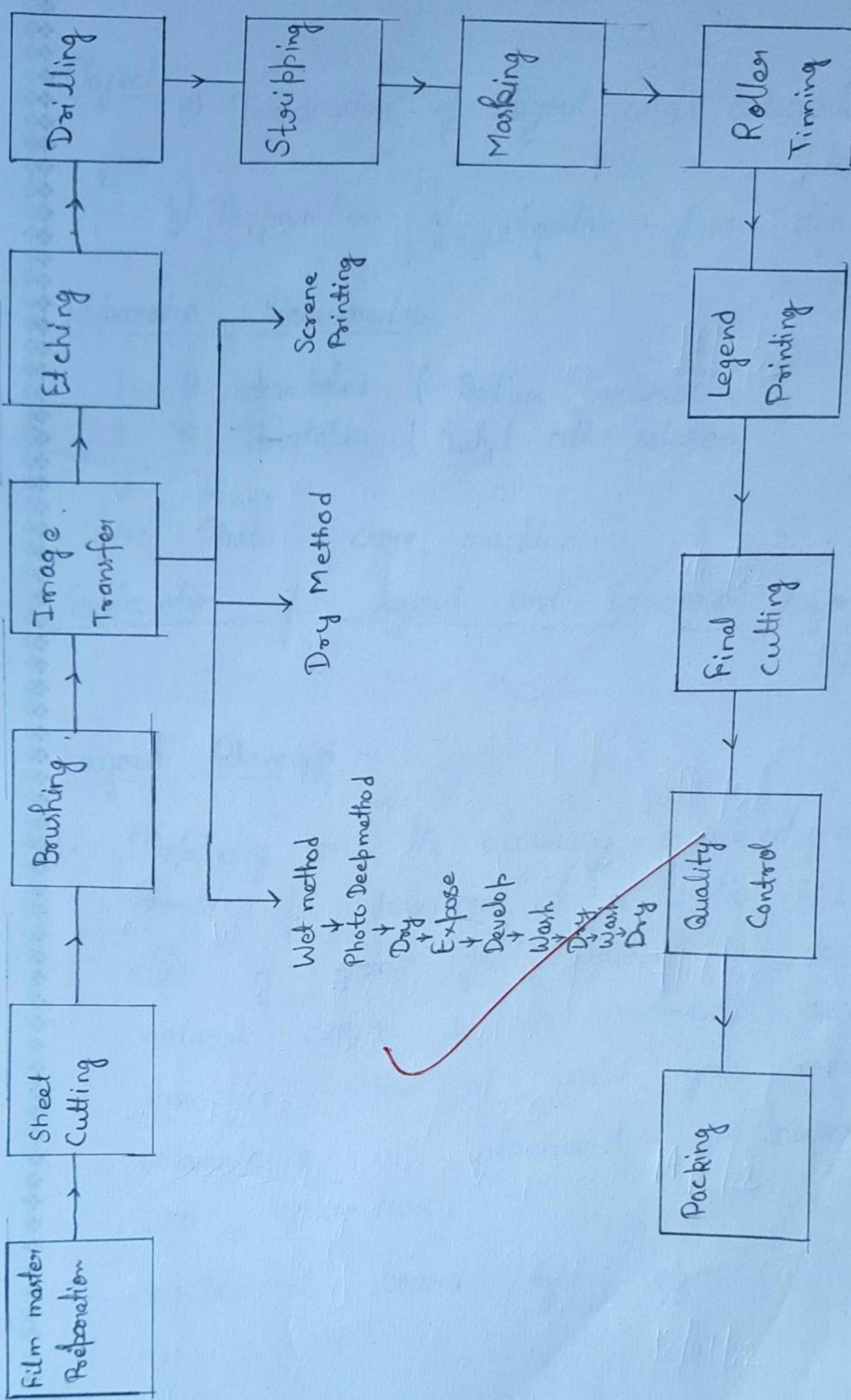


TUTORIAL / PRACTICAL NO.

Index

S.No.	Name of Experiment	Date	Remark	Sign
1.	a) Preparation of layout and artwork layout planning b) Preparation of Negative from the film.	17/05/22		(Sh)
2.	Artwork and printing on the printed circuit board for fabrication .	24/05/22		(Sh)
3.	Etching and Drilling of PCB to fabricate the printed circuit board .	31/05/22		(Sh)
4.	Winding Shop : Step down transformer winding of less than 5 VA .	07/06/22		(Sh)
5.	Fabrication of DC unregulated 6V power supply .	14/06/22		(Sh)
6.	Study the working of distortion meter .	12/07/22		(Sh)

Flow Chart for PCB Preparation



TUTORIAL / PRACTICAL NO.

Experiment no. - 01

Object :-

- Preparation of layout and artwork layout planning.
- Preparation of Negative from the film.

Apparatus Required :-

- A developer (Sodium Carbonate)
- B developer (Butyl cell solution)
- Fixer
- Photo - cure machine.

