mount pads are fabricated from copper foil. The foil is plated on the top side with solder, and an adhesive bonding film is on the bottom side.

6 Before trimming out a new pad, carefully scrape the adhesive bonding film from the connecting track as shown in Fig 4.

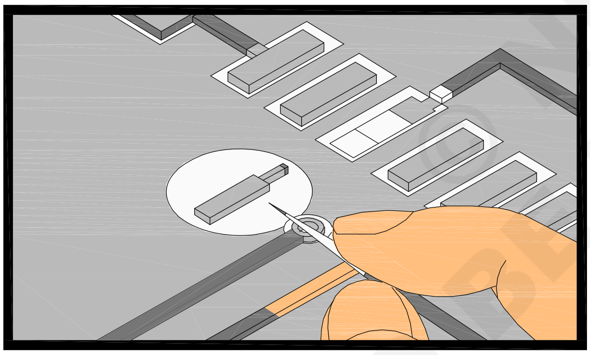
Fig 4



Precaution : Scrape off the epoxy backing only from the joint connection area. When handling the replacement contact, avoid touching the epoxy backing with your fingers or other materials that may contaminate the surface and reduce the bond strength.

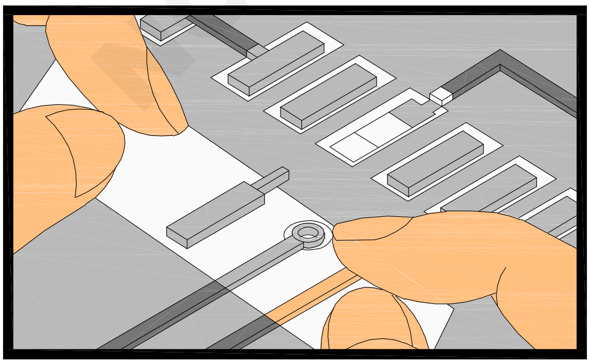
7 Cut out and trim the new pad. Cut the length to provide the maximum allowable circuit overlap for soldering. Minimum 2 times the track width. (Fig 5)

Fig 5



8 Place a piece of High Temperature Tape over the top surface of the new pad. Place the new pad in correct position on the circuit board surface using the tape to proper alignment. (Fig 6).

Fig 6

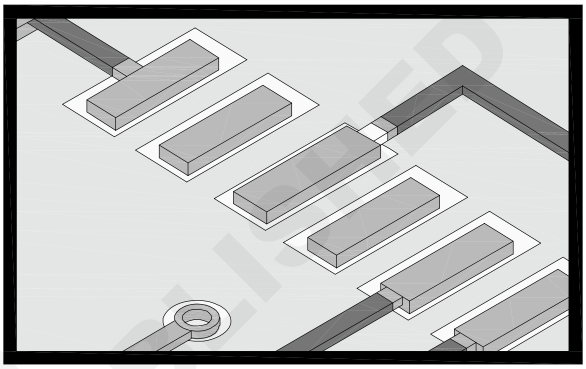


9 Select a bonding tip to match the shape of the new pad. (See bonding tip manual provided with the repair kit).

The tip used for bonding should be as small as possible but should completely cover the entire surface of the new pad.

10 Position the circuit board flat and stable. Gently place the hot bonding tip onto the High Temperature Tape covering the new pad. Apply pressure as recommended in the manual of the repair kit for 5 seconds to tack the new pad in place. Carefully peel off the tape.

Fig 7



Precaution : Excessive bonding pressure may cause measling in the circuit board surface or may cause the new pad to slide out of position.

11 Gently place the bonding tip directly onto the new pad and apply pressure as recommended in the manual of the repair kit for an additional 30 seconds to fully bond the pad.

Note: After the bonding cycle, remove the tape used for alignment. The new pad is fully cured. Carefully clean the area and inspect the new pad for proper alignment.

12 Use minimum flux and solder to ensure a reliable connection. Tape may be placed over the top of the new pad to prevent excess solder.

Note: The overlap solder joint connection should be a minimum of 3 mm.

13 Mix Epoxy and coat the overlap solder joint connection. Cure the Epoxy coating as shown in Fig 7.

14 Get the completed work checked by the Instructor.

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TASK 2: **Apply solder mask on the PCBs**

Precaution: Work on the board under ESD-Safe surface to prevent from electrostatic charges.

1 Inspect and remove the damaged solder mask on the board completely using knife by gentle scraping.

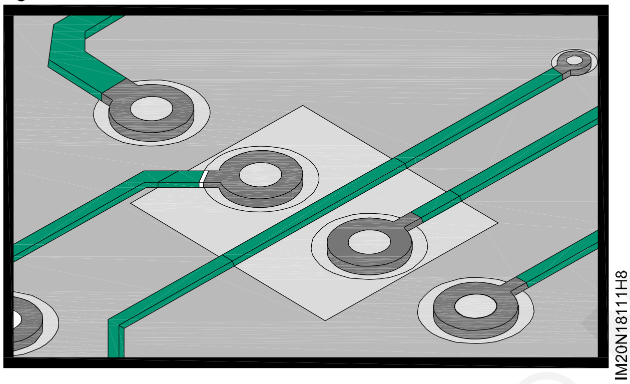
2 Clean the area using cleaner and brush.

Caution: Surface to be coated must be throughly cleaned priror to coating to ensure adequate adhesion, minimised corrosion, and optimised electrical properties.

3 Apply high temperature tape to four sides to expose the area where the solder mask to be applied as shown in Fig 8.

Note: The Instructor has to guide the trainees to prepare the epoxy bond

Fig 8



4 For syringe type, remove the caps of syringe that contains two separate compartments as shown in Fig 9. Press slowly the contents into the mixing cup. Use the mixing stick, slowly stir the mixture for 2 minutes to ensure the resin and hardener have completely mixed without bubbles.

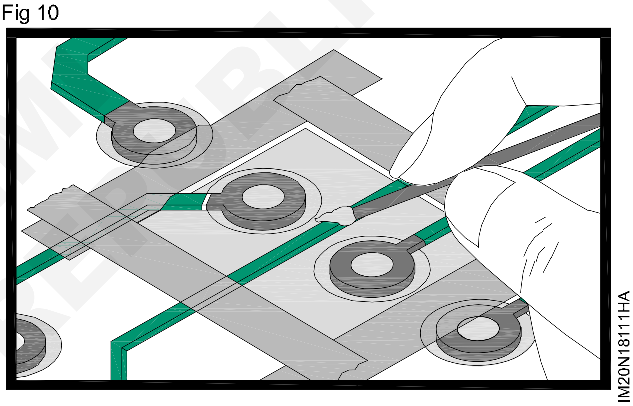
Fig 9

Note: For packaged type, remove the clip and press the resin and hardener into the Mixing cup both halves together with your fingers. Mix for at least one minute to ensure a complete mix of the resin and hardener.

5 Add color agent to the mixed epoxy to match the circuit board colour. Stir slowly to prevent bubbles.

6 Apply the Solder mask to the board surface as required. Use a brush or foam swab to apply and spread the epoxy as shown in Fig 10.

Fig 10



7 Get the work checked by the Instructor and keep the epoxy coated board for 24 hours at room temperature for curing.

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Demonstrate Colpitt's oscillator, Hartley oscillator circuits and compare the output frequency of the oscillator by CRO

Objectives: At the end of this exercise you shall be able to
- **construct and test a Colpitts oscillator**
- **construct and test a Hartley oscillator**
- **compare the measured output frequency with calculated frequency.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- CRO 20 MHz -Dual trace - 1 No
- Regulated DC power supply 0-30V/2A - 1 No
- Digital multimeter with probes - 1 No
- Soldering iron 25W/230V - 1 No
- Soldering iron stand - 1 No

Materials

- Transistor BF 195 - 1 No
- MW oscillator coil - 1 No
- Breadboard - 1 No
- Resistor ¼ W/CR2518kW, 390W, 82kW, 3K9 - 2 Nos each
- Capacitor
  0.1 mF - 1 No
  0.01 mF - 2 Nos
- 2J gang capacitor - 1 No
- Hook up wires - as reqd
- Rosin cored solder - as reqd

PROCEDURE

TASK 1 : **Construction and testing of a Colpitts oscillator**

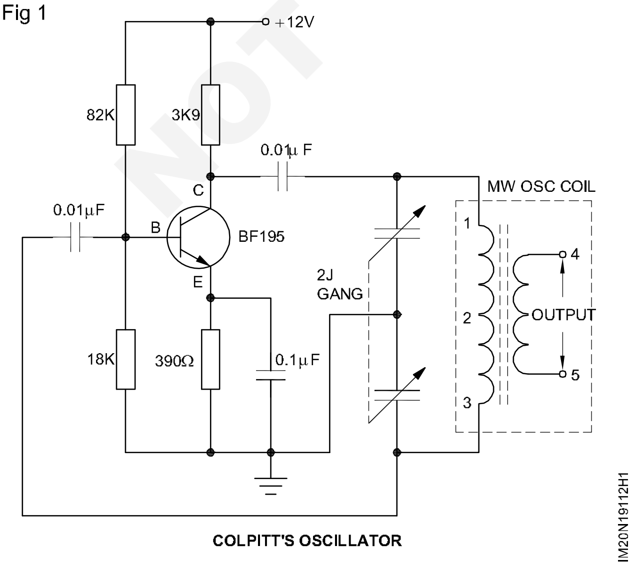
1 Collect all the required components for assembling/ collect trainer kit & test the component for working condition.

2 Plan the layout and assemble the circuit on the breadboard as shown in Fig 1.

Note: If the trainer kit on oscillator is not available, the instructor can use assembled oscillator for demonstration.

3 Get the assembled circuit checked by the Instructor.

Fig 1



COLPITT'S OSCILLATOR

4 Prepare the CRO for measuring the output of oscillator.

5 Switch ON the 12VDC supply to the circuit connect the CRO at the output terminal of the oscillator circuit and measure the waveform.

6 Adjust the gang capacitor to get the desired frequencyo on CRO.

Note: The operating range of Colpitts oscillator using medium wave oscillator coil is from 1000 kHz to 2055 kHz Frequency of Colpitts oscillator can be determined therotically by using Formula:

$$F = \frac{1}{2\pi\sqrt{LC}}$$

Where 'C' is the capacitance of 2J gang and L is the inductance of the oscillator coil in the tank circuit.

7 Repeat the above step, by changing the position of the gang capacitor and record the readings in Table 1.

8 Draw waveform observed at 3 positions of gang capacitor and note down the frequencies.

9 Compare the calculated value with observed value of frequencies.

Table 1

Colpitts oscillator Observation

	Conventional circuit		
Position of gang capacitor	Amplitude in volts	Frequency in Hz	
		Calculated	Observed
Gang capacitor at one extreme end			
Gang capacitor at other extreme end			
Gang capacitor at approximately mid-position			

10 Get the work checked by the Instructor.

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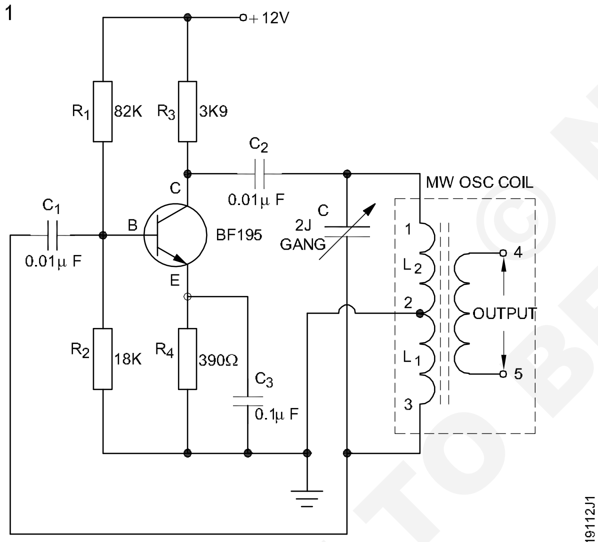
TASK 2 : **Construction and testing of a Hartley oscillator**

1 Use trainer kit (or) assemble the components as shown in Fig 2 on breadboard.

2 Connect the DC supply and set for 12V

Fig 1



HARTLEY OSCILLATOR CIRCUIT SCHEMATIC

3 Switch on the supply

4 Switch on the CRO and adjust to get horizontal trace.

5 Connect the CRO in the O/P terminal of the circuit.

6 Observe the output of the circuit in the CRO, adjust the time/div, V/div knobs to get stable wave form.

7 Measure the time period & calculate the frequency of oscillator using the formula $F = \frac{1}{T}$ practically.

> **Note: Frequency of Hartley oscillator can be determined theoritically by using formula**
>
> $F = \frac{1}{2\pi\sqrt{LC}}$ **, Where 'C' is the capacitance of the capacitor C1 in tank circuit and L = L1 + L2 the effective series inductances of tank circuit.**

8 Repeat the above steps by changing the position of the gang capacitor and record the readings in Table 2.

9 Draw waveform observed at different settings of gauged capacitor and note down the frequencies as given in Table 2.

Table 2

	Conventional circuit	
Position of gang capacitor	Amplitude in volts	Frequency in Hz
Gang capacitor at one extreme end		
Gang capacitor at other extreme end		
Gang capacitor at approximately mid-position		

10 Get the work checked by the Instructor.

Construct and test RC phase-shift oscillator circuits

Objectives: At the end of this exercise you shall be able to
- **construct and test RC phase shift oscillator circuit using transistor and vary the output frequency of the oscillator.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Regulated DC power supply, 0-30V/2A - 1 No
- CRO, 20 MHz - Dual channel - 1 No
- Digital frequency counter - 1 No
- Soldering Iron 25W/230V with stand - 1 No
- Digital multimeter with probes - 1 No

Materials

- Breadboard - 1 No
- Resistor ¼ W/CR25
  10kΩ, 2k2, 680Ω, 47kW - 1 No each
- Resistor 4.7kΩ/¼ W/CR25 - 2 Nos
- Capacitor 25VDC working
  0.01 mF - 3 Nos
  1mF, 22mF - 1 No each
- Transistor BC 107 - 1 No
- POT 4.7kΩ - 1 No
- Hookup wire - as reqd

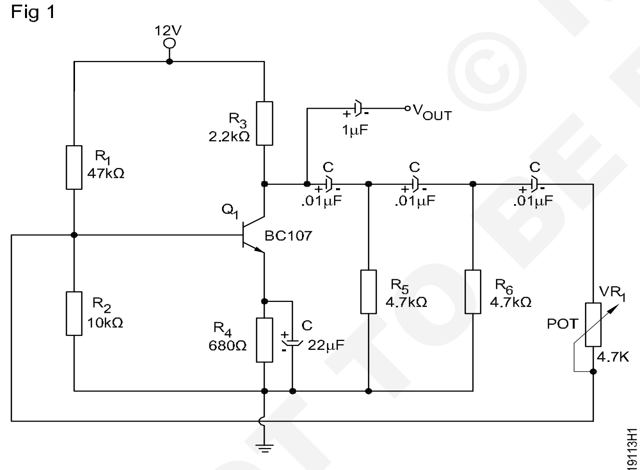
PROCEDURE

TASK 1: **Construction and testing of RC phase shift oscillator circuit using transistor**

1 Collect all the components from instructor and test them.

2 Assemble the RC phase-shift oscillator as shown in Fig 1 on the breadboard.

Fig 1



RC PHASE SHIFT OSCILLATOR

3 Get the assembled circuit checked by the Instructor.

4 Preapre the CRO for measurements and connect it across the output terminals.

5 Switch ON the 12VDC supply to the RC phase shift oscillator circuit and measure the output waveform using CRO.

> **If there is no output, adjust the value of POT to get the output; even after adjusting the POT no output is available consult the instructor.**

6 Keep the preset VR1 at maximum resistance position adjust the preset pot and observe the change in frequency/waveform on CRO.

7 Measure and record the oscillator output frequency in Table1.

8 Measure the output using frequency counter also and record the readings in Table 1.

9 Adjust POT suitably and find the minimum and maximum frequency of oscillations of the circuit. Record the observations in Table.

10 Compare the calculated and measured frequency of the oscillator.

11 Get the work checked by the Instructor.

Table 1

Output frequency at different positions of R_3 preset Calculated frequency ______________ Hz

Sl. No.	Position of preset VR_1	Frquency measured using CRO	Frequency measured using freq counter	Calculated Frequency $\left.\right\} F = \frac{1}{2\pi RC\sqrt{6}}$
1	Minimum			
2	Middle			
3	Maximum			

Construct and test a crystal controlled oscillator circuit

Objectives: At the end of this exercise you shall be able to
- **construct and test a Crystal oscillator using transistor.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Oscilloscope, 20 MHz Dual trace - 1 No
- Regulated DC power supply 0-30V/2A - 1 No
- Digital multimeter with probes - 1 No

Materials

- Breadboard - 1 No
- Hook up wires - as reqd
- 8.44 MHz Crystal with holder - 1 No
- Capacitors - 25V DC wkg, 680pF, 330pF - 1 No
- Capacitor 0.1mF - 2 Nos
- Transistor BF195 - 1 No
- Resistors ¼ W/CR25 82kΩ,18kΩ, 3.9kΩ, 390Ω - 1 No each

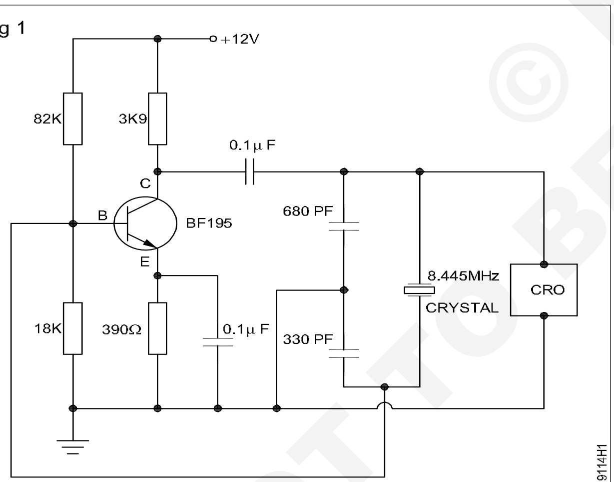
PROCEDURE

TASK 1 : **Construction and testing of crystal controlled Pierce oscillator**

1 Record the frequency marked on the crystal.

2 Collect all the required components, test and assemble pierce crystal controlled oscillator circuit on breadboard as shown in Fig 1.

Fig 1



CRYSTAL OSCILLATOR

3 Connect 12V DC supply to the oscillator circuit.

4 Prepare the CRO for measurement and connect it cross the output of the oscillator.

5 Adjust the CRO time-base to get a clear sinusoidal waveform on the screen. Measure and record the amplitude and frequency of oscillations.

If oscillations are not seen, the crystal may be bad. Consult your instructor.

6 Decrease the supply voltage to find and record the minimum V_{CC} voltage at which the crystal oscillator oscillates satisfac-torily.

7 Get the working of the circuit and the recorded readings checked by the instructor.

1 Frequency marked on crystal : ____________________

2 (a) Amplitude of oscillations : ____________________

(b) Frequency of oscillations : ____________________

3 (a) Minimum V_{CC} at which crystal oscillator work satisfactorily : ____________________

(b) Output frequency : ____________________

(c) Output amplitude : ____________________

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Use analog IC tester to test various analog ICs

Objectives: At the end of this exercise you shall be able to
- **identify various analog ICs with their specifications**
- **testing of Op-Amp and timer ICwith Analog IC tester**

Requirements

Tools/Equipments/Instruments

- Analog/IC Tester with operating manual - 1 No
- Semiconductor Data book/manual - as reqd

Materials/Components

- Assorted analog ICs such as Op-Amp and timer ICs (IC 74, LM 324 IC 555) - Minimum 3 Nos each

Keep a minimum of 10 nos of assorted labeled ICs on a table at two places and instruct the trainees to pick one IC at a time to carry out the testing work.
Instructor should demonstrate the operation of IC tester available in the laboratary. A typical IC tester is shown in Fig 1.

PROCEDURE

TASK 1 : **Identification of various Analog ICs with their specifications and pin diagram**

1 Pick one of the labeled IC from the assorted lot and record its product code /label number printed on the body.

2 Refer to the data sheet semiconductor international data book for Op-Amp / Timer (which ever applicable) and record the following specifications of the given IC;
   – Type of package
   – Manufacturers name
   – Number of OP-Amps/timers in the IC
   – Rated maximum DC supply voltage
   – Open-loop gain A_{VOL}
   – Minimum output current $I_{out(min)}$
   – Slew rate of the IC
   – Any other parameter applicable to this IC
   – Typical applications.

3 Count the number of pins in the given IC. Make a rough sketch of the IC. Identify and record the pin numbers.

4 Repeat the steps for atleast four different ICs having different product code.

Table 1

Sl.No.	Label No.	IC Number	Manufacturer name	V_{cc} max	A_{VOL}	I_{OUT} (min)	Application	Pin diagram

5 Get the work checked by the Instructor.

TASK 2 : **Testing of the given Op- Amp and Timer IC with Analog IC Tester**

IC Tester has self test button. On pressing it, The IC tester performs self Diagnostic test its own hardware. It has two modes of operations

1 Quick test - To test and give result immediately.

2 Stepwise test - To know which portion of hardware in IC has failed.In this method, even if one AMP in a dual Op- Amp IC is GOOD that IC can be used.

1 Refer to the instruction operation manual of IC tester, familiar with operation of analog/universal IC tester available in laboratory.

Fig 1

Use operator manual note down the library of analog ICs of the tester to know which ICs may be tested with the tester as shown in Fig 1.

2 Pick one of the labelled IC, identify the pin no. 1, orient it/as per the ZIF socket position.

3 Open the level of the ZIF socket and insert the IC into position carefully.

Note: ZIF socket refers to Zero Insertion Force.It is a type of socket for mounting electronic devices that is designed not to stress or damage them during Insertion.

4 Switch on the power switch of IC tester enter the IC number on the keypad of the IC tester and press TEST key and see the result.

Note: The IC tester comprises of programs /set of testing procedure to test every analog IC available in its library. it checks the procedures of various steps and produces the result as GOOD or BAD on the display provided in it.

5 Find out whether the given IC is GOOD (or) BAD by observing the display of the IC tester and record the result in Table 2.

6 Repeat the exercise for at least 3 Op-Amps and 3 Timer IC to show the difference between good and defective and record in Table 2.

Table 2

Sl.No.	IC No. test	Mode	Condition of IC

7 Get the work checked by the instructor

— — — — — —

Construct and test various Op-Amp circuits Inverting, Non-inverting, and Summing Amplifiers

Objectives: At the end of this exercise you shall be able to
- **construct and test Inverting amplifier using LM 324**
- **construct and test Non-Inverting amplifier using LM 324**
- **construct and test summing amplifier and differential amplifier using LM 324.**

Requirements

Tools/Equipments/Instruments

- Analog/Universal IC Tester with instruction manual - 1 No
- CRO, 20 MHz Dual trace - 2 Nos
- Semiconductor Data book - 1 No
- Analog/Digital multimeter with probes - 1No
- Dual regulated DC power supply 0-30V/2A - 1 No
- Function generator - 1 No
- Trainees tool kit - 1 Set

Materials

- Op-Amp ICs LM324, UA741 - 2 Nos each
- Breadboard - 2 Nos each
- Resistors 10 kW,¼ W/CR25 - 7 Nos
  100 kW,¼ W/CR25 - 1 No
- Hook up wires/connecting wires - as reqd
- IC base (8 pin), DIP - 2 Nos
- Diodes 1N4001 - 4 Nos

PROCEDURE

TASK 1 : **Construction and testing of an inverting amplifier**

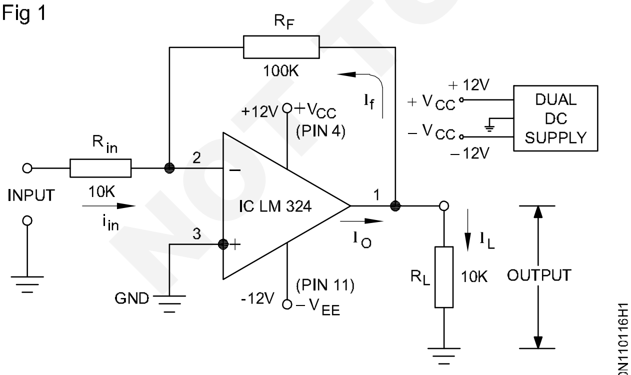
1 Collect all the required components from the instructor and check them with multimeter; use IC tester for checking ICs.

2 Identify the type of package and pins of the given Op-Amp using Data book.

3 Refer to circuit diagram shown in Fig 1 and assemble the in-verting amplifier circuit on bread board.

4 Get the assembled circuit checked by the Instructor.

Fig 1



INVERTING AMPLIFIER

Always keep an IC base fixed on the breadboard for inserting the Op-Amp IC.

5 Connect +12V, -12V and GND of dual DC power supply to pin 4, pin 11 and GND respectively.

6 Prepare the CRO for measurements and apply $0.2V_{p-p}$ at the input.

7 Meaure the output using DMM and CRO.

8 Vary the input voltage and observe the output variations using multimeter and oscilloscope; record the observation in Table 1.

9 Change the value of feedback resistor R_F and R_{in} observe the variation in gain and record them in Table.

8 Get the completed work checked by the Instructor.

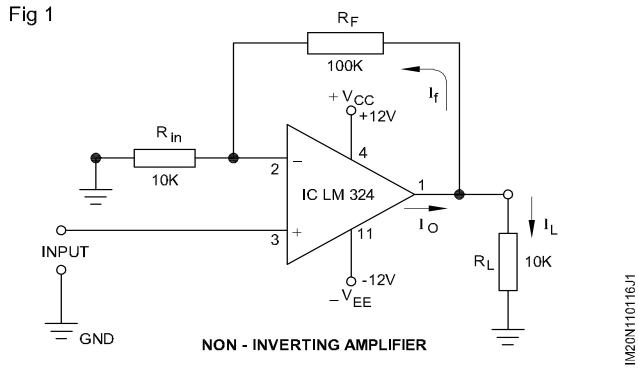
— — — — — —

TASK 2 : **Construction and testing of a non-inverting amplifier using IC LM324**

1 Refer to the circuit diagram shown in Fig 1 and modify the assemblled circuit on Bread board.

2 Get the assembled circuit checked by the Instructor.

Fig 1



NON - INVERTING AMPLIFIER

3 Repeat steps 5 to 8 of Task 1 and record the observations.

4 Repeat the steps 9, record the observations and calculate the gain and record them.

Table 1

S.No.	Input voltage applied (V_i)	Output voltage		Gain normal observed values V_{out} / V_{in}		Gain x Vin= Volt Calculate values	
		Inverting amplifier	Non inverting amplifier	Inverting amplifier	Non inverting amplifier	Inverting amplifer (R_f/R_{in}) x Vin	Non inverting (1+(R_f/R_1)xVin
1	0.2V						
2	0.4V						
3	0.6V						

5 Get the work checked by the Instructor.

— — — — — —

TASK 3 : **Construction and testing of a summing amplifier using IC LM324**

Carry out the experiment on a Bread board. The suitable values for input voltage are kept such that.

$$\frac{R_F}{R_1} = \frac{R_F}{R_2} = \frac{R_F}{R_3} = \frac{R_f}{R_{in}}$$

1 Collect all the required items, check the components and assemble the circuit according to the amplifier circuit shown in Fig 1.

Note the inputs have been applied to inverting terminal.

2 Get the assembled circuit checked by the instructor.

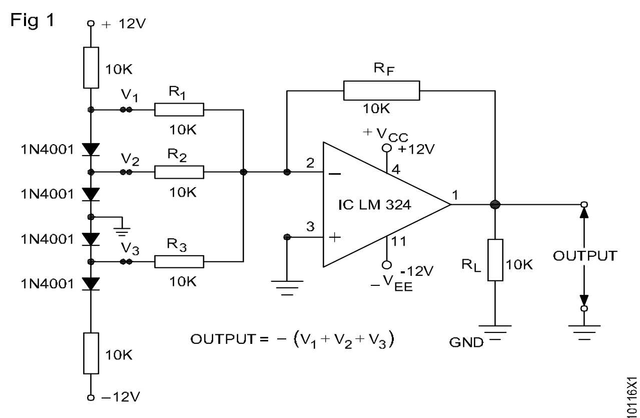
3 Switch ON the dual DC power supply measure the output using multimeter and CRO.

Use the given formula to calculate the output voltage for summing amplifier.

4 Verify the results obtained & compare with the calculated values.

To apply inputs to noninverting terminal exchange the inputs applied on inverting and non inverting terminals.

Fig 1



NOTE: THE – Ve SIGN AT THE OUTPUT INDICATE THAT THE AMPLIFIER IS AN INVERTING AMPLIFIER

Observation table

Table 2

S.No.	Configuration	Output voltage	Result
1	When inputs V_1, V_2 & V_3 have been applied on -Ve terminal	Vo=	Is O/P proportional to sum of inputs? (Yes / No)
2	When input V_1, V_2 & V_3 have been applied on +Ve terminal	Vo=	Is output proportional to sum of inputs? (Yes / No)

Formula to calculate output voltage of summing amplifier

i For Inverting Amplifier

$$V_o = -\left(\left(\frac{R_f}{R_{in}} \times V_1\right) + \left(\frac{R_f}{R_{in}} \times V_2\right) + \left(\frac{R_f}{R_{in}} \times V_3\right)\right) = \frac{R_f}{R_{in}}\left(V_1 + V_2 + V_3\right)$$

ii For Non-Inserting Amplifier

$$V_o = \left(\left(1 + \frac{R_f}{R_{in}}\right)V_1 + \left(1 + \frac{R_f}{R_{in}}\right)V_2 + \left(1 + \frac{R_f}{R_{in}}\right)V_3\right) = \left(1 + \frac{R_f}{R_{in}}\right)\left(V_1 + V_2 + V_3\right)$$

If $R_f = R_1$

$V_o = 2\,(V_1 + V_2 + V_3)$

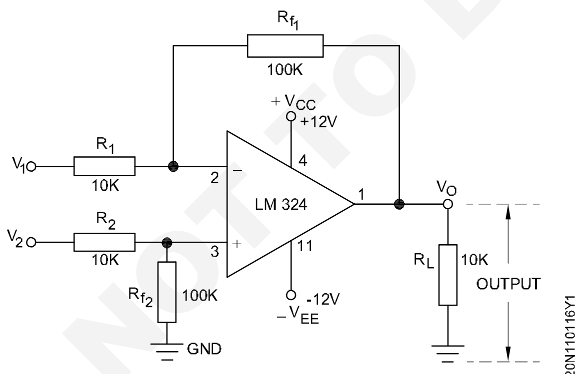
— — — — — —

TASK 4: **Construction and testing of Differential Amplifier using LM324**

1 Modify the components values and assemble the circuit shown in Fig 4.

2 Get the assembled circuit checked by the instructor.

Fig 1



CONSTRUCTION AND TESTING OF DIFFERENTIAL AMPLIFIER

3 Repeat step 5 of Task 1.

4 Apply the DC inputs to the differntial amplifier circuit at pin 2 and pin 3 through 10k resistors as per the Table 3.

5 Measure the output using Multimeter and record in given table.

6 Change the input values at V1 and V2 and record the output readings in Table 3.

7 Compare the calculated value with observed.

8 Get the work checked by the Instructor.

Note: A $R_{f1} = R_{f2} = R_f$ and $R_1 = R_2$ - R_{in}

V_O Output = $(V_2 - V_1)$

Oberservation table

Table 3

Input to Differential Amplfiercalculated		Output to (V_O) (V_O)	Output Observed
V_1	V_2		
0.5V	1V		
+1V	-2V		
-2V	+2.5V		

— — — — — —

Construct and test differentiator and integrator circuits

Objectives: At the end of this exercise you shall be able to
- **construct and test differentiator circuit using Op-Amp IC 741**
- **construct and test integrator circuit using Op-Amp IC 741.**

Requirement

Tools/Equipments/Instruments / Data Book

- Trainees tool kit - 1 Set
- CRO 20MHz dual trace - 1 No
- Digital multimeter with probes - 1 No
- Voltmeter 0-10V - 1 No
- Regulated dual DC power supply 0-30V/2A - 1 No
- Function generator - 1 No

Materials

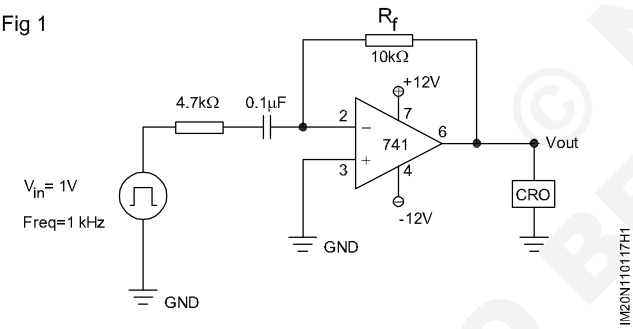
- Resistors 1kW, 10kW, 4.7kW ¼ W/CR25 - each 1 No
- IC 741 Op-Amp - 1 No
- Capacitor 0.1 mF/25V - 1 No
- Hook up wire - as reqd
- Breadboard - 1 No
- Graph sheet (Linear) - 1 No

PROCEDURE

TASK 1: **Construction and testing of a differentiator circuit**

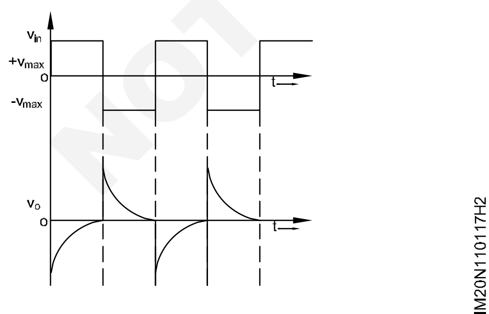
1 Collect and check the components for the good working condition and assemble the circuit on the bread board as shown in Fig 1.

Fig 1



2 Get the assembled circuit checked by the Instructor Calculate RC time constant(T=R_fC).

Fig 2



3 Give a square wave input of 1 V_{p-p} to the inverting terminal and set the frequency to 1/T in the function generator.

4 Switch ON the dual power supply and set it to +12V and -12V and GND as shown in Fig 1.

> **Note: For a differentiator,**
> **VO = R_fC**

5 Prepare the CRO for measurement and observe the output waveform on the CRO.

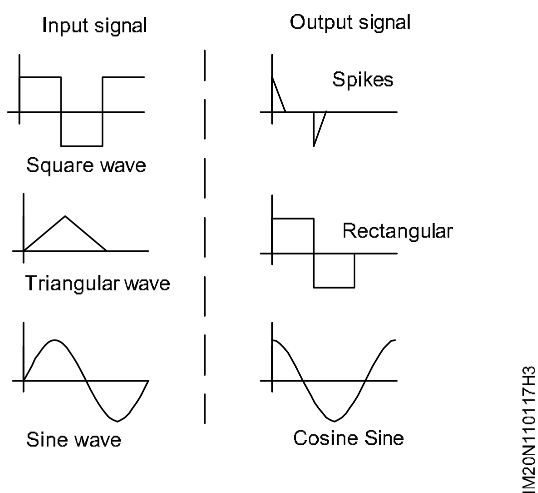
6 Vary the frequency to 1/10T and observe the waveform.

7 Vary the frequency to 1/0.1T and observe the waveform.

8 Draw output and input waveform of the circuit as shown in 2 on a graph sheet for all the 3 steps.

9 Repeat the above procedure for different input signals viz. triangular waveform and sinwave waveform as shown in Fig 3.

Fig 3



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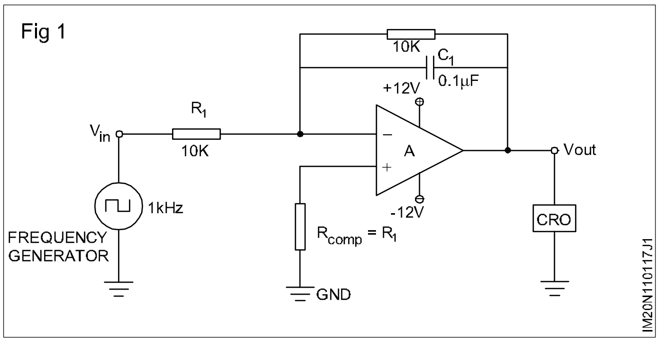
TASK 2 : **Construction and testing of a integrator circuit**

1 Check the components for their good working condition and connect the circuit on the bread board as shown in the Fig 4.

Fig 1



2 Calculate RC time constant($T=R_1C$).

3 Apply a non sinusoidal input of 1 V_{p-p} to the inverting terminal and set the frequency to 1/T in the function generator.

