IoT TECHNICIAN (SMART CITY)

NSQF LEVEL - 3

Volume I of II

TRADE PRACTICAL

SECTOR: IT & ITES

(As per revised syllabus July 2022 - 1200 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

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Post Box No.3142
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INDIA
Email: chennai-nimi@nic.in
Website: www.nimi.gov.in

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FOREWORD

The Government of India has set an ambitious target of imparting skills one out of every four Indians, 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 **IoT Technician (Smart City) - Trade Practical - Volume I of II - NSQF Level - 3 (Revised 2022) in IT & ITES Sector under** Annual pattern. The NSQF Level - 3 (Revised 2022) Trade Theory 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 - 3 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 3 (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

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 **IoT Technician (Smart City) - Volume I of II - NSQF Level - 3** (Revised 2022) under the **IT & ITES** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Shri. N. P. Bannibagi	-	Deputy Director, NIMI, Chennai - 32.
Shri. A. Jayaraman	-	Training Officer (Rtd) MDC Member, NIMI, 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 - 3 (Revised 2022) syllabus are covered.

The manual is divided into Eleven modules.

Module 1 - **Trade and Orientation**

Module 2 - **Basics of AC and Electrical Cables**

Module 3 - **Components and AC & DC Measurements**

Module 4 - **Soldering / Desoldering, SMD Components**

Module 5 - **Diodes and Trasnsistors**

Module 6 - **Basic Gates and Digital Circuits**

Module 7 - **Computer Hardware and Networking**

Module 8 - **Electronic Circuit Simulation**

Module 9 - **Sensors, Transducers and Applications**

Module 10 - **Microcontroller 8051**

Module 11 - **Test and connect Components/parts of IoT system and Arduino board**

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 **IoT Technician (Smart City) - Volume I of II -** Trade Theory NSQF Level - 3 (Revised 2022) in **IT & ITES**. The contents are sequenced according to the practical exercise contained in NSQF LEVEL -3 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	Exercise No
1	Select and perform electrical / electronic measurement of meters and instruments following safety precautions.	1.1.01 - 1.2.13
2	Test various electronic components using proper measuring instruments and compare the data using standard parameter.	1.3.14 - 1.3.26
3	Identify, place, solder and de-solder and test different SMD discrete components and IC packages with due care and following safety norms using proper tools/setup.	1.4.27 - 1.4.40
4	Construct, test and verify the input/ output characteristics of various analog circuits.	1.5.41 - 1.5.47
5	Assemble, test and troubleshoot various digital circuits.	1.6.48 - 1.6.55
6	Install, configure, interconnect given computer system(s) and networking to demonstrate & utilize application packages for different applications.	1.7.56 - 1.7.62
7	Develop troubleshooting skills in various standard electronic circuits using Electronic simulation software.	1.8.63 - 1.8.67
8	Apply the principle of sensors and transducers for various IoT applications.	1.9.68 - 1.9.71
9	Identify, select and test different signal conditioning and converter circuits. Check the specifications, connections, configuration and measurement of various types of sensor inputs as well as control outputs.	1.9.72 - 1.9.85
10	Identify, Test and troubleshoot the various families of Microcontroller. Plan and Interface input and output devices to evaluate performance with Microcontroller.	1.10.86 - 1.10.90
11	Identify different IoT Applications with IoT architecture. Identify, test and interconnect components/parts of IoT system.	1.11.91 - 1.11.101

SYLLABUS

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 30Hrs.; Professional Knowledge 12 Hrs.	Select and perform electrical/ electronic measurement of meters and instruments following safety precautions. (MAPPED NOS: ELE/N9401)	1 Visit to various sections of the institute and identify location of various installations. (02hrs.) 2 Identify safety signs for danger, warning, caution & personal safety message. (02hrs.) 3 Use of personal protective equipment (PPE). (03hrs.) 4 Practice elementary first aid. (02hrs.) 5 Preventive measures for electrical accidents & steps to be taken in such accidents. (03 hrs.) 6 Use of Fire extinguishers. (02hrs.) 7 Identify, Care & maintenance the different Basic hand tools. (4 hrs.)	Familiarization with the working of Industrial Training Institute system. Importance of safety and precautions to be taken in the industry/shop floor. Introduction to PPEs. Introduction to First Aid. Response to emergencies e.g. power failure, fire, and system failure. Importance of housekeeping & good shop floor practices. Occupational Safety & Health: Health, Safety and Environment guidelines, legislations & regulations as applicable. (06 hrs.)
		Basics of AC and Electrical Cables 8 Identify the Phase, Neutral and Earth on power socket, use a tester to monitor AC power. (02hrs.) 9 Construct a test lamp and use it to check mains healthiness. Measure the voltage between phase and ground and rectify earthing. (02hrs.) 10 Prepare terminations, skin the electrical wires /cables using wire stripper and cutter. (02hrs.) 11 Measure the gauge of the wire using SWG and outside micrometer. (02hrs.) 12 Demonstrate various test and measuring instruments (02hrs.) 13 Measure voltage and current using clamp meter. (02hrs.)	Basic terms such as electric charges, Potential difference, Voltage, Current, Resistance. Basics of AC & DC. Various terms such as +ve cycle, -ve cycle, Frequency, Time period, RMS, Peak, Instantaneous value. Single phase and Three phase supply. Different type of electrical cables and their Specifications. Types of wires & cables, standard wire gauge (SWG). Classification of cables according to gauge (core size), number of conductors, material, insulation strength, flexibility etc. Introduction to electrical and electronic measuring instruments. (06hrs.)
Professional Skill 30Hrs.; Professional Knowledge 12 Hrs.	Test various electronic components using proper measuring instruments and compare the data using standard parameter. (MAPPED NOS: ELE/N7001	**Active and Passive Components** 14 Identify the different types of active and passive electronic components. (02 hrs.) 15 Measure the resistor value by colour code, SMD Code and verify the same by measuring with multimeter. (02 hrs.) 16 Practice on measurement of parameters in combinational electrical circuit by applying Ohm's Law for different resistor values and voltage sources. (02hrs.)	Ohm's law. Resistors; types of resistors, their construction & specific use, color-coding, power rating. Equivalent Resistance of series parallel circuits. Distribution of V & I in series parallel circuits. Principles of induction, inductive reactance. Types of inductors, construction, specifications, applications and energy storage concept.

		17 Measurement of current and voltage in electrical circuits to verify Kirchhoff's Law. (02hrs.) 18 Verify laws of series and parallel circuits with voltage source in different combinations. (02hrs.) 19 Identify different inductors and measure the values using LCR meter.Identify the different capacitors and measure capacitance of various capacitors using LCR meter. (03 hrs.) 20 Identify and test the circuit breaker and other protecting devices (Fuse). (03 hrs.) 21 Test Step-up, Stepdown, Isolation Transformer. (02hrs.) **AC & DC measurements** 22 Use the multi meter to measure the various functions (AC V, DC V, DC I, AC I, R). (02 hrs.) 23 Identify the different controls on the Digital Storage Oscilloscope front panel and observe the function of each control. (02hrs.) 24 Measure DC voltage, AC voltage, time period, sine wave parameters using DSO. (02 hrs.) 25 Identify and use different mathematical functions +,-,X, diff, intg, AND, OR of DSO on the observed signal. (03 hrs.) 26 Identify and use different acquisition modes of normal, average, persistence mode. (03 hrs.)	Capacitance and Capacitive Reactance, Impedance. Types of capacitors, construction, specifications and applications. Dielectric constant. Significance of Series parallel connection of capacitors. Properties of magnets and their materials, preparation of artificial magnets, significance of electro Magnetism, types of cores. Relays, types, construction and specifications etc. Multi meter, use of meters in different circuits. Use of DSO, Function generator, Arbitrary Waveform Generator, LCR meter (12 hrs.)
Professional Skill 50Hrs.; Professional Knowledge 12 Hrs.	Identify, place, solder and desolder and test different SMD discrete components and ICs package with due care and following safety norms using proper tools/setup. (MAPPED NOS: ELE/N7812)	**Soldering/ Desoldering** 27 Practice soldering on different electronic components, small transformer and lugs. (03 hrs.) 28 Practice soldering on IC bases and PCBs. (03 hrs.) 29 Practice Soldering on various SMD Components including SMD IC packages. (04hrs.) 30 Practice desoldering using pump and wick. (02 hrs.) 31 Practice Desoldering of SMD Components using SMD Hot Air Gun. (03 hrs.) 32 Join the broken PCB track and test. (03 hrs.) **Basic SMD (2, 3, 4 terminal components)** 33 Identification of 2, 3, 4 terminal SMD components. Desolder the SMD components from the given PCB. (05hrs.)	Different types of soldering guns, related to Temperature and wattages, types of tips. Solder materials and their grading. Use of flux and other materials. Selection of soldering gun for specific requirement. Soldering and De-soldering stations and their specifications. Different switches, their specification and usage. Introduction to SMD technology Identification of 2, 3, 4 terminal SMD components. Advantages of SMD components over conventional lead components. Introduction to Surface Mount Technology (SMT).

		34 Solder the SMD components in the same PCB. Check for cold continuity of PCB. (05 hrs.) 35 Identification of loose /dry solder, broken tracks on printed wired assemblies. (04hrs.) **SMD Soldering and Desoldering** 36 Identify various connections and setup required for SMD Soldering station. (05hrs.) 37 Identify crimping tools for various IC packages. (03hrs.) 38 Make the necessary settings on SMD soldering station to desolder various ICs of different packages (at least four) by choosing proper crimping tools (03hrs.) 39 Make the necessary settings on SMD soldering station to solder various ICs of different packages (at least four) by choosing proper crimping tools (03hrs.) 40 Make the necessary setting rework of defective surface mount component used soldering / desoldering method. (04hrs.)	Advantages, Surface Mount components and packages. Cold/ Continuity check of PCBs. Identification of lose / dry solders, broken tracks on printed wiring assemblies. (12 hrs.)
Professional Skill 18Hrs.; Professional Knowledge 06 Hrs.	Construct, test and verify the input/ output characteristics of various analog circuits. (MAPPED NOS: ELE/N5804)	41 Identify and test different types of diodes, diode modules using multi meter and determine forward to reverse resistance ratio. Compare it with specifications. (03hrs.) 42 Measure the voltage and current through a diode in a circuit and verify its forward/Reverse characteristic. (02hrs.) 43 Construct and test a half wave, full wave and Bridge rectifier circuit. (03hrs.) 44 Identify and test Zener diode and construct peak clipper. (02hrs.) 45 Identify different types of transistors and test them using digital multimeter. (02hrs.) 46 Measure and plot input and output characteristics of a CE amplifier. (03hrs.) 47 Construct and test a transistorbased switching circuit to control a relay. (03hrs.)	Semiconductor materials, components, number coding for different electronic components such as Diodes and Zeners etc. PN Junction, Forward and Reverse biasing of diodes. Interpretation of diode specifications. Forward current and Reverse voltage. Working principle of a Transformer, construction, Specifications and types of cores used. Step-up, Step down and isolation transformers with applications. Losses in Transformers. Phase angle, phase relations, active and reactive power, power factor and its importance. Construction, working of a PNP and NPN Transistors, purpose of E, B & C Terminals. Significance of a, ß and relationship of a Transistor. Transistor applications as switch and CEamplifier. Transistor input and output characteristics. Transistor power ratings & packaging styles and use of different heat sinks.(06hrs.)

Professional Skill 17Hrs.; Professional Knowledge 12 Hrs.	Assemble, test and troubleshoot various digital circuits. (MAPPED NOS: ELE/N7812)	48 Identify different Logic Gates (AND, OR, NAND, NOR, EX OR, EX-NOR, NOT ICs) by the number printed on them. (02hrs.) 49 Verify the truth tables of all Logic Gate ICs by connecting switches and LEDs. (02hrs.) 50 Use digital IC tester to test the various digital ICs (TTL and CMOS). (03hrs.) 51 Construct and Test a 2 to 4 Decoder. (02hrs.) 52 Construct and Test a 4 to 2 Encoder. (02hrs.) 53 Construct and Test a 4 to 1 Multiplexer. (02hrs.) 54 Construct and Test a 1 to 4 De Multiplexer. (02hrs.) 55 Identify and test common anode and common cathode seven segment LED display using multimeter. (02hrs.)	Introduction to Digital Electronics. Difference between analog and digital signals. Logic families and their comparison, logic levels of TTL and CMOS. Number systems (Decimal, binary, octal, Hexadecimal). BCD code, ASCII code and code conversions. Various Logic Gates and their truth tables. Combinational logic circuits such as Half Adder, Full adder, Parallel Binary adders, 2-bit and four bit full adders. Magnitude comparators. Half adder, full adder ICs and their applications for implementing arithmetic operations. Concept of encoder and decoder. Basic Binary Decoder and four bit binary decoders. Need for multiplexing of data. 1:4 line Multiplexer / De-multiplexer. Introduction to Flip-Flop. S-R Latch, Gated S-R Latch, D- Latch. Flip-Flop: Basic RS Flip Flop, edge triggered D Flip Flop, JK Flip Flop, T Flip Flop. Master-Slave flip flops and Timing diagrams. Basic flip flop applications like data storage, data transfer and frequency division. Types of seven segment display. BCD display and BCD to decimal decoder. BCD to 7 segment display circuits. Basics of Register, types and application of Registers. (12 hrs.)
Professional Skill 24Hrs.; Professional Knowledge 12 Hrs.	Install, configure, interconnect given computer system(s) and networking to demonstrate & utilize application packages for different applications. (MAPPED NOS:SSC/N9408)	56 Identify various indicators, cables, connectors and ports on the computer cabinet. (02hrs.) 57 Demonstrate various parts of the system unit and motherboard components. (03hrs.) 58 Identify various computer peripherals and connect it to the system. (02hrs.) 59 Install antivirus software, printer, scan the system and explore the options in the antivirus software. (04 hrs.)	Basic blocks of a computer, Components of desktop and motherboard. Hardware and software, I/O devices, and their working. Different types of printers, HDD, DVD. Various ports in the computer. Working principle of SMPS, its specification. Windows OS MS widows: Starting windows and its operation, file management using explorer, Display & sound properties, screen savers, font management, installation of program, setting and using of control panel., application of accessories, various IT tools and applications.

		60 Browse search engines, create email accounts, practice sending and receiving of mails and configuration of email clients. (04 hrs.) 61 Identify different types of cables and network components e.g. Hub, switch, router, modem etc. (04hrs.) 62 Configure a wireless Wi-Fi network. (03 hrs.)	Concept of Internet, Browsers, Websites, search engines, email, chatting and messenger service. Downloading the Data and program files etc. Computer Networking:- Network features - Network medias Network topologies, protocols- TCP/IP, UDP, FTP, models and types. Specification and standards, types of cables, UTP, STP, Coaxial cables. Network components like hub, Ethernet switch, router, NIC Cards, connectors, media and firewall. Difference between PC & Server. (12 hrs.)
Professional Skill 30 Hrs.; Professional Knowledge 06 Hrs.	Develop troubleshooting skills in various standard electronic circuits using Electronic simulation software. (MAPPED NOS: ELE/N1201)	63 Prepare simple digital and electronic circuits using the software. (06 hrs.) 64 Simulate and test the prepared digital and analog circuits. (06 hrs.) 65 Create fault in particular component and simulate the circuit for it's performance. (06 hrs.) 66 Convert the prepared circuit into a layout diagram. (06 hrs.) 67 Prepare simple, power electronic and domestic electronic circuit using simulation software. (06 hrs.)	Study the library components available in the circuit simulation software. Various resources of the software. (06 hrs.)
Professional Skill 17Hrs.; Professional Knowledge 06 Hrs.	Apply the principle of sensors and transducers for various IoT applications. (MAPPED NOS: SSC/N9444)	68 Identify and test RTDs, Temperature ICs and Thermo couples. (03hrs.) 69 Identify and test proximity switches (inductive, capacitive and photoelectric). (04hrs.) 70 Identify and test, load cells, strain gauge, LVDT, PT 100 (platinum resistance sensor). (04hrs.) 71 Detect different objectives using capacitive, Inductive and photo electric proximity sensors. (06 hours)	Basics of passive and active transducers. Role, selection and characteristics. Sensor voltage and current formats. Thermistors/ Thermocouples - Basic principle, salient features, operating range, composition, advantages and disadvantages. Strain gauges/ Load cell – principle, gauge factor, types of strain gauges. Inductive/ capacitive transducers - Principle of operation, advantages and disadvantages. Principle of operation of LVDT, advantages and disadvantages. Proximity sensors – applications, working principles of eddy current, capacitive and inductive proximity sensors.(06 hrs.)
Professional Skill 32Hrs.; Professional Knowledge 18 Hrs.	Identify, select and test different signal conditioning and converter circuits.	**Integration of Analog sensors** 72 Identify various Analog sensors. (02 hrs.) 73 Identify Roles and Characteristics of each sensor. (02 hrs.)	Working principle of different types of control circuits and their applications for sensors.

	Check the specifications, connections, configuration and measurement of various types of sensor inputs as well as control outputs. (MAPPED NOS: SSC/N9444)	74 Select appropriate Analog sensor. (02 hrs.) 75 Connect & measure AC/DC Analog Input such as voltage / current / RTD two-three-four wire AC mV signal etc. (02 hrs.) 76 Configure Engineering & Electrical zero/span configuration mV, 0-10VDC, 4-20mA, 0-20mA. (02 hrs.) 77 Understand various units and zero span configuration as per sensor datasheet such as temperature, pressure, flow, level, lux level, environment, soil, moisture etc. (02 hrs.) 78 Measure the Analog Input as per configuration and sensor selection. (02 hrs.) 79 Generate and measure Analog Output to operatecontrol valves and actuators. (02 hrs.) **Integration of Digital sensors** 80 Identify various Digital sensors.(02 hrs.) 81 Identify Roles and Characteristics of each sensor.(02 hrs.) 82 Select appropriate Digital sensor. (03hrs.) 83 Connect and Measure Digital Inputs of various voltage level such as TTL (0-5V), 24VDC (0-24 VDC) signals. (03hrs.) 84 Connect Pulse Inputs of various frequency ranging from 10 Hz to 1 KHz and configure the filters. (03hrs.) 85 Select, Configure and ascertain of Digital Outputs and Relay Outputs to take On and Off action for actuators. (03hrs.)	Principle of operation of signal generator, distinguish between voltage and power amplifier. Working principle of different converters. Demonstrate different types of filter circuits and their applications. The specification and working of Analog sensor inputs as well as Analog control outputs. The specifications and working of Digital sensor inputs, Pulse Input as well as Digital control outputs. (18hrs.)
Professional Skill 30 Hrs.; Professional Knowledge 12 Hrs.	Identify, Test and troubleshoot the various families of Microcontroller. (MAPPED NOS: SSC/N9445) Plan and Interface input and output devices to evaluate performance with Microcontroller. (MAPPED NOS: SSC/N9445)	86 Explore different microcontroller families' architecture like 8051, AVR, PIC, ARM, Raspberry pi and Arduino. (06 hrs.) 87 Explore the different Software IDE used for microcontroller. (06 hrs.) 88 Explore ICs & their functions on the given Microcontroller Kit. (06 hrs.) 89 Identify the port pins of the controller & configure the ports for Input & Output operation. (06 hrs.) 90 Explore Universal IC programmer to program burn output file on different ICs. (06 hrs.)	Introduction Microprocessor & 8051 Microcontroller, architecture, pin details & the bus system. Function of different ICs used in the Microcontroller Kit. Differentiate microcontroller with microprocessor. Interfacing of memory to the microcontroller. Internal hardware resources of microcontroller. I/O port pin configuration. Different variants of 8051 & their resources. Register banks & their functioning. SFRs & their configuration for different applications.

			Comparative study of 8051 with 8052. Introduction to PIC Architecture. Introduction to ADC and DAC, schematic diagram, features and characteristic with the applications. (12 hrs.)
Professional Skill 30 Hrs.; Professional Knowledge 12 Hrs.	Identify different IoT Applications with IoT architecture. (MAPPED NOS: SSC/N9462) Identify, test and interconnect components/parts of IoT system. (MAPPED NOS: SSC/N9446)	91 Connect and test Arduino board to computer and execute sample programs from the example list. (04hrs.) 92 Upload computer code to the physical board (Microcontroller) to blink a simple LED. (02hrs.) 93 Write and upload computer code to the physical Arduino board Micro controller to sound buzzer. (02hrs.) 94 Circuit and program to Interface light sensor – LDR with arduino to switch ON/OFF LED based on light intensity. (03hrs.) 95 Set up & test circuit to interface potentiometer with Arduino board and map to digital values for e.g. 0-1023. (03hrs.) 96 Interface Pushbuttons or switches; connect two points in a circuit while pressing them. This turns on the built-in LED on pin 13 in Arduino, while pressing the button. (03hrs.) 97 Rig up the Circuit and upload a program to Control a relay and switch on/off LED light using Arduino. (02hrs.) 98 Make Circuit and upload a program to Interface of LCD display with a microcontroller to display characters. (03hrs.) 99 Rig up the circuit and upload a program to interface temperature sensor – LM35 36 IoT Technician (Smart City) with a controller to display temperature on the LCD. (02hrs.) 100 Set up Circuit and upload program to Interface DC motor (actuator) with microcontroller to control on/off/forward/re verse operations. (03hrs.) 101 Rig up Circuit and upload program micro-controller to switch on/off two lights using relay. (03hrs.)	Introduction to Internet of Things applications in smart city& their distinctive advantages - smart environment, smart street light and smart water & waste management. What is an IOT? What makes embedded system an IOT? Role and scope of IOT in present and future marketplace. Smart objects, Wired – Cables, hubs etc. Wireless – RFID, WiFi, Bluetooth etc. Different functional building blocks of IOT architecture. (06 hrs.) Arduino development board, Pin diagram, Functional diagram, Hardware familiarization and operating instructions. Integrated development Environment, Running Programs on IDE, simple Programming concepts.(10 Hours) (06 hrs.)

Visit to various sections of the ITI and identify location of various installations

Objectives: At the end of this exercise you shall be able to
- **list the trades available at the ITI**
- **identify the staff and their designations**
- **draw the layout of the IoT Technician laboratory**
- **identify the location of power room and switch controls.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool kit - 1 Set
- Steel rule, 300 mm - 1 No

Materials/Components

- Pencil HB - 1 No
- Eraser - 1 No
- Drawing sheet - A 4 size - 3 Nos

PROCEDURE:

TASK 1: **Visiting various sections of ITI and identification of Trades.**

Instructor has to lead the trainees to visit various sections of the ITI.

1 Follow the Instructor, identify each section, name of the staff member, designation and record them in Table - 1

2 Collect the telephone numbers of ITI office, nearest hospital, police station, fire station and record them in Table - 2

The Instructor may add column for any important aspect if required in Table - 2

3 Get the work checked by the Instructor.

Table - 1

Sl. No	Name of the		Designation	Phone number
	Section / Trade	Staff member		
1				
2				
3				

Table - 2

Sl No.	Place	Phone No	Remarks
1	ITI office		
2	Hospital		
3	Police station		
4	Fire station		

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TASK 2: **Drawing the layout of IoT Technician laboratory / Section and identification of control switches**

1 Draw the plan of IoT Technician laboratory / section to a suitable scale in drawing sheet.

2 Identify the location of AC mains power control / back - up power, distribution board, MCB and lighting switch controls.

3 Mark the locations of the above points on the plan drawing / diagram.

Instructor may help them to operate the important switches in case of any emergency situation.

4 Get the work checked by the Instructor.

— — — — — — — —

Identify safety signs for danger, warning, caution & personal safety message

Objectives: At the end of this exercise you shall be able to
- **identify different types of safety signs used**
- **prepare safety sign boards.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set
- Scissors - 1 No

Aids: Wall chart showing all types of safety signs as per the trade syllabus.

Materials/Components

- Pencil - HB - 1 No
- Eraser - 1 No
- Drawing Sheet - A 4 size - 5 Nos
- Colour Sketch Pen - 1 Set
- Cardboard - 1 No
- Gum - 1 No
- Twine Thread - 1 Roll
- Geometry Box - 1 No

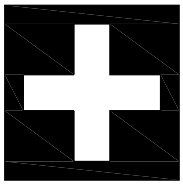
The instructor has to arrange for various types of safety signs with label number for each one.

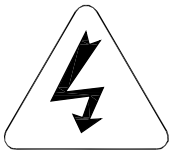
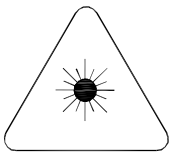
PROCEDURE

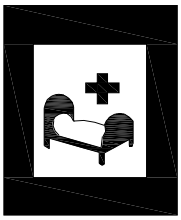
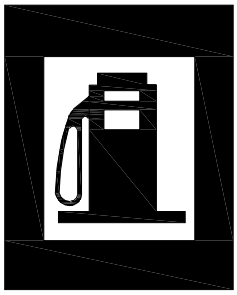
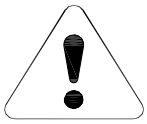
TASK 1: **Identification of different safety signs**

Identify the labelled safety sign, record type of safety sign and the meaning in Table 1.

Table 1

Label No.	Sign	Type	Meaning
1			
2			
3			
4			

Label No.	Sign	Type	Meaning
5			
6			
7			
8			
9			
10			
11			
12			
13			

Label No.	Sign	Type	Meaning
14			
15			
16			
17			
18			

2 Get the work checked by the Instructor.

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TASK 2: **Preparation of safety sign boards**

1 Draw the free hand sketch of warning sign on A4 sheet using geometry box.

2 Use sketch pens and apply appropriate colours, finalise the diagram.

3 Cut along the outside line of the prepared diagram using scissors.

4 Keep the safety sign diagram on the card board, mark along the outside line using pencil and cut the excess portion.

5 Paste the prepared safety sign diagram on the card board using gum and allow it to dry up.

6 Make a small hole, insert the thread and tie it to hang the prepared safety sign board as shown in (Fig 1).

Fig 1

7 Get the work checked by the Instructor.

— — — — — — — —

Use of Personal Protective Equipment (PPE)

Objective: At the end of this exercise you shall be able to
- **state the use of different PPEs.**

Requirements

Tools/Equipments/Instruments		Materials/Components	
• Trainees tool kit	- 1 Set	• Pencil	- 1 No
Aids:		• Eraser	- 1 No
Chart showing all types of PPE items	- 1 No	• Drawing sheet	- 1 No
		• Colour Sketch pen	- 1 Set

The Instructor has to arrange a minimum of Five PPE items and label them before issuing to trainees.

PROCEDURE

TASK 1: **Stating the use of different PPEs**

1 Identify the labelled PPE item and record the details of each Personal protective Equipment in column- 3 to 5 about name type of protection and uses in Table - 1.

Table - 1

Label No.	Sign	Name	Type of Protection	Uses
1				
2				
3				
4				
5				
6				

2 Get the work checked by the Instructor.

— — — — — — — —

Practice elementary first aid

Objective: At the end of this exercise you shall be able to
- **study and practice on first aid Artificial respiration.**

Requirements

Tools/Equipments/Instruments

- Rubber mat. - 1 No
- Wall chart on Artificial respiration practice - as reqd
- Audio Visual Aids: video film on Artificial respiration - as reqd

Materials/Components

- Dry wooden stick - 1 No

PROCEDURE

TASK 1: **Providing First-aid to the Victim**

1 Put the main switch to OFF so as to release the victim from live line contact. Increase of difficulty to reach the main switch release the victim by means of a wooden stick / rubber item etc. while keeping yourself isolated from the “Earth” contact.

2 If the victim is unconscious or blisters (Burns) have developed on his/her body then call a doctor through telephone or through some one else but do not leave the victim.

3 Start the following first-aid procedure till the doctor is available:

i Loosen or remove victim’s shoes, cloths etc. But take care that the blisters (Burns) do not break.

ii Cover victim’s body by using a blanket so as to keep him/her warm.

iii If the victim’s breathing appears to be suppressed then remove the crowd from his / her surroundings. If the victim is in a room then open up all doors and windows so as to enable him / her to breath in fresh air.

4 Remove artificial teeth, tobacco etc. from the victim’s mouth and start artificial respiration procedure (suitable) for restoring normal breathing.

— — — — — — —

TASK 2: **Providing Artificial Respiration**

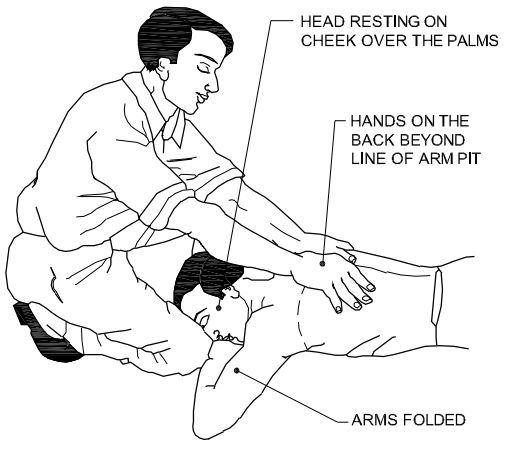
a HOLGEN-NELSON’S method

- **Nelson's arm-lift back pressure method must not be used in case of suspected injuries to the chest wall or abdomen of the victim.**
- **Be brisk in carrying out this method but avoid violent operations which may cause injury to the internal parts of the victim.**

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

2 As shown in the (Fig 2) gently rock forward the arms keeping them straight until they are nearly vertical, and thus steadily pressing the victim's back as shown to force the air out of the victim's lungs.

Fig 1



3 Synchronising the above movement rock backwards sliding your hands downwards along the victim's arms. Grasp his arm just above the elbows as shown in (Fig 3).

4 Now rock backwards. As you rock backwards, gently raise and pull the victim's arms towards you as shown

in (Fig 4) until you feel tension in his shoulders. Remain in this position for a few seconds. To complete the cycle, lower the victim's arm and move your hands up to the initial position.

Fig 2

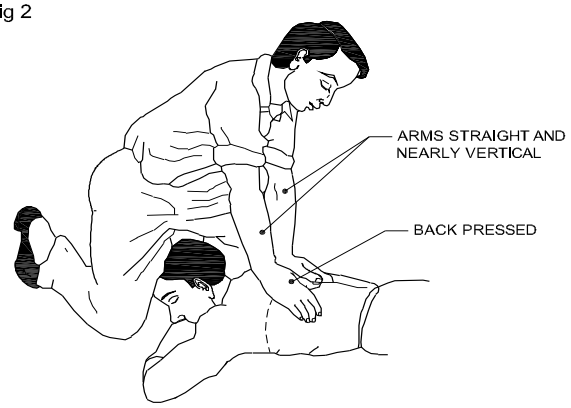


Fig 3

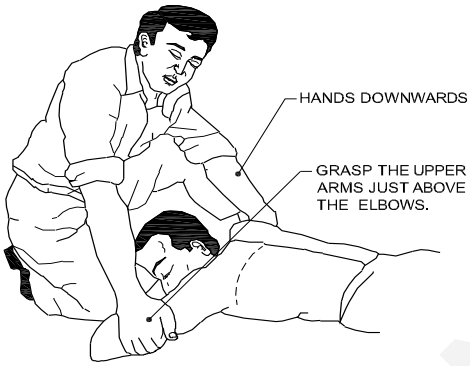
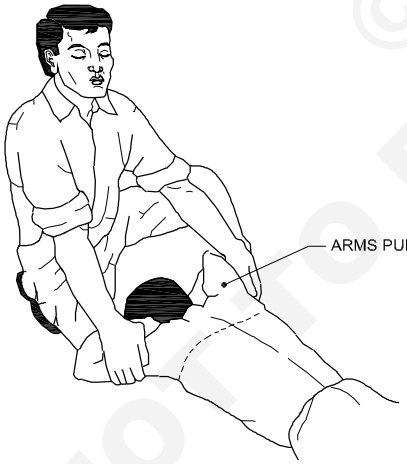


Fig 4



5 Repeat the cycles a few more times by following steps 3 to 6.

b **SCHAFER'S method:**

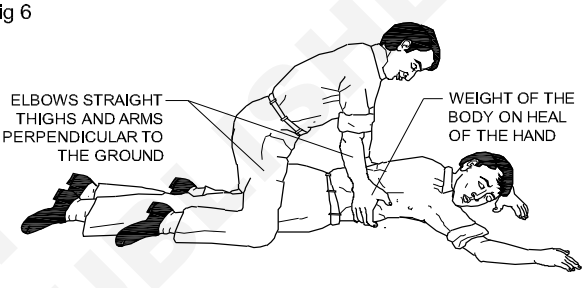
- **Do not use this method of artificial respiration in case the victim has injuries on his chest or abdomen.**
- **Be brisk in carrying out this method but avoid violent operations which may cause injury to the internal parts of the victim.**

1 Lay the victim on his abdomen. Extend one arm directly forward, and the other arm bent at the elbow as shown in Fig 5. Keep the face turned sidewise and resting on the hand or forearm as shown in (Fig 5).

Fig 5

2 Kneel astride the victim as shown in Fig 6 such that his thighs are in between your knees. Position your fingers and thumb as shown in (Fig 6).

Fig 6



3 With the arms held straight, swing forward slowly so that the weight of your body is gradually applied on the lower ribs of the victim as shown in figure. This weight forces the air out of the victim's lungs.

4 Now swing backward immediately removing all pressure on the lower ribs. This allows the lungs to get filled with air.

5 After 2 to 3 seconds, swing forward again and repeat the cycle (from step 4 to 5) twelve to thirteen times in a minute.

c **Mouth-to-Mouth Process (method)**

- **Be brisk in carrying out this method but avoid violent operations which may cause injury to the internal parts of the victim.**

1 Remove loose dentures or other obstructions from the mouth. Make sure that the victim's nose and mouth are clear.

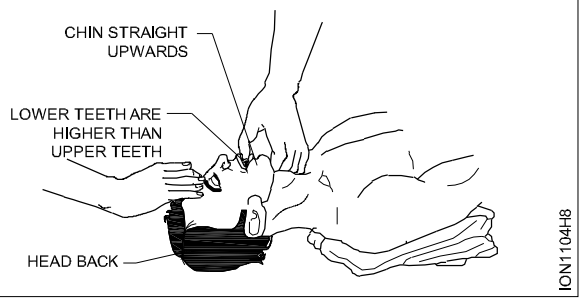
2 Lay the victim flat on his back. Place a roll of clothing under his shoulders such that his head is thrown well back as shown in (Fig 7).

Fig 7

3 Tilt the victim's head back so that the chin points straight upward.

4 Grasp the victim's jaw as shown in Fig 8 and raise it upward until the lower teeth are higher than the upper teeth. Maintain this position throughout the artificial respiration to prevent the tongue from blocking the air passage.

Fig 8



5 Take a deep breath and place your mouth over the victim's mouth as shown in Fig 9 making airtight contact. Hold the victim's nose shut with the thumb and forefinger. Blow into the victim's mouth (gently in the case of infants) until his chest rises. Remove your mouth and release the hold on the victim's nose. If you dislike direct contact, place a porous cloth between your mouth and the victim's mouth.

Fig 9

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

7 Let the victim exhale. Hear the out rush of air from the victim's mouth and nose. 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.

8 Repeat steps 5 and 7, eight to ten times rapidly. Then slow down to 10-20 times a minute. (20 times for infant). Sometimes it may take hours for the victim to breathe normally. Continue giving artificial respiration till he recovers.

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Preventive measures for electrical accidents & steps to be taken in such accidents

Objectives: At the end of this exercise you shall be able to
- **prevent electrical accidents**
- **following the steps to be taken in electrical accidents.**

PROCEDURE

TASK 1: **Prevention of electrical accidents**

1 Keep the work area clean.

2 Use licensed electrical and electronics items only.

3 Ensure that before touching the body of equipment there is no leakage of electric current in it.

4 Before starting the maintenance or repair work on any equipment, either disconnect it from the mains supply or keep yourself isolated from the earth contact by using rubber shoes, rubber matting or dry-wooden board/stool.

6 necessary instruments, circuits, etc. and arrange them on the table as per the sequence of requirement.

7 Select proper insulated tools for the job, clean and restore the same to its place after use.

8 Always disconnect the equipment to be repaired from the mains line by pulling the plug-top and not by pulling the power cord.

9 Always discharge high voltage filter capacitors after opening the equipment and before starting repairs by short circuiting the capacitor terminals with a piece of thick wire.

10 Keep yourself away from the Extra High Tension (EHT) points while the TV receiver is "ON" because 12KV to 25KV EHT remains present on the picture tube and the same can give you a severe electric shock.

11 Always use a 25 Watts or 35 Watts soldering iron while working on a Printed Circuit Board (PCB). The use of more wattage soldering iron can damage the PCB line as well the component.

12 Replace or remove fuses only after switching OFF the circuit / equipment.

— — — — — — — —

TASK 2: **Steps to be taken during the occasion of electrical accidents**

1 Do not touch the victim or the equipment/appliance which is under accident.

2 Unplug the equipment/appliance or turn OFF the mains power.

3 In case you can't turn off the power, use a piece of wood, like a broom handle, dry rope or dry clothing, to separate the victim from the live line.

4 Call the doctor immediately. Even if the victim's breathing and heartbeats have recovered, do not delay in calling a doctor for a check-up and treatment.

5 Keep the victim lying down; Unconscious victim should be placed on their side to allow any fluid coming out from mouth to drain.

6 If the victim is not breathing, apply mouth-to-mouth resuscitation. If the victim has no pulse, begin cardiopulmonary resuscitation (CPR). Then cover the victim with a blanket to maintain body heat, keep the victim's head low and get medical attention.

7 After the victim has recovered, keep the victim warm with blanket, wrapped up with hot water bags. Stimulate circulation by stroking the inside of the arms and legs towards the heart.

8 Do not give the victim any stimulant such as coffee, tea etc., until he is fully conscious.

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Use of fire extinguishers

Objectives: At the end of this exercise you shall be able to
- **identify the types of fire**
- **select the proper type of fire extinguisher**
- **use of the fire extinguishers.**

Requirements

Tools/Equipments/Instruments		Materials/Components	
• Trainees tool kit	- 1 Set	• Scrap material like Wood / Wire pieces/Oil/Cotton cloth	- 1 kg
• Different type of Fire extinguishers	- 1 No (each)	• Match Box	- 1 No

PROCEDURE

TASK 1: **Identification of types of Fire and Fire Extinguisher to be used**

1 If an electrical system begins sparking or a fire ignites at a wire, appliance, or outlet, then cutting the power to the system is the first as well as best step to take.

2 Identify the type of fire like Class-A (Wood, paper cloth), Class-B (Flammable Liquid & Liquefiable solids), Class-C (Gas and liquefied gas), etc.

3 Based on the type of fire, identify the type of fire extinguisher is to be used like, Dry Powder Fire Extinguisher, Foam type Fire Extinguisher, Carbon-di-oxide Fire Extinguisher, Water Fire Extinguisher, etc.

TASK 2: **Using Procedure of Fire Extinguisher**

1 Stand with your back to an exit as shown in figure.

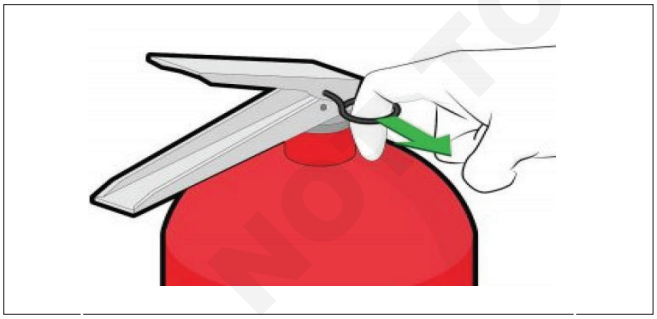
2 To employ the extinguisher with proper technique, just remember the acronym "PASS."

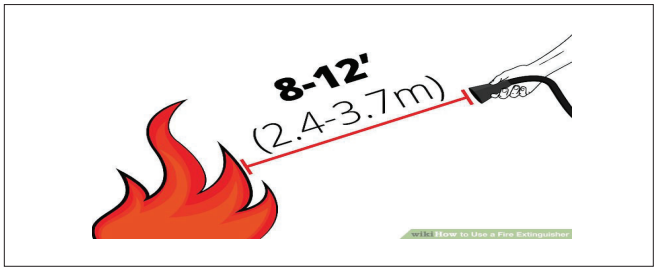
P - Pull

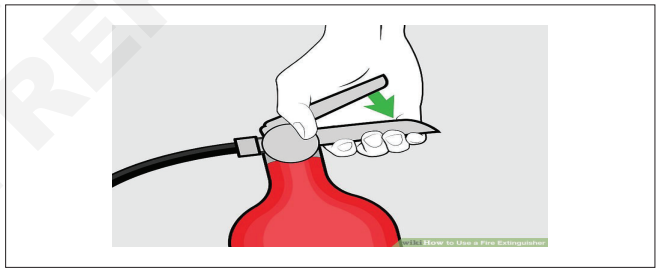
A - Aim

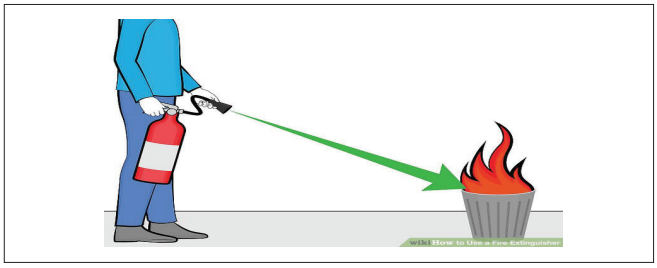
S - Squeeze

S - Sweep









3 **Pull** the safety pin of the Fire extinguisher.

4 **Aim** the nozzle at the base of the fire. Hitting the tops of the flame with the extinguisher won't be effective.

5 **Squeeze** the trigger. In a controlled manner, squeeze the trigger to release the agent.

6 **Sweep** from side to side. Sweep the nozzle from side to side until the fire is put out. Keep aiming at the base while you do so. Most extinguishers will give you about 10-20 seconds of discharge time.

7 Get the work checked by the Instructor.

Identify, care & maintenance the different basic hand tools

Objectives: At the end of this exercise you shall be able to
- **identify the different types of hand tools**
- **record the specification of the hand tools**
- **select proper tools for operation**
- **use the hand tools with precautions**
- **learn and practice care and maintenance of hand tools.**

Requirements

Tools/Equipments/Instruments		Materials/Components	
• Trainees tool kit	- 1 Set	• Cotton Waste	- ½ kg
• Different types of tools used in Electronics work	- 1 No (each)	• Emery sheet	- 1 No
		• Lubricating Oil	- ½ Lt

PROCEDURE

TASK 1: **Identify the different hand tools**

- **The Instructor has to label the tools used for this exercise.**
- **And also arrange for tools and the required materials from scrap for practicing the functioning of tools.**

1 Pick one of the labeled hand tools from the Workbench.

2 Identify and record the name of the labeled hand tool in Table - 1.

3 Measure the size and record the specification of the hand tool in the Column-3 of the table.

4 Draw the outline sketch of the hand tool in Column-4 of the table.

5 Repeat step-2 to 4 for the remaining hand tools.

6 Get the work checked by the Instructor.

Table - 1

Label No.	Name of the Tools	Specification	Sketch of Tool
1	Screw Driver		
2	Star Screw Driver		
3	Line Tester		
4	Instrument Screw Driver		
5	Long Nose Plier		
6	Combination Plier		
7	Side Cutting Plier		
8	Wire Stripper		
9	Scriber		
10	Hack Saw Frame		
11	Ball Pein Hammer		
12	Chisel		
13	Soldering iron stand		

Label No.	Name of the Tools	Specification	Sketch of Tool
14	Soldering Iron		
15	De-soldering Pump		
16	Flat File		
17	Round File		
18	Tweezer		
19	Magnifying Glass		
20	Cleaning Brush		
21	Steel Rule		

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TASK 2: **Selection of proper tools for operation and precautions in operation**

The instructor has to arrange the tools and required materials for practicing the functioning of tools. The Instructor has to label the tools used for this exercise.

1 Pick one of the labeled hand tools from the Workbench.

2 Identify and record the name of the hand tool in Table - 1

3 List the use/application of the tool in Column-3 of the table.

4 Record the precautions involved while operating the tools in Column-4 of the table.

5 Repeat step-2 to 4 for the remaining hand tools.

6 Get the work checked by the Instructor.

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TASK 3: **Care & maintenance of trade tools**

1 Keep the tools in a Dry Place.

2 Wipe or clean after every use with a clean and soft cloth to remove dirt/ dust.

3 Keep all the tools in a tool room / tool rack.

4 Store power tools in their original cases.

5 Apply the recommended appropriate oil to prevent the tools from rusting.

6 Use silica gel packs

7 Do not use knife, screw driver, hammer etc., without a handle. A tool without a handle should not be used.

8 While giving a tool to another person, always give it through its handle side.

9 During rainy season, fine layer of oil or grease should be applied to the appropriate metallic parts of tools.

10 If a layer of oil or grease is present at the handle of a tool then it should be cleaned off first with a piece of cloth soaked in kerosene oil or petrol, and then the same should be used.

11 A plier should not be used like a hammer and its insulating cover should be preserved.

12 Never use screwdrivers as wood chisel or cold chisel.

13 Steel wires should not be cut with a side cutter.

14 A neon tester should not be used as a screw driver.

15 A knife should not be used for cutting wires. It should be used only for scrapping the insulation of wires.

16 A hacksaw blade should be well tight in its frame and it should cut the metal in its forward stroke.

17 Before using a drilling machine, check that the drill bit is properly tighten.

18 Do not use a soldering iron of more than 15 to 25 watts while working on a circuit containing transistors and ICs.

19 Keep the soldering iron's bit clean and maintain its shape.

20 Use plastic and Bakelite screw drivers for the 'Alignment' job of a radio or TV receiver.

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Identify the phase, neutral and earth on power socket use a tester to monitor AC power

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

- **test and identify phase, neutral and earth terminals of a single phase AC mains in a 3 - pin socket using test lamp and neon tester.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- Neon tester, 500 V - 1 No.
- Digital multimeter with probes - 1 No.

Materials/Components

- PVC wire - 1.5 sq.mm -
  Red colour - 1 m.
  Black colour - 1 m.
- Incandescent bulb 60 W/250 V with holder - 1 No.
- Bolt & nut - 1 No.
- Hexagonal M6/40mm length (Stainless steel)

PROCEDURE

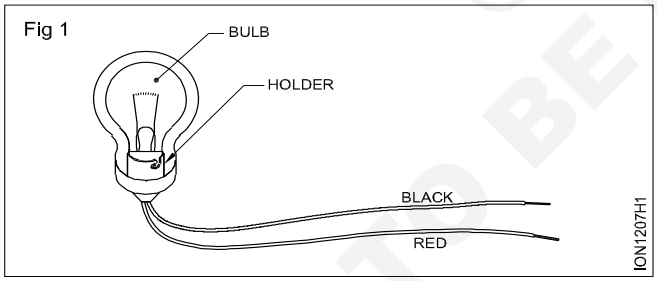
Safety precaution: Be cautious and ensure your safety from electrical shock.

TASK 1: **Fix the grill on the holder to prevent damage to bulb**

1 Skin the insulation at both ends of wires and test their continuity using ohm meter.

2 Connect the wires to the holder, fix the bulb and make the test lamp set up as shown in Fig 1.

Fig 1



3 Test the continuity at the free ends using an ohmmeter to confirm correct wiring and connections of the test lamp.

4 Mark terminal sockets on the 3 - pin 240V, AC mains socket to identify phase, neutral and earth points as A, B and C using sketch pen as shown in Fig 2.

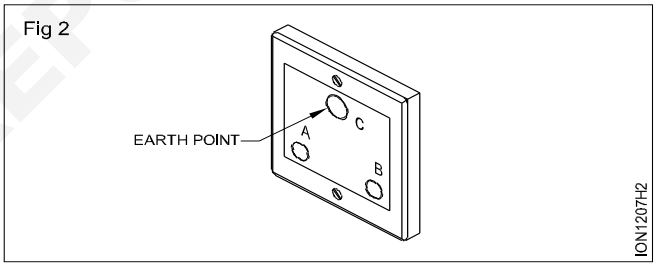
5 Switch ON the AC supply to the 3 pin socket.

6 Connect the test lamp across the marked points A and B and check the presence of mains supply.

7 Record the observation in Table - 1

If supply does not exist (lamp does not glow), consult your instructor before carrying out further steps.

Fig 2



- If lamp glows, the outlet point B is Phase or Live (L) mark outlet B as 'L' using sketch pen. Repeat steps 5 and 6 with the test lamp across Earth and socket B.

8 Repeat steps 5 & 6 with test lamp across A - C and if lamp does not glow, the other point A is neutral (N) mark it as N.

Table - 1

Sl No.	Measurement across	Lamp condition (Glowing / Not Glowing)	Remarks
1	A- B		
2	B - C		
3	C - A		

Note: If the mains supply circuit is provided with ELCB, it may break the circuit when the test lamp is connected across the line L and earth E.

9 Get the work checked by the Instructor.

Construct a test lamp, use it to check mains healthiness, measure the voltage between phase and ground and rectify earthing

Objectives: At the end of this exercise you shall be able to
- **construct a test lamp and use it to check mains healthiness**
- **measure the voltage between phase and ground**
- **defect the fault and rectify the defective earth connection.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- Digital multimeter with probes - 1 No.
- Double spanners - as reqd.

Materials/Components

- PVC wire, 1.5 sq.mm Red colour, Black colour - 1 m each.
- Incandescent bulb 60W/250V - 1 No.
- Pendent lamp holder (Bayonet type) - 1 No.
- Sketch pen - Red colour - 1 No.

PROCEDURE

Safety precaution: Be cautious and ensure your safety from electrical shock. Electrical shock is inevitable and it is your responsibility to avoid it.

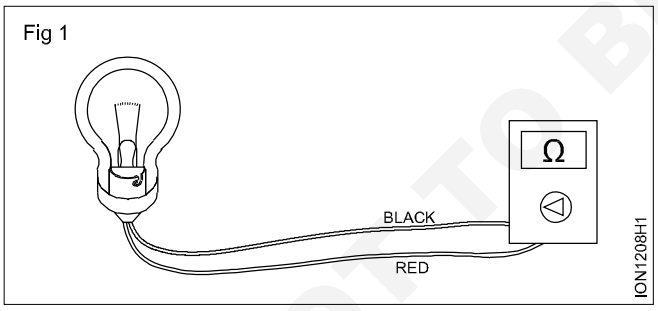
TASK 1: **Construction of test lamp and checking mains healthiness**

1 Skin both 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 to 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.

— — — — — — — —

TASK 2: **Measurement of voltage between phase and ground terminals**

1 Identify the phase and earth terminals of 3 pin AC 240V socket outlet.

2 Mark the three terminals as L.N & E using sketch pen

3 Switch ON the mains supply to the 3 pin socket.

4 Select AC voltage range on the DMM and measure voltage across 'L' and 'E' terminals as shown in Fig 2.

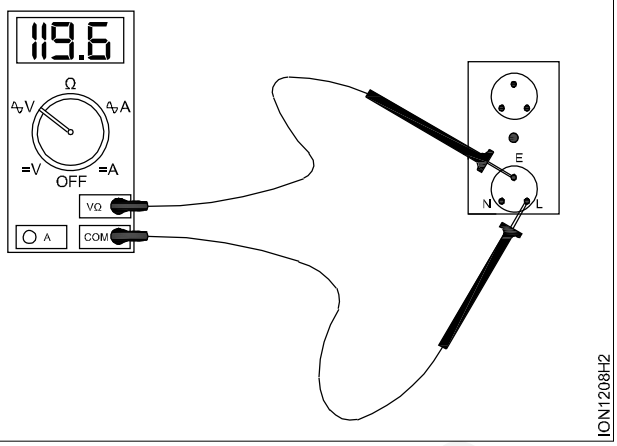
5 Record the observation in Table - 2.

Table - 2

Sl. No	AC voltage measured across terminals	
1	Live to Earth (L to E)	--------
2	Live to Neutral (L to N)	--------

6 Get the work checked by the instructor.

Fig 2



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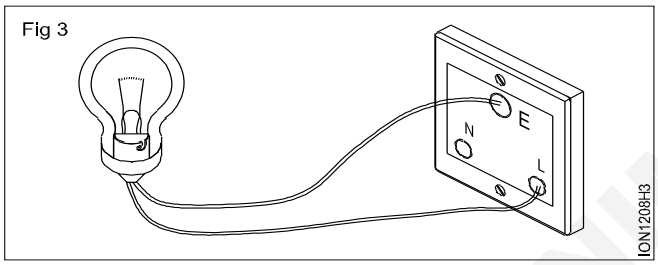
TASK 3: **Rectification of the defective earth connection.**

1 Connect test lamp between the earth and phase terminal socket as shown in Fig 3.

Fig 3



2 Switch ON the AC mains supply and observe the condition whether the lamp is glowing or not.

3 Connect the test lamp between L and N terminals and confirm the lamp glowing.

4 Switch OFF the mains supply, remove the 3 pin socket and observe the wire connection on the earth terminal.

5 Visually inspect the continuity of the wire between the 3 pin socket to the earth pit on the ground.

6 Use ohm meter and check the continuity between the earth electrode and wire conductor to the 3 pin socket.

7 Remove the bolt & nut clean the corrosion on the electrode contact terminal.

8 Use new bolt & nut and refix the earth wire connection to the electrode.

9 Check the continuity from earth electrode to the 3 pin socket terminal using ohm meter.

10 Switch ON power, use test lamp repeat step 1 and measure voltage across 'L' and 'E' terminals record your observations in Table - 3.

Table - 3

Sl. No.	Observation	Test lamp condition		Voltage across L and E
		Glowing	Not Glowing	
1	Before rectification			
2	After rectification			

11 Get the work checked by the Instructor.

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Prepare terminations, skin the electrical wires / cables using wire stripper and cutter

Objectives: At the end of this exercise you shall be able to
- **skin (cut and remove) the insulation of cables using manual stripper**
- **skin the insulation of two core cable using auto ejection type wire stripper**
- **remove the insulation of the PVC sheathed cable using side cutting pliers**
- **terminating wire end with crocodile clip and banana plug**
- **terminating skinned cable to three pin mains plug.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Wire stripper: manual & auto ejection type - 1 each.
- Diagonal cutting pliers 150 mm - 1 No.

Materials/Components

- Copper and aluminium cables of the following sizes:
- PVC single strand 1.5 sq. mm - 3 m.
- PVC single strand 2.5 sq. mm - 3 m.
- PVC cable 14/0.2 mm - 3 m.
- PVC cable 21/0.2 mm - 3 m.
- PVC cable 40/0.2 mm - 3 m.
- Crocodile clips (Black x Red) - 2 Sets.
- PVC insulated and PVC sheathed cable single core - 3 m.
- Two core PVC cable (250V/ 6A) -1 m.
- 3 core PVC cable - 1 m.
- 3 pin electrical mains plug 250 V/6A - 1 No.
- Cut pieces of flat twin core cable - 3 m.

PROCEDURE

TASK 1: **Skinning the cable insulation using a manual wire stripper**

1 Pick one of the labelled cable.

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

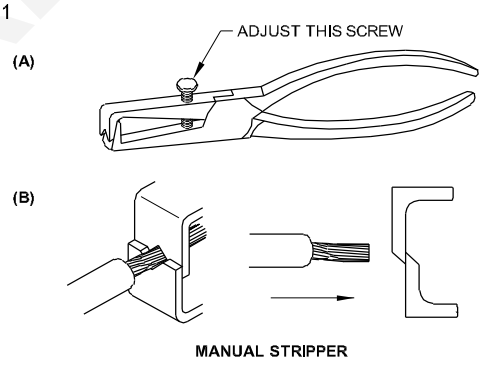
3 Mark the point 10 mm from which the insulation is to be skinned on both the ends of the cable.

4 Adjust the jaws of the manual stripper to suit the gap equivalent to the size of the conductor core. (Fig 1a and 1b) and set the stop position of the screw

5 Hold the cable firmly in one hand, set the jaws at the mark, press the handle of the stripper and make a cut on the insulation.

Safety: Exercise care, not to nick the conductor. For better practice try on small waste pieces of wires.

Fig 1



6 Pull the stripper to remove the insulation.

7 Get the work checked by the Instructor.

TASK 2: **Skinning the cable insulation using an auto ejection type wire stripper**

1 Repeat steps 1 to 3 of Task - 1.

2 Take the auto ejection type wire stripper and jaws, slots for various diameter markings. (Figs 2 & 3)

3 Select a slot in the jaws whose diameter is equal to the conductor core.

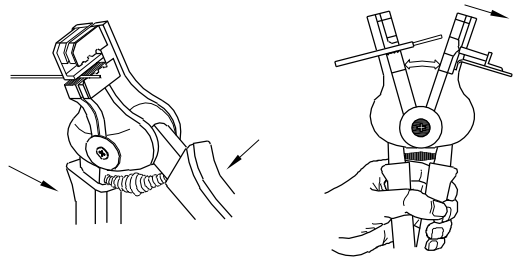
Safety Precaution: While using this stripper the cable insulation should be put in the proper slot to avoid damage to the conductor.

4 Place the marked point of cable at the jaws of the stripper exactly at the slot.

5 Hold the cable firmly in one hand and press stripper handles till the insulation is cut and removed from the cable end.

6 Repeat the above steps to skin the other ends of the cables.

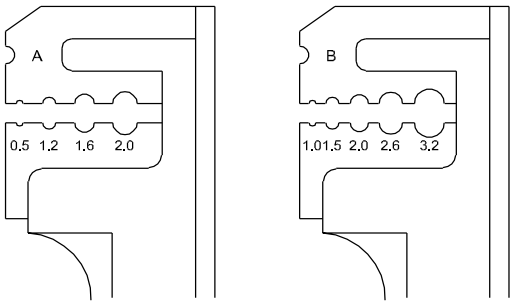
Fig 2



AUTO - STRIPPER

ION1209H2

Fig 3



JAWS OF AN AUTO STRIPPER

ION1209H3

7 Get the work checked by the instructor.

— — — — — — — —

TASK 3: **Skinning the insulation of three core cable**

1 Mark out the length up to which the insulation has to be removed from the cable end.

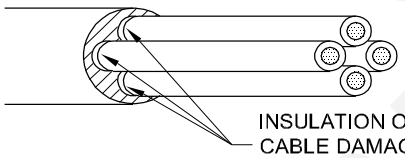
2 Hold the cable firmly, place the electrician knife on the marking of the sheath or insulation of the cable to be removed.

3 Cut the insulation to a depth of approximately 1 mm thickness of the sheath or insulation carefully.

Safety precaution: Use the knife carefully. By cutting too deep into the insulation or sheath of a cable will damage the insulation of wires inside the cable. Avoid deep cutting (Fig 4).

This causes short circuit and breakdowns in electrical installations.

Fig 4



ION1209H4

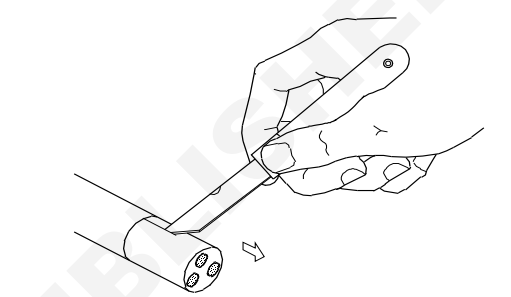
4 Place the cable end on table top, use the knife, slit open the sheath or insulation between the circular cut you have made at the end of the cable, as shown in (Fig 5).

Here again be very careful not to cut the insulation of wires inside the cable.

Alternative method - using diagonal cutting pliers.

1 Cut the covering from the marked end up to the length it should be removed by using side cutting pliers as shown in (Fig 6).

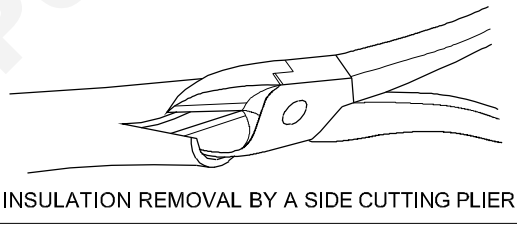
Fig 5



CUT ALONG THE CENTRE OF THE CABLE

ION1209H5

Fig 6

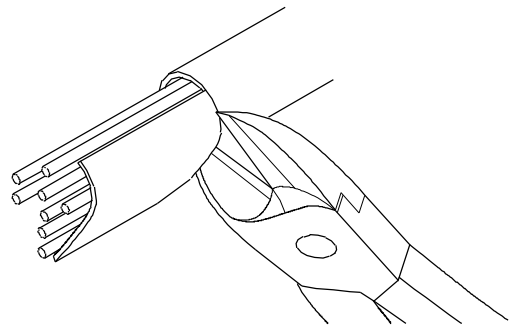


INSULATION REMOVAL BY A SIDE CUTTING PLIER

ION1209H6

2 Cut the sheathing along the circumference as shown in (Fig 7).

Fig 7



ION1209H7

3 Get the work checked by the Instructor.

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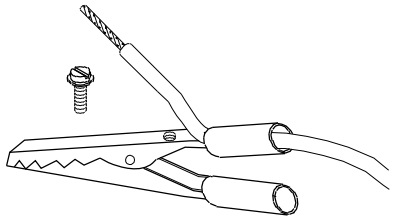
TASK 4: **Terminating wire end with crocodile clip and banana plug**

1 Take a piece of tinned red wire and a red crocodile clip.

2 Unscrew and take out the screw and washer from the crocodile clip.

3 Insert the tinned end of the wire through the leg of the crocodile clip as shown in (Fig 8).

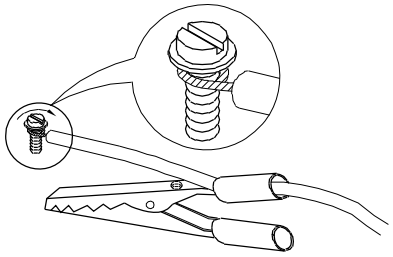
Fig 8



ION1209H8

4 Bend the tinned exposed conductor to form a loop using a round nose plier. Place the loop in the screw, such that the loop is in the direction of screw as shown in (Fig 9).

Fig 9



ION1209H9

5 Put the screw back on the crocodile clip and tighten the screw firmly. While tightening hold the wire such that wire does not protrude below the screw washer.

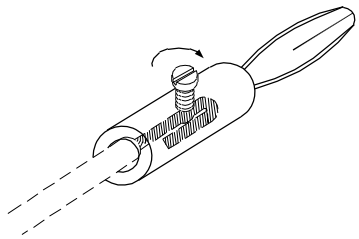
Excessive wire protrusion results in weak termination. Hence, the termination may come out during usage.

6 Take a red colour banana plug, unscrew the loosen screw on it almost fully but do not take out the screw from its place.

As the screw is small it will be time consuming to replace the screw back in its position if taken out from the plug.

7 Bend the other free end of the tinned wire by hand or using a nose pliers such that it takes the shape of a loop and Insert the loop fully into the hole of the banana plug as shown in (Fig 10) and tighten the screw firmly. Hold the wire with the body of the banana plug such that the wire does not slip off while tightening.

Fig 10



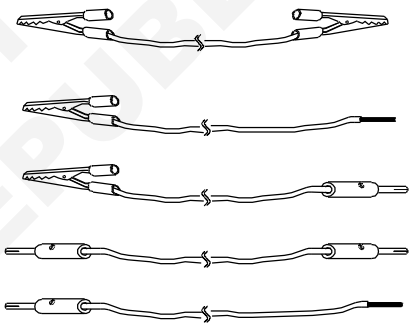
ION1209HA

8 Holding the banana plug in one hand and the wire in the other pull the wire gently to ensure that the termination is firm. If termination is found loose, unscrew the screw, pull out wire and repeat steps 7.

9 Follow steps 1 to 8 above and prepare a black wire termination with crocodile clip to banana plug.

10 Repeat the steps 1 to 8 and terminate different wires as shown in (Fig 11).

Fig 11



ION1209HB

11 Get the work checked by the Instructor.

TASK 5: **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 vary slightly. Consult the instructor in case of difficulty.

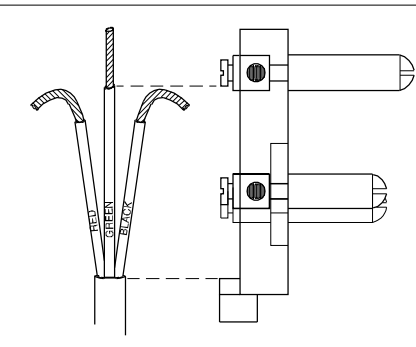
1 Open the outer plastic casing of the 3 pin plug. Remove the cable grip and place them safely in a tray or screw box.

2 Ensure the length of the outer sheath skinned is equal to the distance between the earth terminal and the cable grip as shown in (Fig 12).

3 Remove the anti-king shroud (anti-king ring) from the plug and take the cable through it as shown in (Fig 13).

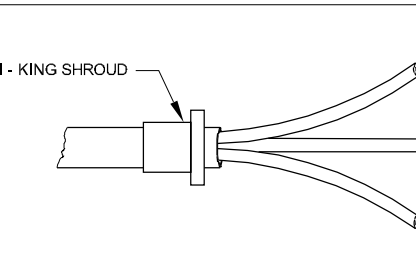
4 Make loops of the tinned conductor end of wires Loosen the screw insert the red wire loop into terminal marked L or Live as shown in (Fig 14a) and tighten the terminal screw.

Fig 12



ION1209HC

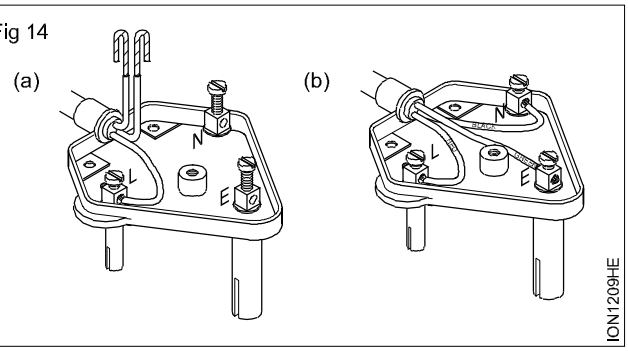
Fig 13



ION1209HD

5 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 14b) and tighten screws.

