DRONACHARYA
Group of Institutions

ELECTRICAL WORKSHOP

LABORATORY MANUAL

B.Tech. Semester

Subject Code: BEE-353

Session: 2024-25, Odd Semester

Name:	
Roll. No.:	
Group/Branch:	

DRONACHARYA GROUP OF INSTITUTIONS
DEPARTMENT OF EEE
#27 KNOWLEDGE PARK 3

GREATER NOIDA

AFFILATED TO Dr. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

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Vision and Mission of the Institute

Vision:

"Dronacharya Group of Institutions, Greater Noida aims to instill core human values and facilitating competence to address global challenges by providing Quality Technical Education."

Mission:

M1: Enhancing technical expertise through innovative research and education, fostering creativity and excellence in problem-solving.

M2: Cultivating a culture of ethical innovation and user-focused design, ensuring technological progress enhances the well-being of society.

M3: Equipping individuals with the technical skills and ethical values to lead and innovate responsibly in an ever-evolving digital landscape.

Vision and Mission of the Department

Vision

To be a Centre of Excellence in Globalizing Education and Research in the field of Electrical and Electronics Engineering.

Mission

M1: To empower technocrats with state-of-art knowledge to excel as eminent electrical engineers with multi-disciplinary skills.

M2: To emphasize social values and leadership qualities to meet the industrial needs, societal problems and global challenges.

M3: To enable the technocrats to accomplish impactful research and innovations.

Programme Educational Objectives (PEOs)

PEO 1. To foster strong knowledge in basic sciences and electrical engineering that enable technocrats to have successful careers.

PEO 2. Imbibed with the state of art knowledge to adapt ever transforming technical scenario.

PEO 3. Inspire engineers to provide innovative solutions to real-world challenging problems by applying electrical and electronics engineering principles.

Programme Outcomes (POs)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: Graduates will be capable to gain knowledge in diverse areas of electrical and electronics engineering and apply that to a successful career, entrepreneurship and higher education.

PSO2: Enhance the competence of graduates to design and analyze systems used in advanced power applications, renewable energy, electrical drives in allied technical fields.

PSO3: Graduate will use advance tools to analyze, design and develop electrical and electronic systems for feasible operation and meet the industry requirements

University Syllabus

BEE353- ELECTRICAL WORKSHOP

Course Outcomes:		Knowledge Level, KL
Upon the completion of the course, the student will be able to:		
CO 1	Perform various types of Electrical connections.	K_3
CO2	Develop small circuits on PCB	K_3
CO3	Differentiate between various electrical wires, cables and accessories.	K_2
CO4	Demonstrate the layout of electrical substation & various safety measures.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1 – Remember K_2 – Understand K_3 – Apply K_4 – Analyze K_5 – Evaluate K_6 – Create

Detailed Syllabus:

Note: Minimum ten experiments are to be performed from the following list:

1. To study the working and Control of two lamps in series and in parallel
2. To perform the stair case working and it's testing.
3. To study the working principle and wiring of fluorescent lamp.
4. To study and wiring of distribution board including power plug using isolator, MCB, ELCB.
5. To study and estimate a typical, BHK house wiring.
6. Familiarization, soldering, testing and observing the wave forms on CRO of a HW and FW uncontrolled rectifier (using diodes) with capacitor filter.
7. Visit your college substation and familiarize the supply system, Transformer, HT Paneland Distribution etc.
8. To study construction, working and application of workshop tools. Also study the Electrical and Electronics Symbols.
9. To study the wires, cables and their gauges, Domestic Electrical Accessories.
10. Mini Project on PCB.
11. To study fault, Remedies in Domestic Installation and Indian Electricity Rules.
12. To study the different types of earthing system and measure the earth resistance.

Course Outcomes (COs)

Upon successful completion of the course, the students will be able to:

CO 1	Perform various types of Electrical connections.
CO 2	Develop small circuits on PCB
CO 3	Differentiate between various electrical wires, cables and accessories.
CO 4	Evaluation and analysis of two-port network parameters.
CO 5	Demonstrate the layout of electrical substation & various safety measures.

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	1	-	-	-	1	2	-	2
CO 2	3	2	-	-	2	-	-	-	1	2	-	2
CO 3	2	2	2	2	-	-	-	-	1	1	-	1
CO 4	2	-	2	2	2	-	-	-	1	1	-	1
Course Correlation mapping	**2.2**	**1.2**	**1.4**	**1.2**	**1.4**	**-**	**-**	**-**	**1**	**1.4**	**-**	**1.6**

Correlation Levels: High-3, Medium-2, Low-1

CO-PSO Mapping

	PSO1	**PSO2**	**PSO3**
CO 1	2	3	1
CO 2	2	3	1
CO 3	2	3	1
CO 4	2	3	1

Course Overview

The significance of the Electrical Workshop Lab is renowned in the various fields of engineering applications. For an Electrical Engineer, it is obligatory to have the practical ideas about the Electrical Workshop. By this perspective we have introduced a Laboratory manual cum Observation for Electrical Workshop. The manual uses the plan, cogent and simple language to explain the fundamental aspects of Electrical Workshop in practical. The manual prepared very carefully with our level best. It gives all the steps in executing an experiment.

List of Experiments mapped with COs

Sl No.	Name of the Experiment	Course Outcome
1	Introduction of tools, electrical materials and abbreviations.	CO1
2	To study staircase wiring.	CO1
3	To study hose wiring.	CO2
4	To study fluorescent tube light.	CO4
5	To study moving iron, Moving coil, Electrodynamic and Induction type meter.	CO4
6	To study circuit of SMPS.	CO3
7	To study circuit and working of UPS	CO3
8	To study circuit and working of home inverter	CO2
9	To study fuses MCBs and importance of earthing.	CO4
10	The working principles and control of two lamps when connected in series and in parallel configurations.	CO4

DOs and DON'Ts

DOs

1. Login-on with your username and password.
2. Log off the computer every time when you leave the Lab.
3. Arrange your chair properly when you are leaving the lab.
4. Put your bags in the designated area.
5. Ask permission to print.

DON'Ts

1. Do not share your username and password.
2. Do not remove or disconnect cables or hardware parts.
3. Do not personalize the computer setting.
4. Do not run programs that continue to execute after you log off.
5. Do not download or install any programs, games or music on computer in Lab.
6. Personal Internet use chat room for Instant Messaging (IM) and Sites is strictly prohibited.
7. No Internet gaming activities allowed.
8. Tea, Coffee, Water & Eatables are not allowed in the Computer Lab.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chestin and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.
4. Immediately call medical emergency and security. Remember! Time is critical; be best.

Precautions (In case of Fire)

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.
2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth if possible isolate the burning equipment from the other surroundingequipment.
3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.
4. Call security and emergency department

immediately:**Emergency : 201**

(Reception) Security : 231

(Gate No.1)

Guidelines to students for report preparation

All students are required to maintain a record of the experiments conducted by them. Guidelinesfor its preparation are as follows: -

1) All files must contain a title page followed by an index page. ***The files will not be signed by thefaculty without an entry in the index page.***

2) Student's Name, Roll number and date of conduction of experiment must be written on allpages.