Note: For a Integrator:

$$VO = -\frac{1}{R_1C_1} \int V_{in}\, dt$$

4 Switch ON the dual power supply and set it to +12V, -12V and GND connections.

5 Observe the output waveform on the CRO.

6 Vary the frequency to 1/10T and observe the waveform.

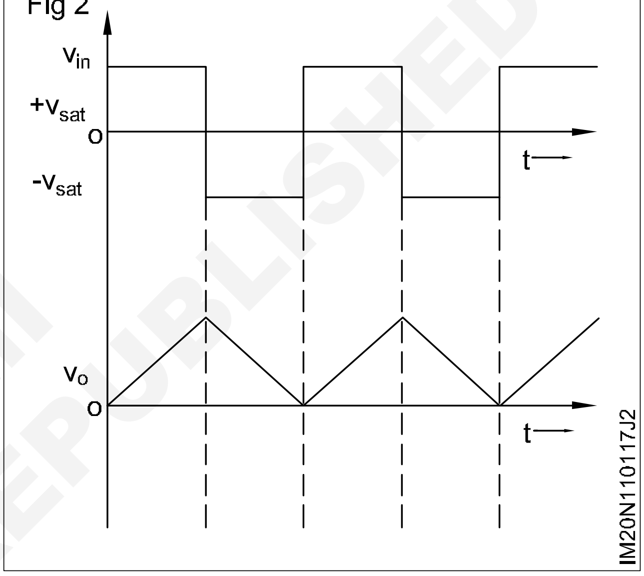
7 Vary the frequency to 1/0.1T and observe the waveform.

8 Draw output and input waveform of the circuit as shown in Fig 5, on a graph sheet for all the 3 steps.

9 Repeat the same procedure for different input signals viz. square wave, triangular waveform.

10 Get the result checked by the Instructor.

Fig 2



Construct and test a voltage to current and current to voltage converter Circuit using Op-Amp

Objectives: At the end of this exercise you shall be able to
- **construct and test voltage to current convertor**
- **construct and test current to voltage convertor.**

Requirements

Tools/Equipments/Instruments / Data Book

- +15V DC power supply - 1 Set
- -15V DC power supply - 1 No
- Resistors
- 1 kΩ - 2 No
- 10 kΩ 1/2W - 2 No
- Potentiometer 1 kΩ - 1 No
- OP AMP 740 C - 1 No

Materials

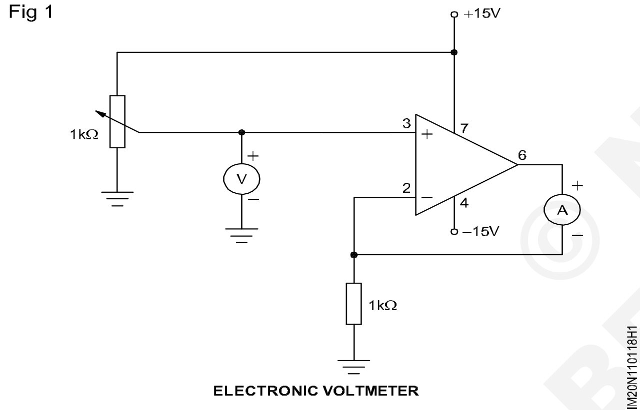
- VOMs (or digital multimeters to measure voltage and current) - 1 No
- Graph sheet (Linear) - 1 No

PROCEDURE

TASK 1: **To construct and test Voltage to current converter**

1 Connect the circuit as shown in Fig 1.

Fig 1



2 Adjust the potentiometer to get an input voltage of 1V.

3 Read the output current and record the value in the given Table 1.

4 Repeat steps 2 and 3 for various input current and record the values in Table 2.

5 Get the work checked by your instructor.

Table 1: Voltage to current convertor

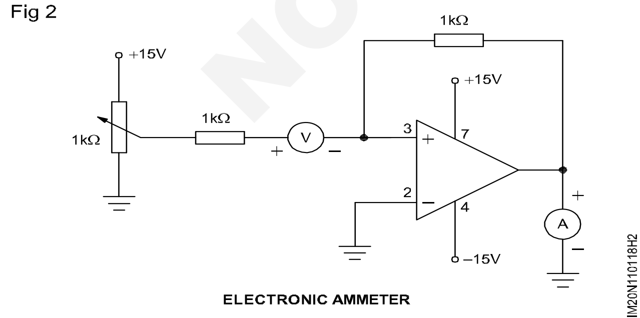
$V_{in'}$ V	$i_{out'}$ mA
1	
2	
3	
4	
6	
8	
10	

— — — — — —

TASK 2: **To construct and test Current to voltage convertor**

1 Connect the circuit as shown in Fig 2.

Fig 2



2 Adjust the potentiometer to get an input current of 1MA.

3 Read the output voltage and record the value in the given Table 2.

4 Repeat steps 2 and 3 for various input current and record the values in Table 2.

5 Get the work checked by your instructor.

Table 2: Voltage to current convertor

I in M4	Vout V
1	
2	
3	
4	
6	
8	
10	

Construct and test instrumentation amplifier

Objectives: At the end of this exercise you shall be able to
- **construct and test Instrumentation amplifier circuit using IC LM324.**

Requirement

Tools/Equipments/Instruments/Data Book

- Function generator - 1 No
- CRO dual trace 20MHz - 1 No
- Dual regulated DC power supply 0-30V/2A - 1 No
- Trainees tool kit - 1Set
- Digital multimeter with probes - 1 No
- Data sheet of the IC LM324 - as reqd

Materials

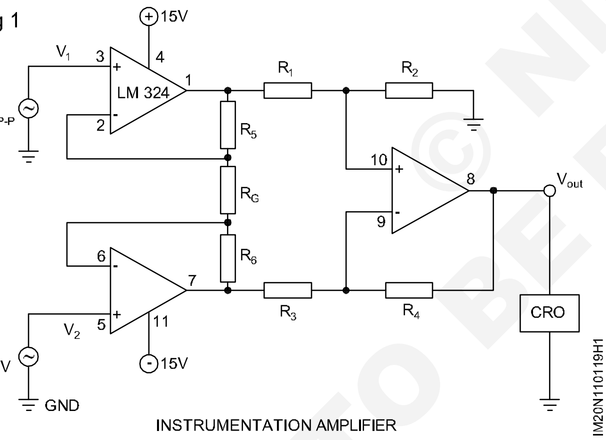
- Resistors ¼ W/CR25
  1kΩ - 4 Nos
  100kΩ - 4 Nos
  1kΩ POT - 1 No
- IC LM324 - 1 No
- Breadboard - 1 set

PROCEUDRE

TASK 1: **Construction and testing of an Instrumentation amplifier circuit**

1 Collect all the components, test them and refer to the pin out diagram of the IC and assemble the circuit as per the circuit diagram shown in Fig 1.

Fig 1



2 Get the assembled circuit checked by the Instructor.

3 Set the inputs V_1 and V_2 at different values but at the same frequency.

4 Switch ON the dual power supply and set the voltage + 15V, -15V and GND.

5 Prepare the CRO for measurements and measure the output at the output pin.

6 Calculate the theoretical gain from the given formula and verify the practical values.

Formula

$$Voltage gain A_V = \frac{V_0}{V_2 - V_1} = \left(1 + \frac{2R_1}{R_{gain}}\right) \times \left(\frac{R_3}{R_2}\right)$$

Table

SI.No.	Applied input voltage	Voltage gain AV	Output voltage calculated (Vo)	Result Observed Output 'Vo'
1	V1= V2 =	Vo=		

7 Get the work checked by the Instructor.

— — — — — —

Construct and test astable timer circuit using IC 555

Objectives: At the end of this exercise you shall be able to
- **assemble and test an astable multivibrator circuit using IC 555**
- **measure pulse repetition frequency (PRF), rise time and fall time of the pulses.**

Requirements

Tools/Equipments/Instruments

- Regulated DC power supply 0-30/2A - 1 No
- Trainees tool kit - 1 Set
- CRO 20MHz, Dual trace - 1 No
- Digital multimeter with probes - 1 No

Materials

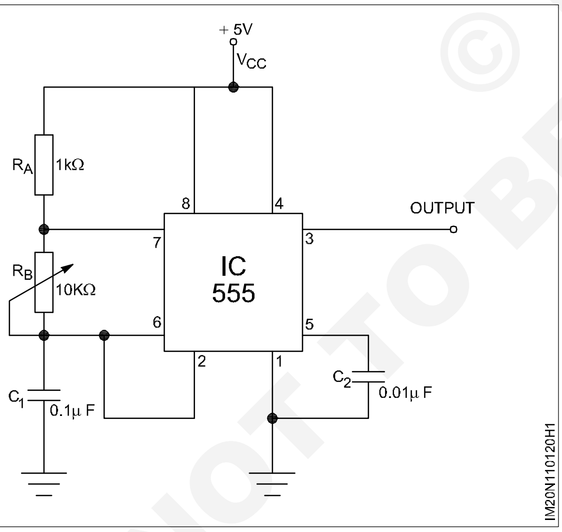
- Bread board - 1 No
- IC base, 8 pin DIL - 1 No
- IC 555 - 1 No
- Carbon resistors, ¼ W/CR25
  1kΩ - 1 No
- Preset, 10kΩ - 1 No
- Capacitors
  0.01 μF/25V - 1 No
  0.1 μF/25V - 1 No
  4.7 μF/25V - 1 No
- Speaker, 8W, 2" or any small speaker (used in pocket radios) - 1 No
- LED 5mm, Red - 1 No
- Hook up wires -as reqd

PROCEDURE

TASK 1 : **Construction and testing of an astable Multivibrator using IC 555**

1 Collect all the required components, check them and assemble the astable multivibrator circuit on breadboard as shown in Fig 1.

Fig 1



2 Get the assembled circuit checked by the Instructor.

> **Place and fix the IC in the IC socket ensuring that the IC pins do not get bent or come out of the IC base.**

3 From the values of the circuit components, calculate and record the ON-time(t_{ON}), OFF-time(t_{OFF}) and the pulse repetition frequency(PRF) of output.

4 Get the calculated values checked by the instructor.

5 Prepare the CRO for measurements.

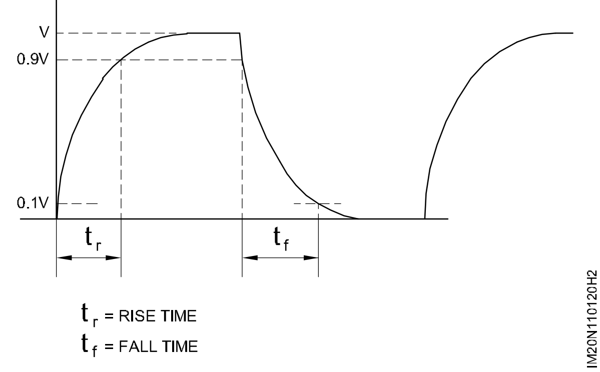
6 Switch ON DC voltage to the circuit and check for continuous rectangular pulses at the output of the circuit using the CRO.

> **If there is no output, switch off the voltage to the cir-cuit and check the circuit connections. Take the help of the Instructor, if necessary.**

7 Measure and record the ON-time, OFF-time and PRF (pulse repetition frquency) of the output pulses.

8 Measure and record the rise-time and fall-time of the pulses as shown in Fig 2.

Fig 2



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Construct and test monostable timer circuit using IC 555

Objectives: At the end of this exercise you shall be able to
- **assemble and test a monostable multivibrator using IC 555**
- **use the monostable multivibrator as a touch switch.**

Requirements

Tools/Equipments/Instruments

• Digital multimeter with probes	- 1 No
• Trainees tool kit	- 1 Set
• Storage oscilloscope/CRO-0-20 MHz dual trace	- 1 No
• Regulated DC power supply 0-30V/2A	- 1 No

Materials

• Breadboard	- 1 No
• 8-pin IC base	- 1 No
• IC 555	- 1 No
• Carbon resistors, 1/4 watt	
10 MΩ	- 1 No
33 kΩ 330Ω, 1MΩ	- 1 No
• Capacitors 25VDC	- 1 No each
0.01µF	- 2 Nos
4.7µF	- 1 No
• LED 5mm, Red	- 1 No
• Push-button switch (Push-to-ON)	- 1 No
• Hook up wires	- as reqd

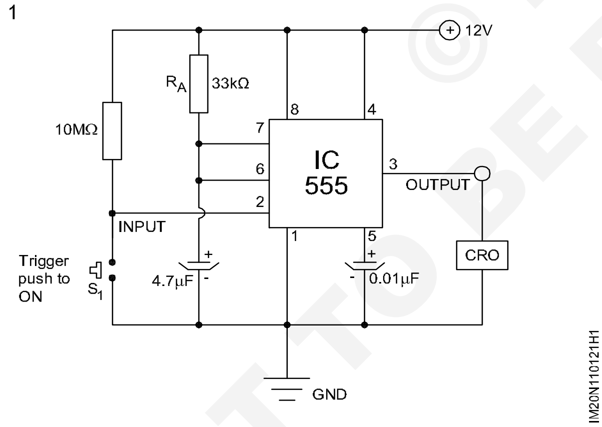
PROCEDURE

TASK 1: **Construction and testing of Monostable multivibrator circuit using IC 555**

1 Collect all the materials required and check them.

2 Assemble the monostable multivibrator on breadboard referring to the circuit diagram shown in Fig 1.

Fig 1



3 Get the assembled circuit checked by the instructor.

4 Switch ON the 12VDC supply to the circuit.

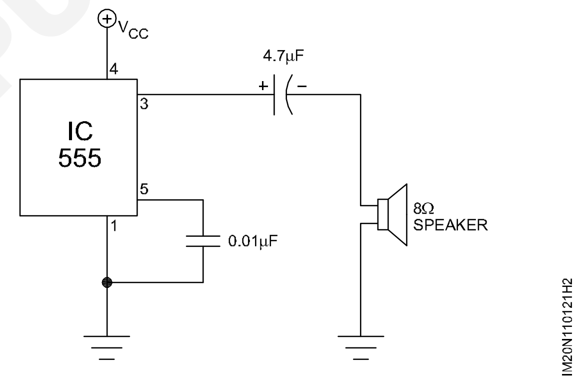
5 Prepare the CRO for measurements and connect the CRO at the output of the monostable multivibrator.

6 Press the push-button(trigger signal) and observe the output pulse on the CRO.

7 Keep pressing and releasing the trigger button and measure the ON-time(t_{ON}) of the output pulse. Record the reading in Table 1 & 2.

> **If the CRO has a storage option, use it to measure the pulse width conveniently. Take the help of the instructor to use the storage option.**

Fig 2



8 Connect the CRO probe at pin No. 2 of the IC; keep pressing and releasing the trigger button and observe the trigger input waveform on the CRO. Sketch the observed waveform in the space provided in the Table 2.

9 Change the value R_A from 33 KΩ to 1 MΩ. Connect the LED with a 330 Ω resistor in series at the output pin 3 to GND.

10 Switch ON DC supply to the circuit; press the push-button (trigger) and observe the LED glow for a few seconds and turn OFF again. Record your observation.

11 Connect a capacitor 4.7µF and a 8Ω, 2 inch speaker at the output in series with a capacitor as shown in Fig 3.

12 Switch ON the DC supply and listen to the audible sound from the speaker. Change the position of the preset 'RB' and check for changed frequency output from the speaker.

13 Measure and record output frequencies and duty cycle at four different positions of preset.

14 Get the working of astable multivibrator circuit and the recorded readings checked by the Instructor.

Note: **The frequency (or) PRF of Astable multivibrator is:**

- **f = =** $\dfrac{1.44}{(R + 2RB)C}$
- **t OFF = 0.693 x RB x C**
- **t ON = 0.693 (RA + RB) C**
- **D = Duty Cycle =** $\dfrac{(RA + RB)}{(RA + 2RB)}$

1 (a) Measured ON-time (t_{ON}) : ________________

(b) Measured OFF-time (t_{OFF}): ________________

(c) Measured pulse repetition frequency (PRF) : ________________

(d) Duty cycle : ________________

2 Rise time of pulse (Observed) : ________________

3 Fall time of pulse (Observed) : ________________

4 (a) Audible output heard from speaker : YES/NO

(b) Frequency/pitch of audible output from speaker varies with position of preset : YES/NO

Table 1

Resistance of preset RB	Output Frequency	Waveform on CRO

— — — — — —

Construct and test 555 timers as pulse width modulator

Objectives: At the end of this exercise you shall be able to
- **construct and test a PWM circuit using IC555 to generate pulse width modulated output.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Digital multimeter with probes - 1 No
- Regulated DC power supply 0-30V/2A - 1 No
- Function generator - 1 No
- AF signal generator - 1 No

Materials

- Breadboard - 1 No
- IC 555 - 1 No
- IC Base-8 pin - 1 No
- Diode 1N4001 - 1 No
- Resistor
  15kΩ, carbon, ¼ W - 1 No
  10kΩ, carbon, ¼ W - 1 No
  5.6kΩ, carbon, ¼ W - 1 No
- Capacitors 25V DC
  0.1µF, ceramic disc - 2 Nos
  10 µF - 1 No
- LED 5mm, Red - 1 No
- Push-button switch (Push-to-ON) - 1 No
- Hook up wires - as reqd

PROCEDURE

TASK 1 : **Construct and test of PWM circuit using IC 555**

1 Collect all the materials required identify the components as per the circuit diagram. Ensure working condition of the components by using multimeter and IC tester.

2 Assemble the PWM control circuit using IC 555 as shown in Fig 1.

3 Switch ON 12V DC power supply.

4 Connect the square wave input as carrier, from function generator. Set the waveform to the required duty cycle and AF signal as message.

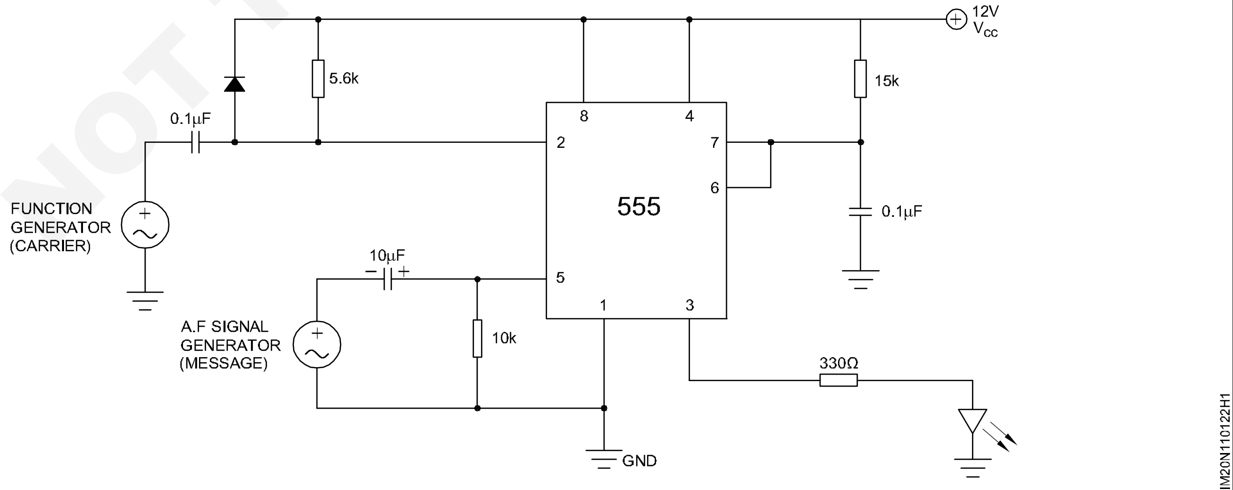
5 Observe the output LED at pin 3 and the brightness of the LED.

6 Prepare the CRO for measurement and observe the out waveform verify PWM frequency and duty cycle; record the waveform in Table 1.

Table 1

Function Generator frequency	A.F. Generator frequency	Output waveform	Remarks

Fig 1



7 Get the result checked by the Instructor.

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Verify the truth tables of all logic gate ICs by connecting switches and LEDs

Objectives: At the end of this exercise you shall be able to
- **construct AND, OR, NOT, NAND, NOR and EX-OR gates using ICs**
- **verify truth tables of AND, OR, NOT, NAND, NOR and EX-OR gates using switches and LEDs.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Regulated DC power supply 0-30V/2A - 1 No
- Digital multimeter with probes - 1 No

Materials

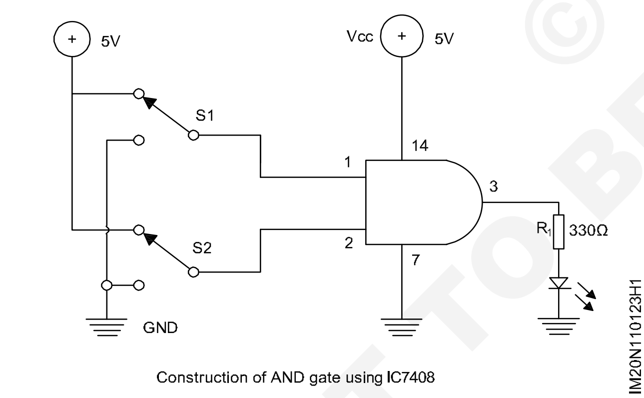
- Breadboard - 1 No
- IC 7408 - 1 No
- IC - 7432 - 1 No
- IC-7486 - 1 No
- IC-7400 - 1 No
- SPDT Switches (Miniature Toggle) - 2 Nos
- IC 7404 - 1 No
- Hook up wire, red and black - as reqd
- Flexible wires - as reqd
- Resistor/¼ W/CR25 - 1 No
- 330Ω - 1 No
- LED 5mm, Red - 1 No
- Data sheets of ICs used - as reqd

PROCEDURE

TASK 1 : **Construction and AND gate using IC 7408 and verification of its truth table**

1 Collect all the components, check them, refer to the data sheet of the IC 7408, assemble the AND gate as shown in Fig 1 on the bread board.

Fig 1



Construction of AND gate using IC7408

2 Use toggle switches S_1 as input A and switch S_2 as input B.

3 Get the assemble circuit checked by the Instructor.

4 Switch ON 5VDC supply and operate switches S_1 & S_2 for different levels either in 5V position or zero volt (GND) position as shown in Table 1.

5 Observe the status of LED for each step of combinations, record the observations in Table 1.

Table 1

Sl.No.	Input		Output LED status
	A	B	
1			
2			
3			
4			

AND gate Truth table

Sl.No.	Input		Output Y=A.B
	A	B	
1	0	0	0
2	0	1	0
3	1	0	0
4	1	1	1

6 Verify the readings with the truth table of AND gate.

7 Get the work checked by the Instructor.

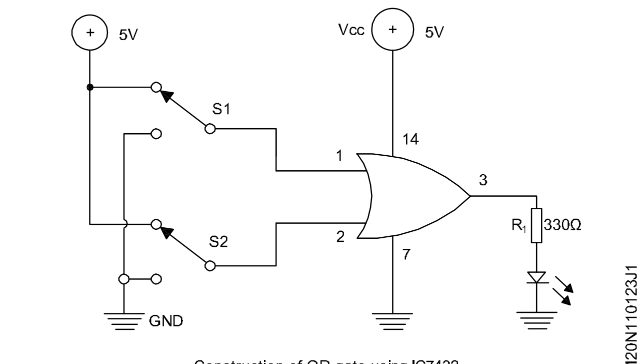
— — — — — —

TASK 2 : **Construction of OR gate using IC 7432 and verification of its Truth table**

1 Collect all the components, check them, refer to the data sheet of the IC 7432, assemble the OR gate as shown in Fig 2 on the bread board.

2 Repeat steps 2 to 5 of Task 1 and record the observations in Table 2.

Fig 1



Construction of OR gate using IC7432

3 Verify the readings with the truth table of OR gate.

4 Get the work checked by the Instructor.

Table 2

Sl.No.	Input		Output LED status
	A	B	
1			
2			
3			
4			

OR gate Truth table

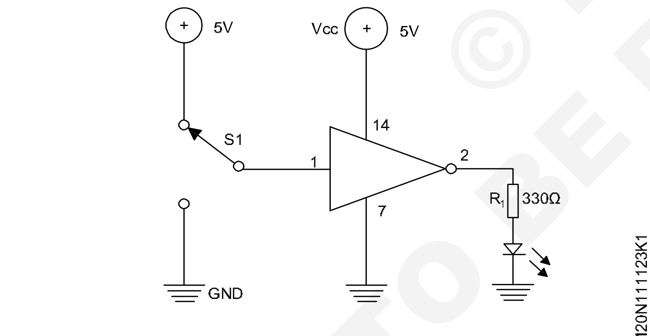
Sl.No.	Input		Output Y=A+B
	A	B	
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1

— — — — — —

TASK 3 : **Construction of NOT gate using IC 7404 and verification of its Truth table**

1 Collect all the components, check them, refer to the data sheet of the IC 7404, assemble the NOT gate as shown in Fig 3 on the bread board.

Fig 1



Construction of NOT gate using IC7404

2 Use toggle switches S_1 as input A.

3 Repeat steps 3 to 5 of Task 1 and record the observations in Table 3.

4 Verify the readings with the truth table of NOT gate.

5 Get the work checked by the Instructor.

Table 3

Sl.No.	Input	Output LED status
	A	
1		
2		

NOT gate Truth table

Sl.No.	Input A	Output Y=A
1	0	1
2	1	0

— — — — — —

TASK 4 : **Construction of NAND gate using IC 7400 and verification of its Truth table**

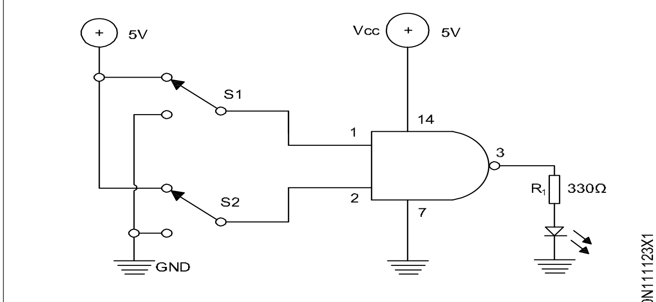
1 Collect all the components, check them, refer to the data sheet of the IC 7400, assemble the AND gate as shown in Fig 4 on the bread board.

2 Repeat steps 2 to 5 of Task 1 and record the observations in Table 4.

3 Verify the readings with the truth table of NAND gate.

4 Get the work checked by the Instructor.

Fig 1



Construction of NAND gate using IC7400

Table 4

Sl.No.	Input		Output LED status
	A	B	
1			
2			
3			
4			

NAND gate Truth table

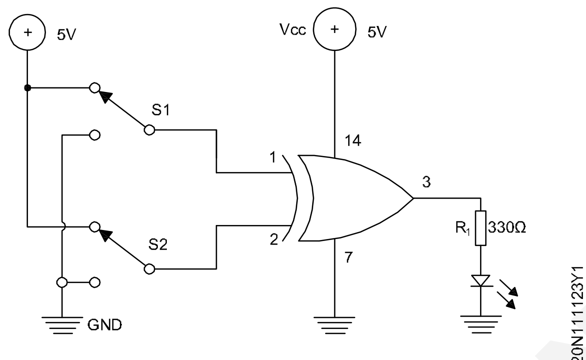
Sl.No.	Input		Output Y=A.B
	A	B	
1	0	0	1
2	0	1	1
3	1	0	1
4	1	1	0

— — — — — —

TASK 5 : **Construction of NOR gate using IC 7402 and verification of its Truth table**

1 Collect all the components, check them, refer to the data sheet of the IC 7402, assemble the NOR gate as shown in Fig 5 on the bread board.

Fig 1



Construction of EX-OR gate using IC7486

2 Repeat steps 2 to 5 of Task 1 and record the observations in Table 5.

3 Verify the readings with the truth table of NOR gate.

4 Get the work checked by the Instructor.

Table 5

Sl.No.	Input		Output LED status
	A	B	
1			
2			
3			
4			

NOR gate Truth table

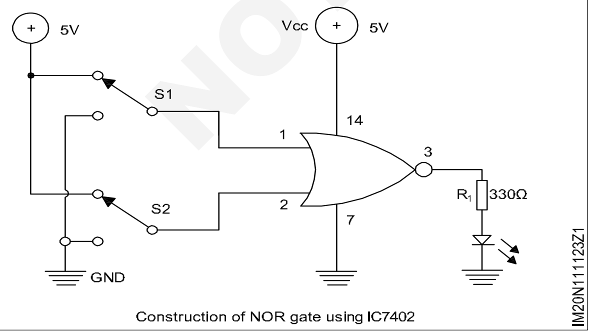
Sl.No.	Input		Output Y=A+B
	A	B	
1	0	0	1
2	0	1	0
3	1	0	0
4	1	1	1

— — — — — —

TASK 6 : **Construction of EX-OR gate using IC 7486 and verification of its Truth table**

1 Collect all the components, check them, refer to the data sheet of the IC 7486, assemble the EX-OR gate as shown in Fig 6 on the bread board.

Fig 1



Construction of NOR gate using IC7402

2 Repeat steps 2 to 5 of Task 1 and record the observations in Table 6.

3 Verify the readings with the truth table of EX-OR gate.

4 Get the work checked by the Instructor.

Table 5

Sl.No.	Input		Output LED status
	A	B	
1			
2			
3			
4			

NOR gate Truth table

Sl.No.	Input		Output Y=A+B
	A	B	
1	0	0	1
2	0	1	0
3	1	0	0
4	1	1	1

Construct and verify the truth table of all the gates using NAND and NOR gates

Objectives: At the end of this exercise you shall be able to
- **construct AND, OR, NOT, NOR, EX-OR and EX-NOR gates using NAND gate**
- **construct AND, OR, NOT, NAND, EX-OR and EX-NOR gates using NOR gates.**

Requirements

Tools/Equipments/Instruments

- Logic probe - 1 No
- Trainees tool kit - 1 Set
- Regulated DC power supply 0-30V/2A - 1 No
- Digital multimeter with probes - 1 No

Materials

- Digital IC data manual - 1 No
- IC 7400 - 2 Nos
- IC 7402 - 2 Nos
- Hook up wires - as reqd
- 14 pin IC base - 4 Nos
- Toggle switches miniature type SPDT - 2 Nos
- Bread board - 1 No
- LED 5mm, Red - 1 No
- Resistor - 330Ω/1/4Ω - 1 No

1 The Instructor has to guide the trainees to record 5VDC given to gate input as logic high (1) and GND (zero volt) as logic low (0)

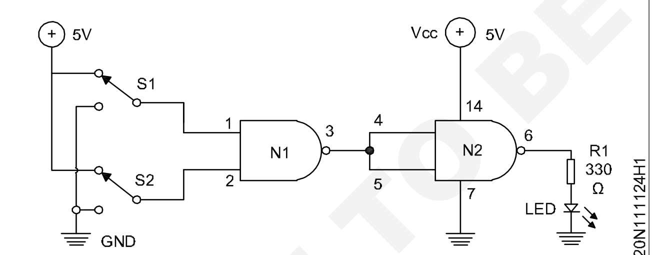
2 The condition of LED ON as Logic '1' and OFF as logic '0'.

PROCEDURE

TASK 1: **Construction of AND gate circuit using NAND gate IC 7400 and verification of its truth table**

1 Collect all the components, check them, refer to the data sheet of the IC 7400, assemble the AND gate as shown in Fig 1 on the bread board.

Fig 1



NAND gates used as AND gate

2 Use toggle switches S_1 as input A and switch S_2 as input B.

3 Get the assembled circuit checked by the Instructor.

4 Switch ON 5VDC supply and operate switches S_1 & S_2 for different logic levels either in 5V position or zero volt position as shown in Table 1.

5 Observe the LED for each step of combinations, record the observations in Table 1.

AND gate Truth table

Sl.No.	Input		Output Y=A.B
	A S_1	B S_2	
1	0	0	0
2	0	1	0
3	1	0	0
4	1	1	1

Table 1

Sl.No.	Input		Output LED Condition
	A S_1	B S_2	
1			
2			
3			
4			

6 Get the work checked by the Instructor.

— — — — — —

TASK 2: **Construction of OR gate circuit using NAND gate and verification of its truth table**

1 Rearrange the connections and assemble the OR gate circuit using NAND gates as shown in Fig 2 on bread board.

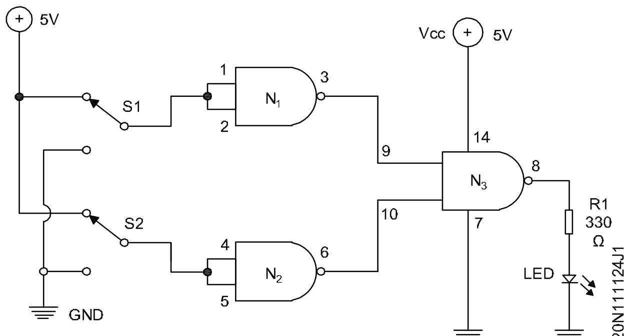
2 Repeat steps 2 to 5 of Task 1 and record the observations in Table 2.

3 Verify the readings with the truth table of OR gate.

4 Get the work checked by the Instructor.

Note: Use logic probe to check the status of each pin to confirm the functioning of each gate.

Fig 1



NAND gates used as OR gate

OR gate Truth table

Sl.No.	Input		Output Y=A+B
	A	B	
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1

Table 2

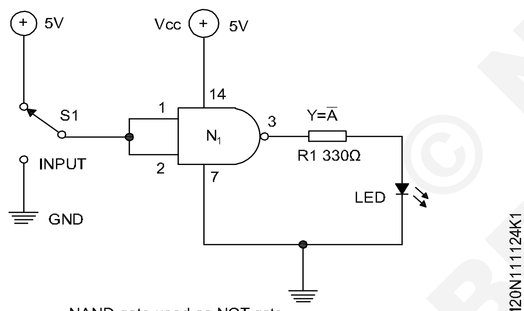
Sl.No.	Input		Output LED
	A	B	
1			
2			
3			
4			

— — — — — —

TASK 3: **Construction of NOT gate circuit using NAND gate and verification of its truth table**

1 Rearrange the connections and assemble the NOT gate circuit using NAND gates as shown in Fig 3 on bread board.

Fig 1



NAND gate used as NOT gate

2 Use toggle switch S_1 as input A.

3 Repeat steps 3 to 5 of Task 1 and record the observations in Table 3.

4 Get the work checked by the Instructor.

NOT gate Truth table

Sl.No.	Input	Output Y=A
	A	
1	0	1
2	1	0

Table 3

Sl.No.	Input	Output LED
	A	
1	0	
2	1	

— — — — — —

TASK 4: **Construction of AND gate using NOR gate IC 7402 and verification of its truth table**

1 Collect all the components, check them, refer to the data sheet of the IC 7402, assemble the AND gate as shown in Fig 7 on the bread board.

2 Repeat steps 2 to 5 of Task 1, and record the observations in Table 7.

3 Verify the readings with the truth table of AND gate.

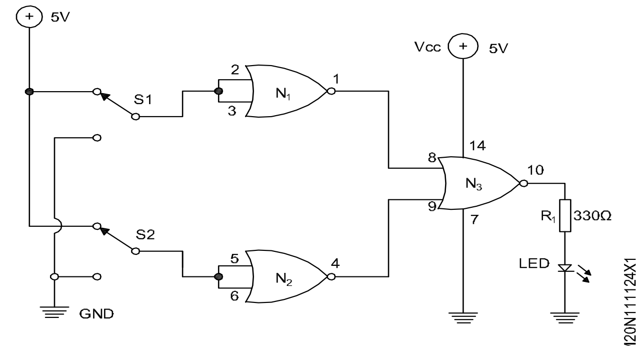
4 Get the work checked by the Instructor.

Note: Use logic probe to check the status of each pin to confirm the functioning of each gate.

AND gate Truth table

Sl.No.	Input		Output Y=A.B
	A	B	
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1

Fig 1



NOR gates used as AND gate

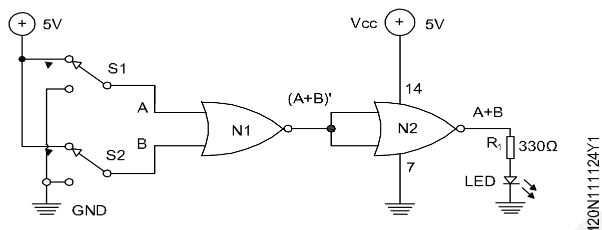
Table 7

Sl.No.	Input		Output LED
	A	B	
1 2 3 4			

TASK 5: **Construction of OR gate using NOR gate IC 7402 and verification of its truth table**

1 Collect all the components, check them, refer to the data sheet of the IC 7402, assemble the OR gate as shown in Fig 8 on the bread board.

Fig 1



NOR gates used as OR gate

2 Repeat steps 2 to 5 of Task 1, and record the observations in Table 8.

3 Verify the readings with the truth table of OR gate.

4 Get the work checked by the Instructor.

Note: Use logic probe to check the status of each pin to confirm the functioning of each gate.

OR gate Truth table

Sl.No.	Input		Output Y=A+B
	A	B	
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1

Table 8

Sl.No.	Input		Output LED
	A	B	
1 2 3 4			

TASK 6: **Construction of NOT gate using NOR gate IC 7402 and verification of its truth table**

1 Collect all the components, check them, refer to the data sheet of the IC 7402, assemble the NOT gate as shown in Fig 9 on the bread board.

