Determine the value of resistance by colour code and identify the types

Objectives: At the end of this exercise you shall be able to
- **identify the types of resistors by referring to the pictorial representation**
- **identify the colour bands, and decode the resistance value**
- **calculate the tolerance value by the colour band.**

Requirements

Tools/Instruments		Materials	
• Multimeter/Ohmmeter	- 1 No.	• Various types of resistors (assorted values) including potentiometers of carbon track and wire-wound type.	- as reqd.

PROCEDURE

TASK 1: **Identify the type of resistor from pictorial representation**

1 Identify the resistor's type by referring Fig 1 and write the type in Table 1.

2 Sketch the I.S. symbol for the identified resistor in Table 1.

Fig 1

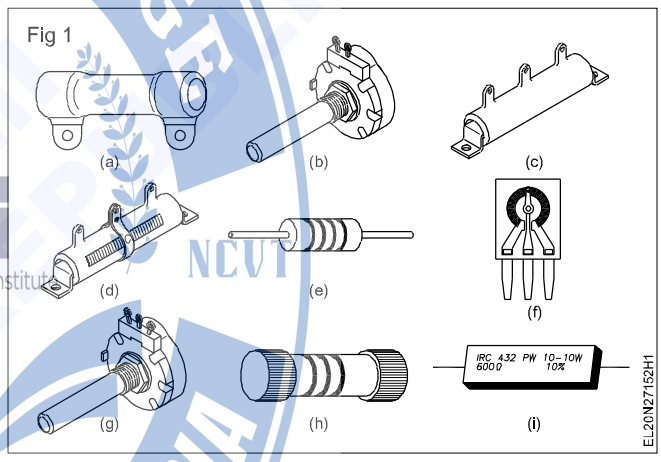


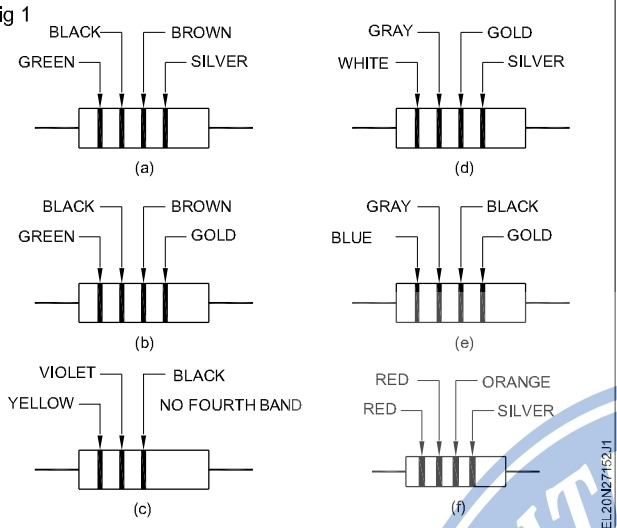
Table 1

Sl. No.	Sketch reference	Type of resistor	Symbol
1	A		
2	B		
3	C		
4	D		
5	E		
6	F		
7	G		
8	H		
9	I		

TASK 2 : **Identify the colour band and decode the resistance value**

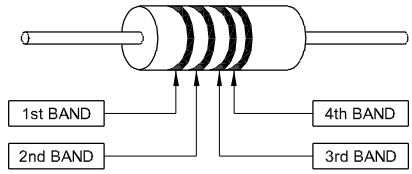
1 Identify the value of resistors shown in Fig 1 from the colour bands and enter Table 1.

Fig 1



2 Identify the first two colour bands of the resistors given by the instructor (in sequence commencing from the 1st colour band closer to one end of the resistor - Refer Fig 2.

Fig 2



3 Write the 1st number and 2nd number in Table 1.

4 Identify the colour of the 3rd band and write the multiplier value in the respective column in Table 1.

5 Compute the value of the resistor and record in Table 1.

6 Identify the 4th band colour and fill up the tolerance in Table 1.

7 Determine the resistance value and the tolerance for the another given resistors and record in Table by repeating the above steps 1 to 6.

8 Measure the value of the resistors by using a multimeter/ohmmeter and enter the values in Table by following the procedure given below.

Table 1

Sl.No.	Colour				1st No.	2nd No.	3rd No.	Multiplier	Resistance value	Tolerance limit (±) in percentage
	1st Band	2nd Band	3rd Band	4th Band						
A										
B										
C										
D										
E										
F										
G										

Test active and passive electronic components and its applications

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

- **identify the electronic components - diode, diode bridge, transistor, SCR, IC by referring to the pictorial representation**
- **identify the given electronic components- diode, diode bridge, selenium bridge, transistor, IC, by visual inspection**
- **identify the passive components by visual inspection**
- **interpret the coding and marking on the components**
- **test the components for its working conditions.**

Requirements

Tools/Instruments

- Multimeters/Ohmmeter - 1 No.

Materials/Components

- Capacitors, inductors, resistors (assorted size, shape and values) - as reqd.
- Assorted components of diodes, transistors, SCRs, DIACs, TRIACs, UJTs, FETs bridge diodes etc of different types with semi-conductor data manual - as reqd.

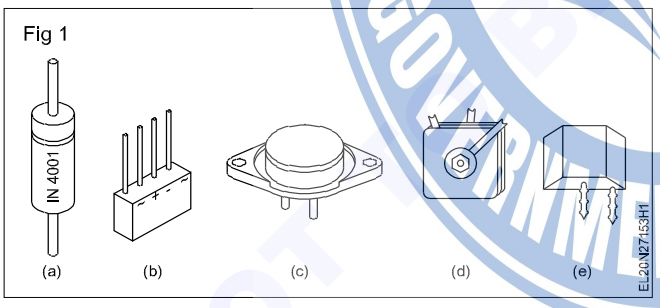
PROCEDURE

TASK 1: **Identify the active components**

Assumption: Given components have their code number, lead identification marks are available in data book

1 Look at the Fig 1. Identify the component from the pictorial representation. Give your response in Table 1.

Fig 1



2 Write the figure Nos. that indicate the components given in Fig 2, in Table 2

Fig 2

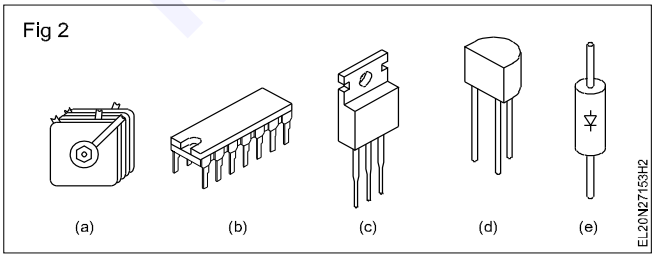


Table 1

Sl.No.	Figure number	Component's name
1	Fig 1 a	
2	Fig 1 b	
3	Fig 1 c	
4	Fig 1 d	
5	Fig 1 e	

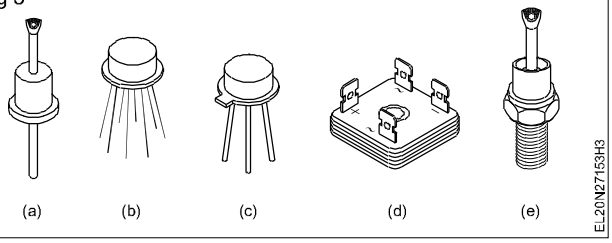
Table 2

Sl. No.	Figure number	Component's name
1		Transistor with heat sink
2		Diode bridge
3		Integrated circuit
4		Diode
5		Transistor

3 Match the names and pictorial representations of the active components (Fig 3).Record your response in the space provided.

4 Collect the electronic (ACTIVE) components from your instructor. Identify the components and record your response in your record book along with sketches of the components. (Refer Fig 3 for guidance)

Fig 3



5 Get it checked by your instructor.

TASK 2 : **Identify and check the passive components**

Instructor shall select the resistors, inductors and capacitors so that, few can be visually identified and other can be identified by coding only.

