LABORATORY MANUAL

Electrical Workshop
EE-213-F
(3rd Semester)

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EXPERIMENT NO.-1

AIM: - Introduction of tools, electrical materials, symbols and devices etc.
Tools generally used by an electrician and used in electrical workshop are following:-

1) Screw Driver:-
   (smaller in size is called connector )
   Size : 10, 15, 20, 30 in cm.
   Uses: used for loosening or tightening.
   Precaution : Do not use in place of firmer chisel and use particular size for screws.

SYMBOLS OF SCREW DRIVERS

PLIER:-
Size: 15, 20, 25 in cm.
Uses: For holding, twisting or cutting wires.
Precaution : Do not cut steel wires. Do not use in place of hammer.
2) ROUND NOSE PLIER OR FLAT NOSE PLIER:-
   Size: 10 cm.
   Uses: For holding, twisting or joining the wires at narrow places.
   Precaution: While using insulate yourself and do not put hot iron on the wire.

3) HAMMER:-
   Size: 1/4 kg or 2 kg.
   Uses: Best suited for chipping on teak wood and reverting purpose in sheet metal works.
Precaution: Never use loose and greasy handled hammer.
SYMBOLS OF HAMMERS

4) HAND SAW:-
Size: 30.5, 40.5 in cm.
Uses: Used to cut wooden board, block casing.
Precaution: Protect from rust, do not use to cut metal pieces.

SYMBOL OF HAND SAW

5) TRY SQUARE:-
Size: 15, 20, 30 in cm.
Uses: To check the right angle of corner.

SYMBOL OF TRY SQUARE.

6) HACK SAW:
   Size: 16, 20, 25, 30 in cm.
   Uses: Use for cutting conduit G.I. pipes or mild steel.
   Precaution: Keep straight while cutting, apply water on blade while cutting and protect form rust.

SYMBOL OF HACK SAW

7) RASP CUT FILE:-
   Size: 15, 20, 30 in cm
   Uses: Used to file wooden things.

Precaution: Do not use without handle.
8) DOUBLE ENDED SPANNER:–
Size: Size are different as per use.
Uses: Used to tighten and loosen bolts, nuts and screw etc.
**EXPERIMENT NO.-2**

**AIM:** To control lamps by two separate switches (house wiring).

**APPARATUS:**
1. Kit Kat fuse: 1Nos. 5 Amps.
2. Single pole switch: 2 Nos. 5 Amps
3. Lamp holders: 2 Nos. 5 Amps
4. Lamps: 2 Nos.
5. Battens, Nails, Clips, CTS wire, Fuse wire.
6. Round wooden block: 04 Nos.
7. Square wooden block: 01 Nos.

**PROCEDURE:**
1. Fix the battens at suitable distance as per the circuit diagram.
2. Cut the wire of suitable sizes. Fix the clips with nails on the battens & put the wire as per circuit diagram. The wire should not cross each other on the batten.
3. Fix the wooden blocks as per correct position & complete the wiring as per circuit diagram.
4. Put fuse wire in Kitkat fuse.
5. Test the complete wiring as per testing procedure.

**CIRCUIT DIAGRAM:**

![Circuit Diagram]

**TESTING:**
1. Connect 230V AC supply to the circuit.
2. ON switch S1 which glows Lamps L1.
3. ON switch S2 which glows Lamp L2 (If this is not happen it means that connections are somewhere wrong)

**USE:**
Such connections are used in house wiring. When one lamp or fan or any electrical application are controlled by one switch in an interlocked fashion

**EXPERIMENT NO.-3**

**AIM:** To control one lamp by two 2-way switches.

**APPARATUS:**
1. Kit Kat fuse: 1Nos. 5 Amps.
2. Single pole switch: 2 Nos., 5 Amps
3. Lamp holders: 2 Nos., 5 Amps
4. Lamps: 2 Nos.
5. Battens, Nails, Clips, CTS wire, Fuse wire.
6. Round wooden block: 04 Nos.
7. Square wooden block: 01 Nos.

**PROCEDURE:**
1. Fix the battens at suitable distance as per the circuit diagram.
2. Cut the wire of suitable sizes. Fix the clips with nails on the battens & put the wire as per circuit diagram. The wire should not cross each other on the batten.
3. Fix the wooden blocks as per correct position & complete the wiring As per circuit diagram.
4. Put fuse wire in Kitkat fuse.
5. Test the complete wiring as per testing procedure.