Preparation of layout and Artwork layout Planning

Layout Planning :-

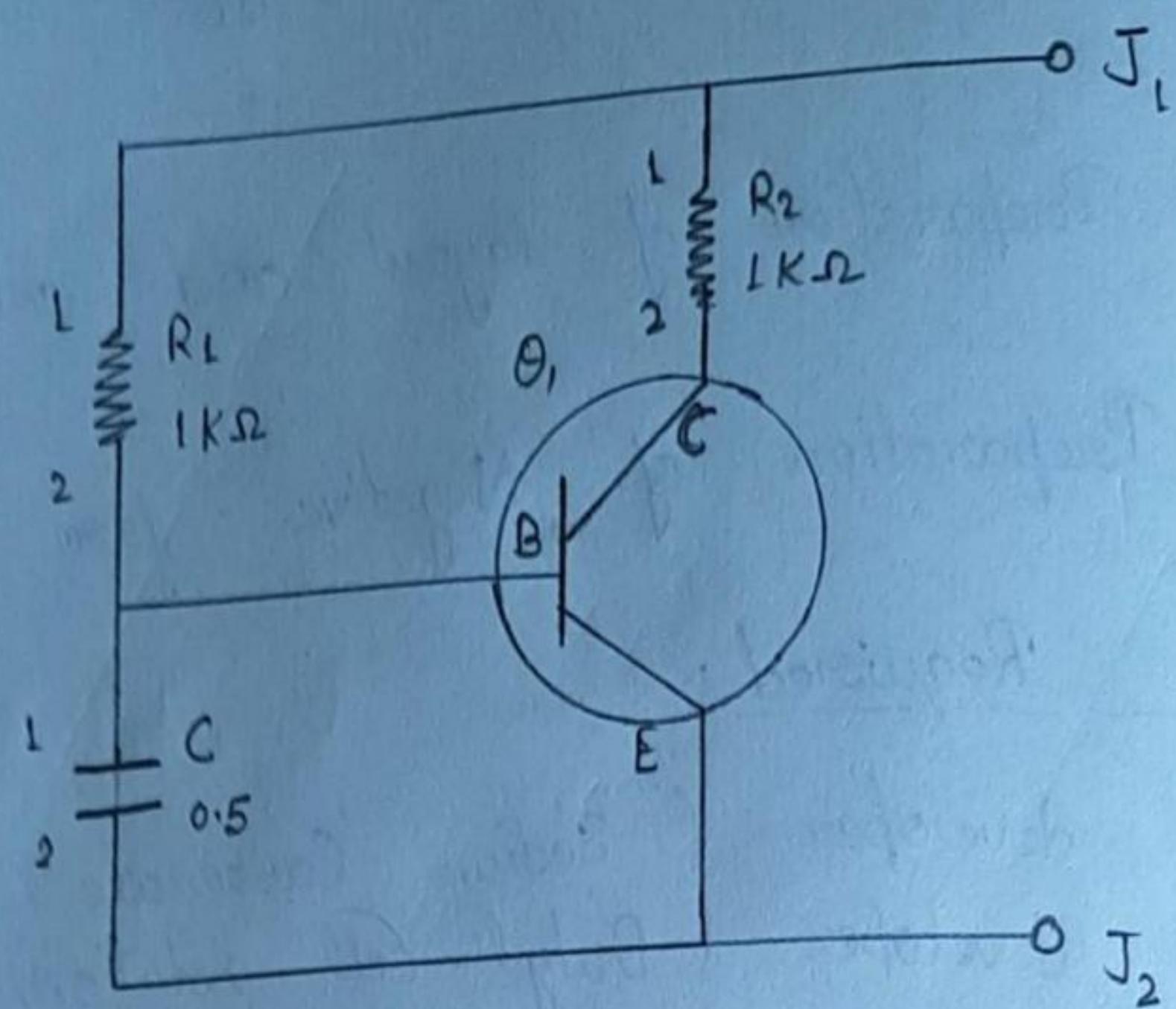
- Depending on the accuracy required artwork should be produced at a ratio 1:1 or 4:1
- Use of ~~grid~~ grid system in layout and artwork design is a commonly accepted practice. Use of ~~gold~~ gives more convenience in placement of components and conductors.
- Selection of board type - signal sided.

TUTORIAL / PRACTICAL NO.

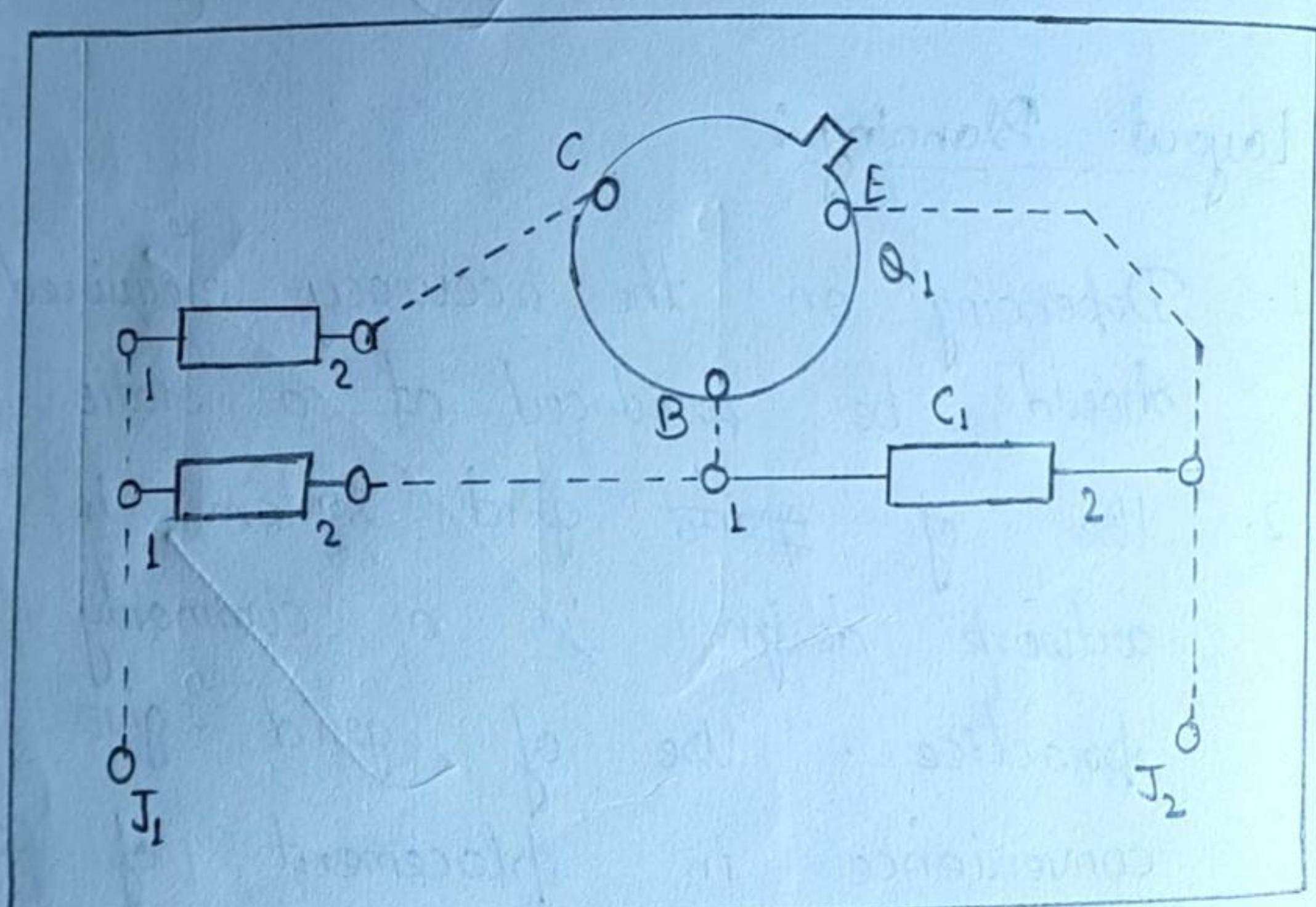
5. To prepare each and every PCB layout as viewed from component side.
6. Unless and until absolutely cleared circuit diagram is available startingly the design of layout is not possible.
7. Complete the layout work and start with interconnection.
8. Develop the layout in direction of single flow.
9. Among the components the longer one is placed first then the space in between is filled with smaller one.
10. Design and interconnection can be done by pencil line.