2 Repeat steps 2 to 5 of Task 9, and record the observations in Table 9.

3 Verify the readings with the truth table of NOT gate.

4 Get the work checked by the Instructor.

Fig 1

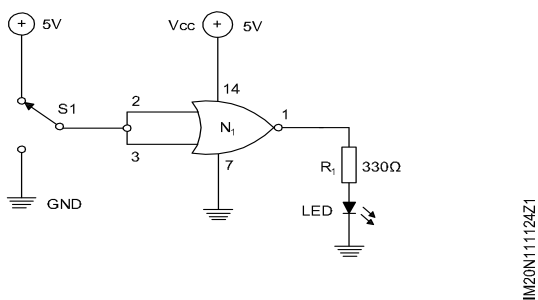


Table 6

Sl.No.	Input	Output LED
	A	
1		
2		

Use digital IC tester to test various digital ICs (TTL and CMOS)

Objectives: At the end of this exercise you shall be able to
- **identify the IC manufacturers' names from the logo given on the IC and manufacturers data**
- **identify IC code number printed on the given digital IC**
- **identify the type of package of the given digital IC (TTL and CMOS)**
- **identify the logic family of the given digital IC referring databook**
- **identify the pin numbers of the given Digital IC referring data book**
- **test the given IC using digital IC tester.**

Requirements

Tools/Equipments/Instruments

- Digital IC databook - 1 No
- Digital IC tester with manual - 1 No
- DMM with probes - 1 No

Materials

- Assorted Digital ICs (both TTL and CMOS types) - 10 Nos
- Breadboard - 1 No
- Hook up wires - as reqd

Note: The Instructor has to label all the ICs serially

Keep a minimum of 20 numbers of assorted labeled TTL and CMOS ICs for thtis exercise. Instruct the trainees to pick one IC at a time and carryout the exercise.

Demonstrate setting the controls and testing ICs using digital IC tester. No detailed procedure for using IC tester is given as different IC testers used in different institures may have different operating procedures and specification.

PROCEDURE

1 Identify operator controls, switches and IC socket on the digital IC tester as shown in Fig 1 with reference to the manual.

2 Pick one of the labeled IC from the assorted lot and record its label number.

3 Refer to the data manual interpret the manufacturer’s logo given on the IC or alphabets used for the IC type identify and record the details in Table 1.

4 Identify and record the logic family supply voltage and function of the IC referring the data manual.

5 Count and record the number of pins on the IC.

6 As demonstrated by the instructor, test and record the condition of the IC using digital IC tester for atleast 10 different ICs both in TTL and CMOS types.

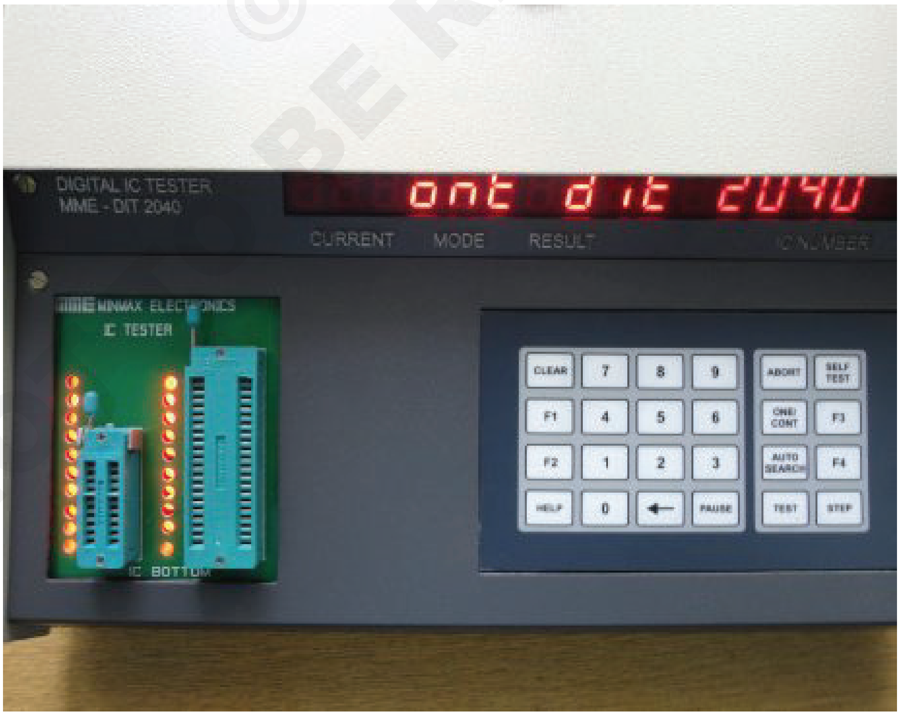
Note: Follow the procedure demonstrated by the instructor for setting the controls on digital IC tester while testing the IC.

7 Get the recorded information checked by the instructor for 10 different ICs.

TABLE 1

Sl. No.	Label No. IC	Code No. of IC	No.of pins	Logic family	Function	Package type	Maximum V_{CC} voltage	Condion of IC tested
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Fig 1



DIGITAL IC TESTER

Construct and verify the truth table of all the gates using DTL circuit

Objectives: At the end of this exercise you shall be able to
- **construct and verify the truth table of NOT gate using DTL circuit**
- **construct and verify the truth table of AND gate using DTL circuit**
- **construct and verify truth table of OR gate using DTL circuit**
- **construct and verify truth table of NAND gate using DTL circuit**
- **construct and verify truth table of NOR gate using DTL circuit.**

Requirements

Tools/Equipments/Instruments/Data manual

- Trainees tool kit - 1 set
- DMM with probes - 1 No

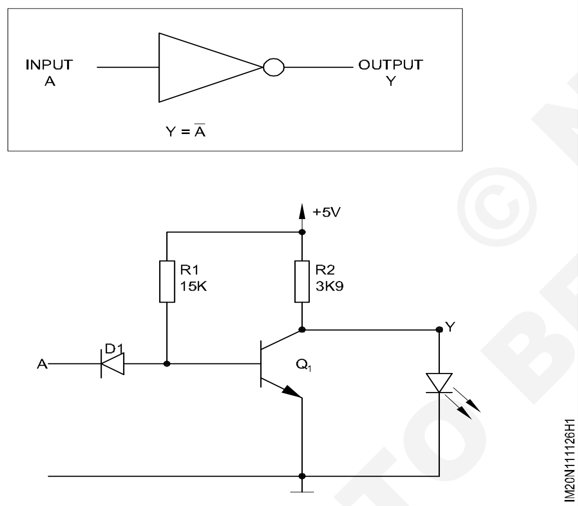
Materials/Components

- Breadboard - 1 No
- Connecting patch cards - as reqd
- Diode IN 4001 - 10 Nos
- Transistor BC547 - 10 Nos
- Zener Diode Z9V1 - 10 Nos
- Resistors +5k - 8 Nos
- Resistors 3 K - 8 Nos
- LED Red color - 5 Nos

PROCEDURE

TASK 1: **Construct and verify the truth table of NOT gate using DTL circuit**

Fig 1



1 Collect the equipment and component and check the items for its good working condition.

2 Connect them as in the circuit diagram (Fig 1).

3 Switch ON the input supply it

4 Verify the truth table and note it table 1.

5 Get the work checked by the instructor.

Truth Table 1

Input	**Output**
A	Y
1	
0	

— — — — — —

TASK 2: **Construct and verify the truth table of AND gate using DTL circuit**

1 Collect the equipments and components and check the items for its good working condition.

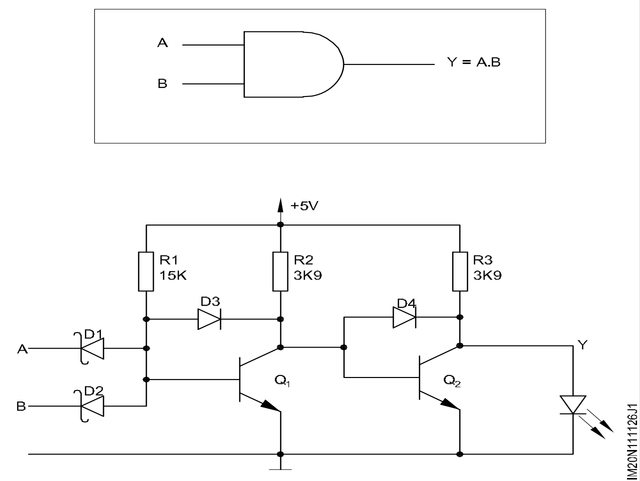
2 Connect them as in the circuit diagram (Fig 2).

3 Switch ON the input supply.

4 Verify the truth table of AND gate and note it in the table 2.

5 Get the work checked by the instructor.

Fig 1



Truth Table 2

Input		Output
A	B	Y
1	0	
0	1	
1	0	
1	1	

— — — — — —

TASK 3: **Construct and verify the truth table of OR gate using DTL circuit**

1 Collect the equipments and components and check the items for its good working condition.
2 Connect them as in the circuit diagram (Fig 3).
3 Switch ON the input supply.
4 Verify the truth table of OR gate and note it the table 3.
5 Get the work checked by the instructor.

Truth Table 3

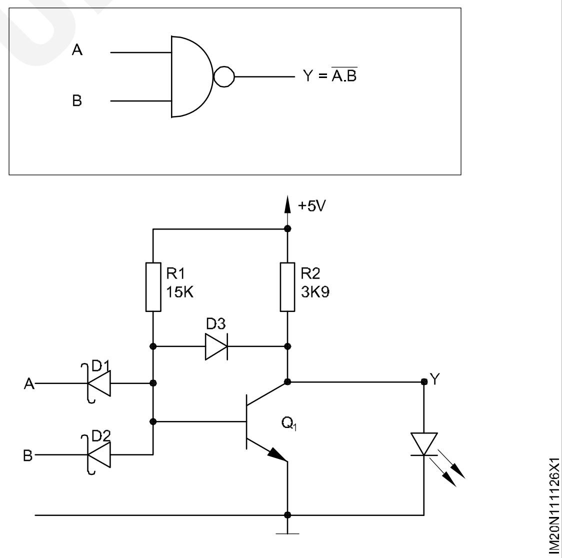
Input		Output
A	B	Y
0	0	
0	1	
1	0	
1	1	

— — — — — —

TASK 4: **Construct and verify the truth table of NAND gate using DTL circuit**

1 Collect the equipments and components and check the items for its good working condition.
2 Connect them as in the circuit diagram (Fig 4).
3 Switch ON the input supply.
4 Verify the truth table of NAND gate and note it the table 4.
5 Get the work checked by the instructor.

Fig 1



Truth Table 4

Input		Output
A	B	Y
0	0	
0	1	
1	0	
1	1	

— — — — — —

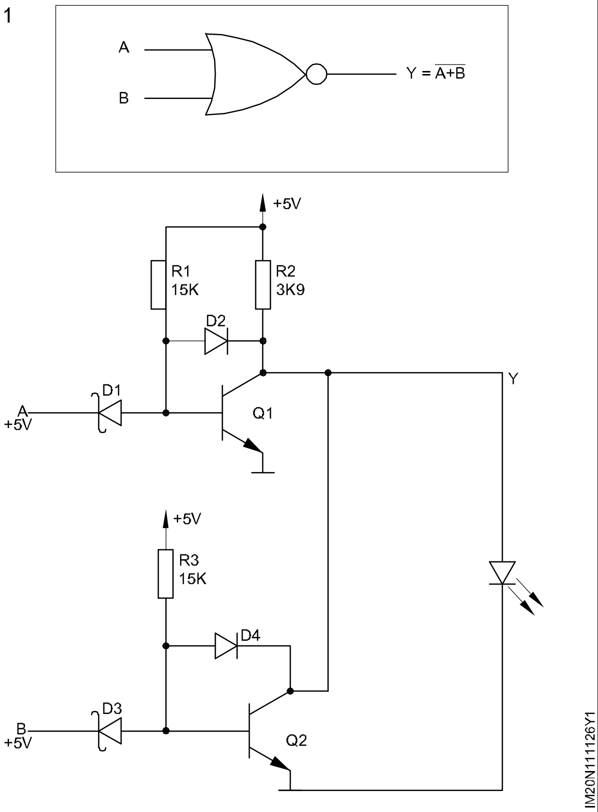
TASK 5: **Construct and verify the truth table of NOR gate using DTL circuit**

1 Collect the equipments and components and check the items for its good working condition.
2 Connect them as in the circuit diagram (Fig 4).
3 Switch ON the input supply.
4 Verify the truth table of NOR gate and note it the table 5.
5 Get the work checked by the instructor.

Truth Table 5

INPUT		OUTPUT
A	B	Y
0	0	
0	1	
1	0	
1	1	

Fig 1



A
B
Y = $\overline{A+B}$
+5V
R1
15K
R2
3K9
D2
D1
A
+5V
Q1
Y
+5V
R3
15K
D4
D3
B
+5V
Q2
IM20N111126Y1

— — — — — —

Construct half adder circuit using ICs and verify the truth table

Objective: At the end of this exercise you shall be able to
- **construct the half adder circuit and verify the truth table.**

Requirements

Tools/Equipments/Instruments

- Soldering iron 25W/230V - 1 No
- Logic probe - 1 No
- Trainees tool kit - 1 Set
- Regulated DC power supply 0-30V/2A - 1 No
- Digital multimeter with probes - 1 No

Materials

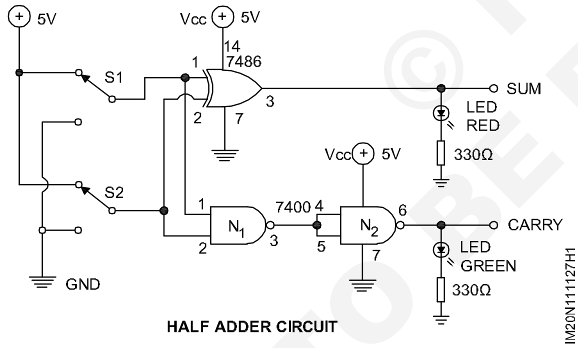
- IC-7486 with base - 1 No
- IC-7400 with base - 1 No
- Data sheet of ICs used - 1 No each
- LED 5mm Red, Green - 2 Nos
- Resistor 330Ω/¼ W/CR25 - 2 Nos
- Miniature toggle switch SPDT - 3 Nos
- Breadboard - 1 No
- Solder, flux - as reqd
- Hook up wires - as reqd

PROCEDURE

TASK 1: **Construction of Half Adder circuit and verification of truth table**

1 Collect all the components, check them and assemble the Half adder circuit as shown in Fig 1on breadboard.

Fig 1



HALF ADDER CIRCUIT

Use 14 pin IC base on the bread board for this task.

2 Use toggle switch S_1 as input A and switch S_2 as input B.

3 Get the assembled circuit checked by the Instructor.

4 Switch ON 5VDC supply and operate switches S1 & S2 for different logic levels either in 5V position for zero volt (GND) position as shown in Table 1.

5 Observe the LEDs for each step of combinations, record your observations in Table 1.

6 Verify readings with truth table of Half Adder.

Use logic probe to check the status of each pin to confirm the functioning of the gate.

Truth Table of Half Adder

Sl.No.	Input		Output	
	A	B	Sum	Carry
1	0	0	0	0
2	0	1	1	0
3	1	0	1	0
4	1	1	0	1

Table 1

Sl.No.	Input		Output	
	A	B	Sum	Carry
1	0	0	0	0
2	0	1	1	0
3	1	0	1	0
4	1	1	0	1

7 Get the work checked by the instructor.

— — — — — —

Construct Full adder with two Half adder circuit using ICs and verify the truth table

Objective: At the end of this exercise you shall be able to
- **construct and test full adder using half adder circuits.**

Requirements

Tools/Equipments/Instruments

- Soldering iron 25W/230V - 1 No
- Logic probe - 1 No
- Trainees tool kit - 1 Set
- Regulated DC power supply 0-30V/2A - 1 No
- Digital multimeter with probes - 1 No

Materials

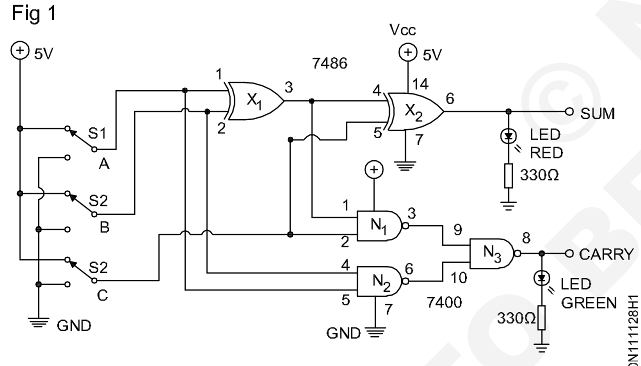
- IC-7486 with base - 1 No
- IC-7400 with base - 1 No
- Data sheet of ICs used - as reqd
- LED 5mm Red, Green - 1 No each
- Resistor 330Ω/¼ W/CR25 - 2 Nos
- Miniature toggle switch SPDT - 3 Nos
- Breadboard - 1 No
- Solder, flux - as reqd
- Hook up wires - as reqd

PROCEDURE

TASK 1 : **Construction of Full Adder using two Half Adder circuits and verification of truth table**

1 Collect all the components, check them and assemble the Full adder circuit as shown in Fig 1on breadboard.

Fig 1



FULL ADDER CIRCUIT

2 Use toggle switch S_1 as input A and switch S_2 as input B and switch S_3 as inpuct C.

3 Get the assembled circuit checked by the Instructor.

4 Switch ON 5VDC supply and operate all the switches for different logic levels either in 5V position for zero volt (GND) position as shown in Table 1.

5 Observe the LEDs for each step of combinations, record the observations in Table 1.

6 Verify readings with truth table of Half Adder.

> **Note: Use logic probe to check the status of each pin to confirm the functioning of the gate.**

Truth table of Full Adder

Sl.No.	Input			Output	
	A	B	C	Sum	Carry
1	0	0	0		
2	0	0	1		
3	0	1	0		
4	0	1	1		
5	1	0	0		
6	1	0	1		
7	1	1	0		
8	1	1	1		

Table 1

Sl.No.	Input			Output	
	A	B	C	Sum	Carry
1					
2					
3					
4					
5					
6					
7					
8					

7 Get the work checked by the instructor.

— — — — — —

Construct test and verify truth table of Half subtractor & full subtractor circuits

Objectives: At the end of this exercise you shall be able to
- **construct and verify truth table of half subhack**
- **construct and verify truth table of full subtractor.**

Requirements

Equipments/Instruments

- Resistor (1K)Ω - 5 Nos
- ICs (XOR-7486, AND-7408, OR-7432, NOT-7404) - 1 No
- A surface mount dip switch - 1 Set
- DC power supply (5V) - 1 Set
- Red/Green LEDs - 2 Nos.
- Connecting wires - 1 No
- Breadboard - 1 No

PROCEDURE

TASK 1 : **Construct test and verify truth table of half subtractor**

1 Construct an half subtractor circuit as given in Fig 1 on the given bread board.

2 Connect the ICs properly to power supply (pin 14) and ground (pin 7) following the schematics for different ICs as shown in Fig 3.

3 Using dip switch and resistors, facilitate all possible combinations of inputs from the power supply.

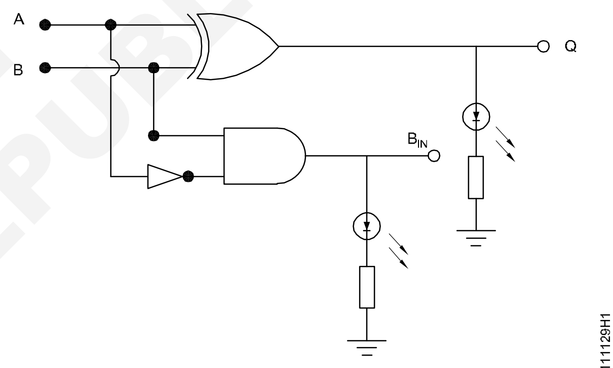
4 Turn on power to your experimental circuit.

5 For each input combination, note the logic state of the outputs as indicated by the LEDs (ON = 1; OFF = 0), and record the result in the table 1.

6 Compare your results with the truth table for operation.

7 When you are done, turn off the power to your experimental circuit.

Fig 1



HALF SUBTRACTOR

— — — — — —

TASK 2: **Construct test and verify truth table by full subtractor**

1 Construct an full subractor circuit as given in Fig 2 on the given bread board.

2 Connect the ICs properly to power supply (pin 14) and ground (pin 7) following the schematics for different ICs as shown in Fig 3.

3 Using dip switch and resistors, facilitate all possible combinations of inputs from the power supply.

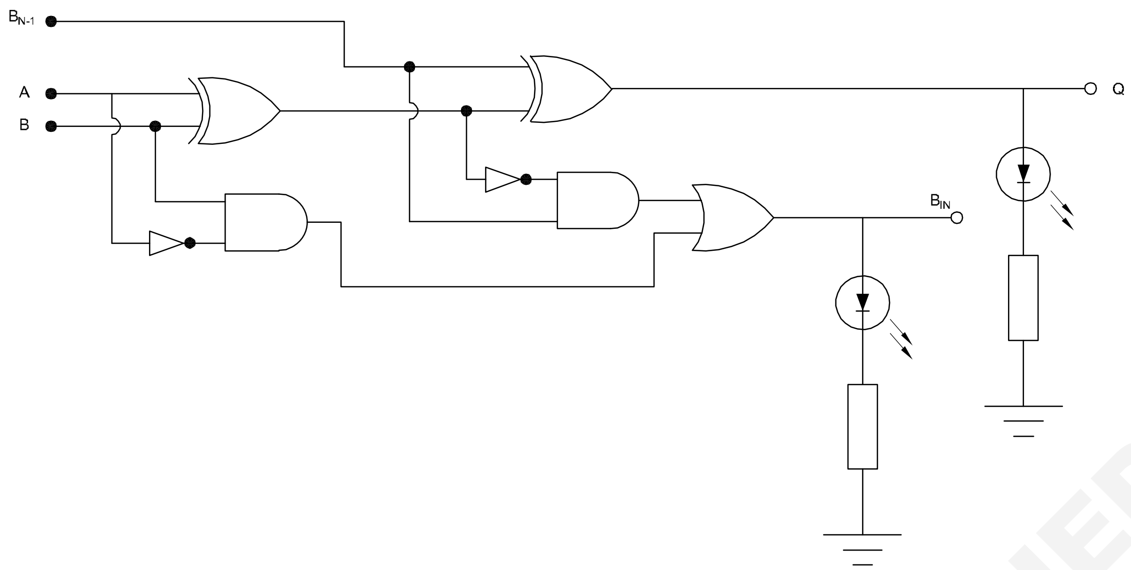
4 Turn on power to your experiment circuit.

5 For each input combination, note the logic state of the outputs as indicated by the LEDs (ON=1; OFF=0), and record the result in the table 2.

6 Compare your results with the truth table for operation.

7 When you are done, turn off the power to your experiemental circuit.

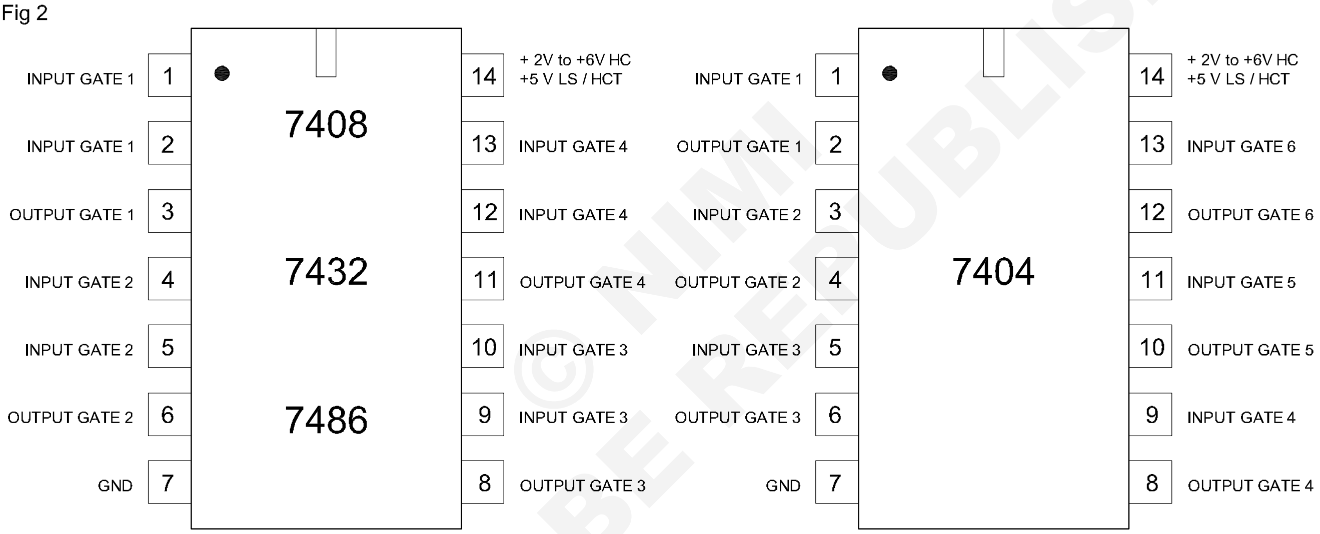
Fig 1



FULL SUBTRACTOR

IM20N111129J1

Fig 2



PIN DIAGARAM OF ICS

IM20N111129J2

Table 1

Half Subtractor

A	B	Q	B_{IN}
0	0		
0	1		
1	0		
1	1		

Table 1

Full Subtractor

B_{N-1}	A	B	Q	B_{IN}
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

— — — — — —

Construct the adder cum subtractor circuit and verify the result

Objectives: At the end of this exercise you shall be able to
- **construct a 4 bit binary adder circuit using IC 7483, IC7486 and verify the result**
- **construct a 4 bit binary subtractor circuit using IC7483, IC7486 and verify the result.**

Requirements

Tools/Equipments/Instruments

- Soldering iron 25W/230V - 1 No
- Trainees tool kit - 1 Set
- Regulated DC power supply 0-30V/2A - 1 No
- Digital multimeter with probes - 1 No
- Logic probe - 1 No
- Data sheet of ICs used - as reqd

Materials

- Miniature toggle switch SPDT - 3 Nos
- IC-7486 with base (14 pin) - 1 No
- IC-7483 with base (16 pin) - 1 No
- Breadboard - 1 No
- Solder, flux - as reqd
- Connecting wires - as reqd
- Resistor 330Ω ¼ W/CR25 - 2 Nos
- Hook up wires - as reqd
- LED 5mm, Red - 4 Nos
- LED 5mm, Green - 1 No
- Resistor 330W/¼ W/CR25 - 5 Nos

PROCEDURE

TASK 1: **Construction and testing of 4 bit binary adder circuit**

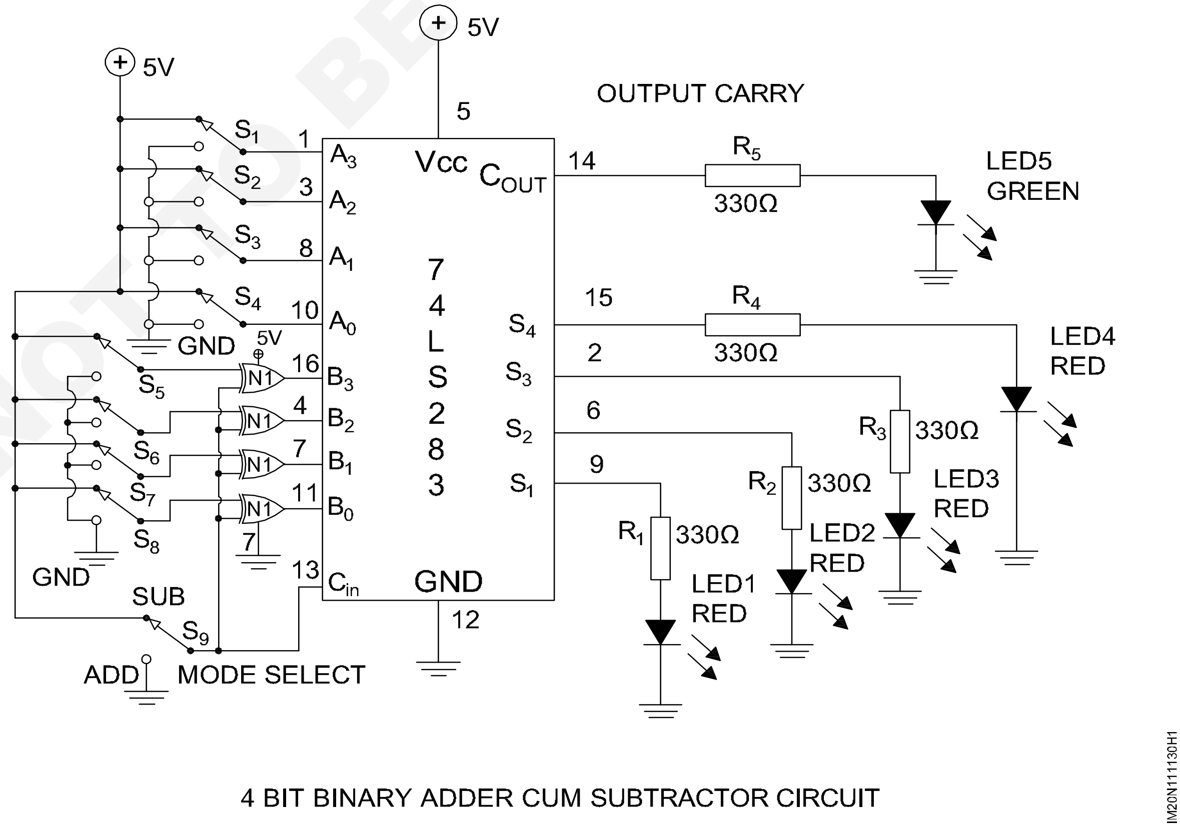
1 Collect all the components required, test them refer to the data sheet of ICs, asssemble the 4 bit binary adder circuit as shown in Fig 1 on bread board.

2 Use toggle switch S_1 as data input A_0, switch S_2 as data input A_1, and switch S_3 as data input A_2, and switch S_4 as data input A_3 as shown in Fig 1.

3 Use toogle switch S_5 as data input B_0, switch S_6 as data input B_1, and switch S_7 as data input B_2, and switch S_8 as data input B_3 and switch S_9 as mode select switch as shown in Fig 1.

4 Get the assembled circuit checked by the Instructor.

Fig 1



4 BIT BINARY ADDER CUM SUBTRACTOR CIRCUIT

5 Switch ON 5VDC supply and operate switches S_1 to S_8 for different logic levels either in 5V position or zero volt (GND) position keeping the switch S_9 at END positon to operate the circuit as 4 bit binary adder as shown in Table 1.

6 Observe the status of all the five LEDs for each step of combinations record them in Table 1.

Table 1

Sl.No	Inputs				Inputs					Mode switch=OV					Mode switch=5V				
										Status of LEDs					Status of LED				
	A_3	A_2	A_1	A_0	B_3	B_2	B_1	B_0	$Carry_{out}$	Q_3	Q_2	Q_1	Q_0	C_{out}	Q_3	Q_2	Q_1	Q_0	$Carry_{out}$
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			

7 Get the work checked by the Instructor.

— — — — — —

TASK 2: **Construction and testing of 4 bit binary subtractor circuit**

Use the assembled circuit for 4 bit binary subtractor function/operation with following steps.

1 Set/toggle the mode select switch S_9 to 5VDC position (Logic '1')

2 Switch ON 5VDC supply and operate switches S1 to S8 for different logic levels either in 5V position or zero volt (GND) position as shown in Table 1.

3 Observe the status of all the five LEDs for each step of combinations and record them in Table 1.

4 Get the work checked by the Instructor.

— — — — — —

Construct and test R-S Flip-flop using IC 7400 with clock and without clock pulse

Objectives: At the end of this exercise you shall be able to
- **construct and test R-S flip-flop using IC 7400 without clock pulse**
- **construct and test RS flip-flop with clock pulse.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- DC power supply 0-30VDC/2A - 1 No
- Digital multimeter with probes - 1 No

Materials

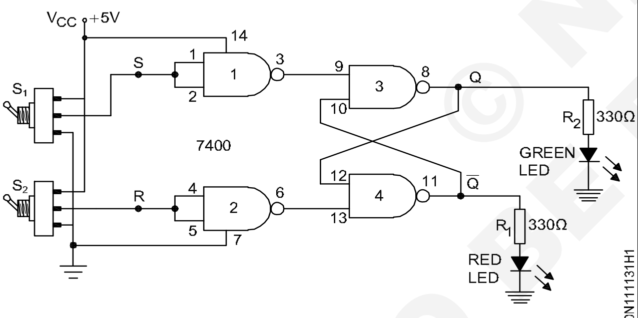
- Breadboard - 1 No
- IC-7400 NAND gate with data sheet - 1 No
- Miniature toggles switch - 2 Nos
- Hook up wires - as reqd
- LED 5mm, Red, Green - 1 No each
- Resistor 330Ω/¼ W/CR25 - 2 Nos

PROCEDURE

TASK 1: **Construction and testing of R-S Flip-Flop without clock pulse using IC 7400**

1 Collect all the components required, check them and assemble the RS flipflop circuit on the breadboard as shown in Fig 1.

Fig 1



R-S FLIP-FLOP CIRCUIT USING NAND GATE

2 Get the assembled RS flipflop circuit checed by the Instructor.

3 Switch ON 5DVC supply to the circuit, use switches S_1 and S_2 for setting input logic levels as shown in Fig 1.

4 Operate the switches to apply different logic levels and observe corresponding output.

5 Record the status of LEDs for each step of logic levels.

Table 1

RS flip-flop using NAND gate

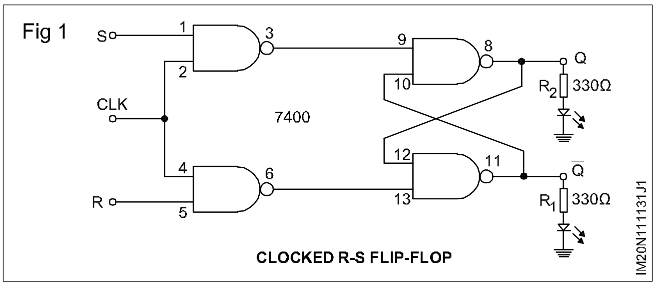
Input		Output				
S	**R**	**Q**	**Q - LED Status (ON/OFF)**	**Q**	**Q - LED Status (ON/OFF)**	**Operating Mode**
0	**1**					**Set**
1	**1**					**No Change**
1	**0**					**Reset**
1	**1**					**No Change**
0	**0**					**Forbidden**

6 Get the work checked by the Instructor.

— — — — — —

TASK 2 : **Construction and testing of RS flipflop with clock pulse using IC 7400**

1 Modify the RS flipflop circuit into clocked RS flipflop circuit as shown in Fig 2.



2 Connect switches S1 and S2 at R and S inputs respectively.

3 Switch ON 5VDC supply to the circuit, operate switches S1,S2 apply differnt logic levels to the input keeping clock input at ground/negative.

4 Observe the status of LEDs for the above four steps and record in Table 2.

5 Connect the clock input to +5VDC and repeat steps 3 and 4 and record the obsevations for next four steps.

Table 2

Clock Input	**Input**		**Output**			
	S	**R**	**Q**	**Q-LED Status (ON/OFF)**	**Q**	**Q-LED Status (ON/OFF)**
0	0	1				
0	1	0				
0	1	1				
0	0	0				
1	0	1				
1	0	0				
1	1	0				
1	0	0				
1	1	1				

6 Get the work checked by the Instructor.

— — — — — —

Verify the truth tables of JK Flipflop using ICs by connecting switches and LEDs

Objectives: At the end of this exercise you shall be able to
- **construct and verify the truth table of JK flip flop by connecting switches and LEDs.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1Set
- DC power supply - 0-30V/2A - 2 Nos
- DMM with probes - 1 No

Materials

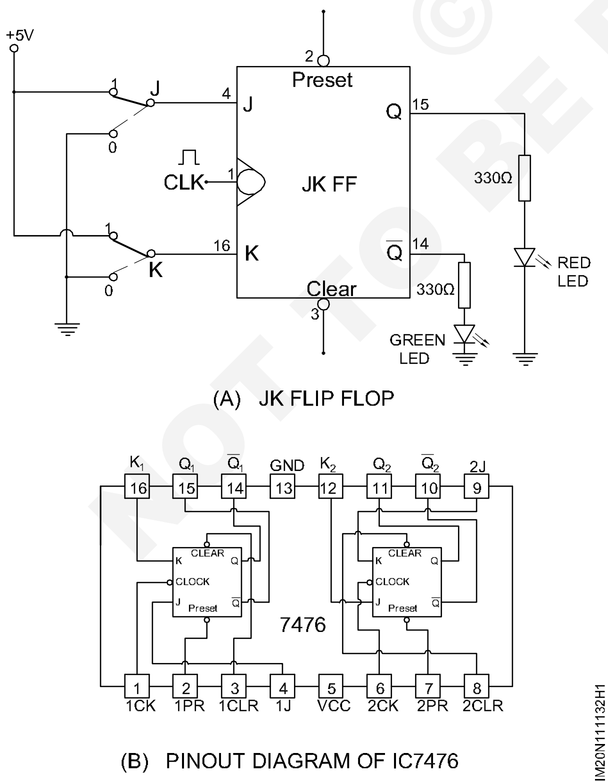
- Breadboard - 1 No
- IC 74 HC00 (Quad Nand Gate) - 2 Nos
- IC 74LS10 (3 Input NAND) - 1 No
- IC MC74HC 73 (Dual/JKFlip-Flop) - 1 No
- IC 74LS76 (JK-FF) - 1 No
- Resistors 330Ω/¼ W/CR25 - 4 Nos each
- LED (Red,Green) - 1 No each
- Toggle switch - 4 Nos
- Connecting wire - as reqd
- Battery (9V) - as reqd
- Semicondutor digital IC-Data manual
- Charts

PROCEDURE

TASK 1: **Construction of JK flipflop circuit and verification of the truth table.**

- Assemble a JK flip-flop circuit by referring to Fig 1 on a bread board.