**CIRCUIT DIAGRAM:**

![Circuit Diagram](image)

**TESTING:**
1. Connect 230V AC supply to the circuit.
2. ON & OFF switch S1 & check that either lamp L1 glows or not.
3. Check lamp L1 by S2.
4. ON the lamp by S1 & OFF that by S2. (If any given points in testing are not working, it means that somewhere connections are wrong.)

**USE:**
Such connections are used in house for stair-case, for double application of fan, Night lamp etc.

**EXPERIMENT NO.-4**

**AIM:** To study fluorescent lamp.

**THEORY:**

**CONSTRUCTION:**
The fluorescent lamp is a low pressure mercury discharge lamp. It is generally consist of a long glass tube (G) with an electrode on each end (E1 & E2). These electrodes are made of coiled tungsten filament coated with electron emitting material. The tube is internally coated with a fluorescent powder & contains small amount of argon with a little mercury at a very low pressure. The control ckt. of tube consist of a starting switch (S) known as starter, an iron cored inductive coil called a choke (L), & two capacitors C1 & C2.

**OPERATION:**
A starting switch namely the glow type (voltage operated device) is used in tube operation. The starter is glow type starter (S) shown in fig. Consist of two electrodes sealed in glass tube filled with mixture of Helium & Hydrogen. One electrode is fix & another is U-shaped bimetallic strip made up of two different metals having two different temperature co-efficient. Contacts are normally open.

When the supply is switched ON, heat is produced due to glow discharge between electrodes of starter is sufficient to bend bimetallic strip until it makes contact with fixed electrode. Thus ckt, between two electrode E1 & E2 is completed & relatively large current circulated through them. The electrodes are then heated to incandescence by this circulating current & gas in their immediate vicinity is ionized. After a second or two, due to absence of glow discharge a bimetallic strip cools sufficiently. This causes to break contact & sudden reduction of current induces an emf of the order of 800-1000V in choke coil. This voltage is sufficient to strike an arc between two electrodes E1 & E2 due to ionization of Organ. The heat generated in the tube vaporizes mercury & potential difference across the tube falls to 100-110V. This potential difference is not sufficient to restart glow in starter.

**FUNCTION OF AUXILLARY CIRCUIT COMPONENTS:**

**CHOKE**
1. It provides a necessary high voltage to start discharge in the tube.
2. Since the voltage required across the tube during normal operation is small, the excess voltage drop across the tube.
3. It acts as a stabilizer.

**CAPACITOR(C1)**
The choke lowers a power factor of the ckt. C1 connected across the supply Improves this power factor.

**CAPACITOR(C2)**

It is connected across starting switch to suppress radio interference due to high frequency voltage oscillation which may occur across it’s contacts.

**CIRCUIT DIAGRAM:**

![Circuit Diagram of Fluorescent Lamp](image)

**ADVANTAGES:**
1. Low power consumption.
2. Longer life which is about 3 to 4 times that of the filament life.
3. Compared to filament lamp efficiency is also about 3 to 4 times, it gives more light for the same wattage.
5. No warming up period is required as in case of another discharge lamp.
6. Different colour light can be obtained, by using different types of fluorescent powder.
7. Low heat radiation.

**DISADVANTAGES:**
1. Initial cost of the lamp along with auxiliary equipment needed is very high
2. With frequent operation life reduces.
3. Voltage fluctuation affect it but not to the extent that filament lamp is affected.
4. Produce radio interference.
5. Fluctuating light output produces undesirable stroboscopic effect with rotating machinery.

**APPLICATION:**

They are very popularly used for interior light in residential buildings, shops & hotels.
They are also extensively used with reflectors for street lightings. Due to their glare free shadow less light, they are ideal for workshop, factories, laboratories & drawing rooms. The fluorescent tubes are normally manufactured with 20, 40 & 80 watts

EXPERIMENT NO.-5

AIM: - Study circuit of a Simple power supply with regulation & filters.

APPRATUS REQUIRED:-
1. Soldering iron, flux solder, soldering stand.
2. Electrical tape, Pliers.
3. Wire cutter, Screw driver.

REQUIRED MATERIAL:-
1. Step down transformer (1A, 230V or 110V primary secondary should be your choice like 6V, 9V etc).
2. Capacitor (470µF, 16V).
3. Diodes x 4 (1N4001 for low power 1N4007 for moderate power).
4. Electric wires.

CIRCUIT DIAGRAM:-

Working
- Circuit consists of 4 parts: Step down transformer, Bridge rectifier, Capacitor filter and Voltage regulator IC.
- The transformer step downs the high voltage AC to a low voltage AC.
During the positive half cycle of secondary voltage, diodes D2 and D3 are forward biased and diodes D1 and D4 are reverse biased now the current flows through D2-->Load-->D3

During the negative half cycle of the secondary voltage, diodes D1 and D4 are forward biased and diodes D2 and D3 are reverse biased Now the current flows through D4-->Load-->D1

In both cycles the load current flows in same direction hence we get a Pulsating DC voltage across the points B-B’.