General Artwork Rule

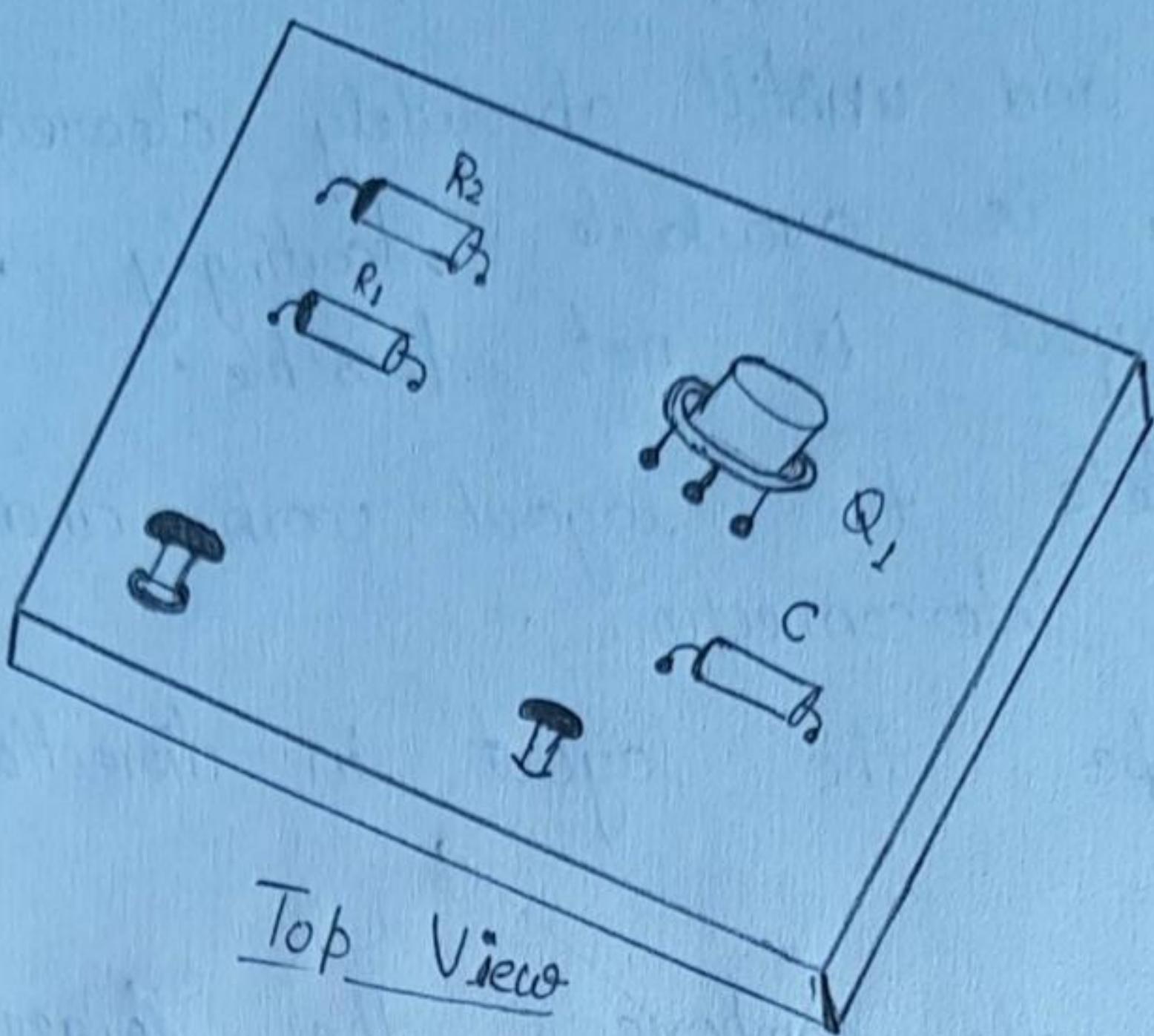
1. In PCB artwork higher conductor density is an established practice.
2. To run the conductors on one side in given direction.
3. Where conductors have to be placed in other direction preference should be given to 45° direction or 30/60° dir.



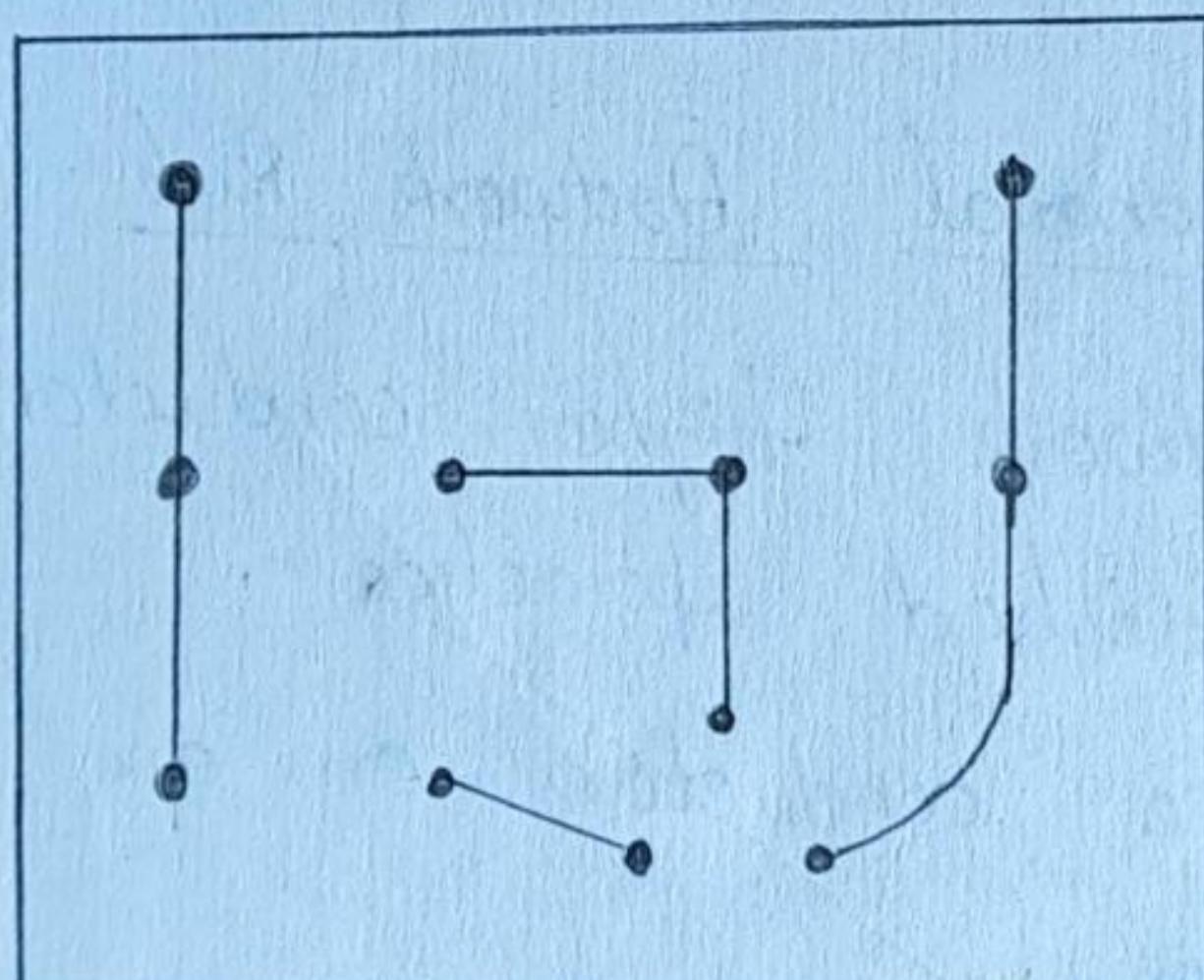
Schematic



Component Assembly



Top View



TUTORIAL / PRACTICAL NO.