3) For each experiment, the record must contain the following

(i) Aim/Objective of the experiment
(ii) Pre-experiment work (as given by the faculty)
(iii) Lab assignment questions and their solutions
(iv) Test Cases (if applicable to the course)
(v) Results/ output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.

2. Students must ensure that their lab record is regularly evaluated.

Lab Assessment Criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes are assessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment is used to compute CO attainment aswell as internal marks in the lab course.

Grading Criteria	**Exemplary (4)**	**Competent (3)**	**Needs Improvement (2)**	**Poor (1)**
AC1: Designing experiments	The student chooses the problems to explore.	The student chooses the problems but does not set an appropriate goal for how to explore them.	The student fails to define the problem adequately.	The student does not identify the problem.
AC2: Collecting data through observation and/or experimentation	Develops a clear procedure for investigating the problem	Observations are completed with necessary theoretical calculations and proper identification of required components.	Observations are completed with necessary theoretical calculations but without proper understanding. Obtain the correct values for only a few components after calculations. Followed the given experimental procedures but obtained results with some errors.	Observations are incomplete. Lacks the appropriate knowledge of the lab procedures.

AC3: Interpreting data	Decides what data and observations are to be collected and verified	Can decide what data and observations are to be collected but lacks the knowledge to verify	Student decides what data to gather but not sufficient	Student has no knowledge of what data and observations are to be collected
AC4: Drawing conclusions	Interprets and analyses the data in order to propose viable conclusions and solutions	Incomplete analysis of data hence the quality of conclusions drawn is not up to the mark	Cannot analyse the data or observations for any kind of conclusions.	Lacks the required knowledge to propose viable conclusions and solutions
AC5: Lab record assessment	Well-organized and confident presentation of record & ability to correlate the theoretical concepts with the concerned lab results with appropriate reasons.	Presentation of record is acceptable	Presentation of record lacks clarity and organization	No efforts were exhibited

LAB EXPERIMENTS

LAB EXPERIMENT -1

AIM: Introduction of tools, electrical materials and abbreviations.

TOOLS:

1. **PLIER**: Generally three types of pliers are used in the electrical workshop. They are:-

- **FLAT NOSE PLIER**: Used for holding jobs or holding wires. It has got only two slotted jaws, which are tapered. Thus it is used for tightening or loosening small nuts.

- **SIDE CUTTING PLIER**: Used for cutting of thin wires and removing insulations from them. It has got cutting edge on its one of its sides.

- **ROUND NOSE PLIER**: Used only to hold or cut the wires. It has no gripping jaws. Its cutting edge is long and rounded on the top.

2. **SCREW DRIVER:** It is used to loosen or tighten or to keep screws in position. It has a wooden or plastic handle and a blade of high carbon steel.

3. **CHISEL:**

- FIRMER CHISEL: Generally used for carpentry works and can be used by hand pressure or with the help of mallet. It has flat blade, which varies from 12mm to 15mm.
- COLD CHISEL: Used for cutting iron pieces (cold). It has cutting angle from 30° to 45°and is made of high carbon steel.

4. **HAMMER:** Most commonly used in the workshop. The head is made of cast iron or forged; the claw is hardened and tampered. The striking place is slightly convex. The head is fitted with a wooden handle of various lengths.

5. **HACKSAW:** Used to cut metal such as iron strips, core pipes etc. it has a blade made of high steel or tungsten.

6. **ELECTRICAL TOOLS**

- **TUMBLER SWITCH:** (6 A for light), this switch was used 3-4 decade ago. It is made of Bakelite.

- **MCB BOX:** Known as the Miniature Circuit Breaker Box.

7. **METAL CONDUIT PIPE WITH JUNTION BOX:** Metallic hollow pipe, which is used as a passage for electrical house, hold wires. It is fixed to walls with the help of metallic saddle.

8. **METAL BEND:** Hollow metallic pipe bend to an angle of 90° to allow smooth movement of wires inserted through the walls during wiring .

9. **BATTEN WIRING:** It is an old fashioned wiring used 4-5 decades ago.

10. **PVC CASING AND LAPPING:** Long rectangular box made of 2 parts. It is made of PVC and used mainly to pass wires through walls during wiring.

11. **PVC BEND:** Work similarly as metal bends but it is made up of PVC that makes it lighter, cheaper and more durable.

12. **BATTEN LAMP HOLDER:** mainly used to hold electric bulbs and lamps.

13. **SWITCH BOARD WITH SWITCHES:** it contains the following:
    - SOCKET OUTLETS: it is a type of electrical material through which electric current flows from wires to various electrical appliances. It is of 6A.

    - TWO WAY SWITCH: it is mainly used in staircase wiring to either on or off the light. It is of 6A.

    - ONE-WAY SWITCH: it is a device used to switch on lights of 6A.

14. **7/20 SWG (POWER WIRE):** they are used in power purposes for duty electrical appliances. 7/20 means 7 numbers of wires in the cable and 20 strands for thickness or gauge size.

15. **3/20 SWG (PHASE WIRING):** mostly used for house wiring purposes.

16. **3/22 SWG (NEUTRAL WIRE):** it is also used for house wiring purposes.
17. **1/18 SWG:** it is used for earthing.

18. **FLEXIBLE CABLE:** This is a temporary wire used for both power and light but temporarily. It is used as extension wire.

ABBREVIATIONS:

S.NO.	NAME OF THE UNIT	ABBREVIATION
1	Ohm	Ω
2	Phase	Φ
3	Amperes	A
4	Alternating Current	AC
5	Air Conditioning	A/C
6	Arc Fault Circuit Interrupter	AFCI
7	Air Handling Unit	AHU
8	Ampere Interrupting Capacity	AIC
9	Aluminum	AL
10	Automatic Transfer Switch	ATS
11	Automatic Temperature Control	ATC
12	American Wire Gauge	AWG
13	British Thermal Units	BTU
14	Conduit	C
15	Cable Television or Community Antennae Television	CATV
16	Critical Branch	CB
17	Circuit Breaker	C/B
18	Certified Ballast Manufacturer	CBM
19	Circuit (also: CIR, CKT)	CCT
20	Closed Circuit Television	CCTV
21	Candela	CD
22	Circuit (also: CCT, CKT)	CIR
23	Circuit (also: CCT, CIR)	CKT
24	Current Limiting Fuse	CLF
25	Control Power Transformer	CPT