The pulsating content is called ripples and a filter capacitor is used to remove the ripples from pulsating DC.

When the instantaneous values of pulsating DC voltage increases, the capacitor gets charged up to peak value of the input.

When the instantaneous values of pulsating DC voltage decreases, the stored voltage in the capacitor reverse biases the diodes D2 and D4 hence it will not conduct now capacitor discharges through the load, then voltage across the capacitor decreases.

During the next cycle, when the peak voltage exceeds the capacitor voltage, Diode D2 or D4 forward biases accordingly as a result capacitor again charges to the peak value. This process continues. Hence we get almost smooth DC voltage as shown.

INPUT:

![Diagram of pulsating DC voltage](Image)

OUTPUT(1):-
Rectification

An essential step in the conversion of ac to dc is a process called rectification. Rectification converts ac voltage to a waveform with average or dc value by passing only one polarity (half-wave) or by generating the magnitude or absolute value (full-wave). Three types of rectifier (diode) circuits are commonly used. Only one diode is required to obtain half-wave rectification. Full-wave rectification can be obtained with four diodes connected in a bridge configuration or with two diodes and a center-tapped transformer. Transformers are normally used at the input of the rectifiers to increase or decrease the voltage and isolate the dc output from the ac input for safety purposes.
Filtering

For most applications the ac or alternating portion of the rectified output is unwanted and may cause undesirable results, such as an annoying hum in audio systems. A capacitor can be used to reduce or filter the ac portion of the rectified waveform. The capacitor is charged through the diodes to the peak ac voltage minus the diode forward voltage. Some of the charge stored on the capacitor is delivered to the load each cycle, but the next voltage peak recharges the capacitor.

Regulation

Regulators are often used to make the power supply output insensitive to input voltage amplitude variations and further reduce the ripple voltage. The regulator may also be used to adjust or change the dc output voltage and limit the amount of current delivered by the power supply. Regulators are a form of dc-to-dc converter.

EXPERIMENT NO.-6

AIM:- To study circuit of a SMPS.
REQUIRED COMPONENTS:-
1. FILTER.
2. RECTIFIER
3. REGULATOR
4. CHOPPER(DC TO DC CONVERTER)

CIRCUIT DIAGRAM:-
THEORY:-
stands for switch mode PSU. In such a supply, power handling electronic components are continuously switching "on" and "off" with high frequency in order to provide the transfer of electric energy via energy storage components (inductors and capacitors). By varying duty cycle, frequency or a relative phase of these transitions an average value of output voltage or current is controlled. The operating frequency range of a commercial SMPS units varies typically from 50 kHz to several MHz. Below is a circuit diagram of a typical off-line SMPS.

WORKING OPERATION:-
AC power provided via the input connector, first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Note that except for ATX computer power supplies and CompactPCI systems, output connectors and pinouts in general are not standardized and are left up to the manufacturers.
F1 and F2 shown on the left of the circuit diagram are fuses. Their main purpose is to protect the line from overloading and overheating, prevent tripping of an external circuit breaker, and prevent a fire that may be triggered by components that failed into a short circuit. The low-pass EMI filter is designed to reduce high frequency currents getting into the AC line to an acceptable level. This is necessary to prevent interference on the other devices connected to the same electrical wiring.
The filter is followed by the rectifier- a circuit that converts bipolar AC waveforms to unipolar pulsating ones. It has four diodes in a bridge arrangement to provide the same polarity of the output voltage for both polarities of the input.
The rectified input voltage is fed into the next stage, whose prime purpose is to increase power factor (PF). There are various regulations that limit the input current harmonic content. The DC-DC converter runs off the PFC output, generates a set of DC busses required for the load, and normally also provides input-to-output isolation. Finally, the housekeeping supply provides bias for all control circuitry. It may also provide a separate stand-by voltage (SBV) which remains active when the PS unit is shut down for any reason. In today's computer power supply a 5VDC SBV is a standard feature.

AIM: - To study circuit & working of a U.P.S.