Fig 14

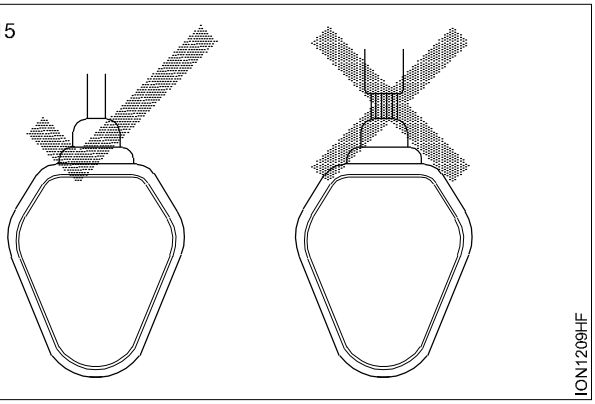


6 Position the anti-king shroud, reassemble the cable grip rubber and its screws.

7 Get the work checked by the instructor.

8 Reassemble the top cover of the plug. The finished work should look as shown in (Fig 15).

Fig 15



The cables terminated with 3 pin main plug made in this exercise will be used in further exercises.

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Measure the gauge of the wire using SWG and outside micrometer

Objective: At the end of this exercise you shall be able to
- **measure the gauge of the wire using**
  a standard wire gauge (SWG)
  b outside micrometer.

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Standard wire gauge (per batch) - 1 No.
- Outside micrometer 0-25 mm (per batch) - 1 No.
- Pocket table book / wire table - as reqd.

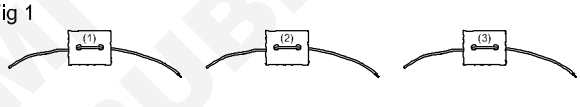
Materials/Components

- Single strand wire pieces (assorted sizes) - 2 Nos.
- Rigid multistrand wire piece - 1 No.
- Flexible multi strand wire pieces
  - Red colour - 1 No.
  - Black colour - 1 No.
  - Green colour - 1 No.
- Dry cloth - as reqd.

PROCEDURE

Note: The Instructor has to attach labels to identify each piece of wire correctly as shown in (Fig 1).

Fig 1



ION1210H1

TASK 1: **Measurement of gauge number of wire using standard wire gauge**

1 Clean the skinned end of single strand wires using dry cloth and straighten the conductors by hand.

Note:

Do not use nose pliers/tweezers to straighten conductors as this may deform conductors diameter.

Dust and other particles on the conductor, bends and kinks in the conductor give wrong measurement of the diameter / gauge number.

2 Pick a labelled single strand wire for measurement of gauge number.

3 Hold the SWG in one hand and insert the exposed conductor of the wire into one of the large holes of the stranded wire gauge (SWG) and take out the wire through the upper slot above that hole as shown in (Fig 2).

4 Repeat step 3 till the conductor exactly fits into the slot as shown in (Fig 3). Remove the conductor by pushing it down into the hole and pulling it out.

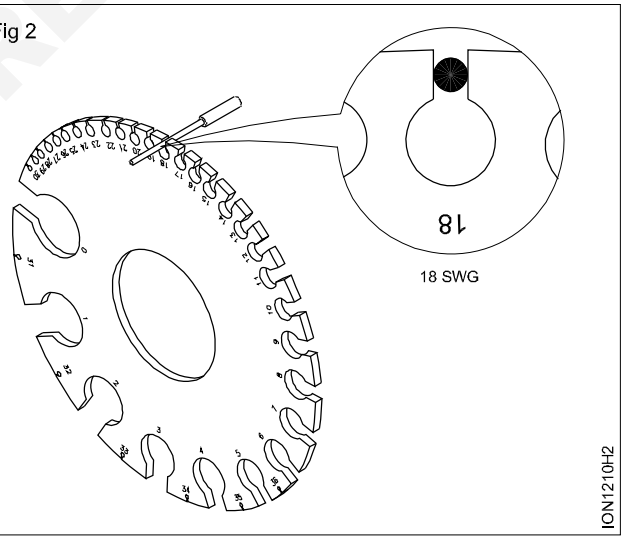
5 Note down the number printed / marked at the hole and record the observation in Table 1.

6 Repeat steps 3 and 4 for the other end of the wire.

7 Repeat steps 3 to 6 for the other single strand wires.

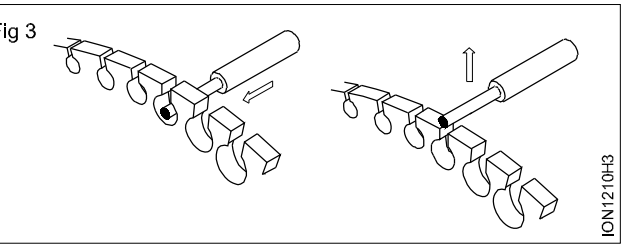
8 Get the work checked by the Instructor.

Fig 2



ION1210H2

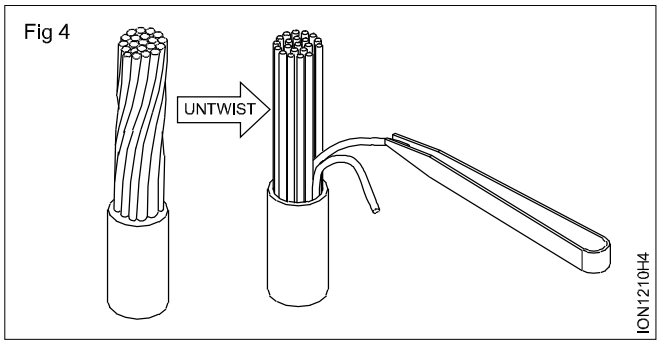
Fig 3



ION1210H3

9 Take the rigid multistrand wire. Clean the conductors and untwist the twisted strands and separate one of the strands as shown in (Fig 4).

Fig 4



10 Carry out steps 3 & 4 measure and record the SWG of one strand of the wire.

11 Count the total number of strands available in that wire and record it in Table 1

12 Repeat steps 9 to 11 for the flexible multistrand wires.

13 Refer pocket table book/wire table and convert the measured SWG value of wires into diameter of the wires in inches and millimeters. Record the readings in Table 1.

Table 1

	WireTag No.		Conductor Size of SWG	Conductor dia. in mm	Conductor dia.in inches	No. of Conductors
Single Strand Wire	Sample Entry	END 1	20	0.91	0.036	1
		END-2	20	0.91	0.036	
	1	END-1				
		END-2				
	2	END-1				
		END-2				
Multi-strand Wire	3					
	4					
	5					
	6					
	7					
	8					

14 Get the work checked by the Instructor.

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TASK 2 : **Measurement of diameter of the wire using Outside Micrometer**

Note: The Instructor has to guide the trainees in handling the micrometer and taking precise measurements.

1 Find the least count and zero error of the given micrometer as shown in (Fig 5). Note down the values in Table 2.

2 Take the wire with label No. 1 for measurement. Clean and straighten the exposed conductor.

3 Carefully hold the micrometer in hand and place the conductor in the gap between the anvil and spindle. Turn the thimble till the conductor is just held between the anvil and the spindle as shown in (Fig 5). Turn the ratchet till a click sound is heard.

Safety precaution:

Do not over tighten as this may deform the conductor and hence give wrong measurement.

4 Record the reading on the barrel and thimble in table 2. Loosen the grip on the conductor and take out the conductor from the micrometer.

5 Repeat steps 2,3 & 4 for the remaining single strand and multi-strand wires

Measure the diameter of only one strand in the case of multi-strand wires.

6 Calculate and record the diameter of the wires in mm for the micrometer readings recorded.

7 Compare the dia. of the wires noted in Table 1 using stranded wire gauge and the dia. measured using micrometer. If readings are found not matching consult the instructor.

8 Get the work checked by the Instructor.

Note: Keep the wires to be utilized for the next exercise.

Fig 5

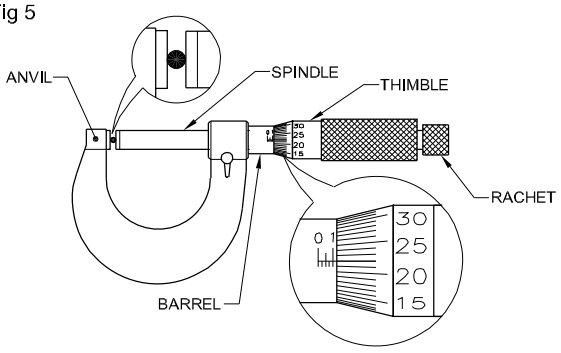


Table 2

Least count (LC)			
Zero error correction (ZC)			
Wire tag No.	**Barrel reading**	**Thimble reading (Thimble div x LC)**	**Wire dia. in mm (2) + (3) ± ZC**
1			
2			
3			
4			
5			
6			
7			
8			
9			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

— — — — — — — —

Demonstrate various test and measuring instruments

Objectives: At the end of this exercise you shall be able to
- **identify various analog measuring instruments and demonstrate them**
- **identify various digital measuring instruments and demonstrate them.**

Requirements

Tools/Equipments

- MC Ammeter 0-5A - 1 No.
- MI Ammeter 0-10A - 1 No.
- MC Milli ammeter 0-1mA - 1 No.
- MC Milli volt meter 0 - 100mV - 1 No.
- MC voltmeter 0-50V - 1 No.
- MI Voltmeter 0-500 V - 1 No.
- Mega ohmmeter 0-10 Mega ohm - 1 No.
- Megger - 1 No.

Materials/Components

- Cotton Waste - as reqd.

PROCEDURE

TASK 1: **Identification of various analog measuring instruments.**

1 **The Instructor has to arrange a set of moving coil / moving iron type analog measuring instruments such as Ammeters, voltmeters, milliammeters, milli voltmeters, etc and demonstrate them to trainees.**

2 **Also arrange Digital type measuring instruments for the above parameters.**

3 **Label each meter type separately and group them under MC / MI category.**

1 Pick one of the labelled meter, observe the panel and record the observations in Table - 1

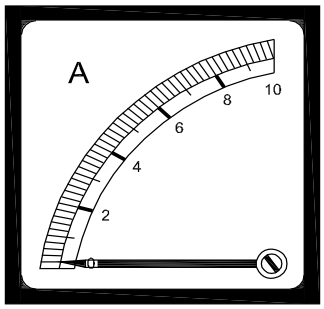
2 Repeat the above step for all the labelled meters.

3 Notedown the number of seven segment display used for measurements (like 3½ digits, 4½ digits etc.,).

Table 1

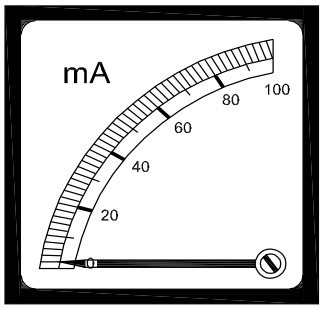
Label No. (1)	Name of the Meter (2)	Measuring Range (3)	Diagram of dial scale marking / Seven segment display (4)
1	MC ammeter		
2	MC Milli Voltmeter		
3	MC Milli ammeter		
4	MC Voltmeter		
5	Mega Ohmmeter		
6	MI Volmeter		
7	MI Ammeter		

Fig 1



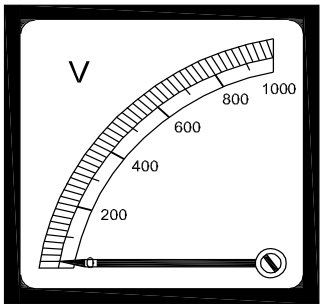
ION1213H1

Fig 2



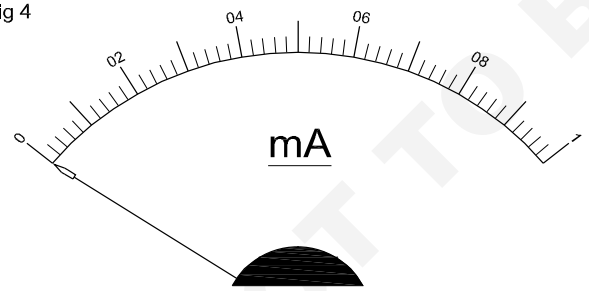
ION1213H2

Fig 3



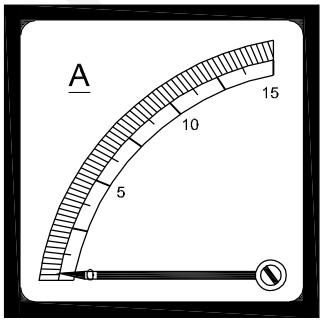
ION1213H3

Fig 4



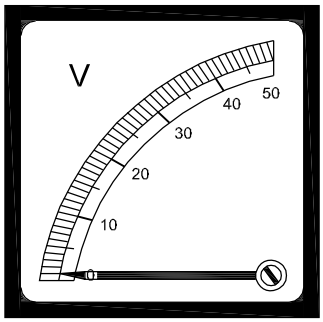
ION1213H4

Fig 5



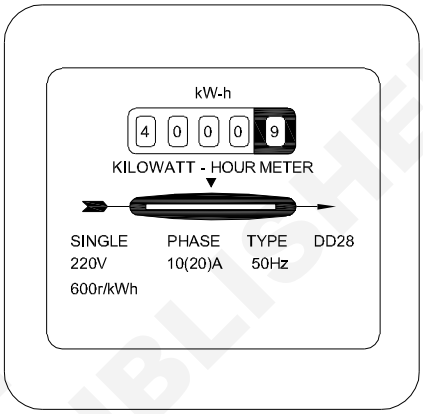
ION1213H5

Fig 6



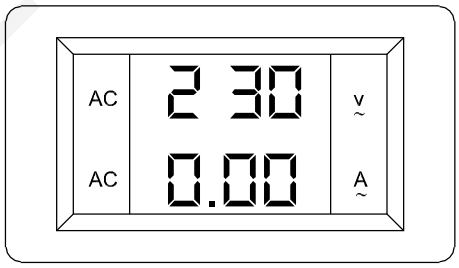
ION1213H6

Fig 7



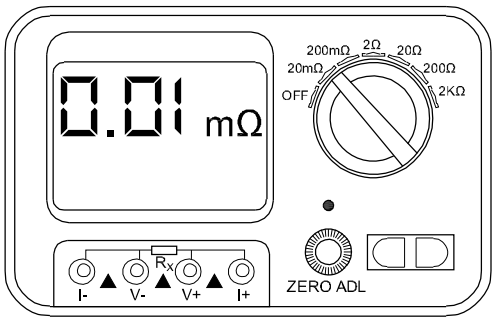
ION1213H7

Fig 8



ION1213H8

Fig 8



ION1213H8

4 Get the work checked by the Instructor.

Measure voltage and current using clamp meter

Objectives: At the end of this exercise you shall be able to
- **identify ranges and display on digital clamp meter**
- **measure AC voltage and AC current using clamp meter**
- **measure DC voltage and DC current using clamp meter.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Digital AC/DC clamp meter with built-in multimeter - 1 No.
- Variac 0-270VAC - 1 No
- Regulated power supply 0-30V DC/2A - 1 No

Materials/Components

- 12V/10W bulb with holder and wire - 1 Set.
- 100W/240V Test lamp with wire - 1 No.

PROCEDURE

Note: The instructor has to provide the user manual of the Digital AC/DC clamp meter utilized for this exercise.

TASK 1: **Identification of ranges and display on Digital Clamp meter**

1 Refer to the user manual of the Digital clamp meter.

2 Switch ON the clamp meter and observe the display, identify each icon representing various parameters measured by the clamp meter.

3 Record each one of them, with reference to user manual, in the Table 1.

4 Get the work checked by the instructor.

Table 1

Sl. No	Description of the display/icon	Meaning/ function	Remarks
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

— — — — — — — —

TASK 2: **Measurement of AC voltage and AC current using clamp meter**

1 Plug the black test probe into the COM terminal/ socket.

2 Plug the red probe into the VΩmA socket.

3 Turn the rotary function switch to ACV/ voltage section as shown in Fig 1.

Note: For auto ranging model it automatically display the measured value for other models refer the user manual.

4 Switch ON the AC wall socket.

5 Insert the probes into the AC wall socket as shown in Fig 1 and observe the voltage displayed.

6 Record the reading in the observation Table 2.

7 Remove the test probes form the clamp meter and select the AC current function.

8 Connect the test lamp (with 100W/240V bulb) into the wall socket.

9 Press open the jaws of clamp meter, keep the phase (LIve) conductor inside and release jaws as shown in Fig 2.

10 Switch ON the test lamp circuit, observe the current reading displayed and record it in Table 2.

Fig 1

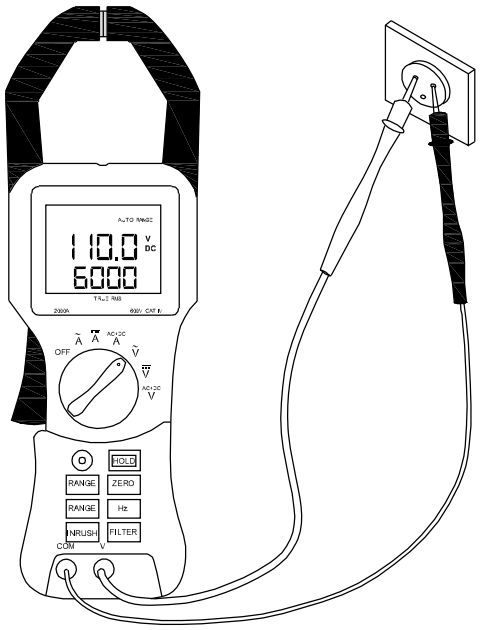


Fig 2

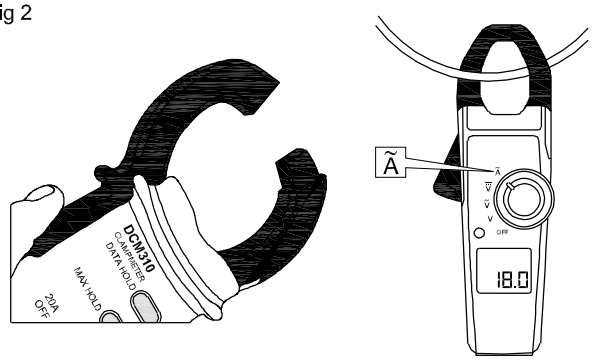


Table 2

Sl.No.	Parameter	Quantity
1	Voltage across wall socket	
2	Current through the test lamp	

11 Get the work checked by the instructor.

TASK 3: **Measurement of DC current using clamp meter**

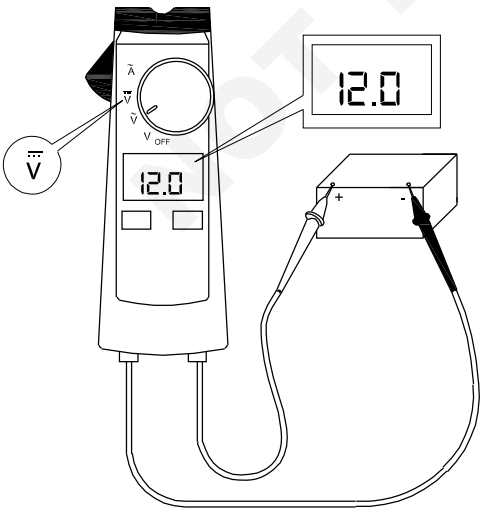
1 Select the DC voltage function on the clamp meter and connect the test probes across regulated power supply (RPS) unit output terminals.

2 Switch ON the RPS unit and adjust the output voltage to 12VDC.

3 Remove the test probes from RPS unit and select the DC current function on the clamp meter.

4 Connect the 12V/10W bulb across the output terminals of RPS unit.

Fig 3



5 Press open the jaws of clamp meter, keep one of the conductor of lamp circuit inside as shown in Fig 4.

6 Switch ON the lamp circuit, observe the current reading displayed and record it in Table 3.

Fig 4

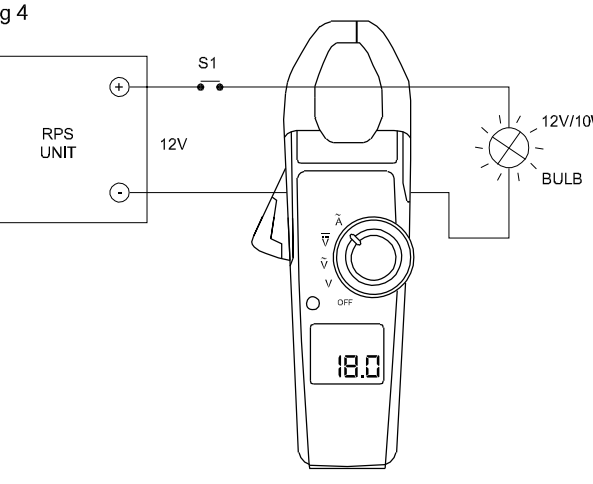


Table 3

Sl.No.	Measurement of DC voltage across
1	Reg. power supply unit
2	Current through the test lamp

7 Get the work checked by the instructor.

Identify the different types active and passive electronic components

Objectives: At the end of this exercise you shall be able to
- **identify the different types of active electronics components by referring to the Pictorial representation.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- Magnifying Glass - 1 Set.
- Components Data Sheet with Lead Identification - 1 No.

Materials/Components

- Diodes - 1 No.
- Zener Diode - 1 No.
- Transistor - 1 No.
- Unijunction Transistor(UJT) - 1 No.
- Field Effect Transistor (FET) - 1 No.
- DIAC - 1 No.
- TRIAC - 1 No.
- Silicon Controlled Rectifier (SCR) - 1 No.
- Integrated Circuit (IC) - 1 No.

PROCEDURE

Note: Instructor shall label the active components used for this exercise.

1 Pick one of the labelled active components from the given lot.

2 Identify the components name from the Pictorial representation (Shape, Leads, Colours).

3 Record the names, code No. and number of Pins of the components in Table-1.

4 Repeat the step-2 & 3 for the remaining components.

Table 1

Sl.No.	Component	Free hand sketch	Device symbol	Remarks
1	LDR			
2	DIODE			
3	LED			
4	Zener Diode			
5	Transistor			
6	SCR			
7	TRIAC			
8	DIAC			
9	UJT			
10	JFET			
11	IC			

5 Get the work checked by the Instructor.

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Measure the resistor value by colour code, SMD code and verify the same by measuring with multimeter

Objectives: At the end of this exercise you shall be able to
- **determine resistance value by decoding the colour bands on fixed resistors**
- **determine resistance value by typographic/numeric code with tolerance value**
- **measure and compare the coded value of SMD resistors**
- **measure resistance value using ohmmeter/multimeter and compare with calculated value.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- Digital multimeter with probes - 1 No.
- Magnifying lens - 1 No.

Aids: Resistor colour code chart - 4 Nos.

Materials/Components

- Different types of fixed value resistors colour code resistors - 5 Nos.
- Typographically coded - 5 Nos.
- SMO resistors - 5 Nos.

The Instructor has to label the different values of fixed resistors and provide the charts related to resistor colour coding scheme for 3,4 and 5 colour bands.

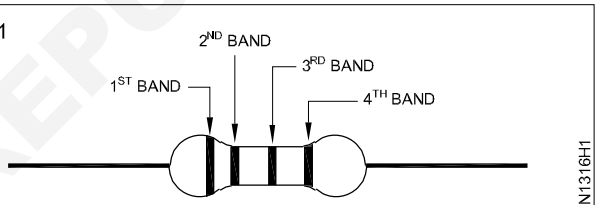
PROCEDURE

TASK 1: **Calculation of Resistor value from Colour bands**

1 Pick one of the labelled resistor from the given lot and identify the colours of bands starting from Left Hand Side of the resistor as shown in Fig 1.

In general three colour bands are provided closely on one end and the tolerance colour on the other end of the resistor body as shown in Fig 1.

Fig 1



2 Refer to the Chart 1, observe the colour bands on the resistor, record them in Table 1, include tolerance colour also.

3 Decode the values of colour bands and calculate the value of resistor, also record the minimum and maximum valves.

Chart 1

Color	1st Band (1st figure)	2nd Band (2nd figure)	3rd Band (multiplier)	4th Band (tolerance)
Black	0	0	10^{0}	±1%
Brown	1	1	10^{1}	±2%
Red	2	2	10^{2}	
Orange	3	3	10^{3}	
Yellow	4	4	10^{4}	
Green	5	5	10^{5}	
Blue	6	6	10^{6}	
Violet	7	7	10^{7}	
Gray	8	8	10^{8}	
White	9	9	10^{9}	
Gold			10^{-1}	±5%
Silver			10^{-2}	±10%

Table 1

Label No.	First Band		Second Band		Third Band		Tolerance		Resistance value using colour code			Meter Measured Value
	Colour	Code	Colour	Code	Colour	Code	Colour	Percentage	decoded value	Maximum value	Minimum value	
1												
2												
3												
4												
5												
6												
7												
8												

4 Repeat above steps for remaining colour coded/ labelled resistors.

5 Measure the resistor valve by colour code, SMD code and verify the same by measureing with multimeter.

Chart 2

Chart 3

Chart 4

6 Get the work checked by the Instructor.

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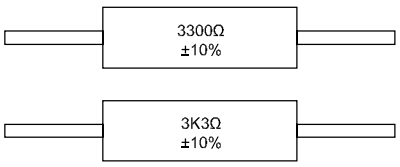
TASK 2: **Calculation of Resistor value from Typographic codes**

1 Pick one of the labelled typographically coded resistor from the lot and observe the value/codes printed on the body as shown in Fig 2.

Fig 2



2 Refer to Chart 5, calculated and record the minimum, maximum valve with tolerance in Table 2.

3 Repeat above steps for remaining typographically coded resistors.

Chart 5

Printed Code Format	Meaning	Example of printed Code	Corresponding Resistance Value
xE	X Ohms	1E	1 Ohms
X	X Ohms	100	100 Ohms
xW	X Ohms	56 W	56 Ohms
xKy	X.y K Ohms	4K7	4.7 K Ohms
x.K	X K Ohms	56K	56 K Ohms
xMy	X.y M Ohms	6M8	6.8 M Ohms
xM	X M Ohms	10 M	10 M Ohms

Table 2

Label No.	Printed code on the Resistor	% Tolerance	Resistance value using code			Meter measured value
			Standard Value	Maximum Value	Minimum Value	

4 Get the work checked by the Instructor.

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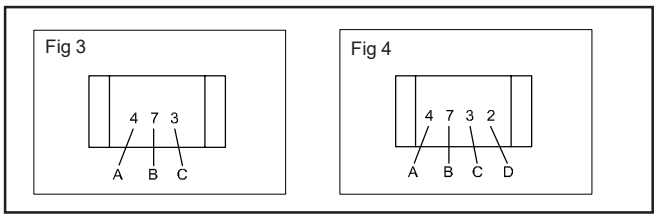
TASK 3: **Identification of SMD resistor value**

1 Pick one of the SMD resistor and refer to the (Figs 3&4) identify the coding marked on the component.



2 Decode the value refering to the Chart 6 & Chart 7.

3 Record the observations in Table 3

Resistors are marked with a three digit number and some typical values are shown in chart 4. The first two numbers are the significant digits of the value, and the last digit is the multiplier (the number of zeros to add to the first two digits). For example, a chip resistor labeled 102 has a value of 1000 Ohms, or 1k Ohms.

Marking on the SMD resistors with 3 letters

A = 1st digit of the resistors value

B = 2nd digit of the resistors value

C = number of zeroes

Chart 6

Code letters printed	Resistance value
101	100 Ω
471	470 Ω
102	1k Ω
122	1.2k Ω
103	10k Ω
123	12k Ω
104	100k Ω
124	120k Ω
474	470k Ω

Typical resistor markings and corresponding values with four letters

A = 1st digit of the resistor value

B = 2nd digit of the resistor value

C = 3rd digit of the resistor value

D = number of zeroes

Chart 7

Code letters printed	Resistance Value
100R	100 Ω
634R	634 Ω
909R	909 Ω
1001	1k Ω
4701	4.7k Ω
1002	10k Ω
1502	15k Ω
5493	549k Ω
1004	1M Ω

Table 3

Code letter printed (1)	Resistance Value	
	Decoded (2)	Measured (3)
102		--- Ω
470		--- Ω
103		--- Ω
222		--- Ω
101		--- Ω
232		--- Ω
333		--- Ω
1243		--- Ω
4743		--- Ω

4 Repeat the above setps for the remaining SMD resistors and record their values.

5 Get the work checked by the Instructor.

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TASK 4: **Measurement of resistance value using ohmmeter**

1 Select the Ohms range on the digital multimeter, short both the test probe terminals and ensure that the meter displays 'Zero' and release them.

2 Pick the first labelled resistor of Task 1 and fix both ends on the crocodile clips/probes.

Use crocodile clip test probes if avaliable readily for measurement of resistor values. Otherwise, use two crocodile clips at the end of test probes.

3 Observe the reading display by the meter and record it in Table 1.

4 Adjust the range selector knob if the display shows INFINITY and change to next position for measurement.

5 Even after changing the range selector to other ohms range, the display shows 'INFINITY' means the resistor may be open and for zero it is shorted.

6 Repeat the above steps for remaining labelled resistors of Task 1.

7 Pick the first labelled resistor of Task 2 and repeat stpes 2 to 6 and record the observations in Table 2.

8 Repeat the steps for SMD resistors of Task 3 and record your observation in Table 3.

9 Get the work checked by the Insctuctor.

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
- **assemble a simple electrical circuit, measure current flow and verify the ohm's law**
- **assemble a combinational circuit and measure parameters.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- Soldering Iron, 230V/25 watts - 1 No.
- Milliammeter 0-100mA - 1 No.
- Milliammeter 0-30mA - 1 No.
- Digital multimeter with probes - 1 No.
- Regulated DC power supply 0-30V/2A - 1 No.

Materials/Components

- SPST Toggle Switch/1A - 1 No.
- Resistor, 100Ω/1W - 3 Nos.
- Rosin cored solder wire - 1 m.
- Hook-up wire - 2 m.
- Lug Board/General purpose PCB - 1 No.

PROCEDURE

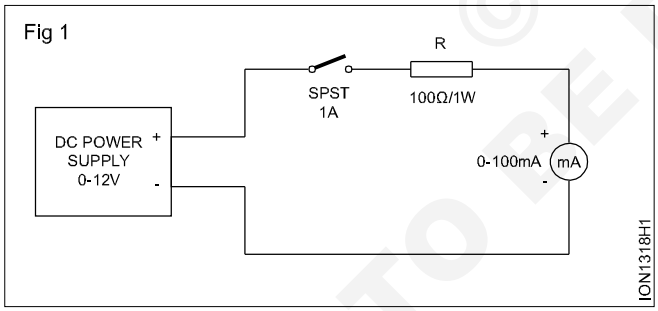
TASK 1: **Measuring current in the circuit with one resistor**

1 Collect all the required items and check their good working condition.

2 Pick one of the resistor, measure and record the value in Table 1.

3 Assemble the circuit as shown in Fig 1 with 3VDC supply.

Fig 1



4 Calculate the theoretical current expected to flow in the circuit for 3 VDC supply and record the calculated value in Table 1.

5 Switch ON the circuit with 3 VDC, measure the circuit current and record it in Table 1.

6 Repeat steps 4 and 5 for 6V and 9V supply.

7 Plot the graph of circuit voltage (V) versus circuit current (I) readings recorded as shown in Fig 2 to verify ohm's law.

Fig 2

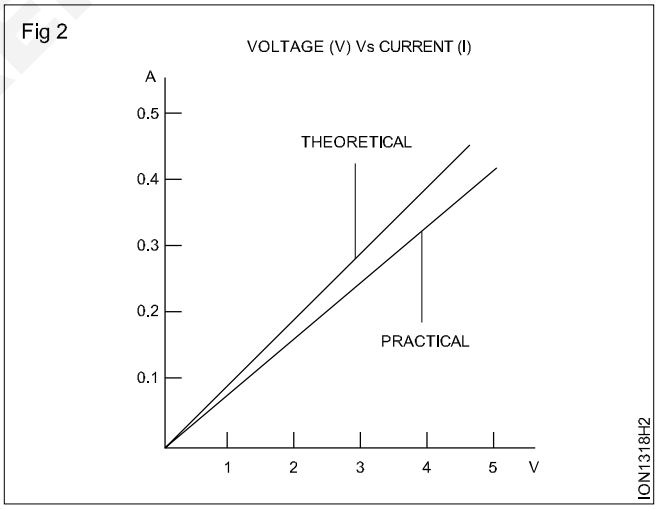


Table 1

Sl. No.	Resistance Value (R)	Supply Voltage (V)	Circuit current (I)	
			Calculated	Measured
1		3 V		
2		6 V		
3		9 V		

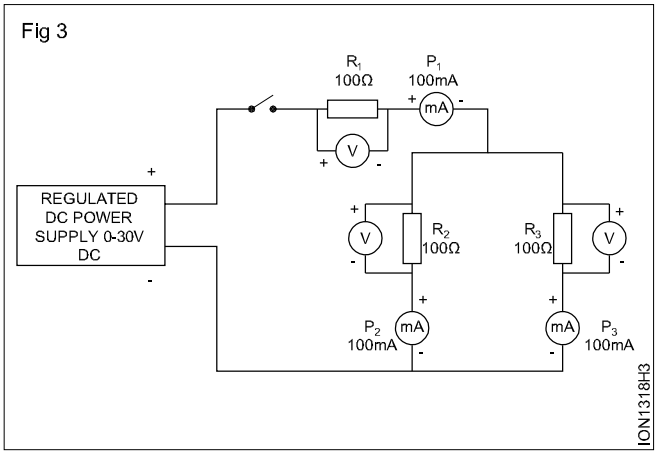
8 Get the work checked by the Instructor.

— — — — — — — —

TASK 2: **Measuring voltage and current in combinational electrical circuit**

1 Assemble the combinational circuit as shown in Fig 3.

Fig 3



2 Verify the polarities of milliammeters correctly connected and get in checked by the instructor.

3 Switch ON the DC supply and adjust the output to 3 VDC.

4 Observe the milliammeters at P1, P2, P3 and record the readings in Table 2.

5 Measure the voltage drop across resistors R1, R2, R3 and record readings in Table 2.

6 Increase the DC supply to 6V and repeat steps 4 and 5.

Table 2

Sl.No	DC supply	Voltage drop resistor			Current flow at position		
		R1	R2	R3	P1	P2	P3
1	3 V						
2	6 V						

7 Get the work checked by the Instructor.

— — — — — — — —

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 the kirchhoff's current law with three branch circuit**
- **verify the kirchhoff's voltage law with one voltage source.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- Soldering Iron, 230V/25 watts - 1 No.
- Milliammeter 0-100mA - 1 No.
- Milliammeter 0-50mA - 2 Nos.
- Milliammeter 0-25mA - 1 No.
- Digital multimeter with probes - 1 No.
- Regulated DC power supply 0-30V/2A - 1 No.

Materials/Components

- SPST Toggle Switch/1A - 1 No.
- Resistor, 150Ω/½ W - 3 Nos.
- Resistor, 220Ω/½ W - 1 No.
- Resistor, 330Ω/½W - 1 No.
- Rosin cored solder wire - 1 m.
- Hook-up wire - 2 m.
- Lug Board/General purpose PCB - 1 No.

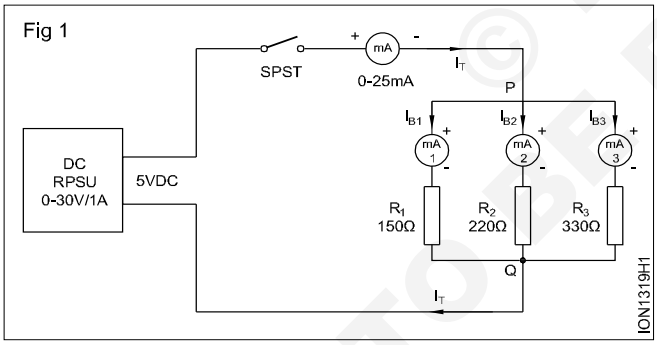
PROCEDURE

TASK 1: **Verification of Kirchhoff's Current Law**

1 Collect all the required items and check their good working condition.

2 Assemble the circuit as shown in Fig 1.

Fig 1



3 Verify the polarities of milliammeters correctly connected and get it checked by the instructor.

4 Switch ON the DC power supply with 5 VDC measured and record total current I_t, branch currents I_{B1}, I_{B2}, I_{B3} in Table 1.

5 Calculate and verify the current equation from the observed readings across Nodes P and Q.

Calculate the expected branch currents I_{B1}, I_{B2}, I_{B3} and total current I_t as per the resistor values shown in the circuit diagram given.

Table 1

RPS Voltage	Total circuit Current I_T	Branch-1 Current (I_{B1})	Branch-2 Current (I_{B2})	Branch-3 Current (I_{B3})	($I_T = I_{B1}+I_{B2}+I_{B3}$)
12V					

6 Get the work checked by the Instructor.

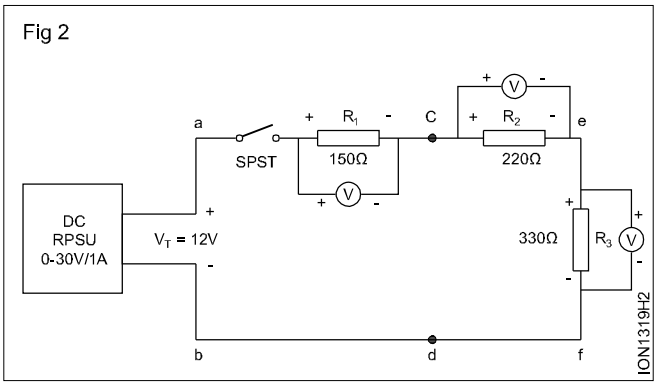
— — — — — — — —

TASK 2: **Verification of Kirchhoff's voltage law**

1 Collect all the required items and check their good working condition.

2 Assemble the circuit as shown in Fig 2 and get it checked by the Instructor.

Fig 2



3 Switch ON the DC power supply with 12 VDC, measure the voltage drops across resistors R_1, R_2, R_3 and record the readings in Table 2.

4 Mark the polarity of the voltage drops across resistors R_1, R_2 and R_3.

5 Verify the voltage equation $V_S = V_1 + V_2 + V_3$ from the measured readings.

Loop:- a-c-d-b-a:

$+V_1 + V_2 - VT = 0$

$+V_1 + V_2 = VT$

Loop:- a-c-e-f-d-b-a:

$+V_1 + V_3 - VT = 0$

$+V_1 + V_3 = VT$

Loop:- c-e-f-d-e:

$+V_3 - V_2 = 0$

$V_3 = V_2$

Table 2

RPS Voltage	Value of Resistor			Voltage Across Resistor			Sum of voltage
	R_1	R_2	R_3	R_1	R_2	R_3	$V_S = V_1 + V_2 + V_3$
12V							

6 Get the work checked by the Instructor.

— — — — — — — —

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

Objectives: At the end of this exercise you shall be able to
- **connect batteries in series circuit and verification of voltage**
- **connect batteries in parallel circuit and verification of current.**

Requirements

Tools/Instruments/Equipments

- Trainees Tool Kit - 1 Set.
- Sealed maintenance free batteries 6V/4Ah - 1 No.
- Sealed maintenance free batteries 12V/4Ah - 1 No.
- 0-10A Ammeter - 1 No.
- Digital multimeter with probes - 1 No.

Materials/Components

- Bolt & Nut M6/25mm - 10 Nos.
- 2 sq.mm cable - Back, Red colours - 2 m each.
- 12V/35W lamp with holder - 1 No.

Note:

1 The Instructor has to ensure that Ampere hour rating of all the batteries utilized for the series connection task is same and label them.

2 Also ensure that the voltage rating of all the batteries utilized for parallel connection. Task is same.

Safety pracaution:

- **Do not connect different Ampere hour rated batteries in series.**
- **Do not connect different voltage batteries in parallel circuit.**

PROCEDURE

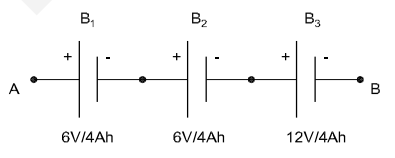
TASK 1: **Connection of batteries in series and verification of voltage**

1 Check the label number of each battery, measure the terminal voltage and record observed readings in Table 1.

2 Arrange the batteries side by side on the workbench with sufficient distance between them for connection.

3 Observe the polarity and connect the batteries as shown in Fig 1, using bolt & nut and jumper cables for series connection.

Fig 1



4 Calculate and measure the total voltage of the series combination across terminal marked A, B and record the reading in Table 1.

Table 1

Label No.	Terminal voltage	Ampere hour rating	Total voltage
S1			
S2			
S3			

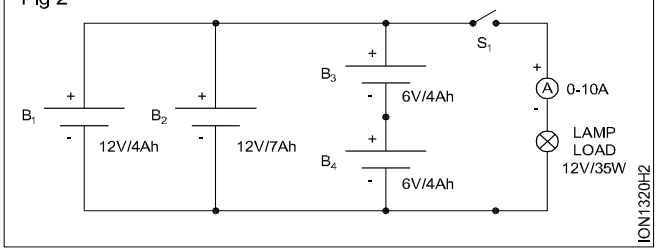
5 Get the work checked by the Instructor.

TASK 2: **Connection of batteries in parallel and verification of volt**

1 Repeat steps 1 and 2 of Task 1 and reocrd observation in Table 2.

2 Connect the batteries in parallel as shown in Fig 2, using bolt & nut and jumper cable.

Fig 2



3 Calculate the total current that can be drawn from the parallel combination and record in Table 2.

4 Switch ON the 12V/35W lamp load, observe the load current and record your readings.

Safety: Keep the lamp cautiously to avoid over heating of nearby wires or any other items.

Table 2

Label No.	Terminal voltage	Ampere hour rating	Total current calculated	Lamp load current
P1				
P2				
P3				
P4				

5 Get the work checked by the Instructor.

Identify different inductors and measure the values using LCR meter. Identify different Inductors, capacitors and measure capacitance of various capacitors using LCR meter

Objectives: At the end of this exercise you shall be able to
- **identify different types of inductors by their appearance**
- **measure the value of inductance using digital LCR meter.**
- **identify different types of capacitors by their physical appearance**
- **determine the capacitance value by typographic codes**
- **measure capacitance values by using LCR meter.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 set.
- DC Regulated Power Supply, 0-30V/2A - 1 No.
- Digital LCR Meter with manual - 1 No.
- Digital multimeter with probes - 1 No.

Materials/Components

- Assorted types and values of inductors - 10 Nos.
- Assorted values of different types of capacitors - 10 Nos.
- Cotton cloth/cleaning brush - as reqd.
- Hook up wires/connecting wires - 1 m.
- Cleaning brush - as reqd.

PROCEDURE

TASK 1: **Identify different inductors and measure the value by using LCR meter**

Instructor has to label the different value of inductors used for this exercise.

1 Pick one of the labelled inductor from the given lot.

2 Identify the type name, symbol and record it in Table 1. Refer the chart (Fig 1) compare identify and record in Table 1.

3 Check the continuity /ohmic resistance value of the inductor using DMM and record the value of inductor readings in Table 1.

4 Connect it across the Digital LCR meter, measure and record the resistance value of the inductor in Table 1.

Note: Switch ON the Digital LCR meter and make the setting for inductance measurement.

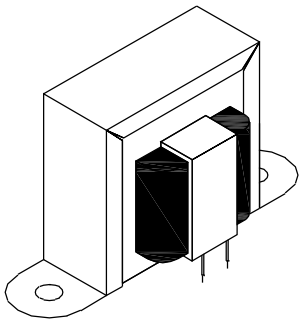
4 Repeat the steps 2 to 5, measure inductance of the remaining inductors, and record in Table 1.

5 Get the work checked by the Instructor.

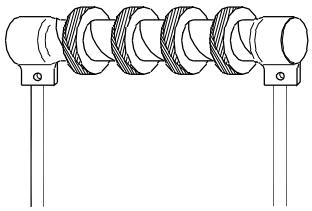
Table 1

Label No.	Type/Name of Inductor	Symbol	Resistance across coil terminals as per DMM	Inductance value as per LCR meter
1				
2				
3				
4				

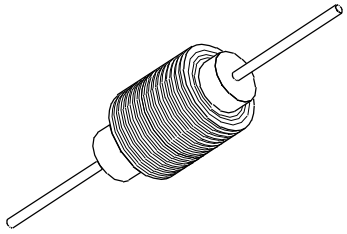
Fig 1



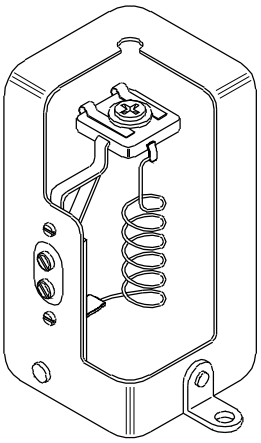
IRON-CORE INDUCTOR



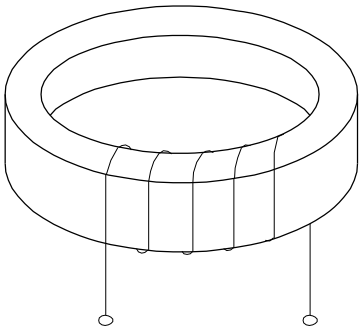
AIR-CORE INDUCTOR



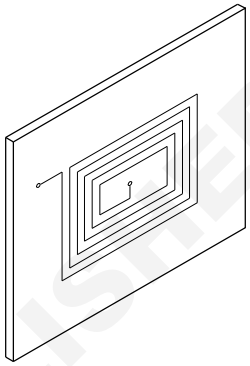
HIGH FREQUENCY INDUCTOR



SHIELDED INDUCTOR



TOROID FERRITE CORE INDUCTOR



PRINTED CIRCUIT INDUCTOR

TYPES OF INDUCTORS

ION1322H1

TASK 2: **Identify different capacitors and measure capacitance of various capacitors using LCR meter**

The instructor has to label the different types of capacitors used for this exercise.

1 Pick one of the labelled capacitor from the given lot.

2 Identify the type name and record it in Table 2.

3 Use DMM and ensure no short circuit or leakage in the capacitor for testing.

Note: Incase of short circuit in any capacitor, get a good capacitor as a relacement.

4 Refer the typographic code chart (Fig 2) for capacitors. Observe and record the Capacitance value of the capacitor.

5 Prepare LCR meter and connect the capacitor, observe and measure the capacitor value and record in Table 2.

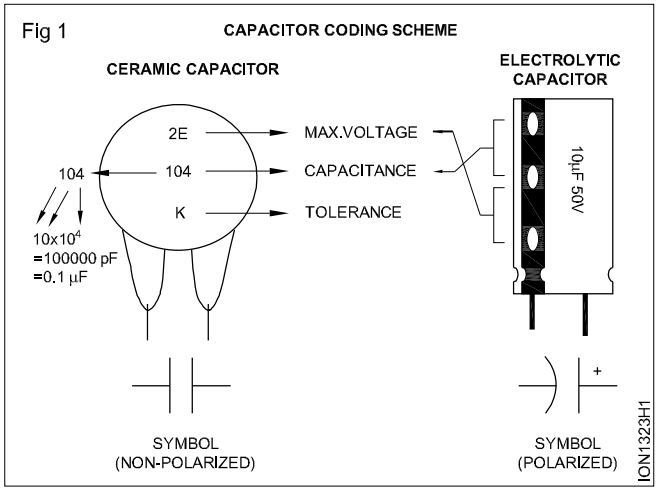
6 Repeat steps-2 to 4 for remaining capacitors and record in Table 2.

7 Get the work checked by the Instructor.

Table 2

Label No.	Type of Capacitor	Capacitor value code	Capacitor value	Capacitor value by measuring LCR meter
1				
2				
3				
4				

Fig 1 CAPACITOR CODING SCHEME



Capacitor Conversion Values

Microfarads (µF)		Nanofarads (nF)		Picofarads (pF)
0.000001 µF	↔	0.001 nF	↔	1 pF
0.00001 µF	↔	0.01 nF	↔	10 pF
0.0001 µF	↔	0.1 nF	↔	100 pF
0.001 µF	↔	1 nF	↔	1,000 pF
0.01 µF	↔	10 nF	↔	10,000 pF
0.1 µF	↔	100 nF	↔	100,000 pF
1 µF	↔	1,000 nF	↔	1,000,000 pF
10 µF	↔	10,000 nF	↔	10,000,000 pF
100 µF	↔	100,000 nF	↔	100,000,000 pF

Tolerance

Code	Percentage
B	±0.1 pF
C	±0.25 pF
D	±0.5 pF
F	±1%

Code	Percentage
G	±2%
H	±3%
J	±5%
K	±10%
M	±20%
Z	±80%, - 20%

Max.Operating voltage

Code	Max.Voltage
1H	50V
2A	100V
2T	150V
2D	200V
2E	250V
2G	400V
2J	630V

— — — — — — — —

Identify and test the circuit breaker and other protective devices (Fuse)

Objectives: At the end of this exercise you shall be able to
- **identify the terminals of Miniature Circuit Breaker (MCB) and ELCB**
- **connect the protective devices in electrical circuit and check the operation.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- Digital multimeter with probes - 1 No.
- Electrical Loads - 5 Nos.
- Single Phase Motor/1HP/240V/50Hz - 1 No.
- M.I. Ammeter 0-10A - 1 No.

Materials/Components

- MCB, Single pole, 240V/6A - 1 No.
- Push to ON - push button switch - 2 Nos.
- ELCB or RCCB - 40A - single phase 2 pole (ELCB + RCCB) - 1 No.
- Wire wound resistor 5KΩ/5W - 1 No.
- Connecting wires - 5 m
- SPST Switch, 240V/15A - 1 No
- Rheostat, 1000 ohm/5A sliding type - 2 Nos.
- 60W/240V test lamp - 1set.

The Instructor has to provide the details/manufacturer's specifications about the MCB and ELCB or RCCB used for this exercise.

PROCEDURE

TASK 1: **Identification of terminals of MCB**

1 Observe the construction, identify the supply and load terminals, single pole MCB and draw outline diagrams note down them in Table 1.

2 Check the continuity between source and load terminals by keeping MCB in OFF position using ohmmeter and record your observation in Table 1.

3 Put the switch in ON position and check the continuity between source and load terminals of MCB and record your observation.

4 Repeat the above steps for ELCB and record observation in Table 1.

Table 1

	MCB	ELCB
Make		
Model/Type		
Code No		
Current rating		
Voltage rating		

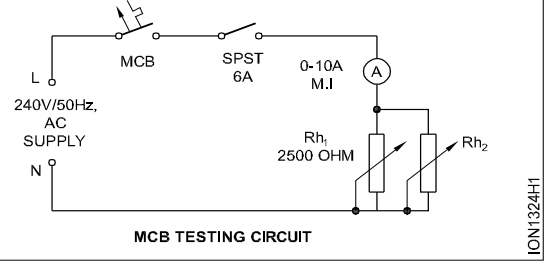
5 Get the work checked by the Instructor.

TASK 2: **Testing of MCB operation in electrical circuit**

1 Collect the MCB and other required items, check their good working condition.

2 Connect the circuit elements as per the circuit diagram shown in Fig 1.

Fig 1



MCB TESTING CIRCUIT

3 Keep both the Rheostats in maximum resistance position before switching ON supply.

4 Keep the MCB in ON condition and switch ON the AC mains power supply.

5 Close the SPST switch observe the current flow and record readings in Table 2.

6 Decrease one of rheostat gradually and note down the readings of the ammeter in Table 2 and continue the process by increasing the load current till the MCB trips.

7 Note down the value of current at which the circuit breaker trips and verify the rated current of the MCB.

Position	Resistance Between Source and Load Terminal	
	MCB	ELCB
OFF		
ON		

Table 2

Sl.No	Load current	MCB status
1	0.5 A	
2	1.0 A	
3	2.0 A	
4	5.0 A	
5	6.0 A	
6	MCB trips at	Amp

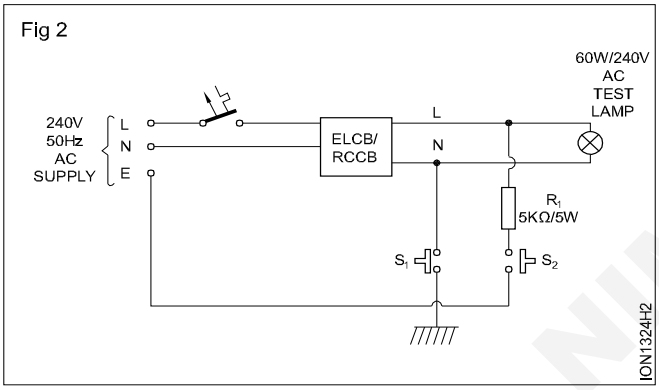
8 Get the work checked by the Instructor.

— — — — — — — —

TASK 3: **Testing of ELCB/RCCB operation in electrical circuit**

1 Collect the ELCB/RCCB and other required items, check and connect the as per the circuit diagram shown in Fig 2.

Fig 2



2 Keep the MCB in OFF position, connect 240V AC mains supply to the circuit.

3 Switch ON the MCB for the lamp to glow, press the push button switch S1 and observe the ELCB/RCCB trips OFF (confirming the earth leakage detention.)

4 Record your onservations on Table 3.

5 Reset the ELCB/RCCB, for the lamp to glow, press the push button S2 and observe the ELCB/RCCB trips OFF (confirming the earth leakage detention).

6 Record your observation on Table 3.

Table 3

Sl. No.	MCB / Switch position	ELCB / PCCB ON / OFF	Lamp glowing / OFF
1	MCB OFF	ON	OFF
2	MCB ON		
3	S1 OFF		
4	S1 ON		
5	S2 OFF		
6	S2 ON		

7 Get the work checked by the Instructor.

— — — — — — — —

Test step-up, step-down, isolation transformer

Objectives: At the end of this exercise you shall be able to
- **identify different types of transformer by ohm meter measurements**
- **test different types of transformer in AC circuits.**

Requirements

Tools/Equipments/Instruments

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

Variac 0 - 270V/5A single phase - 1 No.

Materials/Components

- Step down transformer - 240V/0-12V/1A - 1 No.
- Step down transformer - 240V/0-6V/500mA - 1 No.
- Isolation transformer 1kVA - 1 No.
- Single phase connecting wires 1.5 sq.mm - 2 m.
- Insulation tape - as reqd.

Note: The Instructor has to arrange the details/specifications of step-down, step-up and ioslation transformers with label numbers and identification tags for primary and secondary windings securely.

PROCEDURE

TASK 1: **Identfication of transformer type step-up transformer and isolation**

1 Take one of the labelled transformer from the given lot. Enter its label number in Table 1.

2 Identify the type of the transformer, rated voltage and record details in the Table 1.

3 Determine the primary and secondary winding by measuring resistance with the ohm meter/multimeter/ DMM and record it in Table 1.

4 Draw the symbol of each transformer in Table 1.

5 Repeat steps-2 to steps-4 for the remaining transformers.

6 Get the work checked by the Instructor.

Table 1

Label No.	Name of the Transformer	Voltage rating		Measured Resistance value		Type/shape of core	Symbol
		Primary	Secondary	Primary	Secondary		

— — — — — — — —

TASK 2: **Testing the step-down transformer in AC circuit**

1 Collect all the items required, test their good working condition and connect them as per the curcuit diagram as shown in Fig 1.

2 Connect AC mains supply adjust the variac dial pointer at 180V position.

3 Switch ON the S1, observe output voltage and record itin Table 2.

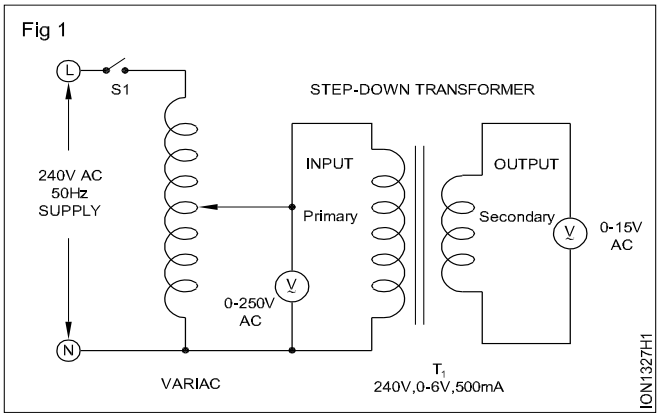
4 Increase the variac output in steps of 20V and repeat step 3 upto 240V and record the readings in Table 2.

Table 2

Sl.No	Input	Output
1	180 V	
2	200 V	
3	220 V	
4	240 V	

5 Get the work checked by the instructor.

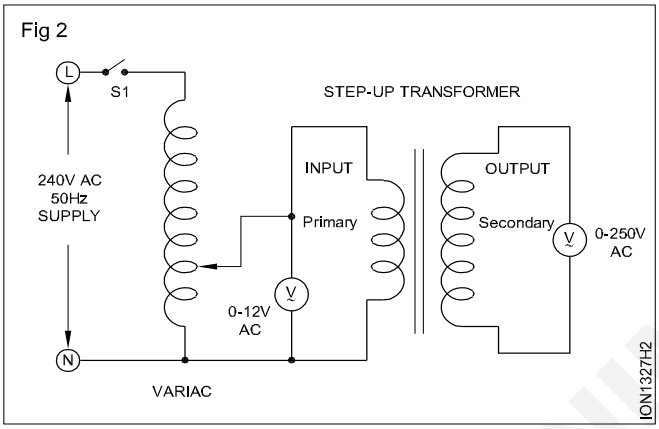
Fig 1



TASK 3: **Testing the step-up transfor in AC circuit**

1 Repeat step 1 of Task 2 with circuit diagram shown in Fig 2.

Fig 2



Note: The Instructor may use the 240V/0 - 12V/ 1A transformer if a step-up transformer is not readily avaliable for this task with the following guide lines:

i Connect the 0-12V/1A winding to act as primary with maximum limit of 12V AC supply through variac.

ii Connect the AC voltmeter across the other winding of the transformer to measure the stepped up voltage.

2 Ensure that the winding of step-up transformer is correctly connected and verfied by the instructor.

3 Connect AC mains supply, adjust the variac dial pointer to 9V AC position.

4 Switch ON the S1, observe the output voltage and record it in Table 3.

5 Increase the variac voltage in step of 1V and repeat above step 4 upto 12V.

Table 3

Sl.No	Input	Output
1	9 V	
2	10 V	
3	11 V	
4	12 V	

6 Get the work checked by the instructor.

TASK 4: **Testing the isolation transformer in AC circuit**

1 Repeat step 1 of Task 2 with circuit diagram shown in Fig 3.

2 Connect AC mains supply, adjust the variac dial pointer at 100V position.

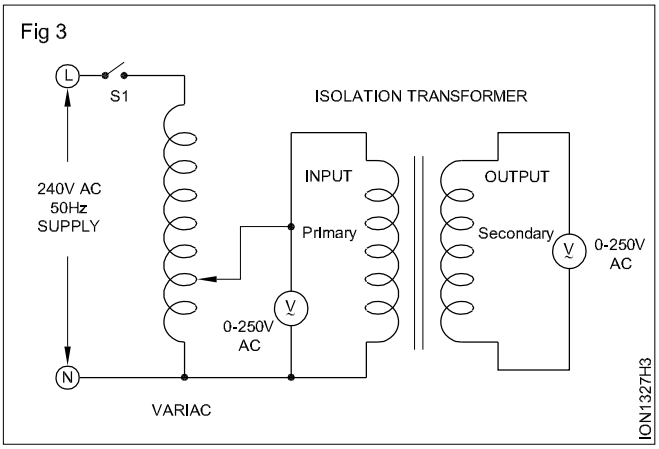
3 Switch ON the S1, observe the output voltage and record it in Table 4.

4 Increase the variac voltage in step of 40V and repeat above step 3 upto 220V and record the readings.

Table 4

Sl.No	Input	Output
1	100 V	
2	140 V	
3	180 V	
4	220 V	

Fig 3



6 Get the work checked by the instructor.

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

Objectives: At the end of this exercise you shall be able to
- **identify available ranges in the given multimeter**
- **measure voltage and current of DC supply**
- **measure voltage and current of AC supply**
- **measure resistance (continuity) of a switch.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- DC Regulated Power Supply 0-30V/2A - 1 No.
- Auto transformer, 0-270V/1A - 1 No.
- Digital multimeter with probes - 1 Set.

Materials/Components

- Battery 1.5V, AA Size - 1 No.
- Lead-acid battery, 12 V - 1 No.
- Assorted value of resistors - 5 Nos.

PROCEDURE

TASK 1: **Study on Multi-meter**

1 In the given multi-meter, check the available ranges scales and other information and record these details in Table -1.

2 Check the symbol on meter indicating its placement position. In the case of analog multimeter, carryout mechanical zero setting of the meter.

3 Connect the meter probes ensuring proper colour of probes at meter terminals.

Table 1

a Name of the given multimeter & model number.

b Manufacturer name.

c List of input socket available on the meter.

d List the available measuring ranges and scale marking on the meter.

Table 1

DC Voltage		AC Voltage	
Range No.	**Voltage Range**	**Range No.**	**Voltage Range**

DC Current		AC Current	
Range No.	**Current Range**	**Range No.**	**Current Range**

Resistance Ranges:

Range No.	Ohms Range

— — — — — — — —

TASK 2: **Measurement of DC voltage**

1 Set the meter range switch to measure cell voltages and choose the scale for taking readings. Record the chosen range position and scale in Table 2.

2 Measure and record the voltage of cell & battery in Table 2.

3 Set the meter range to measure the unknown DC voltage from the regulated DC power supply (RPS).

4 Measure the output voltage of RPS. Change the set range if necessary to measure the set RPS voltage more accurately. Record the measured voltage in Table 2.

Table 2: DC Voltage measurement

Sl.No.	Source of DC Voltage	Label Marked set voltage	Measured voltage
1	AA size battery		
2	Battery, 12V/9V		
3	RPSU output		

— — — — — — — —

TASK 3: **Measurement DC current**

1 Set the multimeter to measure an unknown DC current.

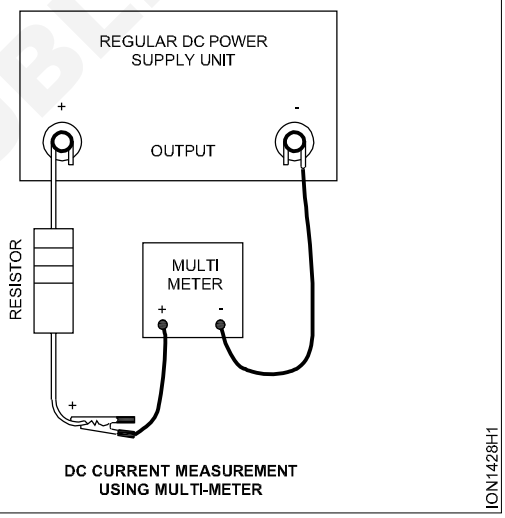
2 Connect the meter terminals as shown in Fig 1.

3 Measure and record the readings shown by the meter in Table 3.

4 Change the set range if necessary to measure the current more accurately.

5 Change the resistor value and measure different current values in Table 3.

Fig 1



DC CURRENT MEASUREMENT USING MULTI-METER

Table 3: DC Current Measurement

Sl.No	Set current range	Measured current
1		
2		
3		

— — — — — — — —

TASK 4: **Measurement of AC voltage**

1 Set the multi-meter to measure higher AC voltage.

2 Connect the meter terminal to a variable AC source (Auto-transformer).

3 Measure and record the readings shown by the meter in Table-4. Change the set range if necessary to measure the voltage more accurately.

4 Change the set value of AC voltage and repeat step-1 to step-3.

Table 4: AC voltage measurement

Sl.No	Set voltage range	Measured voltage
1		
2		
3		

— — — — — — — —

TASK 5: **Measurement of AC current**

1 Set the multi-meter to measure an unknown AC current.

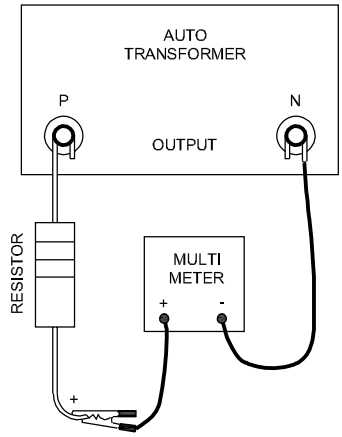
2 Connect an Auto-transformer to the supply source and set the output voltage to 50V, AC.

3 Connect the meter terminals as shown in Fig 2.

4 Measure and record the readings shown by the meter in Table 5. Change the set range if necessary to measure the current more accurately.

5 Change the resistor value and measure different current values in Table 5.

Fig 2



AC CURRENT MEASUREMENT
USING MULTI-METER

ION1428H2

Table 5: AC current measurement

Sl.No	Set current range	Measured current
1		
2		
3		
4		
5		
6		
7		
8		

TASK 6: **Measurement of resistance of a switch**

1 Set the multi-meter to continuity range.

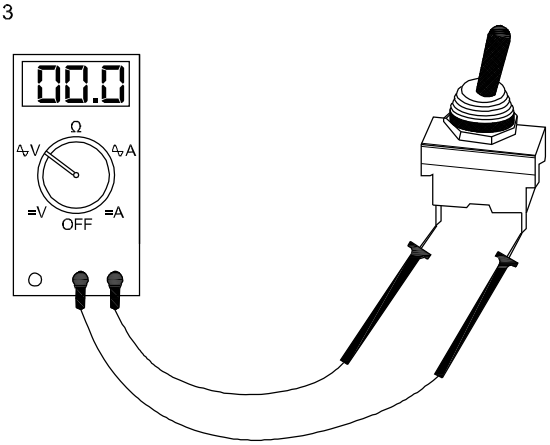
2 Check the switch under both two condition.