1 Identify the passive components referring to Fig 1 and write the type of passive component in Table 1.

2 Sketch the appropriate symbol against the corresponding type of passive components in Table 1.

3 Get your result corrected by your instructor.

4 Collect assorted size, shape and type of passive components from your instructor.

5 Divide the passive components into separate groups as resistor, inductor and capacitor by their appearances (or) code references.

6 Interpret, the code references of resistor and list them in Table 2.

7 Measure the value of resistance of each by multimeter and record in Table 2.

8 Interpret the code references of capacitor and list them in Table 3.

9 Check the capacitor for charge and discharge by multimeter, and record the condition in Table 3 by referring Fig 1.

Table 1

Sl. No.	Fig alphabets	Components identified as	Reasons for identifications	Symbols	Remarks
1	A				
2	B				
3	C				
4	D				
5	E				
6	F				
7	G				
8	H				
9	I				
10	J				
11	K				
12	L				
13	M				
14	N				
15	O				
16	P				

Table 2

Sl. No.	Coded reference	Type of resistors and other details	Measured value of resistor
1			
2			
3			
4			
5			
6			

In case of very low value of capacitors, multimeter may not show any deflection during charge or discharge. Anyhow if the multimeter reading is infinity the capacitor has to be considered as good in case of non electrolytic capacitors.

10 Interpret the code references of inductors/ coils / transformers and list them in Table 4.

11 Check the continuity of the coil and its tapping with the multimeter and record the condition in Table 4.

There should not be any continuity between coil and the core

12 Get the above observation approved by your Instructor.

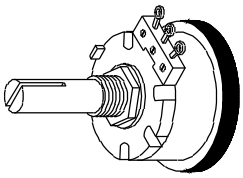
Table 3

Sl. No.	Coded reference	Type of capacitors and other details	Condition of capacitor
1			
2			
3			
4			
5			
6			

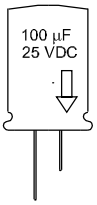
Table 4

Sl. No.	Coded reference	Type of inductors /coils transformers and other details	Condition of coil
1			
2			
3			
4			
5			
6			

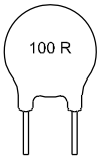
Fig 1



A



B



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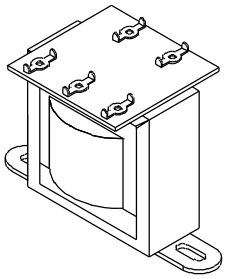

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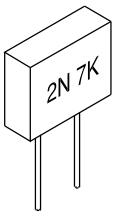

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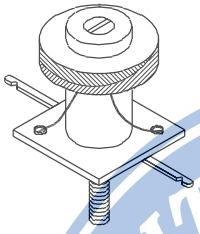

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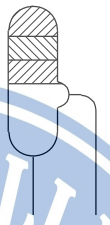
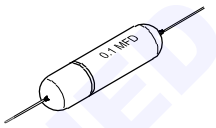
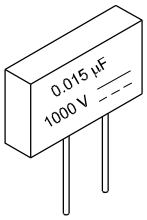


G



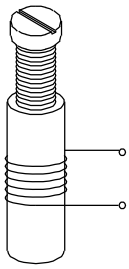
H



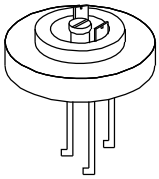
I

J

K

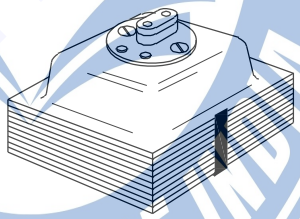


L

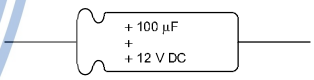


M

N



O



P

EL20N27153J1

Determine the V-I characteristics of semi conductor diode

Objectives: At the end of this exercise you shall be able to
- **refer data book and**
  - **a) identify the diode is Ge, Si etc**
  - **b) verify operating voltage and current rating**
  - **c) list the application of the diode**
- **identify the terminals of a diode and test the diode for its condition**
- **plot the forward characteristics, determine the forward resistance of the diode and the barrier potential**
- **plot the reverse characteristics of the diode and determine the minority carrier current.**

Requirements

Tools/Instruments

- Multimeter (Digital) - 1 No.
- Voltmeter MC 0-1 V - 1 No.
- Milliammeter MC 0-25 mA - 1 No.
- Voltmeter MC 0-30 V - 1 No.
- Micro ammeter MC 0-100 Micro Amp - 1 No.
- Semi conductor diode data book - 1 No.

Equipment/Machines

- DC regulated power supply 0- 30 V, 1 A - 1 No.

Materials

- Assorted types of diodes including IN 4001 or IN 4007 - as reqd.
- 570 Ω, 5W potentiometer - 1 No.
- SPST switch 6A 250V - 1 No.
- Bread board 150 x 150 mm - 1 No.
- Suitable connecting wires for bread board - as reqd.
- Patch cords with clips - 2 sets
- 100Ω 1/4 W resistor - 1 No.
- 10 Ω 1/4 W resistor - 1 No.

PROCEDURE

TASK 1: **Refer the diode with data book**

1 Select any one of the given assorted diodes. Record the type number printed on the diode.

2 Refer diode data book and search for the type number of the selected diode.

3 Look in the data book for the column which indicates Rated peak reverse voltage abbreviated as V_R or V_r or PIV against the referred diode. Find and record the indicated value of rated peak reverse voltage.

4 Get as done in step 4 and record the following specifications of the referred diode from the data book:
- I_F of I_f - Maximum average forward current
- V_F of V_f - Forward voltage drop at specified I_F
- I_s - Maximum forward surge current
- I_{VT} - Maximum reverse current at V_R
- Function - Normal use/application of the diode.

The coding used for Function differs from data book to data book. Consult instructor in case of difficulty.

5 Repeat steps 1 to 5 for atleast ten different types of given diodes.

6 Refer diode data book or diode equivalents data book and identify one or two equivalent diode types for each diode. For those diodes you collected the specification.

7 Get your work checked by your instructor.

— — — — — — — —

TASK 2 : **Identify the terminal leads of a given diode**

1 Set the multimeter in ohms range (W x 1). Connect its leads to a M.C. voltmeter (0-3V), to find out the polarity of multimeter output voltage.

In digital multimeter the marked polarity and polarity of output voltage are the same.

2 Check the deflection of the voltmeter, if it indicates the voltage, mark the terminal of the multimeter corresponding to the voltmeter polarity

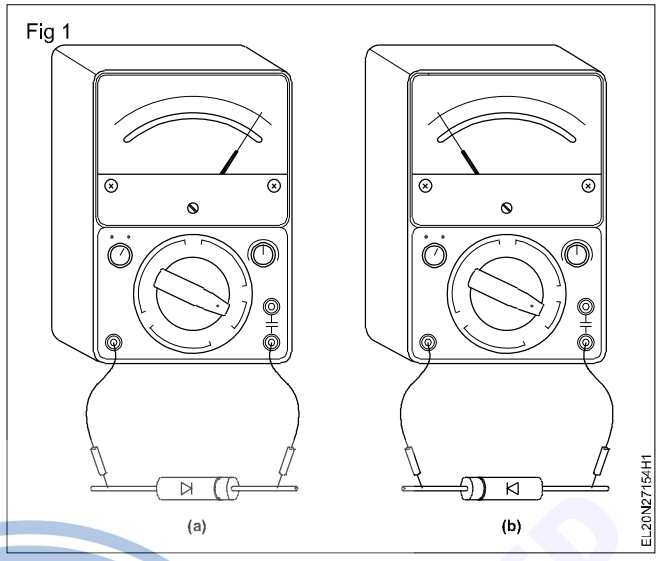
3 Mark the terminal of the multimeter opposite to voltmeter polarity. If the voltmeter kicks back then.