COMPONENTS USED:-
1. Step-down Transformer.
2. Diodes, Resistors and Capacitors.
3. LED, Battery, Fuse.
4. IC-7805 and Electric Wires.
CIRCUIT DIAGRAM:

![Circuit Diagram]

BASIC CIRCUIT DIAGRAM OF UPS

THEORY:-

UPS is an abbreviation of Uninterruptable Power Supply. It is an electronic product used to provide backup power for sensitive devices in case their normal power failure or blackout. Its power is measured in Watts or in Kilo Watts. There are three distinct types of uninterruptible power supplies, namely, (i) on-line UPS (ii) off-line UPS, and (iii) electronic generators.

WORKING OPERATION:-

The circuit drawn pertains to a regular industrial UPS (Uninterruptible Power Supply), which shows how the batteries take control during an outage in electrical supply or variation beyond the normal limits of the voltage line, without disruption on the operation providing a steady regulated output (5 Volts by LM7805) and an unregulated supply (12 Volts).

The input to the primary winding of the transformer (TR1) is 240V. The secondary winding can be raised up to 15 Volts if the value is at least 12 Volts running 2 amp. The fuse (FS1) acts as a mini circuit breaker for protection against short circuits, or a defective battery cell in fact. The presence of electricity will cause the LED 1 to light. The light of LED will set off upon power outage and the UPS battery will take over.
The circuit was designed to offer more flexible pattern wherein it can be customized by using different regulators and batteries to produce regulated and unregulated voltages. Utilizing two 12 Volt batteries in series and a positive input 7815 regulator, can control a 15V supply.

EXPERIMENT NO.-8

AIM: - To study circuit and working of a Home Inverter.

COMPONENTS USED:-

IC1 - NE555, Q1 - TIP 41A(NPN) ,Q2 - TIP 42A(PNP)
T - Stepup Transformer, R1 - 10KΩ, R2 - 150KΩ
C - 0.1µF, C1 - 0.01µF, C2 - 2700µF.
THEORY: -

Inverter is a very useful device which can convert Low voltage from a DC source to high voltage AC. The most common power inverter is 12V to 240V inverter. Perhaps that is because 12V batteries are common. This type of power inverter usually draws current from a DC battery. This battery should be able to provide a high flow of electric current. Normally lead acid batteries can server this purpose well. This current is then converted to 240V square wave alternative current so that we may empower those electric appliances which work on 240V instead of 12V.

CIRCUIT DIAGRAM:-

WORKING OPERATION: -

The circuit mainly consisting of a 555 timer IC, an NPN and PNP Transistors and a Stepup Transformer. The 555 timer IC is powered by a 12V battery. The timer IC(NE555) is wired as an ASTABLE MULTIVIBRATOR in this circuit. It will generate Alternating non sinusoidal output wave form at the instant we giving supply Voltage(12V). Thus primarily we generated Alternating Voltage from direct Current (Battery). The output from 555 Timer is given to the base of two transistors, PNP and NPN. These transistors help the output Voltage to increase its Current for both the positive and negative cycles. The output from these transistors are again fed to the input(primary) of a Stepup Transformer. This will up convert the input Voltage to desired level (230V).

The frequency of power supply is determined by Resistors R1, R2 and C, connected with 555 timer IC. You can even change them with your requirement.

For that you can use our 555 Timer Frequency Calculator.

Here used 50Hz power supply, so it is enough to use 10K, 150K and 0.1mF for R1, R2 and C respectively. The output is taken across the secondary winding of Transformer. Be careful the output is 230V power supply it may cause you serious Injuries.
EXPERIMENT NO.-9

AIM: - To design and fabricate single phase transformer.

COMPONENTS USED IN CONSTRUCTION OF TRANSFORMER:-

1) Silicon steel core (Iron core) It made off silicon coated Steel stampings (E & I Shaped)(The capacity will decide the core size)
2) In centre of he core a bob in is fixed, In this primary & secondary windings wire are wound.
3) Winding wire made of super enameled copper wire we have to select the size according to the capacity of primary & secondary current & voltage Standard wire size & current will be available in Tables.
4) No of turns are calculated according to the size of centre Limp area of the core (8 turns / 1 square inch / Volt) my old thumb rule (According to the quality of core it will change)
5) If you want to design 240/12 volts x 48VA If your core centre limp size is 2 square Inch Primary winding Approximately 960-1000 turns. Secondary 48-50 turns

CIRCUIT DIAGRAM:-

Design Procedures for a Single-Phase Transformer:-

1. Identify Technical Specifications of the Transformer
   Input voltage V1
   Output voltage V2
   Rated output apparent power S (VA) or output current (S=V2*I2)
   Rated frequency (Hz)
   Rectifier circuit topology (bridge, half-bridge, and full-wave center tap)
   Number of phases (single-phase or three-phase)
   Voltage regulation ΔV% (%)
2. Conduct Basic Steps of Calculations

Step 1: Core size estimation
1) Select current density $J$ (2.5 - 4 A/mm²).
2) Select voltage regulation $\Delta V\%$ (5% - 20%).
3) From Figure 1, select no-load magnetic flux density $0B$ (T) at the “knee point” of the B-H curve.