26	Current Transformer	CT
27	Copper	CU
28	Decibel	dB
29	Direct Current	DC
30	Diameter	DIA
31	Equipment Branch	EB
32	Electrical Code or Electrical Contractor	EC
33	Exhaust Fan	EF
34	Elevator	ELEV
35	Emergency	EM
36	Electrical Metallic Tubing	EMT
37	Emergency Power	EP
38	Emergency Power Off (Button or Switch)	EPO
39	Electric Water Cooler	EWC
40	Fuse	F
41	Fire Alarm	FA
42	Fire Alarm Annunciator	FAA
43	Full Load Amperes	FLA
44	Flexible Metal Conduit	FMC
45	Ground	G
46	Ground Fault Circuit Interrupter	GFCI, GFI
47	Ground	GND
48	Galvanized Rigid Metal Conduit	GRMC
49	Hand-Off-Automatic Switch	HOA
50	Heating, Ventilation, Air Conditioning	HVAC
51	Hertz	HZ
52	Institute of Electrical and Electronic Engineers	IEEE
53	Isolated Ground	IG
54	Intermediate Metal Conduit	IMC
55	Interlock	INT
56	Thousand Circular Mils	KCMIL
57	Kilovolt-Amperes	KVA

58	Kilovolt-Amperes Reactive	KVAR
59	Liquid Tight Flexible Metal Conduit	LFMC
60	Lighting	LTG
61	Lock Rotor Amps	LRA
62	Metal Clad Cable	MC
63	Main Circuit Breaker	MCB
64	Motor Control Center	MCC
65	Motor Circuit Protection	MCP
66	Mineral Insulated	MI
67	Main Lugs Only	MLO
68	Megawatt	MW
69	Normally Closed	NC
70	National Electrical Code	NEC
71	National Electrical Manufacturers Association	NEMA
72	National Fire Protection Association	NFPA
73	Night Light	NL
74	Normally Open or Number	NO
75	Pole	P
76	Push Button or Panic Button or Pull Box	PB
77	Panel	PNL
78	Power	PWR
79	Potential Transformer	PT
80	Quantity	QTY
81	Required	REQ
82	Residual-Current Circuit Breaker	RCCB, RCB
83	Residual-Current Device	RCD
84	Rigid Metal Conduit	RMC
85	Root Mean Squared	RMS
86	Rigid Non-Metallic Conduit	RNC
87	Remote Test Station	RTS
88	Roof Top Unit	RTU
89	Service Entrance	SE

90	Service End Line Box or Service Electrical Box	SEB
91	Spare	SP
92	Shunt Trip	ST
93	Switch	SW
94	Symmetrical	SYM
95	Telecommunications, Telephone	TEL, TELE
96	Telecommunications Grounding Busbar	TGB
97	Thermal Magnetic Circuit Breaker	TMCB
98	Under Ground	UG
99	Underwriters Laboratory	UL
100	Volt	V
101	Volt-Ampere	VA
102	Variable Frequency Drive	VFD
103	Voltage Transformer	VT
104	Watt or Wire	W
105	Water Heater	WH
106	Weatherproof or Waterproof	WP
107	Transformer	XFMR

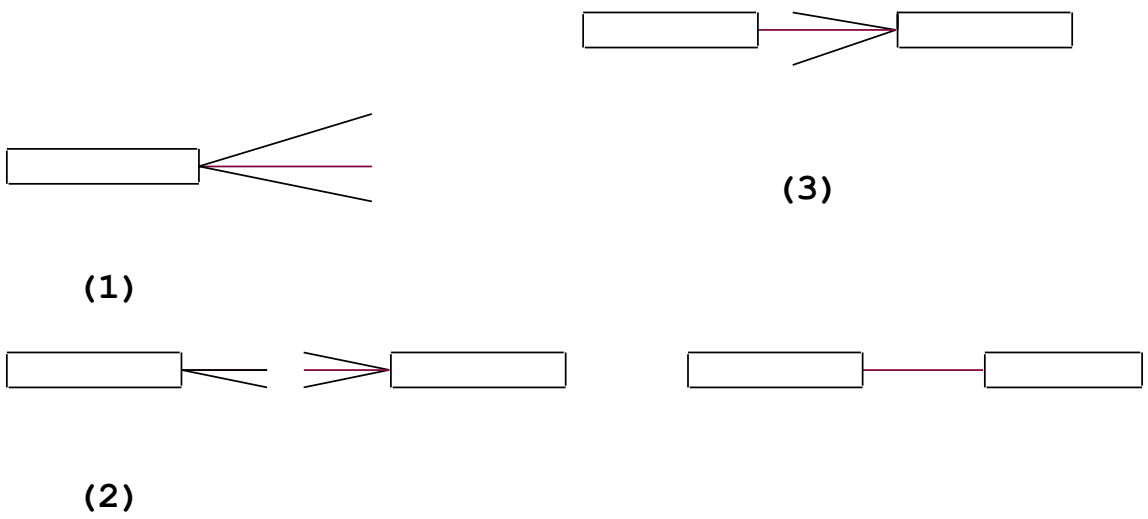
LAB EXPERIMENT 2

AIM: To study staircase wiring.

APPARTUS: 3/22 SWG wires, lamp holders, two way switch, 40w bulb 3 PVC casing, strips and pliers.

THEORY: It is that wiring which makes use of 2 switches to operate bulb at the beginning of the stair lights and the bulb gives off by pushing the button in the end. One of the terminals of the bulb is connected to the main line whose power line is connected to middle slot of two-way switch. Remaining first of there slots is connected in parallel as in crossed node.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Plan the wiring and casing according to the circuit diagram.
2. With the help of plier and stripper share the ends of wire of required length.
3. Connect the wire carrying the current to the central pin of the two-way switch.
4. Connect the remaining ends A and B to the corresponding other two way switch.
5. Connect the center pin wire of second two-way switch to the lamp.
6. Connect the second point to the neutral for completing the circuit.
7. Use PVC case wiring to cover expose wiring.
8. Switch ON and OFF the two switches alternatively to the bulb.

PRECAUTIONS:

1. Tools should be used carefully.
2. Fitting should be tightly fitted.
3. Connection should be tight.
4. Wire should be on the conduit, power gripped properly.

RESULT : The stair case wiring completed and tested .

LAB EXPERIMENT 3

AIM: To study house wiring.

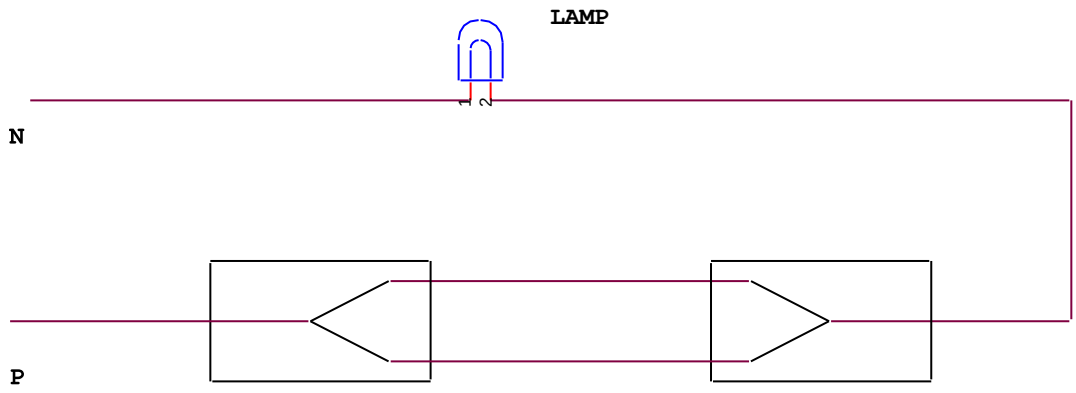
TOOL USED: Tenon saw screwdriver 8 cm (8”), Screwdriver 15(6”), connector Screwdriver, Hammer, Plier drill machine, Try square, chisel, File, Poker knife.