3 In one position, the meter shows zero reading and gives sound that means the switch is in ON position.

4 In another position, the meter shows 1 at the left side of the display that is high resistance and the switch is in OFF position.

5 Record the observations in the Table 6.

Fig 3



ION1428H3

Table 6: Measurement of resistance of a switch

Sl.No	Condition of switch	Resistance
1	ON	
2	OFF	

Identify the different controls on the digital storage oscilloscope front panel and observe the function of each control

Objectives: At the end of this exercise you shall be able to
- **identify different controls on the front panel of a DSO**
- **operate the front panel controls on the DSO.**

Requirements

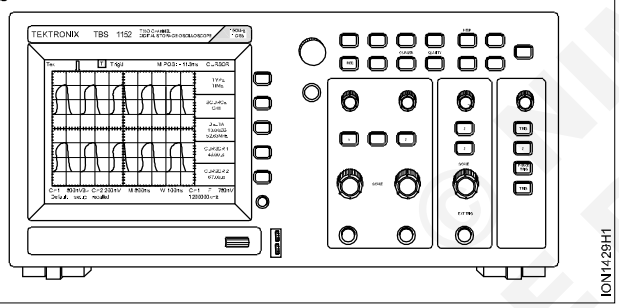
Tools/Equipments/Instruments

• DSO	- 1 No.
• Manual	- 1 No.

PROCEDURE

The Fig 1 shows the front panel of a digital storage oscilloscope for 2-channel models. Here TDS 2002 tektronix oscilloscope as taken as reference. Other DSO will also have the same features. If it differs from this, you may refer manual to understand the functions.

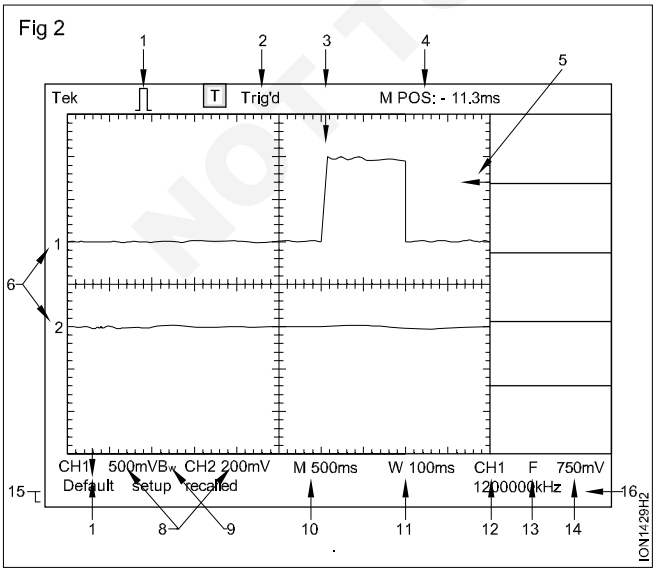
Fig 1



Display Area

In addition to displaying waveforms, the display is filled with many details about the waveform and the oscilloscope control settings. (refer Fig 2)

Fig 2



1 Icon display shows acquisition mode.

Sample mode

Peak detect mode

Average mode

2 Trigger status indicates the following:

Armed : The oscilloscope is acquiring pretrigger data. All triggers are ignored in this state.

Ready: All pretrigger data has been acquired and the oscilloscope is ready to accept a trigger.

Trig'd: The oscilloscope has seen a trigger and is acquiring the post trigger data.

Stop: The oscilloscope has stopped acquiring waveform data.

Acq. Complete : The oscilloscope has completed a single sequence acquisition.

Auto: The oscilloscope is in auto mode and is acquiring waveforms in the absence of triggers.

Scan: The oscilloscope is acquiring and displaying waveform data continuously in scan mode.

3 Marker shows horizontal trigger position. Turn the HORIZONTAL POSITION knob to adjust the position of the marker.

4 Readout shows the time at the center graticule. The trigger time is zero.

5 Marker shows Edge or Pulse Width trigger level.

6 On-screen markers show the ground reference points of the displayed waveforms. If there is no marker, the channel is not displayed.

7 An arrow icon indicates that the waveform is inverted.

8 Readouts shows the vertical scale factors of the channels.

9 A BW icon indicates that the channel is bandwidth limited.

10 Readout shows main time base setting

11 Readout shows window time base setting if it is in use.

12 Readout shows trigger source used for triggering.

13 Icon shows selected trigger type as follows


Edge trigger for the rising edge


Edge trigger for the falling edge


Video trigger for line sync.


Video trigger for field sync.


Pulse width trigger, positive polarity.


Pulse width trigger, negative polarity.

14 Readout shows Edge or Pulse Width trigger level.

15 Display area shows helpful messages; some messages display for only three seconds.

16 Readout shows trigger frequency

Message Area

The oscilloscope displays a message area (item number 15 in the previous figure) at the bottom of the screen that conveys the following types of helpful information:

1 Directions to access another menu, such as when you push the TRIG MENU button:

For TRIGGER HOLDOFF, go to HORIZONTAL Menu.

2 Suggestion of what you might want to do next, such as when you push the MEASURE button:

Push an option button to change its measurement.

3 Information about the action the oscilloscope performed, such as when you push the DEFAULT SETUP button:

Default setup recalled.

4 Information about the waveform, such as when you push the AUTOSET button:

Square wave or pulse detected on CH1.

Using the Menu System

The oscilloscope uses four methods to display menu options:

1 **Page (Submenu) Selection:** For some menus, you can use the top option button to choose two or three submenus. Each time you push the top button, the options change. For example, when you push the top button in the SAVE/REC Menu, the oscilloscope cycles through the Setups and Waveforms submenus.

2 **Circular List:** The oscilloscope sets the parameter to a different value each time you push the option button. For example, you can push the CH 1 MENU button and then push the top option button to cycle through the Vertical (channel) Coupling options.

3 **Action:** The oscilloscope displays the type of action that will immediately occur when you push an Action option button. For example, when you push the DISPLAY Menu button and then push the Contrast Increase option button, the oscilloscope changes the contrast immediately.

4 **Radio:** The oscilloscope uses a different button for each option. The currently-selected option is highlighted. For example, the oscilloscope displays various acquisition mode options when you push the ACQUIRE Menu button. To select an option, push the corresponding button.

Vertical Controls

CH 1, CH 2, Cursor 1 and Cursor 2 position: Positions the waveform vertically. When you display and use cursors, an LED lights to indicate the alternative function of the knobs to move the cursors.

CH 1 & CH 2 Menu: Displays the vertical menu selections and toggles the display of the channel waveform on and off.

VOLTS/DIV (CH 1 & CH 2): Selects calibrated scale factors.

Horizontal Controls

HORI MENU: Displays the Horizontal Menu.

SET TO ZERO: Sets the horizontal position to zero.

SEC/DIV: Selects the horizontal time/div (scale factor) for the main or the window time base. When Window Zone is enabled, it changes the width of the window zone by changing the window time base.

Trigger Controls

LEVEL and USER SELECT: When you use an Edge trigger, the primary function of the LEVEL knob is to set the amplitude level the signal must cross to cause an acquisition. You can also use the knob to perform USER SELECT alternative functions. The LED lights below the knob to indicate an alternative function

TRIG MENU: Displays the Trigger Menu.

SET TO 50%: The trigger level is set to the vertical midpoint between the peaks of the trigger signal.

FORCE TRIG: Completes an acquisition regardless of an adequate trigger signal. This button has no effect if the acquisition is already stopped.

TRIG VIEW: Displays the trigger waveform in place of the channel waveform while the TRIG VIEW button is held down. You can use this to see how the trigger settings affect the trigger signal, such as trigger coupling.

Menu and Control Buttons

SAVE/RECALL: Displays the Save/Recall Menu for setups and waveforms.

MEASURE: Displays the automated measurements menu.

ACQUIRE: Displays the Acquire Menu.

DISPLAY: Displays the Display Menu.

CURSOR: Displays the Cursor Menu. Vertical Position controls adjust cursor position while displaying the Cursor Menu and the cursors are activated. Cursors remain displayed (unless the Type option is set to off) after leaving the Cursor Menu but are not adjustable.

UTILITY: Displays the Utility Menu.

HELP: Displays the Help Menu.

DEFAULT SETUP: Recalls the factory setup.

AUTOSET: Automatically sets the oscilloscope controls to produce a usable display of the input signals.

SINGLE SEQ: Acquires a single waveform and then stops.

RUN/STOP: Continuously acquires waveforms or stops the acquisition.

PRINT: Starts print operations..

Connectors

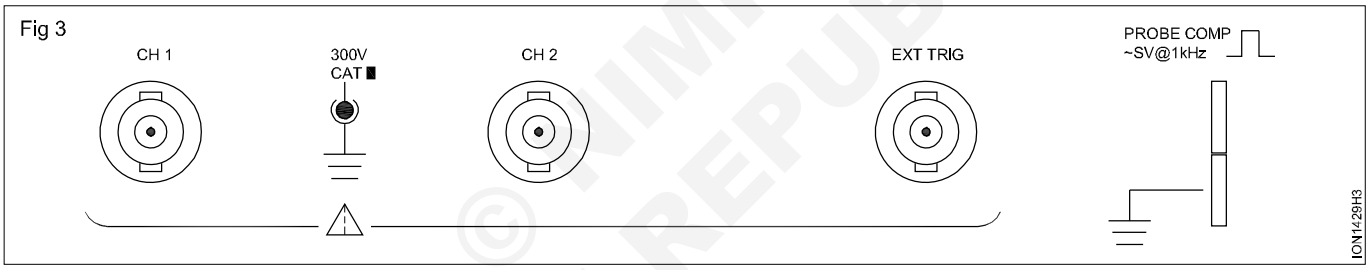
PROBE COMP: Voltage probe compensation output and ground. Use to electrically match the probe to the oscilloscope input circuit. Refer to ex no 1. The probe compensation ground and BNC shields connect to earth ground and are considered to be ground terminals

CAUTION : If you connect a voltage source to a ground terminal, you may damage the oscilloscope or the circuit under test. To avoid this, do not connect a voltage source to any ground terminals.

CH 1, CH 2: Input connectors for waveform display. (Fig 3)

EXT TRIG: Input connector for an external trigger source. Use the Trigger Menu to select the Ext or INT trigger source

Fig 3



Measure DC voltage, AC voltage, time period, sine wave parameters using DSO

Objectives: At the end of this exercise you shall be able to
- **measure the time, frequency and amplitude of a square/ rectangular waveform**
- **measure the time, frequency and amplitude of a sine waveform**
- **measure the time, frequency and amplitude of a two signals to compare the phase shift.**

Requirements

Tools/Equipments/Instruments

- DSO with instruction manual and probe kit - 1 No.
- Analog trainer kit with manual - 1 No.
- Signal generator with manual - 1 No.

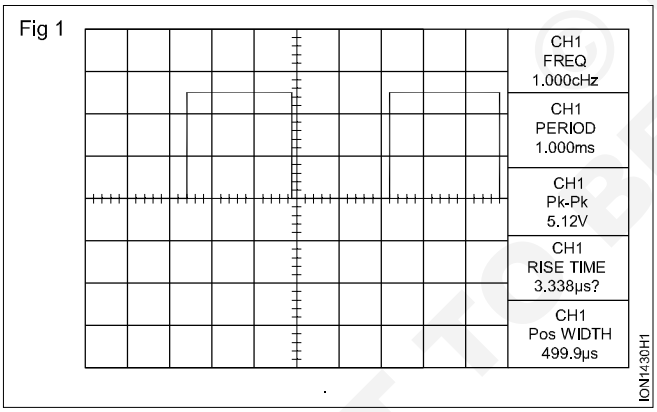
PROCEDURE

TASK 1: **Taking Automatic Measurements of square wave forms**

The oscilloscope can take automatic measurements of most displayed signals, to measure signal frequency, period, and peak-to-peak amplitude. The following steps may be followed.

1 Connect a signal generator to a DSO and switch on the DSO and signal generator. Set signal generator frequency at 1kHz and amplitude at 5V as in Fig 1.

Fig 1



2 Push the **MEASURE** button to see the Measure Menu.

3 Push the top option button; the **Measure 1** Menu appears. Push the Type option button and select Freq. The Value readout displays the measurement and updates.

NOTE: If a question mark (?) displays in the Value readout, turn the VOLTS/DIV knob for the appropriate channel to increase the sensitivity or change the SEC/DIV setting.

4 Push the **Back** option button.

5 Push the second option button from the top; the **Measure 2** Menu appears.

6 Push the Type option button and select **Period**. The Value readout displays the measurement and updates.

7 Push the **Back** option button.

8 Push the middle option button; the **Measure 3** Menu appears.

9 Push the Type option button and select Pk-Pk. The Value readout displays the measurement and updates.(*Pk-Pk= Peak - Peak)

10 Push the **Back** option button.

11 Push the second option button from the bottom; the **Measure 4** Menu appears.

12 Push the Type option button and select **Rise Time**. The Value readout displays the measurement and updates.

13 Push the **Back** option button.

14 Push the bottom option button; the **Measure 5** Menu appears.

15 Push the Type option button and select PosWidth. The Value readout displays the measurement and updates.

16 Push the **Back** option button.

17 Repeat steps 2 to 15 by varying amplitude and frequency.

18 The steps 2 to 11 may be followed by connecting other type of waveforms (sine wave and triangular wave).

TASK 2: **Measure the time, frequency and amplitude of a two signals to compare the phase shift**

To activate and display the signals connected to channel 1 and to channel 2,

1 Construct the amplifier as shown in Fig 2 using the trainer kit. If trainer kit is not available in the lab, construct the circuit using discrete components on breadboard/PCB.

2 Connect two oscilloscope channels to the amplifier input and output as shown.

3 If the channels are not displayed, push the **CH 1 MENU** and **CH 2 MENU** buttons.

4 Push the **AUTOSET** button.

5 Push the Measure button to see the **Measure Menu**

Note: Any amplifier circuit may be used to perform this experiment.

6 Push the top option button; the **Measure 1** Menu appears.

7 Push the Source option button and select **CH1.**

8 Push the Type option button and select **Pk-Pk**.

9 Push the **Back** option button.

10 Push the second option button from the top; the **Measure 2** Menu appears

11 Push the Source option button and select **CH2.**

12 Push the Type option button and select **Pk-Pk**.

13 Push the **Back** option button

14 Read the displayed peak-to-peak amplitudes for both channels and observe the phase differences between the wave forms. It may appear as shown in Fig 2.

15 Vary the frequency and amplitude one by one and repeat the step 14 record your reading in the table 1.

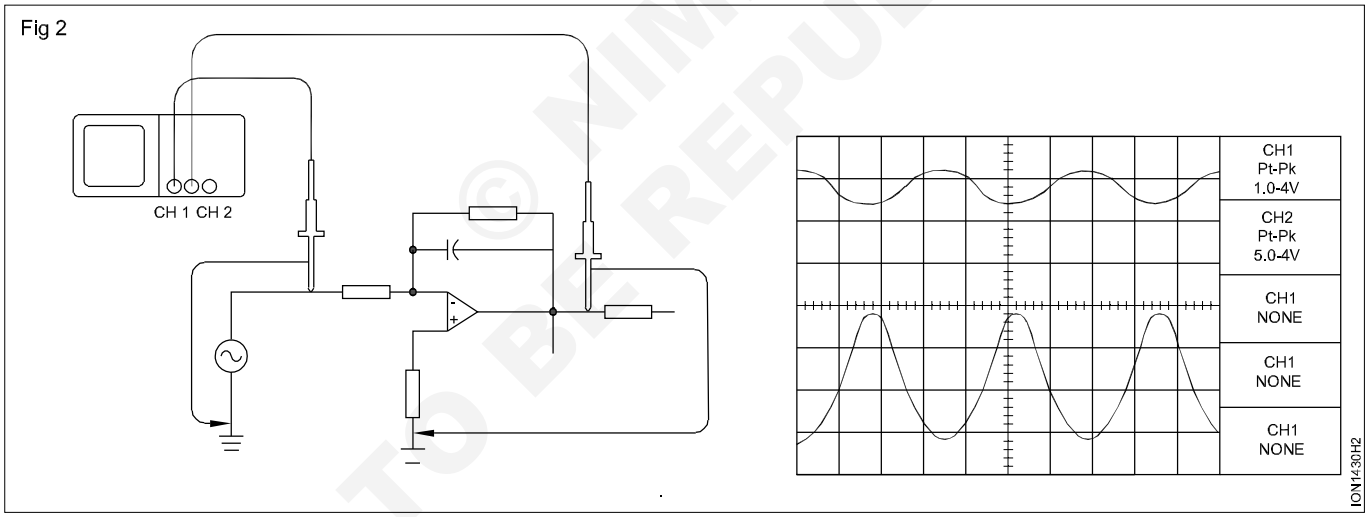
Table 1

Sl. No	Frequency	V_{in}	V_{out}	Gain=V_{out}/V_{in}

16 Performs step 15 till you can read the values thoroughly.

17 Get the work checked by the instructor.

Fig 2



TASK 3: **Measure the Ring Frequency**

1 To measure the ring frequency at the rising edge of a signal, push the CURSOR button to see the Cursor Menu as in Fig 3.

2 Push the Type option button and select Time.

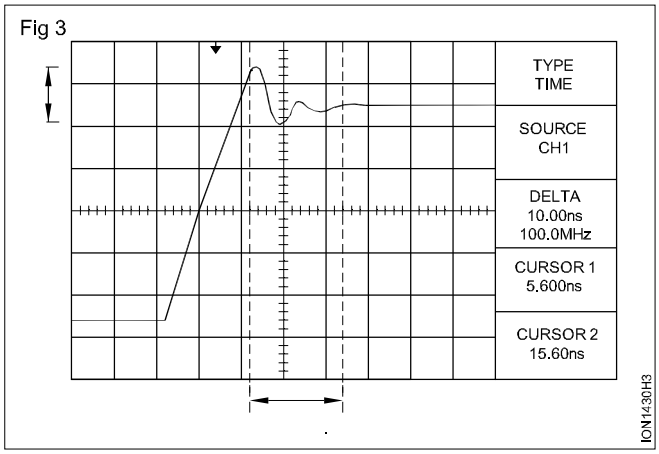
3 Push the Source option button and select CH1.

4 Turn the CURSOR 1 knob to place a cursor on the first peak of the ring.

5 Turn the CURSOR 2 knob to place a cursor on the second peak of the ring.

6 Observe that the delta time and frequency (the measured ring frequency) in the Cursor Menu.

Fig 3



TASK 4: **Measure the ring amplitude**

1 To measure the amplitude of the ringing. To measure the amplitude, push the CURSOR button to see the Cursor Menu as in Fig 4.

2 Push the Type option button and select Voltage.

3 Push the Source option button and select CH1.3.

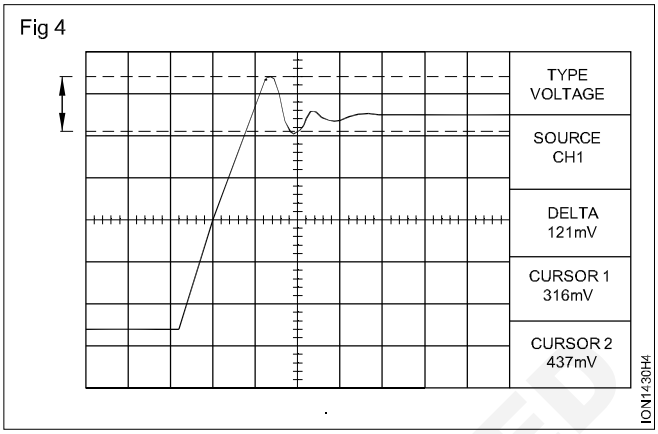
4 Turn the CURSOR 1 knob to place a cursor on the highest peak of the ring.

5 Turn the CURSOR 2 knob to place a cursor on the lowest point of the ring.

6 You can see the following measurements in the Cursor Menu:

- The delta voltage (peak-to-peak voltage of the ringing)
- The voltage at Cursor 1.
- The voltage at Cursor 2

Fig 4



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TASK 5 : **Measure the pulse width**

1 To measure the width of a pulse using the time cursors, push the CURSOR button to see the Cursor Menu as in Fig 4.

2 LEDs light under the VERTICAL POSITION knobs to indicate the alternative CURSOR 1 and CURSOR 2 functions

3 Push the Source option button and select CH1.

4 Push the Type option button and select Time.

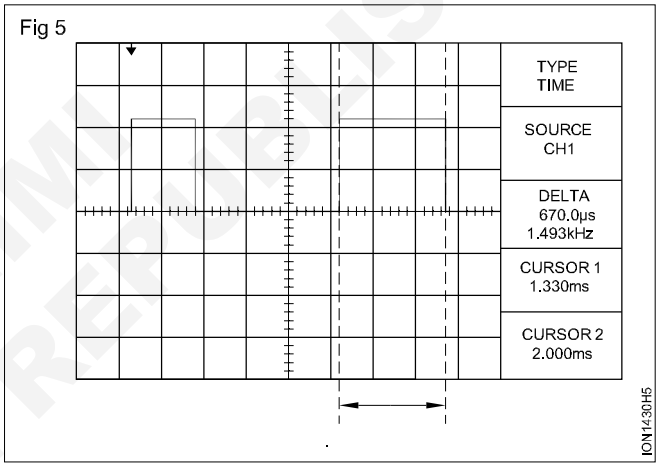
5 Turn the CURSOR 1 knob to place a cursor on the rising edge of the pulse.

6 Turn the CURSOR 2 knob to place the remaining cursor on the falling edge of the pulse.

7 Observe the following measurements in the Cursor Menu:

- The time at Cursor 1, relative to the trigger.
- The time at Cursor 2, relative to the trigger.
- The delta time, which is the pulse width measurement

Fig 5



Note:

The Positive Width measurement is available as an automatic measurement in the Measure Menu.

The Positive Width measurement also displays when you select the Single-Cycle Square option in the AUTOSET.

— — — — — — — —

TASK 6: **Measuring rise time**

1 Turn the SEC/DIV knob to display the rising edge of the waveform.

2 Turn the VOLTS/DIV and VERTICAL POSITION knobs to set the waveform amplitude to about five divisions.

3 Push the CH 1 MENU button to see the CH1 Menu if it is not displayed.

4 Push the Volts/Div option button and select Fine.

5 Turn the VOLTS/DIV knob to set the waveform amplitude to exactly five divisions..

6 Turn the VERTICAL POSITION knob to center the waveform position the baseline of the waveform 2.5 divisions below the center graticule.

7 Push the CURSOR button to see the Cursor Menu.

8 Push the Type option button and select Time.

9 Turn the CURSOR 1 knob to place the cursor at the point where the waveform crosses the second graticule line below center screen. This is the 10% level of the waveform as in Fig 5.

10 Turn the CURSOR 2 knob to place the second cursor at the point where the waveform crosses the second graticule line above center screen. This is the 90% level of the waveform.

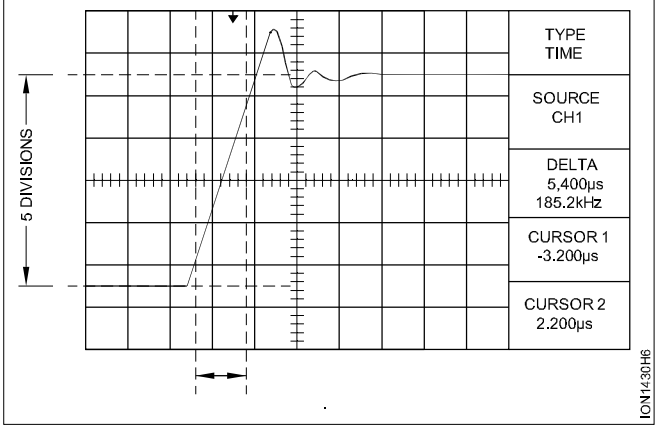
11 The Delta readout in the Cursor Menu is the rise time of the waveform.

Note :

The Rise Time measurement is available as an automatic measurement in the Measure Menu.

The Rise Time measurement also displays when you select the Rising Edge option in the AUTOSET Menu.

Fig 6



Identify and use different mathematical functions add, subtract, multiply, differentiate, intergrate, AND, OR of DSO on the observed signal

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

- **use DSO for mathematical functions of addition, subtraction, multiplication and observe the resultant signal on the screen**
- **use DSO for mathematical functions of differentiate, integrate and observe the resultant signal on the screen**
- **use DSO for logical operation of AND, OR functions.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- DSO - 100 MHz with users manual and probe kit - 1 Set.
- Function generator (1 MHz) with user manual as cables - 1 No.
- BNC to BNC cables - as reqd.

Note:

1 **The Instructor has to go through the user manual of the DSO in the Lab, and operate the controls number of times conducting the demonstration of mathematical function exercise to trainees.**

2 **Make probe compensation for both probes before performing the math operation; otherwise differences in probe will appear as error in the differential signal.**

3 **The Instructor may suitably modify the preocedural steps which is different to the make/model of the DSO available in the lab.**

PROCEDURE

TASK 1: **Performaing the mathematical functions Addition, Subtraction and Multiplication**

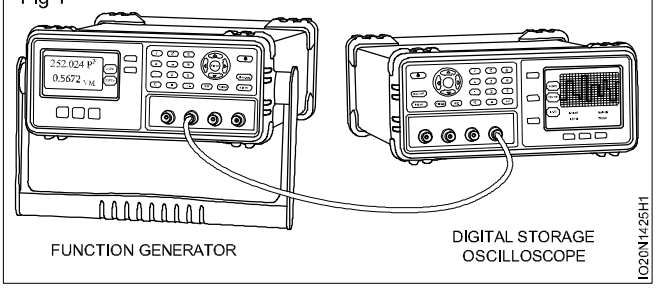
1 Collect all the rrequired items, check and ensure that they are in good condition.

2 Connect the internal AFG signal output to the channel-1 input of DSO with 50Hz/5Vp-p square wave using BNC to BNC cable.

3 Power ON the DSO and wait for a couple of minutes for the oscilloscope to self teat and initialize; observe the square wave on the display in yellow (the dedicated colour for channel-1).

4 Connect the output of function generator to channel-2 of DSO using BNC to BNC cable as shown in Fig 1.

Fig 1



5 Switch ON the function generator with sie wave 50Hz 5Vpeak to peak to channel-2 and observe the waveform in Blue (dedicated colour for chennel-2).

6 Press Math button on the DSO front panel and notice the lighted buttons for active status.

7 Observe the screen for the display of WAVEFORM MATH MENU, press the soft key below the letters and move your fingers to soft keys vertically arranged on the right side of the display.

8 Identify and press the soft key operate for the desired Math function setting on the screen.

9 Select the Addition function (A+B) by using the soft key.

10 Observe the resultant waveform appear in Red colour.

11 Record your observations in the Table 1 and get it checked by the instructor.

12 Press the soft kay for the mathematical operator for suntraction (A-B) function and repeat steps 10 and 11.

13 Switch the soft key for Multiplication function and repeat steps 10 and 11.

Table 1

Sl. No.	Mathematical Function	Ch-1 Waveform	Frequency / Amplitude	Ch-2 Waveform	Frequency / Amplitude	Resultant Waveform	Amplitude
1	Additional						
2	Subtraction						
3	Multiplication						

14 Interchange the signals to channel-1 and channel-2 and observe the resulats for each mathematical functions; get your work checked by the instructor.

— — — — — — — —

TASK 2: **Performaing the Differentiate and Integrate functions**

1 Repeat steps 1 to 5 of Task-1 above.

2 Press **Math** button on the front panel of DSO and observe the **Waveform Mathemenu** displayed at the bottom of screen.

3 Press the soft key below that **Waveform Mathmenu** display for **d/dt** function to differentiate.

4 Press the **Source** soft key for the d/dt function (The source can be any analog channel, ot math functions 1+2, 1-2 and 1*2).

5 Press the **Scale** soft key for vertical scale factor for d/dt expressed in Units/seconds/division. (Where units can be Volts, ampere or Watts).

Note: Use the Offset softkey if you want to change the source, scaling or offset for the differentiate function.

6 Observe the resulatant d/dt function waveform appear in Red colour and record your observation in Table 2.

7 Press the soft key for ∫dt function to integrate.

8 Press the **Source** soft key for the ∫dt function (The source can be any analog channel, or Math function 1+2, 1-2 and 1*2).

9 Press the **Scale** soft key for the vertical scale factor for ∫dt expressed in units/seconds/division (where unts can be Volts, Ampere or Watts).

Note: Offset soft key lets you set your own offset for the ∫vdt math function. After pressing the Offset soft key, turn the Entry knob to change the offset for ∫dt. The integrate calculation is relative to the source signal's offset.

10 Observe the resulatant ∫dt function waveform appear in Red colour and record your observations in Table 2.

Table 2

Sl. No.	Mathematical Function	Ch-1 Waveform	Amplitude	Ch-2 Waveform	Resultant Waveform	Remarks Offset
1	Differentiate					
2	Integrate					

11 Get your work checked by the instructor.

— — — — — — — —

TASK 3: **Performing logical operation of AND, OR functions**

1 Repeat steps 1 to 5 of Task-1 above.

2 Press **Math** button and use Math Operator soft key; select the **A&&B** AND operation function.

3 Press the **Source A** and **Source B** to select Channel-1 and Channel-2 (You can alternatively apply the signals to channel-3 and channel-4 to change the order also possible)

4 Press the **Offset** button and use ↻ multifunction knobs to adjust the vertical offset of the operation result.

5 Press **Scale** and use ↻ knob to adjust the vertical scale of the operation result.

6 Press **Scale Result** automatic adjustment of vertical scale for the current configuration.

7 Press **Tre. A** button and use ↻ knob to set the threshold of source A in logic operation.

8 Press **Tre. B** button and use ↻ knob to set the thershold of source B in logic operation.

9 Press **Option** button to set the start point, end point ot turn ON or OFF the inverted display of operation results.

10 Press **Start** to set the start point of the operation result.

11 Press **End** to set the end point of the operation result.

12 Press **Invert** to turn the inverted display of the operation results ON or OFF.

13 Press **Sens.** to set the sensitivity of the digital signal converted from the analog signal on the analog signal source and the range availabe is 0 div. to 0.96 div.

14 Press **Auto scale** button to turn ON or OFF the auto scale function.

Note:

1 When 'ON' is selected, the DSO will adjust the vertical scale to the best valve according to the current configuration.

2 Horziontal Position and Scale can also be used to adjust the horizontal position and scale of the operation results.

15 Record your observations in Table 3.

16 Get the work checked by the instructor.

17 For OR operation, press the Math operator soft keyt; Select ''A || B".

18 Repeat steps 3 to 15 and get the work checked by the instructor.

Table 3

Sl. No.	Mathematical Function	Ch-1 Waveform	Amplitude	Ch-2 Waveform	Resultant Waveform	Remarks Offset
1	Differentiate					
2	Integrate					

Identify and use different acquisition modes of normal, average, persistence mode

Objectives: At the end of this exercise you shall be able to
- **identify different acquisition modes available in DSO**
- **use normal, average, peak and high resolution acquisition modes in DSO.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Digital Storage Oscilloscope-70 MHz (4 Channel) with user manual and probe kit - 1 set
- Function generator (upto 1 MHz) - 1 No.
- Digital Multimeter with probes - 1 No.
- BNC to BNC coaxial cable - 2 Nos
- BNC to probe tipwith spring loaded removable type cable - 1 No.

Note:

1 The instructor has to ensure that probe compensation has been correctly done before the commencement of this exercise and operate the controls of DSO with reference to the user manual.

2 In some models of DSO there are 5 different acquisition modes available. The instructor may modify the steps according to the model in the lab.

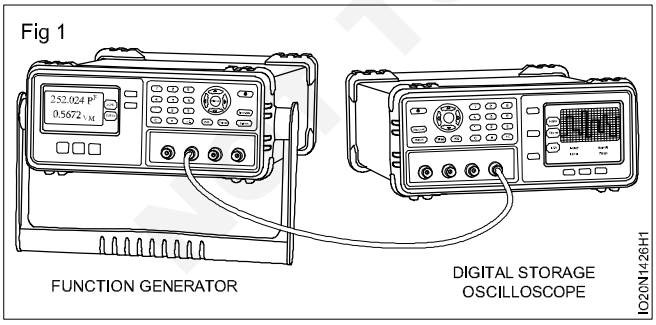
PROCEDURE

1 Collect all the required items, check and ensure that they are in good condition.

2 Connect the Function Generator output to the Ch-1 input of DSO using BNC to BNC coaxial cable as shown in Fig 1

[The oscilloscope probe consisting of a probe tip with spring loaded removable typeand BNC connector on either end of the coaxial cable also may be used for this connection]

Fig 1



3 Switch ON the AC mains supply to the FGandadjust it to 1kHz square wave with 3Vp-poutput.

4 Power ON the DSO and wait for the oscilloscope to self-test and initialize; press the Ch-1 menu key(Yellow)

5 Observe the square wave on the screen displayed in yellow colour and labels at the bottom of the display.[Note: Press the Auto scale button on the front panel to remove any settings made by the previous users of the instrument.]

6 Press the coupling soft key, adjust the position control knob of Ch-1 aligned with the major horizontal axis.

7 Re-adjust the Trigger level control for a stable waveform if necessary.

8 Press the Acquire button on the front panel and observe the corresponding display at right side edge of the screen.

9 Identify the acquisition mode selection Soft key; the default setting is at Normal mode (In some models it tis SAMPLE mode)

10 Observe the waveform details like frequency, peak to peak amplitude, sampling rate, memory depth etc. and record your observation in Table 1.

11 Press the soft key and change the acquisition mode to Peak and repeat the above step 11.

12 Press the soft key and change the acquisition mode to High Resolution mode and repeat the above step 11.

13 Repeat the step 13 for Envelope and Averagemodes.

Table 1

Sl. No.	Acquisition mode	Frequency	Voltage peak to peak	Sampling rate	Memory depth	Waveform/ Remarks
1	Normal					
2	Peak					
3	High resolution					
4	Envelope					
5	Average					

14 Get the work checked by the Instructor.

— — — — — — — —

Practice soldering on different electronic components, small transformer and lugs

Objectives: At the end of this exercise you shall be able to
- **tin the ends of hookup/flexible wires/lug terminals**
- **solder different electronic components on lug terminals**
- **solder a small transformer on a general purpose PCB.**

Requirements

Tools/Equipments/Instruments

- Soldering iron 25W/240V - 1 No.
- Trainees tool kit - 1 Set.
- Cleaning brush, 1/2inch - 1 No.
- Step down transformer 240V/6V 300mA With flexible wire termination - 1 No.

Materials/Components

- Lug board (Code No.103-06-LB) - 1 No.
- Single strand wire(hook-up-wire) - 1 m.
- Solder wire 60/40 18 SWG - 25 gms.
- Soldering flux - as reqd.
- Gen purpose PCB (Type 107) - 1 No.
- Soldering iron stand - 1 No.
- Electronic components assorted items - as reqd.

Note: The instructor has to ensure that the trainees keep the soldering iron on its stand and no electrical leakage on its metal body;

Guide the trainees to keep the tip of thesoldering iron bit tinned.

PROCEDURE

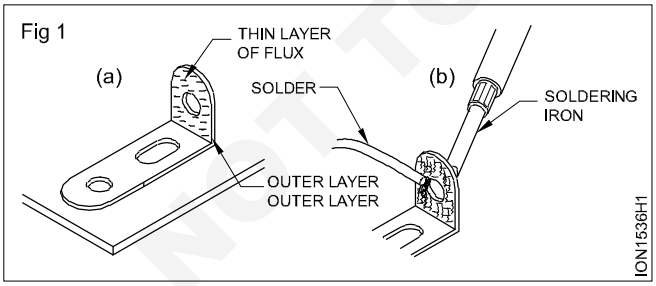
TASK 1: **Tinning the lug terminals**

1 Visually check the lug terminals on the lug board are clean and bright.

2 Scrape the dirt/oxide layer on both sides of the lug terminal using a knife and clean all the lug terminals on the lug board.

3 Apply a thin layer of flux on the face of lug terminal as shown in Fig 1a.

Fig 1



Note: Properly tinned tip of the soldering iron bit is in bright shining, silvery colour; The molten solder on the tip of soldering iron is essential for efficient transfer of heat for soldering or desoldering process.

4 Touch the lug by molten solder on the bit of soldering iron at the lug no.1 as shown in Fig 1b.

5 Hold the tip of solder wire at the outer face of the lug as shown in Fig 1b.

6 Take out the solder wire within 2 to 3 seconds time as the solder melts on the lug and take out the soldering iron tip from the lug.

7 Allow the molten solder to solidify over the lug.

Do not blow air to cool the solder on the lug.

9 Get the work checked by the Instructor.

— — — — — — — —

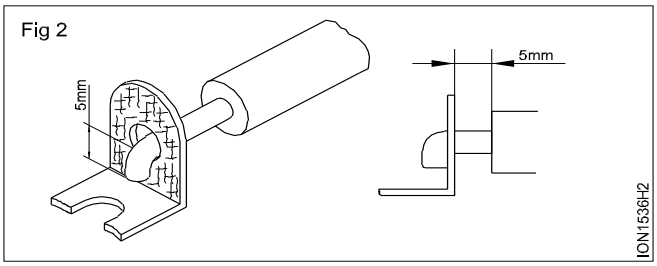
TASK 2: **Soldering of wire/electronic components on lug terminals**

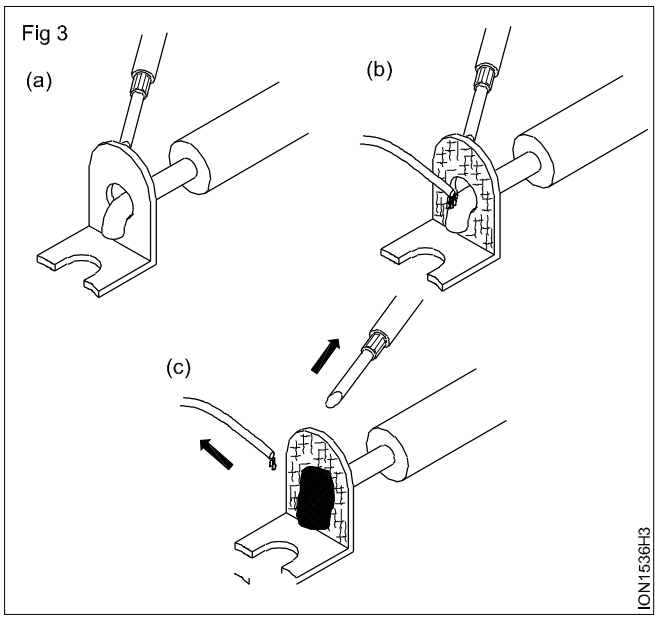
1 Mark 10 mm and skin the insulation at both ends of hook up wire piece.

2 Scrape the conductor using knife, apply flux and tin the conductor ends.

3 Insert and bend the tinned wire in lug 1 hole as shown in Fig 2. (side entry method).

4 Touch the lug by the molten solder on the bit of soldering iron a shown in Fig 3a and hold it for 2 seconds.





5 Apply the tip of solder wire on the lug; as the solder starts melting, take out the solder and within 2 to 3 seconds remove the soldering iron tip from the joint.

Precaution: Due care to be exercised with the hot soldering iron, molten/melting solder.

Keeping the soldering iron tip for more than 2-3 seconds will damage the insulation of the wire.

6 Allow the molten solder to solidify with the wire joined on the lug terminal.

7 Do not shake the wire till the soldered joint on the lug terminal becomes smooth and shiny.

8 Repeat the above steps for tinning all the lugs on the lug board.

9 Select the electronic component to be soldered on the lug terminal (Resistor/Diode).

10 Scrape/clean both ends of the component and tin them.

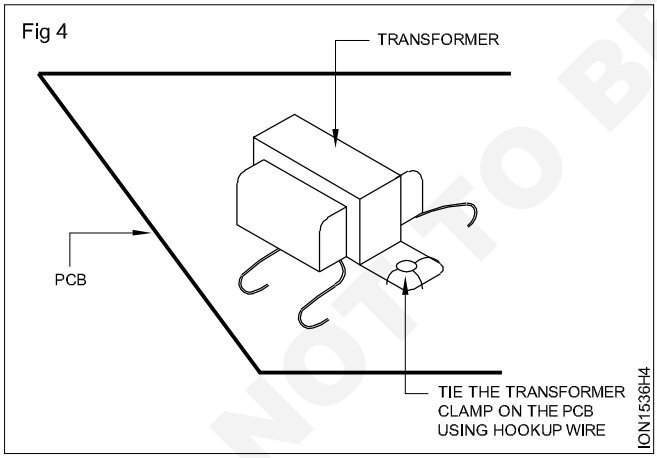
11 Insert the timed lead into lug terminal 2, as shown in Fig 2.

12 Repeat steps 4 to 7 for a smooth and shiny soldered joint.

13 Get the work checked by the Instructor.

TASK 3: **Soldering the transformer on PCB/Lug board**

1 Position the transformer on the component side of the general purpose PCB as shown in Fig 4 and tie it on PCB using hookup wire.



2 Mark 10 mm and skin the insulation at the end of wire; twist the bunch of multi stranded conductors into a single core and tin it.

3 Repeat the above step for all the wires on primary and secondary sides of the transformer.

4 Identify suitable points on the PCB for soldering the primary and secondary wires.

5 Insert the timed terminals at the identified points and solder them correctly.

6 Arrange the lead dress of wires neatly on the PCB after soldering work.

7 Get the work checked by the Instructor.

Follow steps in Task-2 to solder the transformer terminals to the lug board.

Practice soldering IC bases on PCBs

Objectives: At the end of this exercise you shall be able to
- **soldering IC bases on PCB**
- **inspect the soldered joints of IC bases on the PCB.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Soldering Iron, 25W - 1 No.
- Magnifier with lamp and crocodile clip fixture attachment - 1 No.

Materials/Components

- General Purpose PCBs (IC base fixing type) - 1 No.
- IC base (8 pin or 14 pin) - 1 No.
- Solder Wire 60/40 18 SWG - as reqd.
- Flux - as reqd.
- Soldering iron stand - 1 No.
- Desoldering Wick - as reqd.
- Soldering tip cleaning sponge - as reqd.
- Cleaning brush - 1 No.
- IPA solution - as reqd.

PROCEDURE

TASK 1: **Soldering the IC base on PCB**

1 Inspect the copper clad/solder side and component side of the selected PCB is suitable for soldering work.

2 Check all the pins of the IC base in correct shape as shown in Fig 1a & b.

Fig 1a

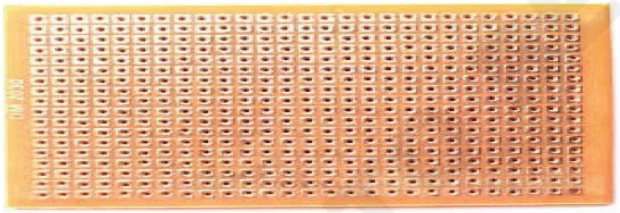
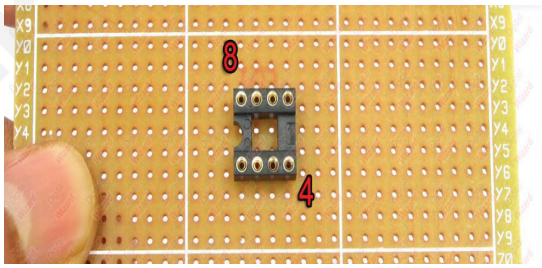


Fig 1b

3 Plan and decide the location on the PCB for the IC base soldering work.

4 Insert the IC base pins through the component side as shown in Fig 2 and press till it sits correctly on the PCB.

Fig 2



5 Prepare the soldering iron for soldering work; apply a small quantity of flux on each pin of the IC base.

6 Solder the pin no. 1 onto the pad quickly within 1 to 2 seconds time.

Safety precaution: Avoid over heating the PCB track/pad.

If the time taken to solder the pin is more, the heat produced by the soldering iron tip will make the pad/track to peel off the PCB damaged permanently.

7 Solder the remaining pins of the IC base quickly.

Caution: Do not apply more solder on the pin. Excessive solder may bridge the pads and short circuit them.

8 Clean the flux and other residue on the soldered pins using the IPA solution with cleaning brush.

9 Get the work checked by the Instructor.

TASK 2: **Inspection of soldered IC base pins**

1 Keep the soldered PCB under the magnifying lens using the crocodile clip fixture attachment as shown in Fig 3.

Fig 3

2 Switch ON the lamp, adjust the height of lens and observe the soldered pins with clarity.

3 Inspect the pins are soldered correctly and no excessive solder is bridging the pin connections/pads or tracks causing short circuit.

4 Desolder the excess solder if found bridging between pins/pads/tracks using soldering iron.

5 Clean the desoldered spot and inspect under the magnifier.

6 Ensure that all the pins of IC base is correctly soldered and no defect found.

7 Get the work checked by the Instructor.

— — — — — — — —

Practice soldering on various SMD components including SMD IC packages

Objectives: At the end of this exercise you shall be able to
- **setting the soldering work station for SMD components**
- **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/Components

- Rosin cored solder wire - as reqd.
- Flux pen/Liquid flux - as reqd.
- IPA cleaning solution - 1 bottle.
- Piece of medium density fiber board - 1 No.
- Crocodile clips holder - 2 Nos.
- Solder paste tube/syringe - 1 No.
- Cleaning brush - 1 No.

Precautions

1 **The instructor has to provide and guide the trainees to use ESD proof bins or trays to store the components.**

2 **Wear the ESD wrist strap to discharge the buildup of body static charge to ground.**

3 **Use the pencil bit for the soldering iron to solder the SMD IC on the PCB.**

4 **Select and fix the appropriate size of hot air nozzle suitable for the soldering work.**

PROCEDURE

TASK 1: **Setting the soldering station for SMD Component Soldering work**

Note: The Instructor has to ensure that all the controls/switches on the panel are kept in zero position before giving to trainees.

1 Select and fix the suitable bit/ tip onto the soldering iron for the SMD Component soldering work.

2 Select and fix appropriate size of hot air nozzle suitable for the soldering work.

3 Switch ON the soldering work station and set the temperature at 275°C.

4 Adjust the hot air pressure control knob to the mid position.

5 Test the soldering iron heat by keeping the solder wire on the tip for melting.

Note: At the time of soldering SMD components, the controls may be re-adjusted for required temperature/air pressure actually needed for the soldering work.

6 Record the settings control position, temperature observations on the Table 1.

7 Get the work checked by the Instructor and switch OFF the soldering workstation.

Table 1

Sl.No	Name of the Control/Switch	Setting/Position	Temperature/Air pressure	Remarks

TASK 2: **Soldering SMD components on the PCB using soldering workstation**

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 workbench.

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.

TASK 3: **Selecting the suitable PCB and soldering leaded SMD ICs and leadless SMD ICs**

1 Use the vacuum pen and pick the given leaded SMD IC for soldering work.

2 Check the pitch of the IC and select the suitable SMD PCB.

3 Place the selected SMD IC on the pads of the PCB.

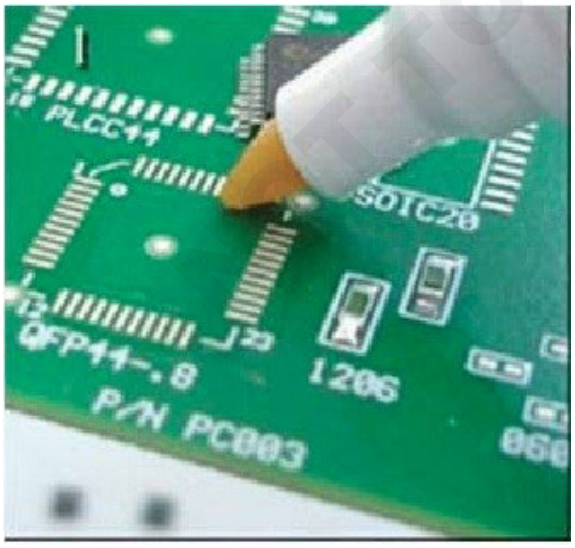
4 Get the work checked by the Instructor, label the PCB as 1 and keep it seperately.

5 Repeat above steps for the leadless SMD IC and label the PCB as 2 and keep it also seperately.

6 Switch ON the soldering workstation and set the temperature of the soldering iron in the range of 250° - 280°C.

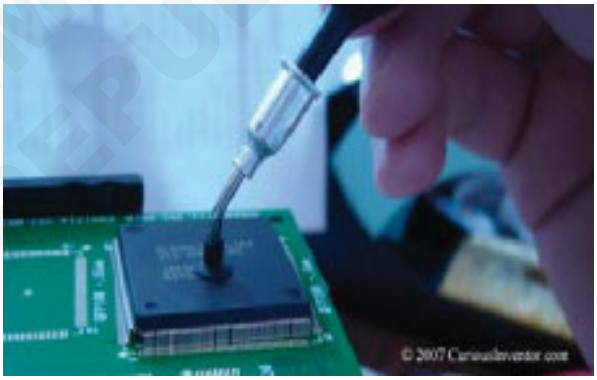
7 Apply the flux on the pads of PCB 1 as shown in the Fig 1.

Fig 1



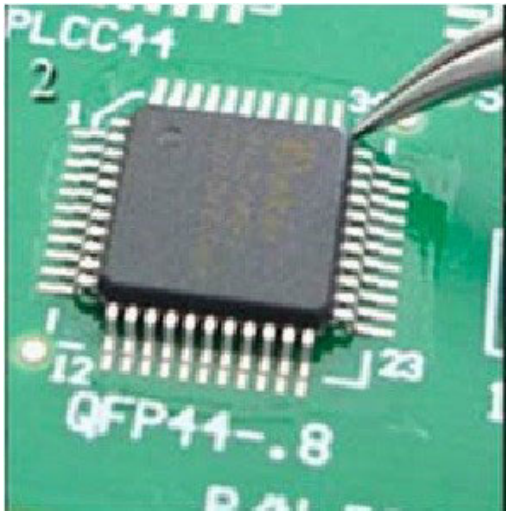
8 Identify the pin no 1 of the leaded SMD IC and pick the vacuum pen and of place it correctly on the pick pad as shown in Fig 2.

Fig 2



9 Align/adjust the chip as shown in Fig 3 using tweezers if necessary

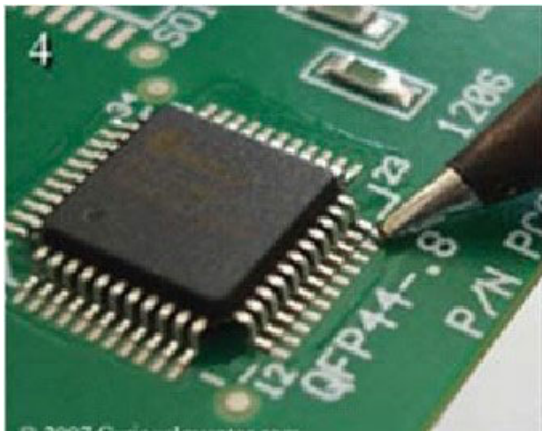
Fig 3



Caution: Once multiple pins are soldered, it's very difficult to make adjustments without removing the chip.

10 Use the soldering iron with a little solder on the tip solder the first pin of the IC as shown in Fig 4.

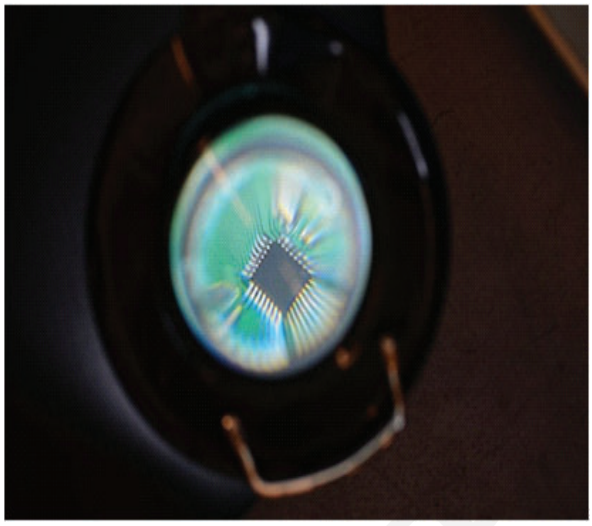
Fig 4



11 Check the alignment is correct through the magnifier as shown in Fig 5.

12 Solder the diagonal corner pin of the IC, recheck and confirm the alignment.

Fig 5



13 Apply the liquid flux over all the pins of the IC and solder the remaining pins.

14 Check IC terminals are perfectly soldered. If any solder bridges are formed remove them using solder wick.

15 Verify the solder joint using magnifier and clean the PCB with IPA solution.

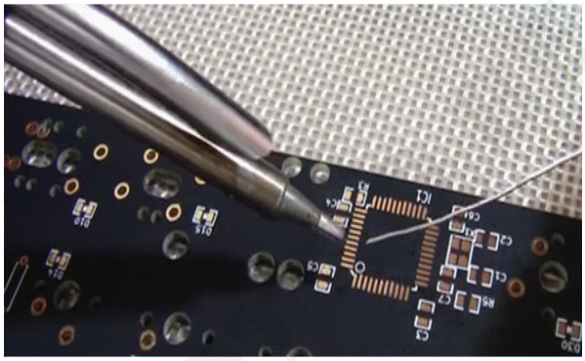
16 Get the work checked by the Instructor.

— — — — — — — —

TASK 3: **Soldering leaded SMD IC using soldering workstation hot air and solder paste**

1 Pick the SMD IC and the PCB-2 selected in Task 3; Identify the pin-1 mark on the land pattern of the PCB as shown in Fig 6.

Fig 6



2 Clean the solder pad with IPA solution and tin the 1st pin, diagonally opposite pin pads.

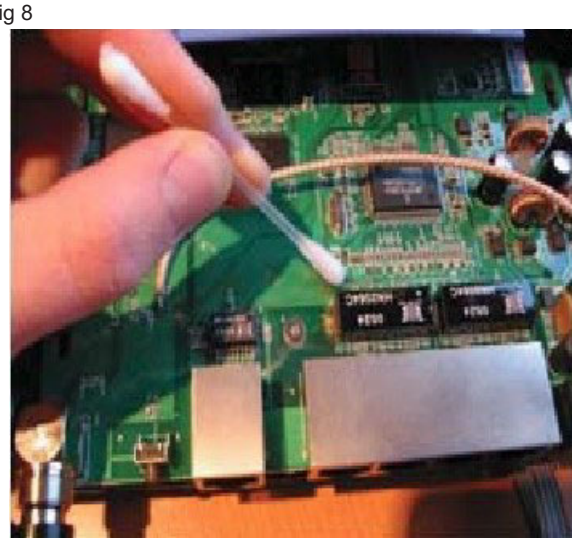
3 Use holding device with crocodile clips to fix the PCB firmly on the work bench as shown in Fig 7.

Fig 7

4 Switch ON the soldering workstation, adjust the temperature setting knob to 275°C.

5 Use the ESD safe tweezers and place the SMD IC on the pads of the PCB at its position correctly as shown in Fig 8.

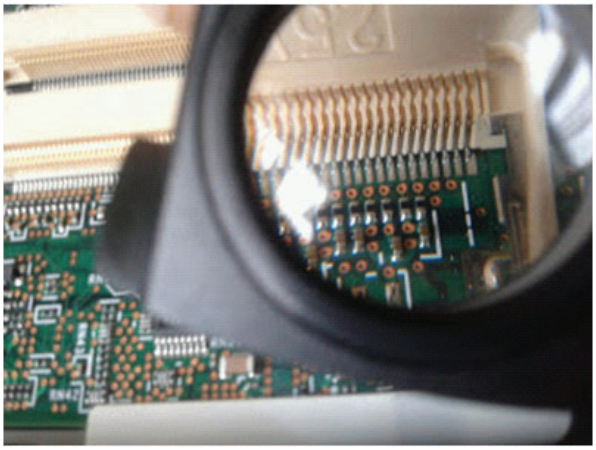
Fig 8



6 Hold the IC firmly and solder the pin-1 using pencil tip soldering iron and solder the diagonally opposite pin; switch OFF power.

7 Check the alignment using magnifier and confirm the SMD ICs correct position on the PCB as shown in Fig 9.

Fig 9



8 Apply the solder paste over the pins on all the four sides of the SMD IC.

9 Power ON the soldering workstation and adjust the air and temperature knobs to 280°C.

10 Apply the hot air nozzle over the SMD IC leads on all the four sides.

11 Keep the hot air nozzle moved around till the solder paste slowly melts and the solder joints formed on the pads of PCB.

Caution: To avoid damage do not keep the hot air nozzle over the device and adjacent components for a longer period of time and burning of the PCB. Don't blow air by mouth; it may cause dry solder.

12 Use magnifier and check all the pins of the SMD IC are correctly soldered to the pads on the PCB as shown in Fig 9.

Note: Solder the pins using soldering iron with pencil tip if needed.

13 Clean the soldered PCB using IPA solution with brush

14 Get the work checked by the Instructor

Repeat the above steps for various SMD IC packages like SOP, SSOP, TSOP, TSSOP, SOIC, SOT packages.

— — — — — — — —

Practice desoldering using pump and wick

Objectives: At the end of this exercise you shall be able to
- **desoldering components from PCB using desoldering pump**
- **desoldering component using desoldering wick.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Soldering iron, 25W - 1 No.
- Desoldering pump (plunger type) - 1 No.
- Heat sink plier - 1 No.

Materials/Components

- Desoldering wick - as reqd.
- Cleaning solution (IPA) - as reqd.
- Flux - as reqd.
- Cleaning Brush - 1 No.
- Safety goggles - 1 No.
- Crocodile clip - 1 No.
- Assembled PCB board for Desoldering work - as reqd.

Note: Check the correct functioning of desoldering pump by closing the nozzle and press the plunger; feel the air pressure. Keep the nozzle closed by a finger and release the button and feel the suction to conform correct working.

PROCEDURE

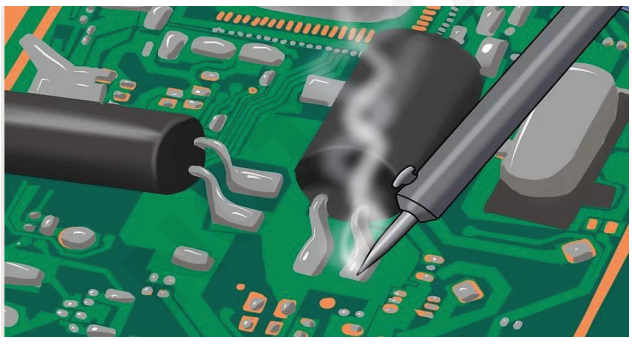
TASK 1: **Desoldering components from PCB using desoldering pump**

1 Clean the PCB using brush; locate the component to be desoldered fro the PCB as shown in Fig 1.

2 Mark the component lead soldered pad/track on the solder of PCB.

3 Prepare the soldering iron for desoldering work; touch the hot soldering iron top on the marked solder joint as shown in Fig 1.

Fig 1



4 Press the plunger, lock and hold the desoldering pump in left hand; keep the nozzle on the desoldering point, hold the desoldering pump firmly and release the button to suck the molten solder as shown in Fig 2 .

5 Empty the desoldering pump into the trash so that pump is ready for next desoldering ping. (Refer Fig 3)

6 Repeat steps 3 to 5 on the other marked point also to desolder the molten solder on the joint.

Fig 2

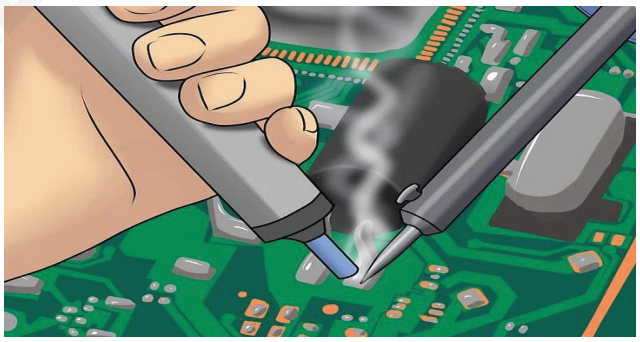
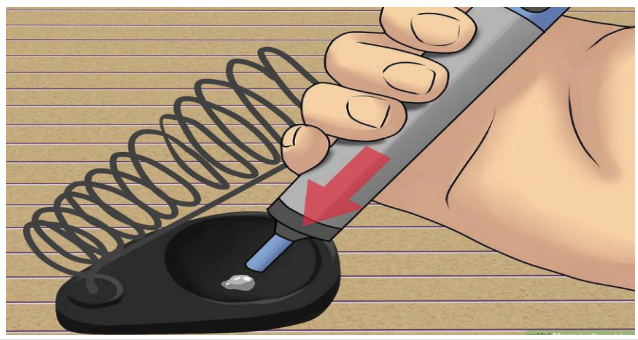


Fig 3



7 Visually inspect for leads of the component are free from the pad and pull the component from top side of PCB using crocodile clip.

8 Get the work checked by the Instructor.

TASK 2: **Desoldering components using desoldering wick**

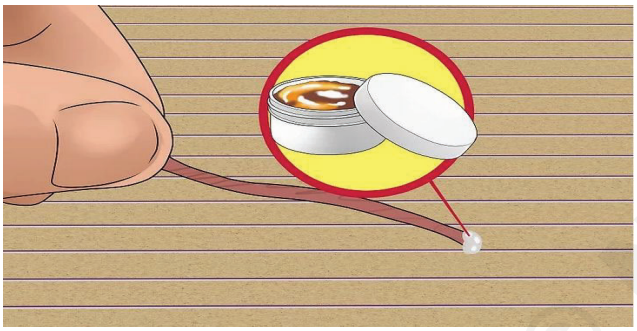
1 Follow the steps 1 to 3 of task 1.

2 Unwind few inches of solder wick from the coil as shown in Fig 4.

Fig 4

3 Dip the end of wick into the flux and make for a clean removal as shown in Fig 5.

Fig 5



4 Place the braid over the marked soldered joint as shown in Fig 6 for desoldering the component.

5 Place a hot soldering iron tip over the braid at the desired pin as shown in Fig 7 and allow the molten solder is absorbed by the desolder wick.

Fig 6

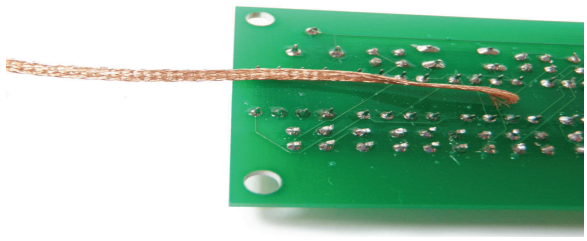
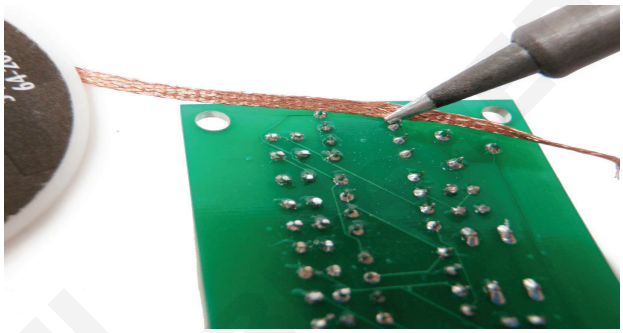


Fig 7



Safety precaution: Do not touch the hot solder wick; keep it away from the PCB.

6 Remove the soldering iron and the braid quickly from the PCB; discard the used portion of the wick.

7 Observe the pad/track on the PCB and ensure the component lead is desoldered from that point.

8 Repeat the above steps for other terminals of component to be desoldered/removed.

9 Clean the PCB using IPA solution with brush.

10 Get the work checked by the Instructor.

— — — — — — — —

Practice desoldering of SMD components using SMD hot air gun

Objectives: At the end of this exercise you shall be able to
- **make necessary settings on SMD soldering workstation for desoldering**
- **desolder the surface mount component using soldering workstation**
- **desolder the SMD IC using hot air gun.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Magnifier with lamp - 1 No.
- ESD table/Surface with wrist strap - 1 No.
- Soldering workstation/hot air temperature/flow controller (with instruction manual) - 1 Set.
- Digital Multimeter with probes - 1 No.

Materials/Components

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

Note: The Instructor has to ensure that the trainees are wearing the ESD strap before handling the electronic components the PCB.

The instructor may provide a portable stand/fixture with crocodile clips to hold the PCB during the desoldering work.

PROCEDURE

TASK 1: **Making necessary settings on the SMD soldering workstation desoldering using hot air gun**

1 Identify the SMD IC and components on the PCB/ assembled board.

2 Use magnifying glass and inspect the size of the soldered joints of the IC to be removed/ desoldered.

3 Select the appropriate blower tip/bit and fix it on to the soldering iron to be used for desoldering work as shown in Fig 1.

Fig 1

4 Apply solder flux over the SMD IC pins using the 5ml syringe as shown in Fig 2.

5 Use the fixure with crocodile clips as shown in Fig 3 to hold the board firmly on the workbench.

Fig 2

Fig 3

6 Switch ON the SMD soldering workstation, adjust the temperature setting knob to 275°C and keep the soldering iron ready for desoldering the SMD IC.

Note: The Instructor has to ensure that the masking of the other components using Kapton tape is done before starting the desoldering of SMD - IC.