4. It is good rule , to begin and the conductors in solder pad .
5. Where one or several conductors have to pass between Pads or other conducting carrier, spacing has to be equally distributed.

Components Polarity Identification :-

It is very essential when artwork is completed , a through check is carried out to prepare and to prove its exact correspondence with circuit diagram .

Preparation of Negative from the film :-

Process :- Draw the circuit on transparency i.e. Artwork with error proof .

Exposure time :- Expose the lith film together with the transparent sheet for 5 sec.

Development :- Use a development tray which is large enough to enable film handling with care . Put sufficient developer in the tray so that the film can get completely covered with it . Now all the

TUTORIAL / PRACTICAL NO.

handling of the film should be done by touching only the corners. To start the development procedure slide the exposed film sheet with emulsion down through the solution only. Start immediately to lift the tray rotationally each side by about 2cm.

Soap bath :- After development is over the film is gripped tray for 3 sec. which enable the excess developer to draw. Now immediately thereafter the film is immersed into the soapbath always with emulsion side. Upward side to mechanical damage on the soaped emulsion. The soap bath stops effectively the development action.

Fixing Bath :- The emulsion is properly fix after in the fixing solution for twice the time. It takes for the milky appearance to clear completely.

Film Washing :- After all undeveloped silver halids have been removed the emulsion is still saturated with the chemicals of the fixing bathe and some

TUTORIAL / PRACTICAL NO.

desolved by washing so they will slowly decompose and attack the image, causing stain and faded film. The effectiveness of washing can be greatly improved if the film sheet after fixing, gets a brief water rinse under the tap to remove the excess fixing solution which otherwise would contaminated the washing tank.

Drying :-

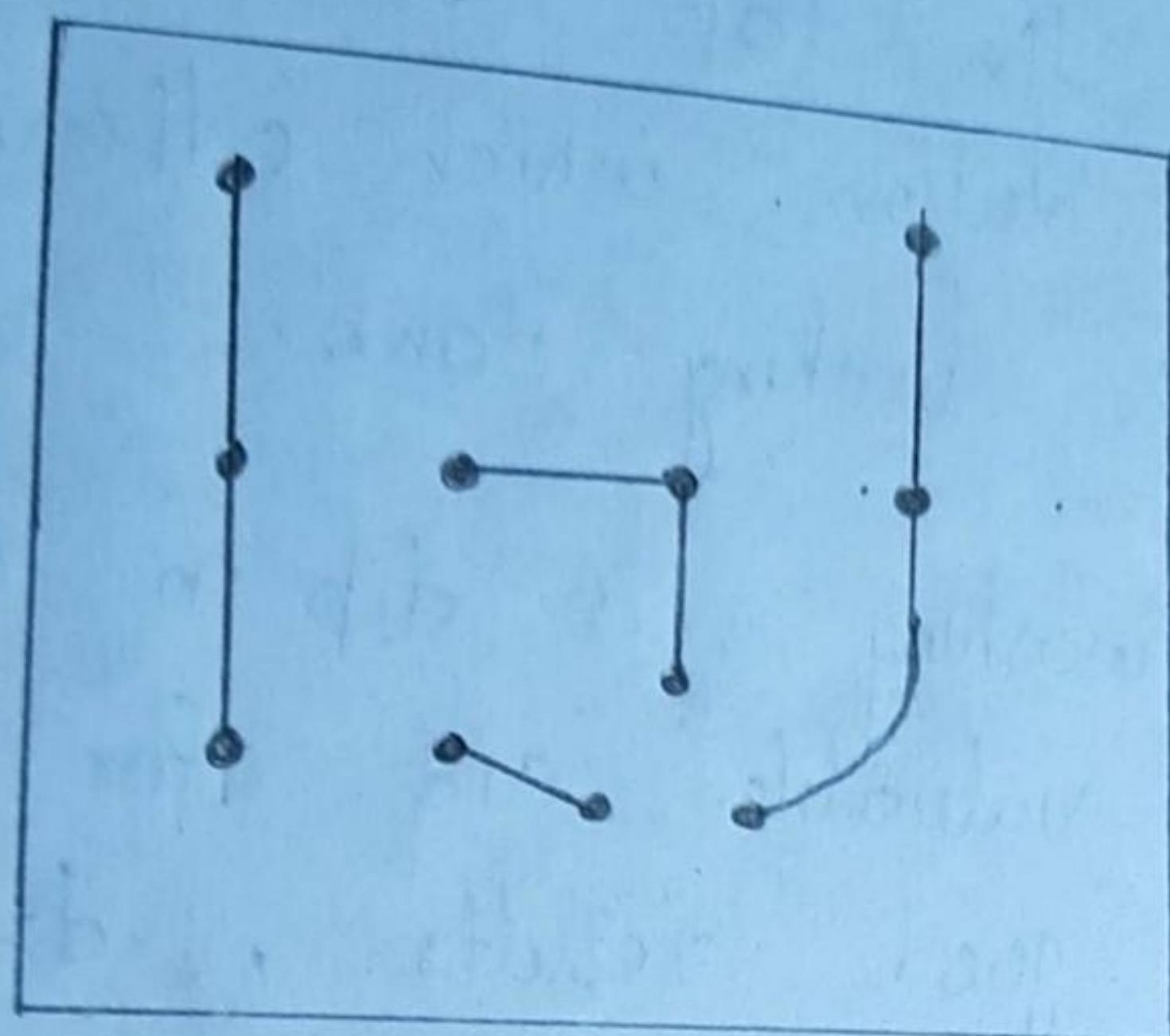
After washing, a dip in a wetting agent is the valuable aid for the drying process. For good results, drying could take place slowly at room temperature.

Result :-

Negative is prepared according to PCB circuit.

Precautions :-

- 1.) Circuit on the transparency should be drawn neat and clean.
- 2.) Process should be done in the absence of Sodium (Yellow).



Bottom View

TUTORIAL / PRACTICAL NO.

PCB Processing

Dark Room

Step 1 :- Expose the film for 5 seconds in Film Exposure Unit.

Step 2 :- Dip the exposed film in film developer for 75 seconds to 165 seconds according to room temp.

Developing Time and Temp

20°C	165 sec. (2.75 min.)
22°C	135 sec. (2.25 min.)
24°C	105 sec. (1.75 min.)
26°C	75 sec. (1.25 min.)

Step 3 :- Wash it in water.

Step 4 :- Dip it in fixer for 2 to 5 minutes (according to temp.)

Step 5 :- Wash it in running water.

TUTORIAL / PRACTICAL NO.

Experiment no. - 02

Object:- Artwork and printing on the Printed circuit board for fabrication.