AIM: - To study fuses, MCB and important of earthing.
FUSE:-
A safety device that detects too much current in a circuit. A fuse often has a component that melts and opens the circuit. A fuse consists of a metal strip or wire fuse element, of small cross-section compared to the circuit conductors, mounted between a pair of electrical terminals, and (usually) enclosed by a non-combustible housing. The fuse is arranged in series to carry all the current passing through the protected circuit. The resistance of the element generates heat due to the current flow. The fuse element is made of zinc, copper, silver, aluminum, or alloys to provide stable and predictable characteristics. The fuse ideally would carry its rated current indefinitely, and melt quickly on a small excess. The element must not be damaged by minor harmless surges of current, and must not oxidize or change its behavior after possibly years of service. The fuse elements may be shaped to increase heating effect.

**MCB:-**

An electric current requires two wires to complete the circuit: From source via the in wire to the load and from there via the out wire back to the electrical source. The current in these two wires should always be identical. When an electrical leak to earth occurs, these two currents are no longer identical. In the MCB both currents are run through 2 small coils, mounted in such way that the magnetic fields produced are annihilating each other. A small mechanical switch mounted near these coils trips however when the fields are no longer identical, and therefore result in an electromagnetical field. (earth leak protection) The system is further wired in such a way that by abnormal high currents the switch also trips (short circuit protection).

Note that MCB's have a max. Current above which tripping occurs. An MCB, therefore, has two forms of over current protection built into its mechanism. To protect against overload currents, it has a thermal device (bimetallic strip) which will trip the mechanism once it reaches a set temperature. To protect against short-circuit currents, it has an electromagnetic device (electromagnet) which will trip the mechanism when the flux density reaches a set point.
Importance of Earthing in Electrical Wiring:

Earthing is basically a part of electrical wiring which is being done on initial level in order to connect the electrical system with general mass of earth so as to have discharge of electrical energy. Earthing is important to make the electrical fitting safe and secure from the immediate shock or thunder storm that may affect building.

Earthing also has many several advantages which makes it important for every building at the time of entire electrical wiring. Many builders avoid providing earthing in the building area during the electrical fitting due to several reasons such as intended negligence etc. However earthing is not important but essential to protect a building from sudden mishap or short circuit that can harm lives of inhabitants.

Before Earthing it is necessary to follow few points regarding its implementation:

- Earthing connection is given with mainly using galvanized wire or copper wire as they are considered good conductor of electricity.
- Copper Pipe or plate must be used during the earthing especially at the place where soil is corrosive.
- Earthing work is ideal in moist earth where it is effective than dried earth that has resistance than moist earth.
- Electric earthing require pipe or plate earthing.
- Earthing place must have reasonable chances of being moist for better and effective earthing.
- It is better to do earthing near the place of water drain, main water pipeline etc to enhance effects of earthing and resistance.
- It is better to spread or fill pit for Earthing with salt or some charcoal pieces.
- It is also said that earthing place should be free from building foundation.
- The pit that has to be made for main Earthing must not an obstructing place or regular place such entrance, below the stairs or pavement etc. Choose some lone place which is secure and away from visits in the building.
- Electrical fittings inside the building must be properly earthed for safety measures and accidents.

<table>
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<th>Specification</th>
<th>Details</th>
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<tbody>
<tr>
<td>1. Number of poles</td>
<td>1P, 2P, 3P, 4P</td>
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<tr>
<td>2. Rated current (A)</td>
<td>1.2, 3, 4, 6, 10, 16, 20, 25, 32, 40, 50, 63</td>
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<tr>
<td>3. Breaking capacity (A)</td>
<td>6000/4500/10000</td>
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<td>4. Rated voltage (V)</td>
<td>230/400</td>
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<td>5. Rated frequency</td>
<td>50/60HZ</td>
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<tr>
<td>6. Endurance</td>
<td>&gt;4000</td>
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<tr>
<td>7. Circumstance Temperature</td>
<td>-30°C~+40°C</td>
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<tr>
<td>8. Electrical life</td>
<td>no less than 6000 operation</td>
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<tr>
<td>9. Mechanical life</td>
<td>(O-C) no less than 20000 operations</td>
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<td>10. Protection degree</td>
<td>IP20</td>
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