MATERIAL AND QUATITY:

1)T.W Batten 19mm x 13mm	42m
2)T.W batten 13mm x 13mm	10m
3)CTS/ T.R.S wire 13/. 039(3/22)	250v
4)Batten holder	2 no.
5)Plug 3pin, 5amp	1 no.
6)Tumbler Switch one-way 5amp	3 no.
7)T.W round blocks (7.75cm x 2.5)	3 no.
8)T.W board	40 mm(1+1/2
9)Hink clip	40 mm(1/2”)
10) Wood Screw	

THEORY: This type of wiring is used in houses. The two terminal of supply are connected to meter and other two terminals are joined to DPIC. One end is attached to N-link of fuse is joined to switch board of a room and neutral pole is also connection to switch board according to our need

CIRCUIT DIAGRAM:



TYPES OF HOUSE WIRING:

CLEAT WIRING: - This is of wiring suitable only for temporary wiring purpose. In lamp or wet location the wire used should be moisture proof and a weather proof.

1. **P.V.C CNDUCT WIRING**:- This uses a conduit pipe for the mechanical protection of wire. In this system of wiring, wires are carried through P.V.C conduit pipe for giving converging to pipes conduit pipe has certain advantage like it is moisture proof and durable.
2. **P.V.C CASTING WIRING**: -This type of wiring is mostly used for fixing cables on a wooden structure called batten by means of metal. It is the surface wiring system whenever wires are broken for connecting to switch on the right point junction box made up of either part plastic or metal C.I must be used and provided same means of earthing.
3. **P.V.C CASTING WIRING**: -This type of wiring is mostly used for indoor and domestic wiring carried through a P.V.C casing wiring

PROCEDURE:

1. Draw the tangent or wiring on the board with cholk.
2. Cut the required length of T.W batten file and link chips on then and file the batten with screw of 3mm size.
3. Cut the C.T.S wire in required length and put them on batten gripped by link chips or per circuit diagram.
4. Fix the T.W round blocks and board after drilling the holes for wire.
5. Fix the batten holder, 3-pin plug and switch on round block.
6. After completing wiring it should be checked before supplying current.

PRECAUTIONS:

1. Tools should be used carefully.

2. Fitting should be tightly fitted.

3. Connection should be tight.

4. Wire should be on the conduit, power gripped properly.

RESULT: Understand the house wiring.

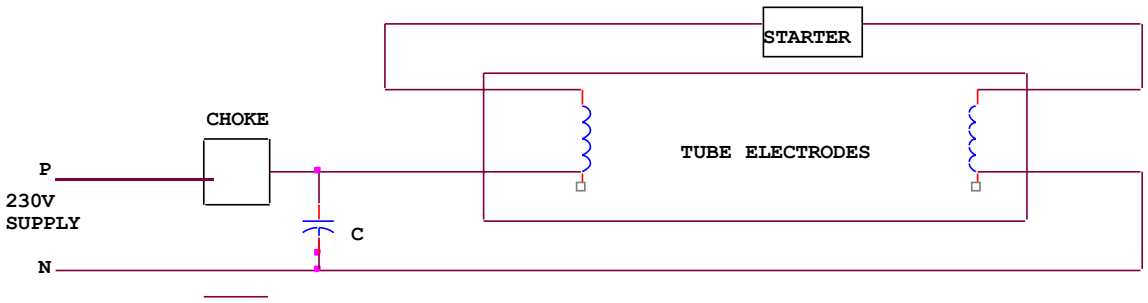
LAB EXPERIMENT 4

AIM: To study fluorescent tube light.

APPARATUS: tube, tube base, starter, choke, and wire.

CONSTRUCTION: Fluorescent tube is a low-pressure mercury vapour lamp. The lamp is in the form of long glass tube due to low pressure, with fluorescent powder coating to its inner surface. Tungsten filaments coated with barium oxide are placed at each side of the tube. The tube contains small amount of mercury with small quantity of argon gas at low pressure. When the temperature increases mercury changes into vapour form. At each end of the tube, electrode in spiral form is made of tungsten coated with electrons emitting barium. A capacitor is connected across the circuit to improve the power factor.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Fix the tube holder and the choke on the tube base.
2. Phase wire is connected in the choke and neutral direct to the tube.
3. Fix the fluorescent tube between the holders.
4. Finally connect the starter in series with the tube.

PRECAUTIONS:

1. Tools should be used carefully.
2. Fitting should be tightly fitted.
3. Connection should be tight.
4. Wire should be on the conduit, power gripped properly

RESULT:

The wiring for the tube light is completed and tested .

LAB EXPERIMENT 5

AIM :- To study moving iron, Moving coil, Electro-dynamic and Induction type meter.

APPARATUS REQUIRED:- Moving iron, moving coil, electro-dynamic and induction type meters

THEORY:-

1. Moving Iron Meters :- The operation of moving iron meters is based on the reaction of the magnetic field set up by the current in instrument coil with a single or several moving cores of ferromagnetic materials. as the deflection torque is obtained either by attraction or repulsion between two bars positioned within a coil. There are two types of meters, attraction type moving and repulsion type moving iron meters both types of meters can be used either AC or DC supply. In most cases the control torque is obtained from a helical spring and damping torque pneumatically.

2. Moving Coil Meters :- There are two types of moving coil instruments.

a) Permanent magnet moving coil(PMMC) Instruments
b) Dynamo type moving coil instruments.

(a) PMMC :- The principle used in the operation of PMMC instruments is that a current passing through a conductor generates a magnetic field around the conductor and if this field is arranged to interact with a field produced by a permanent magnet a force acts on the current carrying conductor.if the conductor is constrained to move in a rotary manner, an angular deflection proportional to the current may be obtained.

(b) Electrodynamic moving coil instrument:- Permanent magnet type moving coil instruments are not suitable for AC current and voltage therefore electrodynamic type moving coil instruments are introduced which are suitable for both AC and DC supply measurement. The essential feature of a dynamo type instrument is that the permanent magnet is replaced by one or two fixed

coils which carry the current to be measured .these coils are air cooled. The deflecting torque is always positive regardless of the direction of current as with change in direction of current in moving coil instrument the field of the fixed coil also changes its direction.

3. Induction type instruments: - These types of instruments are operated by the reaction between alternating magnetic fluxes and current induced in the moving element of the instrument. In this instrument an aluminum disc is placed in the air gap of electromagnets is fitted on the spindle holding the pointer of the instrument. The flux produced by the current acts on the pointer which moves accordingly. These instruments can be used as ammeter, voltmeter, wattmeter and energy meter.

RESULT: understand the study of moving iron, Moving coil, Electro-dynamic and Induction type meter.