Apparatus Required :-

1. Photo-resists developer (methyl tricolored Ethylene)
2. Copper clad board
3. Photo contact printer
4. Photo cube machine
5. Dip coating machine
6. UV. developer exposer machine

Theory :- The manual artwork PCB design is the method used by most manufacturing of PCB with this method extremely accurate, high density PCB can be constructed. This artwork is then photographed to produce a negative which can be used with sensitized printed circuit. Exposing of the negative by contact with coated circuit board is done first and then developing and other processes are required for PCB.

TUTORIAL / PRACTICAL NO.

Process :-

- 1) Clean the laminate :- Before the metal surface is coating with crescent Photoresist, clean surface thoroughly so as to make a completely free of physical and chemical contamination.
- 2) Coating the laminate :- Crescent Photo-resist can apply precisely and economically by using a dipping process, done by a photoresist to coats.
- 3) Thinner :- The thinner is used to dilute the photo - resist as it tends to get the thick during non-use. The use of thinner will depend upon the method of coating.
- 4) Prefacing :- After coating the laminate allow it to dry naturally for 5 min. This helps to evaporate the solvents completely.
- 5) Exposure :- The coated laminate is normally exposed in contact with Photographic negative and positive crescent Photo-resist is sensitive to U.V. radiation and

TUTORIAL / PRACTICAL NO.

therefore U.V. tube based U.V. exposure can be used for exposure

6) Development :- The exposed plate should be placed into the solvents based developer. This will remove unexposed area of the photo-resist and will produce colourless resist image has plastic like appearance.

7) Washing :- Immediately after developer is over, wash it on running water of normal pH. After washing and drying, dying is carried out to improve the visibility of image.

8) Drying of image : Immense the dried that plate in the dye developer bath. The surface of the board is put under the running water after coloured with the dye developer. In order to wash off the dye stain from unexposed areas, which results into a clean dyed image of photo-resist and the dye.

9) Post curing :- The post - baked surface will be stronger than the unbaked one.

The process can be done on PCB curing machine

TUTORIAL / PRACTICAL NO.

Result:-

After these process , the circuit resistors has left on required part of PCB and now coated or unprotected metal may be etched in etching solution to prepare PCB .

Precautions:-

1. Workable , apparatus , tanks , traces should be completely free from dust and dirt.
2. Use of thinner should be done carefully .

TUTORIAL / PRACTICAL NO.

Step - 10 : Wash it in slow running water for 2 minutes.

Step - 11 : Bake it for 5 minutes in PCB curing machine.

Step - 12 : Process it in Etching machine for 10 to 15 minutes . (Etching time is depend upon the dilution of chemical).

Step - 13 : Wash it in running water.

Step - 14 : Remove the resist from PCB with the help of Photoresist stripper.

Step - 15 : Wash it in running water and dry it in curing machine for 4 minutes .

~~J~~

TUTORIAL / PRACTICAL NO.

Experiment No. - 03

Object :- Etching and Drilling of PCB to fabricate the printed circuit board.

Apparatus Required :-

1. Etching Machine
2. Ferric Chloride
3. Drilling Machine

Theory :- This is an important and critical step in chemical processing of direct etched board. Although basically this operation of chemical removal of unwanted copper portion ferric chloride is widely used for copper and copper alloys. It removed the unwanted copper from laminate by photo etching machine. In this machine, laminate put in tank filled with chemical ferric chloride which is agitated by a pump and a heater.

The heater helps the chemical become to warm and help it to etch PCB faster. Fresh chemical is available available to the surface area that dissolved the metal

TUTORIAL / PRACTICAL NO.

from surface is rinse away simultaneously.
Sensors are provided for maintaining temperature.

DRILLING :-

After etching, drilling of PCB is done for making holes on the conductor pattern for inserting the component leads to the solder of PCB.

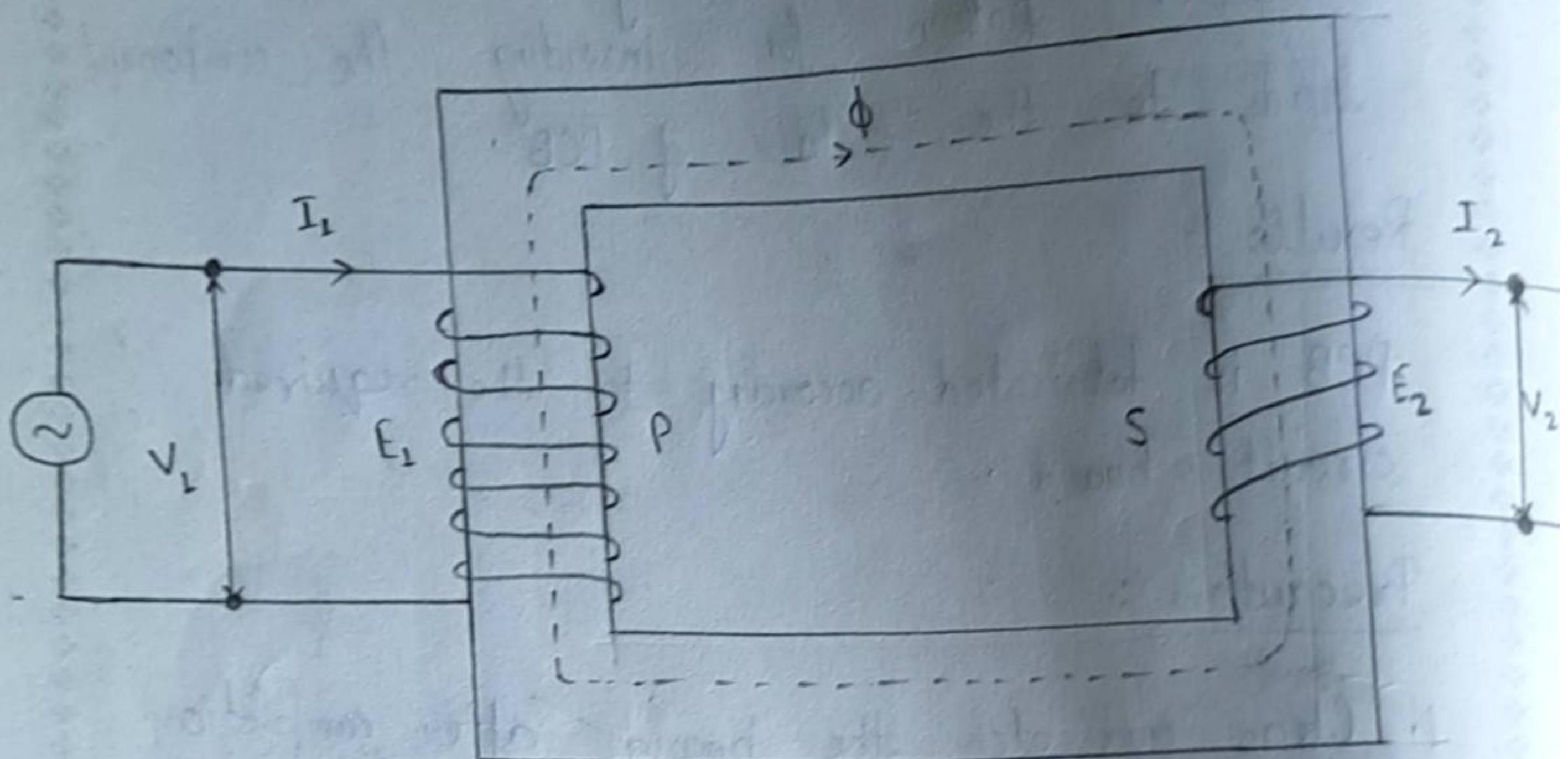
Results :-

PCB is fabricated according to the required circuit board.