7 Adjust and set the temperature and apply the hot air over the SMD - IC to be removed as shown in Fig 4.

Fig 4

8 Slowly try to insert the tweezers to lift from one side and remove the SMD - IC from the PCB as shown in Fig 5.

9 Clean the solder pads using, IPA solution with cotton buds/brush as shown in Fig 6.

10 Check the pad of the SMD - IC using magnifier lens and confirm no pad is damaged.

11 Get the work checked by the Instructor.

Fig 5

Fig 6

TASK 2: **Desolder the SMD components using soldering workstation hot air gun**

1 Collect the defective SMD circuit board from the Instructor and identify the components to be removed.

2 Inspect the size of the solder joints on the component to be removed using magnifying glass.

3 Apply a small quantity of the flux to the solder joint of the component to be removed.

4 Repeat steps 6,7 and 8 of Task 1 for desoldering SMD components form the PCB.

Note: To avoid thermal build up on the adjacent components, desolder the joints alternatively.

5 Clean the surface using IPA solution with brush.

6 Get the work checked by the instructor.

Join the broken PCB track and test

Objective: At the end of this exercise you shall be able to
- **repair the broken PCB track and test the continuity.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Soldering iron 25 watts/240 VAC - 1 No.
- Digital multimeter with probes - 1 No.

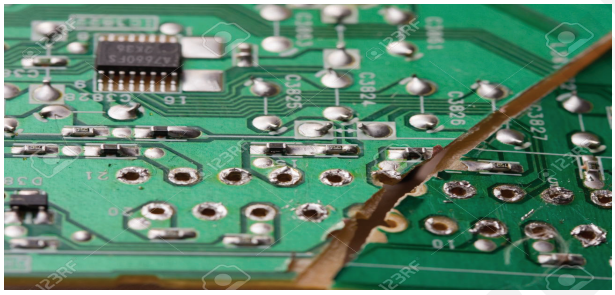
Materials/Components

- Tracks cut broken PCB - 1 No.
- Hook up wire - as reqd.
- Epoxy tube - 1 No.
- Emery cloth /paper - as reqd.
- Magnifying glass - 1 No.
- Solder flux - as reqd.
- Rosin cored solder 60/40 - as reqd.
- Cleaning brush - 1 No.
- IPA solution - as reqd.

PROCEDURE

1 Identify and inspect the edges of the broken track on PCB using magnifying glass as shown in (Fig 1).

Fig 1



2 Mix the Epoxy according to the manufacturer's instructions and apply a little quantity to one side of the PCB.

3 Position them correctly and Press the two halves of the broken PCB together and hold them until the epoxy sets hard.

Hold both ends together without shaking; the epoxy will set in a few seconds, but should wait for thirty minutes for hardening before proceeding to next step.

4 Scrape/clean the solder mask coating on the broken edges of PCB tracks to be joined.

Sand the ends of these traces until bright copper shows clearly.

5 Plug the soldering iron into mains socket and wait for a while to get ready for soldering work.

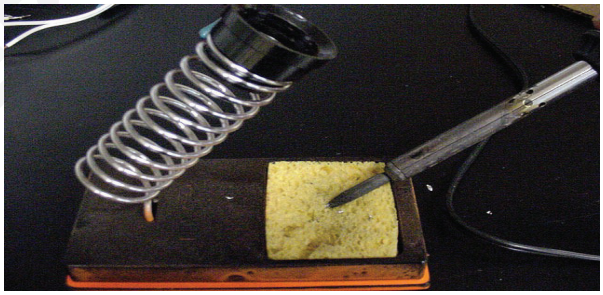
6 Cut a piece of hookup wire, take out the bare conductor; scrape it and tin the conductor.

7 Use tweezers and keep the tinned wire over the joined PCB track bridging both sides, solder it along the track.

8 Check the continuity of the repaired track on the PCB.

Precaution: Avoid bridging/shorting with the adjacent tracks/pads on the repaired PCB.

Fig 2



9 Inspect the repaired track using magnifying lens and also the continuity of track using DMM.

Apply appropriate heat to melt the solder. Too much heat will cause the copper pads/tracks to peel off the PCB.

10 Join the other tracks following above steps; finally clean the tracks on the PCB using IPA solution with brush.

11 Get the work checked by the Instructor.

Fig 3

Identification of 2,3,4 terminal SMD components, desolder the SMD components from given PCB

Objectives: At the end of this exercise you shall be able to
- **identifiy the 2,3,4 terminal SMD components**
- **decode the SMD components from the PCB following desolder wick and hot air methods.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- ESD table with wrist strap - 1 Set.
- Digital multimeter with probes - 1 No.
  Aids: SMD components chart - 1 No.
- Magnifier with lamp - 1 No
- SMD rework station with hot air nozzles/temperature/flow controller with Instruction Manual - 1 Set.

Materials/Components

- Assorted 2,3 & 4 terminal SMD components (Resistors capacitors, transistors, ICS) - as reqd.
- SMD data sheet - 1 No
- Magnifying glass - 1 No
- 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: **Identification of 2,3,4 terminal SMD components**

NOTE: The instructor has to provide different SMD resistors, capacitors, diodes, transistors.

SAFETY PRECAUTION: Wear the wrist strap and ensure that the ESD belt is properly grounded before touching any SMD components.

1 Identify 2,3 or 4 terminal SMD components from the assorted group of SMD components.

2 Separate the SMD components as per the number of terminals, i.e. 2,3 or 4 terminals.

3 Record the code marked on it in Table 1.

4 Identify the component & its value specifications using reference Chart 1.

5 Repeat the above steps for all the SMD components provided.

6 Get the work checked by the Instructor.

Table 1

Sl.No	No.of terminals	Code No. marking	Identified component	Remarks

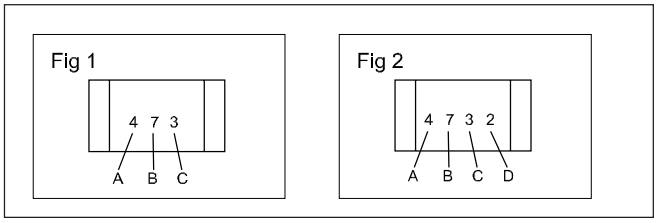
Chart 1

Shape and markings of some common SMDs

Component	Shape	Makings
Chip resistor		Labeled with value
Chip capacitor		Not marked
Diode		Cathode end marked with notch or band
SOT (Small outline Transistor)		May be marked, unmarked, or house numbered, pin one marked with beveled side, dot, band or notch

TASK 2: **Idenfification of value of SMD resister**

1 Pick one of the SMD resistor and refer to the (Figs 1&2) identify the coding marked on the component.



2 Decode the value refering to the Chart 2 & Chart 3.

3 Record the observations in Table 2.

Resistors are frequently marked with a three digit number and some typical values are shown in chart 2. The first two numbers are the significant digits of the value, and the last digit is the multiplier (the number of zeros to add to the first two digits). For example, a chip resistor labeled 102 has a value of 1000 Ohms, or 1k Ohms.

Marking on the SMD resistors

A = 1st digit of the resistors value

B = 2nd digit of the resistors value

C = number of zeros

Chart - 2

Code letters printed	Resistance value
101	100Ω
471	470Ω
102	1kΩ
122	1.2kΩ
103	10kΩ
123	12kΩ
104	100kΩ
124	120kΩ
474	470kΩ

Typical resistor markings and corresponding values

A = 1st digit of the resistor value

B = 2nd digit of the resistor value

C = 3rd digit of the resistor value

D = number of zeros

4 By using the above technique, find values of resistors for those components whose values are printed as below and record in Table 2.

Chart 3

Printed code letters	Resistance Value
100R	100Ω
634R	634Ω
909R	909Ω
1001	1kΩ
4701	4.7kΩ
1002	10kΩ
1502	15kΩ
5493	549kΩ
1004	1MΩ

Table - 2

Code letter printed	Resistance Value
102	--- Ω
470	--- Ω
103	--- Ω
222	--- Ω
101	--- Ω
232	--- Ω
333	--- Ω
1243	--- Ω
4743	--- Ω

— — — — — — — —

TASK 3: **Identification of SMD capacitors**

NOTE: Ceramic multilayer chip capacitors are available with a very wide range of values, from 0.47 pF to 1uF. These values are covered by seven cases forms. The forms depends on the capacitors values. The most popular case are 0805 and 1206.

PRECAUTION: Be very careful with non-marked components Avoid mixing them. SMD tantalum capacitors are available in different case forms, partly without printed values. The + polarity is marked by white line, or white "M". The case forms depend on capacitance value and nominal voltage.

1 Coding with digits

1 Pick one of the SMD capacitor, refer to the Fig. 3,4,5 & 6 and identify the type, coding marked on the capacitor.

2 Decode the values refering to Chart - 4 find the value.

3 Record the observed calculated value in Table 3.

4 Get the work checked by the instructor.

Example

Description “224” means 220 000 pF=220nF=0.22µF

2 Coding with alphanumerical characters

Chart 4

Capacitance pF	1	1.5	2.2	3.3	4.7	6.8
Code	A	E	J	N	S	W
Multiplicator	10^5	10^6	10^4	10^3	10^2	10^1
Code	5	6	4	3	2	1

Nominal voltage code (first digit from left)

Volt 4	6.3	10	16	20	25	35
Code G	J	A	C	D	E	V

Example 1

1 1.0 pF, 16V ... CA

2 2.2 pF, 6.3V ... JJ

Example 2

A6..... 1.0 x 10^6 pF=1..0 µF

J5..... 2.2 x 10^5 pF=0.22 µF

FJ6..... 2.2 x 10^6 pF=2.2 µF

Fig 3

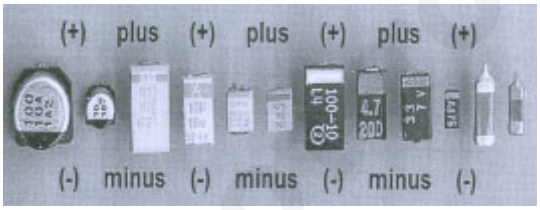


Fig 4

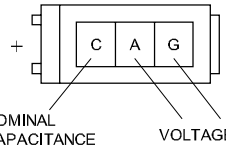


Fig 5

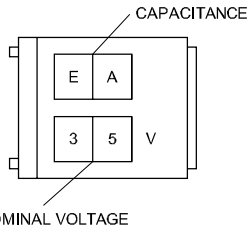


Fig 6

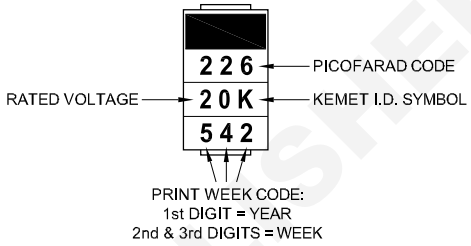


Table 3 - Capacitor Values

Package	**Code on capacitor SMD**	**Calculated Value**
		..... µF
		..... µF
		..... µF
		..... µF
		..... µF
		..... µF
		..... µF
		..... µF
		..... µF

— — — — — — — —

TASK 4: **Identification of SMD Diodes and Transistor**

1 Pick one of the SMD diode, from the sorted SMD components using marking provided on the surface.

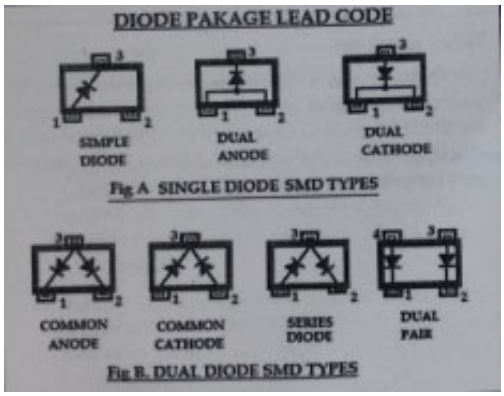
2 Refer Fig 7 and identify the type. Write down the code in Table 4.

Almost all standard diodes are available as SMD components in SOT-23, SOT-89 and SOT-143 cases, In general electrical parameters of SMD diodes are the sme as comparable standard types in coventional cases. SOT -23 and SOT - 143 cases are used for components with power dissipation 200 to 400 mW. SOT - 89 cases are used for power dissipation 500mW to 1W.

SMD LEDs are available in SOT - 23 cases.

By using above package types separate the diode and test it by using multimeter.

Fig 7



3 Select the diode testing mode on the digital multimeter, check the diode in forward and reverse directions.

4 Enter the observation on Table 4.

Table - 4

Sl.No.	Package Type	Forward Resistance Value	Reverse Resistance Value

5 Repeat the above steps for all the remaining diodes.

6 Get the work checked by the instructor.

7 Pick one of the SMD transistor and with the help of Fig 8 identify the terminals.

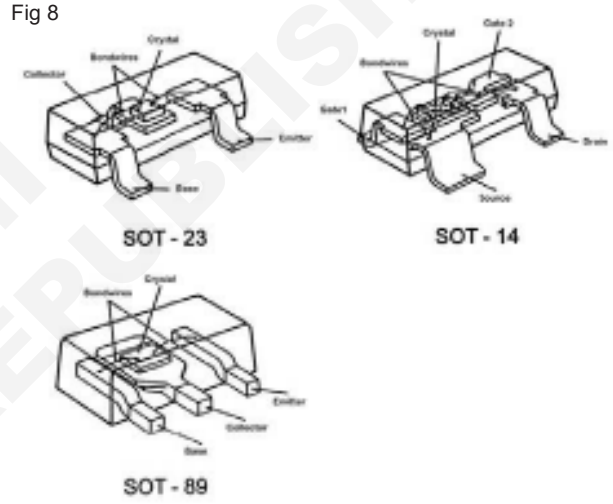
8 Record the package type and the observations in Table 5.

Table - 5.

Sl. No.	Package	Types of component	Test carried out	Remarks

9 Repeat the above steps for all the remaining, SMD transistors.

Fig 8



10 Get the work checked by the instructor.

TASK 5: **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 9.

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 10.

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

Fig 9

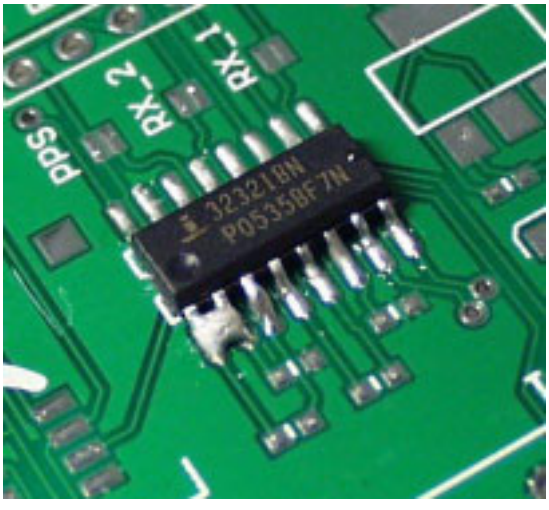
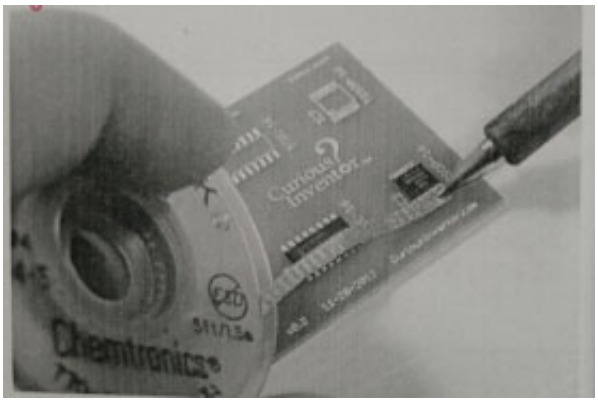


Fig 10



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 6: **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.

— — — — — — — —

Solder the SMD components in the same PCB, check for cold continuity of PCB

Objectives: At the end of this exercise you shall be able to
- **solder the SMD components on the PCB**
- **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.
- SMD soldering work station (hot air temperature/flow controller) with all accessories and instruction manual - 1 Set.
- Vacuum pick up tool - 1 No.

Materials/Components

- 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

TASK 1: **Soldering the SMD components on the PCB**

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.

— — — — — — — —

TASK 2: **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.

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				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

7 Get the work checked by the Instructor.

— — — — — — — —

Identification of loose / dry solder, broken tracks on printed wired assemblies

Objectives: At the end of this exercise you shall be able to
- **identify any loose/dry solder/broken tracks on the given circuit board**
- **record the observed defect/faults 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/Components

- Rosin cored solder and flux - as reqd.
- IPA cleaning solution - as reqd.
- Solder flux pen/liquid flux - as reqd.
- Cleaning brush - 1 No.
- jumper wire/multistranded flexible wire pieces - as reqd.

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 and identify any loose/dry soldered components.

4 Use magnifier and carefully observe for any broken tracks on the board.

5 Record the observations in Table 1.

6 Resolder the identified loose or dry-soldered component; use jumper wire and join the broken track.

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				

7 Get the work checked by the instructor.

— — — — — — — —

Identify various connections and setup required for SMD soldering station

Objectives: At the end of this exercise you shall be able to
- **identify various controls/ connections on the soldering work station**
- **prepare the soldering work station for soldering SMD components.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Digital multimeter with probes - 1 No.
- SMD Soldering workstation with all accessories and operating manual - 1 Set.

Aids: Chart showing panel controls of soldering workstation - 1 No.

Materials/Components

- Solder wire 60/40 rosin core - as reqd.
- Solder flux pen/liquid flux - as reqd.
- Cleaning brush - 1 No.

PROCEDURE

TASK 1: **Identification of Panel Controls/ Switches**

1 Refer to the operating manual Figs 1&2 Identify the front panel controls/switches on the soldering workstation, with reference to the operating manual.

Fig 1

Fig 2

2 Record the name of the control/switch and its function on the Table 1.

3 Identify the accessories used with the soldering workstation and record them in Table 1.

Table 1

Sl. No.	Name of the control/Switch/ accessory	Functions/Uses Specifications	Remarks

4 Get the work checked by the Instructor.

TASK 2: **Setting the soldering station for SMD Component Soldering work**

Note: The Instructor has to ensure that all the controls/switches on the panel are kept in zero position before given to trainees.

1 Select and fix the suitable bit/ tip onto the soldering iron for the SMD Component soldering work.

2 Select and fix appropriate size of hot air nozzle suitable for the soldering work.

3 Switch ON the soldering work station and set the temperature at 275°C.

4 Adjust the hot air pressure control knob to the mid position.

5 Test the soldering iron heat by keeping the solder wire on the tip for melting.

Note: At the time of soldering SMD components, the controls may be re-adjusted for required temperature/air pressure actually needed for the soldering work.

6 Record the settings control position, temperature observations on the Table 2.

7 Get the work checked by the Instructor and switch OFF the soldering workstation.

4 Refer to adjust controls on the trent the operating manual panel of the soldering workstation for 275° c temperature and record it in the Table 2 turn on soldering station.

6 Set proper tip temperature.

7 Now adjust the soldering workstation is ready to work for soldering / desolering.

8 Get the worm checked by the instructor Table 2.

Table 2

Sl.No	Name of the Control/Switch	Setting/Position	Temperature/Air pressure	Remarks

— — — — — — — —

Identify crimping tools for various IC packages

Objectives: At the end of this exercise you shall be able to
- **identify the crimping tools used for holding the ICs**
- **use the crimping tool during the soldering/desoldering processes of IC on the PCBs.**

Requirements

Tools/Equipments/Instruments

- Crimping tools - 1 Set
- 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.

Aids: Wall chart showing all the special tools used for the SMD IC soldering/ desoldering of SMD components - 1 No.

Materials/Components

- Rosin cored solder and flux - as reqd.
- IPA cleaning solution - as reqd.
- Solder flux pen/liquid flux - as reqd.
- Cleaning brush - 1 No.

PROCEDURE

Note:

1 **The Instructor has to label the tool utilized for this exercise.**

2 **Demonstrate the special tools used for the SMD components/ICs soldering/ desoldering in the SMD PCBs along with safety precautions to handle the special tools.**

3 **Provide some sample SMD PCBs for this exercise.**

1 Refer to the WallCharts showing all the special tools used for the SMD IC soldering/desoldering of SMD components as provided by the instructor and identify the name of the tool.

2 Record the observations on the Table 1.

3 Pick one of the labelled special tool displayed by the instructor in the table.

4 Use the tools, hold and grip SMD components ICs on the assembled PCBs.

5 Get the work checked by the instructor.

Table 1

Sl.No.	Label No	Name of the special tool	Use/application	Remarks

Make the necssary settings on the SMD soldering station to desolder various ICs of different packages (atleast four) by choosing proper crimping tools

Objectives: At the end of this exercise you shall be able to
- **make necessary settings on the SMD soldering workstation for desoldering of ICs (different packages)**
- **desolder SMD ICs using wicking braid method**
- **desolder SMD ICs using hot air method.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Crimping tools - 1 Set
- Magnifier with lamp - 1 No.
- Digital multimeter with probes - 1 No.
- SMD Soldering workstation with operating manual - 1 Set

Materials/Components

- Rosin cored solder and flux - as reqd.
- IPA cleaning solution - as reqd.
- Solder flux pen/liquid flux - as reqd.
- Cleaning brush - 1 No.

PROCEDURE

Note:

1 The instructor may use a portable stand/fixture with crocodile clips to hold the PCB during soldering/ desoldering work.

2 Guide the trainees to carryout this desoldering task with soldering iron/wicking braid or hot air for SMD IC assembled PCB given for this task.

TASK 1: **Making necessary settings on the SMD soldering workstation for desoldering of ICs (different Packages)**

1 Identify the SMD IC on the PCB/ assembled board.

2 Use magnifying glass and inspect the size of the soldered joints of the IC to be removed/ desoldered.

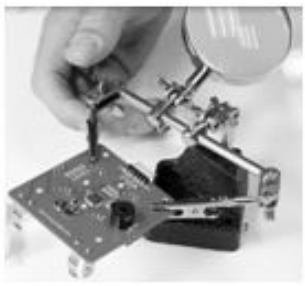
3 Select the appropriate tip/bit and fix it on to the soldering iron to be used for desoldering work.

4 Apply solder flux over the SMD IC pins using the 5ml syringe as shown in Fig 1.

Fig 1

5 Use the fixure with crocodile clips as shown in Fig 2 to hold the board firmly on the workbench.

Fig 2



6 Switch ON the SMD soldering workstation, adjust the temperature setting knob to 275°C and keep the soldering iron ready for desoldering the SMD IC.

7 Use the crimping tool bent tip tweezers and hold the SMD IC.

8 Apply the hot soldering iron tip on the IC pins and desolder the SMD IC.

— — — — — — — —

TASK 2 : **Desoldering using wicking braid**

1 Repeat Steps 1 to 6 of Task 1.

2 Use the desoldering wicking braid one end over the SMD IC pins as shown in Fig 3.

3 Keep the tip of the hot soldering iron over the wicking braid and allow time to melt the solder for few seconds.

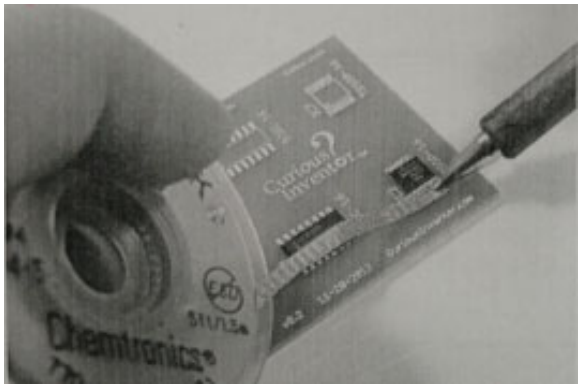
4 After the molten solder completely sucked by the wicking braid lift the soldering iron and wick quickly.

5 Use the crimping tool/bent tweezers, lift the SMD IC from the PCB.

6 Clean the PCB with IPA solution using brush.

7 Get the work checked by the Instructor.

Fig 3



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TASK 3 : **Desoldering using hot air**

1 Repeat steps 1 to 6 of Task 1.

2 Select the nozzle size suitable to the SMD IC and fix it on the tip of the hot air gun.

4 Switch ON the SMD workstation and re- adjust the hot air/ soldering iron temperature according to the desoldering work.

5 Get the work checked by the Instructor and switch OFF the SMD workstation with both control knobs brought back to zero position and soldering iron/ hot air gun kept in their holders.

— — — — — — — —

Make the necessary settings on SMD soldering station to solder various ICs of different packages (at least four) by choosing proper crimping tools

Objectives: At the end of this exercise you shall be able to
- **identify the suitable SMD printed circuit board to solder the SMD ICs**
- **solder SMD IC using soldering workstation (soldering iron type)**
- **solder SMD IC using soldering workstation using hot air and solder paste.**

Requirements

Tools/Equipments/Instruments

- ESD mat or table top and ESD wrist strap (both grounded) - 1 Set.
- SMD soldering workstation with tempe rature controller/hot air flow controller with all accessories - 1 Set.
- Magnifier with lamp - 1 No.
- Vacuum pen - 1 No.
- Tweezers with bent/pointed tips (ESD safe tips) - 1 No.

Materials/Components

- Solder flux pen/liquid flux, solder wick, IPA solutions cleaning cotton bud - as reqd.
- Solder paste - as reqd.
- Prototype SMD PCB suitable to assemble SMD leaded IC and lead leadless IC - as reqd.
- SMD IC - as reqd.
- Flexible PCB tape - as reqd.

PROCEDURE

Precautions:

1 Keep the workbench neat and clean.

2 Use ESD proof bins or trays to store the components.

3 Wear the ESD wrist strap to discharge the buildup of body static charge to ground.

TASK 1: **Selecting the suitable PCB for soldering leaded SMD ICs and leadless SMD ICs**

1 Use the vacuum pen and pick the given leaded SMD IC for soldering work.

2 Check the pitch of the IC and select the suitable SMD PCB.

3 Place the selected SMD IC on the pads of the PCB.

4 Get the work checked by the Instructor, label the PCB as 1 and keep it seperately.

5 Repeat above steps for the leadless SMD IC and label the PCB as 2 and keep it also seperately.

Note:

1 Use the pencil bit for the soldering iron to solder the SMD IC on the PCB.

2 Select and fix the appropriate size of hot air nozzle suitable for the soldering work.

— — — — — — — —

TASK 2: **Soldering leaded SMD IC using temperature controlled soldering workstation**

1 Switch ON the soldering workstation and set the temperature of the soldering iron in the range of 250° - 280°C.

2 Apply the flux on the pads of PCB 1 as shown in the Fig 1.

3 Identify the pin no 1 of the leaded SMD IC and pick the vacuum pen and of place it correctly on the pick pad as shown in Fig 2.

4 Align/adjust the chip as shown in Fig 3 using tweezers if necessary.

Note: Once multiple pins are soldered, it's very difficult to make adjustments without removing the chip.

5 Use the soldering iron with a little solder on the tip solder the first pin of the IC as shown in Fig 4.

Fig 1

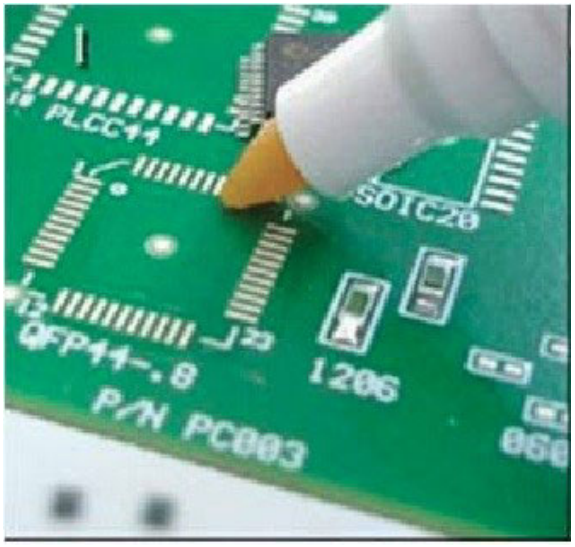


Fig 2

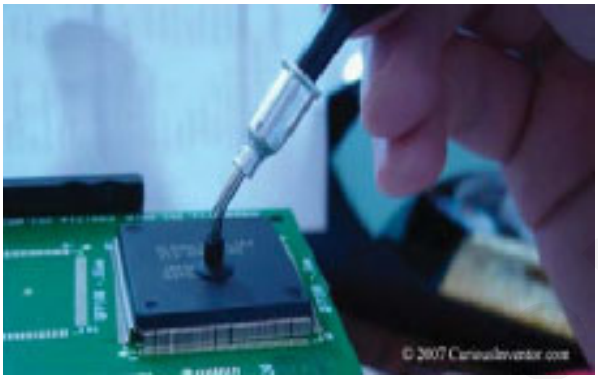


Fig 3

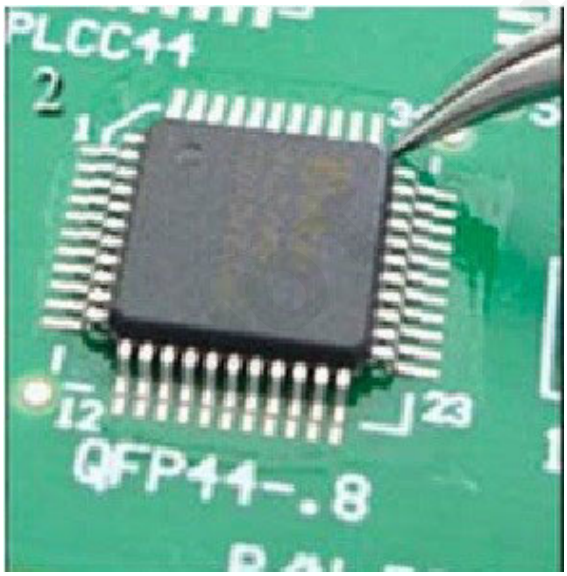
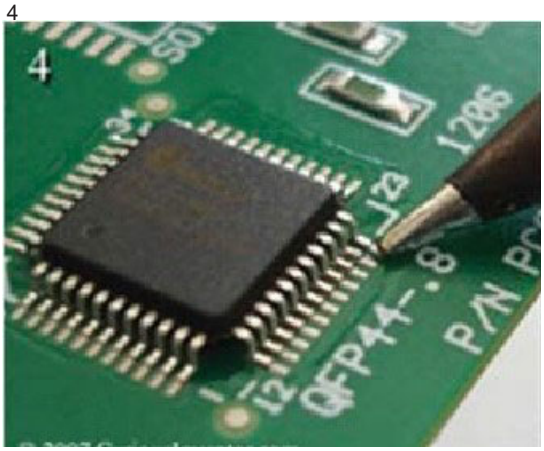
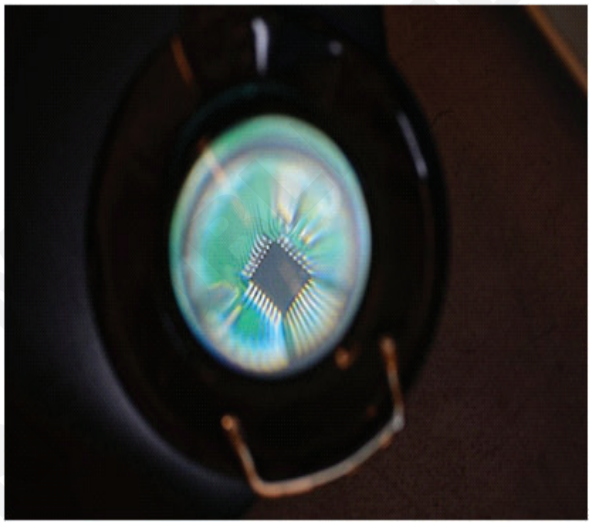


Fig 4



6 Check the alignment is correct through the magnifier as shown in Fig 5.

Fig 5



7 Solder the diagonal corner pin of the IC, recheck and confirm the alignment.

8 Apply the liquid flux over all the pins of the IC and solder the remaining pins.

9 Check IC terminals are perfectly soldered. If any solder bridges are formed remove them using solder wick.

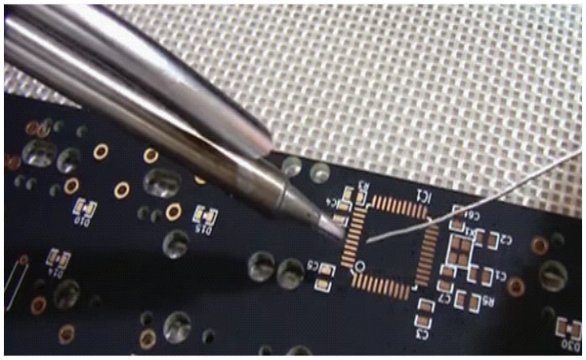
10 Verify the solder joint using magnifier and clean the PCB with IPA solution.

11 Get the work checked by the Instructor.

TASK 3: **Soldering leaded SMD IC using soldering workstation hot air and solder paste**

1 Pick the SMD IC and the PCB-2; Identify the pin-1 mark on the land pattern of the PCB as shown in Fig 6.

Fig 6



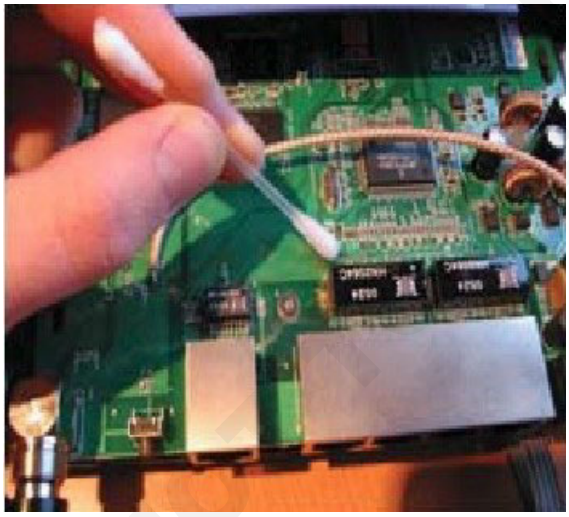
2 Clean the solder pad with IPA solution and tin the 1st pin, diagonally opposite pin pads.

3 Use holding device with crocodile clips to fix the PCB firmly on the work bench.

4 Switch ON the soldering workstation, adjust the temperature setting knob to 275°C.

5 Use the ESD safe tweezers and place the SMD IC on the pads of the PCB at its position correctly as shown in Fig 7.

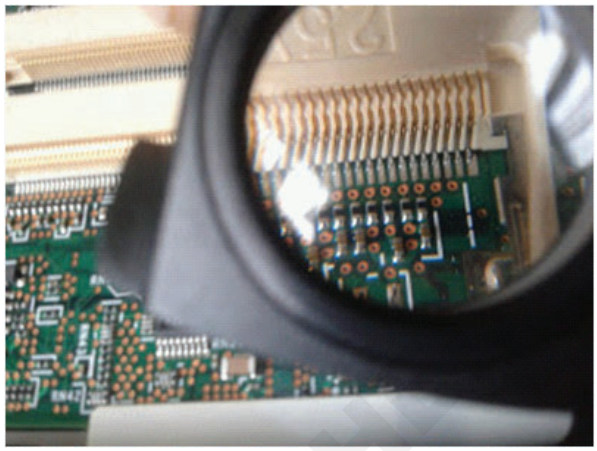
Fig 7



6 Hold the IC firmly and solder the pin-1 using pencil tip soldering iron and solder the diagonally opposite pin; switch OFF power.

7 Check the alignment using magnifier and confirm the SMD ICs correct position on the PCB as shown in Fig 8.

Fig 8



8 Apply the solder paste over the pins on all the four sides of the SMD IC.

9 Power ON the soldering workstation and adjust the air and temperature knobs to 280°C.

10 Apply the hot air nozzle over the SMD IC leads on all the four sides.

11 Keep the hot air nozzle moved around till the solder paste slowly melts and the solder joints formed on the pads of PCB.

Caution: To avoid damage do not keep the hot air nozzle over the device and adjacent components for a longer period of time and burning of the PCB. Don't blow air by mouth; it may cause dry solder.

12 Use magnifier and check all the pins of the SMD IC are correctly soldered to the pads on the PCB as shown in (Fig 8).

Note: Solder the pins using soldering iron with pencil tip if needed.

13 Clean the soldered PCB using IPA solution with brush

14 Get the work checked by the Instructor

Repeat the above steps for various SMD IC packages like SOP, SSOP, TSOP, TSSOP, SOIC, SOT packages.

Make necessary setting for rework of defective surface mount component used soldering/desoldering method

Objectives: At the end of this exercise you shall be able to
- **desolder the surface mount solder joint using solder wick**
- **desolder/solder the surface mount component using soldering workstation**
- **desolder the SMD IC using soldering workstation/hot air**
- **desolder the SMD components using vacuum pump.**

Requirements

Tools/Equipments/Instruments

• Trainees tool kit	- 1 Set.
• Magnifier with lamp	- 1 No.
• ESD table/Surface with wrist strap	- 1 No.
• Soldering workstation/hot air temperature/flow controller (with instruction manual)	- 1 Set.
• Digital Multimeter with probes	- 1 No.
• Desoldering tool with vacuum pump	- 1 Set.

Materials/Components

• 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 IC assembled PCB	- 1 No.

Note: The Instructor has to ensure that the trainees are wearing the ESD strap before handling the electronic components of the PCB.

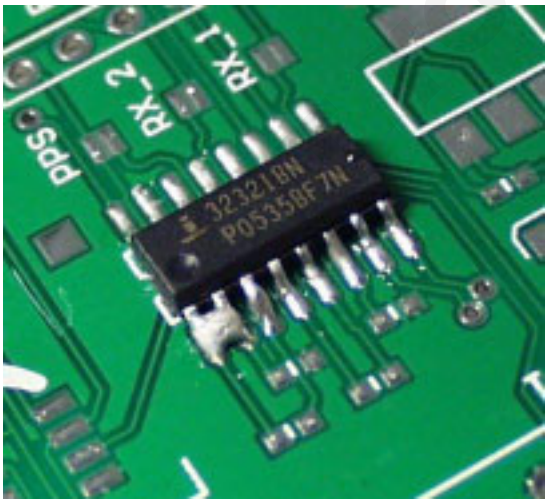
PROCEDURE

TASK 1: **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 joints on the components to be removed as shown in Fig 1.

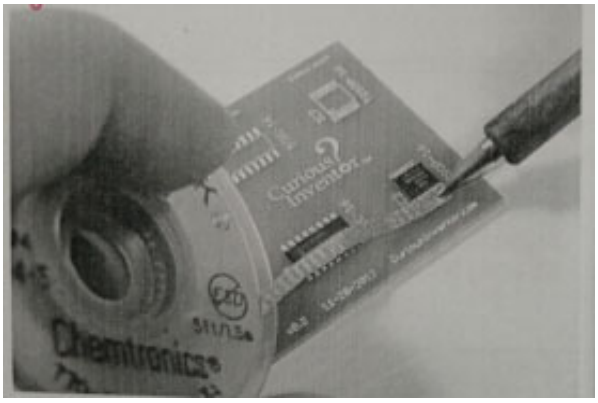
Fig 1



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

4 Place 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 2.

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.

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.

— — — — — — — —

TASK 2: **Desoldering of SMD - IC using soldering workstation/hot air**

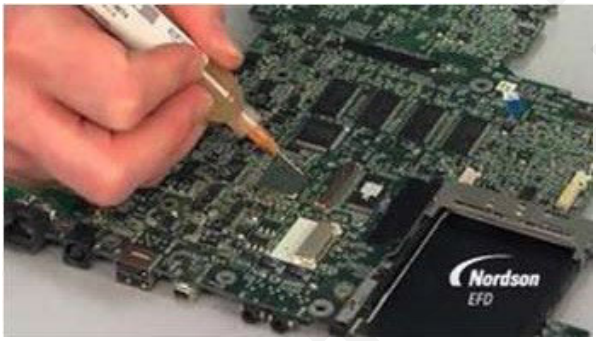
Note: The Instructor has to ensure that the masking of the other components using Kapton tape is done before starting the desoldering of SMD - IC.

1 Select the blower tip of the Soldering workstation as shown in Fig 3 suitable to the SMD - IC to be removed.

Fig 3

2 Apply solder flux over the SMD - IC or chip using the 5ml syringe as shown in Fig 4

Fig 4



3 Adjust and set the temperature and apply the hot air over the SMD - IC to be removed as shown in Fig 5.

Fig 5

4 Slowly try to insert the tweezers to lift from one side and remove the SMD - IC from the PCB as shown in Fig 6.

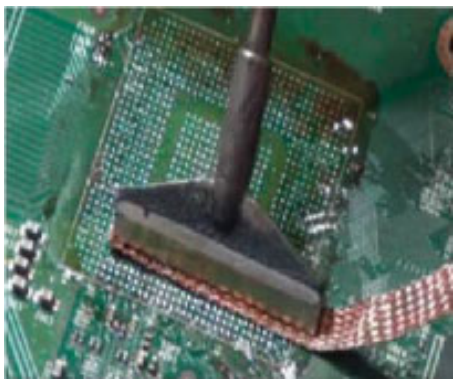
Fig 6

5 Take away the SMD - IC using tweezers as shown in Fig 7.

Fig 7

6 Remove any excess solder over the pads using solder wick as shown in Fig 8.

Fig 8



7 Clean the solder pads using IPA solution with cotton buds/brush as shown in Fig 9.

8 Check the pad of the SMD - IC using magnifier lens is cleaned.

Fig 9

9 Verify no pad is damaged as shown in Fig 10.

10 Get the work checked by the Instructor.

Fig 10

— — — — — — — —

TASK 3: **Removal of SMD components using desoldering pump**

1 Collect the defective SMD circuit board from the Instructor and identify the components to be removed.

2 Inspect the size of the solder joints on the component to be removed using magnifying glass.

Note: If the size of the solder joint is small apply additional solder to form an excess solder joint.

3 Apply a small quantity of the flux to the solder joint of the component to be removed.

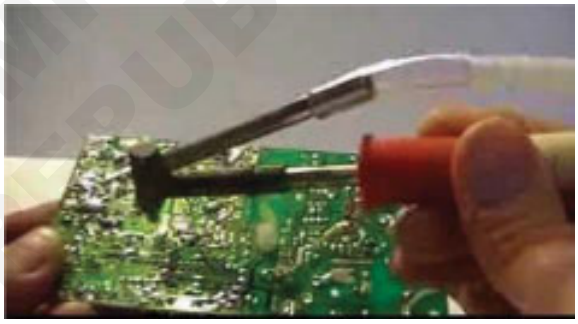
4 Use the Vaccum desoldering tool as shown in Fig 11 and align the desoldering tool tip contact the solder joint.

Fig 11

5 Place the soldering iron tip on the joint to melt solder.

6 Activate the Vaccum bulb immediately to extract the molten solder completely from the joint as shown in Fig 12.

Fig 12



7 Remove the desoldering tool tip and then turn OFF the Vacuum pump.

Note: To avoid thermal build up on the adjacent components, desolder the joints alternatively.

8 Use tweezers to remove the SMD component from the PCB and clean the surface using cleaning solution.

9 Get the work checked by the Instructor.

10 Pad of SMD - IC removes check the cleaner are using magnifier lens.

11 Get the work checked by the Instructor.

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Identify and test different types of diode, diode modules using multimeter and determine forward to reverse resistance ratio, compare it with specifications

Objectives : At the end of this exercise you shall be able to
- **identify the diode type, module and verify specifications**
- **test the diode using multimeter and verify specifications**
- **determine the forward to reverse resistance ratio of the diode.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- Semi conductor diode data book/ manual - 1 No.
- Digital multimeter with probes - 1 No.

Materials/Components

- Assorted type of Diodes - 10 Nos.
- Red colour Sleeve Wire - 1 No.
- Patch Cords - 10 Nos.

The instructor has to arrange different package / types of diodes and level them before using them for this exercise.

PROCEDURE

TASK 1: **Identification of specfications of diode**

1 Pick one of the labelled diode from the given assorted lot.

2 Observe the code number printed on the diode and record in the Table 1.

3 Refer to the semiconductor data book/manual, identify the type of diode, semiconductor material used and type of package.

4 Also verify the maximum Forward Current, I_f, peak Inverse Voltage, (PIV), forward Voltage Drop, V_f and record the observations.

5 Repeat step 2 to 4 for all the remaining diodes, and diode modules record in Table 1.

6 Get the work checked by the Instructor.

Fig 1

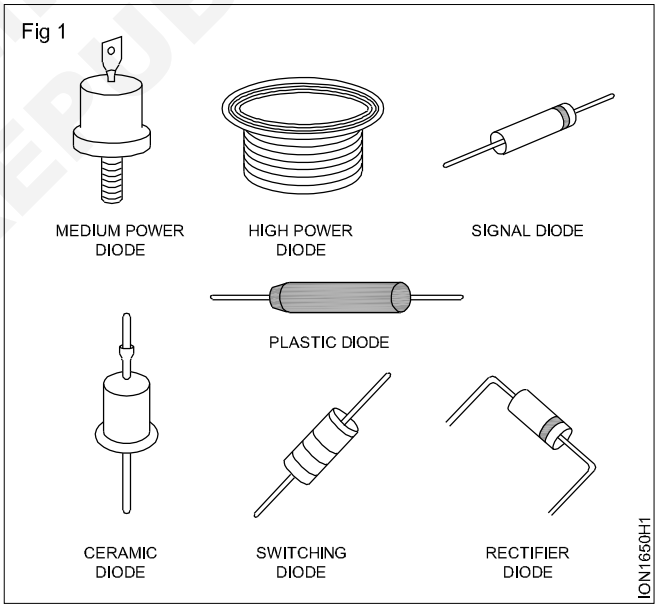


Table 1

Label No.	Code No.of Diode	Type of Diode	Semiconductor Material	Type of Package	Maximum Forward Current I_f	Peak Inverse Voltage (PIV)	Forward Voltage Drop V_f
1							
2							
3							
4							

TASK 2: **Determination of reverse to forward ratio of diode**

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 incase of analog type).

3 Connect the diode across the multimeter probes as shown in Fig 2a. Record the resistance reading shown by the meter in Table 2.

4 Reverse the meter probe connected to the diode as shown in Fig 2b and record the reading in (Table 2).

5 Calculate the ratio of recorded readings of forward resistance (R_F) to Reverse resistance (R_R).

6 Repeat step 3 to 6 for all the remaining diodes, and record in Table 2.

7 Get the work checked by the Instructor.

Fig 2

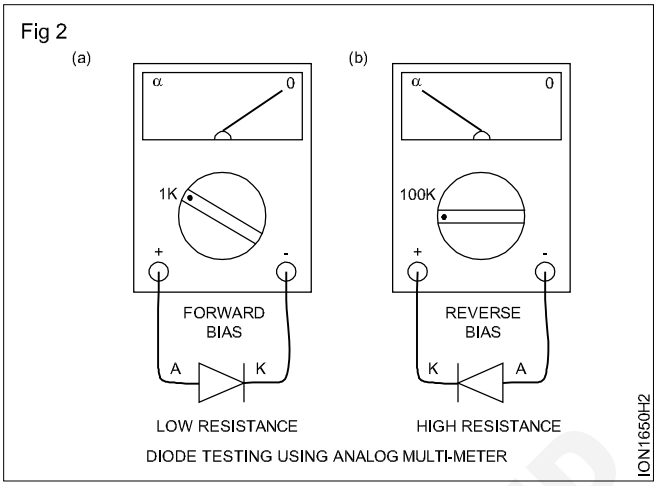


Table 2

Label No.	Code No.of Diode	Forward Resistance (F_R)	Reverse Resistance (R_R)	Ratio of F_R/R_R	Servicable/ UnServicable
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Measure the voltage and current through a diode in a circuit and verify its forward and reverse characteristics

Objectives: At the end of this exercise you shall be able to
- **assemble the circuit to measure the forward bias voltage versus current characteristics of silicon diode**
- **measure the reverse characteristics of silicon 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/Components

- Lugboard - 1 No.
- Semiconductor diode, 1N4007 or equivalent - 1 No.
- Resistor, 470Ω / ½ W - 1 No.
- Hook up Wire / connecting wires - as reqd.

PROCEDURE

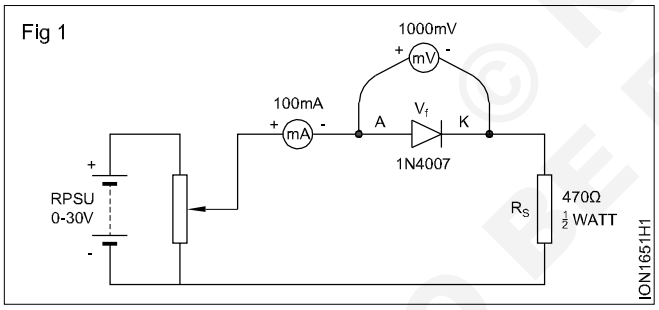
TASK 1: **Measurement of forward bias characteristics of silicon diode**

1 Collect all the components required and check their good working condition.

2 Identify the Anode and Cathode terminals of the diode.

3 Construct the circuit as shown in Fig 1.

Fig 1



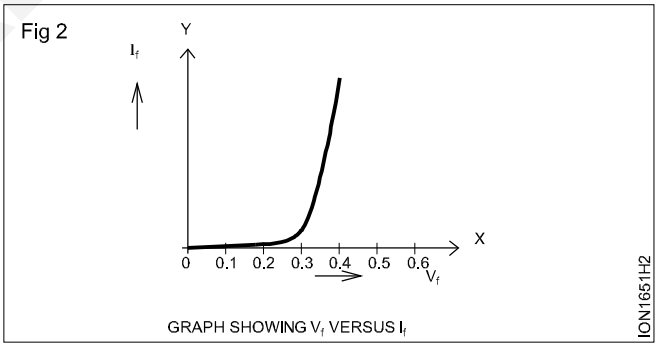
4 Switch ON the Regulated Power Supply and increase the output voltage of the RPSU such that the diode drop V_f varies from 0 to 0.8V in steps of 100mV as given in Table 1.

5 At each step record the values of forward current (I_f).

6 Switch OFF the Power supply. From the recorded values of V_f and I_f, calculate and record the forward resistance R_f of the diode.

7 From the recorded readings in Table 1, plot a graph taking V_f on x-axis and I_f in y-axis as shown in Fig 2.

Fig 2



GRAPH SHOWING V_f VERSUS I_f

Table 1

- Diode Type Number :
- Forward Resistance of Diode :
- Reverse Resistance of Diode :
- Lamp Resistance :

Forward voltage drop across Diode V_f in mV	Forward current I_f in mA	Forward Diode Resistance Ω
100mV		
200mV		
300mV		
400mV		
500mV		
600mV		
700mV		
800mV		

8 Get the work checked by the Instructor.

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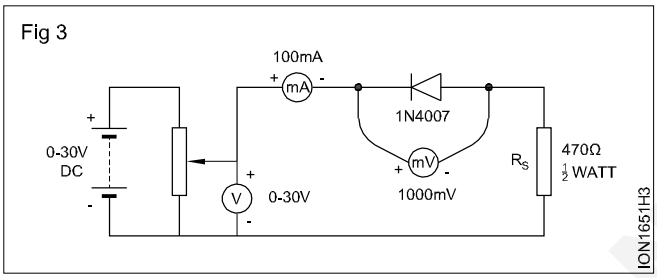
TASK 2: **Measurement of reverse bais characteristics of silicon diode**

1 Reverse the diode and modify the circuit for reverse bias characteristics as shown in Fig 3.

Fig 3



2 Switch ON the DC power supply and slowly increase the output voltage in steps of 1 volt upto 5V.

3 Observe the reverse current and measure the voltage drop across the diode and record in Table 2.

Table 2

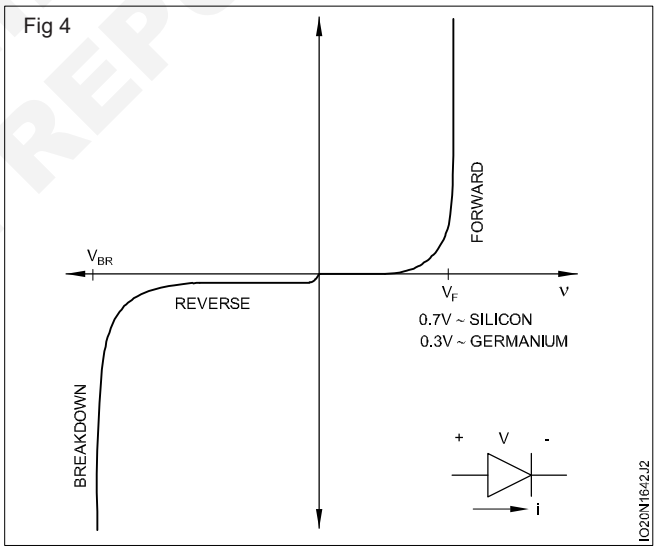
Sl. No.	Applied voltage	Reverse current	Voltage across diode	Reverse resistance of diode
1	1V			
2	2V			
3	3V			
4	4V			
5	5V			
6	10V			
7	15V			
8	20V			
9	25V			
10	30V			

4 Increase the DC supply in steps of 5 volt upto 30V and repeat above step 3.

5 Switch OFF the power supply and calculate the reverse resistance of the diode from the recorded readings.

6 From the readings of Table 2 plot the graph by taking reverse voltage on x-axis and reverse current on y-axis (III Quadrant) as shown in (Fig 4).

Fig 4



7 Get the work checked by the instructor.

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 output voltage and waveform**
- **construct and test a two diode full-wave rectifier output voltage and waveform**
- **construct and test a full-wave bridge rectifier output voltage and waveform.**

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/Components

- Lug Board/General purpose PCB - 1 No.
- Semiconductor diode, 1N4007 or equivalent - 4 Nos.
- Step-down Transformer, 240V/0-12V/500mA - 1 No.
- Centre tapped Step-down Transformer, 240V/12-0-12V/ 500mA - 1 No.
- Mains cord with Three Pin Plug - 1 No.
- Resistor, 470Ω / ½ Watt - 1 No.
- Hook up Wire - 5 m.

PROCEDURE

TASK 1: **Construction and Testing of a Half-Wave rectifier output voltage and waveform**

1 Collect all the components required and check their good working condition.

2 Construct the Half-wave rectifier as shown in Fig 1, using lugboard/ general purpose PCB.

3 Connect the Transformer primary to AC mains and switch ON the circuit.

4 Using multimeter measure and record the mains voltage, 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, $V_{S(rms)}$ is the secondary voltage 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 Prepare the CRO for measurements and connect the two channel input probes adjust for two waveforms at anode and cathode w.r.t ground.

9 Measure and record the waveforms.

10 Calculate and record the,

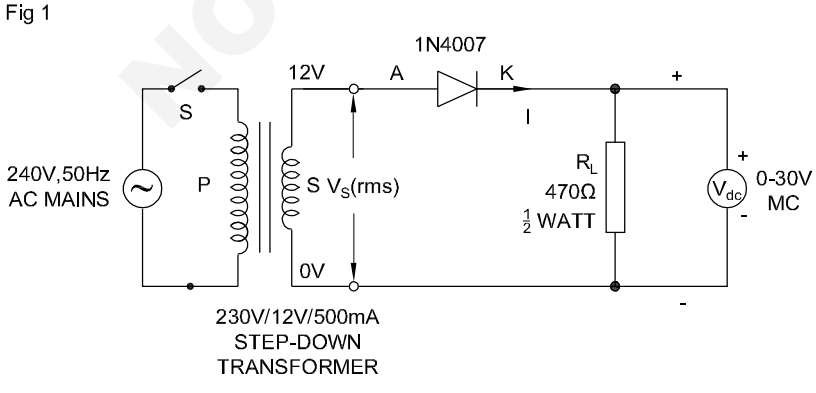
a Peak value of Source Voltage V_S (Input Volt to Rectifier).

b Frequency of Source Voltage V_S.

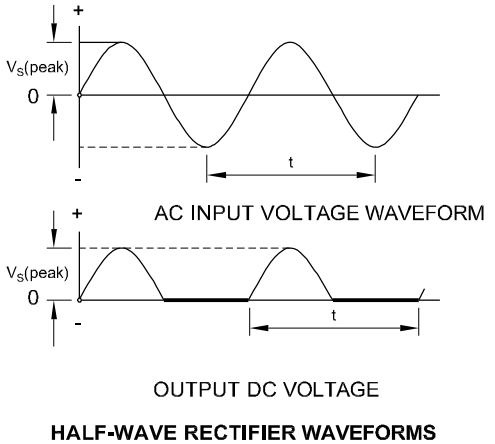
c Peak value of pulsating DC - V_{dc}.

d Frequency of Pulsating DC - V_{dc}.

Fig 1



HALF-WAVE RECTIFIER



HALF-WAVE RECTIFIER WAVEFORMS

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Table 1

Mains supply voltage (1)	Secondary voltage $V_{S(rms)}$ (2)	Calculated V_{dc} (3)	Measured V_{dc} (4)	Difference between (3) and (4)	Peak value V_S	Frequency of V_S	Peak Value of pulsating V_{dc}	Frequency of pulsating V_{dc}

10 Get the work checked by the Instructor.

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TASK 2: **Construction and Testing of a two diode Full-Wave rectifier output voltage and waveform**

1 Collect all the components required and check their good working condition.

2 Full-wave rectifier as shown in Fig 2.

3 Connect AC mains to the centre tapped Transformer primary and switch ON mains.

4 Use multimeter, measure and record the mains voltage across the transformer secondary (AC voltage $V_{S(rms)}$) to the rectifier in Table 2.

5 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.)

6 Repeat steps 6 to 10 of Task 1 and record the measurements in Table 2.

Fig 2

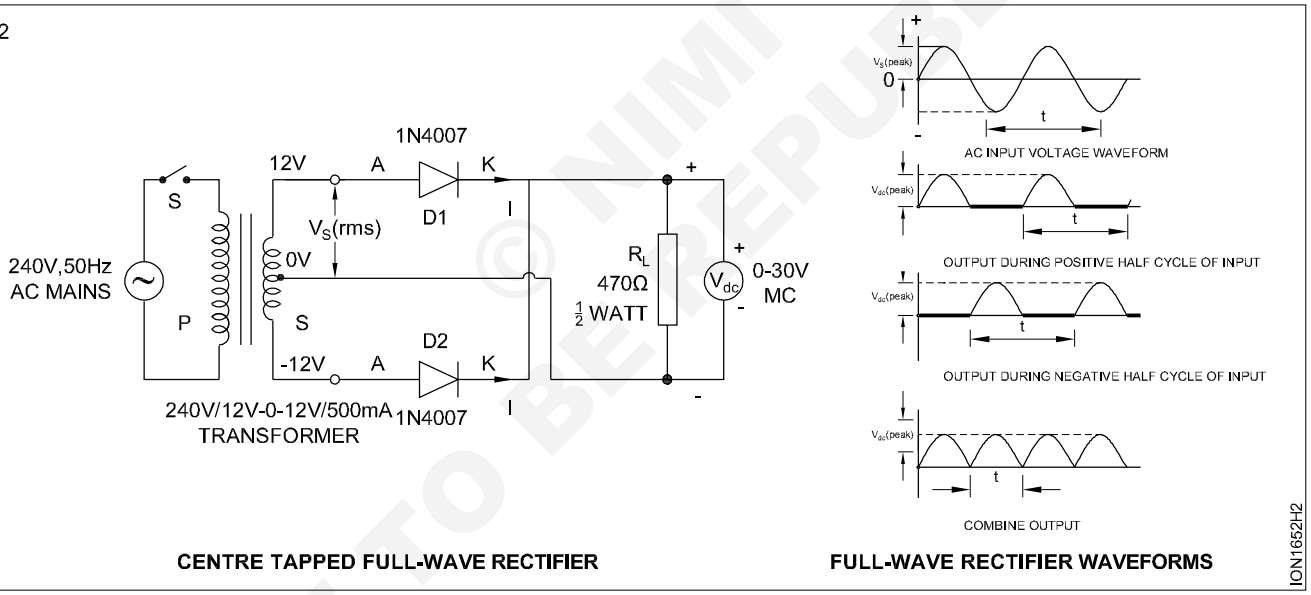


Table 2

Mains supply voltage (1)	Secondary voltage $V_{S(rms)}$ (2)	Calculated V_{dc} (3)	Measured V_{dc} (4)	Difference between (3) and (4)	Peak value V_S	Frequency of V_S	Peak Value of pulsating V_{dc}	Frequency of pulsating V_{dc}

7 Get the work checked by the Instructor.

— — — — — — — —

TASK 3: **Construction and Testing of four diode full wave bridge rectifier output voltage and waveform**

1 Collect all the components required and check their good working condition.

2 Construct the Full-wave Bridge rectifier as shown in Fig 3 using four diodes.

2 Connect AC mains to the Transformer primary and switch ON mains.

4 Use multimeter, measure and record the mains voltage across the transformer secondary (AC voltage $V_{S(rms)}$) to the rectifier in the Table 3.

5 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.)

6 Repeat steps 6 to 10 of Task 1 and record the measurements in Table 3.

Fig 3

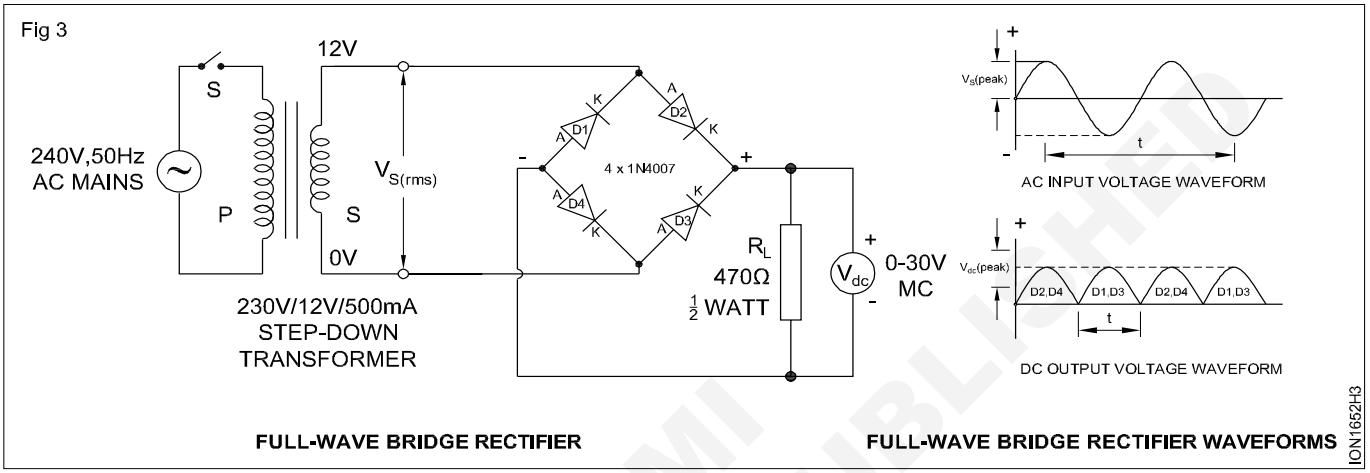


Table 3

Mains supply voltage (1)	Secondary voltage $V_{S(rms)}$ (2)	Calculated V_{dc} (3)	Measured V_{dc} (4)	Difference between (3) and (4)	Peak value V_S	Frequency of V_S	Peak Value of pulsating V_{dc}	Frequency of pulsating V_{dc}

7 Get the work checked by the Instructor.

— — — — — — — —

Identify and test zener diode and construct peak clipper

Objectives: At the end of this exercise you shall be able to
- **test zener diode in a circuit and determine the zener breakdown voltage**
- **construct and test the peak clipper circuit using zener diode.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Function Generator 0-1MHz - 1 No.
- Oscilloscope 20 MHz - Dual trace - 1 No.
- Regulated DC power supply 0-30V/2A - 1 No.
- Digital multimeter with probes - 1 No.
- Ammeter 0-300mAmc - 1 No.

Materials/Components

- Zener Diode IN4728A or equivalent - 1 No.
- Resistor 1kΩ /¼ W/CR25, 470Ω/ ½ W - 1 No each.
- Breadboard - 1 No.
- Connecting wires/Hook up wires - as reqd.

Aids: Semiconductor data manual - as reqd.

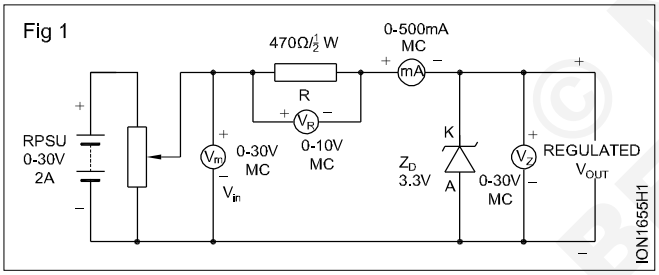
PROCEDURE

TASK 1: **Determination of zener diode breakdown voltage**

1 Collect all the equipments and components and check the items for its good working condition.

2 Connect them as per the circuit diagram shown in Fig 1 and get it verified by the instructor.

Fig 1



3 Switch ON the DC power supply and increase the voltage in steps of 1V upto 10V.

4 Measure and record the values of V_R, V_Z and I_Z in the Table 1 and switch OFF the DC supply.

5 From the recorded readings, determine the zener breakdown voltage.

Table 1

Sl. No.	Unregulated Input voltage, V_{in}	Voltage Drop across series Resistor V_R	Zener voltage V_Z	Zener current I_Z

Zener diode breakdown voltage : _____ volts.