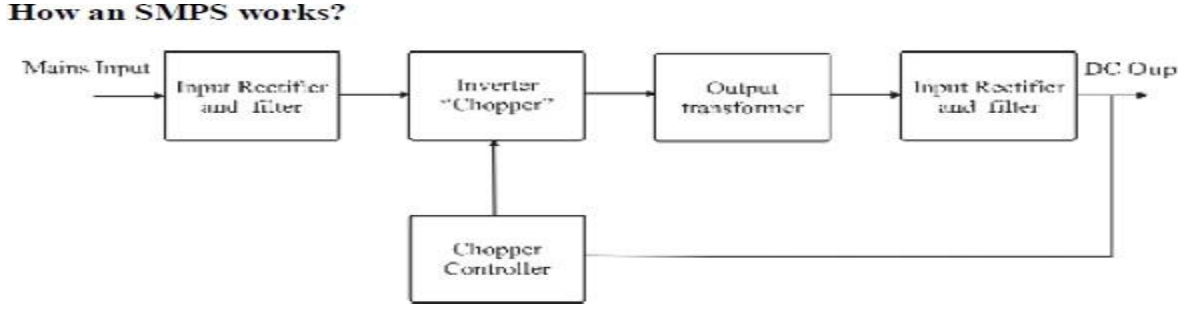
LAB EXPERIMENT 6

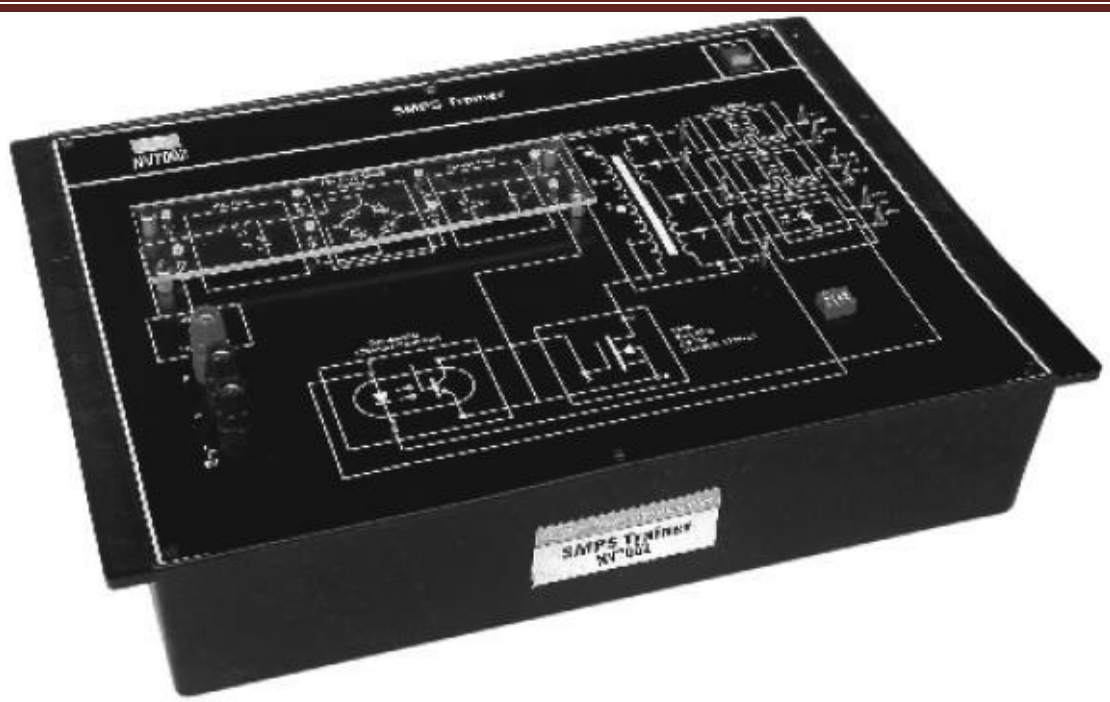
AIM : To study circuit of SMPS.

APPARATUS: SMPS Trainer Kit

THEORY: **SMPS trainer** is a very adaptable kit has been designed to explain a veryremarkable and frequently used switching based power supply-The SMPS (Switched Mode Power Supply).The kit is designed keeping in mind that a student can comprehend each block of SMPS in a very easy way. Different test points have been provided so that one can observe the inputs and outputs of each block contained. Being different from a conventional block diagram internal structures of different blocks are also shown. Switching Transformer and Chopper (The Heart of SMPS) are presented in such a way that a student can readily understand their functioning and pin configuration. Since SMPS is different from a traditional power supplies because it can be used for different voltage inputs (from 80V to 300V AC).If the SMPS has an AC input, then its first job is to convert the input to DC. This is called rectification. The rectifier circuit can be configured as a voltage doubler by the addition of a switch operated either manually or automatically. This is a feature of larger supplies to permit operation from nominally 120volt or 240volt supplies. The rectifier produces an unregulated DC voltage which is then sent to a large filter capacitor. The current drawn from the Mains supply by this rectifier circuit occurs in short pulses around the AC voltage peaks. These pulses have significant high frequency energy which reduces the power factor. Special control techniques can be employed by the following SMPS to force the average input current to follow the sinusoidal shape of the AC input voltage thus the designer should try correcting the power factor. A SMPS with a DC input does not require this stage. A SMPS designed for AC input can often be run from a DC supply, as the DC passes through the rectifier stage unchanged.

CIRCUIT DIAGRAM:





APPLICATIONS:

Switched-mode PSUs in domestic products such as personal computers often have universal inputs, meaning that they can accept power from most Mains supplies throughout the world, with rated frequencies from 50Hz to 60Hz and voltages from 100V to 240V (although a manual voltage "range" switch may be required). In practice they will operate from a much wider frequency range and often from a DC.

PRECAUTIONS:

1. All connections should be tight.
2. The circuit should be according to circuit diagram.
3. The power should be on when the circuit is checked completely.

RESULT: understand the circuit of SMPS .

LAB EXPERIMENT 7

AIM: To study circuit and working of UPS..

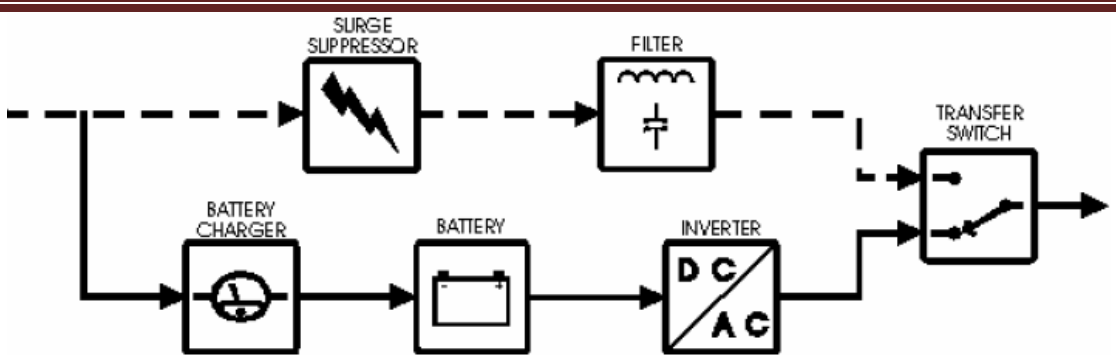
THEORY:

When electrical utility power fails or drops to an unacceptable level, Uninterruptible Power Systems (UPS) are key in saving and protecting valuable computer data. UPS equipment provides power conditioning, power regulation and, in case of power outages, provides the crucial backup power needed for an orderly shutdown of computer processes and files. UPS are also used for emergency power supplies for Hospitals, data centers, municipalities, industrial and commercial centers to supply power in case of power failure from main supply authority.