Precautions :-

1. Clean and etch the board after completion of etching.
2. Drilling should be done carefully.

d



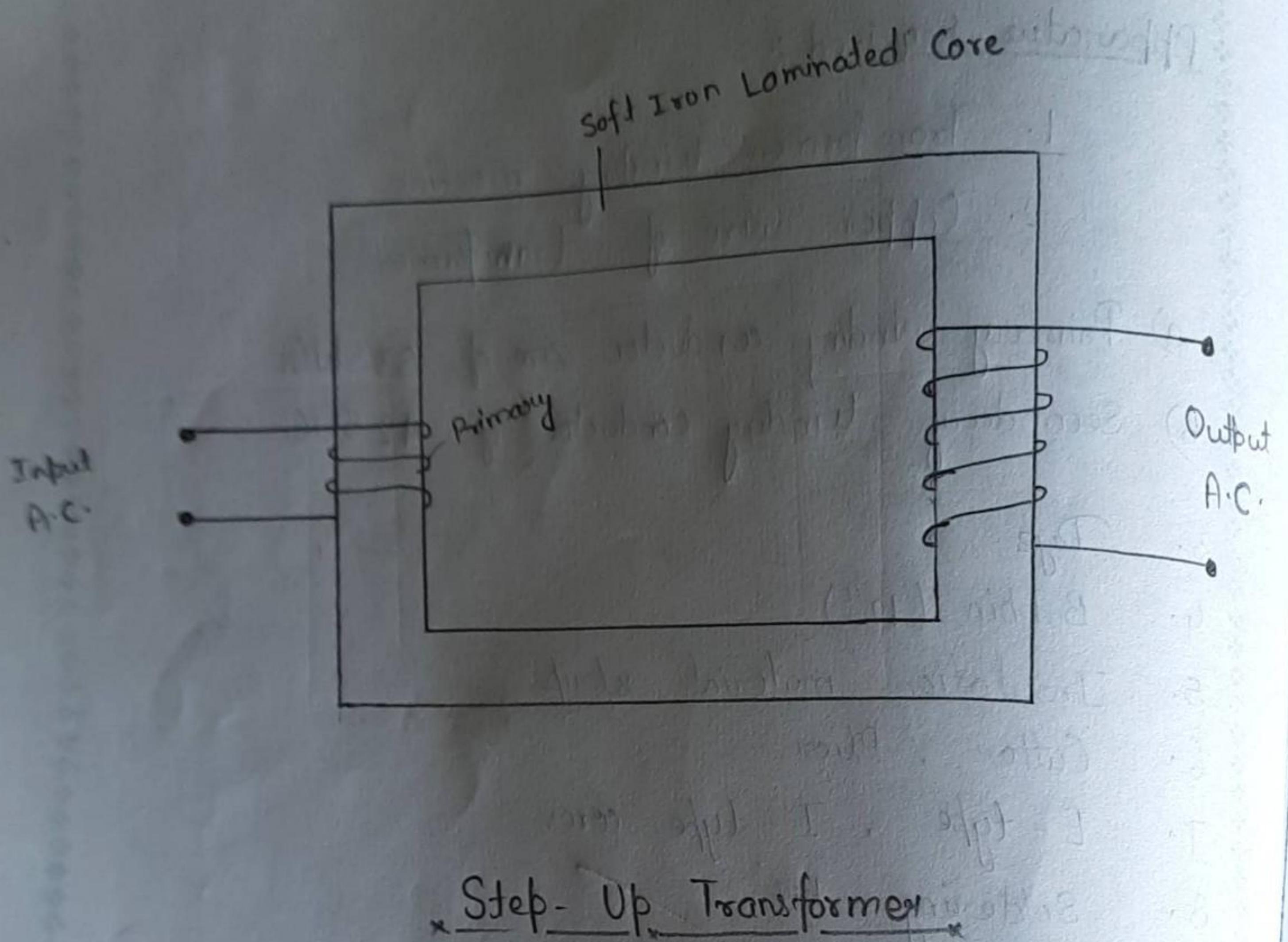
TUTORIAL / PRACTICAL NO.

Experiment No. - 04

AIM :- Winding shop : Step down transformer winding
of less than 5VA

Apparatus Required :-

1. Transformer Winding machine
2. Copper wire of transformer
- a) Primary winding conductor size of 33 SWG
- b) Secondary Winding conductor of 42 SWG
3. Dye
4. Bobbin (12")
5. Insulation material strips
6. Cutter , Plier
7. E-type , I-type cores
8. Soldering Kit
9. Clamp
10. Varnishing material
11. Multimeter



TUTORIAL / PRACTICAL NO.

Theory :- Transformer :- A transformer is a device that

1. Transfer electrical energy from one electrical circuit to another .
2. Does so without a change in frequency.
3. Has electrical circuit that are linked by a magnetic circuit .