6 Get the work checked by the Instructor.

— — — — — — — —

TASK 2: **Construction of peak clipper circuit using Zener Diode**

1 Collect all the components required and check their good working condition.

2 Construct the peak clipper circuit as shown in Fig 2.

3 Check and verify the circuit connection by the Instructor.

4 Switch ON the Function generator, apply Sinewave input amplitude greater than the clipping level of the zener diode.

5 Prepare the CRO for measurements.

6 Observe the output waveform on the CRO, record the amplitude and time period from the waveform in Table2.

7 Measure the clipped voltage, verify with the input voltage using DMM and record the observations in Table 2.

Fig 2

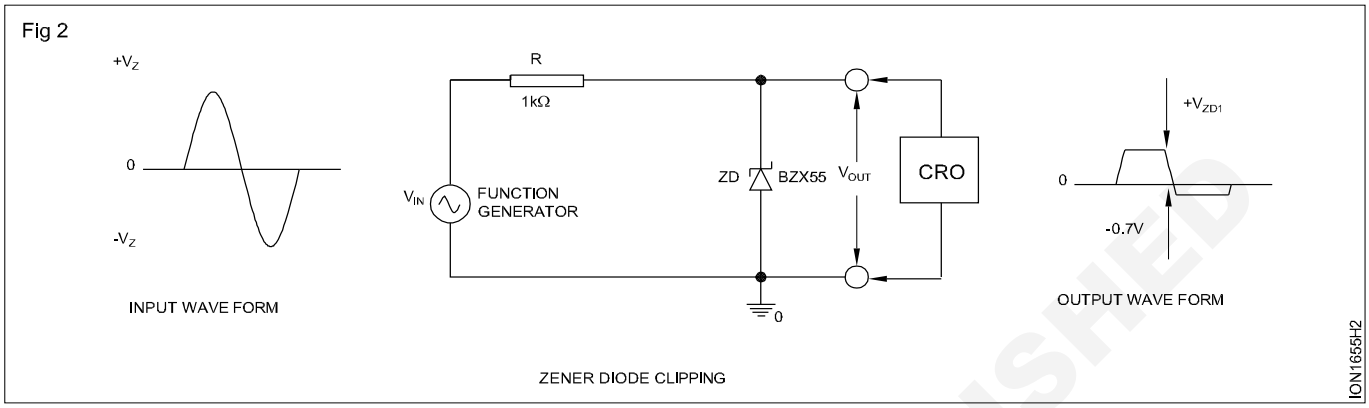


Table 2

Sl. No.	Voltage	Waveform	Voltage as per CRO	Voltage as per DMM	Remarks
1	Input				
2	Output				

8 Get the work checked by the Instructor.

Identify different type of transistors and test them using digital multimeter

Objective: At the end of this exercise you shall be able to
- **identify transistor by different package type, pin configuration.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Transistor databook - as reqd.
- DMM with probes - 1 No.

Aids: Transistor package outline charts - 1 No.

Materials/Components

- Different types of transistor packages from T0-1, T0-5, T0-18, T0-39, T0-72, T0-92, T0-3, T0-66, T0-126, T0-202, T0-220, T0-3P, T0-247 (one each) - 15 Nos.

Note:

1 The Instructor has to select and label the transistors used for this exercise.

2 A minimum of one number in each type of package has to be arranged.

Instruct the trainees to handle the transistor leads carefully and not to bend them.

PROCEDURE

TASK 1 : **Identification of transistor by different package type, pin configuration.**

1 Pick one of the labelled transistors from given assorted lot, identify the code number, and record them in Table 1.

2 Refer to the Chart shown in Fig 1 and also semiconductor data book, identify the type of package, all other details as required in Table 1 and record them.

3 Repeat the above step for remaining labelled transistors.

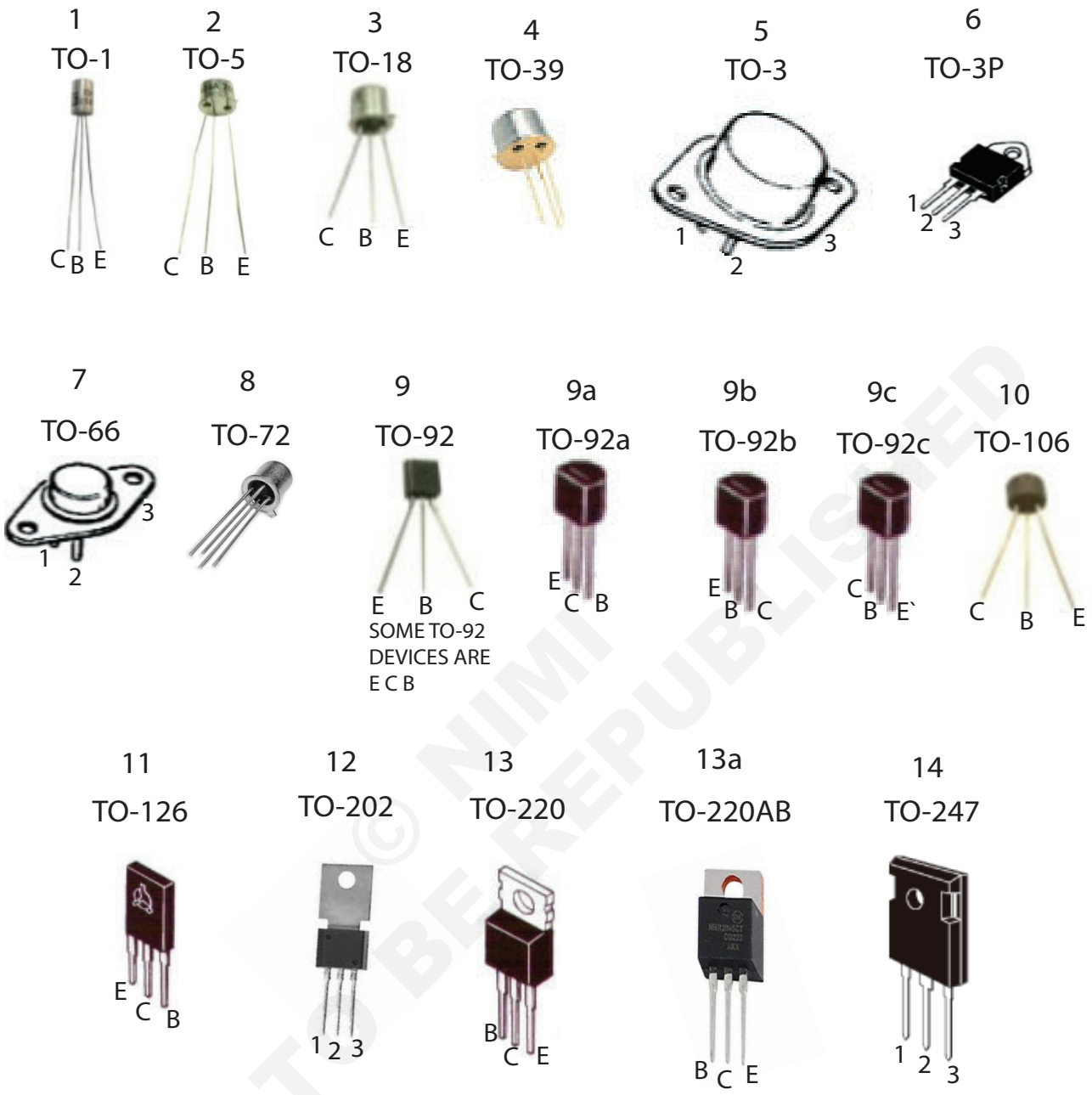
Table 1

Sl.No.	Label No	Transistor code number	Transistor package type	Package diagram with pin description	Current & Voltage		Power rating	Application / uses
					Current rating	Voltage rating		

4 Get the work checked by the Instructor.

Chart

Fig 1



DIFFERENT TRANSISTOR PACKAGES

Task 2: **Testing the condition of transistor using Digital multimeter (DMM)**

1 Pick one of the labelled transistor from the given lot, enter its number in Table 2.

2 Verify the details like transistor type, pin configuration etc recorded in the Table 1 of Ex.No.2.1.102/Refer to the data book, identify all the details required.

3 Connect the crocodile clip probe to the DMM and set the selector, switch to the Diode testing position/range.

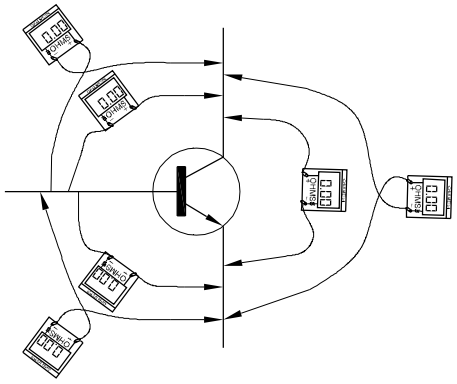
4 Connect the positive test probe of the DMM to the Base (B) terminal and the negative probe to the Emitter (E) of the transistor as shown in Fig 2.

For a good NPN transistor, the meter should show between 0.45V to 0.9V and for a PNP transistor, the meter should show "OL" (Over Limit) means infinity.

5 Observe the reading displayed on the DMM, record the value in Table 2.

6 Keep the positive probe at Base and connect the negative probe to the collector (C) terminal, observe the reading on the DMM, record it in Table 2.

Fig 2



TESTING TRANSISTOR USING DMM

ION1656H2

For a good NPN transistor the meter should show between 0.45 to 0.9V and for a PNP type transistor, the meter should show "OL" (Over Limit) means infinity.

7 Repeat setps 4,5 and 6 with reversed polarities of DMM and record those readings in Table 2.

8 Connect the positive probe to the Emitter terminal and negative probe to the Collector (C) of transistor as shown in Fig 2; Record the observations in Table 2.

9 Repeat step 8 with reversed polarities of DMM.

10 Carry out steps 4 to 9 for all the remaining labelled transistors and record readings in Table 2.

Note:

Compare the resistance values recorded in forward and reverse directions between B-E, B-C and E-C terminals.

Conclude the condition of tested transistor is defective/unserviceable if the resistance value is same on both directions for B-E or B-C junctions, shorted / open junctions show same resistance value in both directions otherwise, the transistor is good/serviceable.

Table 2

Sl.No.	Lable No NPN/PNP	Transistor Code No and type	Ohmmeter reading between the terminals				Remarks
			Direction	Base to emitter	Base to collector	Emitter to collector	
1			Forward				
2			Reverse				
3			Forward				
4			Reverse				
5			Forward				
6			Reverse				
7			Forward				
8			Reverse				
9			Forward				
10			Reverse				

11 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 configuration**
- **measure and plot the output characteristics of a transistor in CE configuration.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 No.
- DC milliammeter, 0-100mA - 1 Set.
- DC microammeter, 0-500µA - 1 No.
- DC millivoltmeter, 0-1000mV - 1 No.
- Regulated DC dual power supply 0-30V/2A - 1 No.
- Semiconductor data manual - 1 No.
- Digital multimeter with probes - 1 No.

Materials/Components

- General purpose PCB - 1 No.
- Transistors, SL 100, - 1 No.
- Resistors
  - 120Ω, ¼ W - 1 No.
  - 10kΩ, ¼ W - 1 No.
  - 3.3kΩ, ¼ W - 1 No.
  - 1 kΩ, 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**

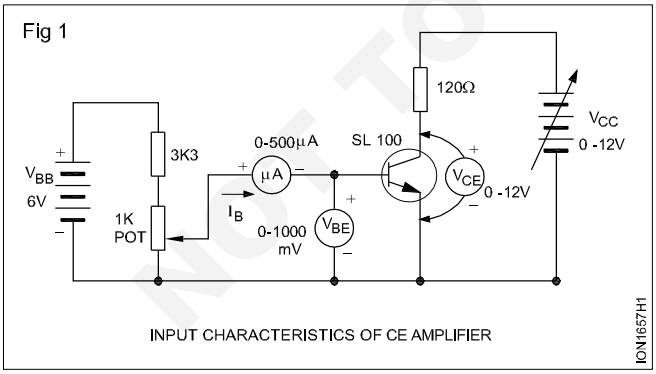
1 Collect all items required, identify transistor refer the data book and record the details and condition of the transistor in Table 1.

Table - 1

Code No	Transistor 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 0V, 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} = 5V, repeat step 5 and record readings in Table 3.

Table - 3

V_{CE} set at 5V 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} = 10V, repeat step 6 and record the readings in Table 4.

Table - 4

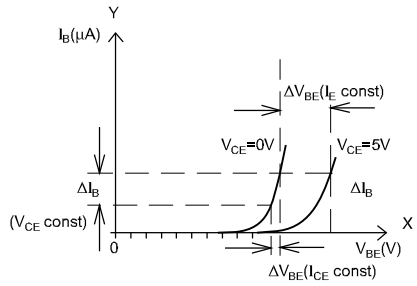
V_{CE} set at 10V constant							
V_{BE}	0	200 mV	300 mV	400 mV	500 mV	600 mV	700 mV
I_B µA							

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} VERSUS I_B

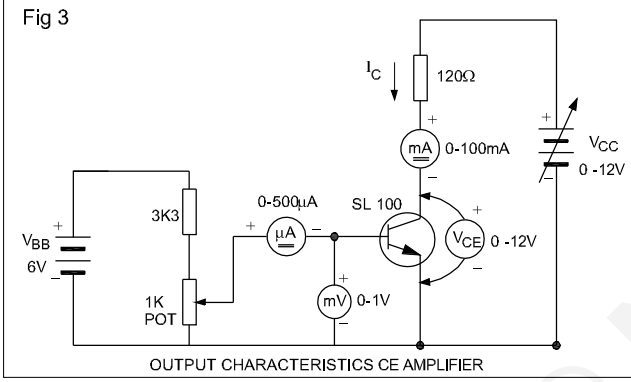
ION1657H2

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.

2 Ensure that the circuit is correctly connected and verified by the Instructor.

Fig 3



OUTPUT CHARACTERISTICS CE AMPLIFIER

ION1657H3

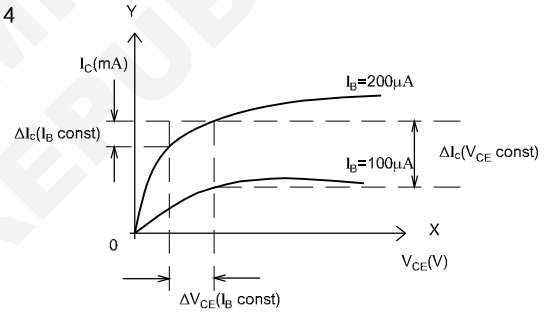
3 Set V_{CC} to 0V such that V_{CE} = 0V and adjust the supply V_{BB} such that I_B = 100 μA.

4 Increase 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.

5 Increase I_B values to 200 μA, 300 μA, 500 μA and at each setting repeat step 4; Record the readings in Table 6, 7 and 8 respectively.

6 Draw the graph of output characteristics of given transistor in CE configuration by plotting the readings recorded in Tables 5,6,7 and 8 as shown in Fig 4.

Fig 4



OUTPUT CHARACTERISTIC V_{CE} Vs I_C

ION1657H4

Table 5

I_B set at 100 μA 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 100 μA constant												
V_{CE}	0.2V	0.4V	0.6V	0.8V	1V	2V	3V	4V	5V	6V	7V	8V
I_C												

7 Get the plotted graph checked by the Instructor.

— — — — — — — —

Construct and test a transistor based switching circuit to control a relay

Objectives : At the end of this exercise you shall be able to
- **construct and test transistor based switching circuit to control a relay.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 No.
- Digital multimeter with probes - 1 No.
- Regulated DC Power supply 0-30V/2A - 1 No.
- Soldering Iron 25W/230V - 1 No.

Materials/Components

- Transistor, SL100 - 1 No.
- Semiconductor data manual - as reqd.
- General purpose PCB - 1 No.
- Resistor
- 10 kΩ , ¼ W/CR25 - 1 No.
- Solder wire - 1 No.
- Solder flux - as reqd.
- SPDT switch - 1 No.
- Connecting wires - as reqd.
- Diode -1N4001 - 1 No.
- 12V/30mA/10A/1CO - 1 No each.
- Relay 5V/50 mA/10A 1CO - 1 No each.
- LED 5mm - 1 No.
- Twisted pair flexible wire - 2 m.

PROCEDURE

TASK 1: **Construction and testing of transistor based switching circuit to control a relay**

1 Collect all the components required, test them and plan the layout of components on the general purpose PCB.

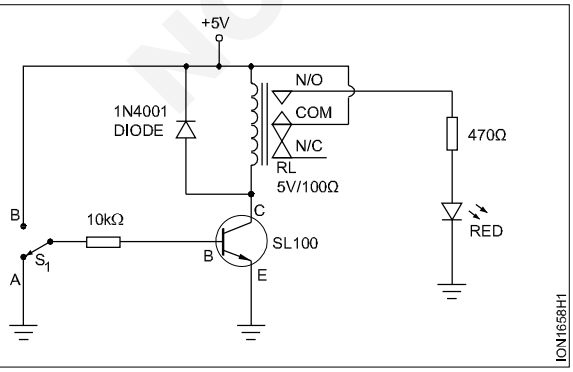
2 Identify the transistor number their leads and record the h_{FE} of given transistor and other parameters with reference to the data sheet in Table 1.

Table 1

Code No.of transistor	Type	I_C	V_{CEO}	V_{CBO}	V_{EBO}	h_{FE}

3 Assemble the circuit as shown in Fig 1.

Fig 1



4 Ensure that the circuit is correctly connected and verified.

5 Keep the switch S_1 in position A, switch ON the 5 VDC supply to the circuit and observe the status of LED.

6 Measure voltage at Base and collector terminals with respect to Emitter terminal; Record the readings in Table 2.

7 Change the switch to point B, repeat step 6, observe the condition of relay and record the observations in Table 2.

Table 2

Sl. No.	Switch position	Voltage at		Relay condition	Status of LED
		Base (V_{BE})	Collector (V_{CE})		
1	A				
2	B				

8 Get the work checked by the Instructor.

Identify different logic gates (AND, OR, NAND, NOR, EX-OR, EX- NOR, NOT ICs) by the number printed on them

Objectives: At the end of this exercise you shall be able to
- **identify different logic gates by the IC number printed on them**
- **identify various ICs and their specifications using data sheet/semiconductor data manual.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Logic Gates (IC) trainer Kit - 1 No.
- Digital multimeter with probes - 1 No.
- Data sheet of ICs used - as reqd.

Materials/Components

- Breadboard - 1 No.
- IC 7400, IC 7408, IC 7432 IC 74266, IC 7402, IC 7404 IC 7486 - 1 No each.

PROCEDURE

Note:

1 Label the ICs used for this exercise.

2 The Instructor has to provide/ensure ICs with their number printed on them is clearly visible and all the ICs are inserted on a bread board safely.

Safety precaution: Do not touch the pins of the ICs with fingers.

1 Pick one of the ICs note down the number in Table -1

2 Refer to the data sheet/semiconductor data manual, find the logic gate function,draw the pin out diagram, mark the input, output and supply pin numbers.

3 Repeat the steps for remaining ICs and record the observations in Table 1.

4 Get the work checked by the Instructor.

Table 1

Sl.No.	Label number	IC number	Name of the Logic gate	Symbol	Pin out
1		IC 7408			
2		IC 7432			
3		IC 7404			
4		IC 7400			
5		IC 7402			
6		IC 7486			
7		IC 74266			

— — — — — — — —

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/Components

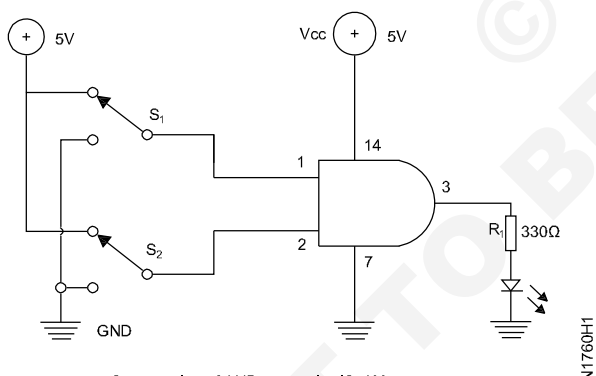
- Breadboard - 1 No.
- IC 7408 - 1 No.
- IC - 7432 - 1 No.
- IC-7486 - 1 No.
- IC-7400 - 1 No.
- SPDT Switches (Miniature Toggle) - 2 Nos.
- IC 7404 - 1 No.
- Hook up wire, red and black - as reqd.
- Flexible wires - as reqd.
- Resistor/¼ W/CR25, 330Ω - 1 No.
- LED 5mm, Red - 1 No.
- Data sheets of ICs used - as reqd.

PROCEDURE

TASK 1: **Construction of 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 on the bread board, as shown in Fig 1.

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 Fig 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

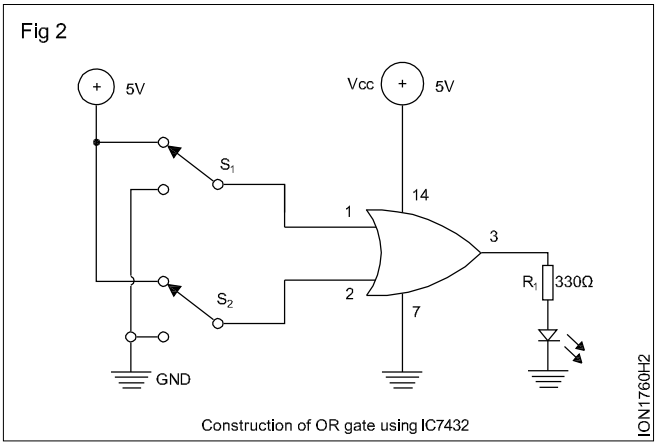
6 Verify the readings with the truth table of AND gate.

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 circuit on the bread board, as shown in Fig 2.

Fig 2



Construction of OR gate using IC7432

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.

Table 2

Sl.No.	Input		Output LED status
	A	B	
1			
2			
3			
4			

OR gate Truth table

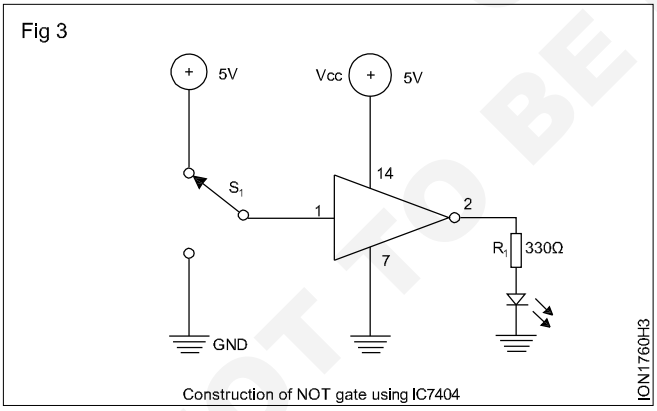
Sl.No.	Input		Output Y=A+B
	A	B	
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1

— — — — — — — —

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 on the bread board, as shown in Fig 3.

Fig 3



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.

Table 3

Sl.No.	Input	Output LED status
	A	
1		
2		

NOT gate Truth table

Sl.No.	Input	Output $Y=\overline{A}$
	A	
1	0	1
2	1	0

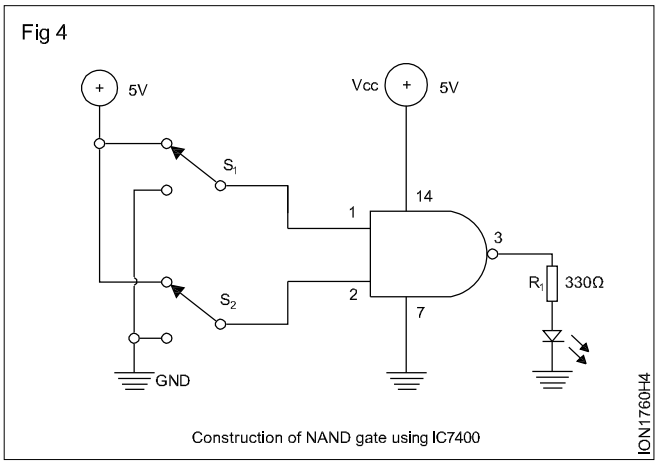
5 Get the work checked by the Instructor.

— — — — — — — —

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 on the bread board, as shown in Fig 4.

Fig 4



Construction of NAND gate using IC7400

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.

Table 4

Sl.No.	Input		Output LED status
	A	B	
1			
2			
3			
4			

NAND gate Truth table

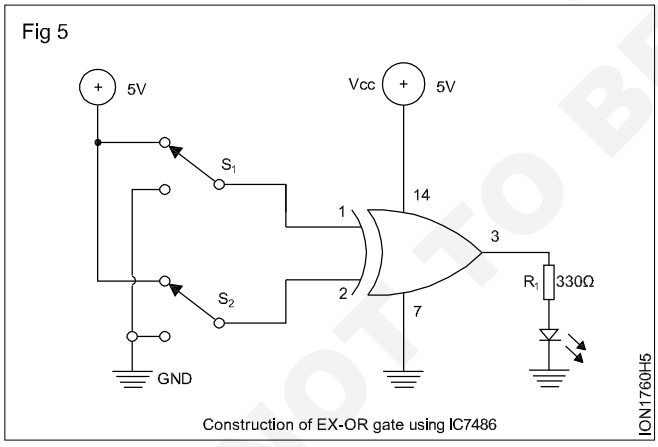
Sl.No.	Input		Output Y=A.B
	A	B	
1	0	0	1
2	0	1	1
3	1	0	1
4	1	1	0

— — — — — — — —

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 on the bread board, as shown in Fig 5.

Fig 5



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 5: **Construction of EX-OR gate using IC 7486 and verification of its Truth table**

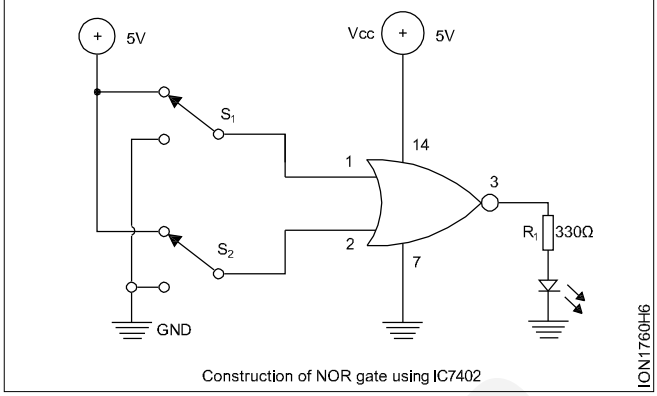
1 Collect all the components, check them, refer to the data sheet of the IC 7486, assemble the EX-OR gate on the bread board, as shown in Fig 6.

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.

Fig 6



Construction of NOR gate using IC7402

Table 6

Sl.No.	Input		Output LED status
	A	B	
1			
2			
3			
4			

Table 6

Sl.No.	Input		Output Y=A⊕B
	A	B	
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	0

— — — — — — — —

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 manufacturer's 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/Data manual

- Digital IC databook - 1 No.
- Digital IC tester with manual - 1 No.
- DMM with probes - 1 No.

Materials/Components

- 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 this 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 institutes 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 20 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 test a 2 to 4 decoder

Objective: At the end of this exercise you shall be able to
- **construct a 2 to 4 decoder using AND, NOT gates and verify the truth table.**

Requirements

Tools/Equipments/Instruments

- Logic probe - 1 No.
- Trainees tool kit - 1 Set.
- Regulated DC power supply 0-30V/2A - 1 No.
- Soldering iron 25W/230V - 1 No.
- Digital multimeter with probes - 1 No.
- Data sheet of ICs used - as reqd.

Materials/Components

- Rosin cored solder - as reqd.
- Miniature toggle switches - 2 Nos.
- 14 pin IC Base Switch SPDT - 2 Nos.
- Breadboard - 1 No.
- IC-7404 - 1 No.
- IC-7408 - 1 No.
- LED 5mm, Red - 4 Nos.
- Resistor 330Ω/¼ W/CR25 - 4 Nos.

Note:

1 **The Instructor has to guide the trainees to record 5VDC given to gate input as Logic High (1) and GND as Logic Low (0).**

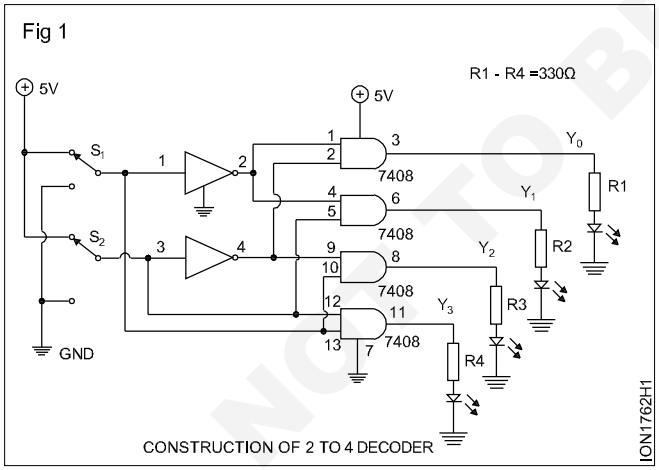
2 **The status of LED ON as Logic '1' and 'OFF' as Logic '0'.**

PROCEDURE

TASK 1: **Construction of 2 to 4 decoder circuit and verification of truth table**

1 Collect all the components, check them, refer to the data sheet of the ICs assemble the 2 to 4 decoder circuit on breadboard, as shown in Fig 1.

Fig 1



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 S_1 & S_2 for different logic levels either in 5V position or zero volt (GND) position as shown in Fig 1.

5 Observe the status of LEDs for each step of combinations and record the observations in Table 1.

Table 1

Sl. No	INPUT		OUTPUT LED Status			
	A	B	Y_0	Y_1	Y_2	Y_3
1	0	0				
2	0	1				
3	1	0				
4	1	1				

2 to 4 Decoder TRUTH TABLE:

Sl. No	INPUT		OUTPUT LED Status			
	A	B	Y_0	Y_1	Y_2	Y_3
1	0	0	1	0	0	0
2	0	1	0	1	0	1
3	1	0	0	0	1	0
4	1	1	0	0	0	1

6 Verify the readings on the Table with the Truth table of 2 to 4 Decoder Truth table given.

7 Get the work checked by the Instructor.

Construct and test a 4 to 2 encoder

Objective: At the end of this exercise you shall be able to
- **construct and test 4 to 2 Encoder.**

Requirements

Tools/Equipments/Instruments

- Soldering iron 25W/230V - 1 No.
- Trainees tool kit - 1 Set.
- DC power supply 0-30V/2A - 1 No.
- Digital multimeter with probes - 1 No.
- Data sheet of ICs used - as reqd.

Materials/Components

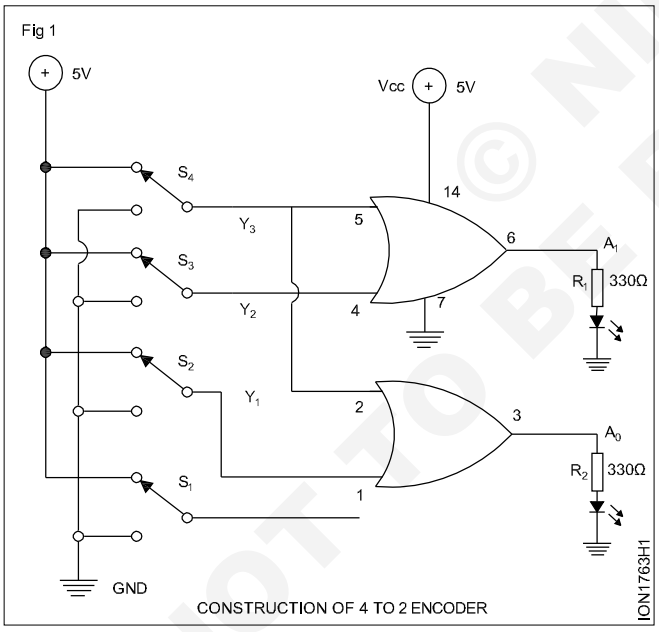
- Miniature toggles Switch SPDT - 4 Nos.
- Breadboard - 1 No.
- IC-7432 - 1 No.
- LED 5mm, Red, Green - 1 No each.
- Hook up wires - as reqd.
- Rosin cored solder - as reqd.
- Resistor 330Ω/¼ W/CR25 - 2 Nos.

PROCEDURE

TASK 1: **Construction of 4 to 2 Encoder circuit and verification of its truth table**

1 Collect all the components, check them and assemble the 4 to 2 Encoder circuit on the breadboard, as shown in Fig 1.

Fig 1



CONSTRUCTION OF 4 TO 2 ENCODER

2 Use toggle switch S_1 as input Y_0, switch S_2 as input Y_1, switch S_3 as input Y_2 and switch S_4 as input Y_3.

In the 4 to 2 Encoder using OR gates note that the switch S_1 is kept unconnected to the input, as neither of the outputs depend on it.

3 Get the assembled circuit checked by the Instructor.

4 Switch ON 5VDC supply, and operate switches S_2, S_3 and S_4 only for different logic levels either in 5V position or zero volt (GND) position as shown in Fig 1.

Table 1

Sl. No	INPUT				OUTPUT	
	Y_3	Y_2	Y_1	Y_0	A_1	A_0
1	0	0	0	1		
2	0	0	1	0		
3	0	1	0	0		
4	1	0	0	0		

2 to 4 Decoder TRUTH TABLE:

Sl. No	INPUT				OUTPUT	
	Y_3	Y_2	Y_1	Y_0	A_1	A_0
1	0	0	0	1	0	0
2	0	0	1	0	0	1
3	0	1	0	0	1	0
4	1	0	0	0	1	1

5 Observe the status of LEDs for each step of combinations and record your observations in Table1.

6 Verify the readings on the Table with the Truth table of 4 to 2 Encoder given.

7 Get the work checked by the Instructor.

Construct and test a 4 to 1 multiplexer

Objective: At the end of this exercise you shall be able to
- **construct and test 4 to 1 multiplexer circuit using IC74LS151.**

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.

Materials/Components

- Rosin cored solder - as reqd.
- IC-74LS151 - 1 No.
- IC base 16 pin - 1 No.
- Digital IC trainer kit with instruction manual - 1 No.
- Resistor 330Ω/¼ W/CR25 - 2 Nos.
- Bread board - 1 No.
- LED 5mm, Red - 1 No.
- Hook up wires - as reqd.
- Miniature SPDT toggle switch - 6 Nos.
- Data sheet of IC 74LS151 - 1 No.

Safety Precaution: Ensure that the IC pins are not bent while inserting into the bread board IC Base.

PROCEDURE

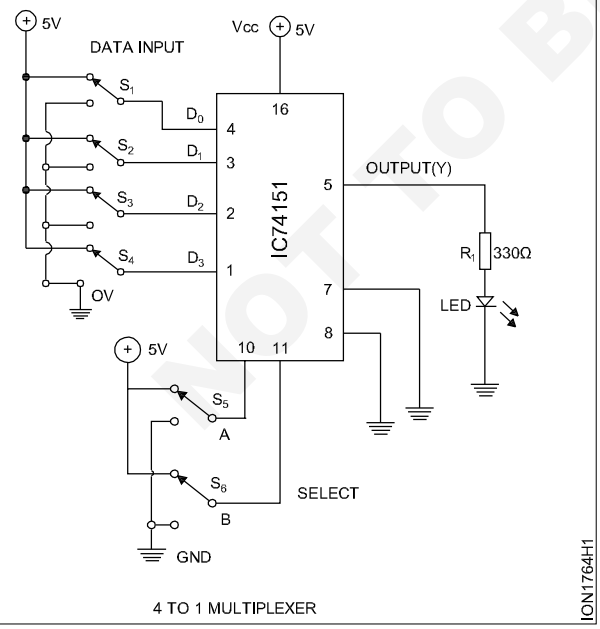
Note: If the digital IC trainer kit is not available in the lab,follow the steps given for this exercise .

TASK 1: **Construction and testing of 4 to 1 multiplexer circuit using IC 74LS151**

1 Collect the components required, check them and assemble the multimeter circuit on breadborad, as shown in Fig 1.

Use the 16 pin IC base for IC74LS151.

Fig 1



4 TO 1 MULTIPLEXER

2 Use toggle switches either in 5V position or in Zero Volt position for different logic levels as shown in Table-1.

3 Get the assembled multiplexer circuit checked by the Instructor.

4 Switch ON the 5VDC supply to the circuit and operate switches S_1 to S_4 for Data inputs and S_5 & S_6 for selection Sequence.

5 Observe the LED for each setting and record it in Table 1.

Note: When data input is not available, multiplexer does not produce output for the select condition.

6 Verify the output by keeping data input switches S_1 to S_4 in 5VDC position and select S_5 & S_6 randomly.

7 Observe the LED and change Data input switches one at a time for theLED to go OFF.

It confirms that input is selected and goes to the output.

8 Repeat steps 6 & 7 with different combinations of S_5 & S_6 and confirm the Data selected.

Table 1

Sl. No.	DATA INPUTS (LOGIC LEVELS)				SELECT SEQUENCE		LED OUTPUT (Y)
	D_3	D_2	D_1	D_0	B	A	
1	0	0	0	1	0	0	D0-LED ON
2	0	0	1	0	0	1	D1-LED ON
3	0	1	0	0	1	0	D2-LED ON
4	1	0	0	0	1	1	D3-LED ON
5	1	1	1	1			

9 Get the work checked by the Instructor.

— — — — — — — —

Construct and test a 1 to 4 demultiplexer

Objective: At the end of this exercise you shall be able to
- **construct and test a 1 to 4 demultiplexer circuit using IC 74LS138.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Regulated DC power supply 0-30V/2A - 1 No.
- Digital multimeter with probes - 1 No.
- Soldering iron 240V/25W - 1 No.
- Digital IC trainer kit with instruction manual - 1 Set.

Materials/Components

- IC-74LS138 with data sheet - 1 No.
- 16 pin IC Base - 1 No.
- LED 5mm, Red, Green - 4 Nos.
- Resistors 330Ω/¼W/CR25 - 4 Nos.
- Hook up wires - as reqd.
- Breadboard - 1 No.
- Rosin cored solder - as reqd.

Note: If the digital IC trainer kit is not available in the lab, follow the steps given for this exercise.

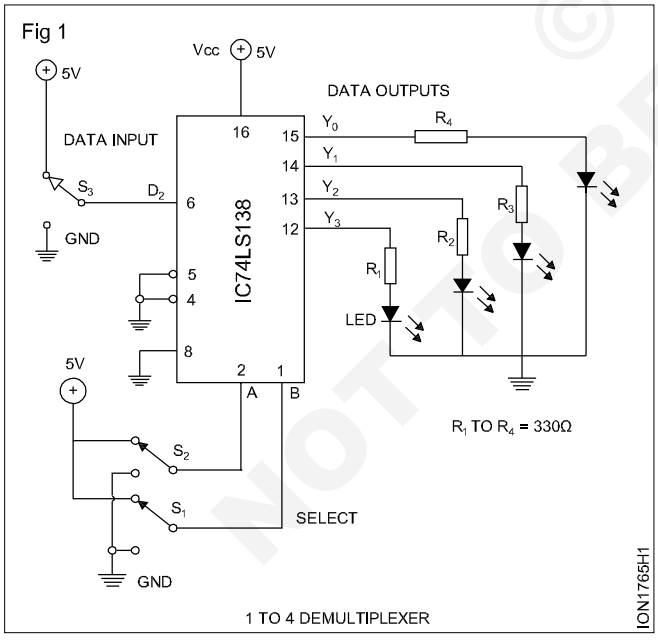
PROCEDURE

TASK 1: **Construction and testing of 1 to 4 Demultiplexer circuit using IC74LS138**

1 Collect all the components check them and assemble the demultiplexer circuit on breadboard, as shown in Fig 1.

Use the 16 pin base for IC74LS138.

Fig 1



2 Connect the toggle switch at input as shown in the circuit

3 Get the assembled circuit checked by the Instructor.

4 Switch ON the 5VDC supply to the circuit, Keep S_1 at + 5VDC for the data input high. Change the settings of switches S_2 and S_3 for different combination of Data select sequence as shown in Fig 1.

5 Observe the LEDs for each setting and record the status in Table 1.

Note: When data input is not available, Demultiplexer does not produce output for that condition in any of the Data output pins.

6 Verify the output by keeping the Data input switch S_1 to ground, Select Switch S_2 & S_3 randomly.

7 Observe the LED, Change switches S_2 & S_3 to other three combinations, for whether any of the LEDs to glow.

8 Repeat steps 6 and 7 by keeping the switch S_1 at +5VDC and confirm the LEDs are glowing independently as per the selection sequence in Table1.

Table 1

Sl. No.	Selection Sequence		Output channels(Pin Nos.) LED ON =1 LED OFF = 0								Remarks
	A	B	Y_0 pin 15	Y_1 pin 14	Y_2 pin 13	Y_3 pin 12	Y_0 LED	Y_1 LED	Y_2 LED	Y_3 LED	
1											
2											
3											
4											
5											

9 Get the work checked by the Instructor.

— — — — — — — —

Identify and test common anode and common cathode seven segment LED display using multimeter

Objective: At the end of this exercise you shall be able to
- **test the common anode and common cathode by using multimeter.**

Requirements

Tools/Equipments/Instruments

- Multimeter with probes - 1 No.

Materials/Components

- Seven segment LED (common anode) - 1 No.
- Seven segment LED (comon cathede) - 1 No.

PROCEDURE

TASK 1: **Testing the seven segment - LED display and identify the type**

1 Collect the components from Instructor. Check the 7-seg display units by using multimeter.

2 Identify the given display whether it is common anode (or) common cathode using data book.

3 Check each segment using multimeter in diode mode as shown in Fig 1. (Each segment is an LED inside when forward biased LED slows when reverse biased LED does no glow). Refer to Fig 3 to know the common terminal.

4 Multimeter +ve terminal is connected to common pin and -ve tenimal is connected to all pins.

Fig 1

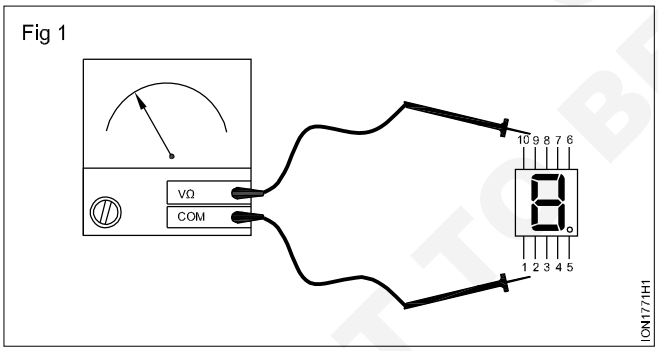


Fig 2

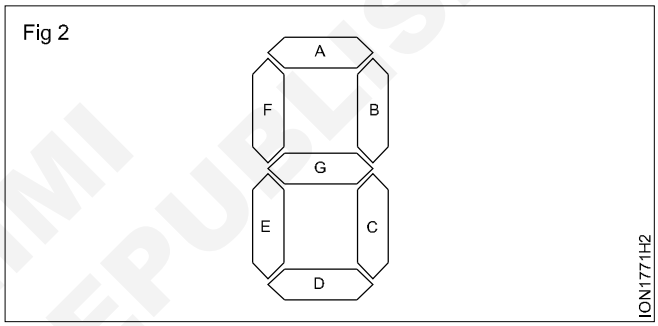
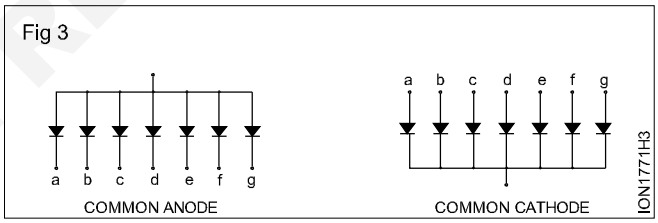


Fig 3



5 7 Segment pins are 10 numbers and 2 pins are common. 1 pin is dot (Details of Pin).

6 Repeat the checking procedure for the other type of display.

7 Get the work checked by the Instructor.

— — — — — — — —

Identify various indicators, cables, connectors and ports on the computer cabinet

Objectives: At the end of this exercise you shall be able to
- **identify various input/output devices connected to the computer**
- **identify different controls and ports on the PC system**
- **identify the internal parts of a system unit**
- **connect devices to related ports on the system unit.**

Requirements

Hardware and software

- Computer set - 1 No.

TASK 1: **Identification of different controls, ports and connectors on the PC system**

The instructor has to demonstrate the uses of the following indicators ,switches controls (Fig 1) and ports external to the processor found on the system unit shown in Fig 2 and the trainees will make a record of it in Table 1 and Table 2.

Fig 1

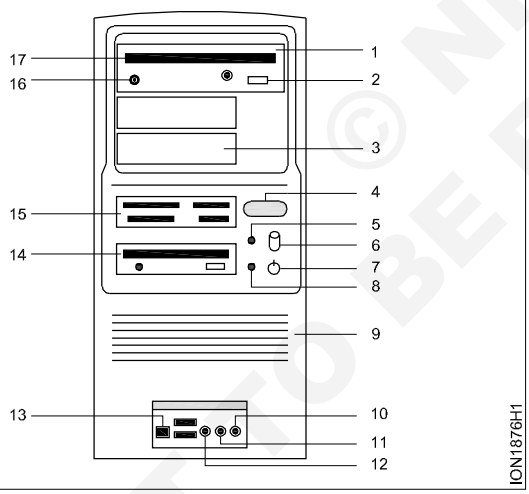


Fig 2

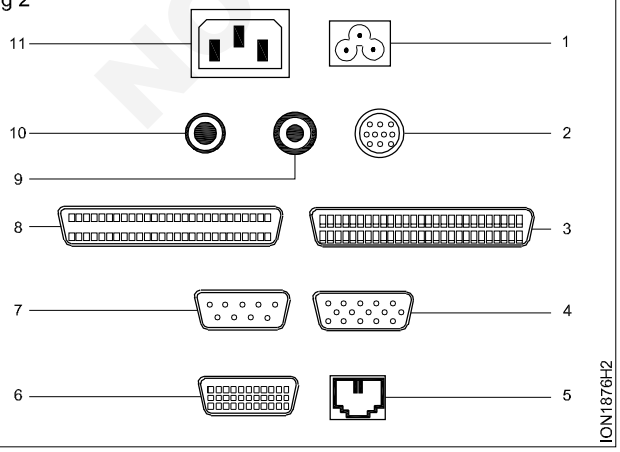


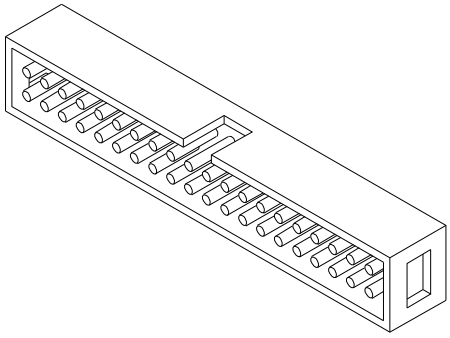
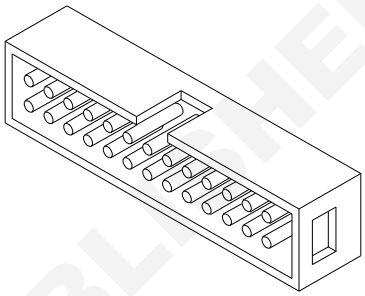
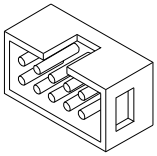
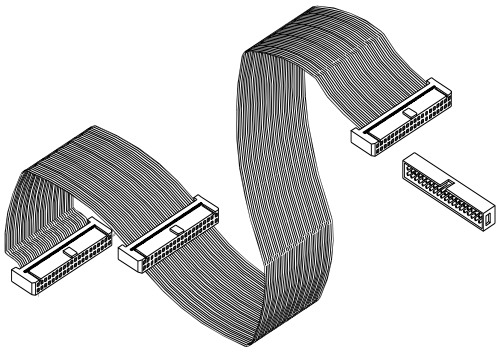
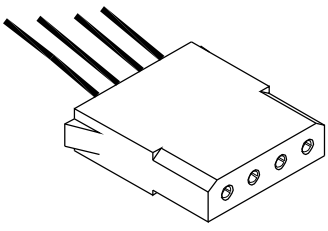
Table 1

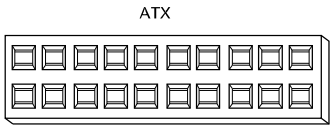
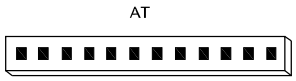
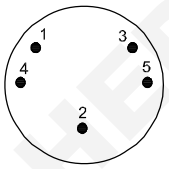
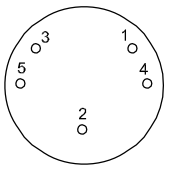
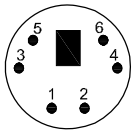
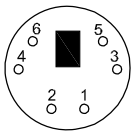
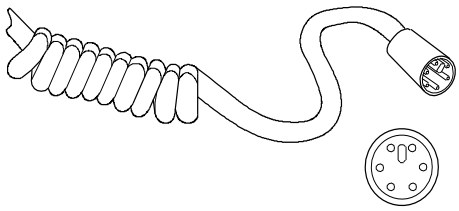
Sl. No	Name the parts on the CPU Front Panel
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	

Table 2

Sl. No	Name the ports on the CPU Rear Panel
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

Chart 1

Description	Application	Cable/connector
40 pin FRC male connector located on MB	To connect MB with HDD	 40 PIN FRC CONNECTOR
25 pin FRC male connector located on MB	To connect MB with Parallel port provided on the rear side of the PC	 26 PIN FRC CONNECTOR
10 pin FRC male connector located on MB	To connect MB with serial port “D” connector provided on the rear side of the PC	 10 PIN FRC CONNECTOR
HDD cable (data) located inside the PC	To connect MB with HDD	 HARD DISK CABLE
4 pin Molex connector from SMPS unit	SMPS to HDD, FDD, CDD	 MOLEX CONNECTOR

Description	Application	Cable/connector
20 pin Berg connector from SMPS unit	SMPS (ATX) to MB	 20 PIN BERG CONNECTOR
12 pin Berg connector	SMPS (AT) to MB	 12 PIN BERG CONNECTOR
5 pin DIN plug on key board cable	Key board to MB	 5-PIN DIN PLUG
5 pin DIN socket provided on the rear side of the PC	MB to key board	 5-PIN DIN SOCKET
5 pin Miniature DIN plug on keyboard cable	Key board to MB	 5-PIN MINI-DIN PLUG
5 pin Miniature DIN socket provided on the rear side of the PC	MB to key board	 6-PIN MINI-DIN SOCKET
PS/2 Key board connectors	MB to Mouse, Mouse to MB	 NEW STYLE PS/2 MINI DIN KEYBOARD CONNECTOR WITH SIX PINS

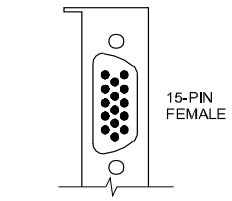
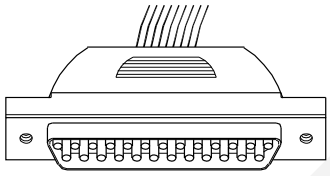
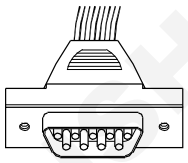
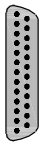
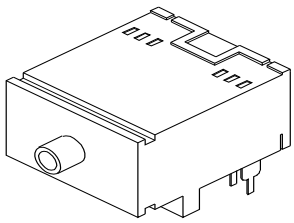
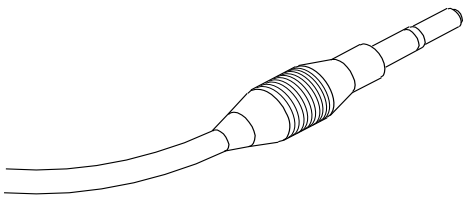
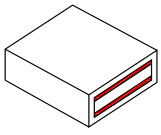
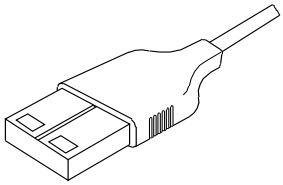
Description	Application	Cable/connector
15 pin High density VGA connector on the rear side of PC	MB to Monitor	 HIGH DENSITY CONNECTOR
D-25 pin male connector on the rear side of the PC	Serial port (Comport)	 25 PIN MALE CONNECTOR
D-9 pin male connector on the rear side of the PC	Serial port (Comport)	 9 PIN MALE CONNECTOR
D-25 pin female connector on the rear side of the PC	Parallel port (Printer port)	 25-PIN FEMALE CONNECTOR
Mini Jack socket on the rear side of the PC	Audio IN / MIC	 MINI JACK SOCKET
Mini Jack from external audio device	External Audio Devices to Sound card	 MINI JACK
USB female connector provided on the rear side of the PC	MB to USB peripherals	 FEMALE USB CONNECTOR
USB male connector from the USB device	USB peripherals to MB	 MALE USB CONNECTOR

Table 3

Sl. No	Name of the Connector/Cable
1	
2	
3	
4	
5	
6	
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Demonstrate various parts of the system unit and motherboard components

Objective: At the end of this exercise you shall be able to
- **identify drives HDD, CD ROM drive, DVD-drive, USB pen drive and various secondary storage devices and their usual maximum capacity for storage of information.**

Requirements

Tools/Instruments

- Screw driver set - 1 No.
- Digital Multimeter - 1 No.

Equipments

- Desktop PC with mouse & keyboard - 1 No.
- Extra SATA and PATA Hard-Disk Drive compatible cables - as reqd.

Materials

- Sticking labels for marking cables & connectors - as reqd.

- **In PC along with one set of I/O devices will be used for demonstration by instructor**
- **Two PCs each with one set of I/O devices and extra SATA HDD with cable, extra PATA DD with cable and one extra CD ROM drive / DVD ROM drive with cable, will be used by two groups of trainees (each group of maximum 20 trainees one group for identification and other for cable connection).**
- **In the PCs used by trainees ensure that all the major components inside system unit are cabled such that trainees can identify referring wall chart diagram.**
- **All the cables internal to system unit (processing unit) should be labelled along with (From - TO) and male - female connectors are also to be labelled by same code with suffix "F"&"T".**
- **All major components inside the processing unit like - HDD, CD R/W drive, DVD R/W drive, CPU processor, ROM BIOS etc to be labelled.**
- **Before opening the system unit processing unit, static charge of our body should discharge through earthing cable connected to body of demonstrator / user.**

PROCEDURE

TASK 1: **Identification of various drives and secondary storage devices in a PC**

1 Remove the cover of the PC system unit

2 Observe hard disk drive type either SATA or PATA and its capacity, power connection cable, its voltage column colour code at cable with voltage supply used.

3 Identify desktop PC HDD, CD-R/W drive & DVD - ROM drive, its connections for both type SATA and PATA hard disk drive and its connection using straight cables, cross cable for making it primary master either, primary slave or secondary master / slave using suitable data cable.

4 Identify connection point at mother board for SATA HDD, PATA HDD, CD R/W drive, and DVD R/W used in desktop PC

5 Identify different type cable connections used for different drive.

6 Identify polarity of connector to avoid wrong connection.

7 Fix the cabinet, switch on supply and check the status of computer.

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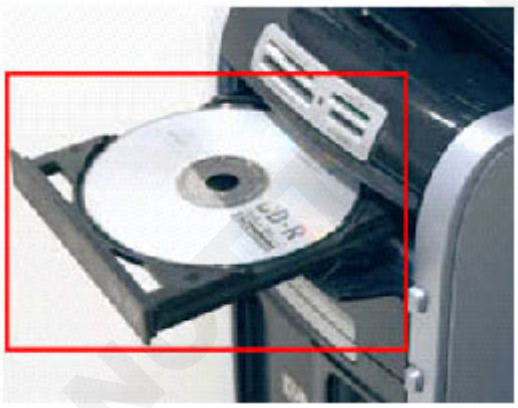
Fig 1

Floppy Drive

Fig 2

DVD Drive

Fig 3



CD Drive

Fig 4

Hard Disk Drive

Fig 5

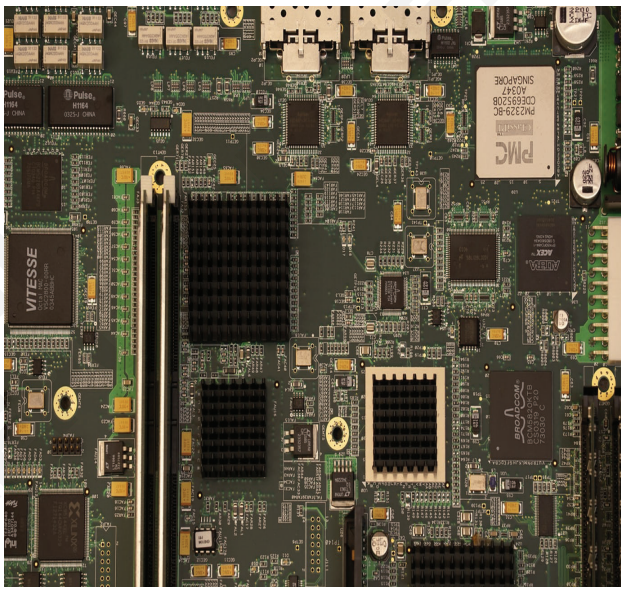
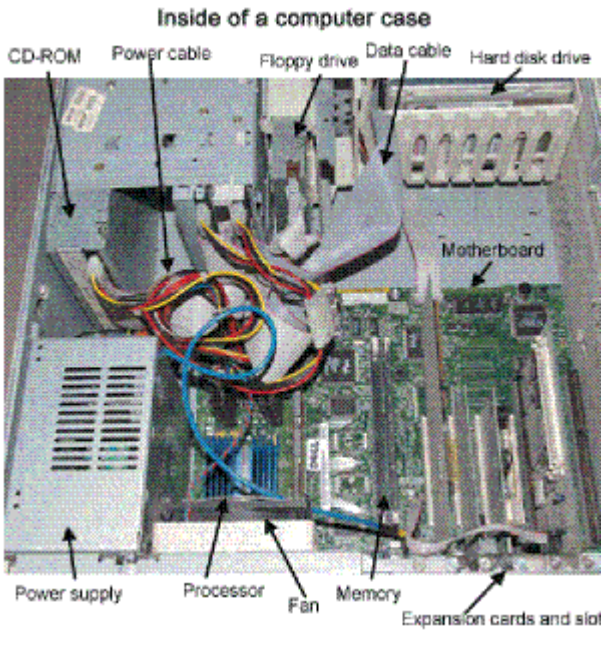


Fig 6



Identify various computer peripherals and connect it to the system

Objectives: At the end of this exercise you shall be able to
- **identify different controls on the processing unit cabinet**
- **identify various input/output devices connected to PC**
- **identify various ports available on PC for various devices.**

Requirements

Hardware and software

- Identical PCs with labelled 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.

- **One PC along with one set of I/O devices will be used for demonstrating by the instructor.**
- **Two PC's each with one set of I/O devices will be used by two groups of trainees(each group not exceeding a maximum of ten trainees).**

PROCEDURE

TASK 1: **Identify the major components, Controls and Ports seen on the processing unit cabinet**

1 The instructor has to demonstrate the uses of the indicators, switches, controls and Ports external to the processor unit found on the cabinet of the processor unit as per the list given below.
- Mains power-on switch.
- Power on LED
- Reset button
- HDD busy LED
- Floppy Disk Drive, Disk eject button, Disk busy LED.
- CD Drive, CD busy/reading LED, controls and sockets found on the disk drive.
- Ports for connecting the Mouse and other devices.
- Printer port, keyboard connector, monitor connector.
- Speaker socket.
- Universal serial bus port (USB).

While demonstrating, the following points should be Highlighted and stressed.
- Function of each switch.
- Function of each LED indicator.
- Function of each visible device.
- Function of each port.
- Basic specification of DVD and CD drive.
- Basic symptoms of healthy processor (fan sound, power light, any unusual noise/smell etc).
- Precaution to be taken while using the computer.
- Precaution to be taken while operating DVD and CD drives.
- Precaution to be taken while handling DVD and CD.
- Precaution to be taken while handling and storing the processor unit.

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TASK 2: **Identification of the I/O devices connected to PC**

1 The Instructor has to demonstrate the controls of different I/O devices connected to PC as per the list.
   - The Monitor
   - The Printer
   - The Mouse
   - The Keyboard
   - Multimedia speakers
   - The microphone
   - The scanner
   - The Modem
   - Any other I/O devices available at the time of conducting this demonstration.

While carrying out the demonstration, the instructor has to ensure the following points are highlighted,

Precautions to be taken for handling the PC system.

1 Record the I/O devices connected to the computer setup given to you.

2 Record the manufacturer, type name and model name/ number of the I/O devices connected.

3 Record against each device whether it is an input device or an output device.

4 Get the recorded details of the devices checked by the instructor.

— — — — — — — —

Install antivirus software, printer scan the system and explore the options in the antivirus software

Objectives: At the end of this exercise you shall be able to
- **install antivirus software from a disc**
- **install the printer driver software and perform the self-test**
- **install antivirus software from internet**
- **scan the system for virus.**

Requirement

Tools/Equipments/Instruments

- Computer or Laptop with Windows Operating System preinstalled - 1 Set.
- Antivirus software CD/DVD (updated version) - 1 No.
- Printer with set of accessories and driver software CD/DVD - 1 Set.
- Internet connection/LAN network - as reqd.
- RJ45 patch cord, USB cable/data cable - as reqd.

PROCEDURE

TASK 1: **Installation of antivirus software from a Disc**

1 Power ON the computer/Laptop and wait for the icons on the desktop.

2 Note down the security code printed on the back of the plastic case for the CD-ROM containing the antivirus software.

3 Load the anti-virus CD-ROM into the disc tray, close and wait for the CD menu to appear on screen.

4 Select and click the "Install Now" button located inside of dialog box of the antivirus software menu.

Clicking this button begins the process. After clicking the "Install Now" button, the required files will automatically download to the computer.

5 Type in the product security code in the boxes on the screen and click/follow the on-screen prompts.

6 Reboot/restart the computer when the installation is complete.

This involves shutting down and restarting the computer so the anti-virus settings can take effect.

7 Get the work checked by the Instructor.

— — — — — — — —

TASK 2: **Installation of Antivirus Software From the Internet**

1 Browser the anti-virus software company site on the Internet for the anti - virus program software as shown in Fig 2.

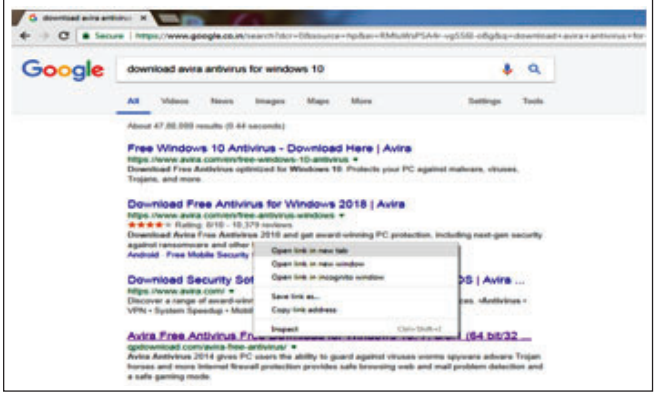
Some offer trial versions/free version of antivirus programs.

2 Choose the software product, wish to download the free version from the company's site and click "Download Now" icon.

3 Follow the on-screen prompts, click "Yes" when asked to download the software to the computer.

4 Wait for the download to complete.

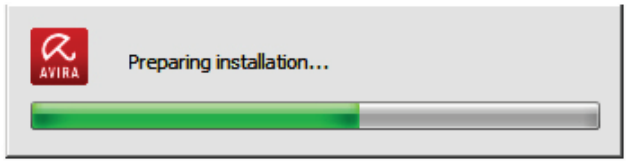
Fig 2



5 Go to “Download Folder”, select and open the downloaded antivirus software.

6 Click the “install” icon and wait dor the installation to complete as shown in Fig 3&4.

Fig 3

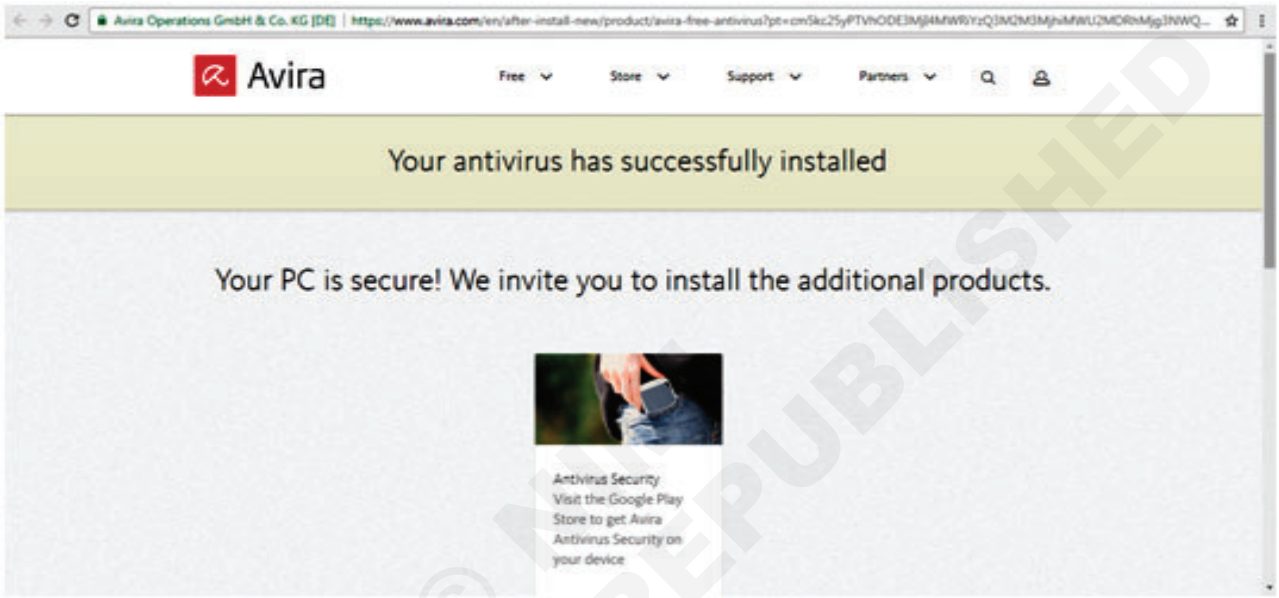


This could take several minutes, depending on the speed of the Internet connection. Do not log off the computer or change any setting until the software has finished downloading to the system.