UNINTERRUPTIBLE POWER SUPPLY:

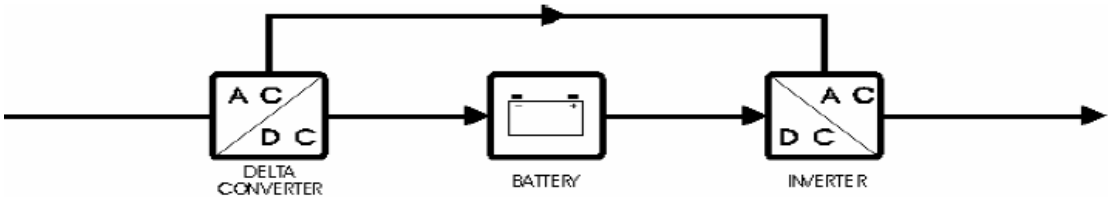
All UPS include core circuitry that manipulates electricity, converting it from the ACpower produced by the utility company to DC power stored in the battery, and backagain for use by your equipment via an inverter. The exact type, nature, size and quality of this circuitry depend on the type of UPS, and more specifically the make and model you have chosen.Most modern UPS are microprocessor-controlled. There is actually a small computer embedded within the UPS itself that controls the key functions of the UPS. This includes detecting AC power failures, handling switching between power sources, monitoring the status of the battery, controlling the status indicators and so on.

CIRCUIT DIAGRAM



Block schematic of an online.

Figure 3



Simplified block schematic of a delta-conversion online UPS.

Figure 4

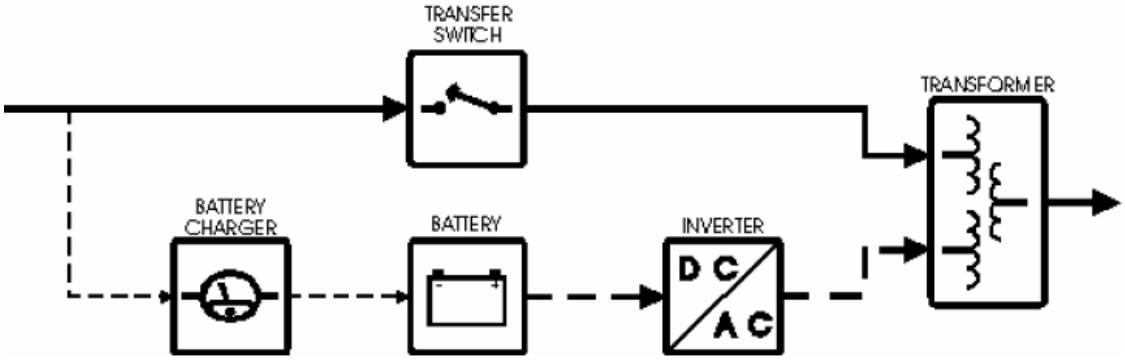


Figure 5

These UPS are available for different Power output range such as: Standby UPS are usually available in a size range of up to about 1000 VA. The Line-interactive UPS isan improved design that is commonly used in units for home and business use, available in sizes up to 3,000 VA or so. It is superior to the standby UPS, but it stillhas a transfer time like standby UPS. Online UPS are typically used only for large servers, and for backing up multiple pieces of equipment in data centers. They are available in sizes from about 5,000 VA up to hundreds of thousands of VA and even larger. Ferro resonant standby UPS are usually available in a size range of up to about 15,000 VA, making them suitable.

LAB EXPERIMENT 8

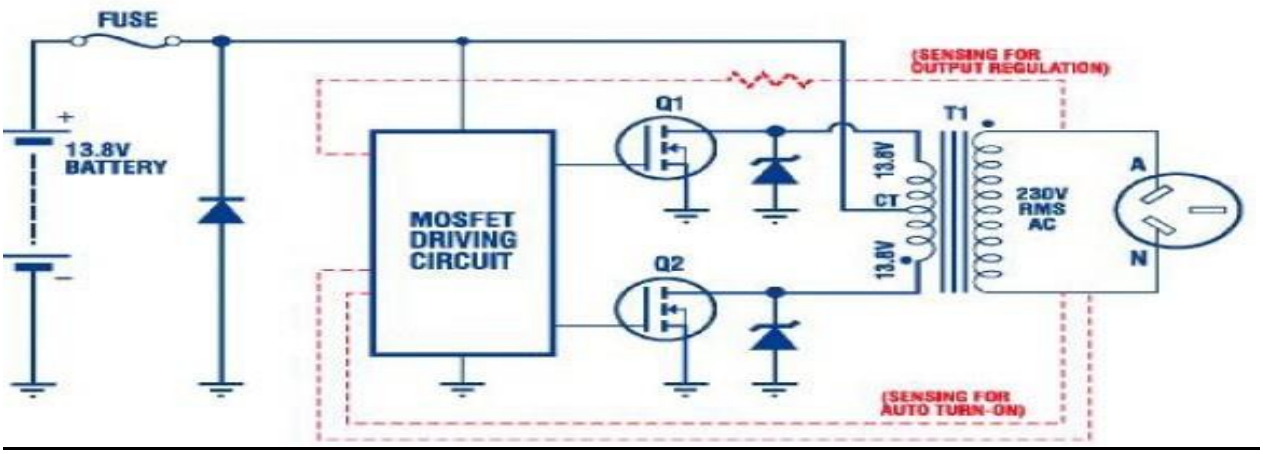
AIM: To study circuit and working of home inverter

APPARATUS: Home inverter

THEORY: Inverter is named so because it inverts DC voltage into AC voltage. It is very useful in industries application basically a DC input voltage converted into AC output voltage with the help of pulse width modulator, oscillator. With help of pulse width modulator, oscillator and a step–up transformer, constant amplitudes pulses are generated and the width of these pulses is modulated to control inverter output voltage with the help of oscillator required. Frequency is generated (50Hz for India) this generated frequency is the frequency of output voltage now this modulated signal of required frequency is supplied to the step-up transformer so that it converts into required voltage with respective frequency. Our inverter trainer kit is fixed at 50Hz ±5% frequency 220 V AC ±10% voltage. It provides with test points at every important section where observation of different type of signal and voltage can be measured with help of multi meter and CRO. Also this trainer is provided with a rechargeable battery. Since kit is carrying high voltage precaution for the safety purpose should be taken always.