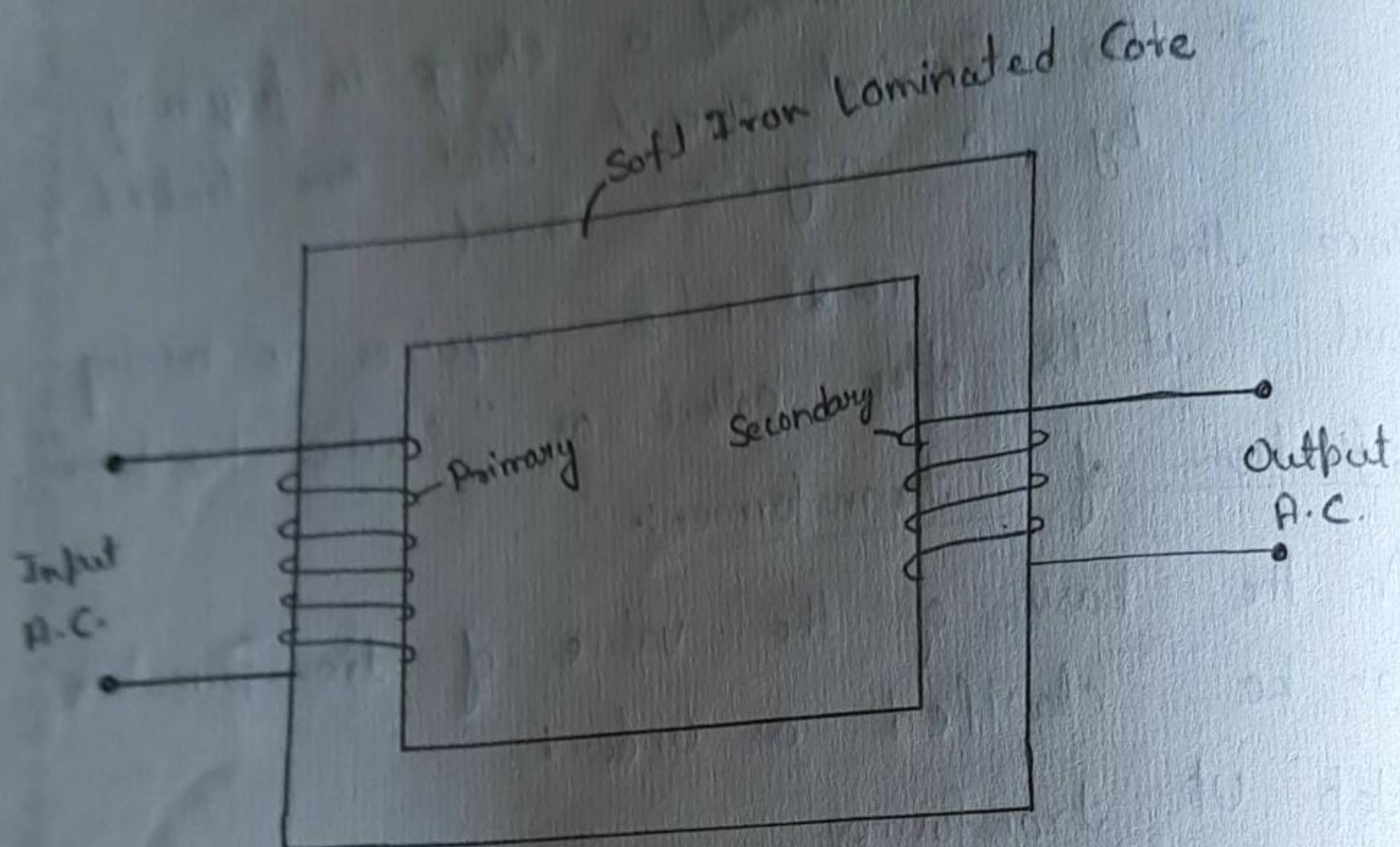
Since the basic construction requires no moving part it is often called as "Static Transformer".

Classification of Transformer :-

On the basis of the value of transformation can be classified as under :

1. Step up transformer
2. Step down transformer

When the transformer raise the voltage when the output voltage of a transformer is less than its input voltage , it is called the step down transformer . Thus in case of step down transformer $V_2 < V_1$, and in case of step up transformer $V_2 > V_1$ and thus K



Step-Down Transformer

TUTORIAL / PRACTICAL NO.

Constructionally, the transformers are two types namely -

1. Core type transformer
2. Shell type transformer

These from next the two are distinguishing from merely the manner in which the primary and secondary coil is placed around the laminated core. In the so called core transformer, the winding surrounds a considerable part of core whereas in the shell type transformer, the core surrounds considerable part the winding.

In the shell type transformer, the iron core surrounds the copper winding the entire flux passes through the iron core. but outside this central core it divides into half going in each direction. The leakage flux reduced to vary by sandwiching the primary winding between the sections of secondary winding.

TUTORIAL / PRACTICAL NO.

Procedure :-

- 1) Take the bobbin and fit it on to dye.
- 2) Tight the dye in the bobbin with the help some paper (butter paper) such that it gets completely fit in it.
- 3) Fix the frame (bobbin) on the transformer winding machine.
- 4) Set the machine at the proper scale as per the setting of frame and wire used.
- 5) Set the counter at zero.
- 6) As first primary is to be wound so placed the thin wire roll on the holders.
- 7) Rotate the handle manually, in such a manner that the copper gets wound up the frame tightly.
- 8) Take the desired number of turns.
- 9) Take care that initial & final ends of the copper wire does not mixed up.
- 10) Place a strip of insulation material round the frame over the primary winding in order to isolate primary from secondary.

TUTORIAL / PRACTICAL NO.

Calculate the secondary no. of turns by -

$$N_2 = N_1 \left(\frac{V_2}{V_1} \right)$$

$$N_1 = 2300, \quad N_2 = ? \quad V_1 = 230 \text{ V}$$

$$V_2 = ?$$

$$\frac{V_2}{V_1} = \frac{N_2}{N_1}$$

$$\Rightarrow \boxed{V_2 = 9 \text{ V}}$$

And wound them over the insulating material over the frame as per before.

12. Again wrap the secondary winding with a strap of insulating material.
13. Apply soldering process to cover the terminals.
14. Now insert the E-section in the frame followed by the inserting of I-section.
15. Now the frame is placed in a tray and dipped in varnish.
16. Transformer is ready and now placed in clamp.
17. Test the transformer for 5VA ($= 9\text{V} \times 500\text{mA}$) with a multimeter.

Result: A step down transformer of less than 5VA has been wound.

- Precautions:-
1. The winding should be tight & uniform.
 2. Secondary and Primary winding should be properly isolated from each other.
 3. The I-section should be in between the E-section at proper position.

TUTORIAL / PRACTICAL NO.