4 Connect the +ve marked terminal for the multimeter to one terminal of the diode and other to the -ve and observe the reading.

a) If the meter reads low resistance then the lead of the diode connected to +ve marked terminal of the meter is the ANODE and the other is cathode. (Fig 1a)

b) If the meter does not deflect as in Fig 1b then the lead of the diode connected to +ve marked terminal for the multimeter is the cathode and the other is anode.

Fig 1



If the meter reads low resistance for both polarities the diode is short.

If the meter reads high resistance for both polarities the diode is open.

TASK 3 : **Determine the forward V-I characteristic of the diode**

1 Construct the circuit in the bread board as in Fig 1.

2 Set initially V_B = 0 and switch ON the power supply.

3 Set V_B= 5V, set the potentiometer to minimum position.

4 Close the switch S and adjust potentiometer to increase the voltage across the diode in steps of 0.1 V as per the Table.1

5 Record the corresponding values of current read by the ammeter in the Table.1.

Fig 1

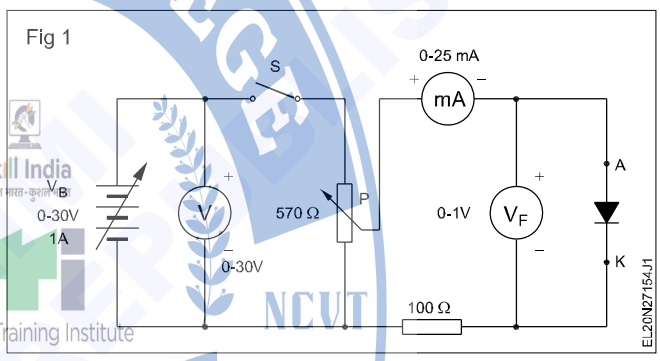


Table 1

V_F Volt	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	2.0
I_FmA	0											

6 Check the value of voltage across the diode at which the current starts increasing and remain constant at later.

7 Switch OFF the supply

8 Plot the graph with V_F on X axis and I_F on Y- axis.

9 Determine the forward resistance.

$$R_F = \frac{V_F}{I_F} \text{ ohms}$$

From the graph determine the knee point voltage at which large quantity of current starts flowing. Enter the value below.

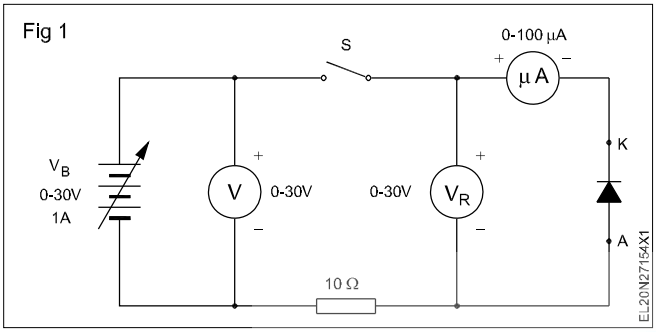
Knee point voltage .... volts If the knee point voltage is around 0.3 V or 0.7V the diode is germanium or silicon respectively.

Note : Increase the voltage beyond 2.0V as indicated in case diode is not reached in saturation current.

TASK 4 : **Determine the reverse V-I characteristic of a diode**

1 Construct the circuit in a bread board as in Fig 1. (Reverse the Diode terminals with respect to previous task)

Fig 1



2 Switch on the power supply and close the switch S.

3 Increase the voltage gradually across the diode by operating the power supply as per Table 1 and note down the corresponding current read by the ammeter in Table 1.

4 Switch OFF the power supply.

5 Plot the graph on the same graph sheet (Task 3) with V_R on x-axis and I_R on Y-axis.

6 Determine the minority carrier current from the graph.

If the reverse voltage becomes equal to the PIV of the diode then the diode starts conducting and not to increase the voltage beyond PIV of the diode.

7 Repeat the experiment for different type of diodes.

Table 1

V_R Volts	0	5	10	15	20	30
I_R in Micro camps						

Construct half-wave, full wave and bridge rectifiers using semi conductor diode

Objectives: At the end of this exercise you shall be able to
- **construct a half-wave rectifier and test**
- **construct and test a full-wave rectifiers using two diodes**
- **construct and test bridge type, full wave rectifiers using four diodes.**

Requirements

Tools/Instruments

- Trainees kit - 1 No.
- Voltmeter MC 0-30V - 1 No.
- Multimeter (Digital) - 1 No.

Materials/Components

- Bread board - 1 No.
- Diode IN4007 - 4 Nos.
- Resistor 470Ω (Ohm) - 1 No.
- Step-down transformer, 240V/12.0.12, 500mA - 1 No.
- Multi strand wire, red, blue 23/0.2 of 650V grade - as reqd.
- Mains cord 3 core cable 23/0.2 of 650V grade - 1 No.
- 3 Pin plug 6A 250 V - 1 No.

PROCEDURE

TASK 1: **Construct half-wave rectifier and test it**

1 Test the continuity of the primary and secondary windings of the given transformer. Record the specifications of the given transformer.

2 Follow the order of steps given below by referring Fig 1.
- Mount the rectifier diode on bread board.
- Connect three core power cord to the transformer.

3 Connect AC mains to the board and switch ON mains. Measure and record the mains voltage and transformer secondary voltage $V_{S(rms)}$ (AC input to rectifier) in the Table 1.

4 Calculate and record the calculated DC voltage across load R_L using the formula,

$V_{dc} = 0.45\ V_{S(rms)}$

where, $V_{S(rms)}$ is the AC input to the rectifier.

5 Measure and record the rectified DC voltage V_{dc} across load R_L using multimeter.

6 Record the difference in the calculated and measured values.

7 Get it checked by your instructor.

Transformer specifications

Rated primary voltage	
Rated secondary voltage	
Secondary current or VA rating of transformer	
Type of transformer step-up/ step down	
No. of windings in secondary	

Fig 1

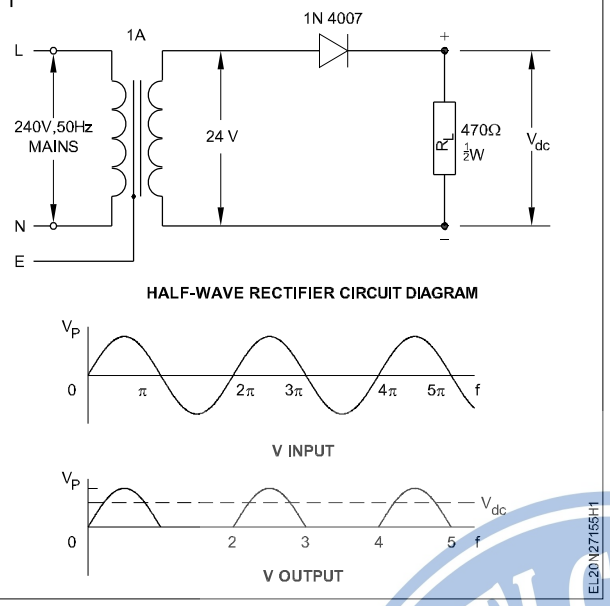


Table 1

Readings of single diode half wave rectifier

$V_{s(rms)}$ (1)	Calculated V_{dc} volts (2)	Measured V_{dc} volts (3)	Difference of (2) & (3) (4)	Peak value of V_s (5)	Frequency of V_s (6)