Fig 1



(A) JK FLIP FLOP

(B) PINOUT DIAGRAM OF IC7476

- Get the circuit checked by the Instructor.
- Apply different Inputs to J and K, as given in truth table 4 and record the corresponding output levels and the status of the LED.
- Thus for different inputs at JK flip-flop corresponding output can be seen through LED Q and Q.
- Get the work checked by the Instructor.

Table 1

Truth table of JK Flip Flop

Clock Input H/L	Inputs				Outputs	
	Preset	Clear	J	K	Q	$\overline{Q}$
X	0	0	X	X	1	1
X	0	1	X	X	1	0
X	1	0	X	X	0	1
L	1	1	0	0	0	Q
L	1	1	1	0	1	0
L	1	1	0	1	0	1
L	1	1	1	1	Toggles	Toggles
L	1	1	X	X	Q	$\overline{Q}$

Construct and test 7493 as a modulus-12 counter

Objectives: At the end of this exercise you shall be able to
- **construct and test modulus 12 counter using TTL IC-7493.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- DC power supply 0-30V/2A - 1 No
- DMM with probes - 1 No
- Clock pulse generator - 1 No
- Dual trace CRO-20 MHz - 1 No

Materials

- Breadboard - 1 No
- IC 7493 - 1 No
- LED 5mm, Red - 5 Nos
- Resistor 330Ω/¼ W/CR25 - 5 Nos
- Connecting wire (hook - up) - as reqd
- IC 7447 & 7 segment display - 1 Set

The 7493 is a four - bit ripple type binary counter. It consists of four flip-flops which are connected as shown in Figure below. In order to function as a four-bit counter, CP1 must be externally connected to QA. If both the master reset pins MR1 and MR2 are raised high, the four-bit flip-flops are reset to zero.

PROCEDURE

1 Connect the modulus 12 counter using 7493 on bread board referring to circuit shown in Fig 1 & 2.

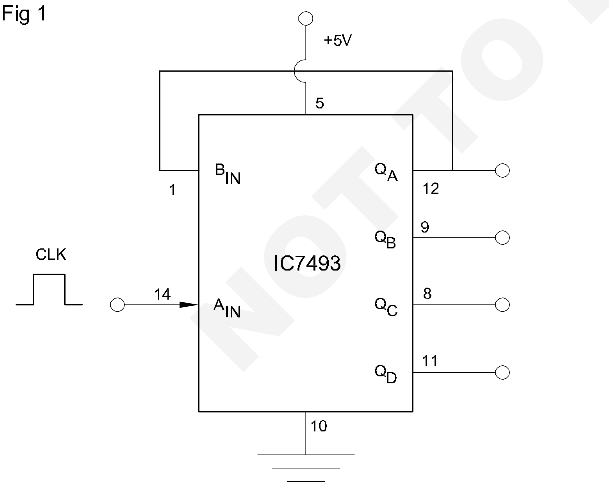
2 Connect Q_C & Q_D (pins 8 & 11) to MR_1 & MR_2 (pins 2 &3) respectively.

3 Get the assembled circuit checked by the instructor

4 Switch on +5V regulated DC power supply.

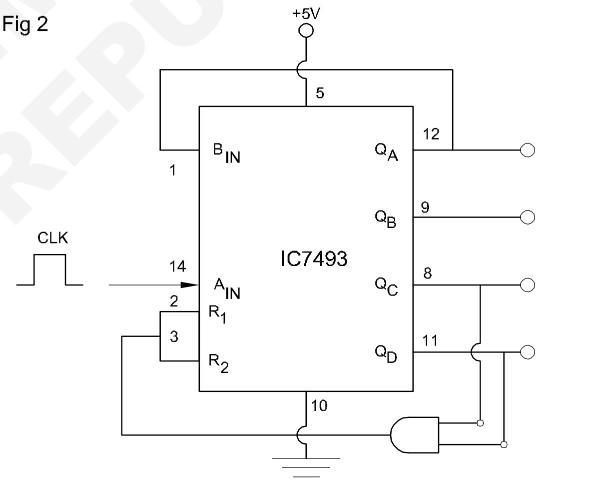
5 Press CLEAR-A & CLEAR-B push buttons switch once, to clear the outputs of all flip flops.

Fig 1



4 BIT COUNTER

Fig 2



MOD-12 COUNTER

6 Record the Q-outputs (Q_A to Q_D) of all the 4-flip flops based on the LEDs status.

7 Apply one clock pulse at the input (first PIN of IC-7493 i.e Cp_1) using the single shot pulser.

8 Record the output logic levels and the status of LEDs A,B,C,D in Table 1.

9 Repeat the steps with 7-segment driver IC 7447 & 7seg display as shown in Fig 3 of Ex 2.9.159.

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Construct and test seven segment LED Display decoder with IC 7447

Objectives: At the end of this exercise you shall be able to
- **construction and testing of seven segment LED display decoder with IC 7447.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- DC power supply, 0-30V/2A - 1 No
- Logic probe - 1 No

Materials

- IC-7490 - 2 Nos
- IC-7447 - 2 Nos
- IC base 14 pin - 2 Nos
- IC base 16 pin - 2 Nos
- 7-segment LED display FND507 - 2 Nos
- Resistors 330Ω/¼W/CR25 - 7 Nos
- Logic probe - 1 No
- Single shot logic pulser - 1 No
- General purpose IC TB/Bread board - 1 No
- Solder, flux - as reqd
- Connecting wires - as reqd

PROCEDURE

TASK 1: **Construction and testing of seven segment LED display decorder with IC7447**

1 Collect all the components, check them and assemble the decade counter using IC 7490 on the bread board as shown in Fig 1.

Make use of IC base to connect IC7490

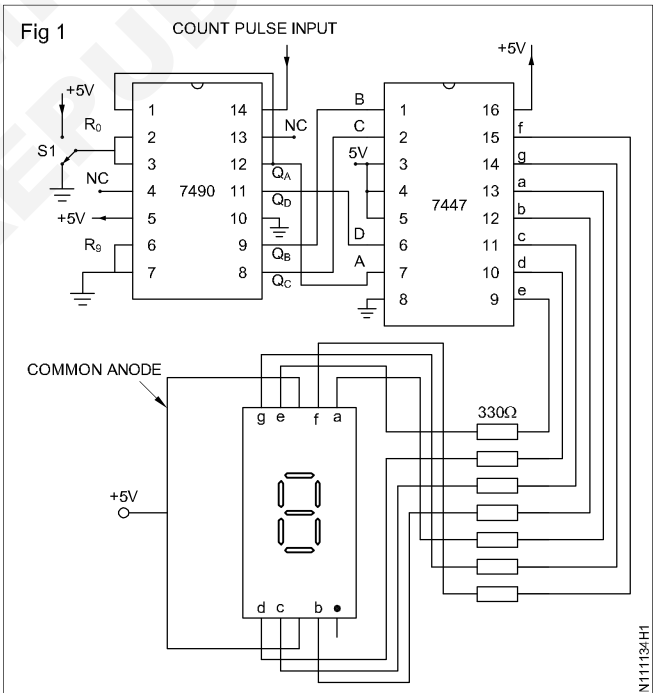
2 Reset the counter output by applying logical 1 input momentarily to reset input pins 2 & 3.

3 Test and record the output logic levels in Table 1 using logic probe.

4 Apply a clock pulse at Pin no.14 using single shot logic pulser and note down the output logic levels in Table 1 at QA, QB, QC & QD using logic probe.

5 Repeat step 4 for different clock pulses and record the observations in the table.

Fig 1



DECADE COUNTER WITH SEVEN SEGMENT DISPLAY

Table 1 Testing of decade counter IC7490

Clock input	Output				Decimal number displayed
	Q_D	Q_C	Q_B	Q_A	
0 (reset)					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

6 Get the work checked by the Instructor.

— — — — — —

Measure current flowing through a resistor and display it on LED module

Objectives: At the end of this exercise you shall be able to
- **measure the voltage in simple circuit using LED module of DPM**
- **measure the current in simple circuit using LED module of DPM.**

Requirements

Tools /Equipments/Instruments

- DPM with LED display 0-250 mA - 1 No.
- DPM with LED display 0-50V - 1 No.
- Regulated DC power supply 0-30V/2A - 1 No.
- Digital multimeter with probes - 1 No.
- Trainees tool kit - 1 Set.

Materials

- Breadboard - 1 No.
- Resistor 500 W/2W - 1 N
- Hook up wires - as reqd.

Safety precaution

1 Avoid loose connections

PROCEDURE

1 Collect the components required and check them for good working condition.

2 Make the simple test set-up of the circuit as shown in Fig 1.

3 Switch ON the DC power supply, increase to 5VDC.

4 Measure the voltage of variable power supply output and current through the load.

5 Record the observations in Table-1.

6 Increase the supply voltage in steps of 5V upto 25VDC and repeat steps 4 and 5.

Fig 1

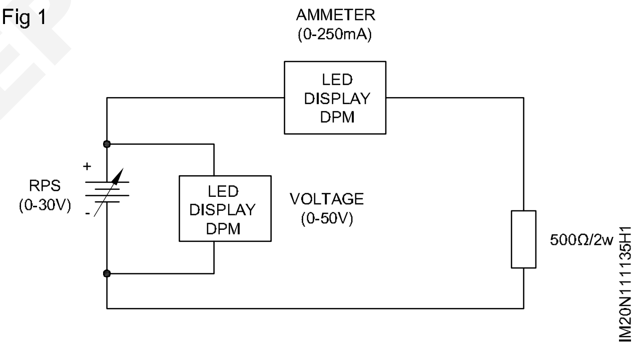


Table-1

SI No.	Value of load resistor	Voltage across load Resistor	Current through the circuit
1			
2			
3			
4			
5			

7 Get the work checked by the Instructor.

Construct and test a Binary weighted and R-2R Ladder type Digital- to- Analog converters

Objectives: At the end of this exercise you shall be able to
- **resister converter by using Op-Amp**
- **construct and test a digital to analog (D/A) Binary weighted**
- **assemble and test a digital to analog converter using R-2R ladder network using Op-Amp.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Regulated dual DC power supply 0-30V/2A - 1 No
- DC power supply 15V/500 mA - 1 No
- Digital multimeter with probe - 1 No

Materials

- IC LM741, ICDAC0808 - 1 No
- Data sheet of the ICs used - as reqd
- Resistor, carbon film 1k Ω 10 kW/¼ W/CR25 - 16 Nos
- Breadboard - 1 No
- IC Base 8 pin - 1 No
- Hook up wire - as reqd
- Miniature toggle switch SPDT - 4 Nos

PROCEDURE

TASK 1: **Construct and test a digital to analog (D/A) Binary weighted resistor converter by using Op-Amp**

1 Remove the using R-2R ladder network wired in step 5 of Task 1 keeping op-amp circuit intact.

2 Replace the feedback resistor of op-amp circuit with 1K resistor referring to Fig 2.

3 Adjust the output of op-amp to zero Volts by repeating steps 2, 3 and 4 of Task 1.

4 Wire the remaining part of circuit using ICDA0808 by referring to Fig 2.

At this stage, do not make connection between (pin 4) DAC0808IC and op-amp circuit.

5 Get the work checked by your instructor.

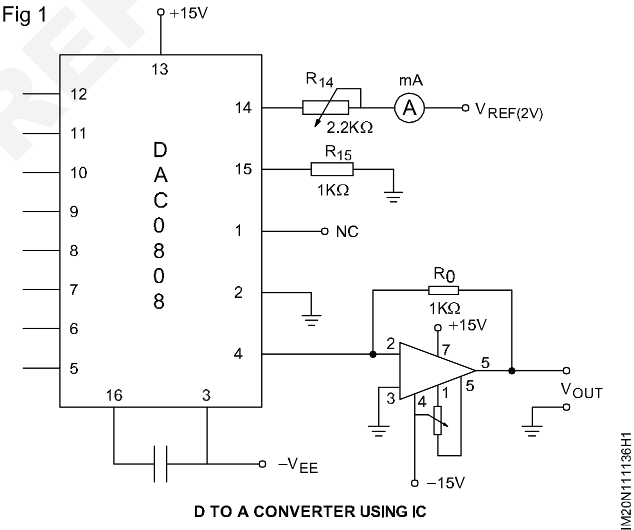
6 Apply 15V to the V_{CC}'-15V to V_{EE} and 2V to V_{ref} pins of DAC0808IC and op-amp circuit.

7 Set the current through pin 14 to 2mA by adjusting the 2.2K Potentiometer.

8 Apply different logic input levels at data input pins D_0 to D_7 referring to Table 2 of O&T sheet and record the corresponding analog output Voltage.

9 Calculate the theoretical value of analog output using formula for each set of digital inputs applied at D_0 to D_7 and record the same in Table 2.

Fig 1



D TO A CONVERTER USING IC

10 Compare the theoretical and practical results of output voltage.

11 Get the work checked by your instructor.

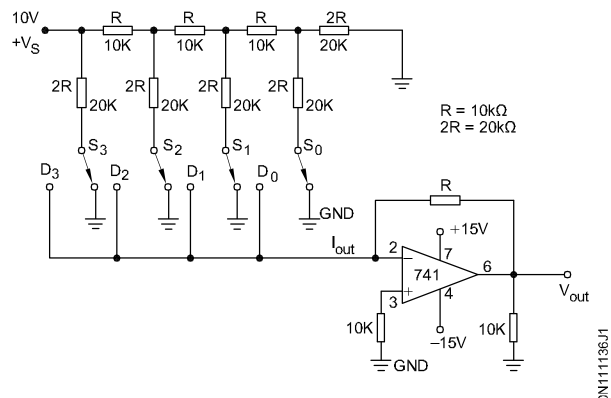
TASK 2: **Construct and test D to A converter using R-2R ladder network**

1 Collect all the components, check them; Refer Fig 1 and assemble the op-amp circuit using IC741 with 8 pin IC base on bread board.

2 Get the assembled circuit checked by the Instructor.

3 Connect the dual DC power supply +15, -15V and GND terminals to the IC741 referring to Fig 1.

Fig 1



D TO A CONVERTER USING R-2R LADDER NETWORK

4 Assemble the remaining part of R-2R ladder network on bread board ensuring four terminal connections D_0 to D_3 which are digital inputs.

5 Use the toggle switches S_0 to S_3 and operate them to provide logic levels low (GND) and thigh (1) as per the Table 1.

6 Get the work checked by the Instructor.

7 Apply binary logic inputs at D_0 to D_3 as per Table 1, measure voltage at the output of the Op-Amp and record them in Table.

8 Repeat step 7 for different binary input combinations.

9 Calculate the theoretical V_o by using the formula for different binary input combinations and record the same in Table 1.

Formula for theoretical output V_0

$$V_0 = \frac{D_0.2^o+D_1.2^1+D_2.2^2+D_3.2^3}{2^3}$$

Digital Input = logic 0/logic 1

Note: For (eg) If the 4 bit binary inuts are [D0 D1 D2 D3 - Decimal values = 7.

The equivalent analog value of the D to A converter can be calculated as follows:

As logic - 2 refer to 5V, V_{ref} = 5V in the circuit.

For the binary inputs 1110, the input voltage x at pin 2 of Op - Amps, is

$$V_x = \frac{1}{2^4}[(2^0 \times 1)+(2^1 \times 1) + (2^2 \times 1) + (2^3 \times 0)]$$

$$\text{Analog} = \frac{1}{16}(7) = \left(\frac{7}{16}\right)$$

$$\text{O/P } V_o = \frac{7}{16} \times 5V$$

For binary Input $(-1111)_2$

Analog output will = -5V

(-1 is the inverting amplifier gain).

10 Get the work checked by the Instructor.

Table 1

Decimal Value of Input	4-bit Digital Input				V_o Calculated	V_o Measured
	D_3	D_2	D_1	D_0		
0	0	0	0	0		
1	0	0	0	1		
2	0	0	1	0		
3	0	0	1	1		
4	0	1	0	0		
5	0	1	0	1		
6	0	1	1	0		
7	0	1	1	1		
8	1	0	0	0		

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Perform the interfacing of IEEE 488.2 standard with a single controller

Objectives: At the end of this exercise you shall be able to
- **connect the interfacing of IEEE 488.2 standard with a single controller can control upto 15 different**
- **instrument connected stat topology.**

Requirements

Tools/Equipments/Instruments

- Personal computer with GPIB software - 1 No
- GPIB IEEE - 488 cableWith IEEE - 488.2 protocol - As reqd.

Materials

- Measuring devices - any Nos
- Recording devices - 5 Nos
- Trainees tool kit - 1 set

PROCEDURE

1 Identify the pin detail of GPIB connector (Fig 1, Fig 2 & Fig 3)

Fig 1

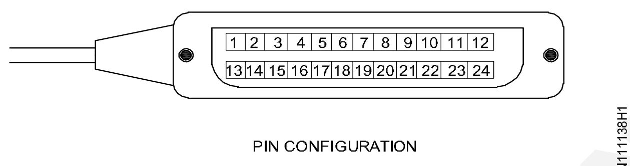


Fig 2

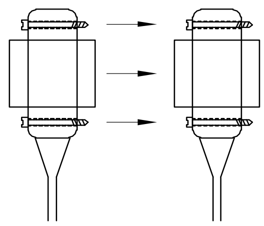


Fig 3

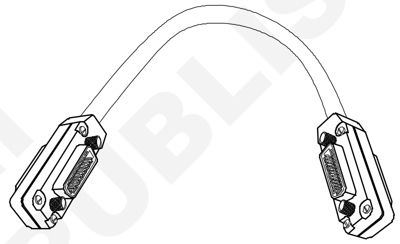


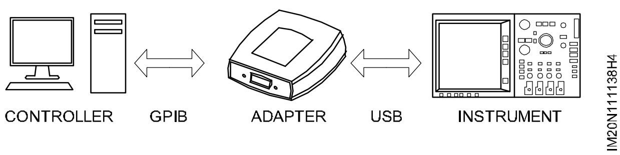
Table 8.1 GPIB pins and signals

Pin	Label	Signal name	Pin	Label	Signal name
1	DIO1	Data	13	DIO5	Data
2	DIO2	Data	14	DIO6	Data
3	DIO3	Data	15	DIO7	Data
4	DIO4	Data	16	DIO8	Data
5	EOI	End or identify	17	REN	Remote enabale
6	DAV	Data valid	18	GND	Twisted-pair ground with DAV
7	NRFD	Not ready fordata	19	GND	Twisted-pair ground with NRFD
8	NDAC	Not data accepted	20	GND	Twisted-pair ground with NDAC
9	IFC	Interface clear	21	GND	Twisted-pair ground with IFC
10	SRQ	Service request	22	GND	Twisted-pair ground with SRQ
11	ATN	Attention	23	GND	Twisted-pair ground with ATN
12	Shield	Chassis ground	24	GND	Signal ground

2 Check the GPIB connectivity in measuring/recording devices

Note: if GPIB provision not available use adopter as shown in Fig 4.

Fig 4

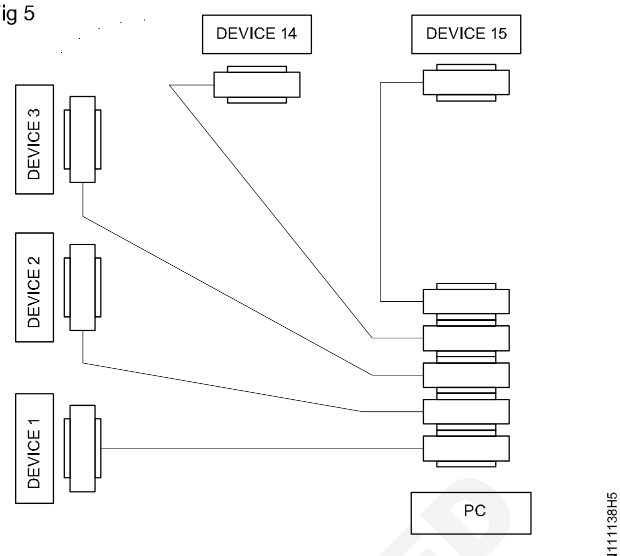


3 Connect the measuring/ recording devices as shown in Fig 5.

4 Check the connections with the instructor

5 Practice the interfacing of IEEE 488.2 standard with a single controller to control of 15 different devices.

Fig 5



GPIB WITH STAR CONNECTION

Identify pins signals of RS 232 and identify RS 485 to RS 232 converter

Objectives: At the end of this exercise you shall be able to
- **identify different pins signal and source of RS 232**
- **perform interfacing of RS 232 to PC**
- **Identify RS 485 to RS 232 convertor.**

Requirements

Tools/Equipments/Instruments

- RS 232 connector (9 pin) - 1 No
- RS 232 connector (25 pin) - 1 No
- RS 232 to RS 485 convertor - 1 No
- RS 485 to RS 232 convertor - 1 No
- Screw driver set - 1 No

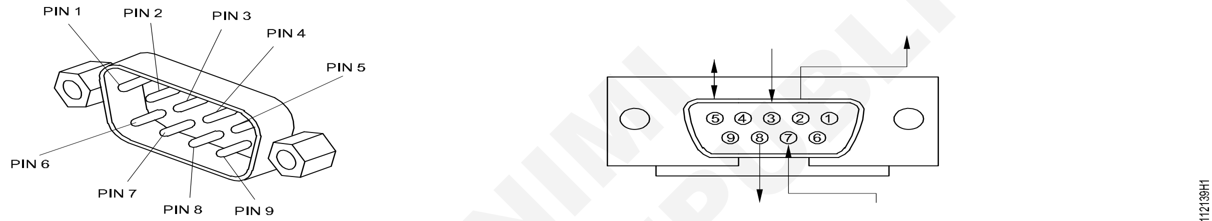
PROCEDURE

TASK 1: **Identify different pins signal and source of RS 232**

1 Identify the RS 232 connector (male or female).

2 Fill the pin detail in space given in table 1 & table 2.

Fig 1



(a) RS 232 PINOUT (25 PIN MALE)

(b) RS 232 FEMALE

Table 1

Pin no	RS 232 male	RS 232 Female
Pin 1		
Pin 2		
Pin 3		
Pin 4		
Pin 5		
Pin 6		
Pin 7		
Pin 8		
Pin 9		

Table 2

Pin no	RS 232 male	RS 232 female
Pin 1		
Pin 2		
Pin 3		
Pin 4		
Pin 5		
Pin 6		
Pin 7		
Pin 8		
Pin 9		

Fig 2

(a) RS 232 PINOUT (25 PIN MALE)

(b) RS 232 FEMALE

Table 3

Pin no	RS 232 male	RS 232 female
110		
25		

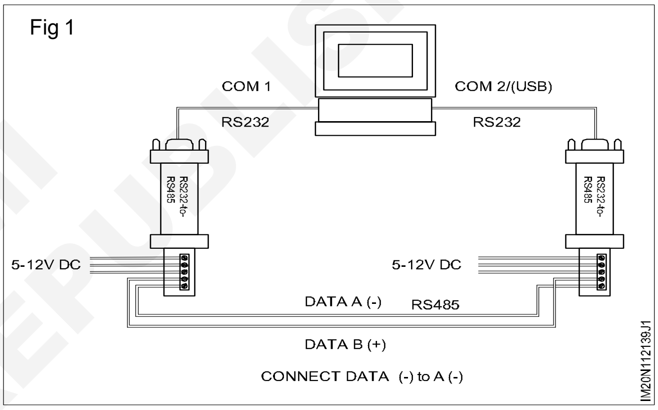
— — — — — —

TASK 2: **Perform interfacing of RS 232 to PC**

1 Connect RS 232 to RS 485 convertor in Fig 1 of task.

2 Wire RS 485 connections-2 converter.

3 Observe the output.



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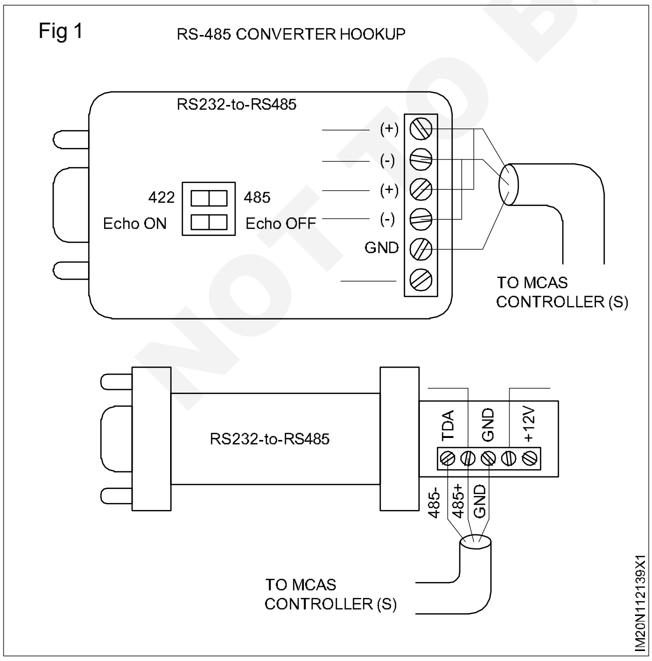
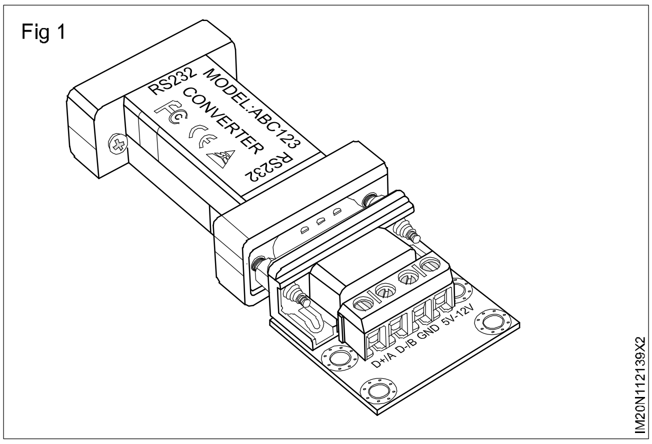
TASK 3: **Identify RS232 to RS485 converter**





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Display a word on a two line LED

Objectives: At the end of this exercise you shall be able to
- **construct a two line LED circuit**
- **Test the two line LED circuit.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Digital multimeter with probes - 1 Set.
- Regulator DC Power supply 0-30V/ 2A - 1 No.
- Soldering iron 25W/230V - 1 No.

Materials

- Breadboard/PCB-GP - 1 No.
- Decade counter IC CD4017 - 1 No.
- Timer IC 555 - 1 No.
- Positive regulator IC 7805 - 1 No.
- Diode, IN5402 - 2 Nos.
- Diode, IN4148 - 2 Nos.
- Transistor, SL100 - 2 Nos.
- Transistor, TIP 122 with heat sink - 1 No.
- Capacitor, 10ΩF, 16V - 1 No.
- Capacitor, 0.1ΩF - 1 No.
- Capacitor, 0.01ΩF - 1 No.
- Pre-set, 100KΩ (Horizontal type) - 1 No.
- Resistor, 10KΩ, 0.5W - 1 No.
- Resistor, 470Ω, 0.5W - 3 Nos.
- Resistor, 220Ω, 0.5W - 5 Nos.
- LED, 5mm, Red - 43 Nos.
- Connecting wires - as reqd.
- Hookup wire - as reqd.
- Rosin cored solder - as reqd.

PROCEDURE

TASK 1: **Construction of a two line LED circuit to display a word**

1 Collect all the components required and test them for good working condition.

Use heat sink for the power transistor T3

2 Plan the layout and assemble the circuit as shown in Fig 1 on the breadboard/ general purpose PCB.

The arrangement of LED1 through LED5 is used to display 'I' as shown in Fig.1. The anodes of LED1 through LED5 are connected to point-A and the cathodes of these LEDs are connected to point-B. Similarly, connect the other letters as shown in Fig.1.

3. Get the assembled circuit checked by the Instructor.

— — — — — —

TASK 2: **Testing the two line LED circuit**

1 Apply 230V, 50Hz, single phase AC supply to the primary of the transformer.

2 Switch ON the 9V DC power supply and check the circuit operation.

3 Observe the output LED display cycle.

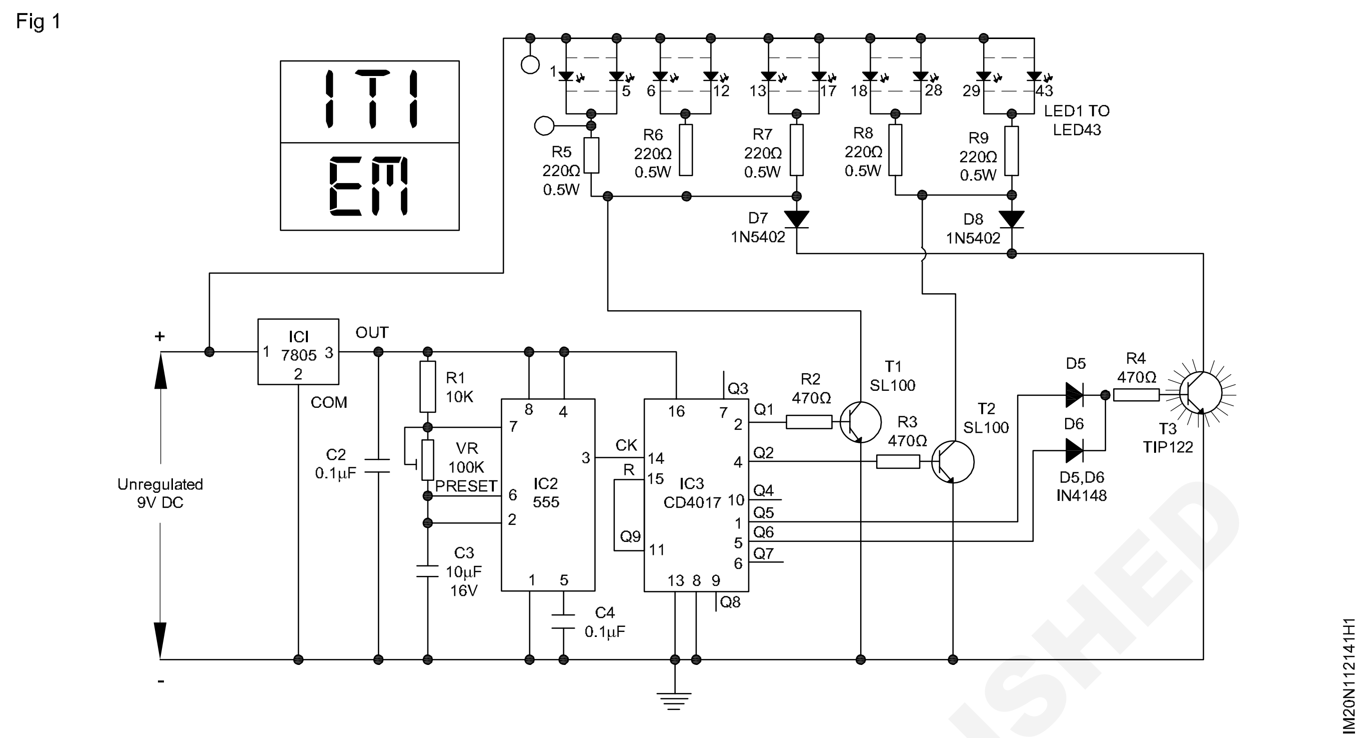
The display board displays 'ITI,' and 'IM' one after another for one second each. After that, the message "ITI IM" is displayed for 4 seconds (because Q5 and Q6 are connected to resistor R4 via diodes D5 and D6).

At the next clock input output Q9 goes high, and IC3 is reset and the display is turned off for one second. Thereafter the cycle repeats.

4 Adjust the pre-set VR of astable multivibrator to change the clock frequency of decade counter to vary the display time.

5 Observe the display output for the time/sequence of LED letters.

Fig 1



6 Get the work checked by the instructor.

— — — — — —

Measure current flowing through sensor and display it on LED Module

Objectives: At the end of this exercise you shall be able to
- **measure the current flowing through the digital panel meter.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 set
- Multimeter with probes - 1 No.
- Regulator power supply 0-30V/2A - 1 No.
- Rectangular battery 9V - 1 No.

Materials

- Shunt resistor 0.1 Ω - 1 No.
- Shunt resitor 0.01 Ω - 1 No.

Safety precaution

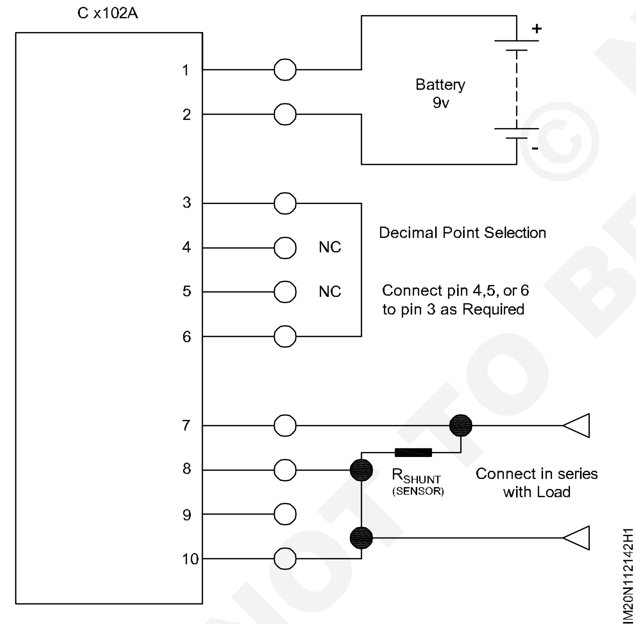
1 Keep the work area dry and clean.

2 Usse proper tools for opening the digital panel meter.

PROCEDURE

1 Connect the shunt resistor to digital panel/meter as shown in the Fig 1.

Fig 1



2 The shunt resistor is placed in series with the applied current which causes a voltage drop to occur across the shunt.

3 The shunt value depends on the maximum current flow that will be encountered. For relatively small current values (below 1 Amp) a 0.1 ohm shunt resistor is adequate. This value will minimise any loading in the circuit but will procedure a reasonable reading on the DPM. If higher current levels will be encountered, 0.01 ohm or lower value should be used.

4 Connect the battery to circuit as shown in the diagram.

5 Connect the Pin No.3 to Pin No.6 of DPM for proper decimal point display.

6 Note that the current value displayed on the meter can be fine-tuned by adjusting the trimmer potentiometer on the back of the DPM.

7 Short Pin No.8 and pin No.10 together and connected to the negative end of the shunt resistor.

8 Connect R_{shunt} across Pin No.7 and Pin No.8 and will be connected in series with the load .

9 Note down the actual and indicated current readings and record in Table-1.

Calculation

- All digital panel meters, the full scale deflection are 200 mV full- scale.
- For the measurement of 1 Amps current through DPM, correct power rating of the shunt resistor can be determined by using the Ohm's Law power formula.

P (Power) = V (Voltage) x I (Current)

$P = V_{max} \times I_{max}$ = (0.200) x (1.0) = 0.1 Watt

- So we should use a 1/2 watt 1% resistor to be safe.

Practice on measuring instruments in single and three phase circuits

Objectives: At the end of this exercise you shall be able to
- **measuring phase sequence of a three phase supply using phase sequency meter**
- **measuring frequency of using frequency meter.**

PROCEDURE

TASK 1: **Measuring phase sequence of a three phase supply using phase sequences meter**

1 Read the marking on the phase sequence indicator and record the direction for - RYB sequence

- RBY sequence

PHASE SEQUENCE

In the direction of arrow on disc:________________

Opposite to the direction of

arrow on disc:______________________________

2 Switch OFF the supply and connect the 3 phases of the supply to the sequence indicator. (Fig 1)

Mark the leads as I, II, III. connect them, such that I is connected to R, II to Y, III to B.

You can connect any lead (phase) to any terminal in the sequence indicator.