DC–AC inverters are electronic devices used to produce 'mains voltage' AC power from low voltage DC energy (from a battery or solar panel) this makes them very suitable for when you need to use AC power tools or appliances but the AC mains power is not available. Most inverters do their job by performing two main functions, first they convert incoming DC into AC and then they step up the resulting AC to Mains voltage level using a transformer. Modern Inverters use a basic circuit scheme like that shown in figure as you can see the DC from the battery is converted into AC very simply by using a pairs of power MOSFETS (Q1 & Q2) acting as very efficient electronics switches.

CIRCUIT DIAGRAM:



PROCEDURE:

The positive 12V DC from the battery is connected to the centre- tap of the transformer primary, while each MOSFET is connected Between one end of the primary and earth (battery negative), so by the switching on Q1, the battery current can be made to flow through 'top 'half of the primary and to earth via Q1.conversely by the switching on Q2 instead, the current is made to flow the opposite way through the 'lower' half the primary and to earth.Therefore by switching the two MOSFET on alternately, the current is made to flow first in one half of the primary and then in the other, producing an alternating magnetic flux in the transformer core. As a result a corresponding AC voltage is induced in the transformers secondary winding, and as the secondary has about 24 times the number of turns as compared to the primary, the induced AC voltage is much higher around 650V peak to peak.In MOSFET based Inverter it is not feasible to control the peak-to peak output, because this is largely fixed by the battery voltage and the transformer's step-up ratio. So in this type of cases regulation is achieved by varying the width of the pulses. This is called 'Pulse Width Modulation' (PWM), and is usually done by the having a feedback system which senses the inverter's output (or load current). When this feedback senses that the load on the inverter's output has increased, the inverter's control circuitry acts to increase the width of the pulses which turn on MOSFETS. So the MOSFETS turn 'On' for longer each half cycle.

PRECAUTIONS:

1 All connections should be tight.

2 Never touch or try to touch any test point in Inverter Trainer Kit :

3 The circuit should be according to circuit diagram.

4. Don't reverse polarity of Battery Input :

5. Never short circuit terminals of battery :

RESULT: Understand the working principal of home inverter .

LAB EXPERIMENT 9

AIM: To study fuses MCBs and importance of Earthing.

THEORY:

EARTHING: ***Earthing*** *or grounding* of equipment refers to the connection of non-current carrying parts of electrical equipment to the earth to maintain earth potential. In domestic systems, the earthing circuit is usually earthed by connecting to metallic water pipes buried in ground. An effective earthing (grounding) system avoids having dangerous potentials on the equipment even during electrical faults and also ensures the proper operation of electrical protection equipment during fault conditions (this will be discussed under the operation of Earth Leakage and Residual Current Circuit Breakers).

FUSES: Fuses are the earliest means of protection against overcurrents in circuits. Basically, the fuse consists of a short length of suitable material (often a thin wire). When the current flow is greater than the fusing current of the fuse, it will get hot and burn (melt), thus interrupting the fault current before damage could be caused. The size of the wire is designed to carry indefinitely the normal circuit current (rated current) and usually designed to fuse (melt/burn) at about 1.7 – 2 times the rated current carrying capacity. They have inverse time characteristics as shown in Figure 1. Accordingly, the operation of the fuse is faster when the fault current is larger. In addition to operating for short circuits between the live and neutral, fuses are expected to operate under overload conditions. Over-loading occurs when extra power is taken from the supply. The increased current due to over-loading will have an immediate effect on the cables; they will begin to heat up. If the over-loading is sustained the result could be an accelerated deterioration of the cable insulation and its eventual breakdown to cause an electrical fault. A heavy-sudden over-load for a very short period (e.g. such as in Motor starting) is not very serious since the over-load current flows for a short time and the rise in cable temperature is not very high. At the standstill the motor behaves as the short circuit secondary transformer and it draws heavy current from mains, which can cause the damages at the starting. It can cause the heavy drops in power line. So direct online starting of motor is not desirable. The motor has to be started at reduced voltage. For heavy duty motors some starting methods are used or resistance has to be included in the circuit at starting.

FULLY ENCLOSED (CARTRIDGE) FUSE was developed to overcome the disadvantages of the re-wirable type of fuse. In its simplest form, the fuse wire is enclosed in an evacuated glass tube with metal end caps. Non-deterioration of the fuse element is one of the most reliable features and is usually more accurate. However, cartridge fuses are more expensive to replace. Both re-wirable and cartridge type fuses are usually of low rupturing capacity (product of maximum current which the fuse will interrupt, and the supply voltage). They are used in general house-hold, commercial and small scale industrial applications.

HIGH RUPTURING CAPACITY (HRC) FUSES are used for high current applications.The HRC fuse is usually a high-grade ceramic barrel containing the fuse element. The barrel is usually filled with sand, which helps to quench the resultant arc produced when the element melts. The barrel is able to withstand the shock conditions which occur when a high fault current is interrupted. Normally, the fuse elements are in parts connected in the middle by bridges which have a very precise melting point of about 230 oC. These are very accurate. With a specific current, the temperature rises and the bridge melts producing a break in the circuit. The metal vapour diffuses with silica powder and the product is of high resistance. The HRC fuses are expensive to replace once blown.

CIRCUIT BREAKERS FOR OVER CURRENT PROTECTION

The circuit breaker is a device for making and breaking a circuit (under normal and abnormal conditions). A circuit breaker is selected for a particular duty taking the following into consideration
(a) the normal current it will have to carry and (b) the amount of current which the supply system will feed into the circuit under a fault (which current the circuit breaker will have to interrupt without damage to itself). It is able to provide a more accurate degree of over current protection than that normally provided by either semi-enclosed or cartridge fuses.The circuit breaker has a mechanism which, when it is in the closed position, holds the contacts together. The contacts are separated when the release mechanism of the circuit breaker is operated by hand or automatically.
Miniature Circuit Breakers (mcb), which are commonly used in domestic installations, incorporate most of the features of the circuit breaker in a compact form and are being fitted in place of fuses in consumer units in the home or office. An MCB eliminates the cost of fuse replacement and may be used as a switch for isolating circuits. In the mcb, the automatic operation is by magnetic or thermal means. The

reason for the two characteristics is to have proper operation during both short circuit and overload conditions.

Magnetic mechanism The magnetic mechanism uses a solenoid with an iron piece. It is used for short circuit (fault) protection, as high fault currents have to be isolated almost instantly. When the circuit current is above a certain level, the magnetic field strength increases to cause the iron piece to move in the direction of solenoid. This operates the tripping linkage and open the contacts.