7 Reboot/restart the computer if prompted at the end of the installation.

8 Go to desltop, identify the icon related to the installed antivirus software.

Fig 4



9 Get the work checked by the Instructor.

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TASK 3: **Scanning the system for virus**

1 Go and select the anti-virus software from the start menu/short cut icon on the desktop screen.

2 Click the icon SCAN button on software screen.

3 Select the option for scanning the drive name/type of scanning to begin.

4 Click the button to scan and observe the screen for warning/notifications shown by the antivirus software.

5 Record your observation in Table 1.

Table 1

Sl.No.	Drive name	Warning / Notification	Remark
1			
2			
3			

6 Get the work checked by the Instructor.

— — — — — — — —

TASK 4: **Installation of Laser/Inkjet Printer on computer.**

Safety precaution

1 Keep the printer in OFF condition, while connection it to the computer.

2 Install printer driver software according to the manufacturer's instructions given in the CD.

1 Connect the power cable of the printer and computer to the AC mains supply.

2 Connect the data cable to the USB port of the computer/laptop.

3 Switch ON the printer and computer/laptop.

4 Load the printer driver CD-Rom into the disc tray close and wait for the CD menu/dialog box to appear on screen.

5 Click and follow the on-screen option in the dialog box to insta the printer driver software.

Add a Local printer on Windows

1 Ensure the printer and computer power cables and data cables are correctly connected.

2 Switch ON the computer ad printer and wait for the desktop screen to appear.

3 Open the “Setting app” by clicking the start menu and inside the menu lise click “Devices” icon.

4 Click “Add a printer or scanner” option and observe the windows detects the connected printer.

5 Click on the Name of the printer and follow the on-screen instructions to finish the installation.

Incase Windows doesnot find the connected printer, click on the “The Printer that I want is not listed” option in the dialog box. Then the windows troubleshooting guide help you find your printer. Otherwise, search the manufacturer’s website and download the driver software and insrtall it following similar steps in Task 2.

6 Get the work checked by the instructor.

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Browse search engines, create email accounts, practice sending and receiving of mails and configuration of email clients

Objectives: At the end of this exercise you shall be able to
- **open yahoo website**
- **open google website**
- **open dictionary website**
- **download the image**
- **download software**
- **create mail account**
- **open the mail account**
- **compose mail**
- **check the inbox.**

Requirement

Tools/Equipments/Instruments

- Desktop Computer or Laptop with windows OS - 1 No.
- Internet Connection

PROCEDURE

TASK 1: **Opening the Yahoo Website**

1 Boot the system, if not booted.

2 Check the internet connection.

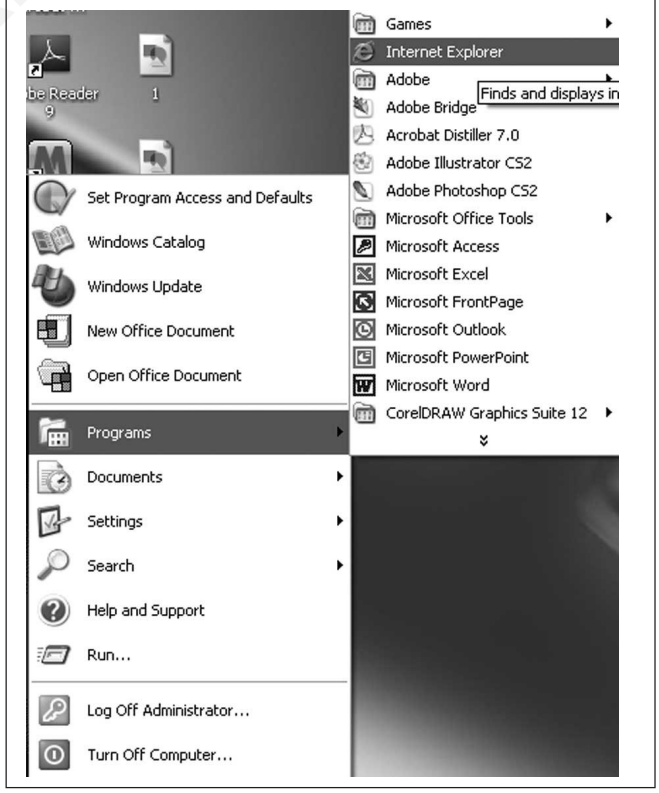
3 Double click the internet explorer on the desktop or.

4 Choose Start button as in Fig 1.

Fig 1

5 Select Programs as in Fig 2.

Fig 2



6 Click Internet Explorer.

7 Opened internet explorer window.

8 Type the website address : www.yahoo.com on address bar as in Fig 3.

9 Displayed yahoo web site.

10 Get the work checked by the Instructor.

Fig 3

TASK 2: **Opening the Google**

1 Type the address : www.google.com on address bar as in Fig 4.

2 Displayed google website.

3 Get the work checked by the Instructor.

Fig 4

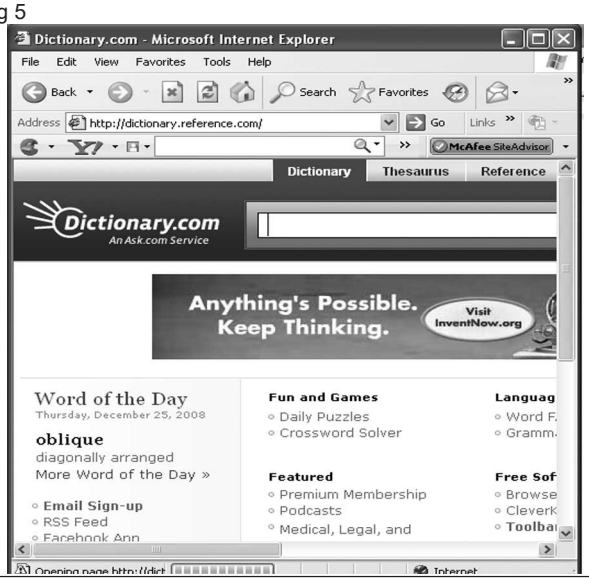
TASK 3 : **Opening Dictionary.com website**

1 Type the address : www.dictionary.com on address bar as in Fig 5.

2 Displayed dictionary website.

3 Get the work checked by the Instructor.

Fig 5



TASK 4: **Downloading a Picture**

1 Type the address : www.google.com on address bar as in Fig 6.

Fig 6

2 Type the word "Flowers" on text box.

3 Click Images tab.

4 Click Search image button.

5 More flower images are displayed.

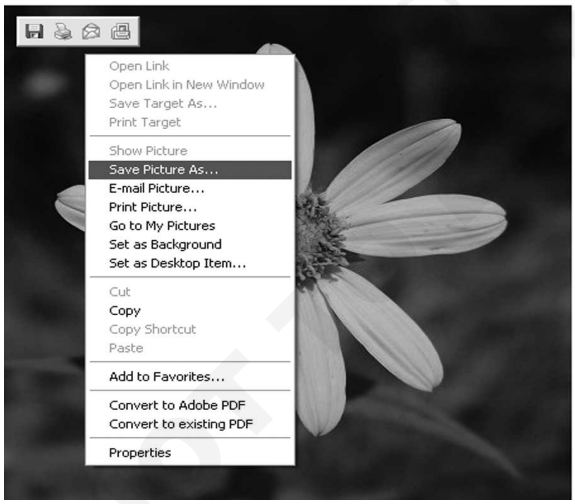
6 Click any one image.

7 Opened the flower image.

8 Select the flower image and right click the mouse button.

9 Click Save Picture as in Fig 7.

Fig 7



10 Choose saving location.

11 Click Save button.

Download Child Image

12 Type the address www.yahoo.com on internet explorer address bar.

13 Displayed yahoo website.

14 Type the word child Image on text box and click search tab.

15 Choose images tab.

16 More child images are displayed.

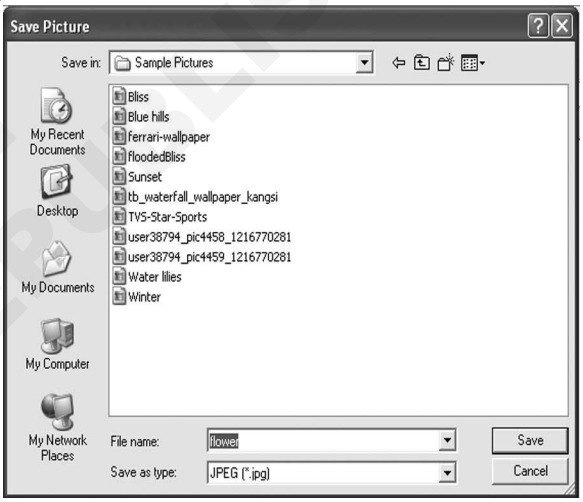
17 Choose any one image.

18 Double click the image.

19 Select the image and Right click the mouse button.

20 Click Save picture as in Fig 8.

Fig 8



21 Choose saving location on image.

22 Click Save button.

23 Get the work checked by the Instructor.

— — — — — — — —

TASK 5: **Downloading the Software**

1 Type the text google.com on internet explorer address bar.

2 Display the google website.

3 Type the text "download winzip software" on text box.

4 Click Search button.

5 More download link displayed.

6 Click any one link.

7 Click Download.

8 Choose saving location.

9 Click Saved button.

10 Get the work checked by the Instructor.

— — — — — — — —

TASK 6: **Creating a new mail account**

1 Type the text **www.gmail.com** on internet explorer address bar.
2 Open gmail website.
3 Click Sign up for Gmail link.
4 Open the Application window.
5 Fill all the columns.
6 Finally click I accept button.
7 Created your own gmail account.
8 Get the work checked by the Instructor.

— — — — — — — —

TASK 7: **Opening the Mail**

1 Type the text www.gmail.com on internet explorer address bar.
2 Open gmail website.
3 Type the user name and password.
4 Click Sign in button.
5 Open mail window.
6 Check Inbox.
7 Inbox means received mail.
8 Get the work checked by the Instructor.

— — — — — — — —

TASK 8: **Composing email**

Step 1

1 Click Compose mail button.
2 Display writing mail window.
3 Type the To address : example **rajesh_143@rediffmail.com**

Step 2

4 Type the Subject : example : Reg. Leave request.
5 Click Attach a file option.
6 Choose location for attached file.
7 Click Open button.
8 Display message.
9 Type the body text.
10 Check the spelling.
11 Finally click send button.
12 Click Sent mail option.
13 Displayed sending mail report.
14 Get the work checked by the Instructor.

— — — — — — — —

TASK 9: **Checking Inbox**

1 Check Inbox button.
2 One mail received is notified by inbox(1).
3 From address rajesh kannan.
4 Click the latest mail.
5 Mail will be displayed.
6 Get the work checked by the Instructor.

— — — — — — — —

TASK 10: **Creating a New Mail account in Yahoo site**

1 Type the address www.yahoo.com on internet explorer address bar.
2 Open yahoo web site.
3 Click mail option.
4 Open email window.
5 Click signup link.
6 Display application window.
7 Compulsory Fill all column your details.
8 Finally click these button " create my account".
9 Display window for account created.
10 Get the work checked by the Instructor.

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TASK 11: **Entering the yahoo mail**

1 Type the mail id and password.
2 Click Sign.
3 Enter the mail account.
4 Check Inbox button (received 1 mail).
5 Check Spam mail (received 1 mail).
6 check online user.
7 Check Trash.

Check the Inbox

8 Check the inbox button (1 mail received).
9 Click inbox.
10 Display mail message.
11 Get the work checked by the Instructor.

— — — — — — — —

TASK 12: **Replying the mail**

1 Click the Reply link.
2 Display the compose window.
3 Automatically typed sender mail address.
4 Automatically subject typed sender subject.
5 Only typed message.
6 Finally click Send button.

Removed your Mail

7 Click received mail check box.
8 Click Delete button.
9 Deleted your current selected mail.
10 Displayed window for only one mail balanced.

Check Contacts

11 Click Contacts link.
12 Displayed all contacts name.
13 Get the work checked by the Instructor.

— — — — — — — —

TASK 13: **Creating a New Folder**

1 Choose My Folder window.
2 Click Add link (right side).
3 Created folder name by default in untitled.
4 Type the folder name "Personal".
5 Folder "Personal" is created.
6 Get the work checked by the Instructor.

— — — — — — — —

TASK 14: **Renaming the Folder**

1 Select the Folder.
2 Right click the mouse button.
3 Click Rename option.
4 Type folder name.
5 Get the work checked by the Instructor.

— — — — — — — —

TASK 15: **Deleting the Folder**

1 Select the Folder.
2 Right click the mouse button.
3 Click Delete option.
4 Deleted the selected folder.
5 Get the work checked by the Instructor.

— — — — — — — —

TASK 16: **Moving to Folder**

1 Select the received mail.
2 Click the check box.
3 Click the Move button.
4 Displayed all created folder.
5 Select personal folder.
6 Moved to personal folder successfully.
7 Displayed message for There are no messages in the inbox folder.
8 Check the personal folder.
9 Successfully moved to personal folder one mail.
10 Get the work checked by the Instructor.

— — — — — — — —

Identify different types of cables and network components e.g. hub, switch, router, modem etc.,

Objectives: At the end of this exercise you shall be able to
- **identify the cable types**
- **identify the network components.**

Requirements

Tools/Equipments/Instruments

- Modem - 1 No.
- Hub - 1 No.
- Router - 1 No.
- Switch - 1 No.

Materials/Components

- Coaxial cable bundle - as reqd.
- UTP cable bundle - as reqd.
- STP/optical cable - as reqd.

Note: The instructor has to select various network cables for this exercise and label them using numbers.

PROCEDURE

TASK 1: **Identification of different types of cables**

1 Pick one of the labelled cable from the given lot and identify the types.

2 Record the observations in the Table 1 (Refer to the Chart-1 to identify the name of the cable).

3 Repeat the steps 1 of 2 for remaining labelled cables.

4 Get the work checked by the Instructor.

Table 1

Sl. No.	Label No	Type Name	Remarks
1			
2			
3			
4			
5			

Chart - 1

Various network cables	Name of the cable
	
	
	
	

TASK 2: **Identification of various devices used in networking.**

1 Follow the steps in task 1 (instead of cable use labelled network devices/components)

2 Refer chart- 2 and record the observation using Table 2.

3 Repeat the steps for remaining labelled devices.

4 Get the work checked by the Instructor.

Table 2

Sl. No.	Label No	Type/Name of device/ components	Remarks
1			
2			
3			
4			

Chart 2

Various devices used in networking	Name of the device
	
	
	
	

Configure a wireless Wi-Fi network

Objectives: At the end of this exercise you shall able to
- **check wi-fi hardware**
- **connect wi-fi network**
- **disconnect wi-fi network.**

Requirements

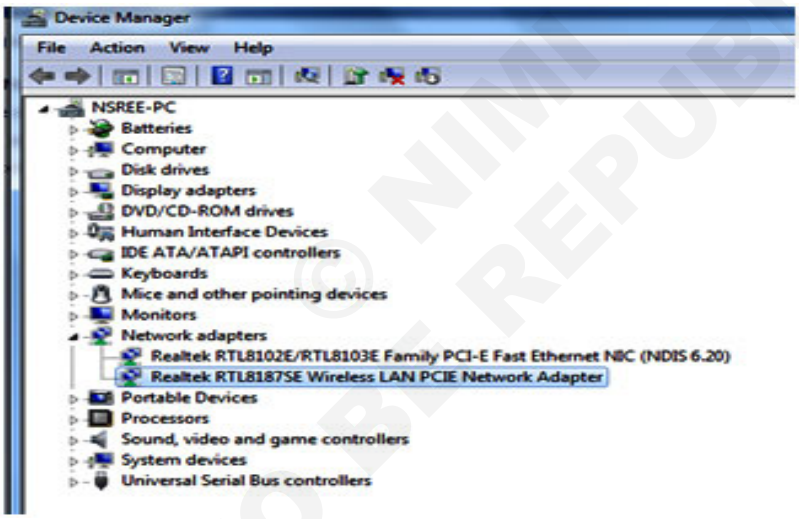
Tools/Equipments/Instruments

- Desk top computer or Laptop - 1 No.
- wifi hardware installation - 1 No.

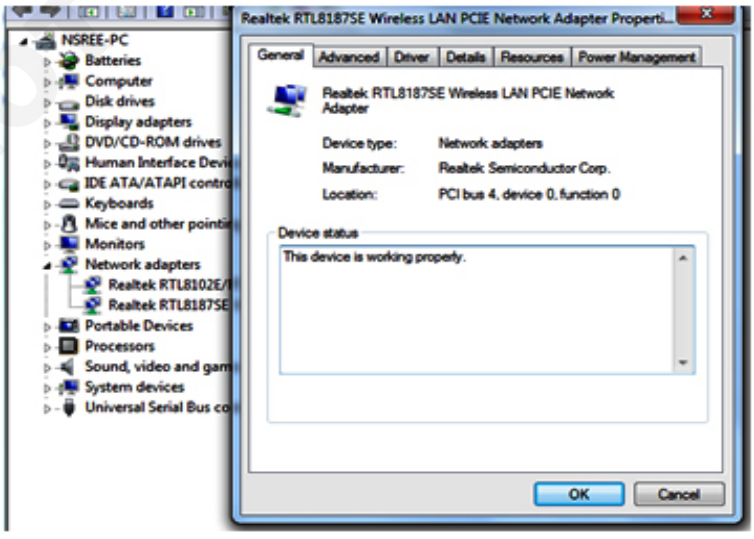
PROCEDURE

TASK 1: **Checking the availability of the wifi hardware and installation**

1 Open the control panel and check the Network adapters for the Wi-Fi.



2 Check the proper working of Wi-Fi device using properties.



3 Install a device if not found in the system as external Wi-Fi dongle.

4 Install driver for the device using CD or Internet download.

5 Check in the device manager for successful installation.

6 Get the work checked by the Instructor.

— — — — — — — —

TASK 2: **Connecting a Wi-Fi network**

1 Click the wireless icon in the notification area.

2 Select the network to connect.

3 Check the Connect automatically option.

4 Click the Connect button.

5 Enter the network security key.

6 Click the Next button.

Note : If the network flyout is not reporting any wireless network, try the steps shown below to turn off and on again Wi-Fi to see if that fixes the problem.

7 Get the work checked by the Instructor.

— — — — — — — —

TASK 3: **Disconnecting of Wi-Fi network**

1 Click the wireless icon in the notification area on the task bar.

2 Select the network that is currently connected.

3 Click the Disconnect button on the network connection.

4 Get the work checked by the Instructor.

Note : Alternatively, click the quick action Wi-Fi button at the bottom to turn off the adapter and disconnect from the network using flyout menu.The same Wi-Fi button can also be found in the Action Center's Quick Actions section (Windows key + A).

— — — — — — — —

Prepare simple digital and electronic circuits using the software

Objectives: At the end of this exercise you shall be able to
- **construct EX-OR gate using IC7404, 7408 and 7432 by the simulation software**
- **construct a positive shunt clipper circuit using discrete components by simulation software.**

Requirements

Tools/Instruments/Equipments

- Personal computer installed with simulation software like TINA/Multisim or similar software - 1 No.
- Printer - 1 No.

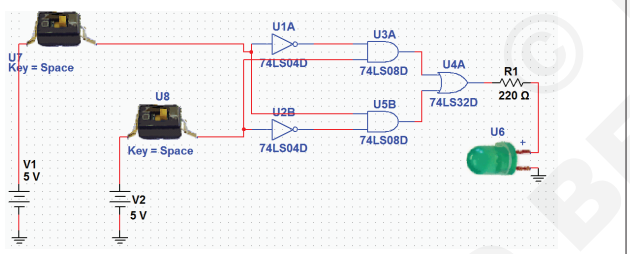
Note: This exercise has been developed using the multisim simulatiom software. The instructor has to follow/guide the trainees as per the steps/sequence with reference to the software available in the Lab/ computer.

PROCEDURE

TASK 1: **Construction of EX-OR gate using simulation software**

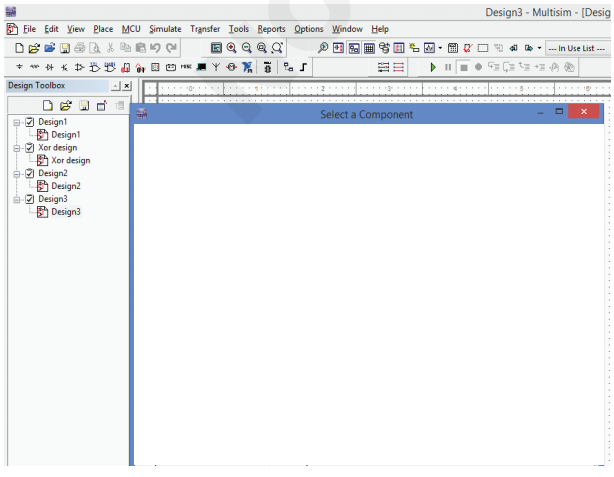
1 Select the circuit diagram to construct using simulation software. (For example the XOR gate is selected for this exercise) as shown in Fig 1.

Fig 1



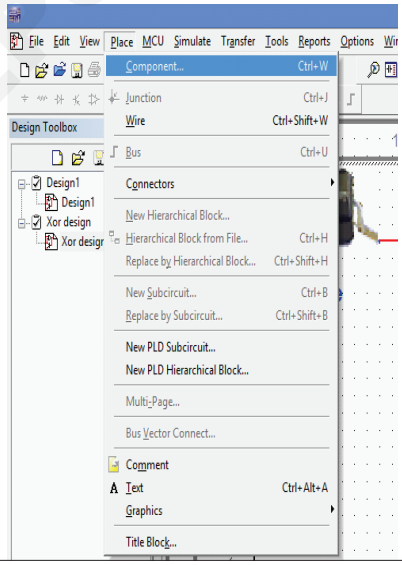
2 Switch ON computer, open the simulation software through the windows start menu or click on the simulator icon on your desktop and get the first screen as shown in Fig 2.

Fig 2



3 Click on **Place** menu and pull down the options as shown in Fig 3.

Fig 3



4 Click on component group, select **TTL** and scroll to **74LS** and select the required IC (**74LS04D**) and click **OK** as shown in the Fig 4.

5 Click on A and OK, if more than one gate is required click on A and B, etc. as shown in the Fig 5.

6 Follow the step 4&5 to select the other logic gates 7408 and 7432 as shown in Fig 6.

Fig 4

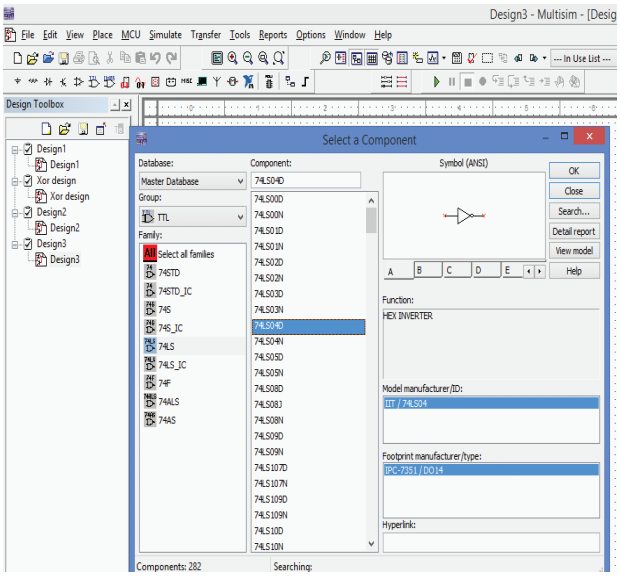


Fig 5

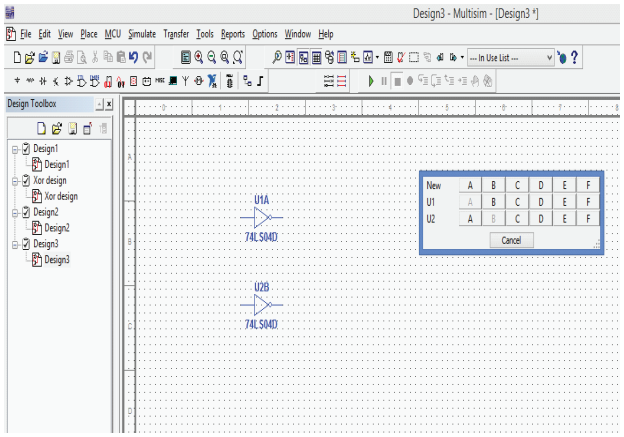
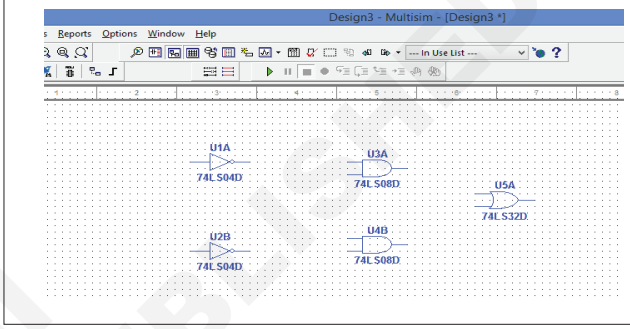


Fig 6



7 Select the required resistor by referring the figure given in Fig 7 and click **OK.**

8 Select the required LED and click OK.

9 Add the power supply and ground to the circuit as shown in Fig 8.

Fig 7

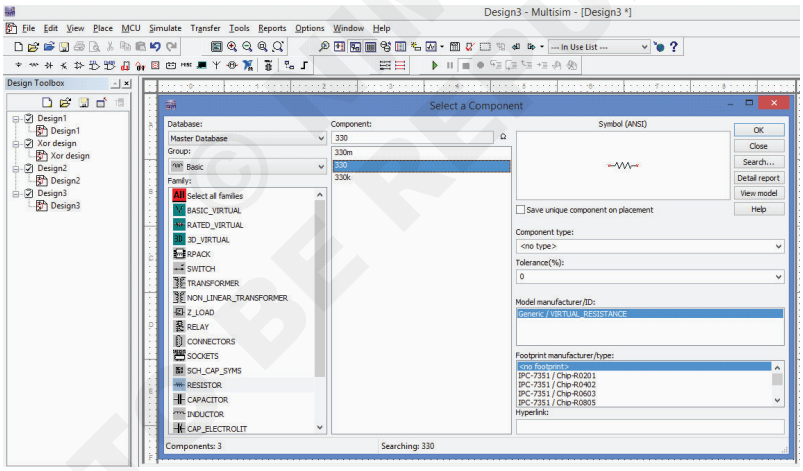
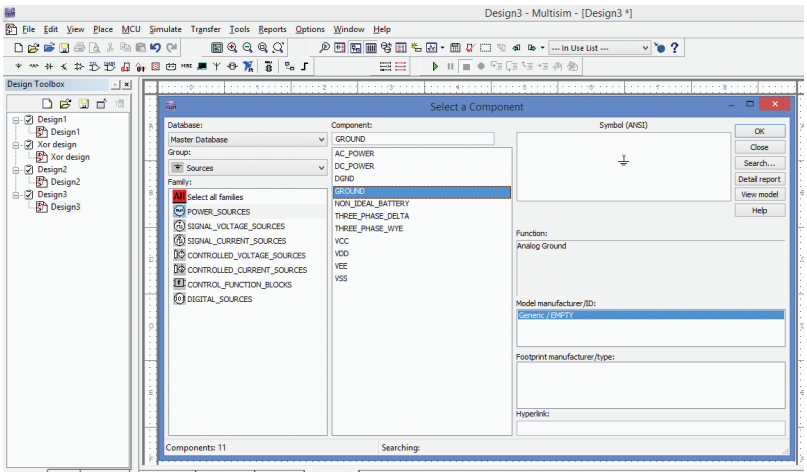


Fig 8

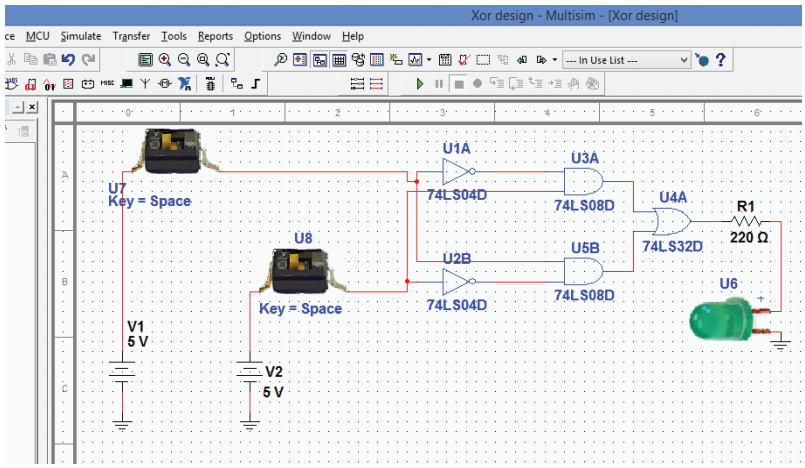


10 Make the wiring of the circuit by following Fig 1. Keep the cursor at one node of the component a dot will appear, move the cursor to the place of wiring the dot will appear at that node, now click the mouse to finish the wiring.

11 Double click on the power supply and change the label as A and B and set the voltages to 0.

12 Double click on the LED and change the label as C as shown in Fig 9 and save it.

Fig 9



13 Get the work checked by the Instructor.

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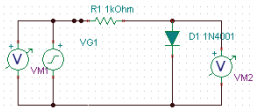
TASK 2 : **Construction of positive shunt clipper circuit using simulation software**

1 Select the positive shunt clipper circuit by referreing to the circuit as shown in in Fig 10.

Fig 10

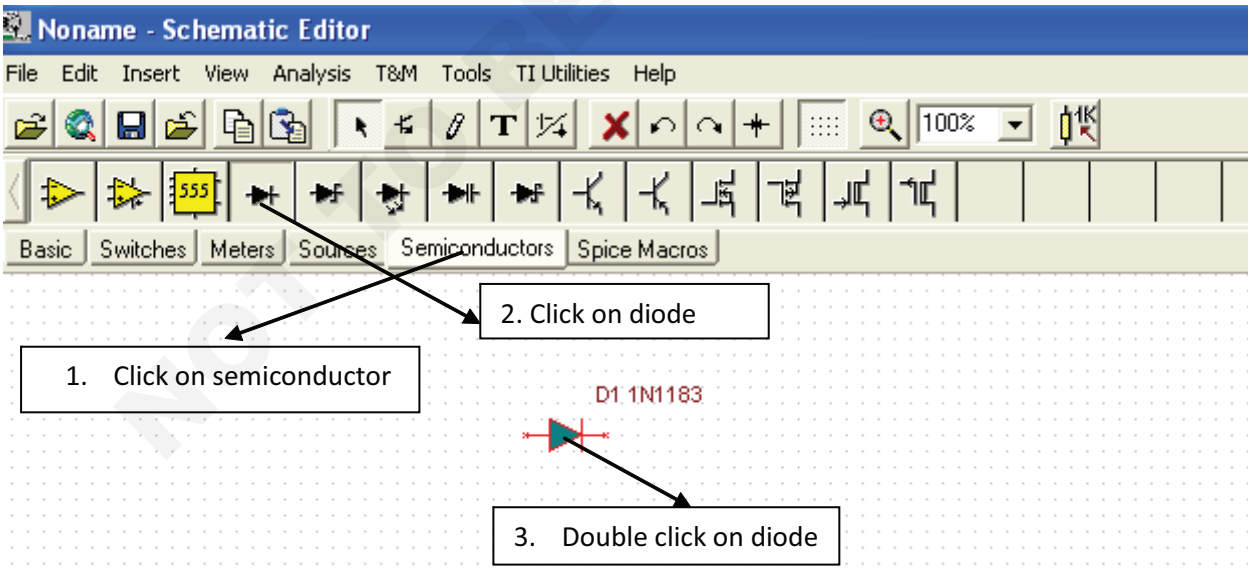


2 Switch ON the computer, double click on the simulator icon on the desktop.

3 Click on semiconductor and then click on diode, drag the diode into the user area as shown in Fig 11

4 Double click on the diode in the user area and click on the TYPE.

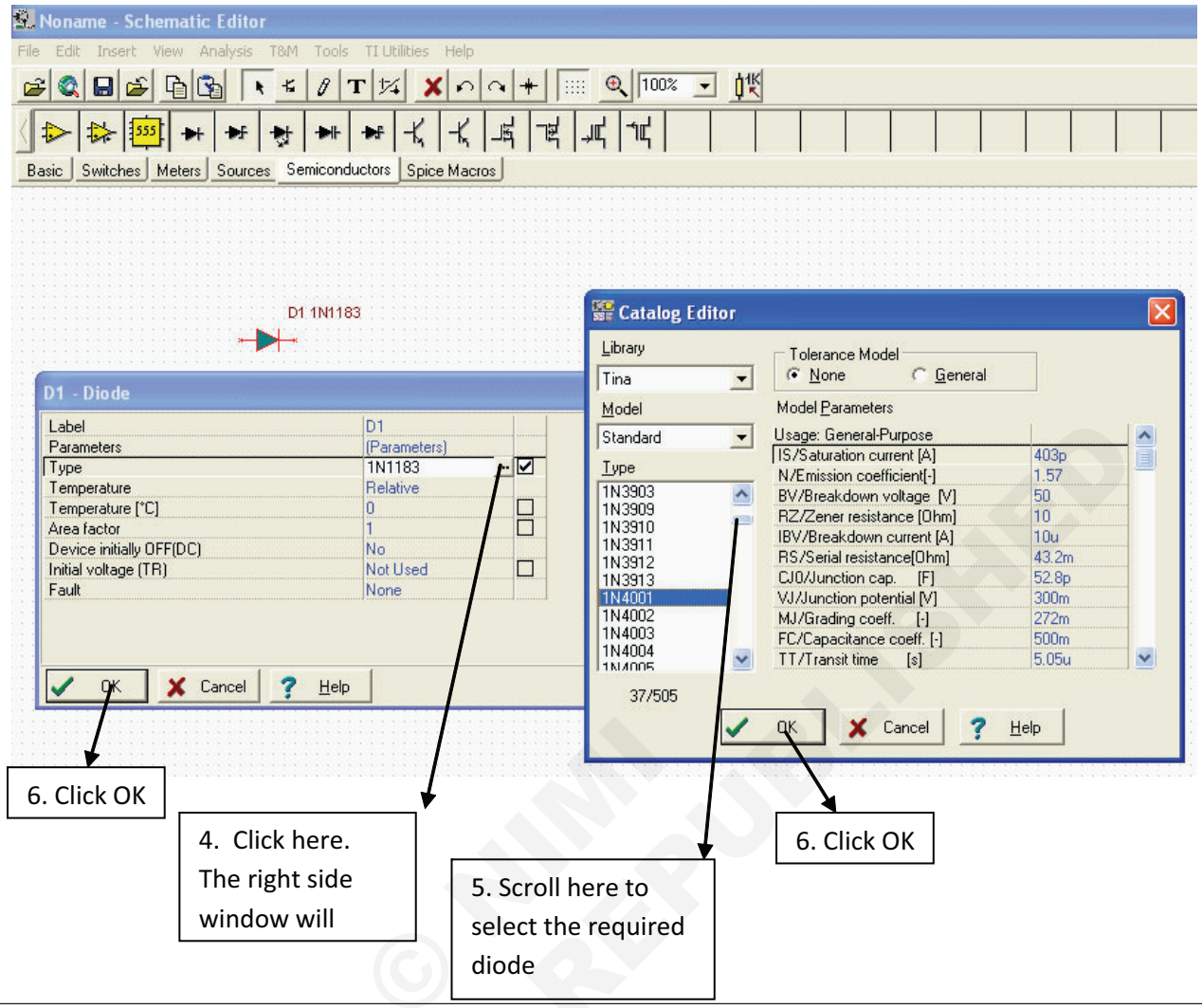
Fig 11



5 Select the suitable diode as shown in Fig 12 and Click **on OK** tab.

6 Ensure that the selected diode type number is displayed near the diode symbol.

Fig 12



7 Right click on the diode select **Rotate Right** if you want to place the diode in the vertical position as shown in Figs 13 & 14.

Fig 13

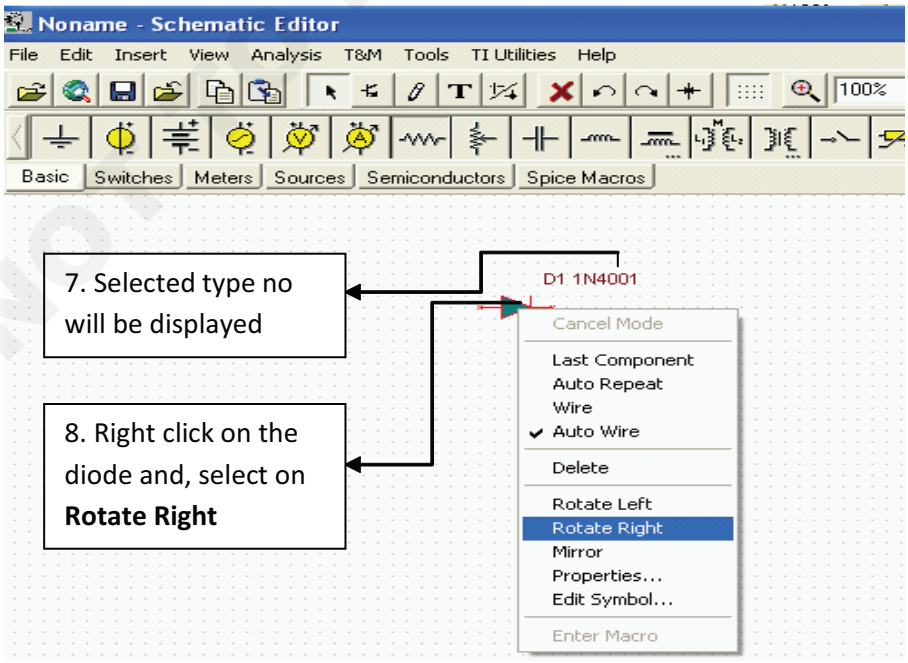
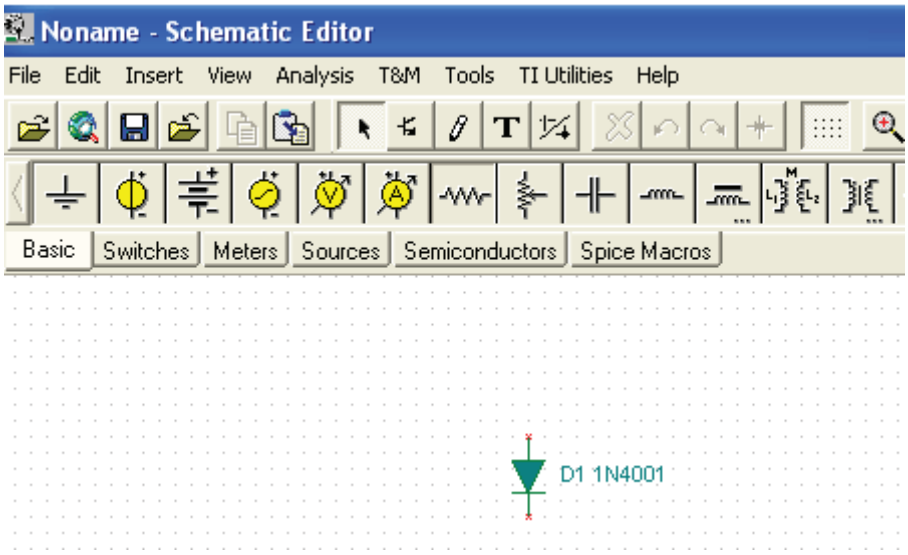


Fig 14



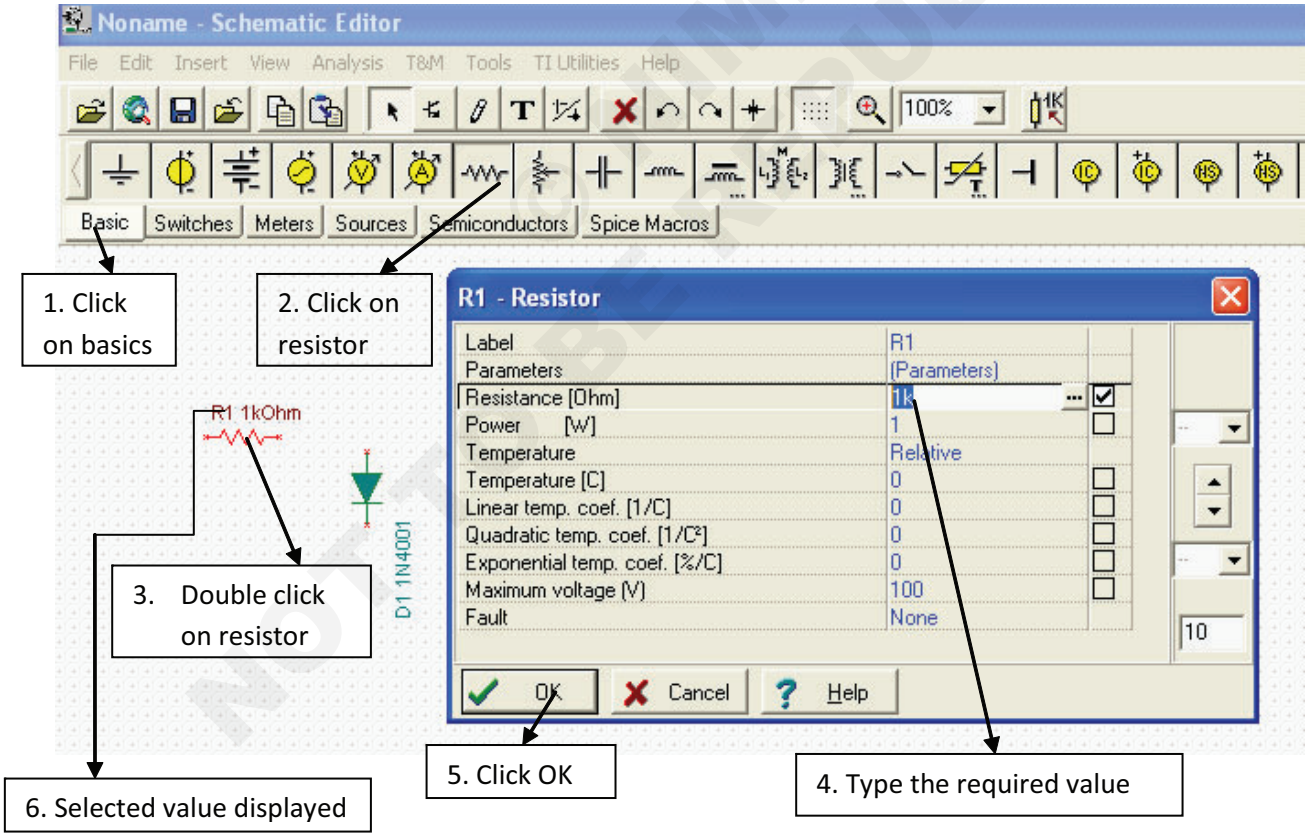
8 Click on **Basic menu to select a resistor and** click on resistor, drag the resistor into the user area.

9 Double click on selected resistor, type the value of resistor and click OK as shown in Fig 15.

Ensure that the selected resistor value is displayed near the resistor symbol.

10 Keep the cursor at one of the resistor terminal and drag the mouse towards the terminals of the diode make the wiring.

Fig 15



Refer the circuit in figure 10 for making other connections.

1 Keep the cursor at the red dot of one of the terminal and then drag the mouse, till the red dot of the other device where you want to make the wiring.

2 If any component/device is edited by double clicking on it, the symbol will appear red, otherwise it appear in green colour.

3 Press ESC on the keyboard if you have clicked on any symbol which you donot want to use in the circuit.

11 Click on the **Sources** menu to connect a voltage generator and voltmeters.

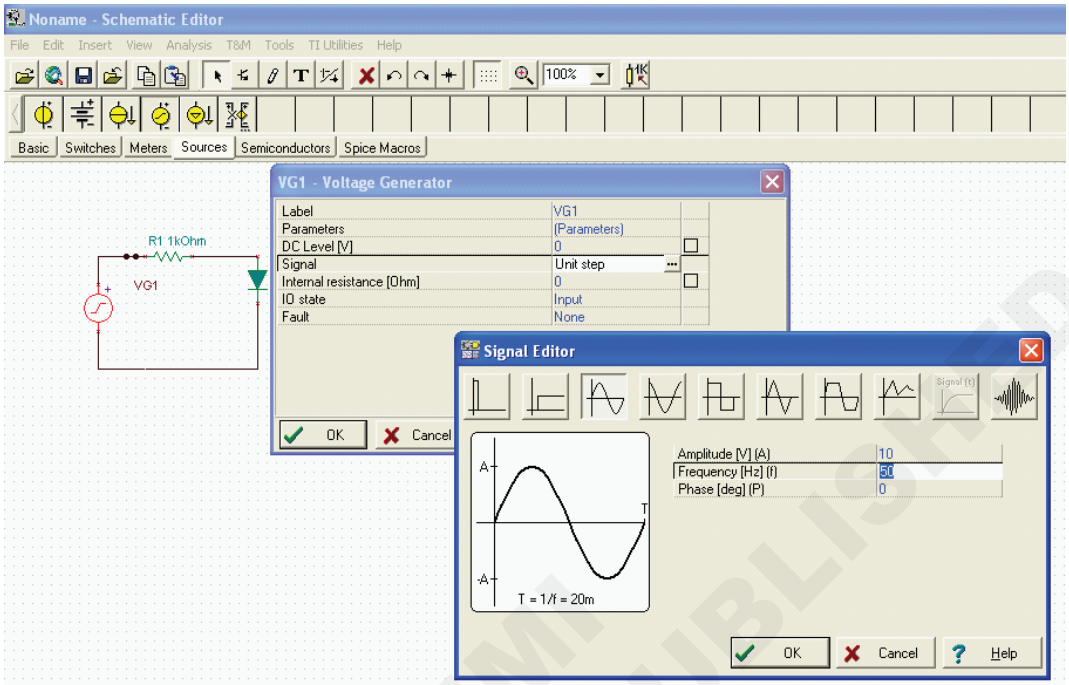
12 Click on the **voltage generator** dialog box and double click on the generator symbol.

13 Click on **Signal** and then **Unit step** dialog box.

14 Click on the required waveform appearing in the pop up window as shown in Fig 16.

15 Click on amplitude, frequency and phase to select the required value respectively and click OK and save the circuit.

Fig 16



16 Get the work checked by the Instructor.

— — — — — — —

Simulate and test the prepared digital and analog circuits

Objectives: At the end of this exercise you shall be able to
- **test the prepared digital circuits using simulation software**
- **test the prepared analog circuits using simulation software.**

Requirements

Tools/Equipments/Instruments

- Desk top computer with simulation software installed - 1 No.

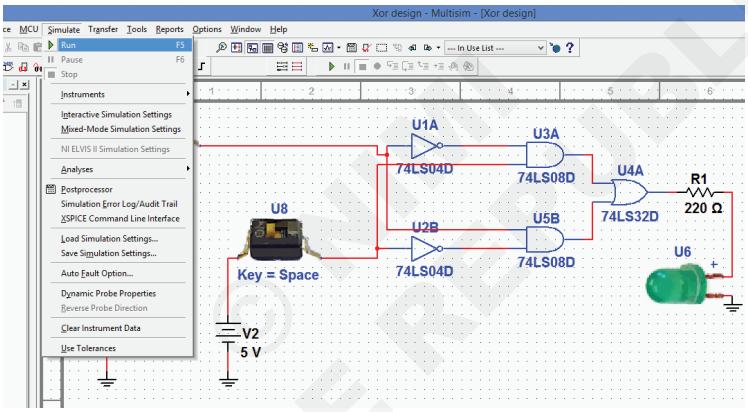
PROCEDURE

TASK 1: **Testing the constructed digital circuit (OR gate) using simulation software**

1 Switch ON the computer, open the simulation software and open the saved OR gate circuit.

2 Click on simulate menu to run the circuit as shown in Fig 1.

Fig 1

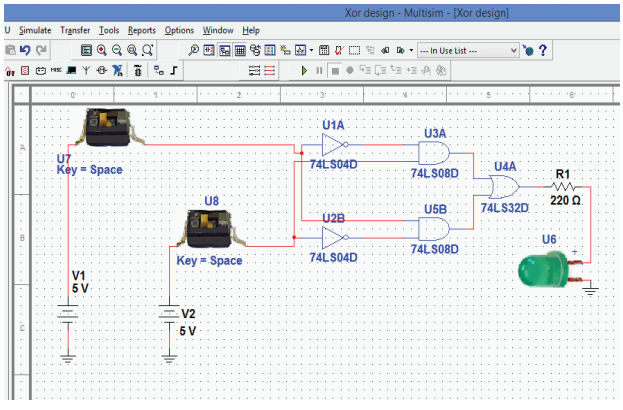


3 Modify the supply voltages as shown in the truth table and verify the truth table (If the output is one, the arrow in the LED will become RED (if red LED is selected; otherwise respective colour as shown in Fig 2, if the output is zero the arrow will be no glow).

Truth table of OR gate

S_1	S_2	LED condition
Open	Open	
Open	Close	
Close	Open	
Close	Close	

Fig 2



4 Get the work checked by the Instructor.

TASK 2 : **Testing the prepared analog circuit positive shunt clipper using simulation software**

1 Open the saved positive shunt clipper circuit.

2 Click on **meters** on the menubar.

3 Click and drag **volt meter** and connect across the voltage generator.

4 Once again Click and drag **volt meter** and connect across the diode (output terminal) as shown in Fig 3.

5 Click on **T&M** on the menubar, Select **oscilloscope** and click on it.

6 On pop up window Click on **Run** and observe the wave form displayed in the CRO.

7 Adjust **Time/div** and **Volt/div positions** to the suitable value as shown in Fig 4.

8 So that the waveform clearly seen select second channel by the probe in the CRO and click on the output terminal get both the waveforms visible on the CRO.

Fig 3

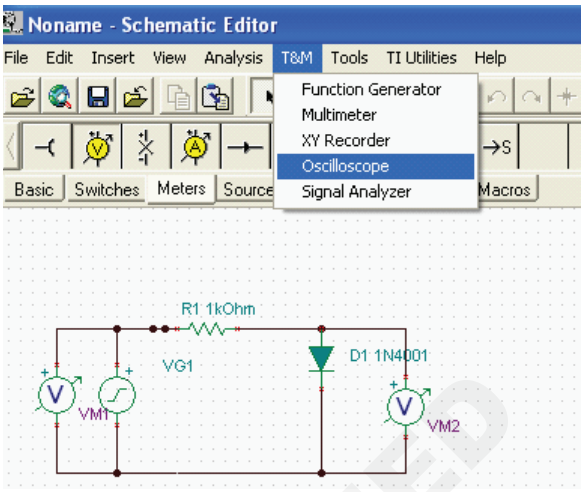
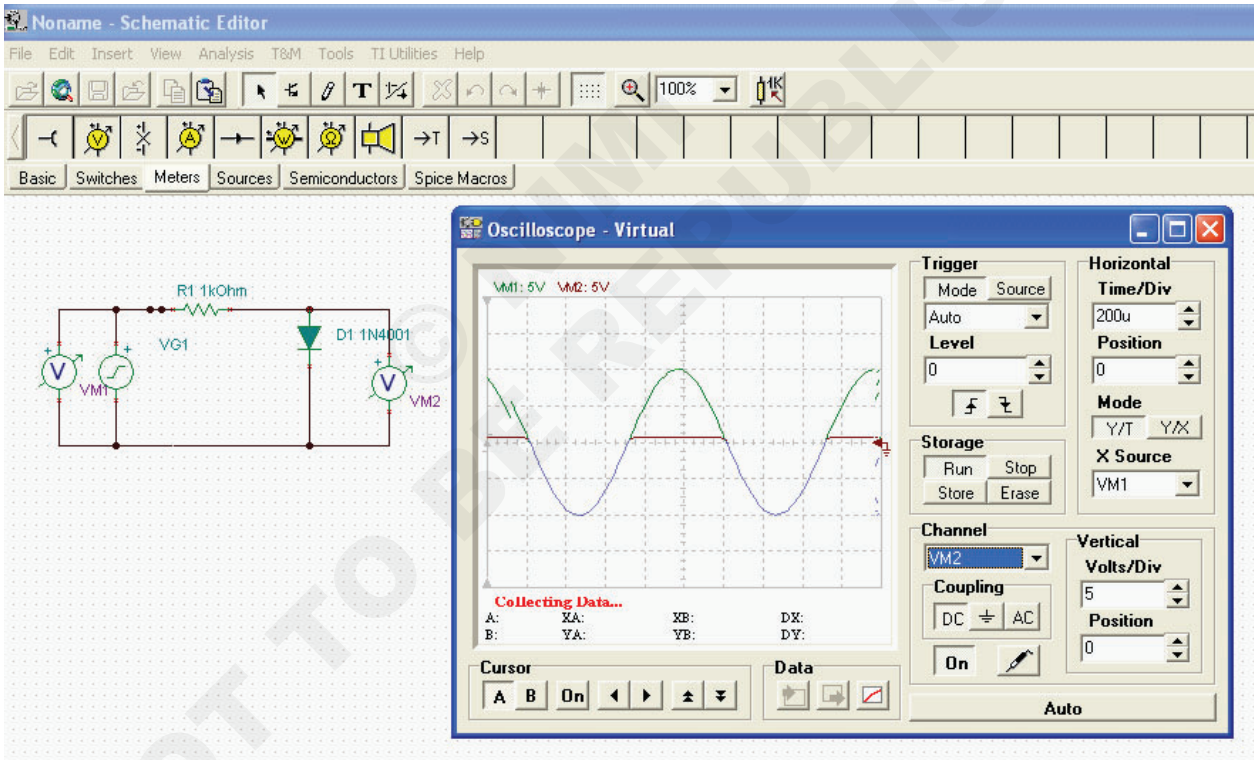


Fig 4



9 Click on stop , trace the waveforms and save it.

10 Get the result checked by the Instructor.

Save the circuit, so same circuit may be used later for revision.

Create fault in particular component and simulate the circuit for its performance

Objectives: At the end of this exercise you shall be able to
- **identify the fault**
- **analysis the fault performance**
- **simulate the performance of circuit.**

Requirements

Tools/Equipments/Instruments

- Desk top computer with simulation software installed - 1 No.

PROCEDURE

TASK 1: **Identify and analysis the fault performance and simulate the performace of the circuit**

1 Trainee take the component.

2 Create fault in the component in the presence of instructor.

3 Switch ON the computer, open the simulation software and Click on simulate menu to run the circuit

4 Connect the fault in the component to the simulation software.

5 After connection, check the performance of the component.

6 Note down the performance (in the table).

7 Get the result checked by the instructor.

Table

S.No	Name of the Component	Performance

— — — — — — — —

Convert the prepared circuit into a layout diagram

Objectives: At the end of this exercise you shall be able to
- **construct a single stage transistor amplifier using simulation software**
- **construct the prepared circuit into a layout diagram using simulation software.**

Requirements

Tools/Equipments/Instruments

- Personal computer installed with simulation software - 1 No.

PROCEDURE

TASK 1: **Construction of a single stage transistor amplifier circuit using simulation software**

1 Switch ON the computer, double click the icon on the desktop, open the software and pick the required components from the transistor amplifier circuit.

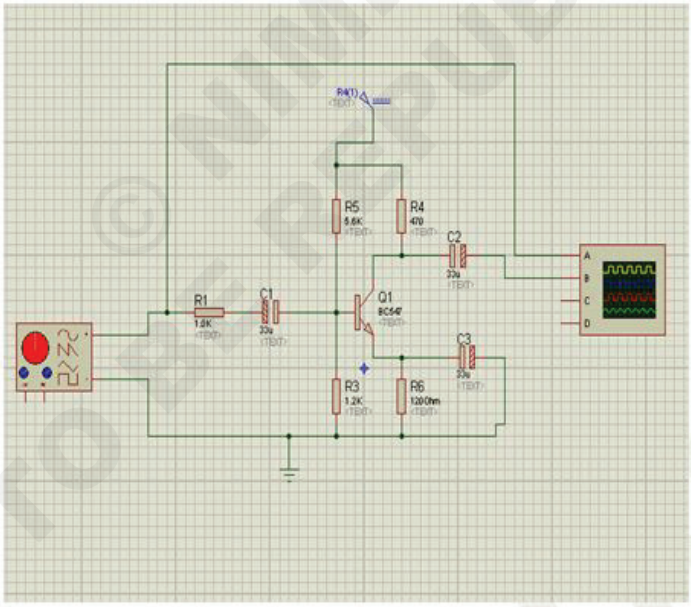
2 Place the required components, assemble the circuit in the work sheet area as shown in Fig 1.

3 Select required junction dot, terminal lead place in circuit for coupling required to construct wiring.

4 Connect the necessary equipments and instruments to the circuit as shown and save it.

5 Get the work checked by the Instructor.

Fig 1



TASK 2: **Conversion of the prepared circuit into a layout diagram.**

1 Open the circuit for conversion in the user area.

2 Click file menu, select convert PCB option and open PCB layout.

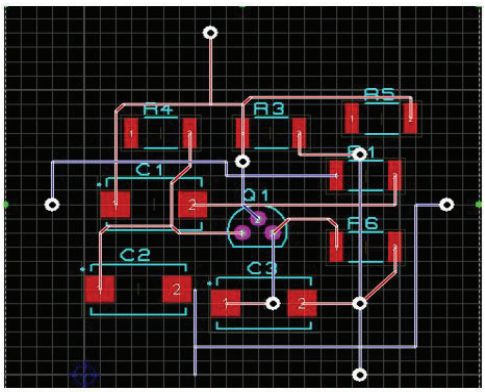
3 Click view menu, select grid size, and board outline.

4 Click and drag the components into the created layout.

5 Click for auto routing and save the lay out diagram as shown in Fig 2.

6 Get the work checked by the Instructor.

Fig 2



Prepare simple, power electronic and domestic electronic circuit using simulation software

Objectives: At the end of this exercise you shall be able to
- **prepare a simple power electronic circuit (half wave rectifier) using simulation software**
- **construct a domestic electronic circuit using simulation software.**

Requirements

Tools/Equipments/Instruments

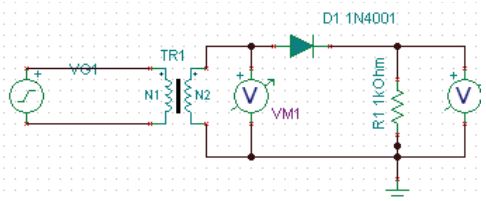
- Desk top computer installed with simulation software

PROCEDURE

TASK 1: **Construction of simple power electronic circuit (half wave rectifier) using simulation software**

1 Select the components required for constructing the half wave rectifier as shown in Fig 1.

Fig 1



2 Switch ON the computer and double click on the simulator icon available in the desk top.

3 Refer to the Ex No. 2.8.155, Task 2, follow steps and select the required resistor, diode and voltmeter by clicking on them.

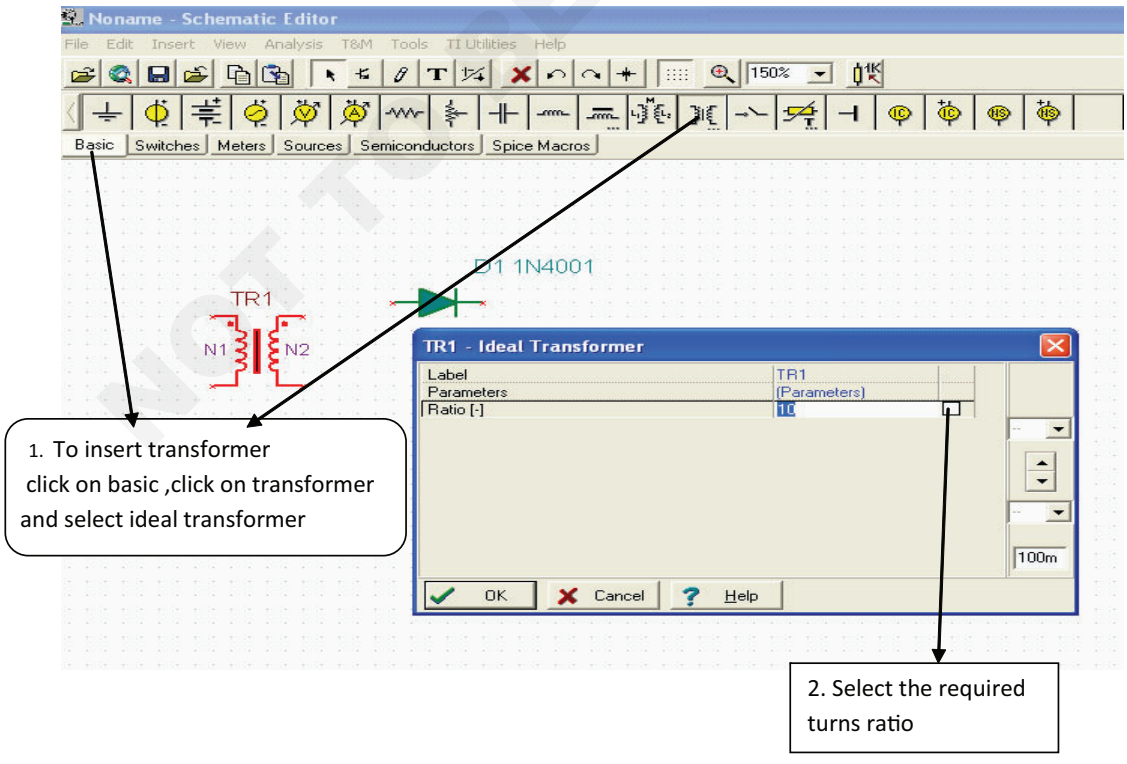
1 If you need to change the type of diode double click on diode & change its type.

2 To rotate the diode right click on it & select rotate option.

4 Click on Basics menu and on transformer, select ideal transformer.

5 Double click on the transformer, select the required turns ratio as shown in Fig 2.

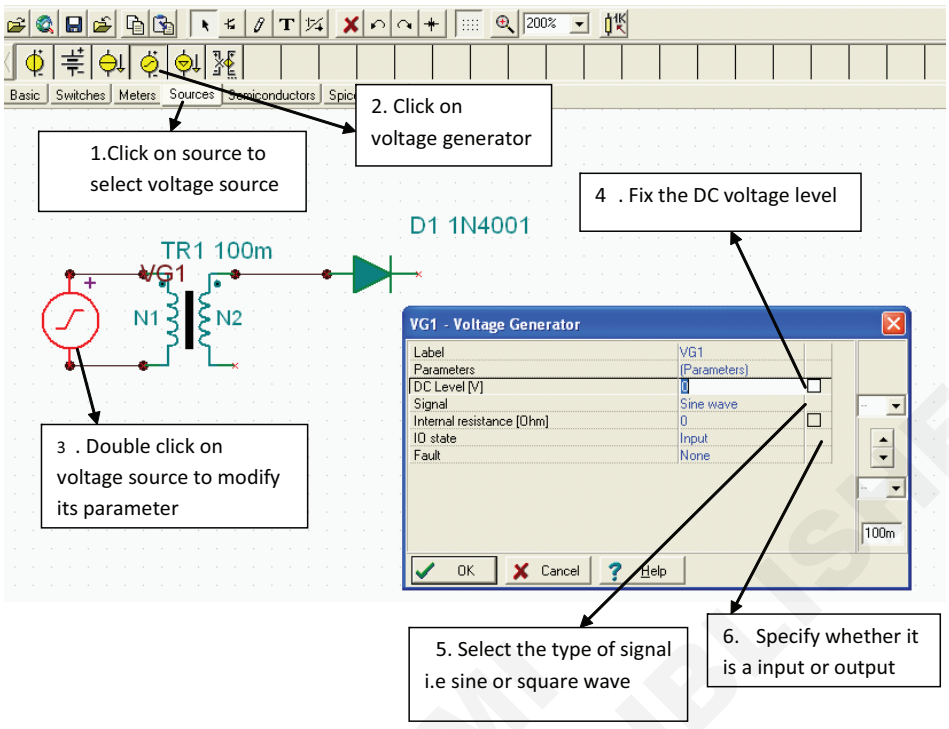
Fig 2



6 Click on **source** menu and insert the voltage source.

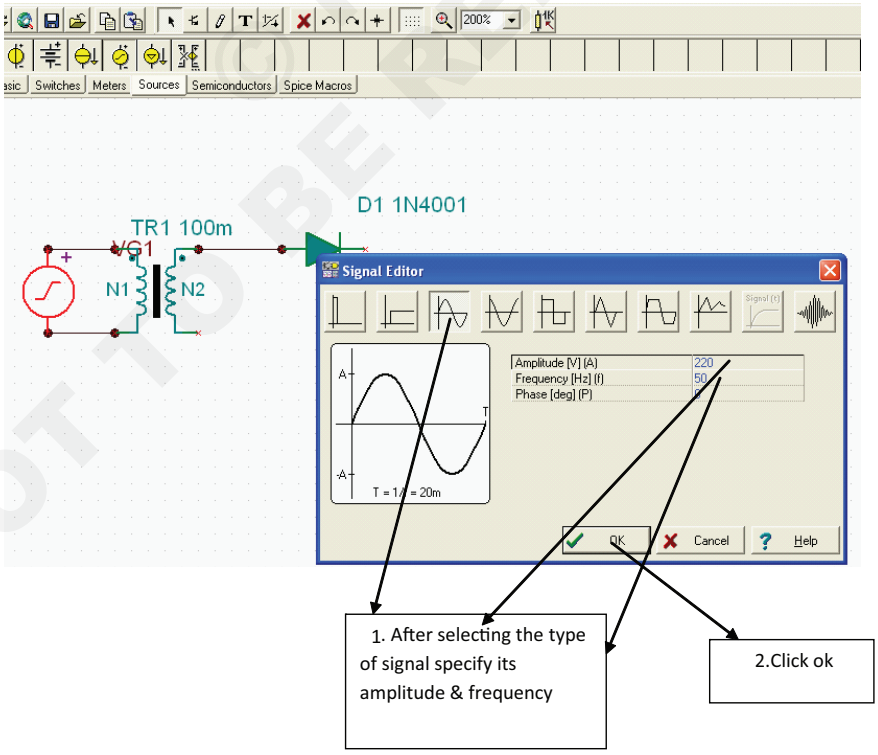
7 Click on **voltage generator** and double click on voltage generator to fix the parameters as shown in Fig 3.