TASK 2 : **Construct full wave rectifier with centre tap transformer**

1 Check to confirm good condition of the given components. Record specifications of the transformer.

2 Construct a full wave rectifier circuit as shown in the schematic and layout diagram at Fig 1.

Transformer specifications

1 Rated primary voltage ——

2 Rated secondary voltage between centre tape and one end ——

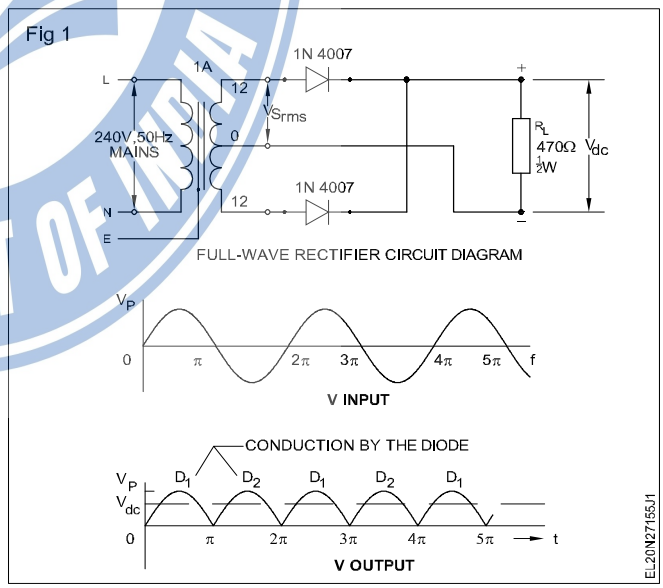
3 Rated secondary current or VA rating transformer ——

3 Switch ON the circuit. Measure the AC input voltage $V_{s(rms)}$ to the rectifier across the center-tap and any one end of the transformer and record it in Table 1.

4 Calculate the expected DC voltage V_{dc} across load R_L using the formula given below;

In full wave rectifier, V_{dc} = 0.9 $V_{s(RMS)}$ where, $V_{s(rms)}$ is the voltage across the centre-tap and any one end terminal of secondary. Record the value in Table 1.

Fig 1



5 Measure the rectified output V_{dc} across load R_L and record it Table 1.

6 Calculate and record the difference in the calculated and measured V_{dc} values. Get it checked by your instructor.

Table 1

Readings of two-diode full-wave rectifier

$V_{s(rms)}$ (1)	Calculated V_{dc} volts (2)	Measured V_{dc} volts (3)	Difference of (2) & (3) (4)	Peak value of V_s (5)	Frequency of V_s (6)

— — — — — — — —

TASK 3 : **Construct bridge rectifier**

1 Modify the two diode full wave rectifier wired in Task 2 to construct a bridge rectifier, referring to the schematic and layout diagrams (Fig 1).

2 Switch On the circuit. Measure and record the AC input $V_{s(rms)}$ to the rectifier in Table 1.

3 Calculate the expected output DC voltage V_{dc} across load R_L using the formula, In a bridge rectifier.

$V_{dc} = 0.9\ V_{s(rms)}$ where, $V_{s(rms)}$ is the AC input to the rectifier (refer Fig 1). Record the value in Table 1.

4 Measure the DC output V_{dc} across the load R_L and record it in Table 1.

5 Record the difference in the calculated and measured values in Table 1.

6 Report and get it checked by your instructor.

Fig 1

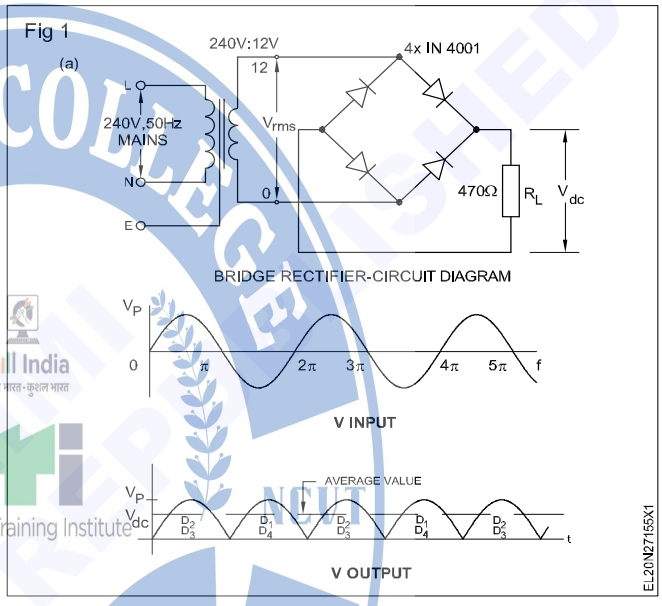


Table 1

Readings of bridge rectifier

$V_{s(rms)}$ (1)	Calculated V_{dc} volts (2)	Measured V_{dc} volts (3)	Difference of (2) & (3) (4)	Peak value of V_s (5)	Frequency of V_s (6)

— — — — — — — —

Check transistors for their functioning by identifying its type and terminals

Objectives: At the end of this exercise you shall be able to
- **identify a transistor from its type-number the following information referring to a data book;**
  a) silicon or germanium
  b) PNP or NPN
  c) package type
  d) base, emitter, collector pins.
- **test the condition of a given transistor using ohmmeter/multimeter.**

Requirements

Tools/Instruments
- Trainees kit - 1 No.
- International transistors data book - 1 No.
- Ohmmeter/multimeter - 1 No.

Materials/Components
- Assorted type of transistors - 10 Nos
- Sleeve wires of red, yellow, blue and black colours 1mm dia - as reqd.

PROCEDURE

TASK 1 : **Identify transistor type and leads, referring to data manual**

1 Take any one transistor from the given assorted lot (Fig 1), enter its label number and transistor type number in Table 1.

2 Refer to transistor data manual, find and record the following details of the transistor in Table 1
- Whether silicon or germanium
- Whether NPN or PNP
- Type of packaging or case outline (Example: TO5, TO7 etc.)

Fig 1

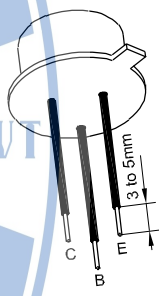


Table 1 (With sample data)

Label No.	Transistor type No.	Semi-Conductor /type	Type of package	Pin Diagram	E-B Junction resistance in forward bias E-B	B-C Junction resistance in reverse bias (E-B & B-C)
Sample	BC107	Si/NPN	T018		Low	Very High

3 From the type of package recorded, refer to the transistor data manual and draw the pin diagram indicating base, emitter and collector for the transistor in Table 1.

4 Put sleeves of suitable length (Fig 1) to the identified pins of the transistor using the colour scheme given below:

Base : Blue colour sleeve

Emitter : Red colour sleeve

Collector : Yellow colour sleeve

Shield : Black colour sleeve

In power transistors, the metal body itself will be the collector. In such cases, mark 'C' on the metal body using a pencil. All transistors will not have shield pin.

5 Repeat steps 1 to 4 for atleast five transistors of different types in the given lot and get your work checked by your instructor.

— — — — — — — —

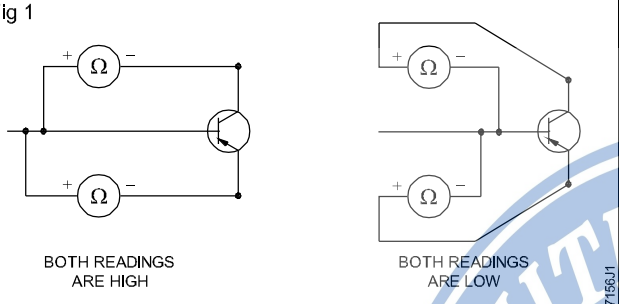
TASK 2 : **Check the transistor for PNP or NPN type**

Referring a data book with respect to transistor number gives the information whether transistor is PNP or NPN. In the absence of data book this test will be useful.

1 Ascertain the +ve and -ve polarity of the ohmmeter leads.

2 Hook the negative lead of the ohmmeter test prod to the base and the positive lead of the ohmmeter to emitter of the transistor.

Fig 1



3 Read the resistance value.

A low reading shows the transistor is PNP and the high reading shows the transistor is NPN provided the condition of the transistor is good. Refer Fig 1 and 2.