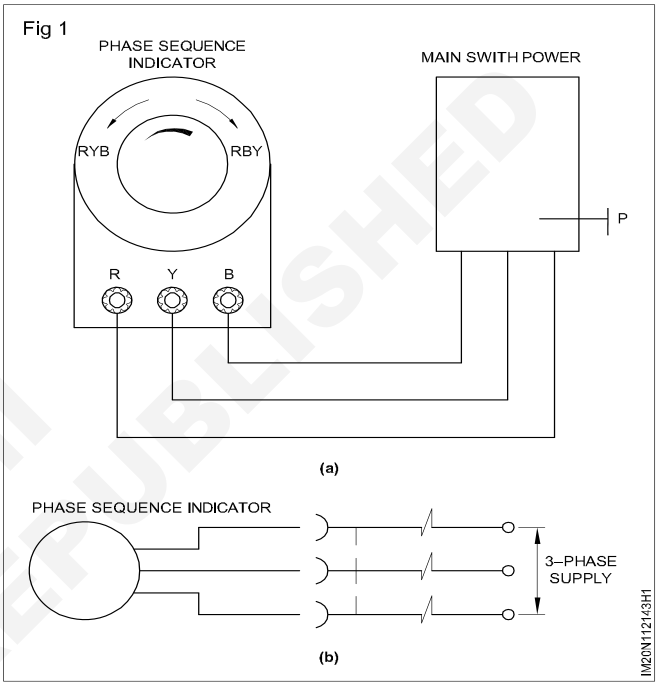
3 Switch ON the supply and observe the direction of the disc movement.

4 Record the direction by a tick mark.

Rotation	
Same as the arrow on disc	
Opposite to the arrow on disc	

5 If the rotation is opposite, switch off the supply and interchange the leads II & III connected to the terminals Y and B. Switch on the supply.

Fig 1



6 Now the disc will rotate in the direction of the arrow.

7 Mark the leads corresponding to the letters on the phase sequence indicator.

— — — — — —

TASK 2: **Measuring frequency using frequency meter**

1 Identify and electrical resonance type frequency meter.

2 Identify the terminals and their voltage ratings.

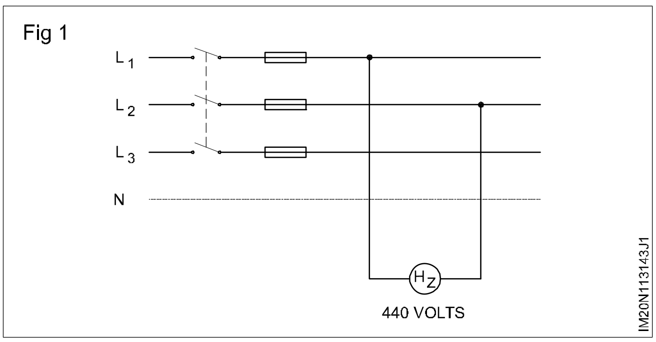
The frequency meter will have two ranges 250 V and 440 volts.

3 Connect flexible leads to the meter terminals for 440 volts.

4 Connect the frequency meter between the two phases of the three-phase supply lines as in Fig 1.

Whenever you connect the frequency meter, remember to switch 'off' the supply.

Fig 1



5 Get the connect by the instructor.

6 Switch 'ON' the power supply and note down the frequency in Table 1.

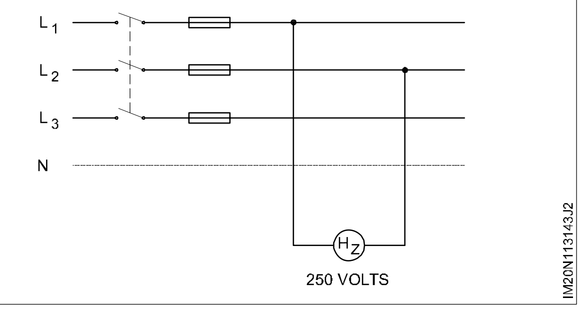
7 Repeat the procedure for measure frequency between the other phases (i.e. L_1 - L_3 and L_2 - L_3).

8 Switch 'OFF' the power supply.

9 Change the load connections of the frequency meter to 250V range.

10 Connect the frequency meter between one phase line (i.e.L_1) and neutral as in Fig 2.

Fig 2



Do not connect the frequency meter between phases as the meter range is only 250 volts. Any how there will not be any difference in frequency of supply either when you connect the frequency meter across the lines or the phase and neutral.

Table 1

Sl.No.	Frequency measured between	Measured Frequency by resonance type meter
1	L_1 - L_2	
2	L_1 - L_3	
3	L_2 - L_3	
4	L_1 - N	
5	L_2 - N	
6	L_3 - N	

11 Switch 'ON' the power read and record the supply frequency in Table 1.

12 Repeat the procedure for measuring frequency between the other phases and neutral and enter values in Table 1.

— — — — — —

Practice on time measuring instrument to measure the time in different electrical control circuits

Objectives: At the end of this exercise you shall be able to
- **identify the terminals of the timer relay**
- **test and verify the operation of the timer Relay.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set
- Regulated DC Power Supply, 0-30V/2A - 1 No
- Multimeter with probes - 1 No
- Timer Relay 12V DC - 1 No

Materials

- Hook-up wire - 5 m
- Bulb, 230V/40W - 1 No
- Power Cord - 1 No
- SPST Switch/1A - 2 Nos

PROCEDURE

TASK 1: **Identification of terminals of the Timer Relay**

1 Collect the timer relays along with the instruction booklet.

2 Inspect and determine the terminal connection of the coil and the number of contacts.

3 Identify the normally open and closed contacts by using Ohmmeter/Multimeter.

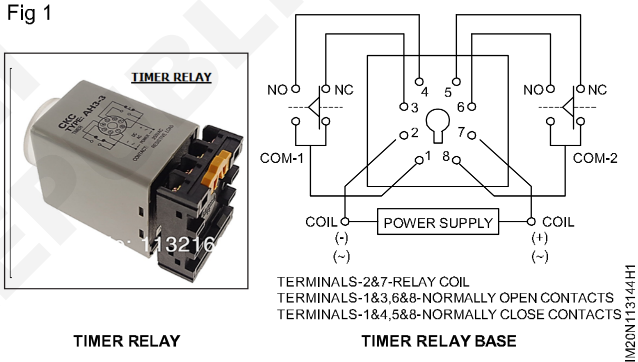
4 Record the relay and contact terminal number.

5 Draw the connection diagram of the relay in the record.

6 Measure the coil resistance and record.

7 Get the work checked by the Instructor.

Fig 1



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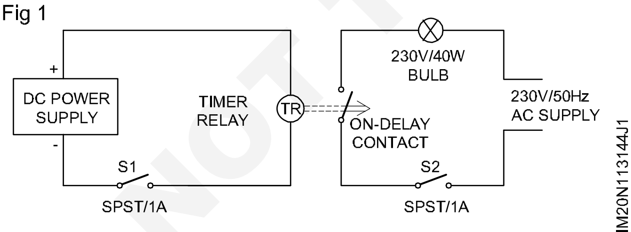
TASK 2: **Test, measure and verify the operation of the timer relay**

1 Connect the timer relay control and power circuit connection as per the circuit diagram shown in Fig 1.

Fig 1



2 Note down the coil supply of the timer relay in the Table-1 and set the DC power supply voltage accordingly.

3 Set the time of the timer relay to 1 minute.

4 Switch ON the SPST Switch 'S1' and check the control circuit operation of the relay.

5 Give 230V/50Hz/AC power supply to the power circuit and Switch ON the SPST switch S2.

6 Note down the delay time in the Table-1 and observe the bulb condition.

7 Get the work checked by the Instructor.

Table 1

Coil Supply	Timer setting	Delay Time Measured

— — — — — —

Measure amplitude frequency time period using CRO

Objectives: At the end of this exercise you shall be able to
- **measure D.C. voltage (V_{DC})**
- **measure the values of AC voltage (V_{P-P})**
- **measure the time period and frequency of a sine wave parameters.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Oscilloscope, 20MHz - 1 No
- RPS, 0-30V, 1A - 1 No
- Voltmeter/Multimeter - 1 No

Materials

- Step-down transformer, 230V/12V, 200 mA - 1 No
- Probes for Oscilloscope - 1 No
- Dry cell, 1.5 V - 1 No
- Hook-up wire - 1 m

PROCEDURE

TASK 1: **Measurement of DC voltage**

1 To measure the voltage of the dry cell, set the volt per division to 0.5 V/Div.

2 Connect the black (ground) probes to the negative end and the red probe to the positive end of the dry cell.

3 Observe the trace on the screen. It will be observed that the trace will move up by 3 divisions from the center line indicating the voltage in positive.

4 The magnitude of the EMF of the cell is given by,

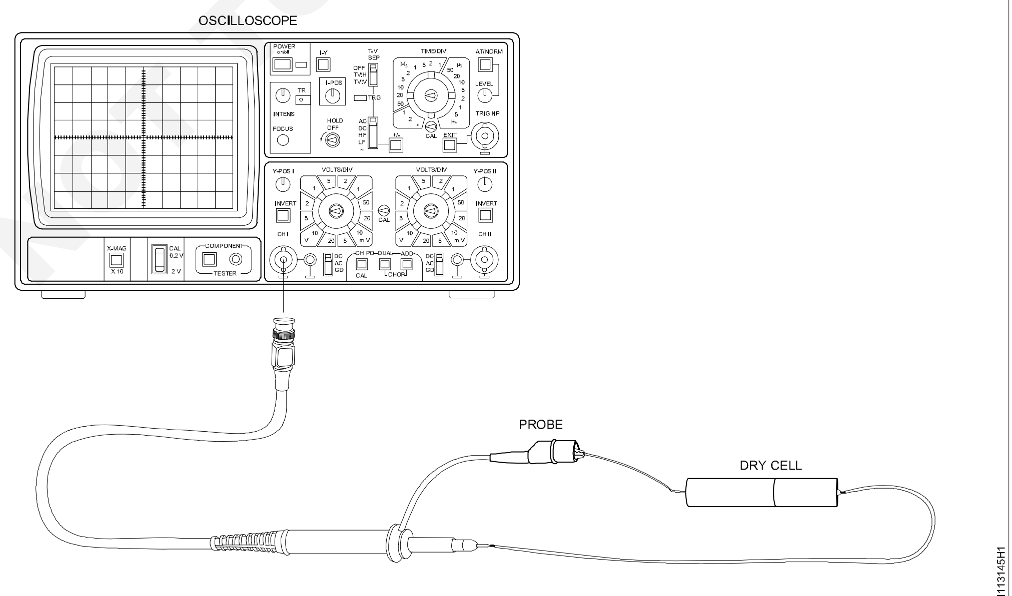
5 Now, reverse the leads, the trace will move down by 3 divisions indicating the voltage is negative and again the EMF of the cell = 3 x 0.5 = -1.5V.

6 Instead of a dry cell use the regulated DC power supply (0-30V) and repeat steps-2 to step-4 and record the observations in Table 1.

Table 1

Sl No.	Power supply voltage in volt	Attenuator position	No.of divisions moved up	No.of divisions moved down	Voltage measured in CRO
1					
2					

Fig 1



DC VOLTAGE MEASUREMENT

— — — — — —

TASK 2: **Measurement of AC voltage**

1 To measure AC voltages, set the AC-DC switch in (out) AC position.

2 Set the volt per division to 50V, if the input voltage is unknown and adjust the time base switch to 10 milliseconds.

3 Connect a step-down transformer secondary leads one to the common input terminal to the ground side for signal source and another lead to the input terminal.

4 Switch ON the oscilloscope, adjust the trace to center and focus intensity controls for a sharp bright trace.

5 Switch ON and energize the primary of the transformer.

6 Observe the wave form that appears on the screen.

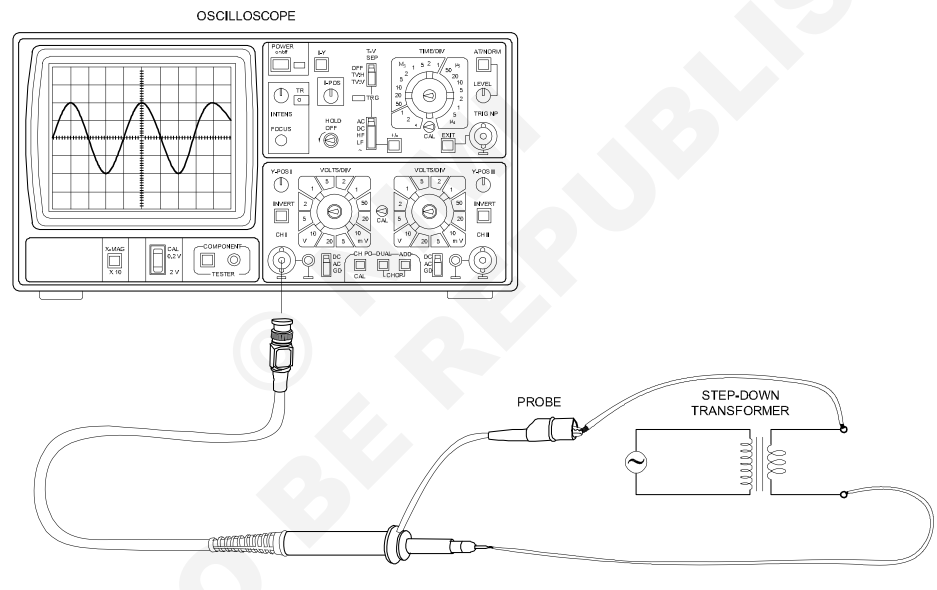
7 Increase the vertical sensitivity by the Volts/Div switch such that the wave form display is clearly seen.

8 Measure the peak to peak voltage of the displayed waveform, by counting the number of divisions between positive and negative peaks. Record the observations in Table 2.

9 Determine the RMS value of the voltage by measuring the voltage across the secondary of the transformer using multimeter.

Table 2

SI No.	Attenuator switch range Volts/Div	No.of divisions counted peak voltage	No.of divisions counted peak to peak voltage	Peak voltage voltage	Peak to peak	RMS voltage (measured by voltmeter)
1						



AC VOLTAGE MEASUREMENT

— — — — — —

TASK 3 : **Measurement of time period and frequency of sine wave**

1 After measurement of peak to peak voltage in Task 2, turn the time base vernier (1) to CAL position.

2 Set the Time/Div switch to a range where the signal can be clearly seen.

3 Count the number of divisions horizontally for one complete cycle and record the same in Table 3.

4 Calculate the frequency of the displayed wave form the using formula,

Where, T is the time period in seconds. Enter the values in Table 3.

5 Formula to be used:

Time period (T) = Time base range x No. of divisions/ Cycles.

Frequency (f) = 1/T Hertz.

Table 3

SI No.	Attenuator switch range Time/Div	No.of divisions per cycle	Time period (T)	Frequency f=1/T Hertz
1				

— — — — — —

Take a print of a signal from DSO by connecting a printer and tally with applied signal

Objectives: At the end of this exercise you shall be able to
- **connect a printer to a DSO and print the screen data**

Requirements

Tools/Equipments/Instruments

- DSO - 1 No.
- Manual - 1 No.
- Analog trainer kit - 1 Set
- Signal generator - 1 No.
- Power supply 0-30 V/2A - 1 No.

Materials

- IC -555 - 1 No.
- Resistor W/CR25 - 1 No.
- 47 kΩ - 1 No.
- 68 kΩ - 1 No.
- 330Ω - 1 No.
- Diode 1N 4007 - 1 No.
- Capacitor
- 0.01µF - 2 Nos.
- 10µF - 1 No.
- LED - 1 No.

PROCEDURE

TASK 1: **Connect a printer to a DSO and print the screen data**

1 Assemble an analog circuit using the analog trainer kit. E.g assemble a astable multivibrator circuit as shown in Fig 1.

2 Connect a power supply to the circuit and switch on the power supply and connect the output to the DSO.

3 Switch on the Digital storage oscilloscope

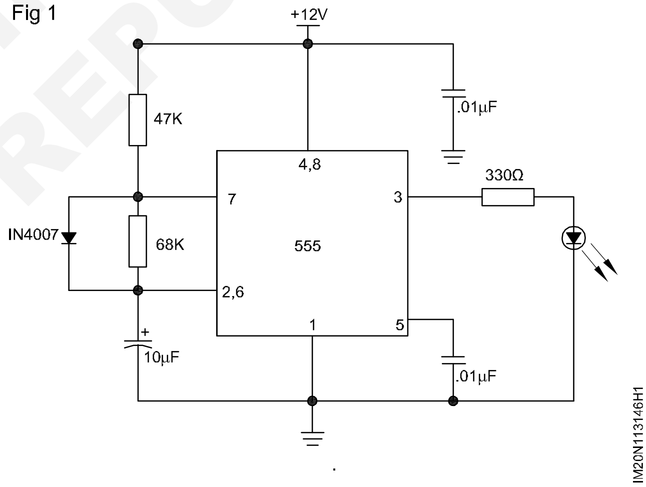
4 Press **AUTOSET**

5 Connect the printer using a USB cable to the rear panel of the DSO

6 Select the **UTILITY** ® **OPTIONS** ® **Rear USB Port ® Printer® Printer setup**

7 Push the option button labeled **PRINT Button** to select prints. The oscilloscope takes a snapshot of the screen and begins to send the image to the printer.

Fig 1



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Practice on windows interface and navigating windows

Objectives: At the end of this exercise you shall be able to
- **invoke and close application from Start Menu**
- **invoke/close application from shortcut icon on the desktop and close using file menu**
- **open multiple applications and close using system menu**
- **arrange icons and windows on the desktop**
- **resize, move and arrange windows**
- **create shortcut icon on the desktop.**

Requirements

Tools/Equipments/Instruments

- different types of CRO probes - as reqd.

PROCEDURE

TASK 1: **Invoke and close application from Start Menu**

1 Boot the computer with windows (After booting Windows desktop appears).

2 Identify and record the icons, start button, task bar seen on the desktop.

3 Record the system time at the right end corner of the task bar.

4 Get the work checked by your instructor.

Fig 1

The instructor should explain the components of windows desktop.

5 Move the mouse pointer over the button and click on it.

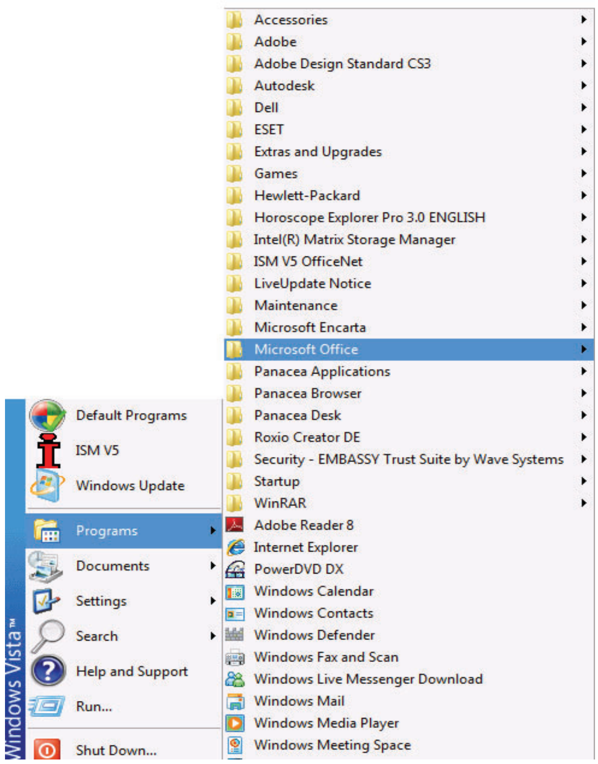
A pop-up menu will be displayed as shown in Fig 1.

6 Move the mouse pointer over the option in the popped up menu to highlight it.

A cascading menu which contains list of executable programs and / or executable program groups gets popped up as shown in Fig 2.

Sub menu exists only for items which have got arrow at the end, as shown in the following figure.

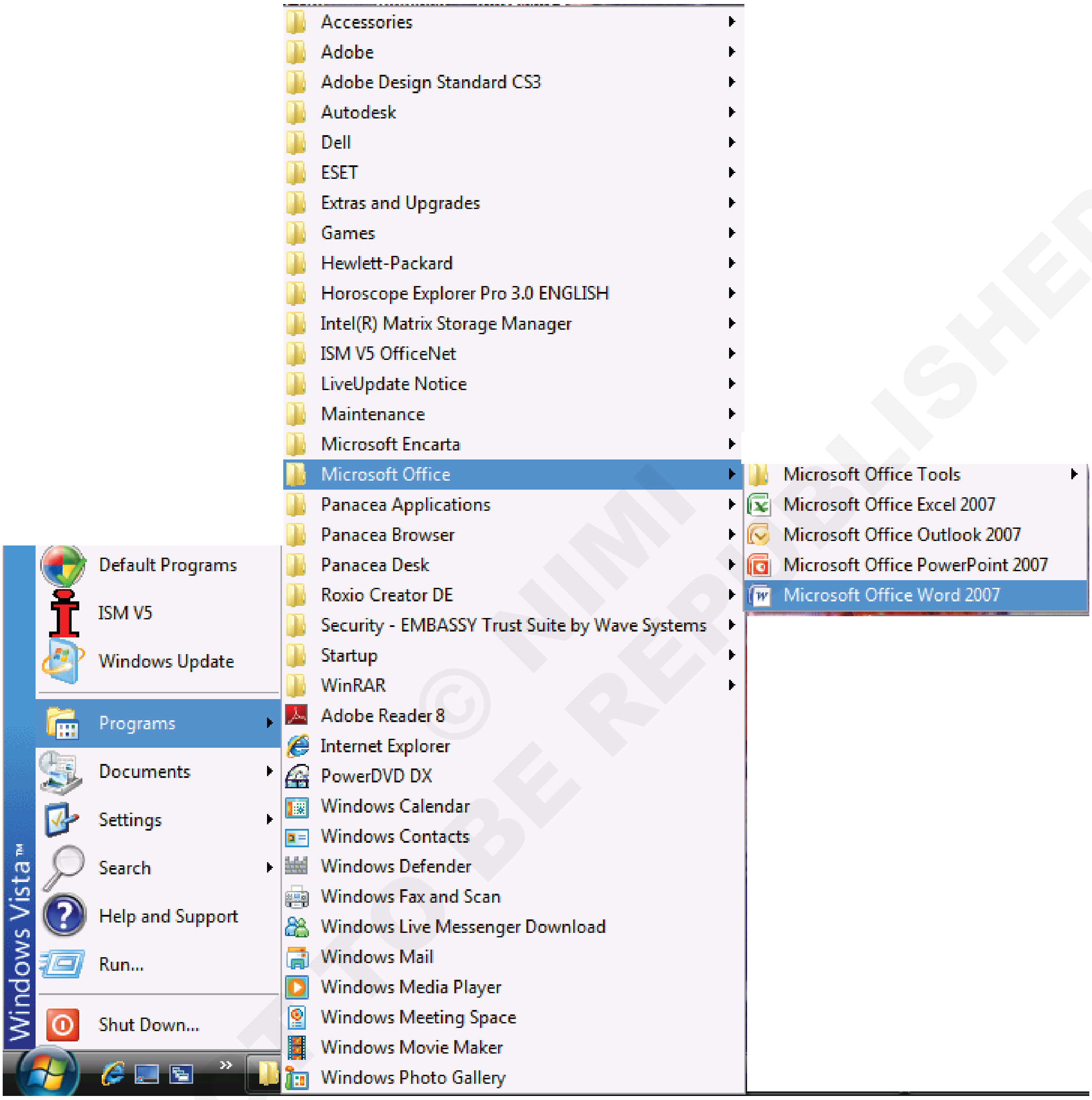
Fig 2



7 Move the mouse pointer over the microsoft Office, a cascading menu will be appeared as shown in Fig 3.

While moving the mouse pointer from Microsoft Office to MSOffice work 2007. First move horizontally up to the next cascading menu and then move vertically to place the mouse pointer on MSOffice 2007.

Fig 3



8 Move the mouse pointer on that menu over the microsoft Office Word 2007 as shown in Fig 3 and click on it.

This starts Microsoft Word applications and spreads on the screen.

9 Record the displayed Window title seen at the top of the window title bar as shown in the Fig 4.

10 Click on maximize button found at the top right corner of the window title bar as shown in Fig 4.

Fig 4

If the application is already spread over the full screen or maximized even before performing previous step,practice restoring by clicking onbutton and then maximize by clicking on maximize button.

11 Click on the minimize the opened Microsoft work application and check for the presence of Microsoft word button on the taskbar.

Minimized applications reside at the taskbar as shown in Fig 5.

Fig 5

12 Click on the minimized Microsoft word application found at the taskbar to activate and maximize the application.

This restores the application and spred it on the desktop.

13 Click on the close button found at the top right corner (control box) of the spread application to Close/Exit Microsoft word application.

14 Repeat all the previous steps and practice to open, maximize, restore, minimize and close a different executable program (say Microsoft Excel) Instead of Microsoft word.

— — — — — —

TASK 2: **Invoke/close application from shortcut icon on the Desktop and close using file menu**

1 Move the mouse pointer over Microsoft word shortcut icon and double click on the icon in the Windows desktop.

This invokes the Microsoft word application and the opened application spread on the screen. This is another way of invoking an application other than selecting from the Start menu.

2 Move the mouse pointer over the File menu and click once in the menu bar.

A pulls down the File menu list will appear as shown in Fig 6.

3 Move the mouse pointer over the menu item Exit in the File menu list and click to close and exit the Microsoft word application.

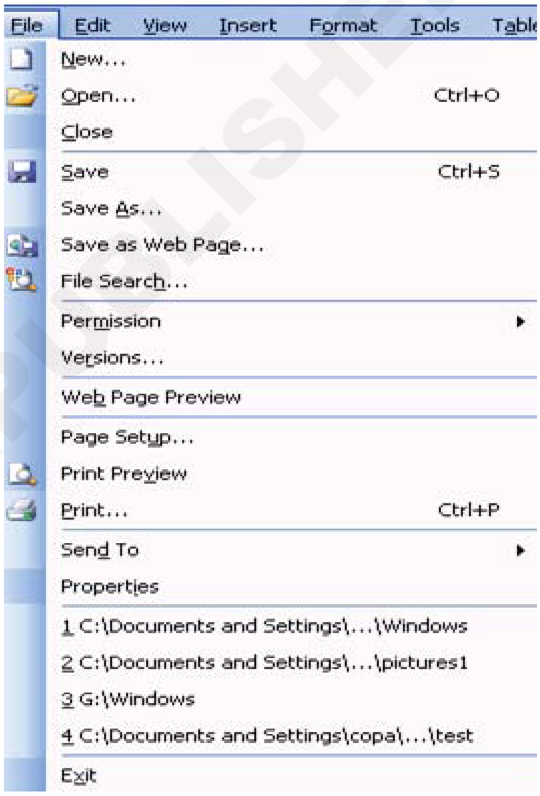
This is an alternative method of closing an application in addition to the methods like, using Close button and choosing close from the system menu.

4 Open Microsoft Excel and close it by choosing Exit from the file menu as practiced in steps from 1 to 3.

5 Repeat step 1 to 4 for Microsoft PowerPoint application.

6 Ask the instructor to check your progress before practicing the next task.

Fig 6



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TASK 3: **Open multiple applications, and close using system menu**

1 Open Microsoft Word application and make the size of the application less than the full size of the screen by clicking the Restore button.

This restores the microsoft word application window size to less than full screen, Now the restore button changes to maximize button.

2 Open and spread on the screen, open another application say Microsoft Excel by Clicking on with the Microsoft Word office Excel 2007.

Start → All Programs → Microsoft Office → Microsoft Office Excel 2007

3 Make the size of the Microsoft Excel application less than the full size of the screen by clicking on the Restore button.

4 Minimize Microsoft Excel application by clicking on the minimize button.

This minimizes the Excel appliction and places it in the taskbar as an inactive application. Now only the Word application is seen on the screen and is active.

5 Change the active application from Microsoft Word to Excel by clicking on the Microsoft Excel button (icon) found at the taskbar.

This makes the Word application inactive and places it as button at the taskbar.

6 Minimize Excel application and make the Microsoft Word as the active application.

7 Right click on the plain area of the title bar of the word application.

This pulls down a menu referred to as the System (Control) menu as shown in Fig 7.

8 Select **Close** from the system menu and click on the close and exit from Microsoft Word application.

Note that this is another way of closing and exiting from active applications in addition to closing by clicking on the buttion practiced earlier in this exercise.

When once the Word is closed, Microsoft Excel which was till then inactive and residing at the taskbar becomes active and spreads on the screen.

9 Repeat step 8 and close/exit from Microsoft Excel application.

Fig 7

10 Check and record the application if any, residing at the taskbar.

— — — — — —

TASK 4: **Arrange Icons and Windows on the Desk Top**

1 Move the mouse pointer over the My computer icon.

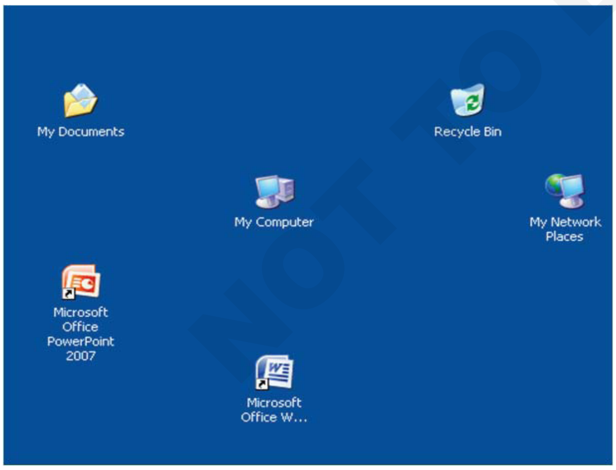
Click & hold the left mouse button, move the cursor to approximately the center of the screen and release the mouse button.

This drags the My computer icon and places it in the new position on the desktop.

2 Repeat step 1 to drag and place Microsoft Word icon just below the newly placed My computer icon.

3 Repeat step 1 to placle a few other icons as shown in Fig 8 on the desktop.

Fig 8



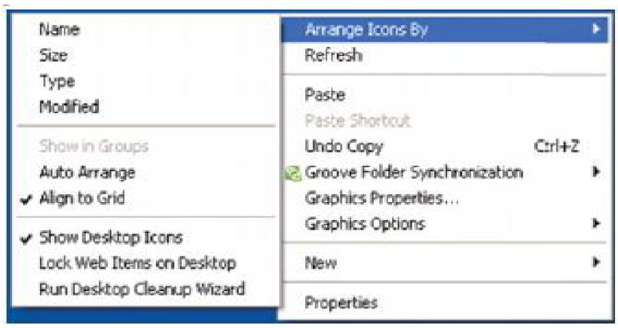
4 Move the mouse pointer on the desktop where there is no icon and click the right mouse button.

A pulls down a context menu will appear as shown in Fig 9.

Fig 9

5 Move the mouse pointer over the menu item in the displayed list, a cascading menu will be displayed as shown in Fig 10.

Fig 10



— — — — — —

The cascading menu lists different ways of arranging icons on the desktop.

6 Click on menu item from the displayed cascading menu **Name** and observe the icon arrangement on the desktop.

This action arranges the icon alphabetically, and vertically

7 Note the positions of the arranged icons by their names from the desktop. Verify whether the icons are arranged by name.

8 Repeat step 4 to 7 by selecting the other options listed under (such as size, Type and Modified).

9 Drag and place the icons as shown in Fig 11.

10 Repeat step 4 to pop, up display context menu. Choose Arrange Icons by 'Auto Arrange. Observe and record the rearranged icons.

Once Auto Arrange is selected a check mark is placed in front of Auto arrange as shown

This selection can only be removed if Auto Arrange option is chosen once again. This makes the check mark disappears in front of Auto Arrange. DONO deselect the check mark now.

11 Drag the icons to different positions on the desktop and record the result and icon arrangement.

Fig 11

12 Repeat step 10 to deselect Auto Arrange option from the Arrange Icons menu.

13 Repeat step 11.

14 Arrange icons on the desktop as shown in Fig 11,and get it checked by you instructor.

— — — — — —

TASK 5: **Resize, Move and Arrange windows**

1 Open WordPad application by selecting as below,

Start → All Programs → Accessories → WordPad

On opening an application, generally, it occupies full screen, if not, maximize using maximize button

2 Restore the application window size by clicking on Restore button

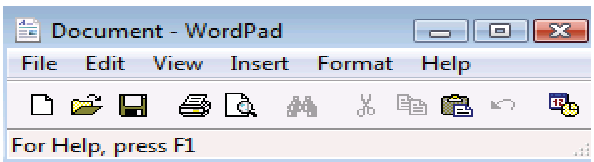
This makes the window size less than the full screen size.

3 Move the mouse pointer over the right side border of the window where the cursor shape changes from to

4 Hold the left mouse button down and drag the cursor towards left with the changes cursor shape, till the width of the window reduces to approximtely 1/3 of the screen width. Release the mouse button.

5 Move the mouse pointer over the title bar of the window as shown in Fig 12.

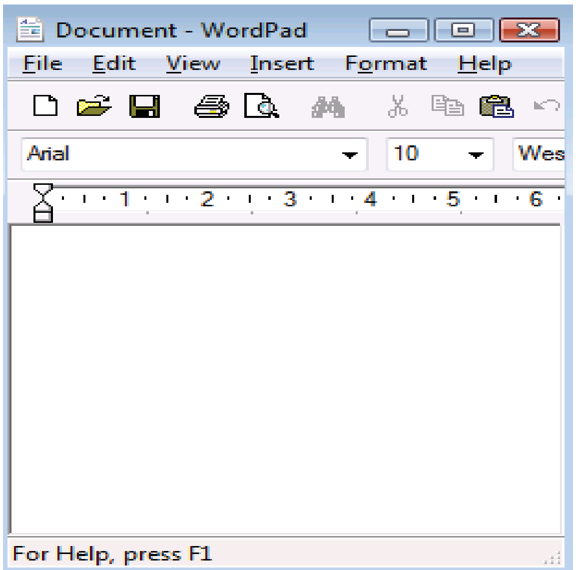
Fig 12



6 Hold the left mouse button down and drag the window side wards such that the WordPad application window comes at the right side of the screen.

7 Repeat steps 5 and 6 to drag the WordPad application window back to the left side of the screen (see Fig 13).

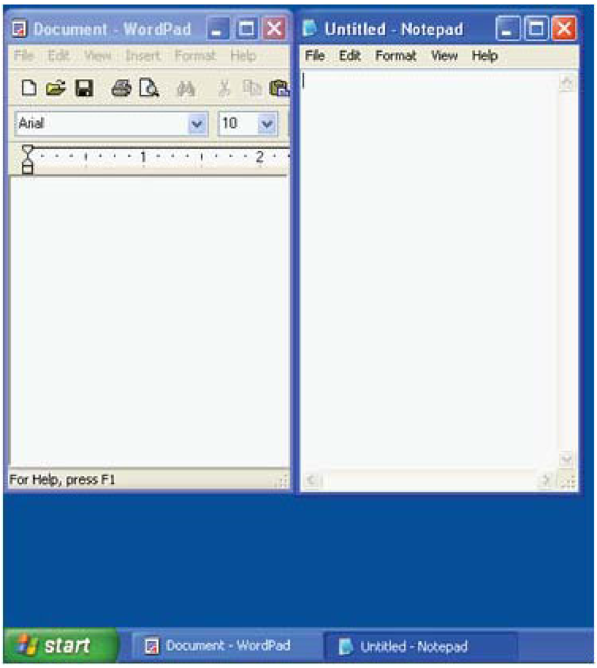
Fig 13



8 Practice to move the WordPad window to any other places on the screen. After satisfactory practice, place the WordPad window at the left edge of the screen.

9 Open Notepad application and repeat steps 2 to 7. Finally place the reduced Notepad window by the side of the WordPad window as shown in Fig 14.

Fig 14



10 Open microsoft Word Application. Repeat steps 2 to 7 and finally place it by the side of Notepad window. Get it checked by instructor.

11 Move the pointer over the taskbar (at the bottom of the screen) and right click where no buttons/icons are placed.

This pops up menu list as shown in Fig 15.

12 Select Cascade Windows option from the popped up menu to arrange all opened windows as shown in Fig 16.

Fig 15

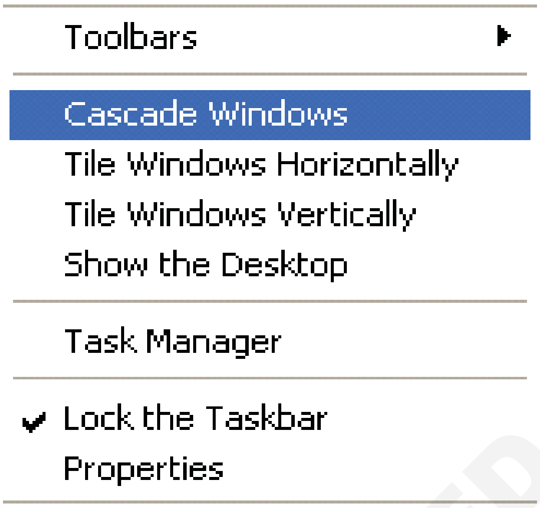
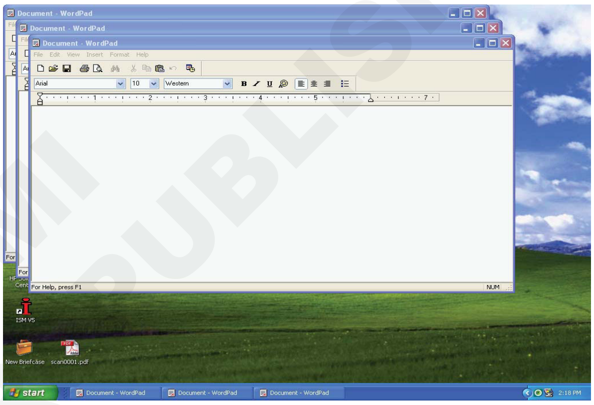


Fig 16



13 Select the other two options in the popped up menu, shown below one after one check the arrangement of windows for each selected option.