Fig 3



8 Click on signal dialogue box, set the type of waveform, amplitude, frequency & phase as shown in Fig 4.

Fig 4

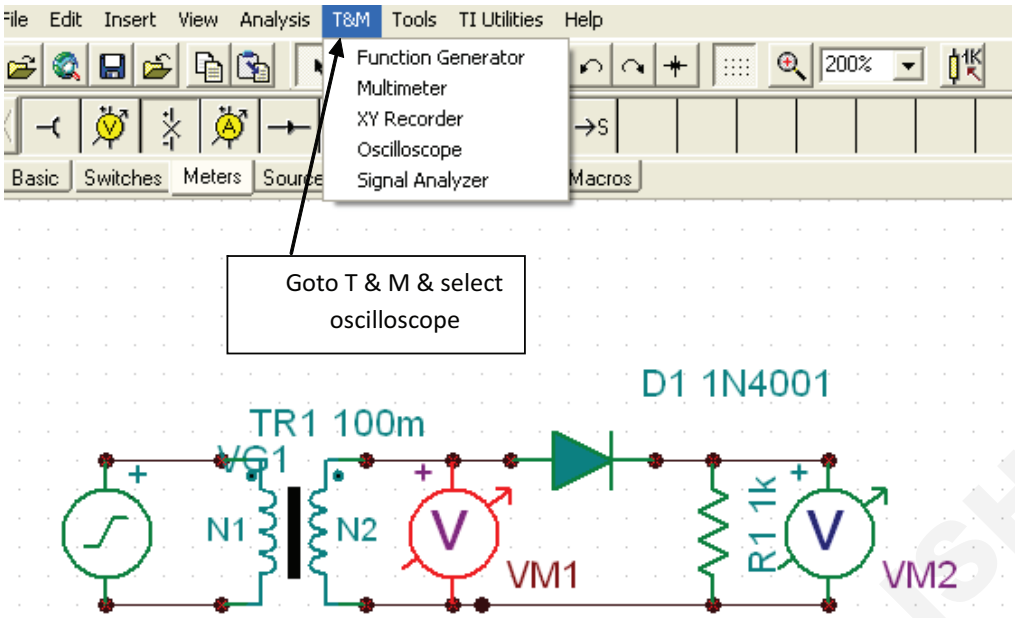


9 Make the connections by referring to the circuit diagram in Fig 1; Keep the cursor on the x mark on the component and drag the mouse wherever it need to be connected.

10 Go to menu bar & click T&M, select CRO as shown in Fig 5, click on it to use CRO.

11 Get the work checked by the Instructor.

Fig 5



TASK 2: **Construction of electronic lamp dimmer circuit using simulation software**

Note:

This exercise /Task has been developed using proteus - ISIS free simulation software.

The Instructor has to guide the trainees to follow each and every critical steps to select the components their values and placement / position, printing their numbers etc to complete the task as per the simulation software available in the lab.

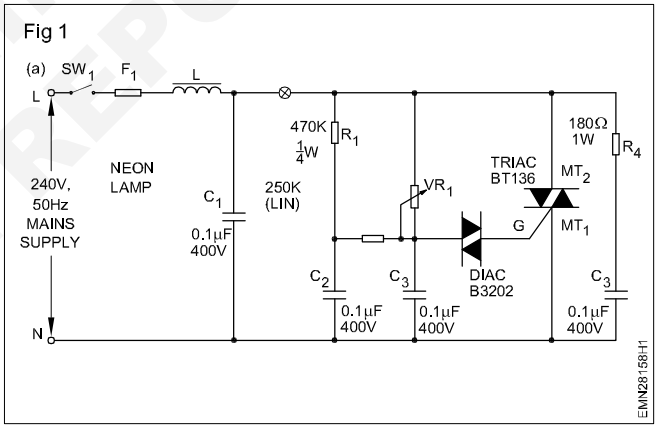
1 Select the circuit for construction of electronic dimmer circuit as shown in Fig 6.

2 Switch ON the computer, double click the simulator icon on the desktop.

3 Open a new project the schematic and go to the schematic capture option.

4 Click and select all the parts required from resistors, capacitor to diac and triac into the library as shown in Fig 7.

Fig 1

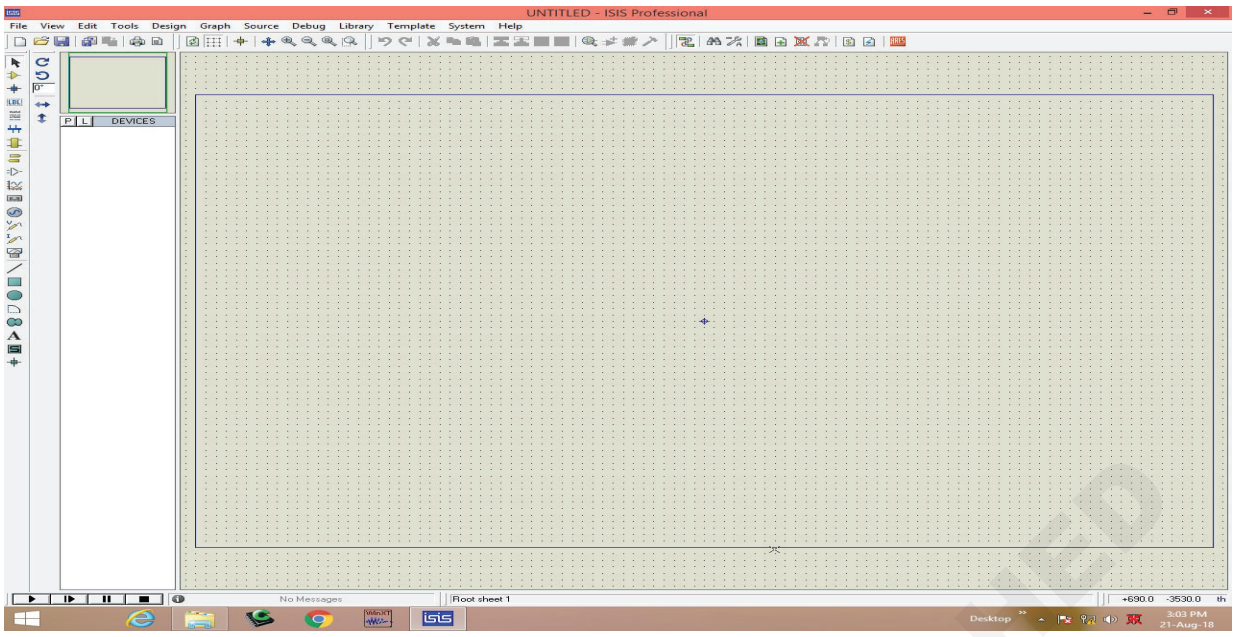


5 Move the cursor, select the triac, left click drag and place it on the user area place and position it on the user area.

6 Similarly select and place all the components, voltage source etc as per the diagram of the dimmer circuit.

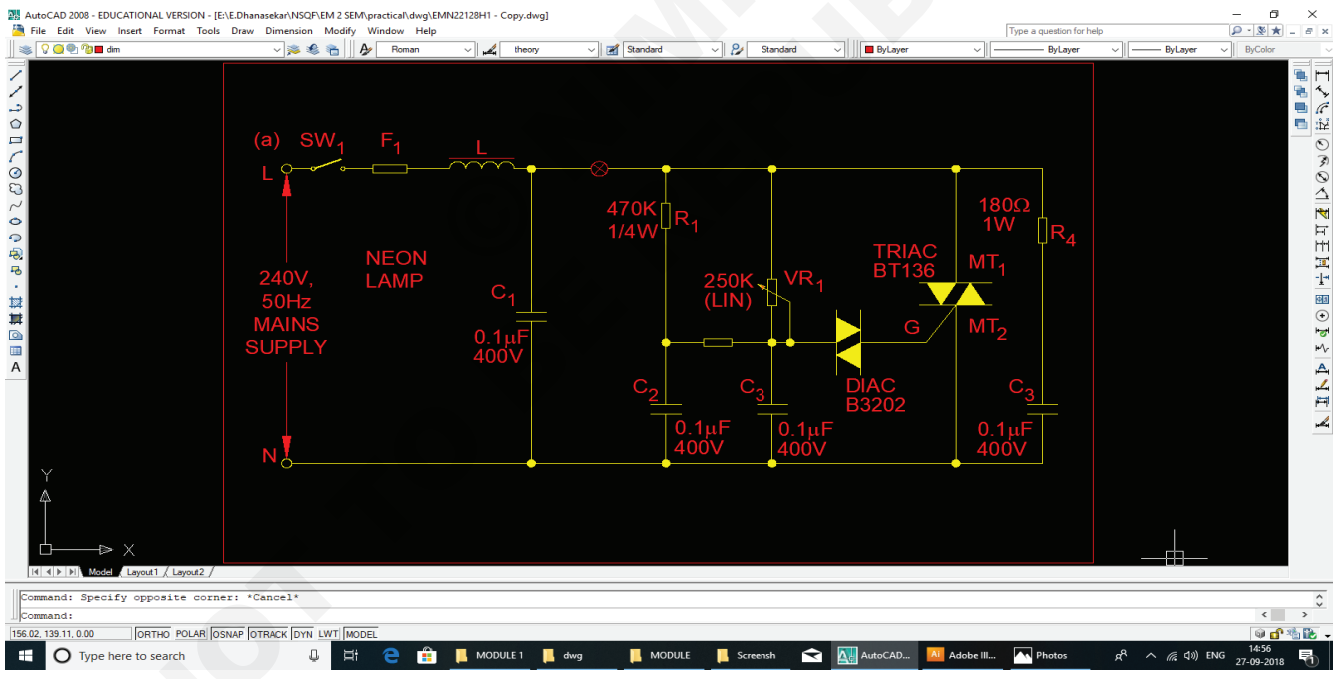
7 Click the cursor to wire the connection on the component tip a red square dot appears move the cursor click again complete the wiring.

Fig 7



8 Close the switch S1 and observe the bulb is ON and adjust the a rheostat VR1 the brightness is reduced as shown in Fig 8.

Fig 8



9 Get the work checked by the Instructor.

Identify and test RTDs, temperature ICs and thermo couples

Objectives: At the end of this exercise you shall be able to
- **identify the type of sensor used in process industries**
- **select suitable sensor for a specific purpose/application**
- **draw the layout of the Electronics Mechanic laboratory**
- **identify the location of power room and switch controls.**

Requirements

Tools/Equipments/Instruments

- Magnifier lamp - 1 No.
- Trainees tool kit - 1 Set.
- Digital Multimeter/millivolt meter with probes - 1 Set.
- Steel rule 300mm and vernier - 1 No.
- **Aids:** Chart showing the image of all the sensors with colour code, physical appearance and other details - 1 No.
- Thermocouple Leads colour chart - 1 No.
- Thermocouple temperature table - 1 No.
- Thermocouple specification data sheet - 1 No.
- RTD Leads colour chart - 1 Set.
- RTD temperature data sheet table - 1 No.
- RTD specifications data sheet - 1 No.
- **Aids:** Wall chart showing the types of temperature sensors. - 1 No.

Materials/Components

- All types of sensors with instruction leaflet brouchure - 1 No each. (RTD, Temperature IC i.e., Thermocouple, Proximity switch (inductive capacitive photo electric) Load cells, Strain gauge, LVDT, PT100 thermostat, float switch, float valve).
- Temperature sensors (assorted types) - as reqd.
- Thermocouple J & K type sensor - as reqd.
- Hot bath or water bath or heating source or Candle with match box - 1 No.
- RTD PT - 100 sensor - as reqd.

PROCEDURE

Note:

1 The instructor has to label the RTD temperature IC, thermocouple, proximity switches (Inductive, capacitive and photoelectric), Loadcell, strain gauge, LVDT float switch and float valve for water level.

2 Prepare technical data chart providing the type, code number and use/application for all the above sensors for this exercise.

1 Pick one of the labeled sensor from the lot.

2 Observe the physical shape and contructional detail, refer to the chart -1 and identify the name of the sensor.

3 Use magnifier for viewing small/delicate details of the sensor.

4 Refer to the technical details of the selected sensor on the data chart, record the observations in Table -1.

5 Repeat the steps 1 to 4 for remaining sensing devices.

6 Get the work checked by the Instructor.

Table 1

Sl.No	Label No. Sensor	Name of the Code/Number	Type/Colour Criteria	Sensing Application	Using	Remarks
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

TASK 1 : **Identification of thermocouple from the assorted temperature sensors by quick test**

Note: The instructor has to demonstrate the procedure to identify and test the thermocouple used for this exercise and label them serially.

1 Take the digital multimeter and select low DC millivolts range.

2 Connect the DMM across the Thermocouple leads and observe the DC millivolts reading.

3 Heat the end of the thermowell bulb by using lit fire from candle or by using Hot bath or water bath or heating source.

4 Observe the DC millivolt reading on the meter and record the observations in Table 2.

5 Separate the temperature sensors into two groups which are changing DC millivolts and which are not changing DC millivolts for heating.

6 Mark the temperature sensor as "THERMOCOUPLE" that produced DC millivolts variation for change in temperature.

Table 2

Sl. No.	Label No.	Millivoltmeter reading		Remarks
		Before heating	After heating	
1 2 3				

Note: The sensors not responded for temperature change may be defective or RTDs.

7 Repeat steps 2 to 6 for the remaining sensors.

8 Get the work checked by the Instructor.

— — — — — — — —

TASK 1: **Identification of RTD from the assorted temperature sensors by quick test**

Note: The instructor has to demonstrate the procedure to identify and test the RTD used for this exercise.

1 Identify the RTD by physical appearance along with lead colours from the chart 1.

2 Use the DMM, select low resistance range and connect the ohm meter across the temperature sensor leads, observe the resistance value and record the readings in Table 3.

3 Lit the candle using match box.

4 Heat the end of the thermo well bulb by using the flame from candle.

5 Observe the variation of resistance value on Ohm meter and confirm the device under test is RTD.

6 Get the work checked by the Instructor.

Note: The sensors not responded for temperature change may be defective or thermocouple.

7 Use the RTD specification data sheet and note down the available name plate data like type of sensor, material of the sensor, resistance of sensor, calibrated, output of sensor and thermowell material in Table 3.

8 Note down and record the physically observed, length, thickness, (dia), number of lead wires and their colours in Table 3.

9 Use the DMM select low resistance range, connect the ohm meter across the RTD leads, measure the resistance value at room temperature and record the reading in Table 3.

Table 3

Reistance value of RTD at room temperature = ... Ohms (as per data sheet)

Sl. No.	Description of Item	Details
1	Type of sensor	
2	Sensor element material	
3	Number of wires	
4	Lead colours	
5	Sensor output (if available)	
6	Sensor calibrated range (if available)	
7	Thermowell length (in mm)	
8	Thermowell dia (in mm)	
9	Thermowell material	
10	Resistance measured at room temperature	

10 Verify the resistance reading at room temperature from the RTD specification data sheet table and record in Table 3.

Note: Compare the DMM reading with above observation for correctness of RTD.

11 Get the work checked by the Instructor.

— — — — — — — —

Identify and test proximity switches (inductive, capacitive and photoelectric)

Objectives: At the end of this exercise you shall be able to
- **identify the type of sensor used in process industries**
- **select suitable sensor for a specific purpose/application.**

Requirements

Tools/Equipments/Instruments

- Magnifier lamp - 1 No.
- **Aids:** Chart showing the image of all the sensors with colour code, physical appearance and other details - 1 No.

Materials/Components

- All types of sensors with instruction leaflet brouchure - 1 No each. (RTD, Temperature IC i.e., Thermocouple, Proximity switch (inductive capacitive photo electric) Load cells, Strain gauge, LVDT, PT100 thermostat, float switch, float valve).

PROCEDURE

Note:

1 The instructor has to label the RTD temperature IC, thermocouple, proximity switches (Inductive, capacitive and photoelectric), Loadcell, strain gauge, LVDT float switch and float valve for water level.

2 Prepare technical data chart providing the type, code number and use/application for all the above sensors for this exercise.

1 Pick one of the labeled sensor from the lot.

2 Observe the physical shape and contructional detail, refer to the chart -1 and identify the name of the sensor.

3 Use magnifier for viewing small/delicate details of the sensor.

4 Refer to the technical details of the selected sensor on the data chart, record the observations in Table -1.

5 Repeat the steps 1 to 4 for remaining sensing devices.

6 Get the work checked by the Instructor.

Table 1

Sl.No	Label No. Sensor	Name of the Code/Number	Type/Colour Criteria	Sensing Application	Using	Remarks
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

— — — — — — — —

Identify and test, load cells, strain gauge, LVDT, PT 100 (platinum resistance sensor)

Objectives: At the end of this exercise you shall be able to
- **identify the type of sensor used in process industries**
- **select suitable sensor for a specific purpose/application.**

Requirements

Tools/Equipments/Instruments

- Magnifier lamp - 1 No.
- **Aids:** Chart showing the image of all the sensors with colour code, physical appearance and other details - 1 No.

Materials/Components

- All types of sensors with instruction leaflet brouchure - 1 No each. (RTD, Temperature IC i.e., Thermocouple, Proximity switch (inductive capacitive photo electric) Load cells, Strain gauge, LVDT, PT100 thermostat, float switch, float valve).

PROCEDURE

Note:

1 The instructor has to label the RTD temperature IC, thermocouple, proximity switches (Inductive, capacitive and photoelectric), Loadcell, strain gauge, LVDT float switch and float valve for water level.

2 Prepare technical data chart providing the type, code number and use/application for all the above sensors for this exercise.

1 Pick one of the labeled sensor from the lot.

2 Observe the physical shape and contructional detail, refer to the chart -1 and identify the name of the sensor.

3 Use magnifier for viewing small/delicate details of the sensor.

4 Refer to the technical details of the selected sensor on the data chart, record the observations in Table -1.

5 Repeat the steps 1 to 4 for remaining sensing devices.

6 Get the work checked by the Instructor.

Table 1

Sl.No	Label No. Sensor	Name of the Code/Number	Type/Colour Criteria	Sensing Application	Using	Remarks
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Detect different objectives using capacitive, inductive and photo electric proximity sensors

Objectives: At the end of this exercise you shall be able to
- **construct capacitive proximity sensor circuit and test it**
- **construct inductive proximity sensor circuit and test it**
- **construct photo electric proximity sensor circuit and test it**
- **defect different objects using proximity sensors.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Soldering iron 25 watts/240 V - 1 No.
- Regulated power supply 0-30V/2A - 1 No.
- DMM with probes - 1 No.

Materials / Components

- IC CD 4026 - 2 Nos.
- 7 Segment display common cathode - 2 Nos.
- Resistor CR 25-2k2, 3k9, 4k7 - 1 No each.
- Resistor 150 Ohm/¼ W/CR25 - 2 Nos.
- PC 817 Optocoupler - 1 No.
- Bread board - 1 No.
- Proximity sensor PNP type - 1 No.
- Photo electric sensor - 1 No.
- Microswitch - 2 Nos.
- LM 7805 - 1 No.
- PSA - 6B inductive sensor - 1 No.
- Hook up wire - 2m.
- Rosin cored solder - as reqd.

PROCEDURE

TASK 1: **Construction and testing the inductive type proximity sensors**

Note: The instructor has to guide the trainees to fix the proximity sensor (inductive/photo electric sensors) and adjust the distance detection sensitivity to detect the objects.

1 Collect all the components, plan the layout of the display device, counter IC and all other components on the bread board / PCB.

2 Check all the components and assemble the counter circuit as per the schematic diagram shown in Fig 1 except the proximity sensor.

3 Switch on the 12V DC power supply, press the reset switch1 and abserve the seven segment display shows zero.

4 Pick and identify the terminals of the inductive proximity sensor, connect it on the circuit as input.

5 Bring a piece of iron object and move it in front of the sensor such that it detect the object and the display changed to show the number '1'.

6 Repeat the object number of times and observe the display shows incremental numbers confirming the detection of the object.

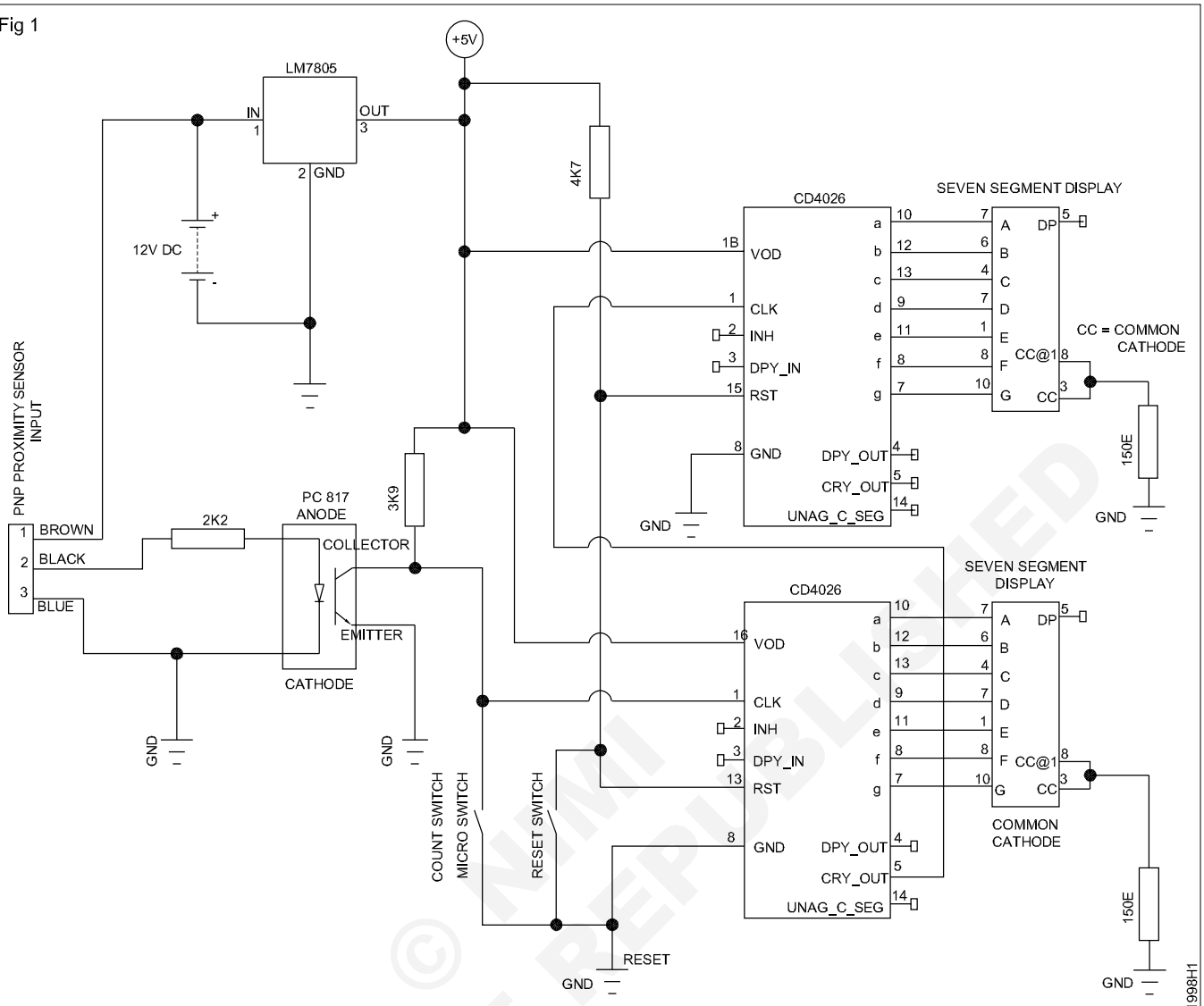
7 Record the number observed in Table - 1

Table 1

Sl. No.	No. of attempts	Number displayed	Remarks
1	First		
2	Second		
3	Third		
	.....		
	.....		

8 Get the work checked by the Instructor and switch off the circuit

Fig 1



CIRCUIT CONNECTION AND ITS COMPONENTS

— — — — — — — —

TASK 2: **Construction and testing of photo electric type of proximity sensor**

1 Use the asembled counter circuit as per the step 1 to 3 of TASK 1.

2 Pick the photoelectric proximity sensor, identify the terminals and connect it to the counter circuit input.

3 Switch ON the 12 V DC power supply and observe the display.

4 Pick any item/object, bring it closer to the proximity sensor and observe for any changes in the display.

5 Repeat the above step with any ferrous or non-ferrous objects and observe the change in display to confirm the detection of the object.

6 Record the number observed in Table 2.

Table 2

Sl. No.	No. of attempts	Number displayed	Remarks
1	First		
2	Second		
3	Third		
	.....		
	.....		

7 Get the work checked by the instructor and switch OFF the circuit.

— — — — — — — —

TASK 3: **Construction and testing of capacitive proximity sensor**

1 Use the counter circuit assembled as per the step 1 to 3 of TASK 1.

2 Pick the three wire capacitive proximity sensor and identify the terminals, connect it to the input of counter circuit.

3 Switch ON the 12V DC power supply and observe the display.

4 Pick any object and bring it very closer to the proximity sensor input and observe the display for any change.

5 Repeat the above step number of times and observe the increment of number in the display to confirm the detection of the object.

6 Record the number observed in Table 3.

7 Get the work checked by the instructor and switch off the circuit.

Table 3

Sl. No.	No. of attempts	Number displayed	Remarks
1	First		
2	Second		
3	Third		
	.....		
	.....		

Note: The circuit will display upto the number 99. Exceeding this limit another set of IC CD 4026 and seven segment display may be added.

— — — — — — — —

Identify various analog sensors

Objectives: At the end of this exercise you shall be able to
- **identify various analog sensors, their names and functions**
- **differentiate the pin configuration of analog sensors.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set
- Digital Multimeter with probes - 1 No
- Sensors data sheets for all the Analog sensors utilized for this exercise - as reqd
- **AIDS:** Pictorical chart showing all types of analog sensors - 1 No.

Materials

- Photo resistor / LDR, LM35 Temperature sensor, Sound sensor, Pressure sensor, Ultrasonic sensor, Potentiometer, Moisturesensor, Ultraviolet light sensor, Flex sensor, Thermistor

Note:

- **The instructor has to label each Analog sensor and group/arrange them as per their physical quantity/ sensing function separately.**
- **Provide the sensor data sheets for all the analog sensors being utilized for this exercise.**

PROCEDURE

Idetification of sensors, their names and functions

1 Pick one of the labelled analog sensor from the lot, observe it's label number and record it in Table 1.

2 Refer to the Chart 1 provided and identify the name and enter it in Table 1.

3 Select the Analog sensor data sheet/manual, go through it and find the pin configuration, function etc. as per the table and record them.

4 Repeat the above steps for all the remaining analog sensors and record all the details in Table -1.

Table 1

Sl.No.	Label No	Name of sensor	Physical quantity Sensed/Function	Pin configuration of sensor	Voltage		Output signal (Voltage or Current)
					Minimum	Maximum	
1							
2							
3							
4							
5							
6							
7							
8							

5 Get the work checked by the instructor.

— — — — — — — —

Identify roles and characteristics of analog sensors

Objectives: At the end of this exercise you shall be able to
- **test the characteristics of light sensor**
- **test the characteristics of temperature sensor**
- **test the characteristics of sound sensor**
- **test the characteristics of thermistor.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- DMM with probes - 1 No.
- RPSU - 0 - 30V / 2A Dual DC power supply soldering iron - 1 No.
- 25w/240v - 1 No.
- Milli voltmeter 0-250mV - 1 No.
- Milli ammeter 0-25mA, 0-100mA - 1 No each.

AIDS: Data sheet for LM35, Transister and diode - 1 No.

Materials

- Breadboard - 1 No.
- General purpose PCB - 1 No.
- Potentiometer 10k/Lin 2.2kΩ - 1 No.
- Thermistor - 1 No.
- Transistor BC547 - 1 No.
- Transistor BC548 - 1 No.
- LDR (Ground 250kΩ dark resistance) - 1 No.
- 1N 4007 Silicon diode - 1 No.
- LM35 (temperature IC) - 1 No.
- Condensor microphone - 1 No.
- LED white - 5mm - 1 No.
- Resistor CR25 330Ω, 47Ω, 10kΩ, 8k2, 220k - 1 No each.
- Ceramic capacitors 25VDC 0.7μF - 1 No.
- Relay 5VDC/1 c/o - 1 No.
- Hook up wire Red, Black - 2 m.
- Electret mic capsule - 1 No each.
- Rosin cored soler wire (60/40) - as reqd.
- Single core shielded wire - 15 cm
- SDST Switch - 1 No.

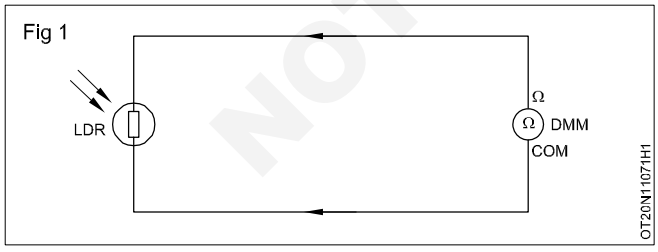
PROCEDURE

TASK 1: **Testing the characteristics of LDR as a light sensor**

1 Collect all the required items, check and ensure that they are in good condition.

2 Select ohm's function / range on the DMM and connect the test probes across the LDR as shown in Fig 1: Observe the reading and record in Table -1. (This reading corresponds to the ambient light)

Fig 1



3 Cover the window on LDR partly using a proper and repeat the above step 2.

4 Use black colour paper, close completely and repeat step 2.

5 Expose LDR to bright light (LED) and repeat step 2.

Table - 1

Sl. No.	Condition	Measured valve in ohms
1	Not covered	
2	Partly closed	
3	Exposed to bright light	
4		

6 Get the work checked by the instructor.

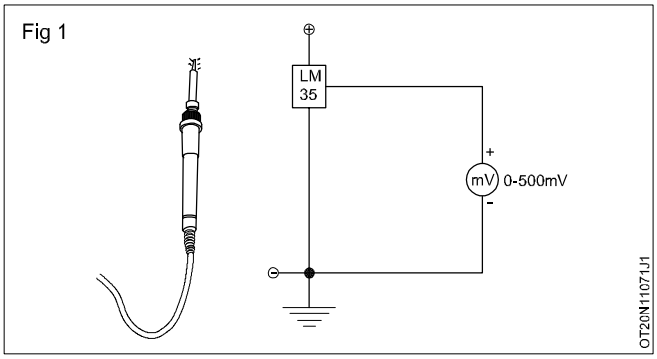
— — — — — — — —

TASK 2: **Testing the characteristics of temperature sensor IC LM35**

1 Collect the IC LM35, identify the terminals with reference to the data sheet and plug them on the breadboard.

2 Use hook up wire and connect 5VDC power supply lines and output terminal to millivolt meter as per the circuit shown in Fig 1a.

Fig 1



3 Switch ON the 5VDC supply and observe the reading on millivolt meter. [This is the reference output voltage that corresponds to the ambient/room temperature]

4 Record the observed reading in Table - 2.

5 Plug the 25W soldering iron into main supply and keep it on the stand.

Table 2

Sl.No.	Source of heat	Output - mV	Remarks
1	Ambient temperature		No source
2	Heated soldering iron – 25mm		25mm away from IC
3	Heated soldering iron – 15mm		Little closer
4	Heated soldering iron – 5mm		Very closer

6 Switch ON the mains supply and allow the soldering iron to get heated up its maximum.

7 Bring the IC LM35 setup to 25mm distance from the soldering iron boy and record the reading in table.

8 Move further upto 15mm distance, 5mm distance and record the observed readings in table.

9 Get the hook checked by the instructor.

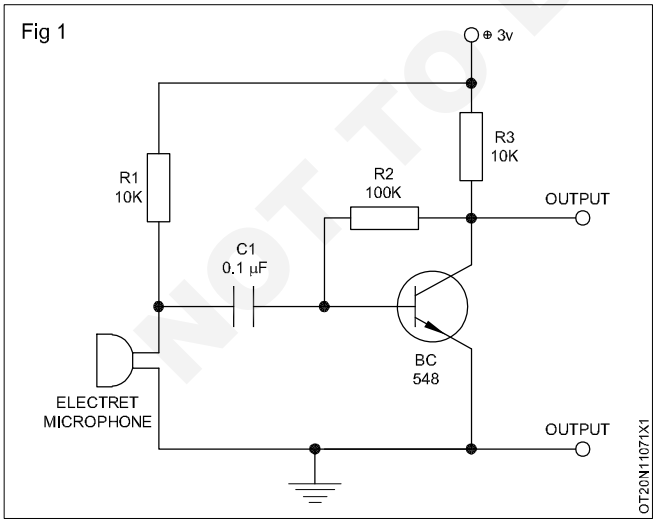
— — — — — — — — —

TASK 3: **Testing the characteristics of microphone as a sound sensor (Electret condenser mic.)**

1 Collect all the required components and connecting wires, check and ensure that they are in good condition.

2 Pean the layout of components on the general purpose PCB for the Mic-pre amplifier circuit shown in Fig 1.

Fig 1



3 Identify the output terminal point and ground terminal on the electret Mic capsule; Prepare one end core of shielded wire, solder it on the output and shielding on the ground point.

4 Insert all the components as per the circuit following the layout, solder them on the general purpose PCB correctly.

5 Solder the prepared microphone wire to the input point and common ground point.

6 Verify the connections and get the assembled circuit checked by the instructor.

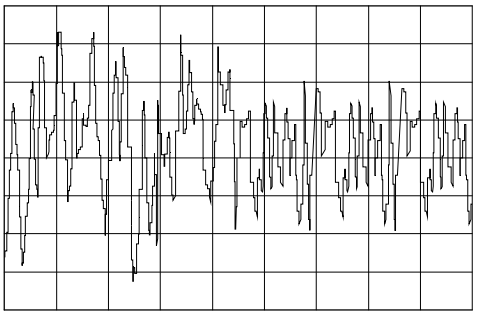
7 Connect 5VDC to the circuit and millivolt meter across the output and common ground.

8 Switch ON the power supply, observe the output for the ambient sound (Back ground noise) and record the reading in Table -3

Table 3

Sl.No.	Sensing signal	Output (in mV)
1	Ambient sound	
2	Snapping sound	
3	Clapping sound (Mild)	
4	Clapping sound (Loud)	

Fig 2



ELECTRET MICROPHONE OUTPUT SIGNAL

OT20N11071X2

9 Produce a snapping sound using your thumb and middle finger in front of the mic; observe the output voltage and record the readings.

10 Observing the output voltage produce a clapping sound mildly and then loudly; record the respective readings in the Table -3

11 Get the work checked by the instructor.

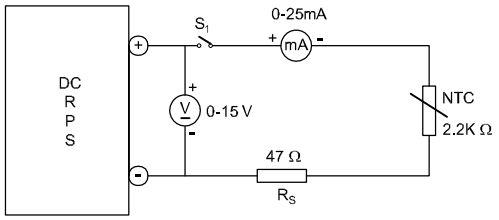
— — — — — — — —

TASK 4: **Testing the characteristics of thermistor as a temperature sensor.**

1 Collect all the required items, check and ensure that they are in good condition.

2 Assemble the circuit using breadboard and hookup wire as per the circuit diagram shown in Fig 1.

Fig 1



OT20N11071Y1

3 Switch ON the 10VDU supply and observe the reading on milli ammeter. [This initial reading corresponds to the ambient temperature]

4 Record the observed reading in Table 4.

5 Repeat steps 5 and 6 of Task .

2 and prepare the soldering iron.

6 Observe the milli ammeter for any change in current for the decreased resistance value of thermistor after 2 minutes.

7 Bring the thermistor upto 25mm distance to the soldering iron body and record the readings in Table 4.

8 Move further upto 10mm distance 5mm distance and record the observed readings in Table 4.

Table 4

Sl.No.	Source of heat	Observed current
1	Ambient temperature	
2	Power dissipated by thermistor	
3	Soldering iron at 25mm	
4	Soldering iron at 10mm	
5	Soldering iron at 10mm	

9 Get the work checked by the instructor.

— — — — — — — —

Select appropriate analog sensor

Objectives: At the end of this exercise you shall be able to
- **study the technical features of sensors given in their manufacturer's data sheets**
- **identify the important parameters / physical quantity / sensing functions of given analog sensors.**

Requirements

Tools/Equipments/Instruments

- **AIDS:** Data sheet for LM35, Transister and diode - 1 No.
- Data sheets/manuals of all the above Analog Sensors - 1 No each.

Note:

- **The instructor has to collect all the/ different types of Analog sensor manufacturer's data sheets in advance and ensure that the important points are available in them.**
- **Mark serial numbers in each data sheet/manual before giving them to trainees.**

PROCEDURE

1 Collect all the data manuals / data sheets of Analog sensors utilized for this exercise along with the pictorial chart showing different types of analogue sensors.

2 Go through the important parameters listed in Table1, Table-2, Table-3 for selection of particular analog sensor.

3 Pick the first labelled data sheet of Analog sensor, go through all the detailed technical features, specifications etc. given in it.

4 Record these important technical information's under the respective row/column of Table-1 to Table-3

Table 1: **Application Criteria**

Sl.No	Data sheet No.	Function/parameter sensed	Counting	Temperature	Pressure	Liquid level	Operating voltage	Remarks
1								
2								
3								
4								
5								

5 Repeat the above step 3 and 4 for all the remaining labelled sensors data sheets.

Table 2: **Characteristics Criteria**

Sl.No	Data sheet No.	Analog/Digital output	Sensitivity/ Range	Stability	Repeatability	Response time	Linearity/ deviation	Remarks
1								
2								
3								
4								
5								

Table 2: **Environmental Criteria**

Sl.No	Data sheet No.	Name of sensor	Temperature range	Size/shape/ connectivity	Humidity effects	Electro-magnetic interference	Corrosion etc.	Ruggedness/ Protection class
1								
2								
3								
4								
5								

6 Get the work checked by the instructor.

Note: The instructor may modify/after the Row or Column of the observation table according to the criteria/parameters of the analog sensor available in the laboratory.

— — — — — — — —

Connect & measure AC/DC analog Input such as voltage / current / RTD twothree-four wire AC mV signal etc

Objectives: At the end of this exercise you shall be able to
- **connect RTD with 2 wires into a circuit and measure AC/DC voltage/current**
- **connect RTD with 3 wires/4wire and measure voltage/current.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- Digital multimeter with probes - 1 No.
- DC regulated PSU 0-30V/2A - 1 No.
- Digital milli voltmeter 0-200mV - 1 No.
- Electric kettle 1.5 lit, 240V/1500W - 1 No.
- Digital thermometer - 1 No.

Note: (Stainless steel bowl with 1 lit capacity may be utilized alternatively with immersion heater 240VAC/1500W)

Materials

- RTD PT100 with 2 wires
  RT100 with 3 wires/4 wires - 1 No each.
- Breadboard - 1 No.
- IC LM 358 - 1 No.
- Resistors 1/4 watt - 1 No.
- 3.3 kilo ohms - 1 No.
- 1.2 kilo ohms - 1 No.
- 1 kilo ohms 1% tolerance - 1 No.
- Hook up wire - as reqd.
- Ice cubes - as reqd.

Safety:

1 **The instructor has to arrange the demonstration with due care for the safety precautions white handling the electric kettle / Immersion heater and boiling water.**

2 **Alert the trainees about the inherent danger while handling the above items and to be cautions enough.**

PROCEDURE

TASK 1: **Voltage measurement of RTD with 2 wires in a circuit**

1 Collect all the required items, check and ensure that they are in good condition.

2 Measure the ohm resistance value across the RTD sensor terminals using ohm meter and record the value in Table 1.

3 Assemble the testing circuit on breadboard as per the diagram shown in Fig 1 and get it checked by the instructor.

4 Switch ON the 5VDC supply measure the Vref voltage, Vpt.

5 Record your observations in Table 1.

Resistance value of RTD _____ ohms **Table 1, 2, 3** **Vref voltage = 1.2V, Vref current = 1 mA**

Sl.No.	Condition of RTD	Temperature (in Celsius)	Measured voltage
1	Kept in open air (at room temperature)		
2	Immersed in water with ice cubes		
3	Immersed in warm water		
4	Immersed in boiling water		

6 Pour water into the kettle, drop 4 to 5 ice cubes into it, wait for 2-3 minutes for cooling the water.

7 Immerse the RT sensor into the cool water; repeat the step 4 with cool water temperature and record your observations in table.

8 Switch ON the AC mains supply to the electric kettle or Immersion heater supply) wait for few minutes for warmup of water and switch off AC supply.

9 Repeat step 4 with warm water temperature and record your observations in Table.

10 Repeat step 8 for boiling of water, measure temperature, voltage across RTD sensor and record your observations in table.

11 Get the work checked by the instructor.

— — — — — — — —

TASK 2: **Voltage measurement of RTD with 3 wires / 4 wires**

Note: The instructor has to follow the above steps with reference to the circuit set up diagrams shown in Fig 2 / Fig 3 to demonstrate the voltage measurement of RTD sensor accordingly.

— — — — — — — —

Configure engineering and electrical zero/span configuration mV, 0-10VDC, 4-20mA, 0-20mA

Objective: At the end of this exercise you shall be able to
- **adjust and configure the electrical and engineering zero setting of 4mA point**
- **adjust and configure the electrical and engineering span setting for 2mA point.**

Requirements

Tools/Instruments/Equipments

- Trainnes tool kit - 1 Set.
- 24VDC/2A power supply - 1 No.
- Pneumatic pressure pump/ hand pump (up to 600 psi) - 1 No.
- High precision digital pressure gauge - 1 No.
- Differential pressure transmitter (analog tape) - 1 No.
- Digital multimeter with probes - 1No.
- 0 - 25MA digital panel meter - 1No
- 3valve manifold - 1No

Materials/Components

- Flexible pneumatic pipe tube hose - 1 No.
- 220 ohms - as reqd.
- ½W resister - 1 No.

1 The instructor has to demonstrate the zero and span adjustments setting utilizing the equipment's tools that are available in the section otherwise arrange these activities at an appropriate laboratory setting.

2 It HART communicator like a single multifunction calibrator is available the instructor has to explain its correction and functional aspects to the trainees prior to the start of the exercise.

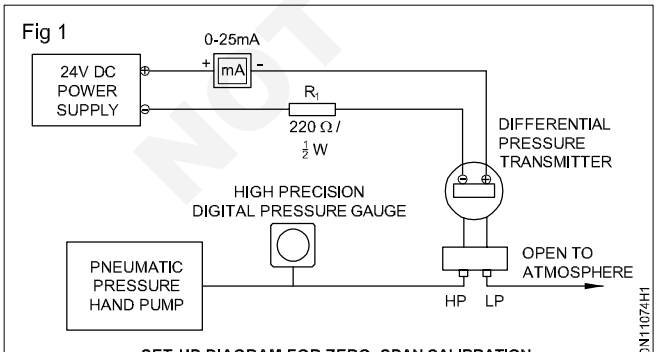
PROCEDURE

1 Collect all the items required for this exercise check and ensure they are in good condition.

2 Connect the differential pressure transmitter pressure source using the hose tube from the 3 valve manifold. (make sure that the equalizing valve manifold is closed)

3 Connect the milliammeter, 24VDC power supply and resistor R1 with differential pressure transmitter as per the setup diagram shown in fig 1.

Fig 1



SET-UP DIAGRAM FOR ZERO, SPAN CALIBRATION

4 Close the vent knob and supply valve.

5 Get the connections made as per the set up diagram checked by the instructor and take permission to proceed.

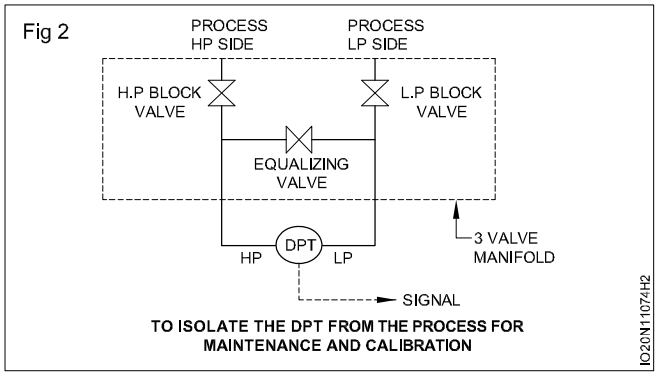
6 Switch on the 24VDC power supply and apply pressure by releasing the valve to the transmitter

7 Apply pressure equal to the lower range from the pump (that is zero adjustment corresponds to 4mA in transmitter output) by closing down the valve for zero adjustment till necessary pressure is reached.

8 Read the pressure in transmitter LCD screen display and mA meter reading and record the observations in Table -1

9 Adjust zero adjust screw such the output of transmitter on millimeter is 4mA

Fig 2



TO ISOLATE THE DPT FROM THE PROCESS FOR MAINTENANCE AND CALIBRATION

10 For span adjustment apply a pressure equal to the upper range corresponding to 20mA in transmitter output.

11 Repeat step 8 above and it necessary adjust the pressure fill it reads 20mA current flow for span configuration.

Table 1

Sl.no	Differential pressure transmitter reading	Pressure gauge reading	Zero adjustment current	Span adjustment current	Remarks

12 Get the work checked by the instructor

— — — — — — — —

Understand various units and zero span configuration as per sensor datasheet such as temperature, pressure, flow, level, lux level, environment, soil, moisture etc

Objectives: At the end of this exercise you shall be able to
- **go through the details given in the data sheet /manual of the sensors**
- **list out their practical unit of measurement and differentiate them.**

Requirements

Tools/Instruments/Equipments

- **AIDS:** Pictorial chart showing all types of Analog digital sensors -1 No each.
- Data sheets of temperature sensor, Differential Pressure Transmitter Pressure Sensor, Flow sensor, Lux level sensor, soil moisture sensor -1 No each.

Note:

1 The instructor has to provide the sensor data sheets for all the sensors being utilized for this exercise.

2 Label data sheet of each sensor and arrange them as per their physical sensing function.

PROCEDURE

1 Collect all the data manuals /data sheets of sensors utilized for this exercise along with the Pictorial chart showing different types of analog / digital sensors.

2 Pick one of the labelled data manuals /data sheets of sensors.

3 Go through the technical features, important specifications and parameters etc. provided in the data manuals / sheets.

4 Identify the unit of measurement of that particular parameter provided in it; record this unit of measurement in Table-1 against the physical quantity.

5 Find the definition of ZERO, SPAN and record it in the Table-1

6 Repeat the above steps for all the labelled sensors, record your observations.

Table 1

Sl. No.	Parameter	Label No.	Unit of measurement	Remarks
1	Temperature			
2	Pressure			
3	Flow level			
4	Lux level			
5	Soil moisture			
6	Zero:			
7	Span:			

7 Get the work checked by the instructor.

— — — — — — — —

Measure the analog input as per configuration and sensor selection

Objective: At the end of this exercise you shall be able to
- **select an analog sensor from the assorted lot and identify the name fraction**
- **measure the analog input of that selected sensor..**

Requirements

Tools/Instruments/Equipments

- Trainnes tool kit - 1 Set.
- Digital multimeter with probes - 1 No.
- 0-30V/2A DC regulated power supplying - 1 No.

Materials/Components

- Assorted types of analog and digital sensors with their data sheets - 1 No.
- Connecting wires - 2 Nos.

The instructor has to arrange an assorted lot of different types of sensors with label number tag to each one also provide their data sheets/ user manual along with them.

PROCEDURE

TASK 1: **Selection and identification of sensor**

1 Pick one of the labelled sensor check and ensure that it is am analog sensor or digital sensor.

2 Identify its name and function record your observations in Table - 1

Table 1

Sl. No.	Label No.	Name	Function	Remarks
1				
2				
3				

3 Repeat steps 1 and 2 for another two labelled sensors.

4 Get the work checked by the instructor.

— — — — — — — —

TASK 2: **Measurement of analog import to the sensor**

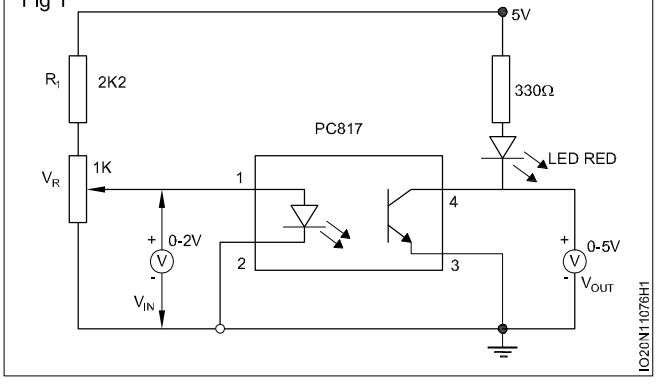
1 Collect all the required items for the circuit assembling and check and ensure that they are in good condition.

2 Plan the layout on the bread board and assembly the circuit as per the diagram shown in fig 1.

3 Verity the connection and get the assembled circuit checked by the instructor.

4 Keep the pretention meter VRI in zero position switch on the 5VDC supply.

Fig 1



5 Observing the LED slowing increase, the input supply in steps of 0.1V up to 0.5V.

6 Measure the input voltage and record the observations in table -2.

Table 2

Sl. No.	Input voltage	Status of LED	output voltage	Remarks
1				
2				
3				

7 Repeat steps 5 and 6 up to 0.5V, record your observations in table - 1 with remarks.

8 Get the work checked by the instructor

— — — — — — — —

Generate and measure analog output to operate control valves and actuators

Objectives: At the end of this exercise you shall be able to
- **assemble a circuit with analog output to operate control valve and actuator**
- **measure the analog output voltage to operate the relay for the control valve and actuator.**

Requirements

Tools/Instruments/Equipments

- Trainnes tool kit - 1 Set.
- Digital multimeter with probes - 1 No.
- (0-30V/2A- Dual) DC regulated power supply unit - 1 No.

Materials/Components

- Bread board - 1 No.
- 5V 1 C/O relay - 1 No.
- 10k Lin potentiometer - 1 No.
- Transistor BC547 or equivalent - 1 No.
- Diode 1N 4007 - 1 No.
- Resistor CR25 values 10 kΩ, 33 kΩ, 1.5 kΩ - 1 No.each
- Hookup wire - as reqd.
- 12DC control valve - 1 No.
- LED 5mm Red colour - 1 No.

Note:

1 The instructor has to use the 10k? Lin potentiometer as the Analog sensor.

2 A Solenoid valve with 12 VDC working may be connected across the switching terminals of relay if a control valve is not available for this exercise.

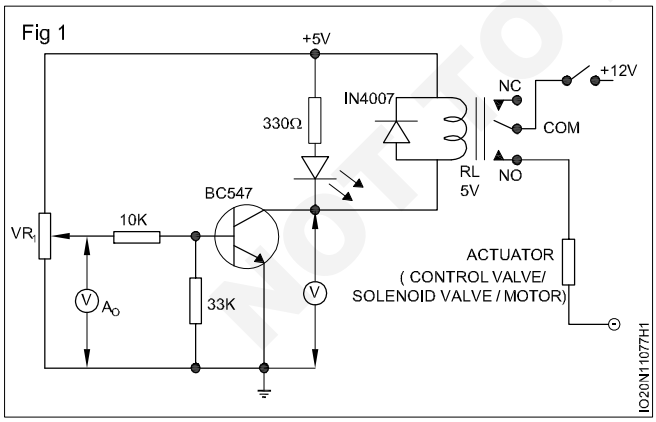
PROCEDURE

1 Collect all the required items, check and ensure that they are in good working condition.

2 Plan and assemble the analog sensor circuit on breadboard as per the diagram shown in Fig 1.

3 Verify the connections and get it checked by the instructor.

Fig 1



4 Keep the switch S1 in OFF position, potentiometer VR1 in minimum position power ON the 5VDC supply and observe the status of LED.

5 Generate and measure the analog output across the slider point Vo and ground of potentiometer VR1; observing the LED gradually rotate the shaft in steps of 0.1V up to 0.5V, record your observations in the Table-1.

Table 1

Sl. No.	Analog Output voltage (Vo)	Collector voltage (Vce)	LED status	Relay status	Remarks
1	0.1V				
2	0.2V				
3	0.3V				
4	0.4V				
5	0.5V				
6	0.6V				
7	0.7V				
8	0.8V				

6 Repeat the above step 5 up to 0.8V; record your observations in Table and bring down the Vo to ZERO.

7 Now switch ON the 12VDC and repeat the steps 5 to 6 and record your observations in Table-2.

Table 2

Sl. No.	Analog output voltage (Vo)	Collector voltage (Vce)	LED status	Relay status	Control valve status	Remarks
1	0.1V					
2	0.2V					
3	0.3V					
4	0.4V					
5	0.5V					
6	0.6V					
7	0.7V					
8	0.8V					

8 Get the work checked by the instructor.

— — — — — — — —

Identify various digital sensors

Objectives: At the end of this exercise you shall be able to
- **identify various Digital sensors, their names and functions**
- **differentiate the pin configuration of digital sensors.**

Requirements

Tools/Instruments/Equipments

- Trainnes tool kit - 1 Set.
- Digital multimeter with probes - 1 No.
- Sensors data sheets for all the sensors utilized for this exercise - as reqd.
- **AIDS**: Pictorial chart showing all types of Digital sensors - 1 No.

Materials/Components

- Proximity sensor, PIR sensor, IR sensor, Gyroscope sensor, RFID sensor, GPS sensor
- Digital accelerometers
- Digital temperature sensor -1 No each.

Note:

1 **The instructor has to label each Digital sensor and group /arrange them as per their physical quantity / sensing function separately.**

2 **Provide the sensor data sheets for all the sensors being utilized for this exercise.**

PROCEDURE

TASK 1: **Identification of sensors, their names and functions**

1 Pick one of the labelled sensor from the lot, observe its Label Number and record it in Table 1.

2 Refer to the Chart 1 provided and identify name and enter it in Table 1.

3 Select the sensor data sheet/manual, go through it and find the pin configuration, function etc as per the table and record them.

4 Repeat the above steps for all the remaining sensors and record all the details in Table 1.

Table 1

Sl. No.	Label No	Name of Sensor	Physical quantity Sensed/Function	Pin configuration of sensor	Voltage		Output signal (Voltage or Current)
					Minimum	Maximum	
1							
2							
3							
4							
5							
6							
7							
8							

5 Get the work checked by the Instructor.

— — — — — — — —

Identify roles and characteristics of each sensor

Objectives: At the end of this exercise you shall be able to
- **test the characteristics of PIR sensor**
- **test the characteristics of IR sensor**
- **test the characteristics of proximity sensor (capactive type).**

Requirements

Tools/Instruments/Equipments

- Trainnes tool kit - 1 Set.
- Digital multimeter with probes - 1 No.
- (0-30V/2A- Dual) DC regulated power supply - 1 No.

Materials/Components

- Ardinrino UNO developments board - 1 No.
- PIR sensor - 1 No.
- 5V-1C/0 relay - 1 No.
- Transistor BC 547 - 1 No.
- Diode 1N4007 - 1 No.
- Resistor CR25 1kΩ,330Ω - 1 No each.
- LED - 5mm - Red - 1 No.
- Hook up wires - as reqd.
- Beard board - 1 No.
- DHT11- Humidity and Temperature sensor - 1 No.
- 16 x 2 LCD display - 1 No.
- Male / Female jumper wires - as reqd.

Note:

The instructor has to guide the trainees to identify the PIR sensor, IR LED, and photo diode, proximity sensors with reference to their data sheets and interpret respective technical details.

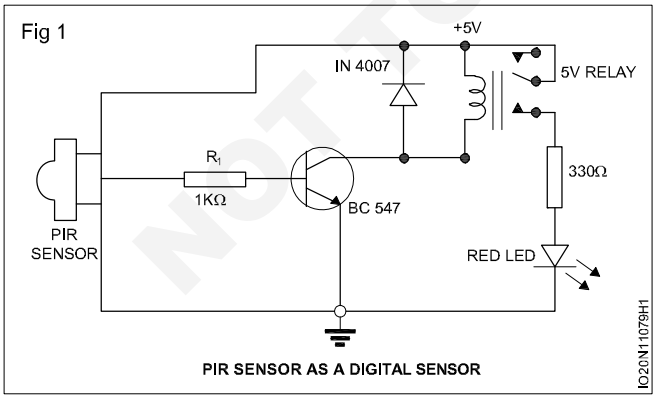
PROCEDURE

TASK 1: **Testing the characteristics of PIR sensor as a digtial sensor**

1 Collect all the requred items, check and ensure that they are in good condition.

2 Plan the layout of compoents on the beardboard, wires for sensor and relay as per the circuit diagram shown in Fig 1.

Fig 1



PIR SENSOR AS A DIGITAL SENSOR

3 Assemble the circuit, verify the connections and get it checked by your instructor.

4 Connect 5 VDC supply to the circuit and swtich ON.

5 Walk through infront of the PIR sensor and observe the status of LED indicator and relay action.

6 Repeat the above step with a little incerase distance and record the observations for the above steps in Task 1.

Table 1

Sl. No.	Signal condition	Condition of		Remarks
		Relay	LED	
1	Walking near by			
2	a little longer			
3				

TASK 2: **Testing the characteristics of Humidity sensor - DHT11**

1 Collect all the required items, check and ensire that they are in good condtion.

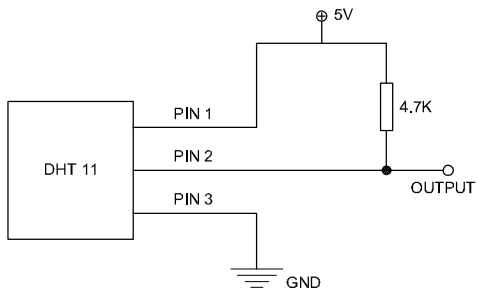
2 Identify the terminals of sensor DHT11 with referece to the data sheet and proceed.

3 Plan the layout of components on beardboard and assemble it using male/female jumper wires as per the circuit diagram.

4 connect 5VDC to the circuit and switch ON/

5 Observe the output correcponding to the present humidity level and record your observation.

Fig 2



RELATIVE HUMIDITY AND TEMPERATURE SENSOR
DHT11 CIRCUIT

Select appropriate digital sensor

Objectives: At the end of this exercise you shall be able to
- **study the technical features of digital sensors given in their manufacturer's data sheets**
- **identify the important parameters / physical quantity/ sensing functions of given digital sensors.**

Requirements

Tools/Instruments/Equipments

- **AIDS:** Pictorial chart showing all types of digital sensors - 1 No each.
- Data sheets/manuals of all the above digital Sensors - 1 No each.

Note:

1 The instructor has to collect all the /different types of digital sensor manufacturer's data sheets in advance and ensure that the important points are available in them.

2 Mark serial numbers in each data sheet/manual before giving them to trainees.

PROCEDURE

TASK 1: **Selection and identification of sensor**

1 Collect all the data manuals /data sheets of digital sensors utilized for this exercise along with the Pictorial chart showing different types of digital sensors.

2 Go through the important parameters listed in Table1, Table 2, Table 3 for selection of particular digital sensor.

Table-1: Application Criteria

Sl. No	Data Sheet No.	Function/parameter sensed	Counting	Temperature	Pressure	Liquid level	Operating voltage	Remarks
1								
2								
3								
4								
5								

3 Pick the first labelled data sheet of digital sensor, go through all the detailed technical features, specifications etc. given in it.

4 Record these important technical informations under the respective row/column of Table 1 to Table 3.

Table 2: Characteristics Criteria

Sl. No	Data Sheet No.	Analog/Digital Output	Sensitivity/ Range	Stability	Repeatability	Response time	Linearity/ Deviation	Remarks
1								
2								
3								
4								
5								

Table 3: Environmental Criteria

Sl. No	Data Sheet No.	Name of sensor	Temperature Range	Size/shape/ connectivity	Humidity effects	Electro-magnetic interference	Corrosion etc.	Ruggedness/ Protection class
1								
2								
3								
4								
5								

5 Repeat the above steps 3 and 4 for all the remaining labelled sensors data sheets.

6 Get the work checked by the instructor.

NOTE: The instructor may modify /alter the Row or Columns of the Observation Table according to the criteria/parameters of the digital sensor available in the Laboratory.

— — — — — — — —

Connect and measure digital input of various voltage level such as TTL (0-5V), 24 VDC (0-24 VDC) signals

Objective: At the end of this exercise you shall be able to
- **connect a circuit and test the TTL voltage levels.**
- **Measure the TTL-05V and 0-24 VDC for digital inputs.**

Requirements

Tools/Instruments/Equipments

- Trainnes tool kit - 1 Set.
- DMM with probes - 1 No.
- DC Reg. power supply 0-30V dual type - 1 No.
- CRO - general purpose 0-20 MHz with probe kit - 1 No.

Materials/Components

- Breadboard - 1 No.
- Transistor BC547 or equivalent - 2 Nos.
- Optocoupler PC817 - 1 No.
- Resistors CR25
  1kΩ, 100k Ω - 2 Nos each.
  2kz, 330 Ω - 1 No each.
- Capacitor 3.3µF/25VDC - 2 Nos.
- Hookup wire - as reqd.

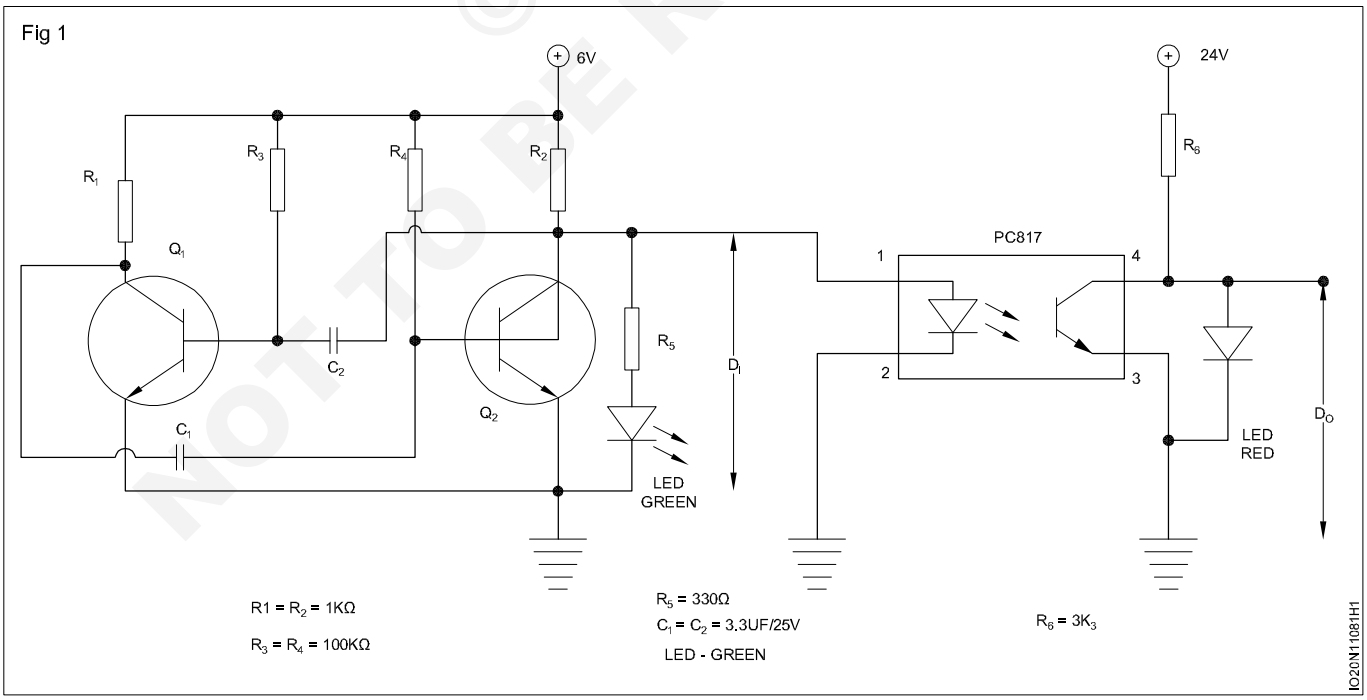
PROCEDURE

TASK 1: **Connecting a circuit and testing TTL voltage levels**

1 Collect all the required items for the circuit assembling, check and ensure that they are in good condition.

2 Plan the layout on the breadboard and assemble the circuit as per the diagram shown in Fig 1.

Fig 1



3 Verify the connections and get the circuit checked by the instructor.

4 Switch on the 6 VDC supply only and observe the status of LED.

5 Power on the CRD and prepare it for measurements.

6 Measure the waveform/voltage across the point do and ground.

7 Record your observations in table 1

Table 1

Transistor	V_{CE}	V_{BE}	Voltage across DO	Status of Green LED
Q1				
Q2				

8 Get the work checked by the instructor.

— — — — — — — —

TASK 2: **Measurement of TTL 0-5V and 0-24 VDC as digital inputs**

1 Keep the 6 VDC supply for the transistor circuit on, switch on the 24VDC supply.

2 Measure the digital input voltage Di and output voltage Do across the opto-coupler terminals using digital voltmeter.

3 Record your observations in Table 2.

4 Repeat step 2 and 3 using CRO; record your observations in Table 2.

5 Get the work checked by the instructor.

Table 2

Voltage across optocoupler		Waveform across optocoupler		Status of LED	
Input	Output	Input	Output	Green	Red

— — — — — — — —

Connect pluse inputs of various frequency ranging from 10 Hz to 1KHz and configure the filters

Objective: At the end of this exercise you shall be able to
- **designs and assemble a passive low pass filter using resistor and capacitor**
- **test the low pass filter circuit by connecting the pulse signal from 10Hz to 1kHz**
- **plot the readings on a graph and configure the response curve of the filter circuit.**

Requirements

Tools/Instruments/Equipments

- Trainnes tool kit - 1 Set.
- Function generator (with instruction manual) - 1 No.
- DMM with probes - 1 No.
- CRO - general purpose with probe kit - 1 No.