4 Record your findings in Table 1 and mark the identified type and condition.

Fig 2

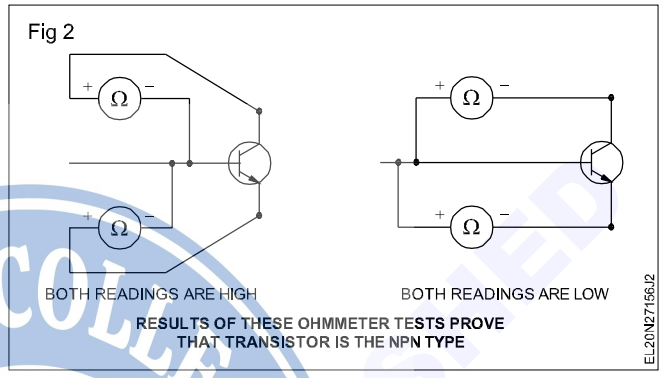


Table 1

Transistor No.	Forward bias		Ohmmeters reading	Reverse bias		Ohmmeters reading	Transistor Type	Remarks
	+Ve	-Ve		+Ve	-Ve			
AC128	E	B	Low	C	B	Low	PNP	Good
	B	E	High	B	C	High		

TASK 3 : **Test transistor for its working condition**

1 Identify which terminal of the ohmmeter being used is connected to the +ve terminal of the internal battery of the meter. Set the meter range to RX100Ω.

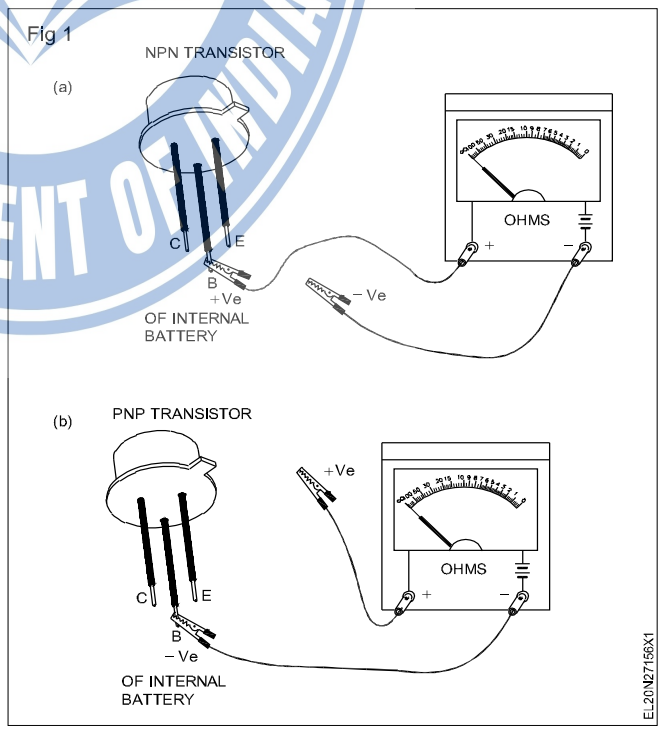
Ohmmeters in very low or very high ohms range can produce excessive current/voltage and may damage low power transistors while testing.

2 Take a transistor whose pins are identified and sleeved at Task 1. Depending on whether the chosen transistor is NPN or PNP, clip/hold the +ve or -ve of the meter prod to the base of the transistor as shown in Fig 1a and 1b.

3 Clip the other meter prod to the emitter. Check if the base-emitter junction diode of transistor shows low resistance (few tens of ohms) or very high resistance (few tens of kilo ohms). Record your observation in Table 1.

4 Reverse the polarity of the prod connected across the base-emitter and check if the base-emitter junction diode of transistor shows low resistance or very high resistance. Record your observation in Table 1.

Fig 1



5 From the recorded observations in steps 3 and 4, and referring to the table given below, conclude and record, the condition of the base-emitter junction diode of the transistor as GOOD, open or shorted in Table 1.

If the resistance of the junction measured in both directions is high, in addition to the condition of the junction given in table, an other possibility is, your identified base pin may be wrong. You may be measuring resistance across emitter-collector. In case of doubt, recheck the identified pins of the transistor and repeat steps 2,3 and 4.

6 Repeat steps 2,3,4, and 5 and check the condition of the base-collector junction diode of the transistor.

7 Measure the resistance across the emitter-collector and record the observation as V-HIGH (> 1MΩ) or LOW (<500Ω).

In a good transistor the resistance between the emitter and collector will be very high. A low resistance indicates that the transistor is leaky.

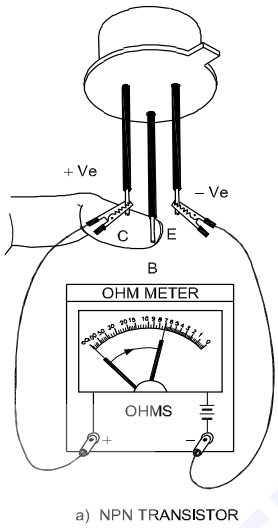
8 Clip the meter across the emitter-collector with correct polarity as in Fig 2. Touch the base-collector with moist finger as in Fig 2 and check if the resistance shown by the meter decreases indicating that the transistor is turning ON. Record your observation as YES or NO in Table 1.

9 From the observations recorded at steps 5,6,7 and 8, give your conclusion on the overall condition of the transistor under test. Refer Table 1.

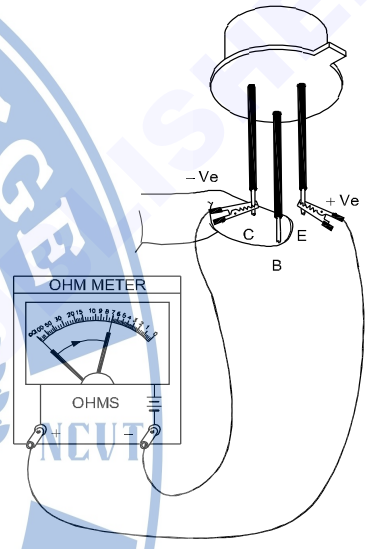
10 Repeat the steps 1 to 9 for at least five more transistors of different types.

11 Report and get your work checked by your instructor.

Fig 2



a) NPN TRANSISTOR



b) PNP TRANSISTOR

EL20N27156X2

Table 1

Resistance of P - N junction with meter prods in one direction	Resistance of P - N junction with meter in reversed direction	Condition of P - N Junction
Low	Very High	Good
Low	Low	Shorted
Very High	Very High	Open (see Note above)

Bias the transistor and determine its characteristics

Objectives: At the end of this exercise you shall be able to
- **wire up and test a fixed-bias transistor amplifier**
- **wire up and test a emitter-bias transistor amplifier**
- **wire and test a voltage divider-bias transistor amplifier**
- **draw characteristics curve with respect to base current with collector current in all conditions.**

Requirements

Tools/Equipments/Instruments

- Trainees kit - 1 No.
- DC millammeter, 0 - 1 mA - 1 No.
- DC millammeter, 0- 30 mA - 1 No.
- Regulated power supply, 12V, 1A - 1 No.
- DC micro ammeter 0 - 500 µA
- Tag board code no.110-03-TB - 1 No.
- Resistors, Carbon, 1/4 W
  - 120 Ω - 1 No.
  - 470 Ω - 1 No.
  - 1K Ω - 2 Nos
  - 5.6K Ω - 1 No.
  - 182K Ω - 1 No.
  - 330K Ω - 1 No.

Materials/Components

- SL100 or equivalent metal can transistors - 2 Nos.