— — — — — —

TASK 6: **Create shortcut icon on the desktop**

1 Click Start button and move the mouse pointer as follows and right click on it.

All Programs → Accessories → Calculator

A popped up menu appears as shown in the Fig 17 when mouse pointer is right clicked.

2 Move the mouse pointer over the option in the displayed menu.

A cascading menu will be displayed as shown in the Fig 18.

3 Click on the Desktop (create shortcut) option in the menu.

Fig 17

Fig 18

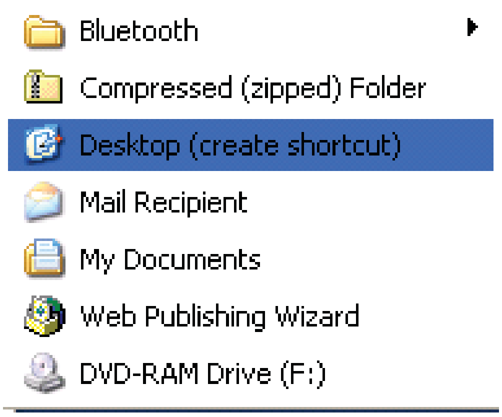
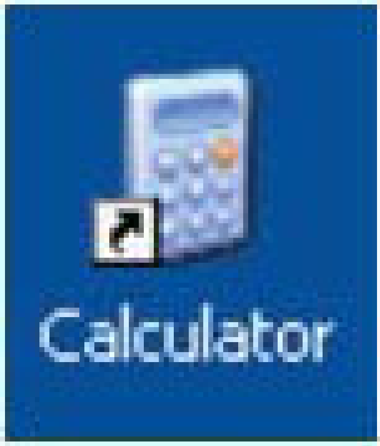


Fig 19



A shortcut for Calculator application will be created on the desktop as shown in the Fig 19.

— — — — — —

Customize desktop settings and manage user accounts

Objectives: At the end of this exercise you shall be able to
- **open desktop settings**
- **modify desktop settings**
- **create new user**
- **grant and modify the user rights.**

Requirements

Tools/Equipments/Instruments

- PC with MS-Office - 1 No. /trainee

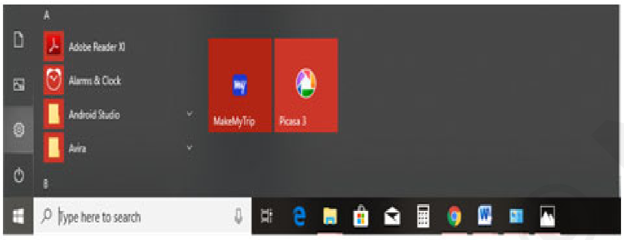
PROCEDURE

TASK 1: **Open desktop settings from control panel**

1 Click on Start menu.

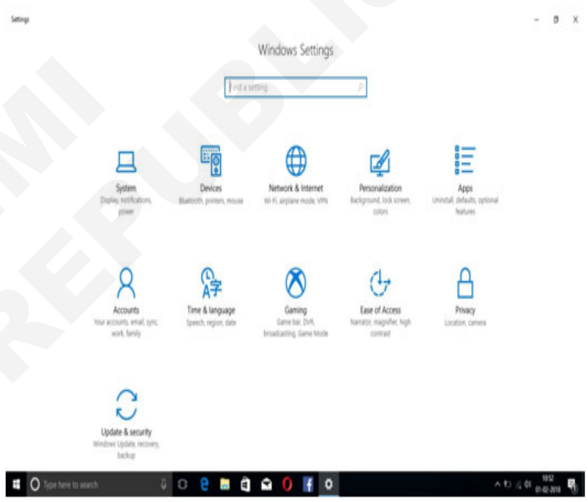
2 Select Settings tab. (Fig 1)

Fig 1



3 This will open Settings Window (Fig 2).

Fig 2



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TASK 2: **Modify the desktop settings**

1 Open the Settings Window (Fig 2)

2 Click on System in the Settings Window

3 Click Display to change the display settings (Fig 3)

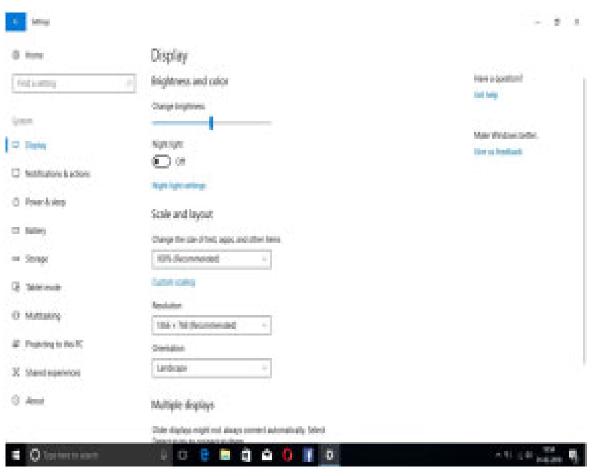
4 Change the brightness of the display by dragging the bar of Change brightness from left or right.

5 Record the brightness percentage at the left most and right most end of the Change brightness bar.

6 Change the orientation and note the how the display changes.

Note: To go back to the initial orientation, press Revert

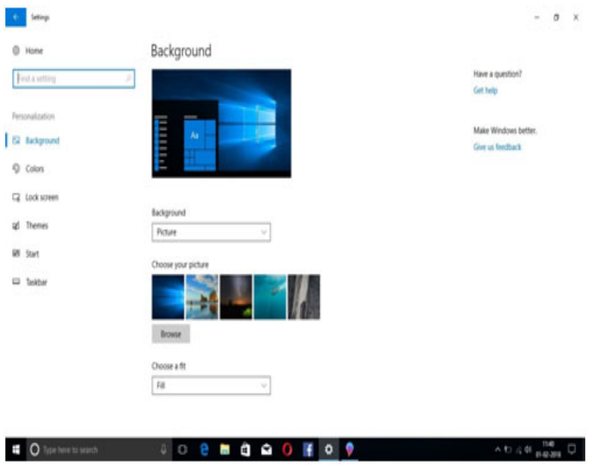
Fig 3



7 To change the background, click on the Personalization icon of settings window. (Fig 2)

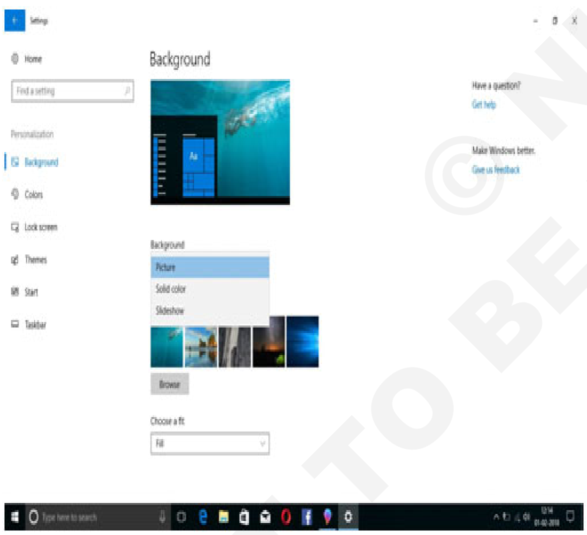
8 Click on the Background tab in the Personalization window. (Fig 4)

Fig 4



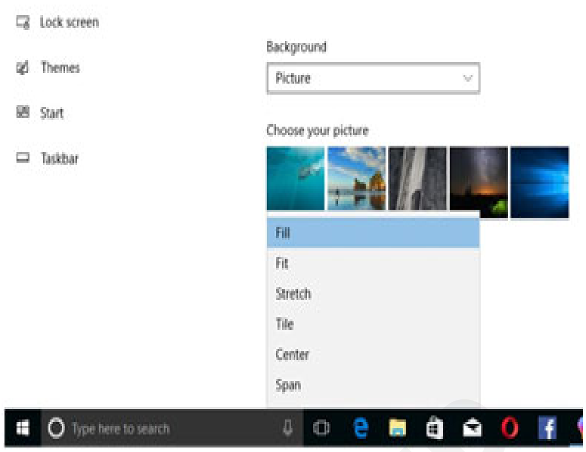
9 Select the Type of Background you want to keep. If it is Picture, choose from picture given or You can browse your desired picture. (Fig 5)

Fig 5



10 Select Fill in Choose a fit. (Fig 6)

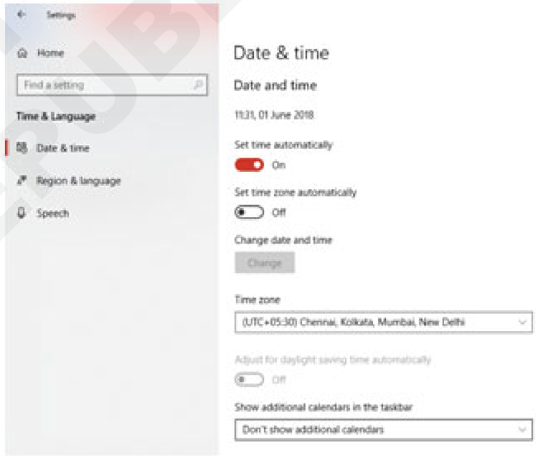
Fig 6



11 To change the date,time and language click on the Time & Languageicon of settings window. (Fig 2)

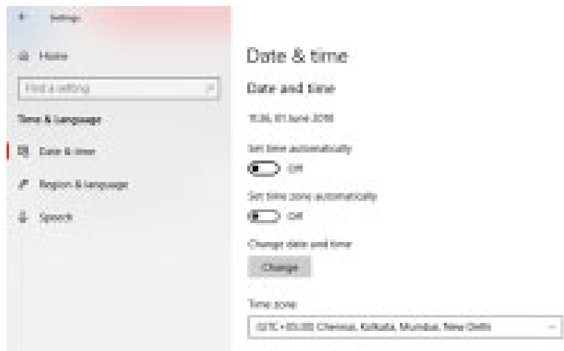
12 Click on Date & time tab. If you want to change the time zone , Select from Time zone menu (Fig 7).

Fig 7



13 To change the date and time, Set time automatically toOff. Click change. (Fig 8)

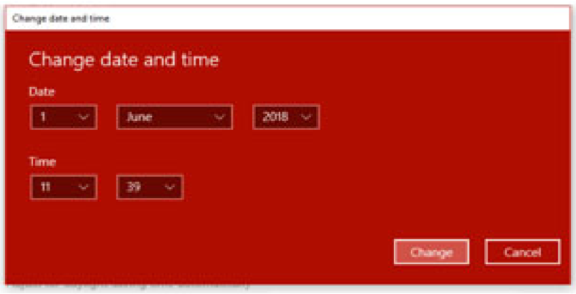
Fig 8



Close the Window.

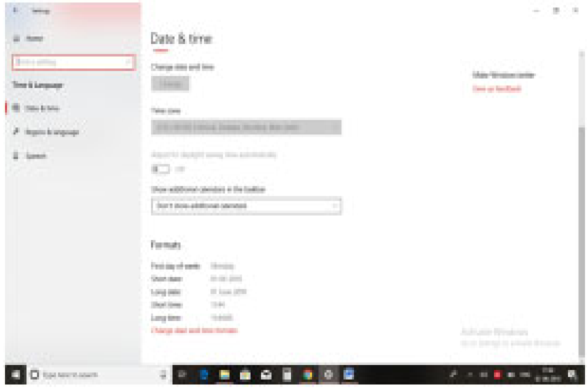
14 Type in the date and time. Click Change. (Fig 9)

Fig 9



15 The format of date and time can be changed by clicking on the Change date and time formats as shown in Fig 10.

Fig 10



Close Window

— — — — — —

TASK 3: **Create new user**

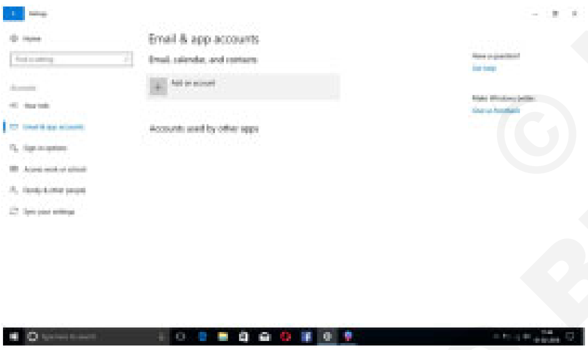
1 Open the Settings Window. (Fig 2)

2 Click on Accounts in the Settings Window.

3 Select E-mail & app accounts in Fig 11.

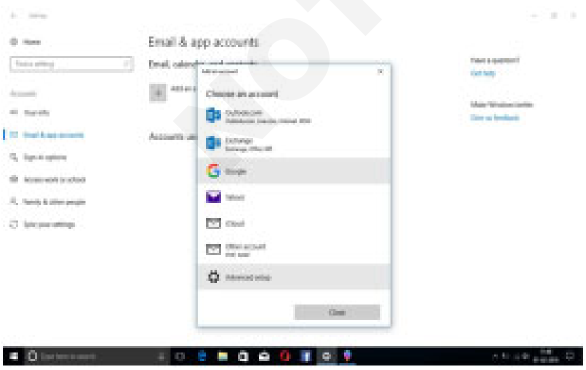
4 Click on Add an account to create a new user. (Fig 11)

Fig 11



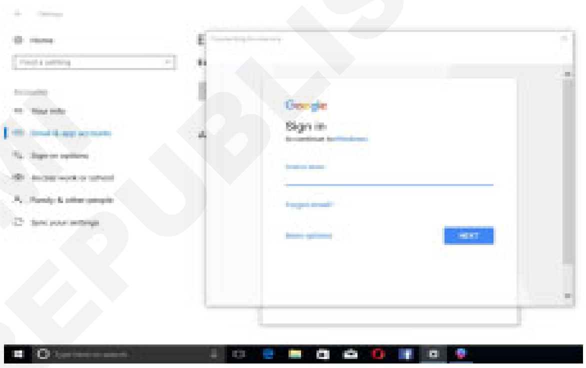
5 Select your account in Choose an account drop down menu. Click Close. (Fig 12)

Fig 12



6 Type the e-mail or phone in the Sign-in Window and click NEXT. (Fig 13)

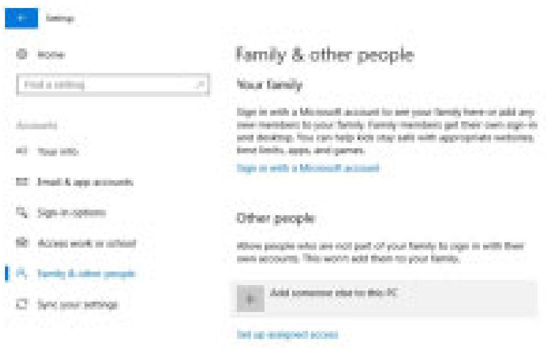
Fig 13



7 Enter the password in the Password field.

8 To create a new user account for family or other people in the system, click on Family & other people tab in Fig 14.

Fig 14



9 Click on the + Add someone else to this PC to add a new user.9 Sign-in with a valid e-mail account.

10 Sign-in with a valid e-mail account.

11 Click NEXT and confirm the password.

12 Close Window.

— — — — — —

TASK 4: **Granting and modify the user rights**

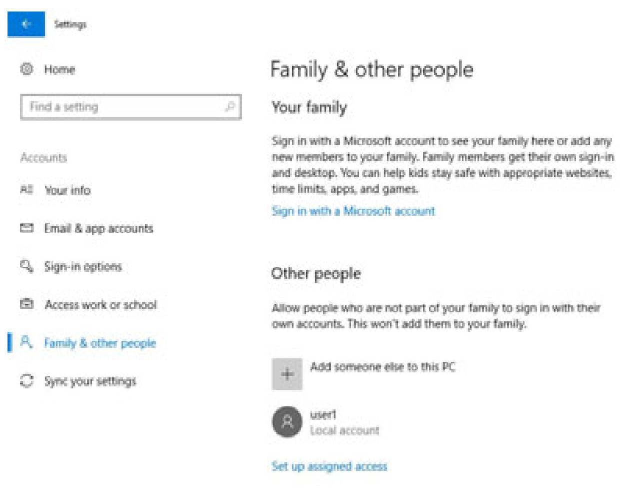
1 Open the Settings Window (Fig 2)

2 Click on Accounts in the Settings Window.

3 Select Family & other people in Fig 14

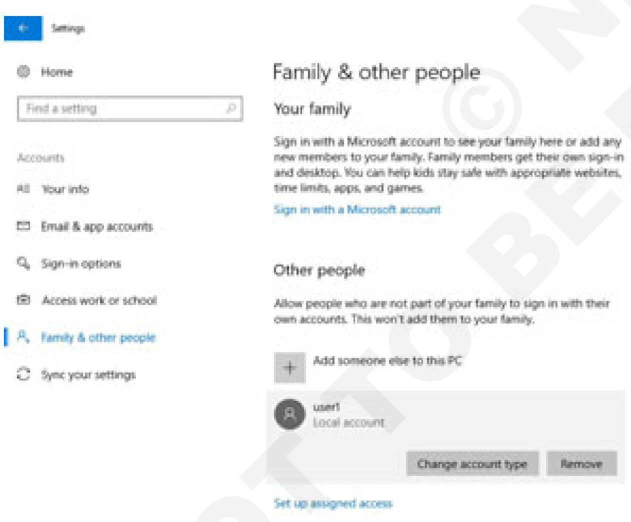
4 Click on the user account whose user rights have to be granted or modified. (Fig 15)

Fig 15



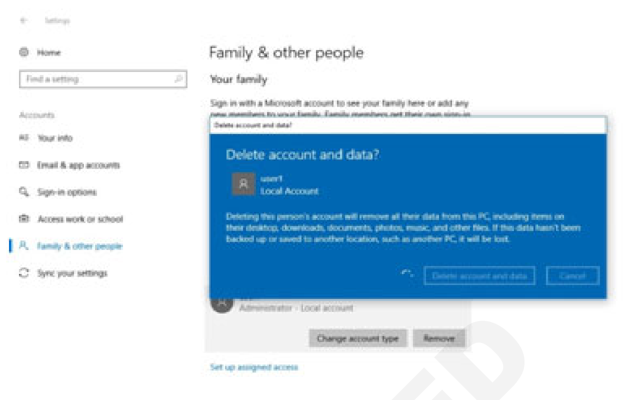
5 If you want to delete the account of the user, Click the user account and select Remove. (Fig. 16)

Fig 16



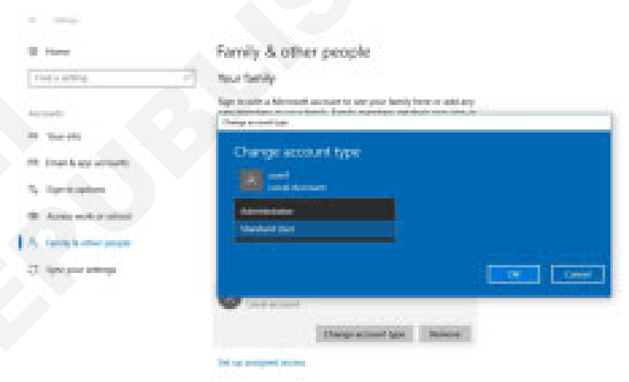
6 Click on the Delete account and data tab to remove the selected user account from the system. (Fig 17)

Fig 17



7 Change the user rights, click on the user account and click on Change account type. (Fig 18)

Fig 18



8 Select Administrator to give the user account rights to do major changes in the system .

9 Select Standard User to give the user account to do perform common daily tasks.

10 Click OK Close the Window.

— — — — — —

View system properties and control panel

Objectives: At the end of this exercise you shall be able to
- **identify the desktop components in device manager**
- **change clock, date, regional language in control panel**
- **repair, modify and uninstall the applications in control panel.**

Requirements

Tools/Equipments/Instruments

- PC with MS-Office - 1 No. /trainee

PROCEDURE

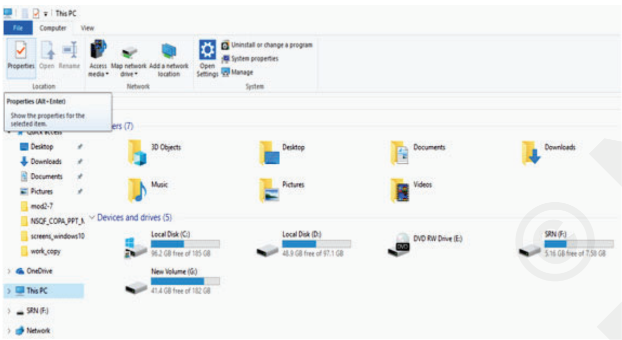
TASK 1: **Identify the desktop components in device manager**

1 Click on File manager in the taskbar.

2. Select and Right click this PC.

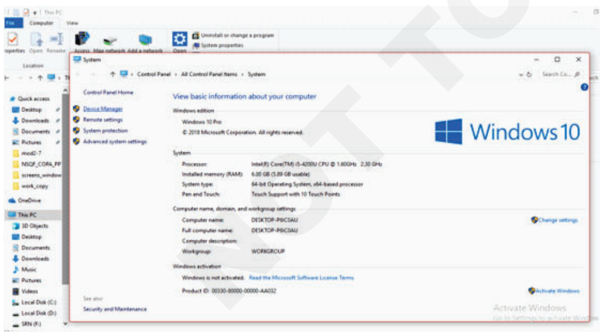
3 Right Click on Properties. (Fig 1)

Fig 1



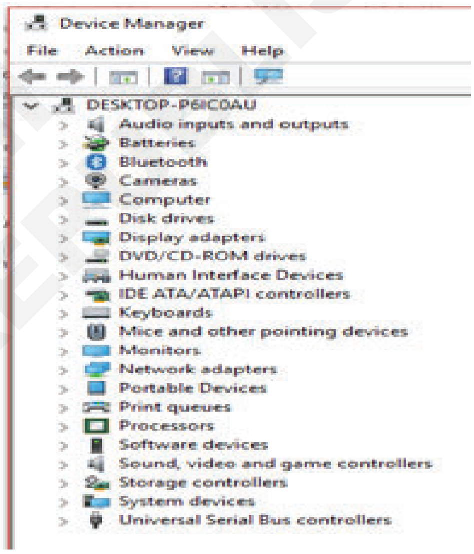
4 Click on Device Manager in Fig 2.

Fig 2



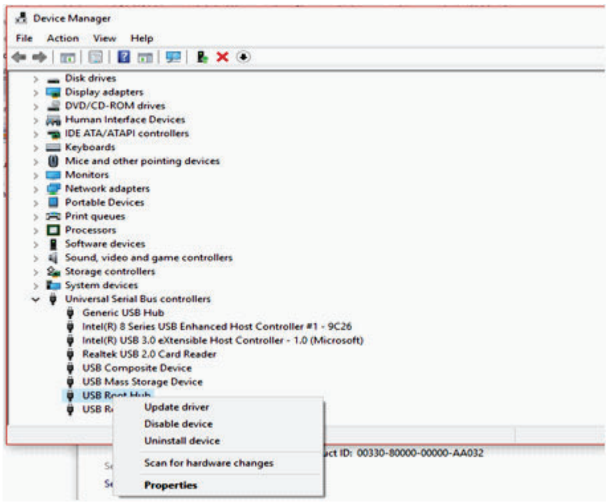
6 Double click on the Universal Serial Bus controllers in the menu in Fig 3.

Fig 3



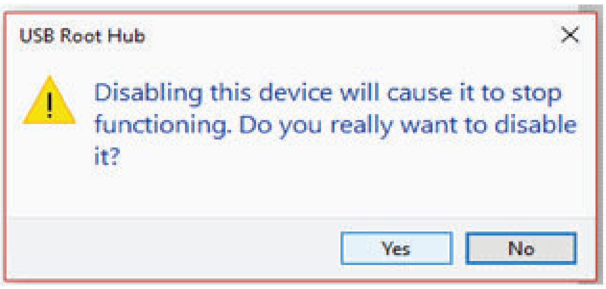
7 Right click on USB Root Hub and select Disable device (Fig 4).

Fig 4



8 Click Yes in the USB Root Hub. (Fig 5)

Fig 5



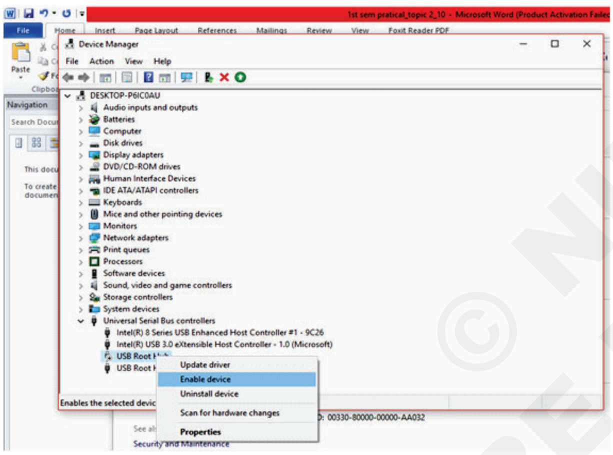
9 Insert a Pendrive/ USB in the USB slot.

10 Check This PC folder to see if any removable device/ USB is shown.

11 Go to Device Manager and double click on the Universal Serial Bus controllers.

12 Right click on USB Root Hub and select Enable device (Fig 6).

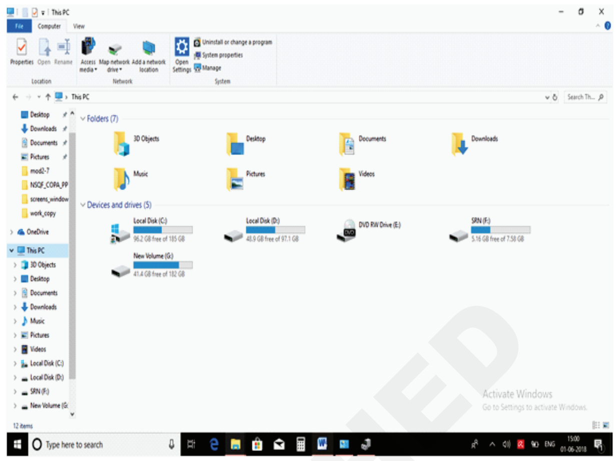
Fig 6



13 Insert a Pen drive/ USB in the USB slot

14 Check This PC folder to see if any removable device/ USB is shown. (Fig 7)

Fig 7



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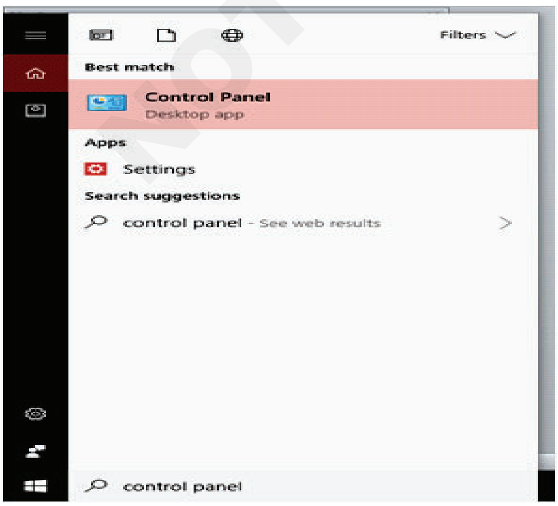
TASK 2: **Change clock, date, regional language in control panel**

1 Type Control Panel in the Search box

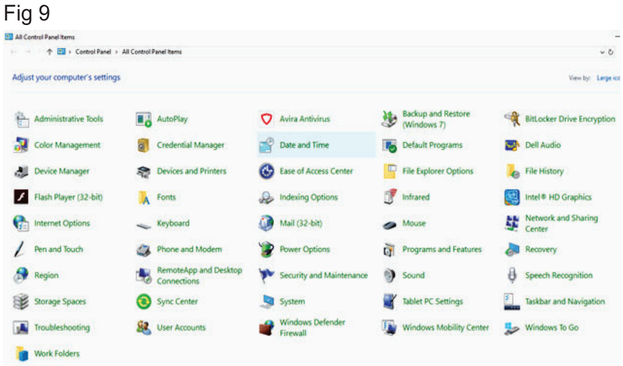
2 Select Control Panel app from the menu. (Fig 8)

Fig 8



3 Select Date and Time from the Control panel. (Fig 9)

Fig 9



4 Click on Change date and time (Fig 10).

5 Change the date and time. Press OK. (Fig 11)

6 Close window

Fig 10

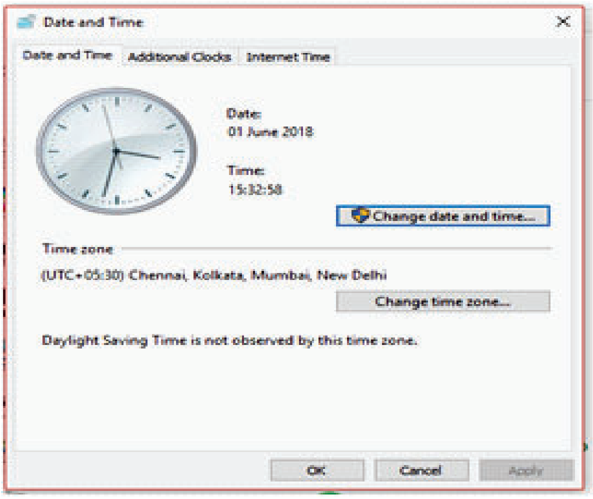
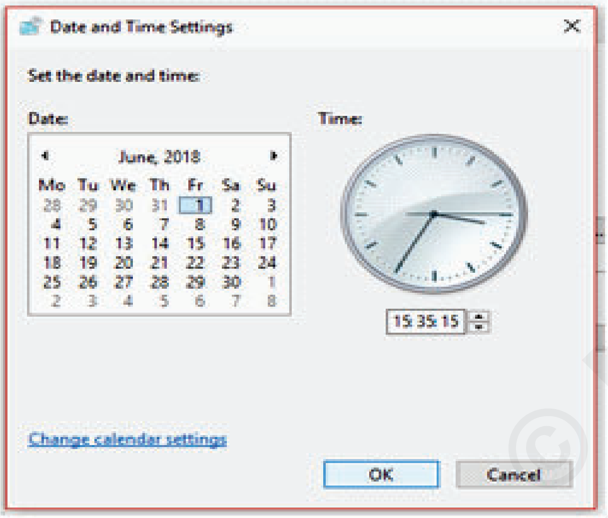


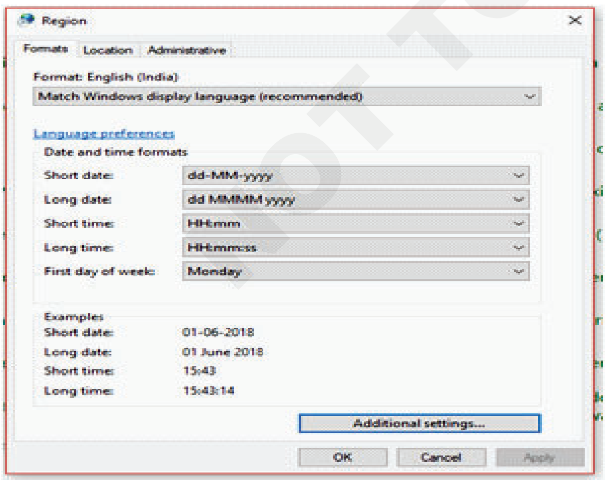
Fig 11



7 To change language, select Region from the Control panel (Fig 9)

8 Click on Language preferences as shown in Fig 12.

Fig 12



9 Click on + Add a Language(Fig 13)

10 Type the name of the language you need the system to work/change .(Fig 14)

Fig 13

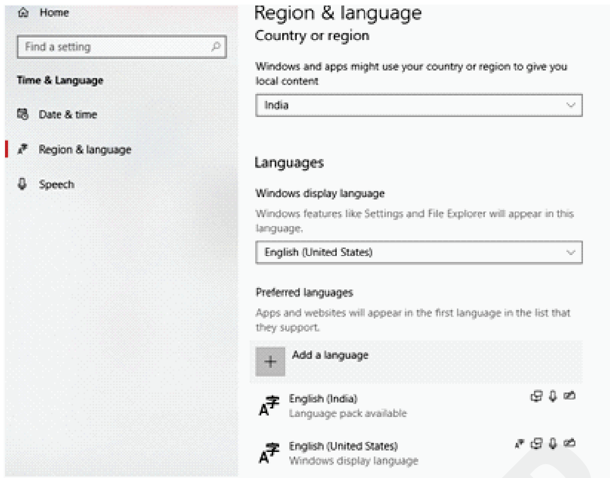
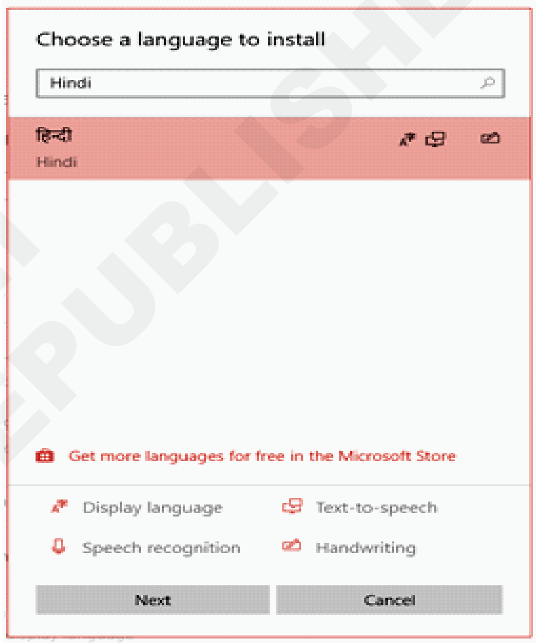


Fig 14



12 Click Install.

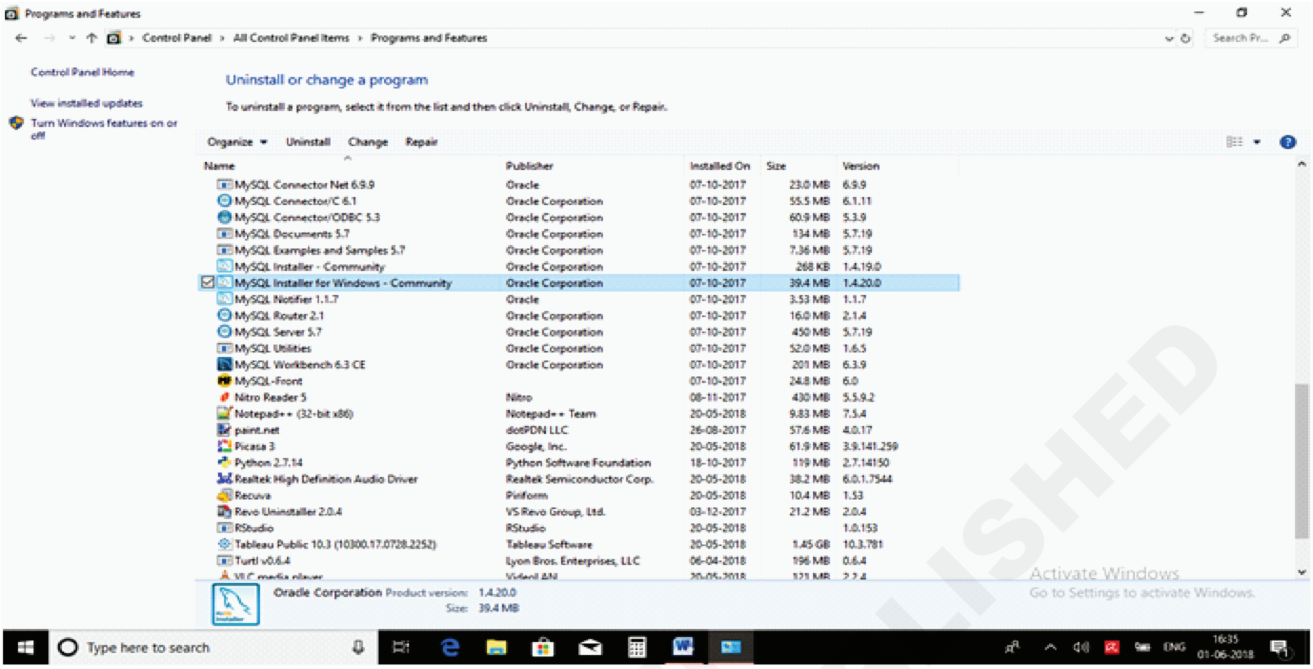
13 Close the Window.