Experiment No. - 05

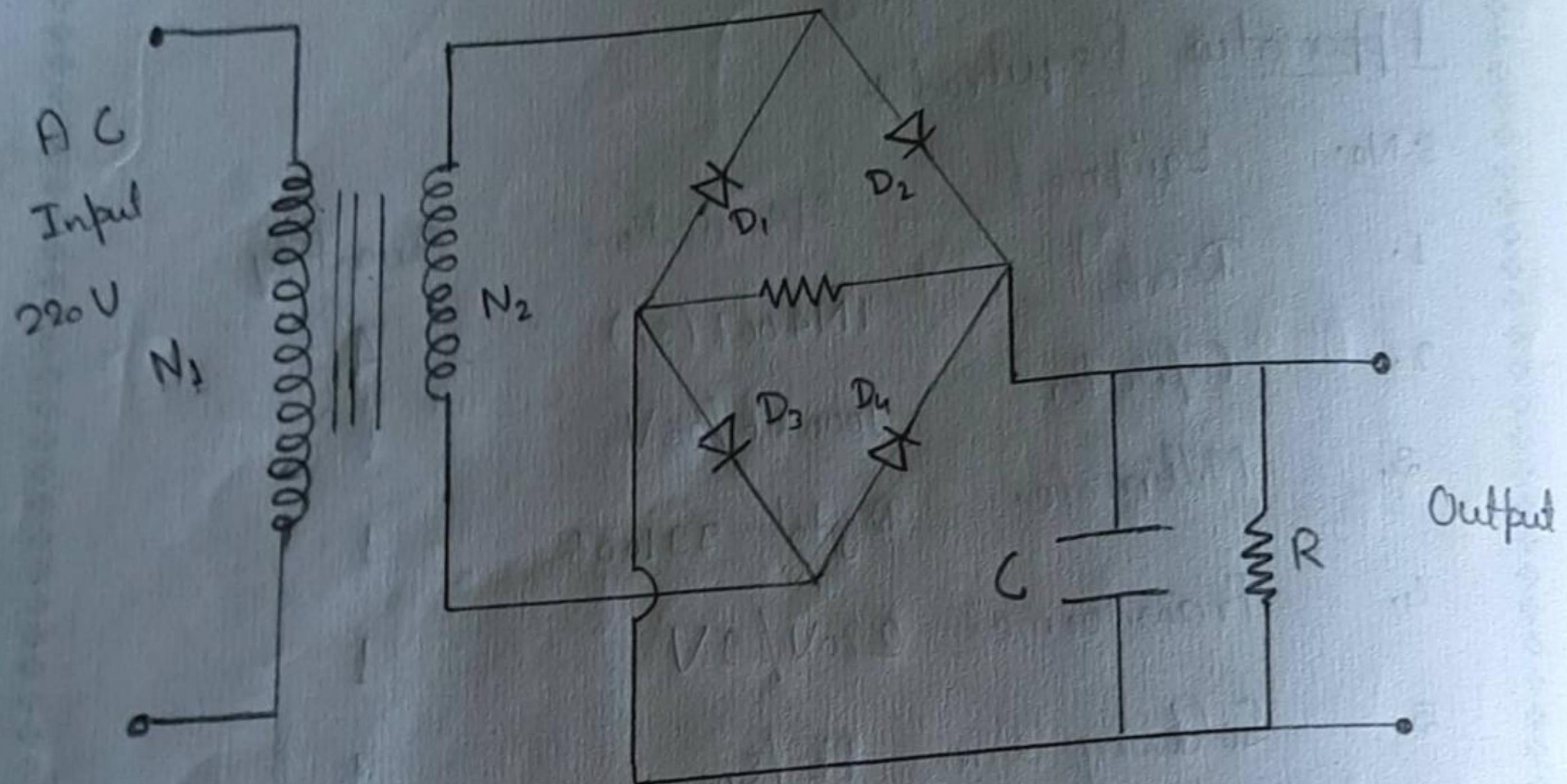
Object :- Fabrication of DC unregulated 6V power supply.

Apparatus Required :-

S.No.	Equipment	Specifications	Quantity
1.	Diode	IN4007 (Si)	4
2.	Capacitor	1000 μF / 25V	1
3.	Millimeter	Digital - 991006	1
4.	Transformer	220V / 9V	1
5.	Soldering Wires	Pb / Sn	1
6.	Wires	Yellow Red	1
7.	Resistance	100 Ω	2

Theory :- Rectifier circuit converts AC power to DC. When PCB (rectifier circuit) is connected to the transformer into DC output of PCB.

Here four diodes are used in rectifier circuit and capacitor is used to reduce the ripple factor in output.



DC Regulator Power Supply

TUTORIAL / PRACTICAL NO.

Process :- First attach the electronic components (4-diodes, 1 capacitor) in the configuration of bridge rectifier, by soldering process on the PCB. Check the primary and secondary side of the transformer, then connect the secondary of the transformer as the input of the bridge rectifier. Finally by filtering through the capacitor, we will obtain an unregulated DC power supply.

Ripple Factor of Bridge Rectifier :-

$$= \left[\left(\frac{I_{rms}}{I_{DC}} \right)^2 - 1 \right]^{1/2} = 0.428$$

V_r - ripple voltage

In case of capacitive filter -

$$V_r = \frac{I_{DC}}{2fC}$$

$$V_{DC} = V_m - \frac{V_r}{2}$$

$$V_{r, rms} = \frac{V_r}{\sqrt{3}}$$

$$\sqrt{ } = V_{r, rms} / V_{DC} \text{ (ripple factor of capacitive filter)}$$

Result :- The output of PCB circuit is 11.8 Volts DC.

Precautions :- ① Components should be attached rightly.

② Only output wire or transformer is connected to PCB.

TUTORIAL / PRACTICAL NO.

Experiment no. 06

Aim :- Study the working of distortion meter.

Apparatus Required :- Caddo 4092 distortion meter.

Theory :- The Caddo 4092 distortion meter was developed for the measurement of non-linear distortion in the audio frequency range. Due to its low residual distortion and noise of 0.005% it is ideally suited for tests and measurements of high quantity audio systems.

The Caddo 4092 features an LCD display readout with a resolution of 0.1% to simplify and enhance distortion measurements. A calibrated distortion output is provided for visual inspection or spectral analysis of the input signal after the fundamental has been filtered out.

Together with pushbutton frequency range selectors and signal control frequency tuning, the automatic frequency nulling with 20% capture range ensure quickly and easy measurements with the Caddo 4092.

TUTORIAL / PRACTICAL NO.

Features :- Frequency Range 20Hz to 20KHz
Distortion measurement up to 0.1%.

LCD Readout for frequency and Distortion measurement
Automatic frequency ranging & Nulling Facility
Output for Distortion Analysis
In built 50 MHz frequency Counter.

Front Panel :-

- ① Power :- Push button , selects instrument to switch
- ② LCD display :- LCD readout for indication of the measured distortion factor in %
- ③ Attenuator (Push button) :- Input signal attenuation with two push button switches of 20dB or 10dB attenuation respectively . They can be used separately . Both push button switches activated , together with the variable attenuator (9) must enable a 100% reading when in the calibration mode ; otherwise the input voltage should be adjusted .
- ④ Tuning control with LED Indicator (LED) :-
If the built - in - filter is incorrectly tuned , one of the two variables LED's will indicate in which direction the filter frequency deviates from the input frequency . Twin tuning knob (5) (N.A.) in the opposite direction until the LED goes out .

TUTORIAL / PRACTICAL No.

- 5) Level \ Distortion (Pushbutton switch) :- Adjust for 100% reading with level and then selection for 100 % full scale.
- 6) Level (Adjust knob) :- Continuous attenuation of input signal up to max. 50 dB to achieve 100% reading when in the calibration mode.
- 7) Output (BNC connector) :- Monitor output for distortion factor. (Residual distortion) Output voltage is 1mV/digit.
- 8) Input (BNC connector) :- Input for measurement signal. The permissible input voltage range is 0.3V - 50 V for a valid measurement.
- 9) External Counter :- It is the input for external signal whose frequency is to be measured.

Precaution :-

Use proper mains cord :- Use only the mains cord designed for the this instrument. Ensure that the mains cord is suitable for your country.

TUTORIAL / PRACTICAL No.

Ground the Instrument :- This instrument is grounded through the protective earth conductor of the mains cord. To avoid electric shock the grounding conductor must be connected to the earth ground. Before making connections to the input terminals, ensure that the instrument is properly grounded. Connections to the input terminals, ensure that the instrument is properly grounded.

Observe Terminal Ratings:- To avoid fire or shock hazards, observe all ratings and marks on the instrument.

Use only the proper fuse:- Use the fuse type and rating specified for ~~this~~ this instrument.

Use in Proper Atmosphere:- Please refer to operating conditions given in the manual.

1. Do not operate in wet/damp conditions.
2. Do not operate in an explosive atmosphere.
3. Keep the product dust free.