PROCEDURE

TASK 1: **Wire up and test fixed bias transistor amplifier**

1 Construct the circuit (Fig 1) on the tag board. Identify the type of biasing used in Fig 1 and record in Table 1

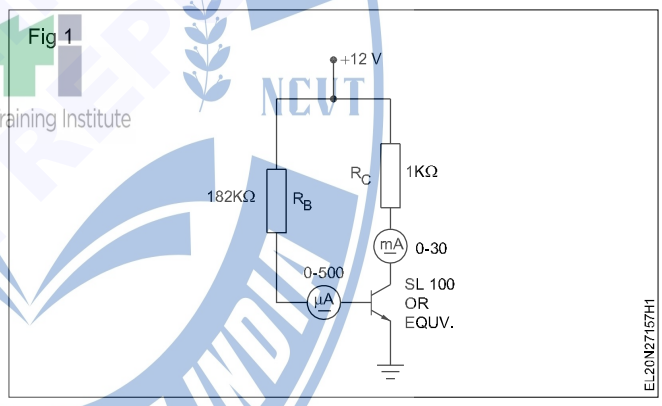
Use the transistor having low β value, (around 100)

2 Switch ON 12V, DC supply to the circuit. Measure and record values of I_B, I_C, V_{BE} and V_{CE} in Table 1.

The readings taken are at normal room temperature.

3 Hold the heated barrel of the soldering iron close to the transistor (but not touching) for 30 sec to 1 min and observe the change in the collector current. Record the changed value of I_B, I_C, V_{BE} and V_{CE} at elevated temperature of the transistor.

Fig 1



The transistor is heated to observe the effect of heat on the set Q point of the transistor.

Table 1

Fixed bias transistor amplifier

Description	I_B µA	I_C mA	V_{BE} volt	V_{CE} volt
Reading taken at room temperature				
Readings taken at elevated temperature				

4 Get your readings checked by your instructor.

5 Switch OFF, power to the circuit. Modify the wired circuit to that in Fig 2. Identify the type of biasing used in Fig 2 and record in Table 2.

6 Switch ON DC supply to the circuit. Measure and record I_B, I_C, V_{BE} and V_{CE} in Table 2.

7 Repeat step 3 and 4.

8 Switch OFF DC supply to the circuit. Modify the wired circuit to that shown in Fig 3. Identify and record the type of biasing used in Fig 3 in Table 3.

Use the transistor having low β value (around 100)

Fig 2

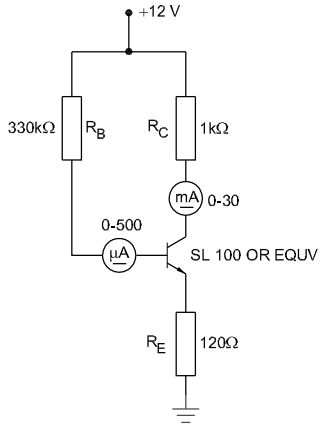


Fig 3

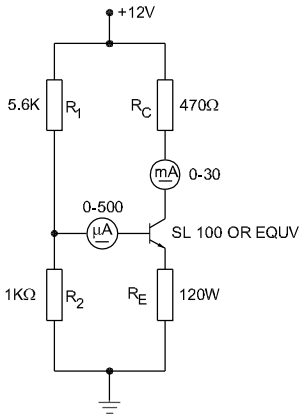


Table 2

Emitter bias transistor amplifier

Description	I_B μA	I_C mA	V_{BE} volt	V_{CE} volt
Reading taken at room temperature				
Readings taken at elevated temperature				

Table 3

Voltage divider bias transistor amplifier

Description	I_B μA	I_C mA	V_{BE} volt	V_{CE} volt
Reading taken at room temperature				
Readings taken at elevated temperature				

9 Repeat steps 2,3, and 4 and record the readings in Table 3

10 Write the conclusion based on the types of bias and stability of current value at collector and base when the circuit is heated.

11 Report and get your readings and graph checked by your instructor.

12 Draw the characteristics curve base current V_S collector current in both cases. (Room temperature and relevant temperature) in the same graph (two curves in one graph).

Use transistor as an electronic switch and series voltage regulator

Objectives: At the end of this exercise you shall be able to
- **determine the minimum forward bias current required to switch the transistor from OFF to ON condition**
- **construct transistorised series voltage regulator and test**
- **measure ripple at input and out put of the regulator and find ripple factor.**

Requirements

Tools/Instruments

- Ammeter MC - (0-100 milliamp) - 1 No.
- Ammeter MC (0-100 microamp) - 1 No.
- Voltmeter MC (0-15 V) - 1 No.
- Trainees Kit
- Unregulated DC power supply 0-30VDC/1A - 1 No.
- CRO, 20 MHz - 1 No./ batch

Equipment/Machines

- DC regulated power supply; 0-30 V 1amp - 1 No.

Materials

- Transistor BC 107 - 1 No.
- Lamp 6V, 150 mA - 1 No.
- Variable resistor 250K 1 W - 1 No.
- Bread board - 1 No.
- Connecting leads - as reqd.
- Dry cell 1.5 V - 1 No.
- Tag board (Code no. 111-01-TB) -1 No.
- Transistor SL 100 or equivalent - 1 No.
- Zener diode, 12V, 1/4W - 1 No.
- 180Ω - 1 No.
- 1KΩ - 2 Nos.
- 220 Ω - 1 No.
- 330 Ω - 1 No.
- Capacitor, 10µF, 25V - 1 No.
- LED, Red colour - 1 No.
- Hook up wires (Red and Black) each - 1 Meter
- Rosin core solder - 20 cms.

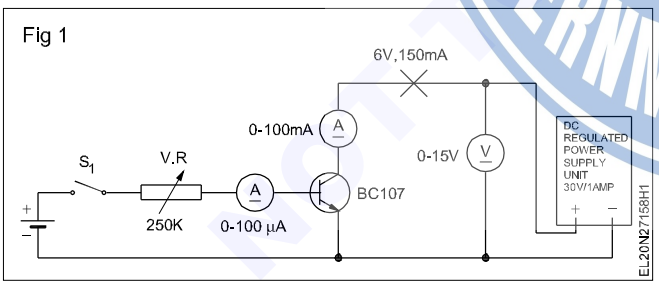
PROCEDURE

TASK 1: **Perform the using of the transistor as an electronic switch**

1 Collect the specifications from the data book for the transistor used in the circuit diagram. (Fig 1)

2 Form the circuit as per the given circuit diagram (Fig 1)

Fig 1



Check for the specific range of instruments and correct polarity.

Keep the supply OFF and the voltage knob of power supply unit at 0V.

3 Switch ON the power and set the collector supply to 10V by operating the voltage knob.

4 Switch ON the battery supply by closing the switch S_1 to the base-emitter circuit.

5 Adjust VR for base current of 5 microamps and note the collector current and record it in Table 1.

6 Change I_b to 90 microamps insteps as in the Table 1.

Table 1

Base current in micro-ampere	5	10	20	30	40	50	60	70	80	90
Collector current in milliampere										
State										

7 Check the value of I_b for which I_c has not changed, (i.e. I_c is saturated).

8 Vary the I_b base current between the two readings to find the exact value of I_b at which I_c reaches saturation.

9 Set the I_b to a value just above minimum to cause I_c saturation and check for 'ON' 'OFF' action by operating switch S_1. Switch OFF power supply.

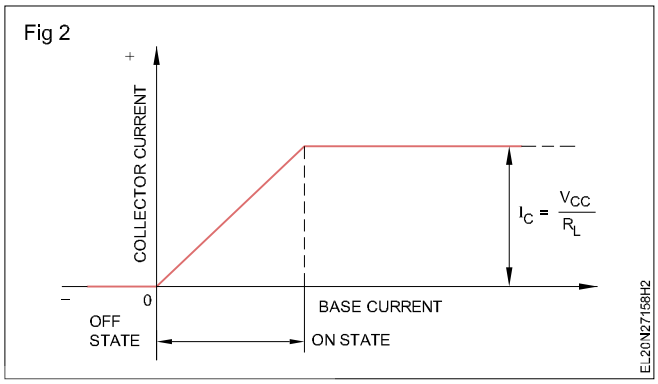
10 Connect a lamp 6V, 150mA in the collector circuit as in Fig 1 and switch 'ON' the power supply.