TASK 3: **Repair, modify and uninstall the applications in control panel**

1 Select Programs and Features from the Control panel (Fig 9).

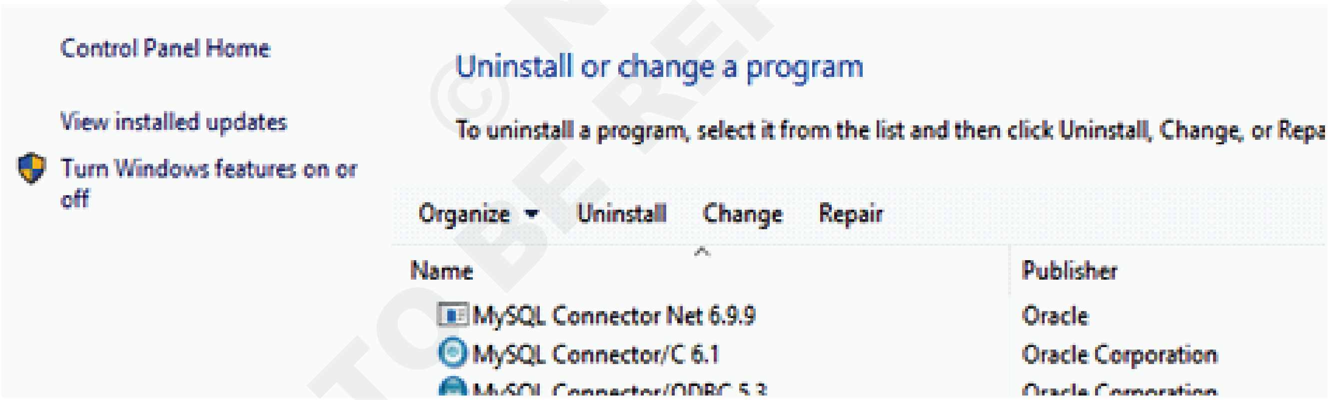
2 Select the program from the drop down menu. (Fig 15).

Fig 5



3 Click on Uninstall / Change / Repair (Fig 16).

Fig 16



4 Click Yes to Uninstall / Change / Repair the application.

5 Close the window.

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Installing system application software

Objectives: At the end of this exercise you shall be able to
- **Install MS-Office 2010**
- **Instal Nero software in windows operating system**
- **Instal VLC Media player**
- **Instal Adobe PDF Reader**
- **Download and Install Avira Free Antivirus software in windows operating system.**

Requirements

Tools/Equipments/Instruments

- PC with MS-Office - 1 No.
- MS-windows 10 Software - 1 No.

PROCEDURE

TASK 1: **Installing Ms-Office 2010**

Hardware and Software Requirements

Microsoft Office 2010 is available in both 32 and 64-bit versions and will install on the following minimum hardware requirements.

- **500 MHz or faster processor**
- **256 MB or more RAM memory**
- **3 GB or larger available hard disk space**
- **1024x578 display resolution**
- **Windows XP SP3 32-bit, Windows Vista SP1 32/64-bit, Windows Server 2003 R2 32/64-bit with MSXML 6.0, Windows Server 2008 32/64-bit or later, Windows 7 32/64-bit, Windows 8 32/64-bit, Windows Terminal Server and Windows on Windows applications are supported as well.**

When inserting the CD a prompt should show windows explorer

1 Confirm whether PC meets the Office 2010 system requirements.

2 Check to see if your PC is preloaded with Office 2010.

3 Click Run SETUP.EXE as shown in Fig 1.

4 Read the Microsoft Software License terms, place a check mark in the box to indicate that agree with them and press the Continue button as shown in Fig 3.

Fig 1

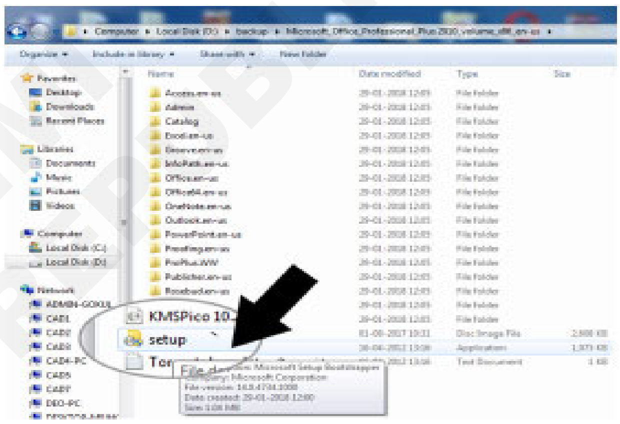


Fig 2

5 Enter the 25 character product key on the MSU CD case and then click Continue as shown in Fig 2.

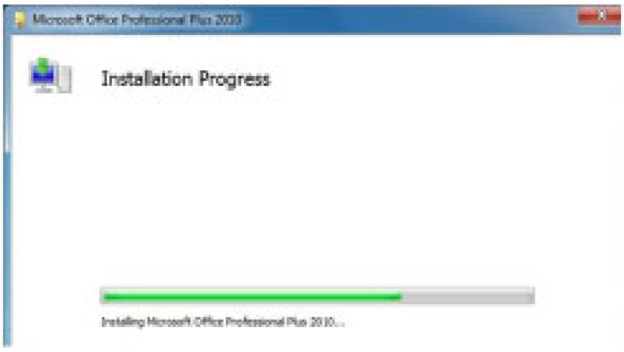
Fig 3

6 Press the Install Now button to begin the installation as shown in Fig 4.

Fig 4

The Fig-5 shows the progress bar will indicate how far along the installation has progressed. Depending upon the speed of the computer, this step could take several minutes on older systems.

Fig 5



7 Click Close when the installation completes as shown in Fig 6.

Fig 6

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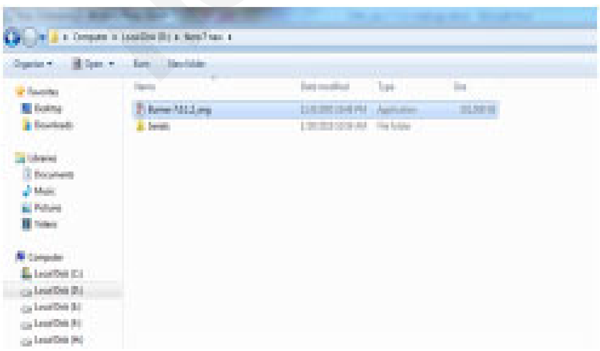
TASK 2: **Installing nero software in windows operating system**

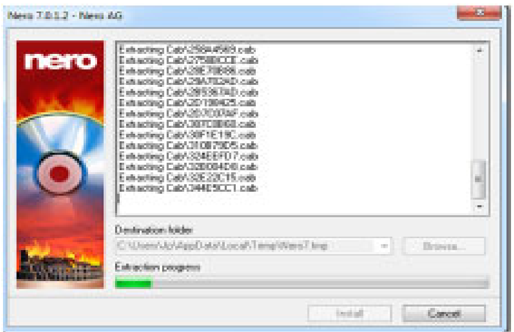
1 Double click the application file of Nero as shown in Fig 7.

Fig 7



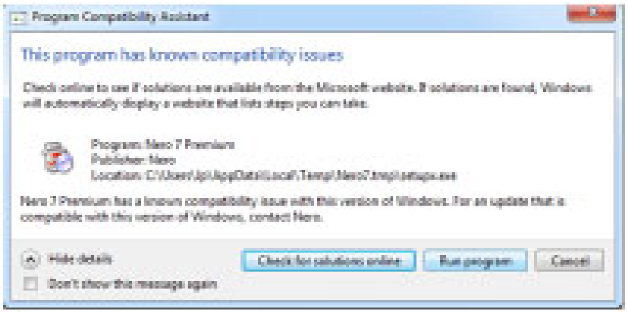
Initial file extracting window will appear as on Fig 8.

Fig 8



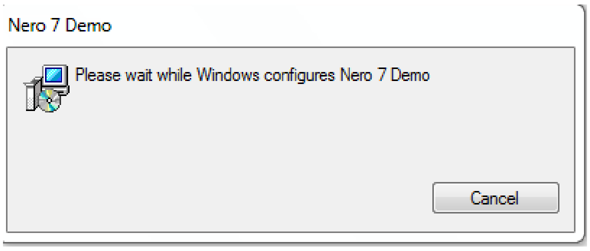
2 Click "Run Program" button as on Fig 9.

Fig 9



Window files configuring process will appear few seconds as on Fig 10

Fig 10

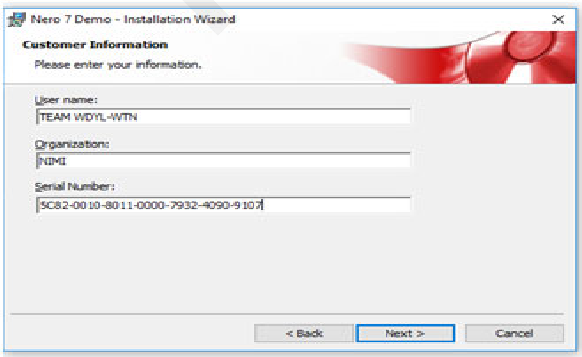


3 Click "Next" in the installation wizard as on Fig 11.

Fig 11

4 Type the user name , organization and serial number as on Fig 12.

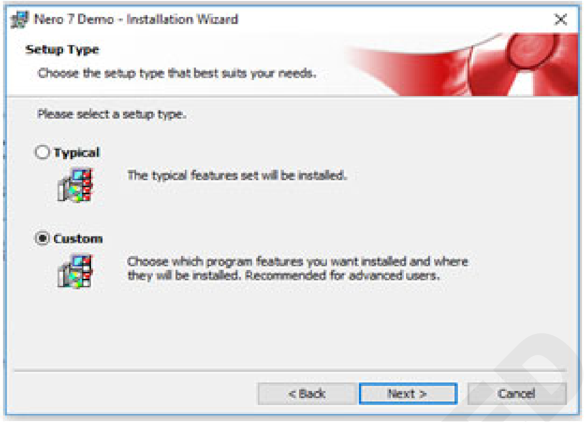
Fig 12



Serial number look it printed on CD ROM

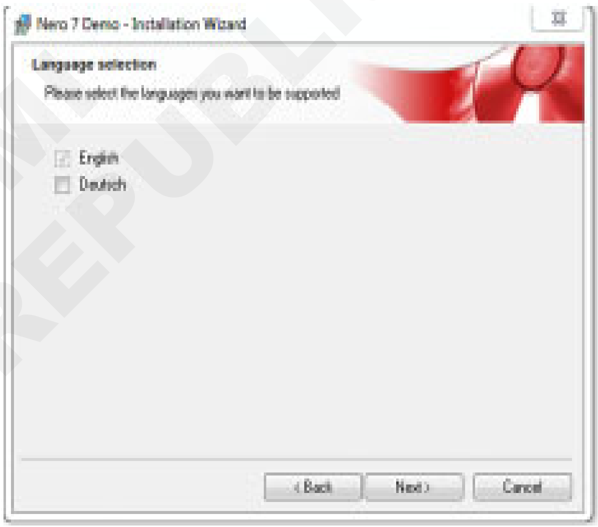
5 Select the setup type as "Custom" as on Fig 13.

Fig 13



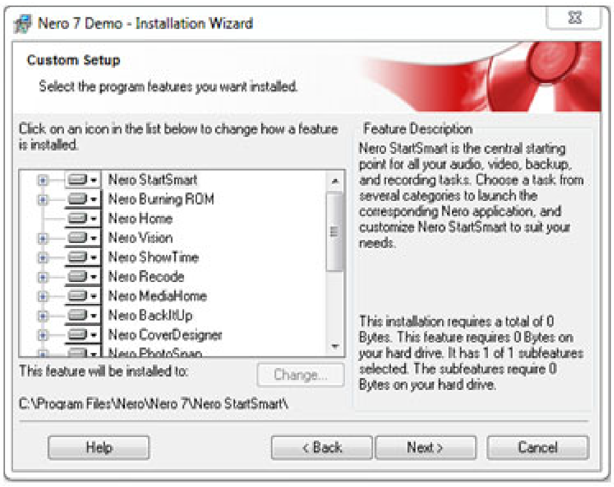
6 Select "English" and click "Next" in the language selection window as on Fig 14.

Fig 14



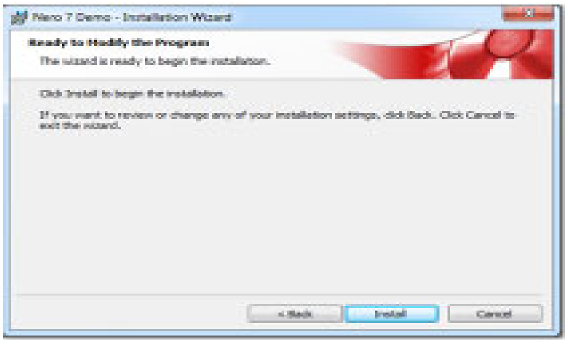
7 Click "Next" in the custom setup window as show in Fig 15.

Fig 15



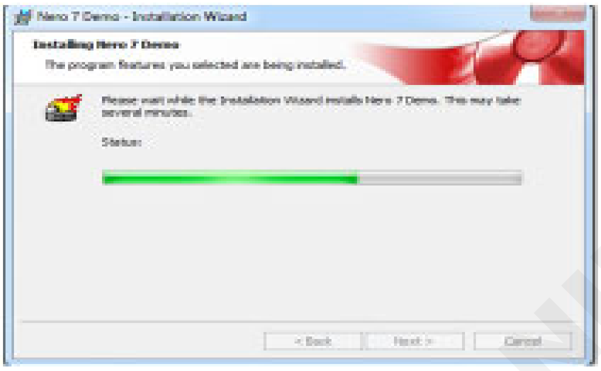
8 Click "Install" in the installation wizard as shown in Fig 16.

Fig 16



The installation process wizard will appear as on Fig 17

Fig 17



9 Click "Finish" button in the installation wizard as on Fig 18.

Fig 18

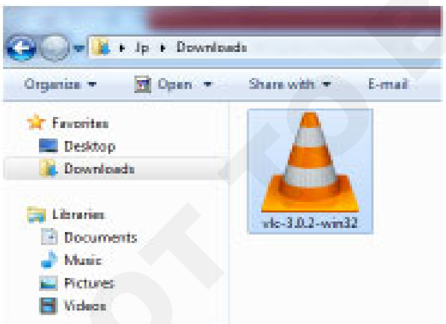
10 Get it check with your instructor.

— — — — — —

TASK 3: **Installing VLC media player**

1 Double click on the Vlc-3.0.2-win32 exe file as on Fig 19.

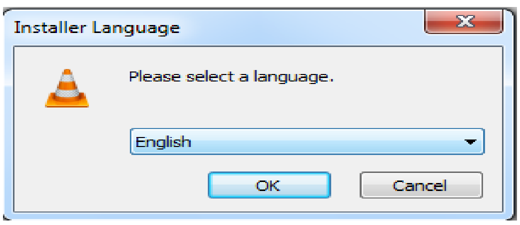
Fig 19



2 Click Run button in the window.

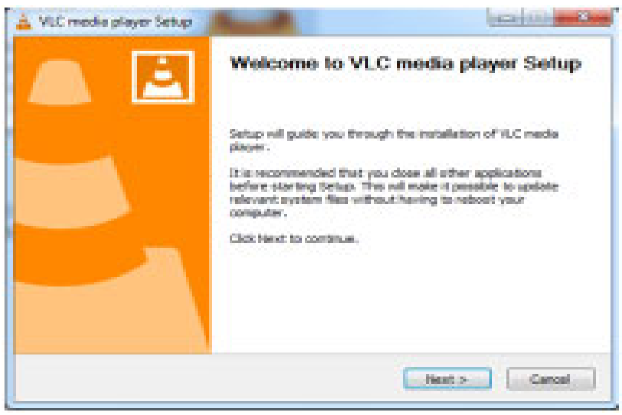
3 Select the language and click ok button as shown in Fig 20.

Fig 20



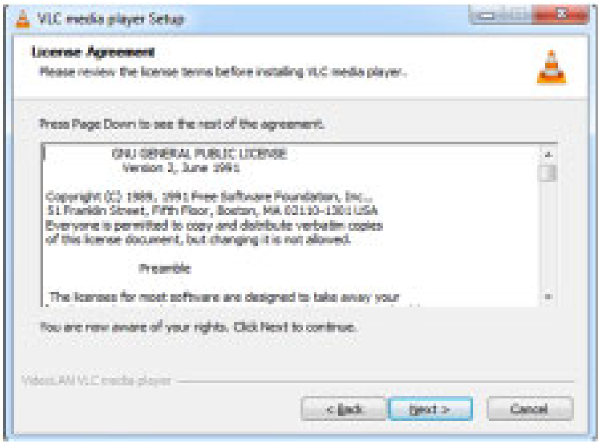
4 Click Next Button as shown in Fig 21.

Fig 21



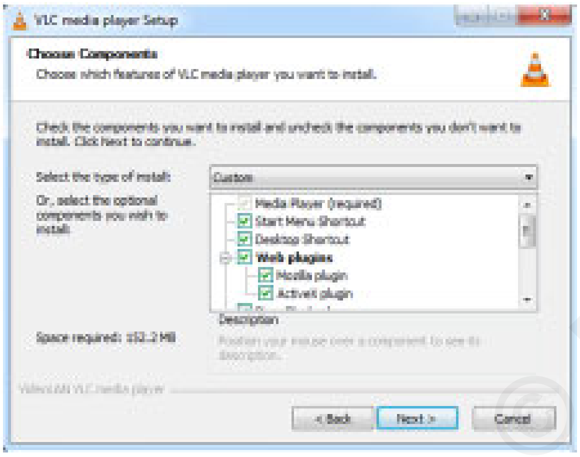
5 Click the Next Button On the License Agreement window as on Fig 22.

Fig 22



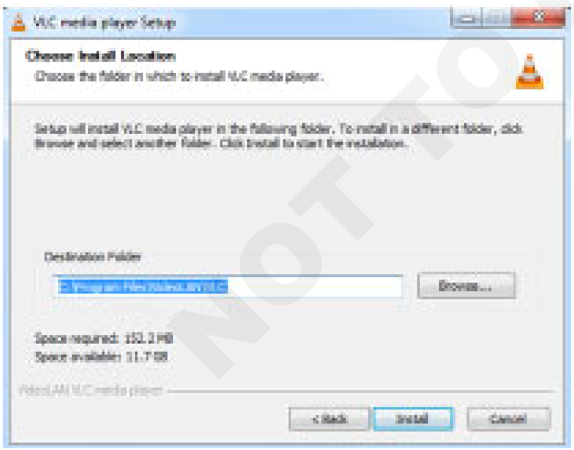
6 Select components of Media player and click Next Button as shown in Fig 23.

Fig 23



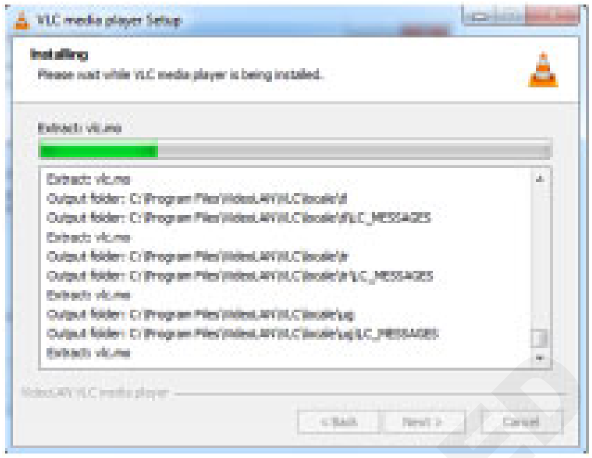
7 Click Install Button as on Fig 24.

Fig 24



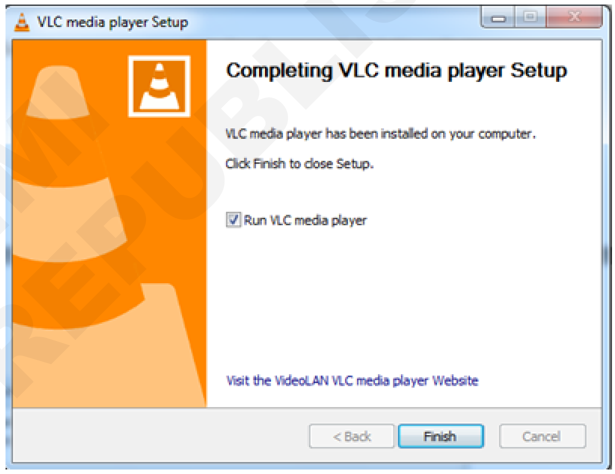
The installation process window will display as on Fig 25.

Fig 25



8 Click Finish Button as on Fig 26.

Fig 26



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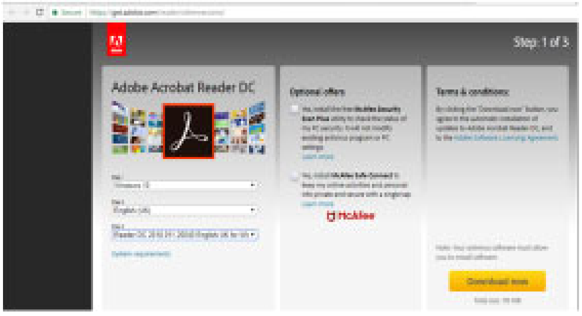
TASK 4: **download and install the adobe Acrobat Reader DC from the Internet**

1 Open the browser

2 Select the corresponding website https://get.adobe.com/reader/otherversions/ as shown in Fig 27.

Fig 27

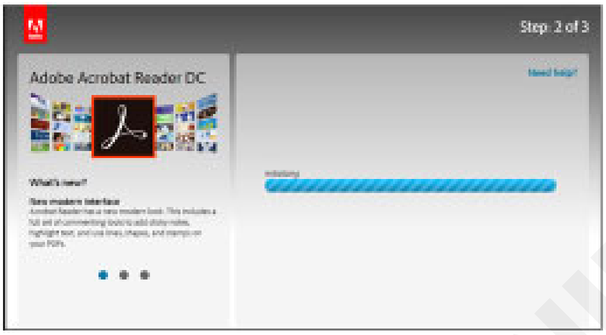


3 Slect "windows version, Language and Reader version"

4 Click download button as shown in Fig 28.

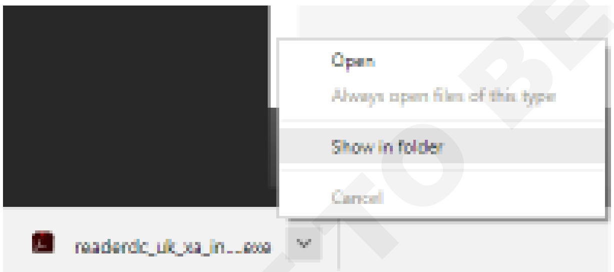
The down loading process will start and the EXE file will show bottom of the Browser

Fig 28



5 Click the up arrow and again click show in folder menu as shown in Fig 29.

Fig 29

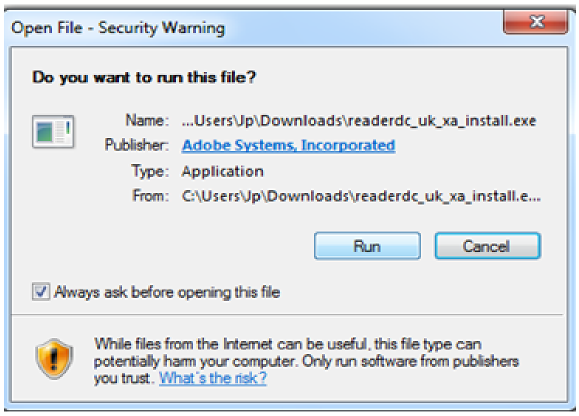


6 Double click the file as shown in Fig 30.

Fig 30

7 Click Run button as shown in Fig 31.

Fig 31

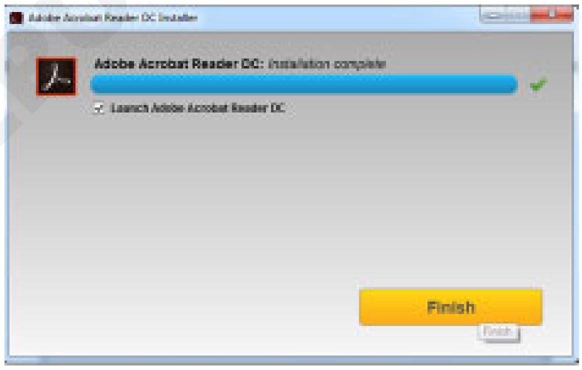


The down loading process window is shown in Fig 32.

Fig 32

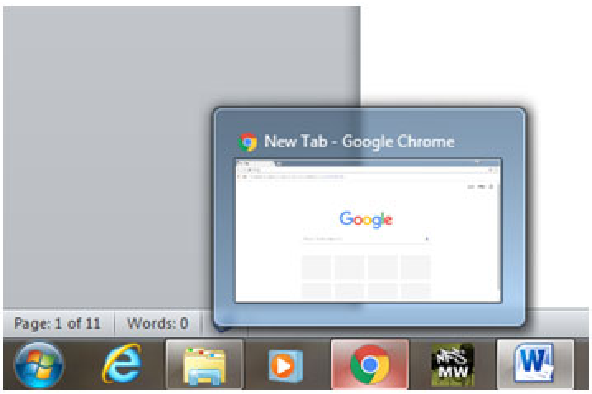
8 After complete the installation click Finish Button as shown in Fig 33.

Fig 33



The welcome window is shown in Fig 34.

Fig 34



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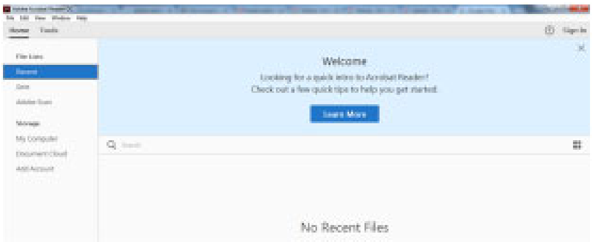
TASK 5: **Installing Avira Free Antivirus software in windows operating system**

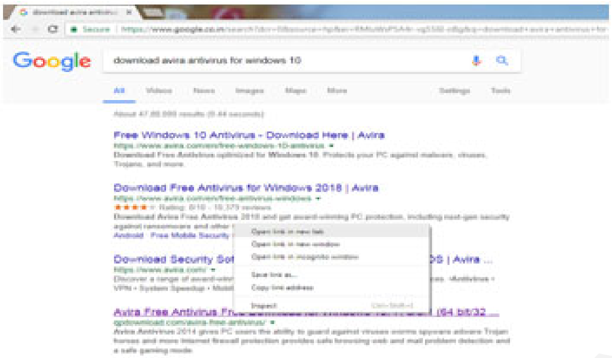
1 Click "Google Chrome" icon in windows task Bar as shown in Fig 35.

Fig 35



2 Type the text "download avira antivirus for windows 10" in text box and click "Search" Button as shown in Fig 36.

Fig 36



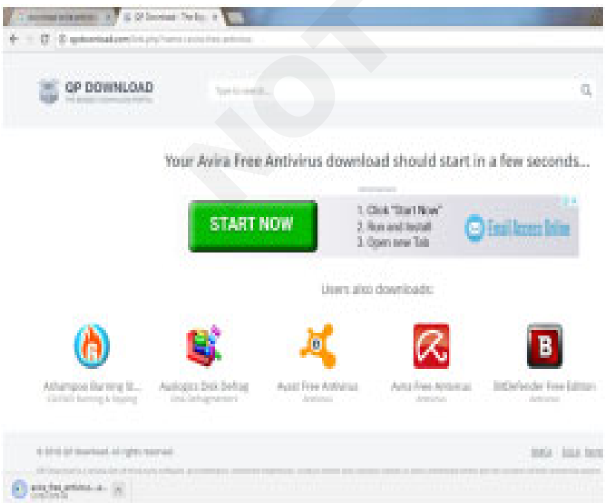
Display the list of related links in the chrome web page.

3 Right click on the related link and click "Open link in new tab" as shown in Fig-36.

The corresponding software exe file will download bottom of the web page

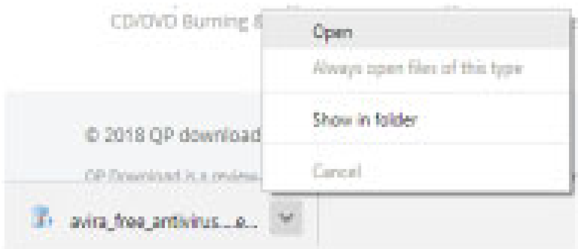
4 Click "START NOW" button in the web site as shown in Fig 37.

Fig 37



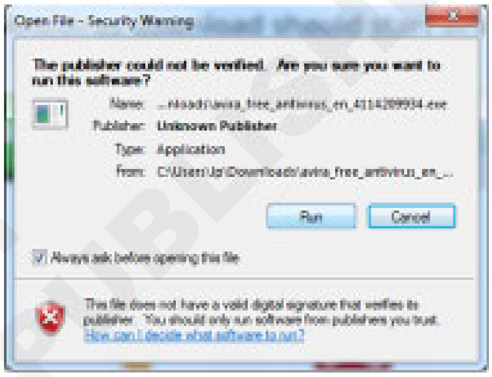
5 After download the file "click the ^ button" and click "open" menu as shown in Fig 38.

Fig 38



6 Click "Run" button in the below window as Shown in Fig 39.

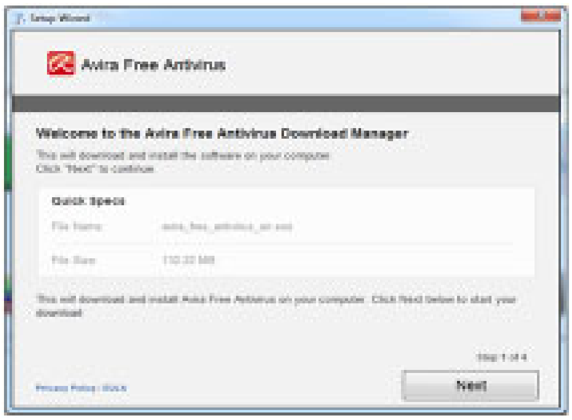
Fig 39



The bellowed screen shows "This will down load and install the software on your computer"

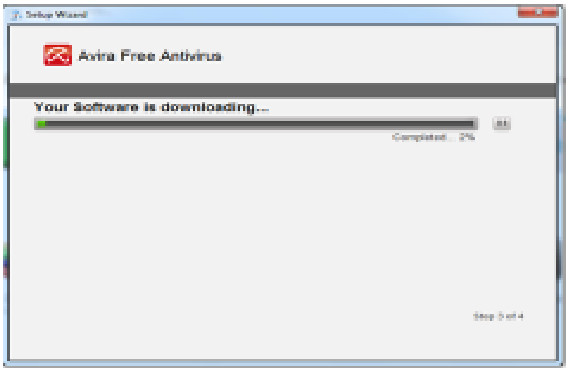
7 Click "Next" to continue the downloading process as on Fig 40.

Fig 40



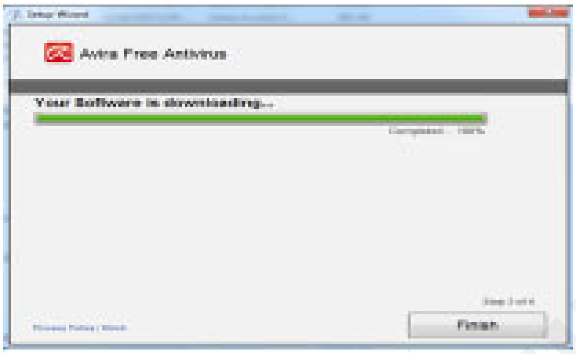
The downloading progress bar will display the downloading status as shown in Fig 41.

Fig 41



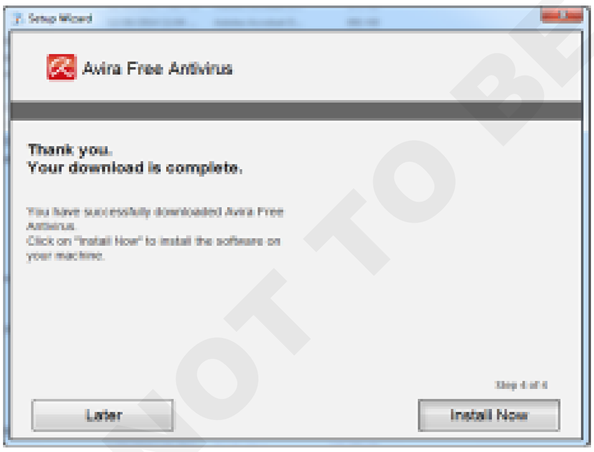
8 Click "Finish" button after complete the 100% downloading progress as on Fig 42.

Fig 42



9 After complete the downloading process the window will appear as on Fig 43.

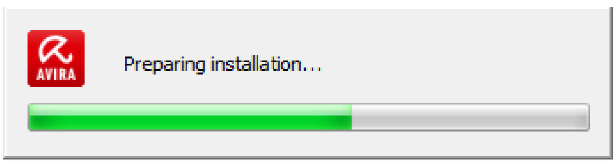
Fig 43



10 Click "install now" button in the bottom of the window.

The "preparing installation" process begins as on Fig 44.

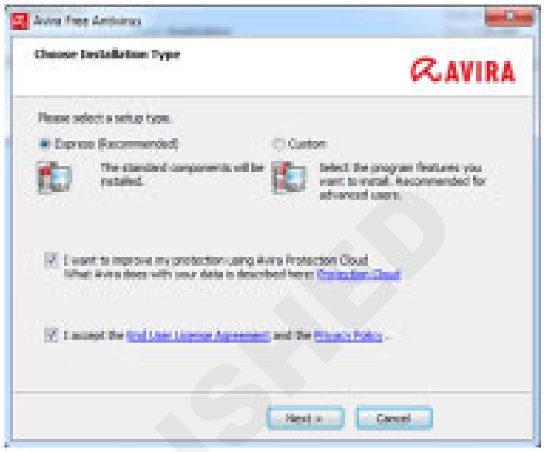
Fig 44



After complete the "preparing installation" process the " Choose Installation Type" window will appear

11 Select the "Express(Recommended)" setup type option and select the license agreement and privacy policy option in the bottom of the window as shown in Fig 45.

Fig 45



12 Click "Next" button

The Avira Antivirus application installation completed as shown in Fig 46 and 47

13 Get it checked with your instructor.

Fig 46

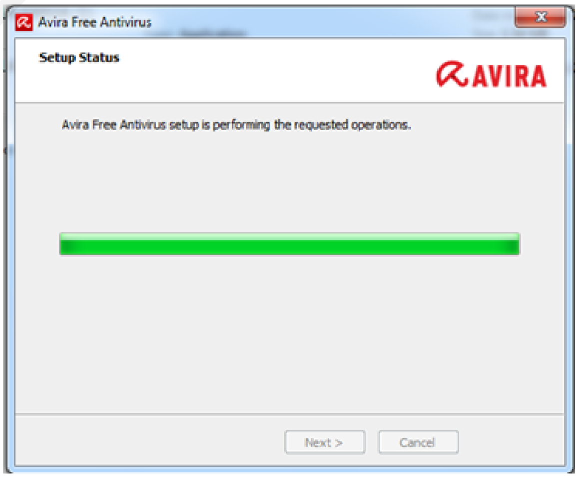
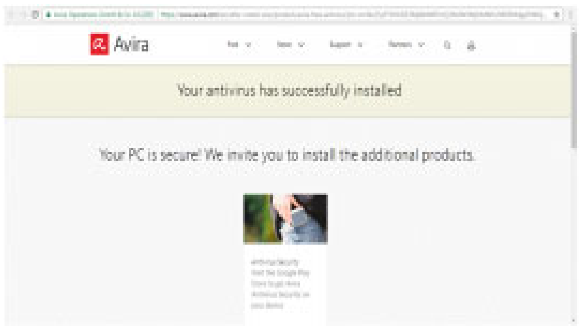


Fig 47



Burning a data in CD or DVD's using Nero

Objectives: At the end of this exercise you shall be able to
- **Burn a data CD or DVD.**

Requirements

Tools/Equipments/Instruments

- PC with MS-Office - 1 No.
- Nero software - 1 No.

PROCEDURE

TASK 1: **Burn a Data in CD or DVD**

1 Put the CD in the CD/DVD writer

2 Go to Start > All programs > Nero, then Nero StartSmart.

3 Scroll over the icons on the top right of the program window, to find the Data icon. See Fig 1.

Fig 1

4 Choose Make Data CD. This will launch Nero Express as shown in Fig 2.

5 Click Add and browse the hard drive and select the files like included on the CD. When finished adding files click Finished.

6 Click Next and name the disk.

7 Check Verify data after burning if you want to make sure your burn happened correctly (this will take a little more time).