Materials/Components

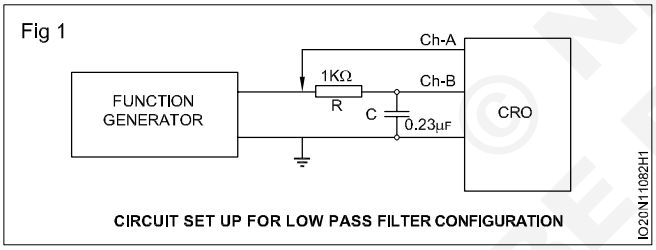
- Breadboard - 1 No.
- 1k ohms/ 1/2w resistor - 1 No.
- 0.23 μF/25VDC capacitor - 1 No.
- Flookupwire - as reqd.
- Semi-log graph sheet (A4 size) - 1 No.

PROCEDURE

1 Collect all the required items, check and ensure that all are in good condition.

2 Assemble the circuit using breadboard and flookup wire as per the circuit diagram shown in Fig 1.

Fig 1



CIRCUIT SET UP FOR LOW PASS FILTER CONFIGURATION

3 Switch on the setup and prepare the CRO for measurement.

4 Apply the square wave signal of 10Hz with amplitude 2 V_{p-p} as input to the filter circuit.

5 Observe the input, output using CRO record in Table 1 and calculate the gain.

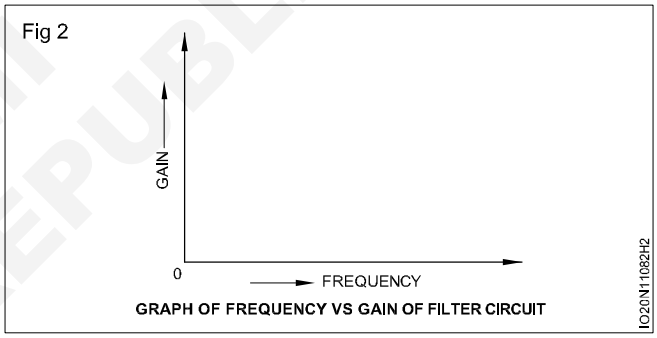
6 Increase the input signal frequency in steps of 10Hz upto 100Hz and step 5.

7 Get the readings checked by the instructor.

8 Repeat step 5 and 6 with increasing frequency in steps of 100Hz upto 1kHz and record in table 1.

9 Plot the graph of frequency versus gain on semilog graph sheet taking frequency on xaxis and gain on the y axis as shown in Fig 2.

Fig 2



GRAPH OF FREQUENCY VS GAIN OF FILTER CIRCUIT

10 Mark the 70.7% of maximum gain point cut off frequency on thegraph pass band.

11 Get the work checked by the instructor.

Note : The cut-off frequency can be theoretically verified by substituting the values of R and C in the formula $f_c = \frac{1}{2\pi RC}$.

Table 1

Input voltage = --------- V_{p-p}

S.No	Input Frequency	Output Voltage	Gain = $\frac{V_{out}}{V_{in}}$

Select configure and ascertain of digital outputs and relay outputs to take ON and OFF action for actuators

Objective: At the end of this exercise you shall be able to
- **asemble a relay circuit and ascertain the digital output**
- **test the ON and OFF action of actuator by relay output.**

Requirements

Tools/Instruments/Equipments

- Trainnes tool kit - 1 Set.
- DMM with probes - 1 No.
- DC regulated power supply (Dual type) 0-30V/2A - 1 No.

Aids: Data sheet for the optocoupler and transistor

Materials/Components

- Breadboard - 1 No.
- 5V relay/1c/0 - 1 No.
- Transistor - 1 No.
- BC547 or equivalent optocoupler PC817 or equivalent - 1 No.
- Resistor CR 25 valves
  - 10 kilo ohms - 2 Nos.
  - 1 kilo ohms - 2 Nos.
  - 33kΩ ohms - 1 No.
- Flookup wire - as reqd.
- SPDT switch - 1 No.
- Solenoid valve 12 VDC (or any actuator) - 1 No.
- LED 5 mm (Green) - 1 No.

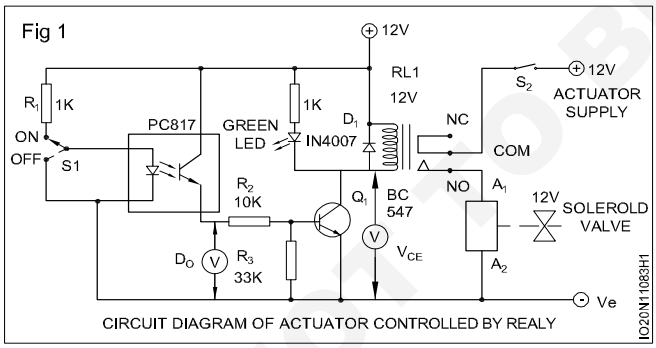
Note : The Instructor may use any type of actuator in place of solenoid valve to test the relay output.

PROCEDURE

1 Collect all the required items, check and ensure that all are in good condition.

2 Assemble the relay circuit on breadboard as per the circuit diagram shown in Fig 1 and get it checked by the instructor.

Fig 1



CIRCUIT DIAGRAM OF ACTUATOR CONTROLLED BY REALY

3 Keept the switch S1 in OFF position and power on the 5VDC supply observe the status of Green LED.

4 Measure the voltage across DO, VCE, observe relay functioning and record your observations in Table 1.

5 Put the switch S1 to ON position and observe the status of LED.

6 Repeat step 4 and observe the solenoid valve functioning. Toggle the switch 1 into OFF and ON positions, observe the ON, OFF action of actuator and record your observations in table 1.

7 Switch ON S2 and power ON the actuator supply toggle switch S1 into OFF and ON positions.

8 Observe the ON/OFF action of the actuator and record your observation in Table 1

Table 1

S.No.	Swich position	Green LED	Voltage across		Relay status	Solenoid valve
			DO	VCE		
1	OFF					
2	ON					
3						
4						

9 Get your work checked by the instructor.

— — — — — — — —

Explore different microcontroller families' architecture like 8051, AVR, PIC, ARM, raspberry pi and arduino

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

- **compare the architecture of different microcontroller families between 8051, AVR, PIC, ARM and rospberripi and archino development boards**
- **list out the similarities and differences between them with respect to their technical features.**

Requirements

Tools/Equipments/Instruments

- Data sheets of 8051, AVR, PIC, ARM microcontrollers boards and raspberry pi, arduino development boards - 1 No each.

Materials

Aids: Chart showing the architecture of different microcontrollers and development boards used - as reqd.

PROCEDURE

1 Collect all the data manuals / sheets of microcontrollers and development boards utilized for this exercise along with their pictorial chart showing their architecture.

2 Pick one of the chart showing the architecture of microcontroller, go through the respective data manual, detailed specifications, technical features, I/o ports, Oscillator frequency, etc.

3 Observe the building blocks and signal flow with their important parameters, Connectivity.

4 Record your observations in Table 1.

Table 1

Sl.No	Name of the microcontroller	
1	8051	
2	AVR	
3	PIC	
4	ARM	

5 Pick the next chart, repeat step 2 to 4 for all the micro controllers and development boards.

6 Compare the technical features recorded in the Table-1 and also go through the data sheets and list out the similarities and differences between the microcontrollers in Table 2.

Table 2

Sl.No	Name of the microcontroller	Similarities	Differences
1	8051		
2	AVR		
3	PIC		
4	ARM		

7 Repeat step 6 for the raspberry pi and Arduino development boards and record your observations in Table 3.

Table 3

Sl.No	Name of the development board	Similarities	Differences
1	Raspberry pi		
2	Arduino		

8 Get the work checked by the instructor.

Explore the different IDE software used for microcontrollers

Objectives: At the end of this exercise you shall be able to
- **explore the IDE software for 8051 microcontroller, ATmega 32 PIC microcontroller, AVR, ARM microcontrollers**
- **list out the IDE software of above microcontrollers.**

Requirements

Tools/Equipments/Instruments

- Instruction manual / user manual of 8051 Microcontroller - 1 No each.
- PIC microcontroller, AVR, ARM and Arduino Uno development boards - 1 No each.

Note:

1 The instructor has to arrange the instruction manual, user manuals of the microcontroller kits available in the laboratory for this exercise with suitable lable nos.

2 Also guide the trainees to refer to the respective instruction manual to explore an find the IDE software's given in it.

PROCEDURE

1 Pick one of the given labelled instruction manual of the microcontroller kit; explore and find the name of IDE software used for microcontroller.

2 Note down your observations in the Table 1.

Table 1

Sl.No	Label number	Name of microcontroller	Name of the IDE software
1			
2			
3			
4			
5			

3 Repeat steps 1 and 2 for the remaining labelled instruction manual/user manuals of microcontroller bit/Arduino uno development board.

4 Get the work checked by the instructor.

— — — — — — — —

Explore ICs & their functions on the given microcontroller kit

Objectives: At the end of this exercise you shall be able to
- **note down various ICs on the microcontroller trainer kit**
- **identify the function of ICs on the microcontroller trainer kit.**

Requirements

Tools/Equipments/Instruments

- 8051 Microcontroller Trainer kit with manual - 1 Set
- Trainees tool kit - 1 Set.
- Digital Multimeter with probes - 1 No.

Materials/Components

- **Aids:** Layout diagram of ICs on the 8051 microcontroller kit - as reqd.

PROCEDURE

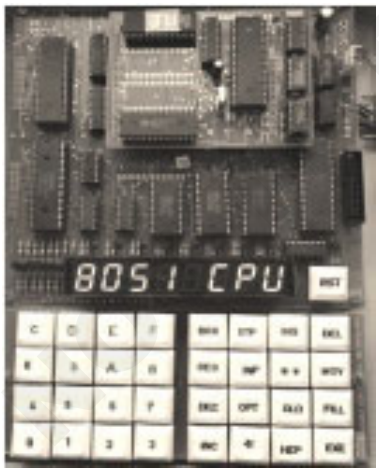
Note:

1 The Instrument has to prepare the layout diagram of ICs in the 8051 microcontroller trainer kit.

2 Label the main ICs for the functions like interfacing, RAM EPROM latch, buffer, keyboard controller, peripheral control etc. according to the microcontroller trainer kit available in the lab, to be provided along with the trainer kit for this exercise.

1 Collect the microcontroller trainer kit with its operating instructions manual.

Fig 1



2 Open the top cover of the microcontroller trainer kit, and observe the ICs on the board with reference to the layout diagram.

3 Note down the code number/marking on each IC, number of pins and record the observations in Table 1.

Table - 1

S. No.	Function	IC No.	No.of Pins	Function/ Purpose of IC	Remarks
1	IC 1				
2	IC2				
3	IC3				
4	IC4				
5	IC5				

4 Get the work checked by the Instructor.

Identify the port pins of the controller & configure the ports for input & output operation

Objectives: At the end of this exercise you shall be able to
- **identify the port pins in 8051 microcontroller**
- **enter the program in the microcontroller kit and execute it.**

Requirements

Tools/Equipments/Instruments

- 8051 Microcontroller Trainer kit with manual - 1 Set.
- DMM with probes - 1 No.
- Logic probes - 1 No.

Materials /Components

- Program to operate the I/O port - as reqd.

PROCEDURE

TASK 1: **Identification of port pins in 8051 microcontroller**

1 Collect the 8051 microcontroller kit and identify the sections using instruction manual.

2 Identify the pin connection used for different ports on the microcontroller IC 8051.

3 Notedown the pin number of ports in Table 1, and mark the ports with dual function.

4 Note down the alternative pins of the ports in Table 1.

5 Get the work checked by the instructor.

Table - 1

S. No.	Port Number	Pin Number	Alternative

— — — — — — — —

TASK 2: **Entering the program into the microcontroller**

1 Refer to the instruction manual and identify all the operating controls and switches.

2 Connect the switch to port - 1.

3 Configure the port - 1 as input port.

4 Connect the output port to LEDs.

5 Enter the given program and execute it on the trainer kit.

Note: In the given program LED port address (FF13) is designed and tested as per the manufacturer of the microcontroller kit. It may vary for kits of different manufacturer / models.

6 Operate the switches one by one and verify the output by using LEDs.

Program

```
LOOP    MOV A, P1
MOV     DPTR, #FF13
MOV  X @ DPTR, A
SJMP LOOP
```

Note: The instructor has to explain about the given program and its working. The above program can be repeated for different Input/ Output ports.

— — — — — — — —

Explore universal IC programmer to program burn output file on different ICs

Objectives: At the end of this exercise you shall be able to
- **install the driver software and contect the universal IC programmer computer system**
- **the copy program contents of asource IC ad write it onto another chip.**

Requirements

Tools/Equipments/Instruments

- Trainees Tool Kit - 1 Set.
- DMM with probes - 1 No.
- Desktop computer or laptop computer with windows OS - 1 Set.
- Universal IC programmer with accessories and driver instruction manual S/W - 1 Set.
- Internet connectivity - as reqd.
- Chip remover - 1 No.

Materials / Components

- Source IC 8051 UC 40 pin DIP - 1 No.
- Destination IC chip 8051 UC 40 pin DIP IC - 1 No.

Note:

1 **The instructor has to ensure whether the universal IC programmer device had already been installed in the computer system utilized for this exercise.**

2 **Microcontroller IC AT 89S52 programmed IC chip may be used as source IC and blank new 40 pin DIP IC chip used as the destination IC chip for program writing activity.**

3 **Follow steps as per the instructions / guidance given in the user manual of the make. model in your lab.**

PROCEDURE

TASK 1: **Connecting the universal IC programmer to computer**

1 Collect the universal IC programmer device, USB cable and other accessories along with the instruction manual.

2 Power ON the computer / Laptop and wait for the icons on the desktop and identify the programmer icon.

If the software has not been installed, get the S/W CD or download the program from the device manufacturer's website using internet; follow the instructions and finalize installation.

Safety precaution: Do not connect the universal IC programmer to the computer before software installation.

3 Connect the USB cable to the programmer device and computer.

4 Observe the LED on the programmer to indicator power ON.

5 Move the mouse pointer on the programmer icon and double click to open the functioning of the device.

6 Choose the IC chip (device) you wish to program by clicking on the device icon.

7 Select the chip manufacturer and the device name by following the ON - screen instructions and the operating instructions given in the manual.

TASK 2: **Copying the program contents of source IC chip and writing it onto destination IC chip**

1 Observe the ZIF socket on the programmer (Generally it has 48 sockets, it may vary depending upon the manufacturer)

2 Identify the Pin 1 socket, move the lever to open sockets.

3 Check the Pin No.1 of source IC, position it correctly on the ZIF socket Pin 1; insert the chip and move the lever to lock and get the work checked by the instructor.

4 Ensure the selection activity of step – 7 of the IC Task-1 is correctly matching with the chip manufacturer and device name.

5 Click the READ button to copy the microcontroller program contents.

6 Next click the CONFIG button and the READ button inside the CONFIG window; observe the LED.

7 Open the lever, take out the source IC using chip remover / tweezer and keep it safely.

8 Insert the destination IC chip following step 3 above and lock the IC.

9 Click config button and WRITE button button inside the config window to write the program (the program writing will be done after the ERASE function completed) observe the LED.

10 Click the VERIFY button to check the programmed contents.

Note: Some EPROM chips cannot be erased by programmer; you need to use UV lamp to erase this type chip

11 Get the work checked by the instructor and remember to turn OFF the programmer after completed the task.

— — — — — — — —

Connect and test arduino board to computer and execute sample programs from the example list

Objectives: At the end of this exercise you shall be able to
- **to connect arduino board to computer**
- **to execute simple programs.**

Requirements

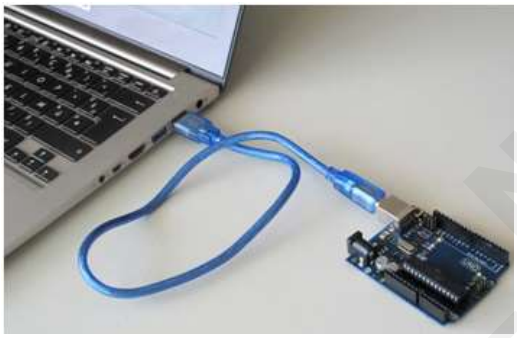
Tools/Instruments

- Arduino uno board
- PC with Arduino IDE installed.

PROCEDURE

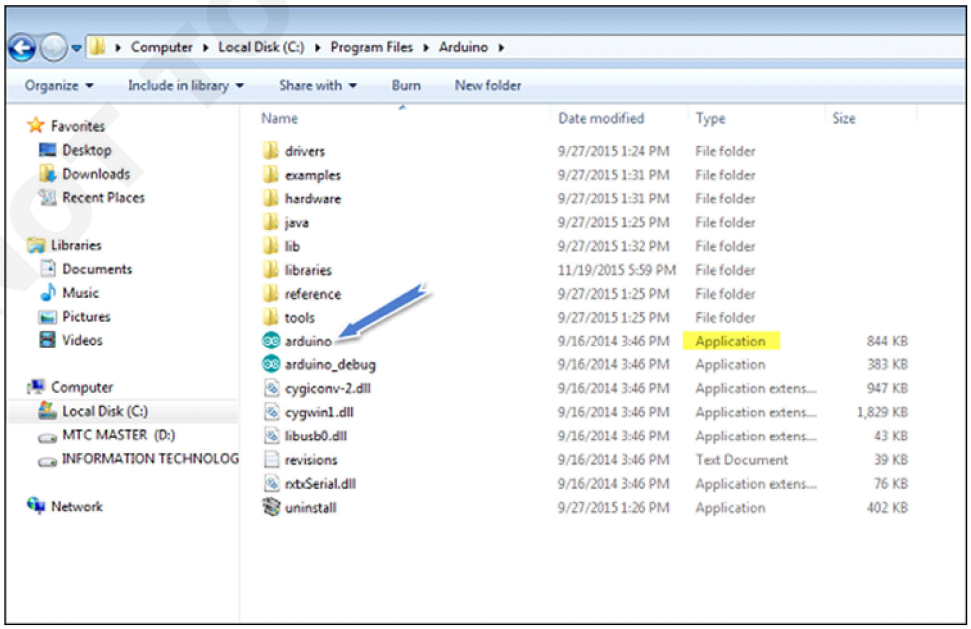
TASK 1 : **Take an arduino board. Connect it with the PC using USB cable as given in Fig 1**

Fig 1



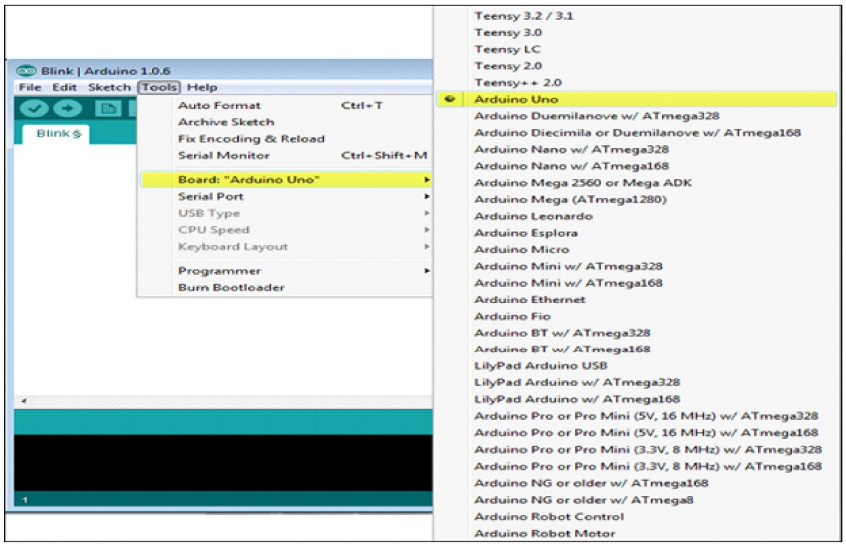
TASK 2 : **Open the arduino application icon as given in Fig 1**

Fig 1



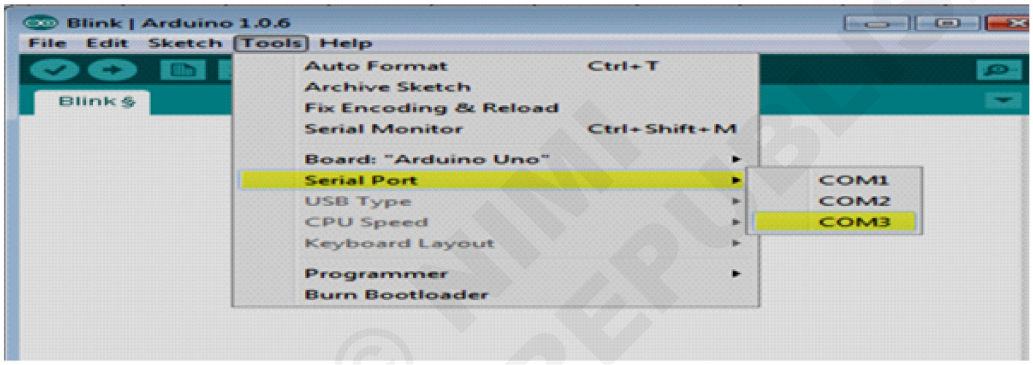
TASK 3 : **Select the arduino board. Go to Tools ? Board and select your board as shown in Fig 1**

Fig 1



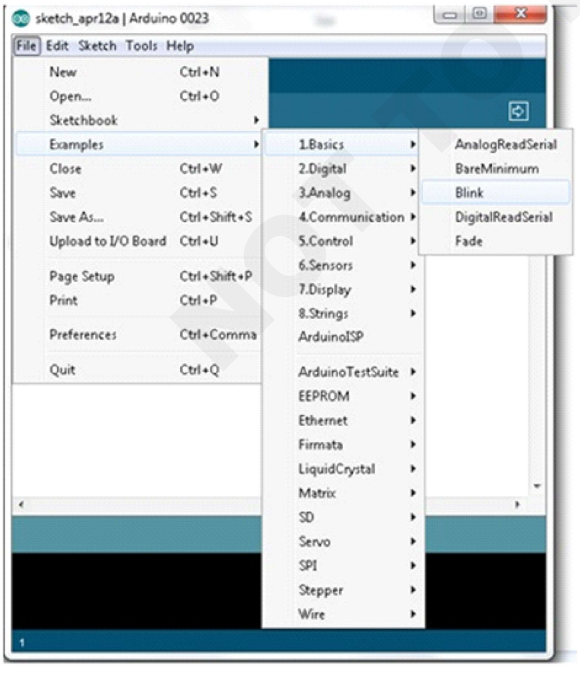
TASK 4 : **Select the serial port. Go to Tools ? Serial Port menu as show in Fig 1**

Fig 1



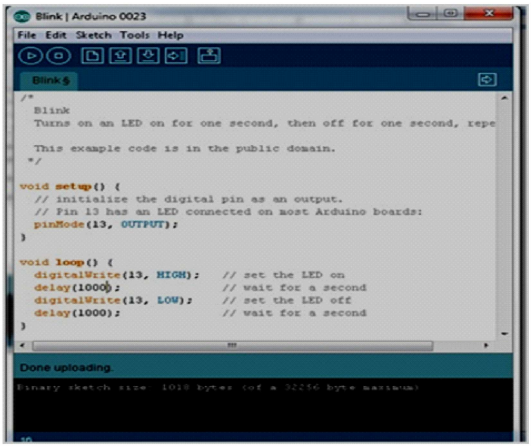
TASK 5 : **To open existing project example select File ? Example ? Basics ? Blinkas shown in Fig 1**

Fig 1



TASK 6 : **Code will be displayed in the screen as in Fig 1**

Fig 1



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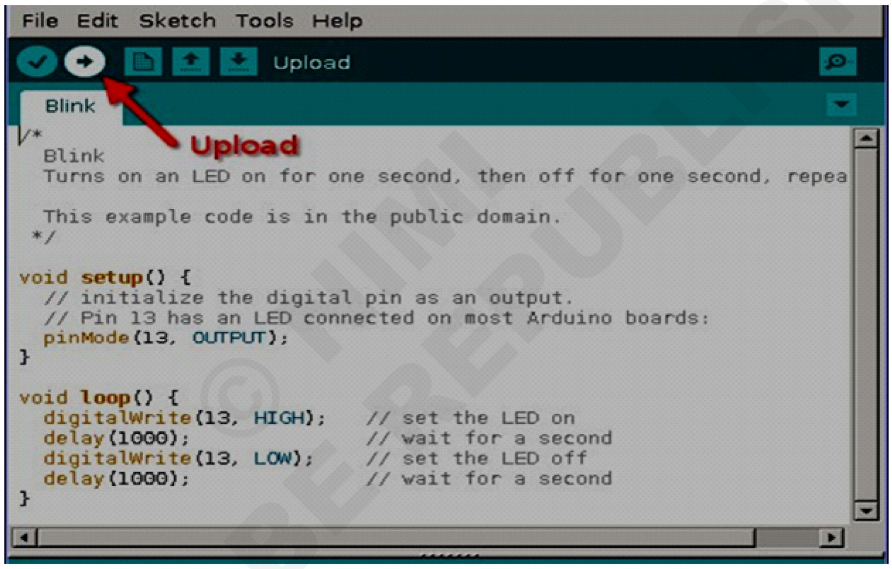
TASK 7 : **Click the upload button as shown in Fig 1**

Fig 1



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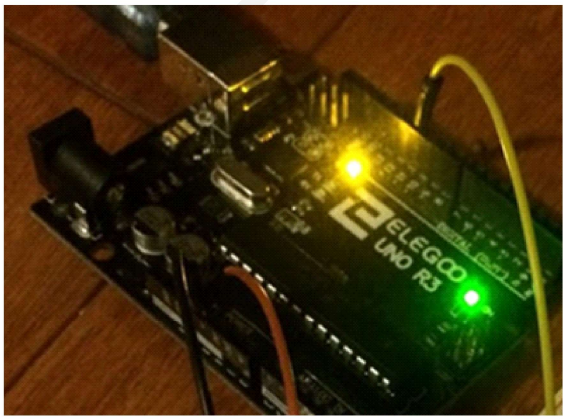
TASK 8 : **Observe the Arduino board where light will be blinking(yellow color) as shown in Fig 1**

Fig 1



Exercise : Students can try other example sketches in the Arduino IDE

— — — — — — — —

IoT Technician (Smart City) - Test and connect Components/parts of IoT system and Arduino board

Upload computer code to the physical board (microcontroller) to blink a simple LED

Objectives: At the end of this exercise you shall be able to
- **to execute simple programs**
- **to observe the performance of sketch and actuation.**

Requirements

Tools/Instruments/Equipments

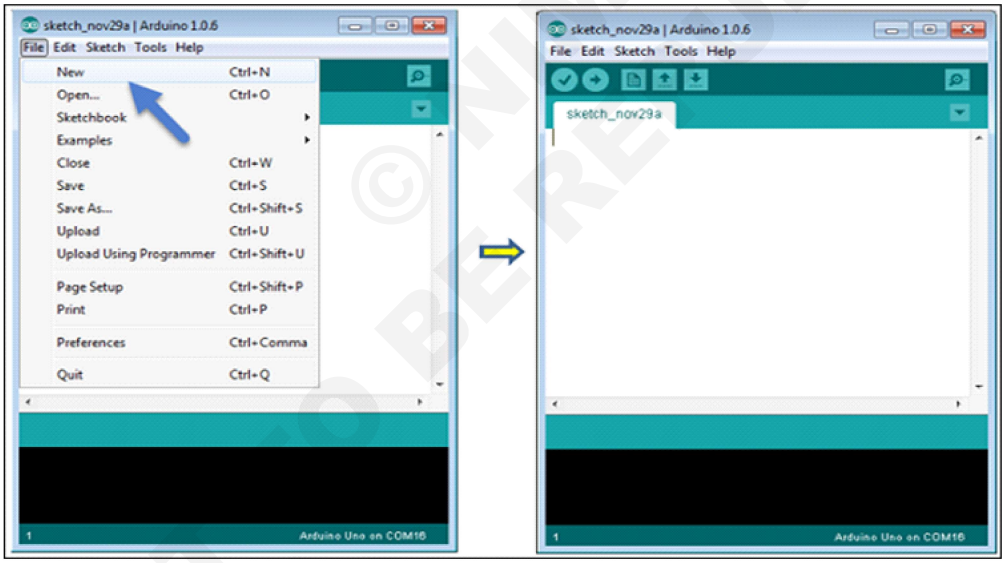
- Arduino uno board
- LED bulb
- Resistor
- PC with Arduino IDE installed
- Jumper Wires
- Breadboard

PROCEDURE

TASK 1 : **Follow the steps in Exercise 21.134 till Task 4.**

TASK 2 : **Create a new project File ? New as shown in Fig 1**

Fig 1



TASK 3 : **Enter the code**

```
/*
Blink
Turns on an LED on for one second, then off for one second, repeatedly.
This example code is in the public domain.
*/
// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;
// the setup routine runs once when you press reset:
void setup(){
// initialize the digital pin as an output.
pinMode(led, OUTPUT);
}
// the loop routine runs over and over again forever:
void loop(){
digitalWrite(led, HIGH);
// turn the LED on (HIGH is the voltage level)
```

```
delay(1000);
// wait for a second
digitalWrite(led, LOW);
// turn the LED off by making the voltage LOW
delay(1000);
// wait for a second
}
```

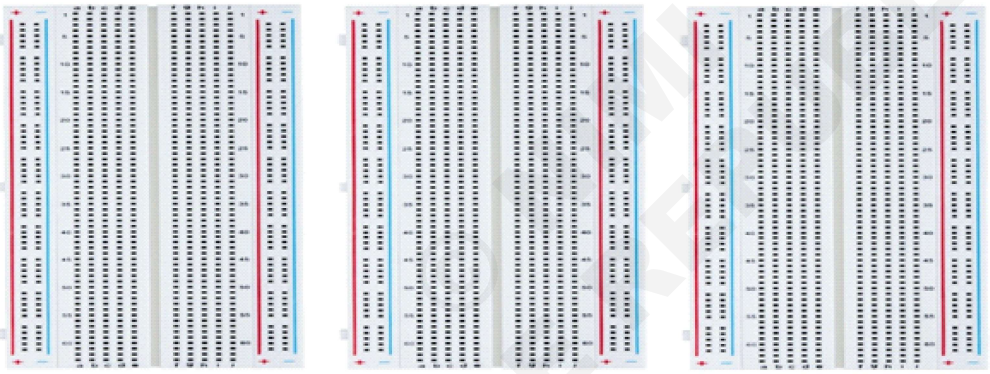
— — — — — — — —

TASK 4 : **Get ready with the below components**

LED

Jumper wires

Breadboard



Resistors 1kohm

— — — — — — — —

TASK 5 : **Connect the LED with Arduino using breadboard as shown in Fig 1 & Fig 2**

Fig 1

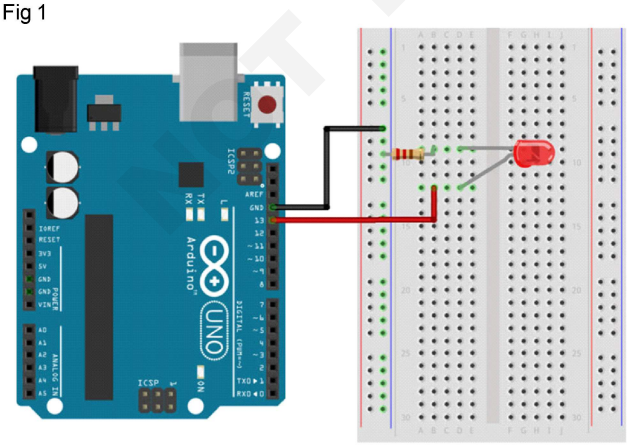
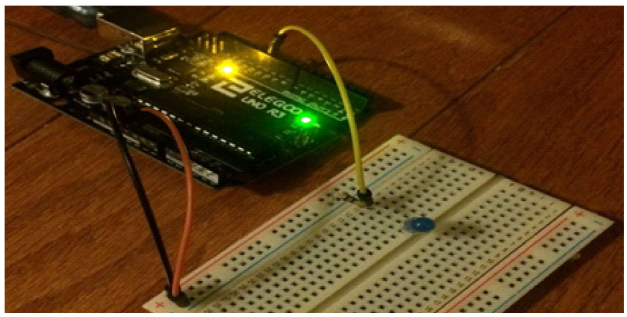


Fig 2



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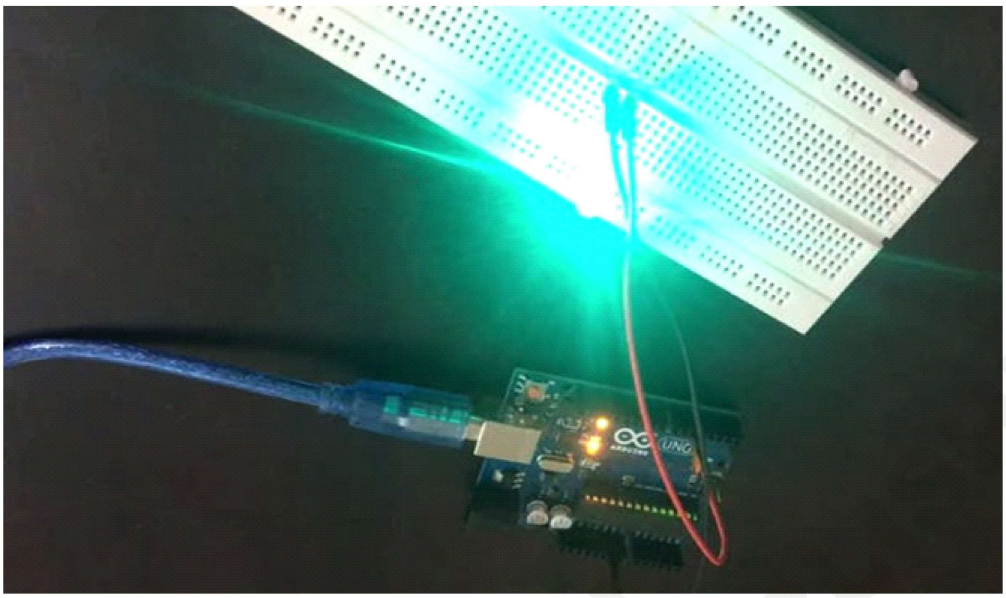
TASK 6 : **Repeat Task 7 in Exercise 22.134**

— — — — — — — —

TASK 7 : **Observe the LED glowing which is fixed in breadboard. Do the Exercise.**

Fig 1



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IoT Technician (Smart City) - Test and connect Components/parts of IoT system and Arduino board

Write and upload computer code to the physical arduino board micro controller to sound buzzer

Objectives: At the end of this exercise you shall be able to
- **to connect buzzer and give power supply**
- **to observe the performance of sketch and actuation.**

Requirements

Tools/Instruments/Equipments

- Arduino uno board
- Buzzer
- Resistor
- PC with Arduino IDE installed
- Jumper Wires
- Breadboard

PROCEDURE

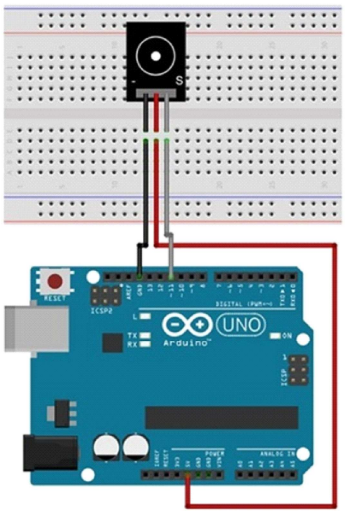
TASK 1 : **Based on previous exercises 22.134 and 22.135, the additional component introduced here is buzzer as shown in Fig 1**

Fig 1

S: Signal pin 5V: input pin Ground: Ground pin

TASK 2 : **Interface buzzer with Arduino as shown in the Fig 1**

Fig 1



TASK 3 : **Type the code given below**

```
intbuzzerPin=11;.....// initializing the buzzer pin at pin 11 of Arduino
voidsetup(){.....// Code written in it will only run once
pinMode(buzzerPin, OUTPUT);.....// This will set the pin 11 as output
beep(50);.....// This will make a beep sound Beep
beep(50);
delay(1000);.....//Adding a delay of 1 sec.
}
voidloop(){.....// Code written in it will run continuously
beep(50);.....// This will make a beep sound after every 500 milliseconds
delay(1000);.....// Adding a delay of one second.
}
voidbeep(unsignedchardelayms){.....// Created a function for beep
analogWrite(buzzerPin,20);.....// This will set pin 11 to high
.delay(delayms);.....// Giving a delay
analogWrite(buzzerPin,0);.....// This will set pin 11 to LOW
delay(delayms);.....// Giving a delay
}
```

— — — — — — — —

TASK 4 : **Upload the code and observe the actuation**

— — — — — — — —

Circuit and program to interface light sensor – LDR with arduino to switch ON/ OFF LED based on light intensity

Objectives: At the end of this exercise you shall be able to
- **to connect LDR and to give power supply**
- **to observe the performance of sketch and actuation.**

Requirements

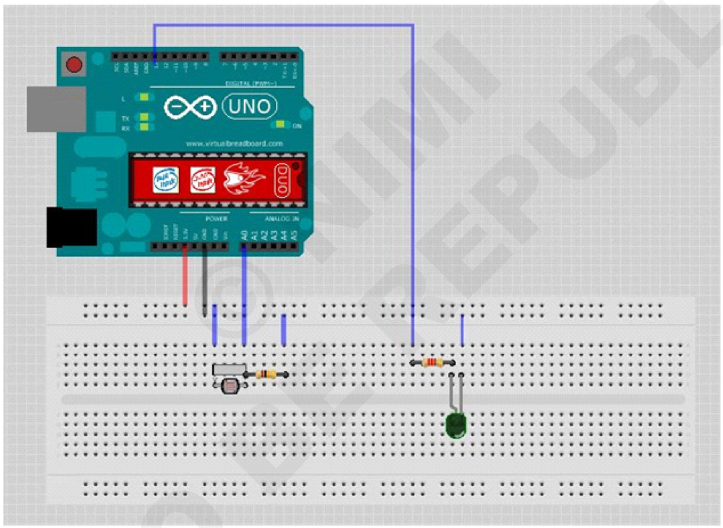
Tools/Instruments/Equipments

- Arduino uno board
- LED
- 10k and 220 Ohm Resistor
- PC with Arduino IDE installed
- Jumper Wires

PROCEDURE

TASK 1 : **Connect LDR and LED as show in the Fig 1**

Fig 1



TASK 2 : **Type the code as shown below**

```
onst int ledPin = 13;
const int ldrPin = A0;
void setup() {
Serial.begin(9600);
pinMode(ledPin, OUTPUT);
pinMode(ldrPin, INPUT);
}
void loop() {
int ldrStatus = analogRead(ldrPin);
if (ldrStatus<= 200) {
digitalWrite(ledPin, HIGH);
Serial.print("Its DARK, Turn on the LED : ");
Serial.println(ldrStatus);
} else {
digitalWrite(ledPin, LOW);
Serial.print("Its BRIGHT, Turn off the LED : ");
Serial.println(ldrStatus);
}
}
```

TASK 3 : **Observe the Output.**

IoT Technician (Smart City) - Test and connect Components/parts of IoT system and Arduino board

Set up & test circuit to interface potentiometer with arduino board and map to digital values for eg. 0-1023

Objectives: At the end of this exercise you shall be able to
- **to connect potentiometer and to give power supply**
- **to observe the performance of sketch.**

Requirements

Tools/Instruments/Equipments

- Arduino uno board
- Buzzer
- Breadboard
- PC with Arduino IDE installed
- Jumper Wires
- Breadboard

PROCEDURE

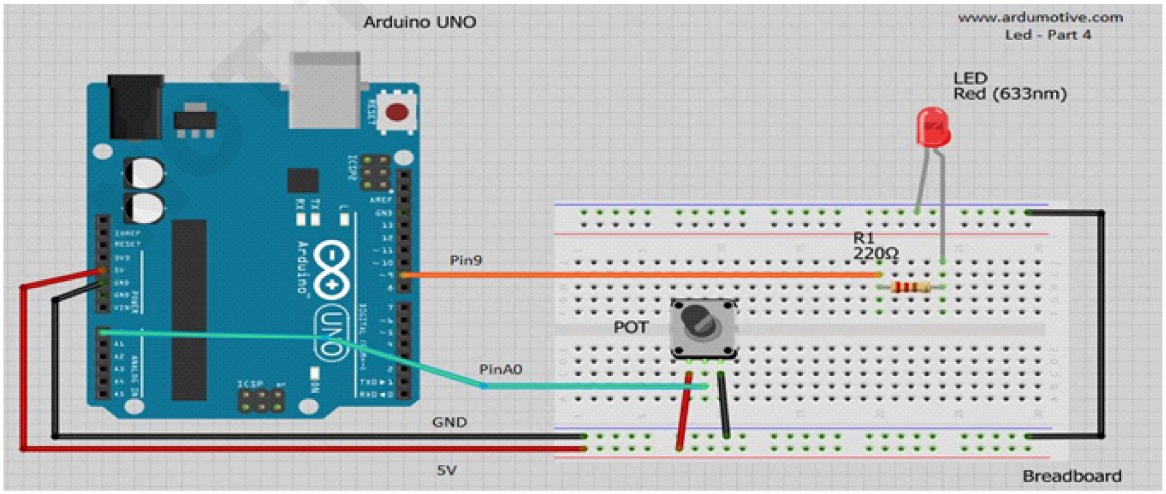
TASK 1 : **Take a Potentiometer as show in Fig 1**

Fig 1

— — — — — — — —

TASK 2 : **Observer the circuit given in Fig 1**

Fig 1



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TASK 3 : **After connect setup, type the below code**

```
//Constants:
const int ledPin = 9;  //pin 9 has PWM funtion
const int potPin = A0; //pin A0 to read analog input
//Variables:
int value; //save analog value
void setup(){
 //Input or output?
pinMode(ledPin, OUTPUT);
pinMode(potPin, INPUT); //Optional
}
void loop(){
value = analogRead(potPin);      //Read and save analog value from potentiometer
value = map(value, 0, 1023, 0, 255); //Map value 0-1023 to 0-255 (PWM)
analogWrite(ledPin, value);      //Send PWM value to led
delay(100);                      //Small delay
}
```

TASK 4 : **Observe the Output.**

IoT Technician (Smart City) - Test and connect Components/parts of IoT system and Arduino board

Interface pushbuttons or switches, connect two points in a circuit while pressing them. This turns on the built in LED on pin 13 in arduino, while pressing the button

Objectives: At the end of this exercise you shall be able to
- **to connect pushbuttons and to give power supply**
- **to observe the performance of sketch and actuation.**

Requirements

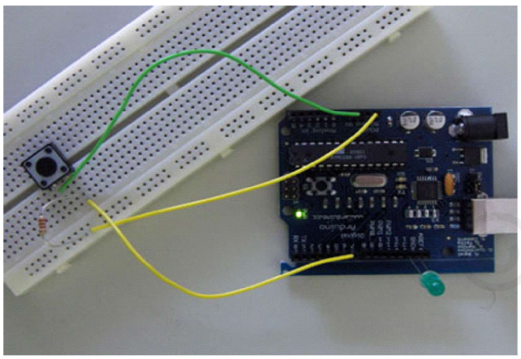
Tools/Instruments/Equipments

- Arduino uno board
- LED
- Resistor
- PC with Arduino IDE installed
- Jumper Wires
- Breadboard

PROCEDURE

TASK 1 : **Set up the connection as shown in Fig 1**

Fig 1



TASK 2 : **Type the code given below**

```
/* Basic Digital Read
* ....................
* ....................
* turns on and off a light emitting diode(LED) connected to digital
* pin 13, when pressing a pushbutton attached to pin 7. It illustrates the
* concept of Active-Low, which consists in connecting buttons using a
* 1K to 10K pull-up resistor.
*/
int ledPin = 13; // choose the pin for the LED
int inPin = 7;   // choose the input pin (for a pushbutton)
int val = 0;     // variable for reading the pin status
void setup() {
pinMode(ledPin, OUTPUT);  // declare LED as output
pinMode(inPin, INPUT);    // declare pushbutton as input
}
void loop(){
val = digitalRead(inPin);  // read input value
 if (val == HIGH) {       // check if the input is HIGH (button released)
digitalWrite(ledPin, LOW);  // turn LED OFF
 } else {
digitalWrite(ledPin, HIGH);  // turn LED ON
}
}
```

TASK 3 : **Observer the LED based on button press**

IoT Technician (Smart City) - Test and connect Components/parts of IoT system and Arduino board

Rig up the circuit and upload a program to control a relay and switch ON/OFF LED light using arduino

Objectives: At the end of this exercise you shall be able to
- **to connect relay with arduino and triggering bulb**
- **to observe the performance of sketch.**

Requirements

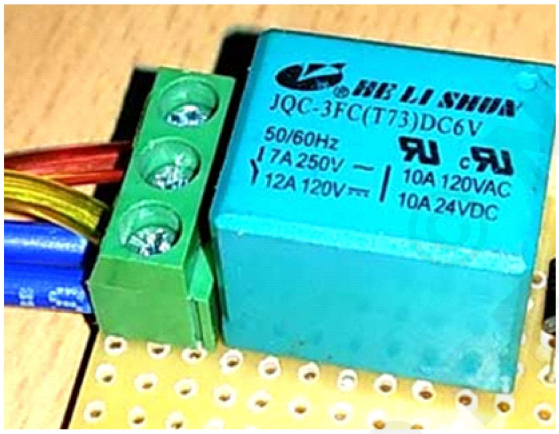
Tools/Instruments/Equipments

- Arduino board
- Bulb
- 5v Relay
- PC with Arduino IDE installed
- Jumper Wires
- 1k resistor

PROCEDURE

TASK 1 : **Take a 6V relay circuit as shown in Fig 1**

Fig 1



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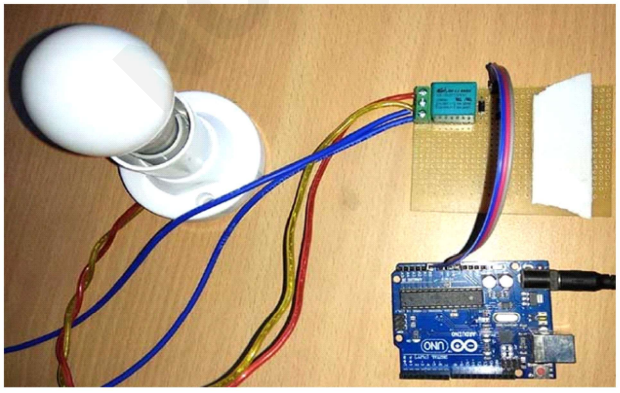
TASK 2 : **Fix the relay in the breadboard and establish a connection with Ardunio as done in previous exercises then connect bulb with the relay as shown in Fig 1**

Fig 1



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TASK 3 : **Type the code given below**

```
// Arduino Relay Control Code
#define relay A0
#define interval 1000
void setup() {
pinMode(relay, OUTPUT);
}
void loop()
{
digitalWrite(relay, HIGH);
delay(interval);
digitalWrite(relay, LOW);
delay(interval);
}
```

— — — — — — — —

TASK 4 : **Observe the Output**

— — — — — — — —

IoT Technician (Smart City) - Test and connect Components/parts of IoT system and Arduino board

Make circuit and upload a program to interface of LCD display with a microcontroller to display characters

Objectives: At the end of this exercise you shall be able to
- **to establish connection of LCD with arduino**
- **to observe the circuit configuration and display of text in the LCD.**

Requirements

Tools/Instruments/Equipments

- Arduino board
- 16 X 2 LCD
- Jumper wire
- PC with Arduino IDE installed
- 100 uF Capacitor

PROCEDURE

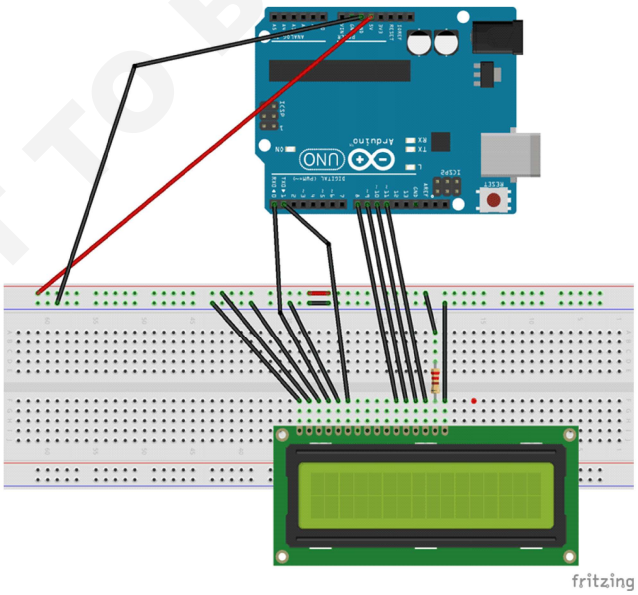
TASK 1 : **Take 16 X 2 LCD as shown in Fig 1**

Fig 1

— — — — — — — —

TASK 2 : **Observer the connection set up as shown in Fig 1**

Fig 1



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TASK 3 : **Establish the pin connections for LCD as shown below :**

PIN1 or VSS to ground

PIN2 or VDD or VCC to +5v power

PIN3 or VEE to ground (gives maximum contrast best for a beginner)

PIN4 or RS (Register Selection) to PIN0 of ARDUINO UNO

PIN5 or RW (Read/Write) to ground (puts LCD in read mode eases the communication for user)

PIN6 or E (Enable) to PIN1 of ARDUINO UNO

PIN11 or D4 to PIN8 of ARDUINO UNO

PIN12 or D5 to PIN9 of ARDUINO UNO

PIN13 or D6 to PIN10 of ARDUINO UNO

PIN14 or D7 to PIN11 of ARDUINO UNO

— — — — — — — —

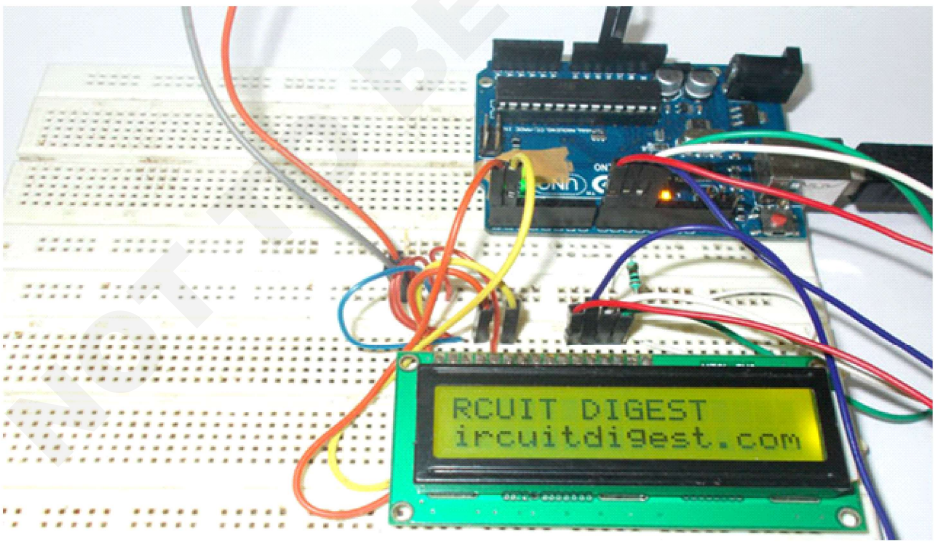
TASK 4 : **Type the below code**

```
#include <LiquidCrystal.h>
// initialize the library with the numbers of the interface pins
LiquidCrystallcd(0, 1, 8, 9, 10, 11); /// REGISTER SELECT PIN,ENABLE PIN,D4 PIN,D5 PIN, D6 PIN, D7 PIN
void setup()
{
  // set up the LCD's number of columns and rows:
lcd.begin(16, 2);
}
void loop()
{
// set the cursor to column 0, line 1
lcd.print("  CIRCUIT DIGEST");//print name
lcd.setCursor(0, 1); // set the cursor to column 0, line 2
lcd.print("www.circuitdigest.com");//print name
delay(750);//delay of 0.75sec
lcd.scrollDisplayLeft();//shifting data on LCD
lcd.setCursor(0, 0);// set the cursor to column 0, line1
}
```

— — — — — — — —

TASK 5 : **Observe the Output and it will be as shown in Fig 1**

Fig 1



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Rig up the circuit and upload a program to interface temperature sensor – LM35 with a controller to display temperature on the LCD

Objectives: At the end of this exercise you shall be able to
- **to establish connection of LM35 sensor with arduino**
- **to observe the circuit configuration and display of temperature in the LCD.**

Requirements

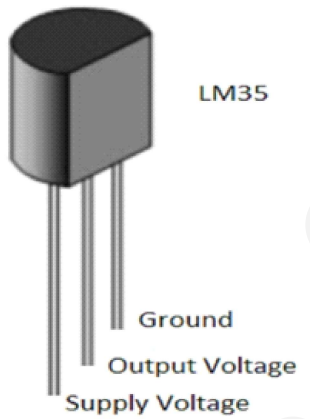
Tools/Instruments/Equipments

- Arduino uno board
- LM35 Sensor
- PC with Arduino IDE installed
- Jumper Wires
- 16 X 2 LCD Module

PROCEDURE

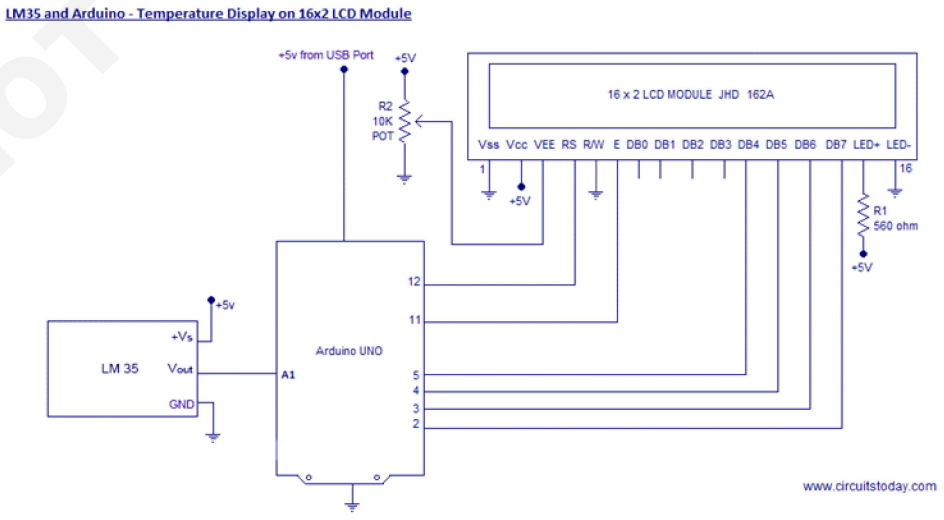
TASK 1 : **Take an LM35 Sensor as show in Fig 1**

Fig 1



TASK 2 : **Observe the circuit diagram shown in Fig 1**

Fig 1



TASK 3 : **Type the code given below**

```
#include<LiquidCrystal.h>
LiquidCrystallcd(12, 11, 5, 4, 3, 2);
const int sensor=A1; // Assigning analog pin A1 to variable 'sensor'
float tempc;  //variable to store temperature in degree Celsius
float tempf; //variable to store temperature in Fahreinheit
float vout;  //temporary variable to hold sensor reading
void setup()
{
pinMode(sensor,INPUT); // Configuring pin A1 as input
Serial.begin(9600);
lcd.begin(16,2);
delay(500);
}
void loop()
{
vout=analogRead(sensor);
vout=(vout*500)/1023;
tempc=vout; // Storing value in Degree Celsius
tempf=(vout*1.8)+32; // Converting to Fahrenheit
lcd.setCursor(0,0);
lcd.print("in DegreeC= ");
lcd.print(tempc);
lcd.setCursor(0,1);
lcd.print("in Fahrenheit=");
lcd.print(tempf);
delay(1000); //Delay of 1 second for ease of viewing in serial monitor
}
```

— — — — — — — —

TASK 4 : **Observe the output temperature displayed in the LCD**

— — — — — — — —

IoT Technician (Smart City) - Test and connect Components/parts of IoT system and Arduino board

Set up circuit and upload program to interface DC motor (actuator) with microcontroller to control on/off/forward/reverse operations

Objectives: At the end of this exercise you shall be able to
- **to connect DC motor with arduino and triggering the operation**
- **to observe the performance of sketch.**

Requirements

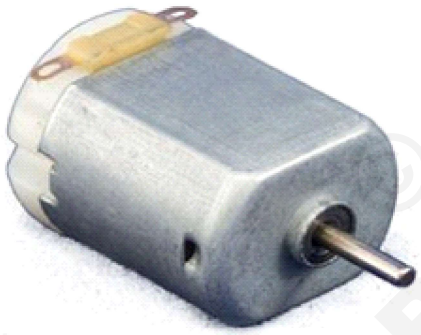
Tools/Instruments/Equipments

- Arduino uno board
- Diodes
- USB cable
- DC motor
- Jumper Wires
- PC with Arduino IDE installed
- 9V Battery
- Potentiometer – 10KÙ

PROCEDURE

TASK 1 : **Take a DC motor as shown in Fig 1**

Fig 1



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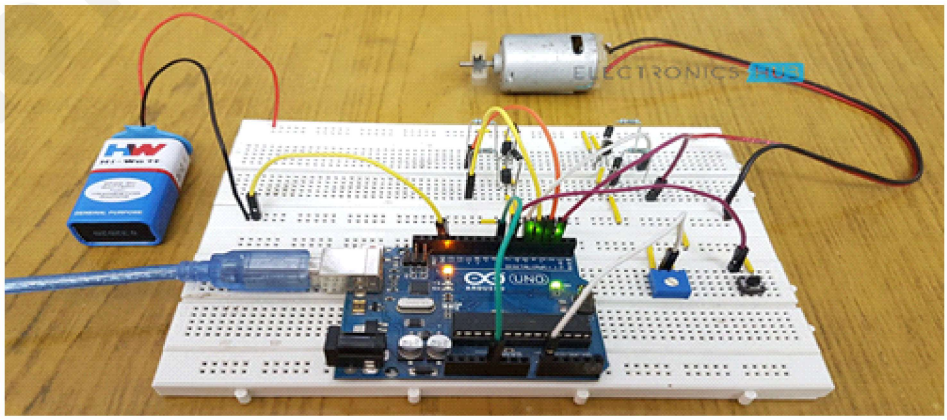
TASK 2 : **Observe the circuit design shown in Fig 1**

Fig 1



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TASK 3 : **Observe the connections established as given below**

The wiper terminal of the POT is connected to the Analog Pin (A0) of the Arduino. The other terminals are connected to Vcc and GND. Four transistors are connected as shown in the Fig 2.With the load i.e. a DC Motor in the center, they form an H - bridge. Transistors Q1 and Q4 form the backward direction path while transistors Q2 and Q3 form forward rotation path.

The inputs to the transistors are given from the Arduino. The pins 3 and 2 of the Arduino are connected to the base of Q1 and Q4 respectively. Pins 5 and 4 are connected to base of Q2 and Q3 respectively. All these connections are made through four 1 K? resistors.

A DC Motor is an inductive load and can produce back EMF when changing the direction. In order to eliminate the effect of any back EMF, four diodes are connected across the collector and emitter of each transistor.

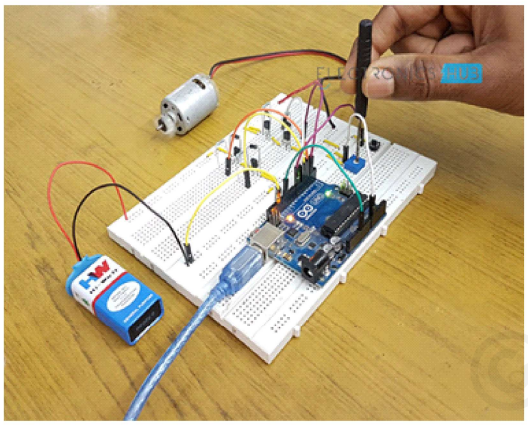
The POT is connected to the analog pin A0 of the Arduino. This is used to adjust the speed of the motor. The normal operation of the motor is to rotate in forward direction.

When a button, which is connected to the Pin 7 of the Arduino, is activated or pressed, the direction of the rotation is reversed and continue to rotate in that direction until the button is pressed once again.

For forward rotation of the motor, transistors Q2 and Q3 must be turned on. Hence, the outputs 5 and 4 of the Arduino are high

TASK 4 : **Look into the performance as shown in Fig 1**

Fig 1



The Arduino is programmed to detect a logic low on the Pin 7 when the button is pressed. When the button is pressed once, the transistors Q1 and Q4 must be turned on. Hence, the pins 3 and 2 of Arduino are made high. The motor rotates in reverse direction if the button is pressed once again.

TASK 5 : **Type the code below:**

```
Const int potPin = A0;
const int buttonPin = 7;
const int forward1 = 5;
const int forward2 = 4;
const int backward1 = 3;
const int backward2 = 2;
int potValue = 0;
int motorValue = 0;
int buttonState = 0;
boolean a;
void setup()
{
pinMode(buttonPin, INPUT_PULLUP);
pinMode (forward1, OUTPUT);
pinMode (forward2, OUTPUT);
pinMode (backward1, OUTPUT);
pinMode (backward2, OUTPUT);
}
void loop()
{
potValue = analogRead(potPin);
motorValue = map(potValue, 0, 1023, 0, 255);
buttonState = digitalRead(buttonPin);
if (buttonState == LOW)
{
a=!a;
}
```

```
if(a)
{
analogWrite(backward1, motorValue);
digitalWrite(backward2, HIGH);
digitalWrite(forward1, LOW);
digitalWrite(forward2, LOW);
}
else
{
analogWrite(forward1, motorValue);
digitalWrite(forward2, HIGH);
digitalWrite(backward1, LOW);
digitalWrite(backward2, LOW);
}
}
```

— — — — — — — —

Task 5: **Observe the performance**

— — — — — — — —

IoT Technician (Smart City) - Test and connect Components/parts of IoT system and Arduino board

Rig up the circuit and upload a program micto controller to switch on/off two lights using relay

Objectives: At the end of this exercise you shall be able to
- **to connect relay with Arduino and triggering bulb**
- **to observe the performance of sketch.**

Requirements

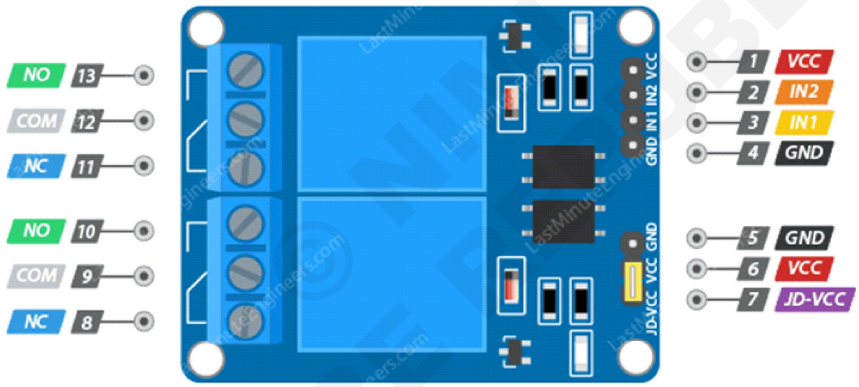
Tools/Instruments/Equipments

- Arduino uno board
- Bulb
- 5v Relay
- 1k resistor
- PC with Arduino IDE installed
- Jumper Wire

PROCEDURE

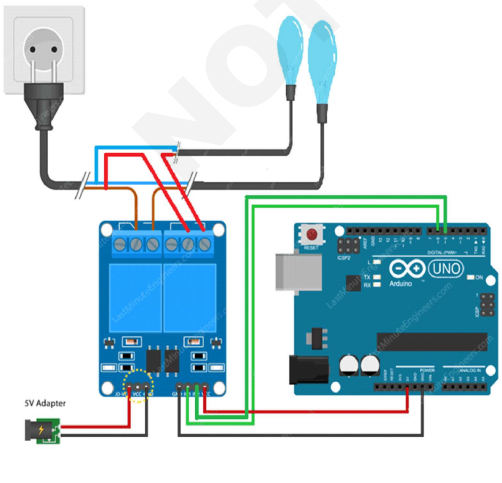
TASK 1 : **Take a 6V relay circuit as shown in Fig 1**

Fig 1



TASK 2 : **Fix the relay in the breadboard and establish a connection with Ardunio as done in previous exercises then connect bulb with the relay as shown in Fig 1**

Fig 1



TASK 3 : **Type the code given below**

```
int RelayPin1 = 6;
int RelayPin2 = 5;
void setup(){
// Set RelayPin as an output pin
pinMode(RelayPin1, OUTPUT);
pinMode(RelayPin2, OUTPUT);
}
void loop(){
// Let's turn on the relay1 and turn off the relay2...
digitalWrite(RelayPin1, LOW);
digitalWrite(RelayPin2, HIGH);
delay(3000);
// Let's turn on the relay2 and turn off the relay1...
digitalWrite(RelayPin1, HIGH);
digitalWrite(RelayPin2, low);
delay(3000);
}
```

TASK 4 : **Observe the Output**