11 Check lamp glowing; if not slightly adjust the base current to increase till the lamp 'ON'.

12 Confirm the lamp operation by operating base current of Transistor.

13 Draw the base to the collector current graph, and mark the states of the transistor. (Fig 2)

Fig 2



TASK 2 : **Construct transistorised series voltage regulator**

1 Refer data book and record the required details of the given transistor in Table 1.

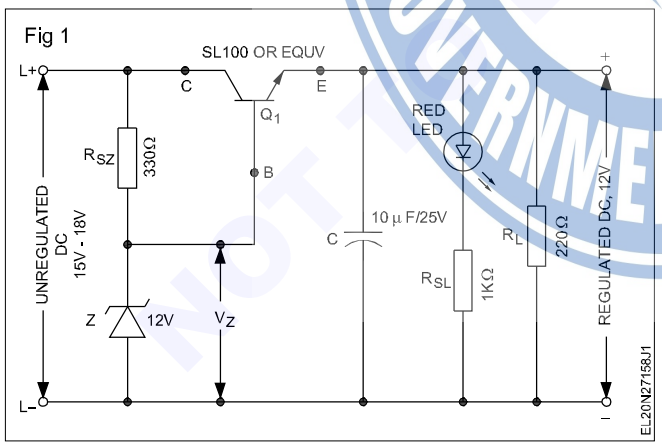
Table 1

Sl.No.	Input P.S voltage in volts	O/P P.S voltage in volts	Remarks
1	6		
2	8		
3	10		
4	12		
5	14		
6	16		

2 Test to confirm the condition of the given components.

3 Solder the components on the given Tag board as per the schematic diagram shown in Fig 1. Get the wired circuit checked by your instructor.

Fig 1



4 Connect an unregulated DC voltage of 0 - 30V to the input terminals of the wired series regulator board.

5 Get the interconnections made checked by your instructor.

6 Switch on the AC mains supply to the unregulated dc supply.

7 Measure and record the input voltage and output voltage of the series regulator.

8 Measure and record the following voltage levels in observation and tabulation sheet .

a) Voltage across zener, V_Z

b) V_{CE} of the transistor Q_1

c) V_{BE} of the transistor Q_1.

9 Keep input P.S Voltage 2V and measure O/P voltage and record in Table 1.

10 Increase the voltage steps of two and record the corresponding O/P voltage in Table 1.

11 Increase the voltage steps up to 16V and record.

Beyond 12V in the output voltage, any increase in input voltage beyond 12V, 14V or 16V will not make any change in output voltage.

12 Switch 'OFF' & Connect to the CRO to the I/P side and O/P side of P.S. (using dual trace CRO) measure and record the ripple presentation the circuit. Record it in Table 1.

13 Calculate the ripple factor in Table 1.

Operate and set the required frequency using function generator

Objectives : At the end of this exercise you shall be able to
- **identify the various controls of the function generator**
- **operate the equipment and set the required frequency and wave form**
- **measure the time and frequency of the set waveform using CRO.**

Requirements

Tools/Instruments

- 10 MHz oscilloscope dual Trace - 1 No.
- Function generator - 1 No.
- AF oscillator 20 kHz - 1 No.

Materials

- Patch cords - 1 Set.

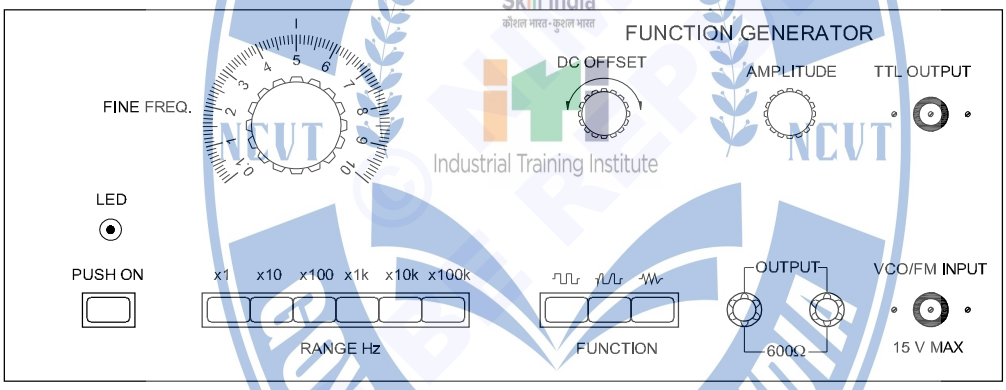
PROCEDURE

TASK 1: **Practice using of a function generator**

1 Locate the various control of the function generator on its front panel which may look like Fig 1. (Some other model have few changes)

2 Keep the amplitude adjustment knob to a minimum position.

Fig 1



FRONT PANEL OF FUNCTION GENERATOR

3 Connect B & C cable to CRO and set CRO working/ measuring conditions.

4 Using patch cords connect the output terminals of the function generator to the input terminals of the CRO. Keep both the instruments in OFF position.

5 Press the function switch to select sine wave.

6 Select 10 Kilo Hertz Range by pressing the range switch marked 'X 10 K'

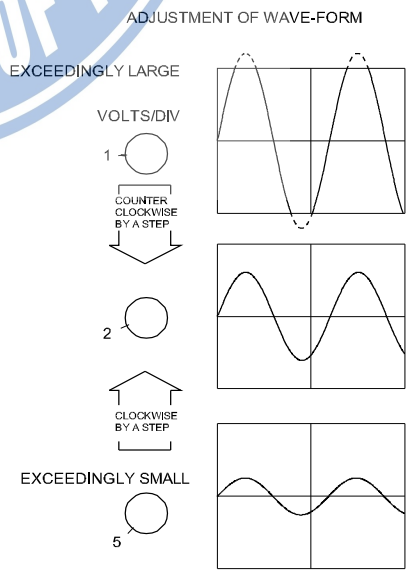
7 Keep the fine frequency dial to position 2 (Fig 1).

8 Set AC-DC switch to AC position (out) in the CRO.

9 Switch 'ON' the power of both function generator and the CRO. Adjust the trace to be on the centre of the screen.

10 Adjust the amplitude knob of the function generator and the Volts/DIV on the CRO To get a clear sine wave on the screen follow the illustration (Fig 2).

Fig 2

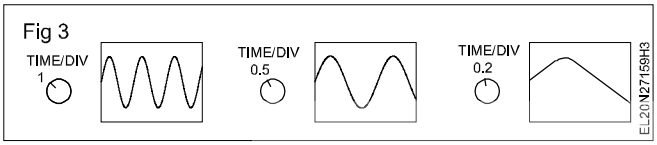


11 Adjust the TIME/DIVISION knob to get adequate number of peaks on the screen.

Relationship between TIME/DIV. (sweep time) and No. of peaks.

When the TIME/DIV. switch is turned clockwise, the time per one period of saw-tooth wave will become small and the wave-form part is stretched. (Fig 3)

Fig 3



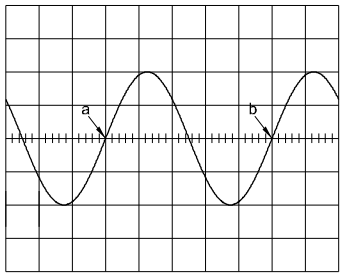
12 Adjust the X-shift control to move the start of the measurement period to a convenient reference point (intersecting point of vertical and horizontal lines). (Fig 4)

13 Check the time period of the wave form. The time between a and b can be determined by counting the no. of horizontal divisions and multiplying it with time base range.

Example

If the time base is set to 0.01 millisecond. There are 5 divisions between 'a' and 'b'.

Fig 4



therefore time period t = 5 x 0.01 = 0.05 ms

therefore frequency of the wave form

$$'f' = \frac{1}{t} = \frac{1}{0.05 \times 10^{-3}}$$

$$= 20 \text{ kHz.}$$

14 Vary the frequency range settings on the functions generator (follow the Table.1) and verify the output frequency using oscilloscope.