8 Click Burn and insert a blank CD as on Fig 3.

Fig 2

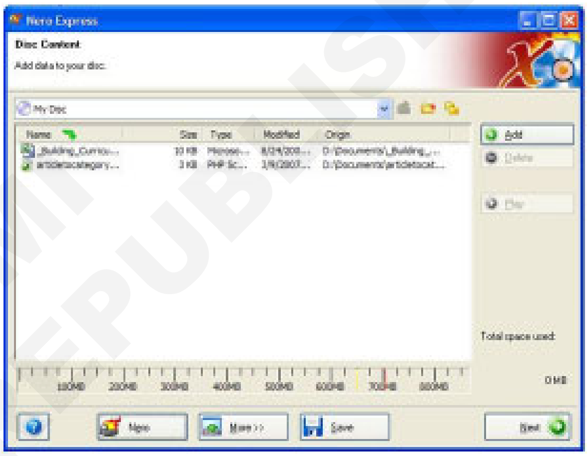
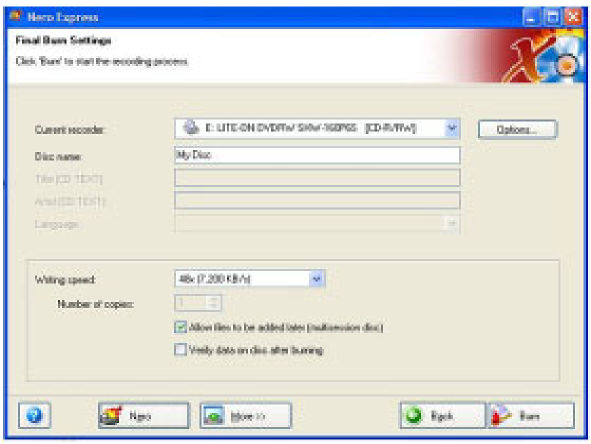


Fig 3



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Dismantle and assemble the desktop computer system

Objectives: At the end of this exercise you shall be able to
- **dismantle and assemble desktop computer system**
- **connecting data cable and power cable to the various devices in the desktop.**

Requirements

Hardware and software

- Identical PCs with labeled ports, connection cables (could even be dummy) - as reqd
- I/O devices such as Keyboard, Mouse Monitor, Printer, Multimedia, Speaker, CD Drive, DVD Drive and Microphone - as reqd
- Screw driver set and Allen key (depending upon the type of fixing used with connectors) - as reqd
- Sticking labels - as reqd

PROCEDURE

TASK 1 : **Dismantling and assembling the computer system**

1 Switch off and unplug the power cord from the PC.

2 Remove the component connections from the Cabinet i.e. USB connections, Keyboard/Mouse Connections, LAN Connection, Parallel and Serial Port Connections

3 Ensure no power related connection is there with Cabinet

4 Unscrew the cover that is opposite to the Mother board section, as the motherboard section closure is fully closed by motherboard base, and remove the cover.

5 Remove the SMPS connections to Hard Disk drive, DVD Drive, Motherboard Main Power, CPU Power, Fan Power Connector, PSU Connections, inside the Cabinet.

6 Remove the connectors from devices like SATA/IDE Cables to HDD and DVD, Audio Connectors, Cabinet Front USB/Audio Connectors.

7 Unscrew the motherboard screws, HDD-DVD screws and other removable items and dismantle.

Warning: Do not remove or misplace any jumpers placed across the motherboard, as it will result malfunctioning or dead - error motherboard operation.

Note: Now the pc totally dismantled.keep a note of all the parts is being dismantled, which will be easier to re-assemble the system.

8 Clean the objects with a soft cotton cloth, mild blower etc. to remove dust and patches on them.

Note : Don't use any water based cleaner inside the system as it is power conductive and may short-circuit in case of moisture. Keep the parts separated and clean.

9 Place the SMPS at right position and screw it.

10 Place properly the motherboard on the legs of cabinet. In case any placement problem place the motherboard first and screw it before fixing SMPS.

11 Fix the processor and fan, RAM,PCI Cards which ever removed at proper places.

12 Fix the Harddisk,DVD Drive,Floppy Drive,Other components that to be screwed with the cabinet.

13 Connect the connectors from motherboard to various devices like SATA,IDE,USB Extensions,etc.

14 Plug the SMPS connections to Motherboard,CPU PSU,Devices,which are on power required connections.

15 Screw up the side cover to close the cabinet.

16 Connect the devices and external devices using connectors into motherboard.

17 Connect the power chord finally to the Cabinet.

Note: Ensure that all connections are proper Now switch ON the power and switch-ON the system.

— — — — — —

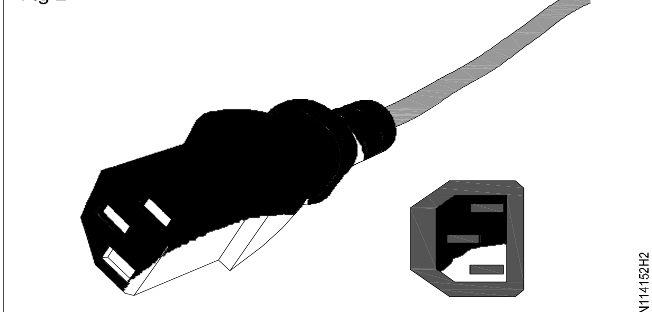
TASK 2: **Connect data cable and power cable to the various devices in the desktop.**

The trainees will connect the system with I/O devices as shown in (Fig 1)

Fig 1

1 Connect the system power cable to the appropriate socket on the rear side of the PC as Shown in (Fig 2).

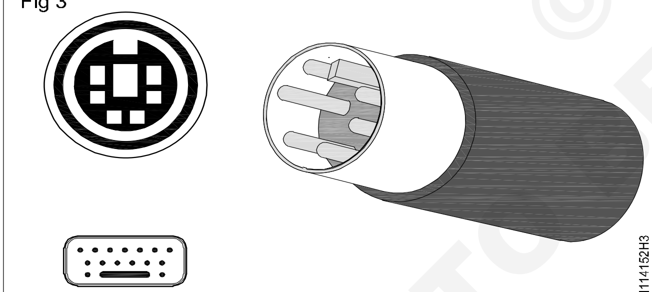
Fig 2



CONNECTING THE POWER CORD

2 Connect the Keyboard connector to the appropriate Keyboard socket on the rear side of the PC as shown in (Fig 3).

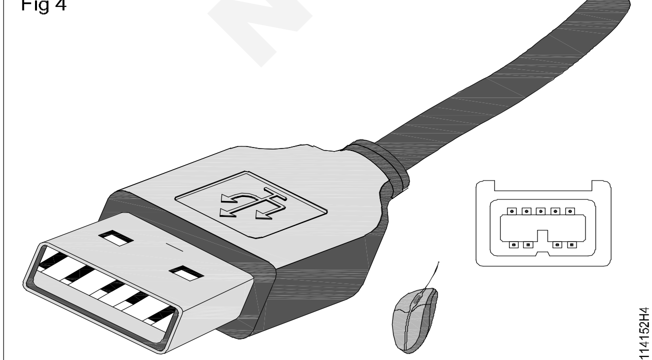
Fig 3



CONNECTING YOUR PS/2 KEYBOARD

3 Connect the Mouse connector to Com1, Com2 , PS/ 2 or USB port (according to type of connector the Mouse comes with) as shown in (Fig 4).

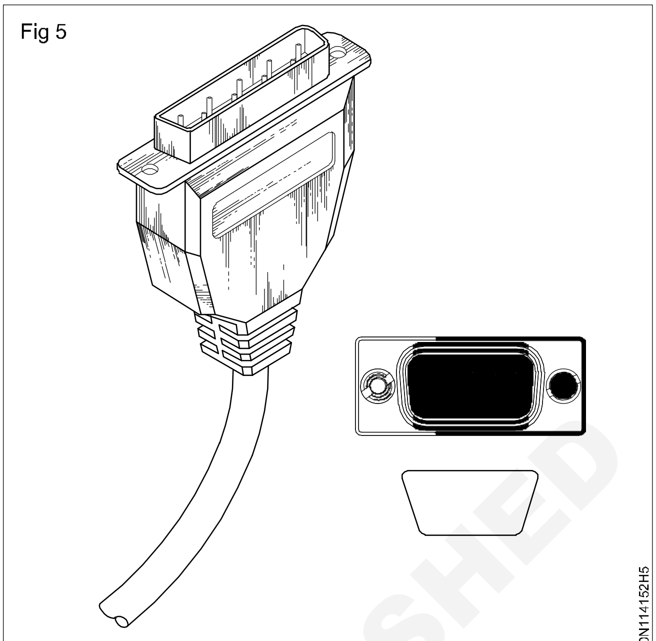
Fig 4



CONNECTING YOUR USB DEVICE

4 Connect the monitor Data cable connector to the VGA connector on the rear side of PC as shown in (Fig 5).

Fig 5

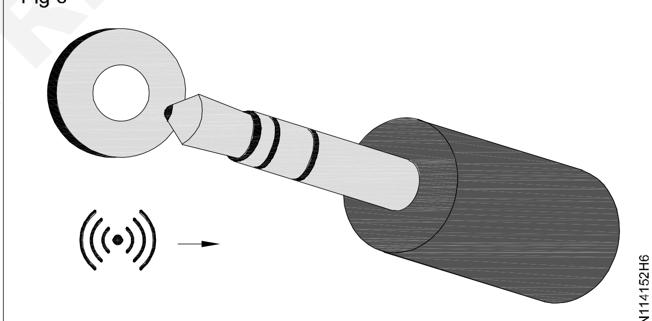


CONNECTING YOUR MONITOR

5 Connect the power cable of the monitor either to the lower socket on the PC itself or a separate wall socket depending on the type of power connector the cable is provided with.

6 Connect the speaker boxes/Headphone cable connector (RCA jack) to line out speaker jack (RCA female) on the rear end of the PC as shown in (Fig 6)

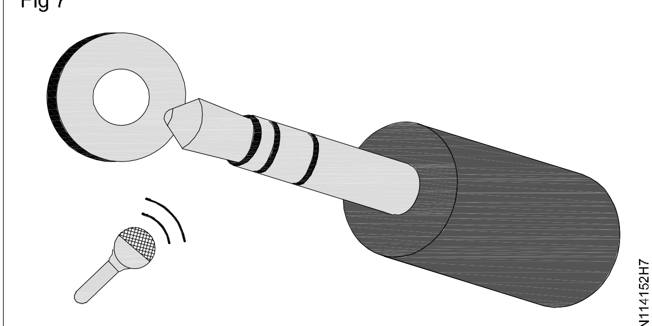
Fig 6



CONNECTING YOUR SPEAKER / HEADPHONE

7 Connect mics cable connector. RCA Jack to the MIC in RCA socket provided at the rear side of the PC and record it as shown in (Fig 7).

Fig 7

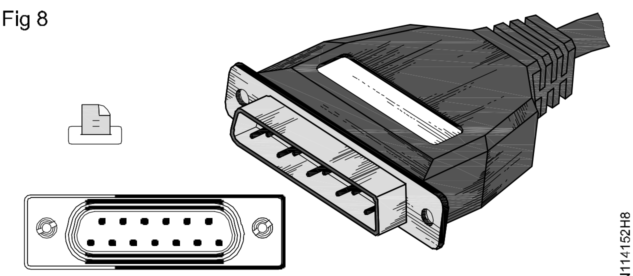


CONNECTING YOUR SPEAKER / HEADPHONE

8 Connect printer data cable DB 25 pin male connector to the parallel port DB 25 pin female connector provided on the rear side of PC as shown in (Fig 8).

9 Get the work checked by the instructor.

Fig 8



CONNECTING YOUR PRINTER

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Replace RAM and ROM from CPU

Objectives: At the end of this exercise you shall be able to
- **install and replace a RAM in mother board**
- **install and replace a ROM from CPU.**

Requirements

Tools/Equipments/Instruments

• Antistatic wrist strap	- 1 No.
• Windows PC	- 1 No.
• Multimedia speaker 5.1 & 7.1 etc/ Head phone	- 1 No.
• Microphone	- 1 No.
• Sound card different types 5.1,7.1 etc.	- 1 No.
• Sound card driver CD	- 1 No.
• Internet connection	- as reqd.

PROCEDURE

TASK 1: **Install and replace a RAM in mother board**

1 Shut down and turn off the computer.

If a PSU is used as grounded metal source, keep it plugged in. If a separate ground is available, unplug the computer completely. After turning off the power supply, wait at least 10 seconds before opening case to allow the motherboard's capacitors to discharge.

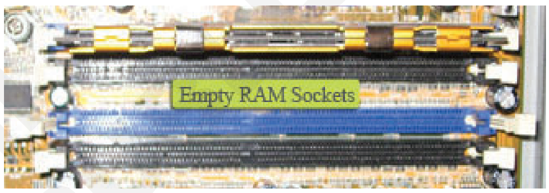
2 Open up your case as shown in Fig 1.

Fig 1

This process varies from cabinet to cabinet, usually involving the removal of a couple of screws and a side panel. While servicing computers be mindful of static electricity. To avoid building up a static charge that could potentially short out a component, Use an anti-static strap to ground yourself.

3 Locate the RAM sockets on the motherboard as shown in Fig 2.

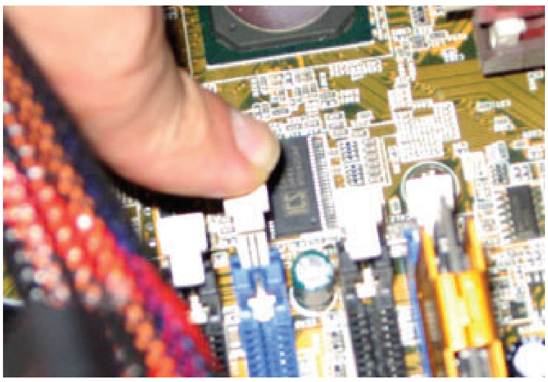
Fig 2



While freshly installing RAM in your computer, you should have at least one or two empty slots. While choosing the RAM socket, refer mother board manual. Some motherboards may require to fill the sockets in a particular order.

4 Open RAM retaining clips by gently pressing retaining clips outward as shown in Fig 3.

Fig 3



5 Remove the RAM module as shown in Fig 4.

6 Check the type and size of RAM.

7 Blow off any loose dust or debris from the RAM using hand blower.

Fig 4

8 Clean the RAM module contacts using a cotton swab slightly moistened with isopropyl alcohol or use a soft cloth that does not leave fibers behind, such as lens cleaning cloth.

Do not use eraser (Pencil eraser). Rubbing eraser against epoxy laminate on RAM module will produce static electricity and damage the RAM chips.

9 Set the RAM module aside and allow it to dry completely.

10 Repeat the steps 7, 8 and 9 for remaining RAM modules.

11 Blow out the empty RAM bay with canned air and cleaning brush.

12 After drying replace the ram sticks in their bays.

Note : Make sure you line up the notches correctly.

Apply firm and even downward pressure to each side of the module until it snaps into place.

13 Remove the antistatic wrist strap replace the side panel, plug the power cable back in and power on the computer.

14 Check the installed memory module size during startup, by entering CMOS setup.

15 Check the installed memory module size by right clicking my computer icon on windows desktop, select properties.

— — — — — —

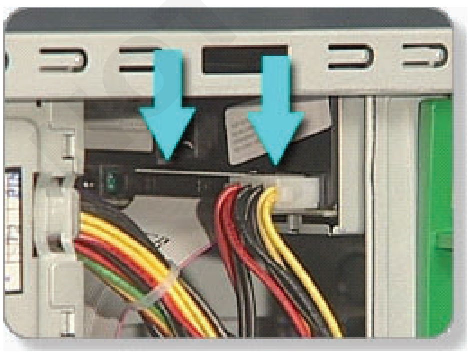
TASK 2: **Install and replace ROM from CPU**

1 Find the CD or DVD drive you want to replace, probably in a top bay towards the front of the computer. (Fig 6)

Fig 6

2 Disconnect the power cable and IDE/SATA interface cable from the back of the drive. Label the cable and connectors for a identification. (Fig 7)

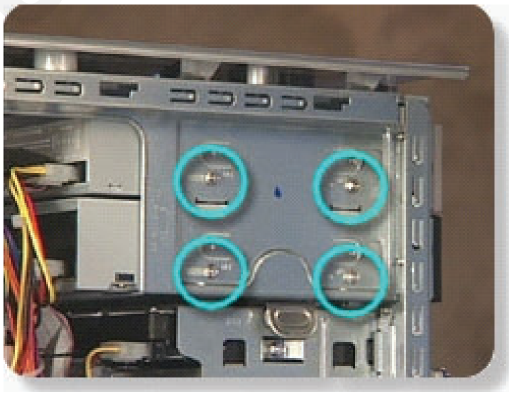
Fig 7



There might also be a small audio cable connected to the drive. Detach this cable from the back of the drive.

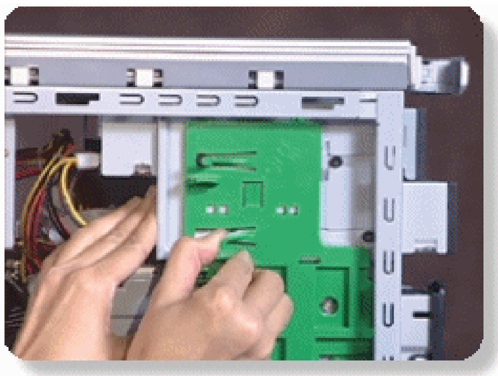
3 If the drive is attached to the case with screws, remove all screws on each side of the drive. Keep the screws safely for later use as shown in Fig 8.

Fig 8



4 Slide the drive forward through the front of the computer and remove it as shown in Fig 9.

Fig 9



Identify the different parts , its function and operation of modem.

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

- **identify an different parts, its function and operation of modem**

PROCEDURE

Identifying the modems in device manager

1 Go to "start" then click on "control panel".

2 Click on "System & Security" then.

3 Double click on "Administrative tools".

4 Double click on "Computer management".

5 Click on "Device manager" and wait for some seconds to get explore.

6 Check a list of devices installed in computer will appear.

7 Search for the "modems" installed in your pc. Click on sign (+) to explore modems installed in the PC.

8 Right click on specific moden, and select "Properties" to bring up more information (Such as Driver version & Data etc.,)

Idenitifying the modem physically in the computer case

1 Turn off the computer and takeoff the power cont.

2 Open the case by taking out a few screws on the back of the case.

3 Locate the modem installed.

4 Remove the modem for inspection.

5 Pull the modem from the PCI slot, using firm but gentle force.

6 Look at the modems lable to identify it.

7 Reinstall the modem by reversing the process-push it firmly and squerly back in the PCI slot.

8 Put the screw back in.

9 Close the case and put the power cord back in.

— — — — — —

Install a modem to computer to send and receive data over telephone line, cable or satellite a connection

Objectives: At the end of this exercise you shall be able to
- **identify an different parts, its function and operation of modem**
- **install a modem to the computer to send and receive data over a telephone line or satellite connection.**

Requirements

Tools/Equipments/Instruments

- PIV based system or above - 1 No.
- Modems (different types) - 1 No.
- Phone cable with RJ-11 jacks - 1 No.
- Ethernet cable - 1 No.
- RJ-45 Pins (Male) - 1 No.
- Wifi enabled devices Like (Lapops, Mobile phone etc.,) - 1 No.

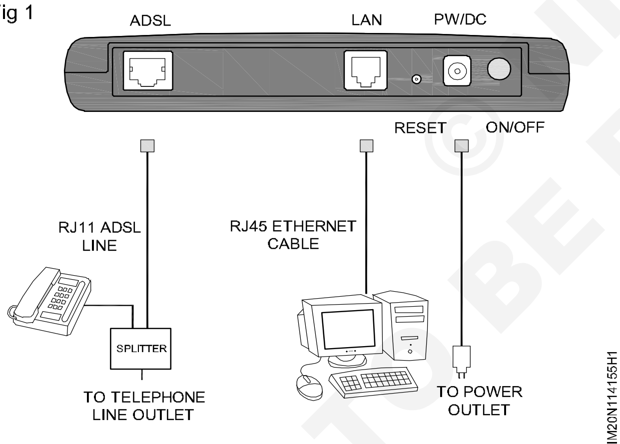
PROCEDURE

TASK 1 : **Install a modem to the computer to send and receive data over a cable or a satellite connection**

1 Unpack the modem and its accessories. It should have the modem, cable, phone cord, power adapter, installation diskette or CD, and instruction manual.

2 Turn off the computer and any attached devices (Fig 1).

Fig 1



3 Attach on end of the modem cable to the serial port (wide, 25-pin connector) on the computer and the other end to the modem.

4 Connect one end of the phone cord to the modem port marked “wall” or “line” and the other end to the wall jack of your phone line. If the modem will be sharing the line with a telephone, connect the cord of the telephone to the modem port marked “phone”.

5 Attach the power adapter plug to the modem and the power transformer plug to the power outlet, if this is required for your modem.

6 Turn on the computer and the modem, if it has an off switch.

7 When your computer starts up, follow the software installation instructins if prompted by your computer system (e.g., windows Plug ‘n play feature).

8 Insert the installation diskette or CD (if you do not receive prompts for installing the modem), click the drive, and click (or double-click) the installation program on the diskette or CD.

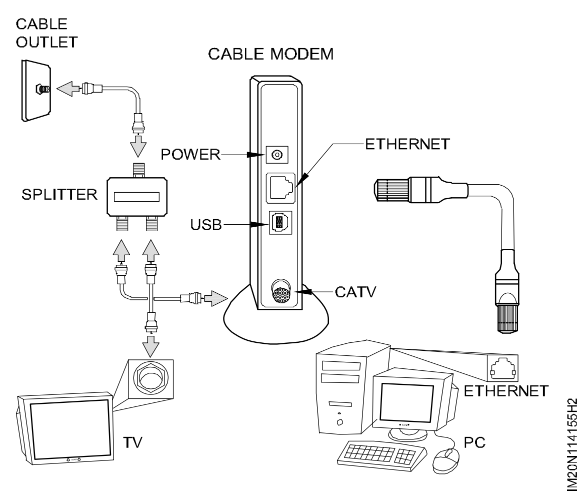
9 Run any test program that comes with the installation software to ensure that the modem is working correctly.

Installing an cable modem

1 Buy a cable modem or request one from the internet service provider.

2 Once it was there (Fig 2).

Fig 1



3 Connect the cable TV to the modem first.

4 Plug the modem in to a standard wall outlet.

5 Shouldn’t be any confusion as to which end goes in to the modern and which goes in to the TV outlet.

Construct and test DAC and ADC using computer network circuit

Objectives : At the end of this exercise you shall be able to
- **construct and test DAC and ADC using computer network circuit.**

Requirements

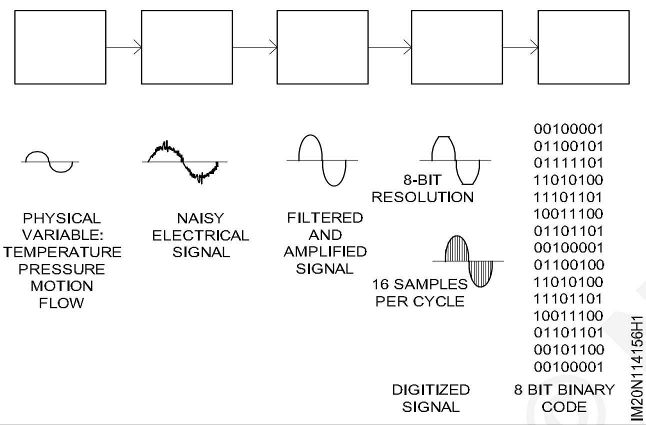
Tools/Equipments/Instruments

- A working PC - 1 No
- DAS (Data acquisition system) - 1 No
- RS 232 or RS 485 connectors - 1 No
- Screw driver - 1 No
- Cable as required - as reqd.

PROCEDURE

TASK 1: **Construct and test DAC and ADC using computer network circuit.**

Fig 1



1 Fill the empty boxes in the block diagram with the help of instructor.(Fig 1)

2 Check the DAS by connecting to the AC supply.

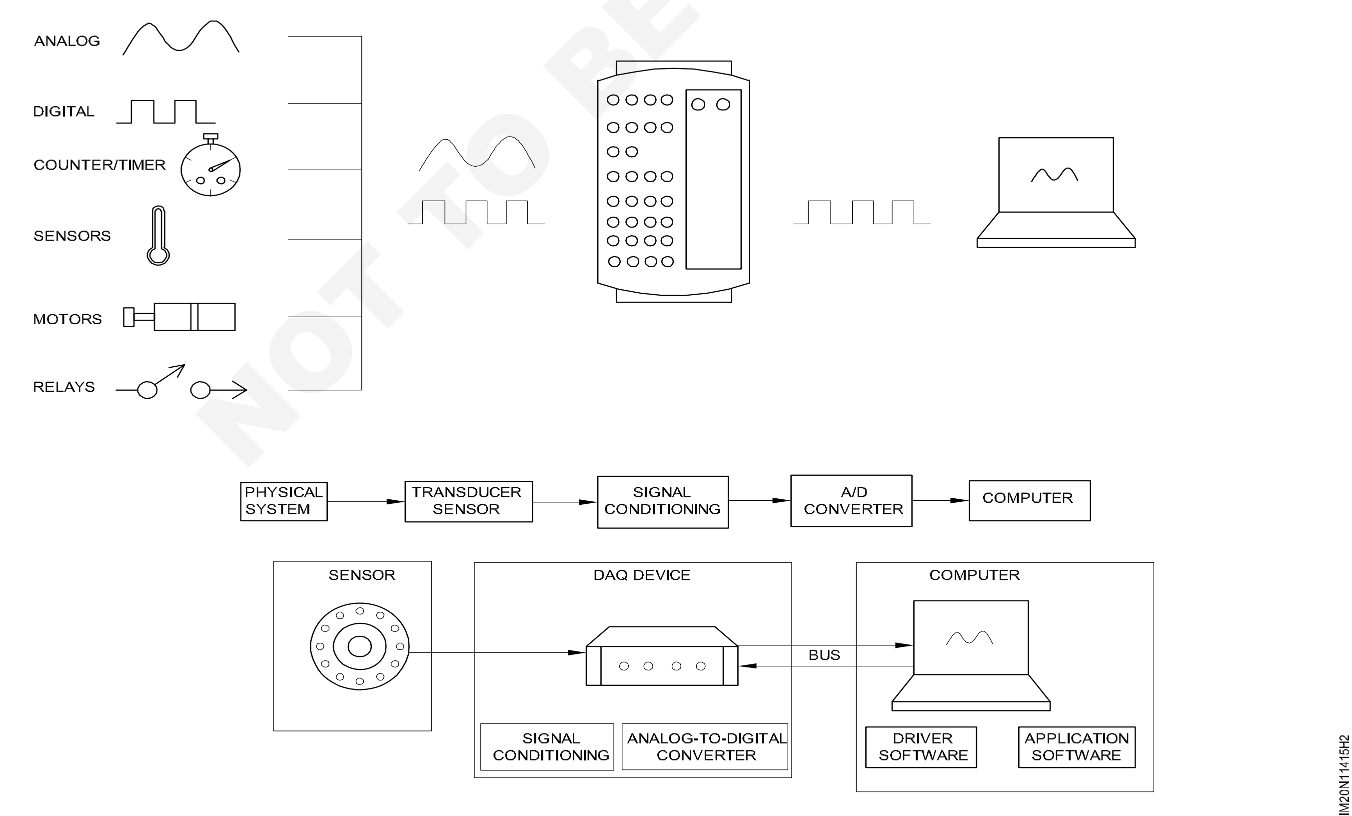
3 Connect RS.485 / RS.232 connector between PC and DAS.

4 Connect sensor / Trans devier output to DAQ/DAS (Fig 2).

5 Get the connections checked by the instructors.

DAS / DAQ - hardware interfaces the signal and a PC

Fig 2



Measure the crystal frequency, connect it to the processor

Objectives : At the end of this exercise you shall be able to
- **identify the crystal oscillator in the given microprocessor kit**
- **measure the clock frequency of the given microprocessor kit.**

Requirements

Tools/Equipments/Instruments

- 8085 Microprocessor Trainer kit with manual - 1 Set
- DMM with probes - 1 No.
- Digital frequency meter - 1 No.
- Oscilloscope (0-20 MHz) with manual and probes - 1 No.

Materials

- Nil

PROCEDURE

1 Collect the microprocessor kit from the instructor.

2 Identify the crystal oscillator in the microprocessor kit.

3 Refer to the operating manual note down the freq and locate the pin number 1 and 2 of the microcontroller IC 8051 (refer Fig 1).

Note: Use DMM and measure the clock frquency by selecting the Hz range if available.

4 Prepare the CRO for measurements with Ch-1 input.

5 Switch ON the microcontroller and measure the crystal signal waveform at pin 1 with respect to ground and calculate the frequency.

6 Repeat step 5 at pin no. 2.

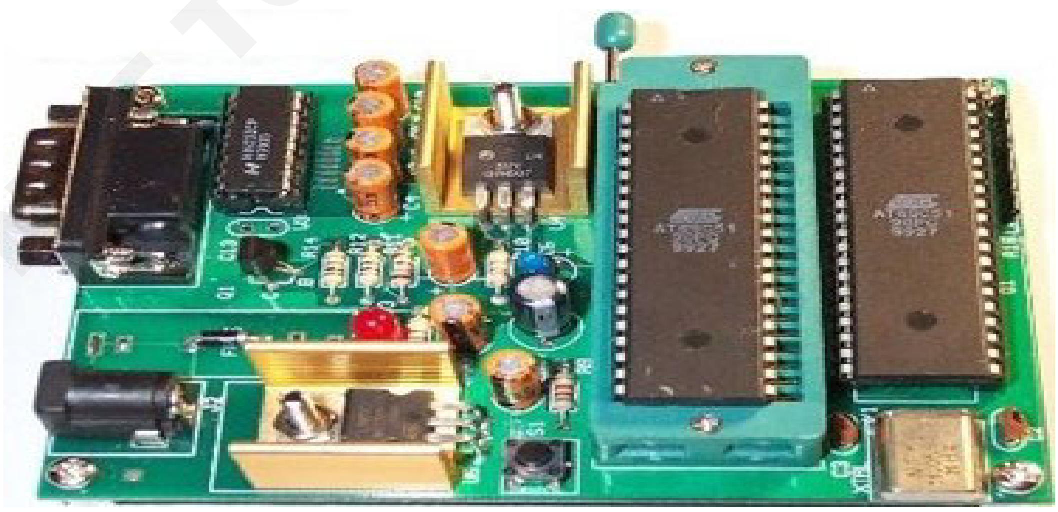
7 Record the observed readings in the Table 1.

8 Get the work checked by the Instructor.

Table - 1

Clock frequency as per manual	CRO waveform/ frequency		Remarks
	Pin No. 1	Pin No. 2	

Fig 1



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Use 8085 microprocessor, connect 8 LEDs to the port and blink the LEDs with switch

Objectives : At the end of this exercise you shall be able to
- **enter the program to blink 8 LEDs using switch and run it on the microprocessor trainer kit**
- **check the result through the port - 1 and record the observation.**

Requirements

Tools/Equipments/Instruments

- 8085 Microprocessor trainer kit with instructional manual - 1 Set.
- Trainees tool kit - 1 Set
- Digital multimeter with probes - 1 No.
- Logic probe - 1 No.

Materials

- 8 LEDs interface module (available on board) - 1 No.
- Program to blink the 8 LEDs through switch - as reqd.

PROCEDURE

Note:

1. **The instructor has to enter the program, execute and ensure that the 8051 microprocessor trainer kit is functioning correctly before given to the trainees for this exercise / task**
2. **Make necessary modifications in steps / program according to the microprocessor trainer kit available in the section**

1 Collect the 8085 microprocessor trainer kit from the instructor

2 Refer to the instruction manual and identify all the operating controls / switches

3 Configure the port - 1 of 8085 microprocessor kit as input port

The onboard 8 LED interface module connected internallly is used for this task.

4 Enter the given program to blink the 8 LEDs through switch into the microprocessor trainer kit.

5 Execute the program and observe the blinking of LEDs.

6 Get the work checked by the instructor.

Program

```
LOOP    START   JNB 90, START
                MOV DPTR, #FF13
                MOV A, #FF
                MOV X, @DPTR, A
                LCALL DELAY
                MOV A, #00
                MOV X @DPTR, A
                LCALL DELAY
                SJMP LOOP
                DELAY LOOP
                MOV RO, #FF
        LOOP 2  MOV R1, #FF
        LOOP 1  DJNZ R1, LOOP 1
                DJNZ RO, LOOP 2
                RET
```

— — — — — —

Perform addition and subtraction of two 8 bit numbers using 8085 microprocessor

Objectives: At the end of this exercise you shall be able to
- **perform additional of two 8 bit numbers using 8085 micro processor**
- **perform subtraction of two 8 bit numbers using 8085 micro processor.**

Requirements

Tools/Equipments/Instruments

- Micro processor 8085 - 1 No
- Instruction manual - 1 No
- Screw driver - 1 No
- Multimeter - 1 No

PROCEDURE

TASK 1: **perform addition of two 8 bit numbers using 8085 micro processor**

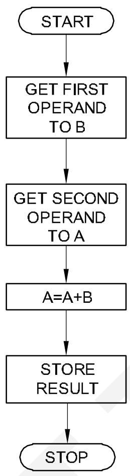
1 Test the micro processor to confirm the good working condition.

2 Enter the following addition of two 8 bits program with the help of instructor.

3 Check the result.

FLOW CHART

Fig 1



FLOW CHART FOR ADDITION

IM20N115159H1

PROGRAM

LDA	4150	; (4150) = (A) = 23
MOV	B,A	; (A) = (B)
LDA	4151	; (4150) = (A) = 35
ADD	B	; (A) + (B) = (A)
STA	4152	; (A) = (4152) = 58
HLT		

Object codes

Memory address	Opcodes	Mnemonics
4100	3A	LDA 4150
4101	50	
4102	41	
4103	47	MOV B, A
4104	3A	LDA 4152
4105	51	
4106	41	
4107	80	STA 4152
4108	32	
4109	52	
410A	41	
410B	76	HLT

1 Key in the opcodes from the address specified.

2 Enter data at 4150 and 4151 as specified in the example.

3 Execute the program and check for the result at 4152.

4 Change data at 4150 and 4151 and execute each time and check for result.

— — — — — —

TASK 2: **perform addition of two 8 bit numbers using 8085 micro processor**

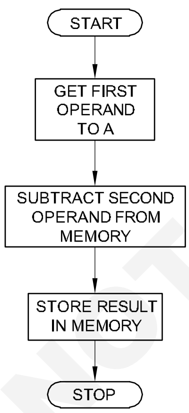
1 Test the micro processor to confirm the good working condition.

2 Enter the following addition of two 8 bits program with the help of instructor.

3 Check the result.

FLOW CHART

Fig 2



FLOWCHART

IM20N113159H2

PROGRAM

LXI	H, 4150	; Initialise memory pointer to 4150
MOV	A, M	; (4150) => (A) = 49
INX	H	; Point to next data.
SUB	M	; (4151) => (A)
INX	H	; Point to next location
MOV	M,A	; (A) => (4152)
HLT		

Object codes

Memory address	Opcodes	Mnemonics
4100	21	LXI H,4150
4101	50	
4102	41	
4103	7E	MOV A, M
4104	23	INX H
4105	96	SUB M
4106	23	INX H
4107	77	MOV M,A
4108	76	HLT

1 Key in the opcodes from the address specified.

2 Enter data that is needed for execution at 4150 and 4151.

3 Execute the program and check for result at 4152.

4 Try changing data and check for results each time.

— — — — — —

Demonstrate entering of simple program, execute and monitor the result

Objectives : At the end of this exercise you shall be able to
- **Write a program to control stepper motor using micro processor (8085) kit.**

Requirements

Tools/Equipments/Instruments

- Micro processor 8085 kit - 1 No
- Stepper motor module / trainer - 1 No
- Screw driver - 1 No

PROCEDURE

TASK: **Write a program to control stepper motor using micro processor (8085)**

1 Test the micro processor kit for its good condition.

2 Enter the following program in micro processor and execute it.

3 Connect stepper motor module with micro processor via patch card.

4 Observe the control of motor speed.

Power Supply | Micro Processor | Stepper Motor Module | Stepper Motor

Program

4100	21	1A	41		START	LXI	H, LOOK UP
4103	06	04				MVI	B,04
4105	7E				REPT:	MOV	A,M
4106	D3	CO				OUT	OCHO
4108	11	03	03			LXI	D,0303H
410B	00				DELAY:	NOP	
410C	1B					DCX	D
410D	7B					MOV	A, E
410E	B2					ORA	D
410F	C2	0B	41			JNZ	DELAY
4112	23					INX	H
4113	05					DCR	B
4114	C2	05	41			JNZ	REPT
4117	C3	00	41			JMP	START
411A	09	05	06	OA	IOOK UP:	DB	09 05 06 0A

— — — — — —