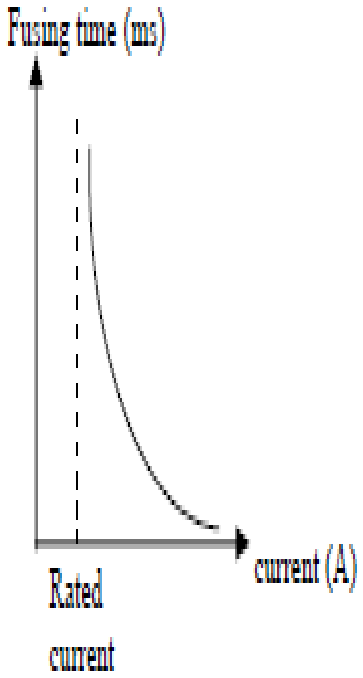
MCB Miniature Circuit Breaker (MCB) is a device which can open or close a circuit either manually or automatically under all conditions like no load, full load and fault conditions. it consists of a moving contact and affixed contact. It is so designed that it can operate manually under normal condition and automatically under fault condition. Under normal conditions the contacts of MCB remain closed and carry normal full load current. When the fault occurs the secondary current of CT increases thus energizing the trip coil, there by the CB contacts are opened and circuit is disconnected from the bus bar. The main advantage of MCB is that when it trips off due to a fault it can not be switched on again until the fault is rectified.

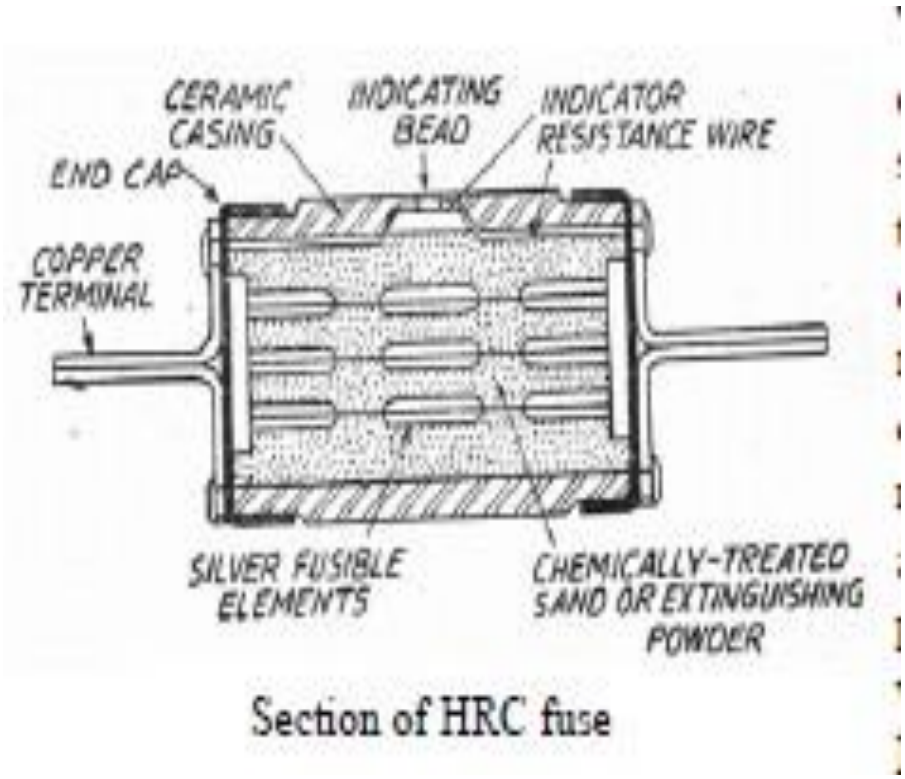
EARTHING OR GROUNDING

Earthing is carried out in an electrical installation for the purpose of,

(a) limiting the potential (voltage) of current carrying conductors forming a part of the system − "*neutral earthing*"

(b) limiting the potential of non-current carrying metal work associated with equipment, apparatus and appliances in the system − "*equipment earthing*". The potential of an installation is measured with respect to the general mass of the earth or commonly called *earth*. Thus the potential is limited with respect to earth.*Neutral earthing*: This is important because the performance of the system in terms of short circuits, stability, protection, etc., is greatly affected by the state of the neutral conductor. When the neutral is properly grounded, voltages of the phases are limited to near phase to ground voltage. *Equipment earthing*: This refers to grounding of all metal work of equipment other than the parts which are normally current carrying. This is governed by various regulations such as the IEE regulations. The objective of this grounding is to ensure effective and rapid operation of the protective gear in the event of earth fault currents which might otherwise be undetected and cause fire and also protect against danger to life through shock due to installation metal work being maintained at a dangerous potential relative to earth.





Section of HRC fuse

RESULT: Understand the fuses MCBs and impotance of Earthing .

LAB EXPERIMENT 10

AIM:

The objective of this experiment is to understand the working principles and control of two lamps when connected in series and in parallel configurations.

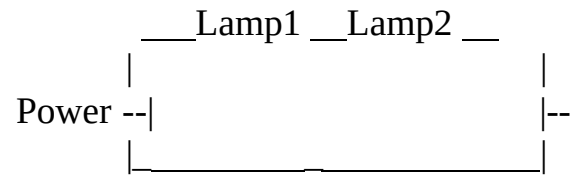
MATERIALS:

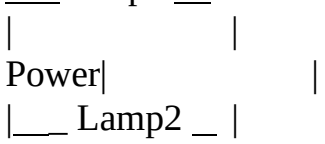
1. Two lamps
2. Connecting wires
3. Power supply (DC or AC)
4. Switches
5. Ammeter
6. Voltmeter
7. Circuit diagram board or breadboard
8. Safety goggles

- Series Connection:

- Parallel Connection:

PROCEDURE:





- Ensure that the power supply is turned off and disconnected from the main power source.
- Put on safety goggles to protect your eyes during the experiment.

- Set up the circuit according to the circuit diagram.
- For the series connection:
    a. Connect one end of Lamp 1 to the positive terminal of the power supply using a connecting wire.
    b. Connect the other end of Lamp 1 to one end of Lamp 2 using a connecting wire.
    c. Connect the remaining end of Lamp 2 to the negative terminal of the power supply using a connecting wire.
- For the parallel connection:
    a. Connect Lamp 1 to the positive terminal of the power supply using a connecting wire.
    b. Connect Lamp 2 to the positive terminal of the power supply using a separate connecting wire.
    c. Connect the negative terminal of the power supply to both Lamp 1 and Lamp 2 using a common connecting wire.
- Make sure that all connections are secure.
- Connect the ammeter in series and the voltmeter in parallel to the lamps to measure current and voltage, respectively.
- Turn on the power supply.
- Observe and record the readings of current and voltage for both series and parallel connections.
- Repeat the experiment for different combinations of switches to control the lamps.
- Analyze the results and note any differences in the behavior of lamps in series and parallel connections.

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- Finally, turn off the power supply and disconnect the circuit.

1. Wear safety goggles to protect your eyes from any possible accidents.
2. Handle the power supply and wiring with caution to avoid electric shocks.
3. Ensure that the circuit connections are secure to prevent short circuits or loose connections.
4. Do not touch the lamps or any other components while the circuit is powered.

RESULT: The voltage, current, power and power factor of series RLC circuit was found out and the values are

This lab manual has been updated by

Ms. Anuradha Yadav

Crosschecked By HOD EEE

Verified By
Director, DGI Greater Noida

Please spare some time to provide your valuable feedback.