15 Set the function switch to some other wave (e.g. square, triangular etc.,) and repeat the steps 9 to 13 (Note to record the readings in Table 1). Only sine wave entry is needed in Table 1.

Table 1

Trial No.	Range switch position	Fine freq. dial position	Set frequency	Measured frequency using CRO	Remarks
1	x 1	10	10 Hz	—	
2	x 10	5	50 Hz	—	
3	x 100	3.5	350 Hz	—	
4	x 1K	5	5 kHz	—	
5	x 10K	0.1	1 kHz	—	
6	x 100K	2	200 kHz	—	

Make a printed circuit board for power supply

Objectives: At the end of this exercise you shall be able to
- **transfer the layout on to a copper clad board**
- **punch component mounting holes**
- **paint the pattern using etch-resist ink pen, Indian ink or enamel paint**
- **etch a painted copper clad board**
- **trace the component side pattern and make the components**
- **drill holes on the PCB**
- **rivet tags/terminals at input and output points.**

Requirements

Tools/Equipments/Instruments

- Centre punch, sharp tip - 1 No./batch
- Wooden mallet - 1 No./batch
- Trainee's Kit - 1 No./each
- Hand drill/Push-type drill gun - 1 No./batch
- Drill bit, 0.8 m - 1 No./batch
- Drill bit, 2 mm - 1 No./batch
- Bench vice/Table vice - 1 No./batch
- Wooden block (of PCB size) - 1 No./batch
- Glass rod, 30 cm long - 1 No./batch

Materials/Components

- Detergent soap powder - 10 gms.
- White cotton cloth - 1/4 mt.
- Carbon paper, A4 size - 1 No.
- Adhesive tape - as reqd.
- Etch-resist ink pen, black or Indian ink & fine brush No.6 - 1 No.
- Copper clad, 1 oz, 75 x 60 mm (Phenolic) single side - 1 No.
- Copper clad board - as reqd.
- $FeCl_3$ in liquid or powder form - 50 ml.
- Detergent soap powder - 10 gm.
- Thinner/Alcohol/Petrol - 100 ml.
- Post-type termination tags, riveting type - 4 Nos.
- Turret type termination tags, riveting type - 2 Nos.
- Carbon paper, A4 size - 1 No.
- Plastic tray, 30 cm x 15 cm aprox. - 1 No.
- Plastic hand gloves - 1 pair
- Glass rod, 30 cm - 1 No.
- Plastic table spoon, 10 ml - 1 No.
- Painting brush, fine, No. 6 - 1 No.
- Permanent marker, blue, fine tip - 1 No.

PROCEDURE

TASK 1: **Prepare the tracks on copper clad board**

1 Clean the copper side of the 75 mm x 60 mm single side copper clad board using soap and water. Dry it using a piece of cloth.

Presence of oil or dust on the clad hinders transferring of the layout on the board.

2 Take a fresh carbon paper of 85 x 70mm and fix it on the copper clad board. (Fig 1)

3 Take out the PCB circuit pattern diagram of power supply, prepared for making power supply.

4 Fix the circuit pattern over the carbon paper (fixed on the copper clad board at step-2) as in Fig 2. Get it checked by your instructor.

Use adhesive tapes at several places such that the layout drawing sheet does not slip off while tracing.

Fig 1

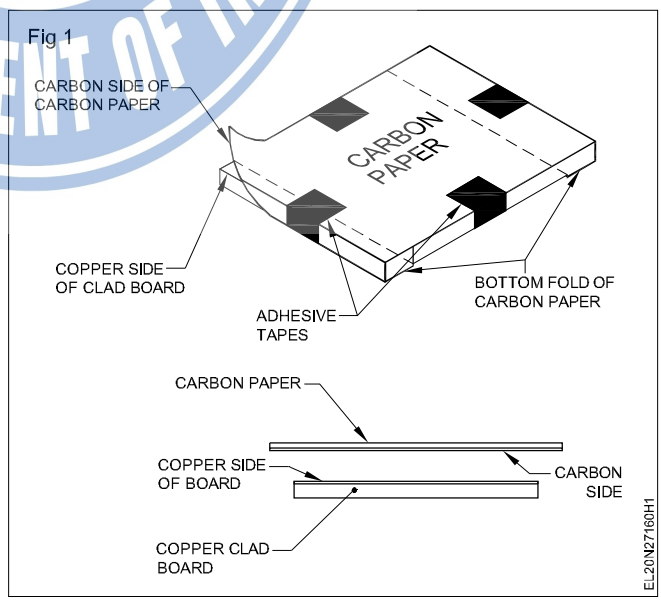
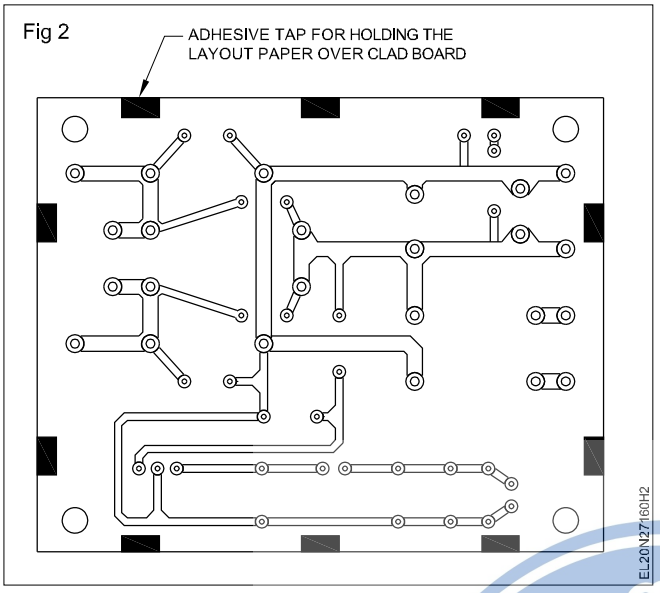


Fig 2



5 Make punch marks using a centre punch, at the centres of all inner circles and the mounting hole circles.

The punching is only to make a mark on the copper clad and not to make a hole on the clad. So, do not hit very hard.

6 Trace all the pads and connecting tracks using a 2H pencil.

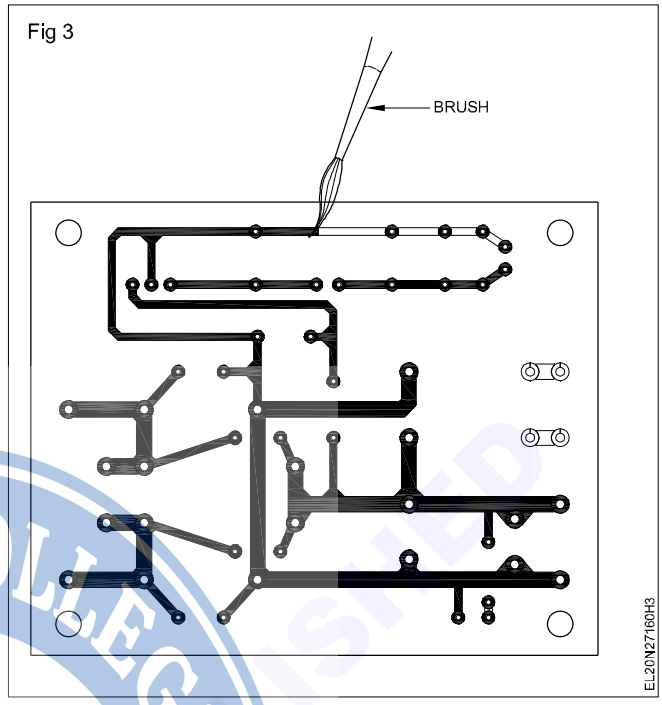
Do not use excessive force while tracing, as this may tear off both the layout and carbon paper. At the same time, do not trace with very little force as this may not transfer the pattern on the copper clad.

7 Take out both the circuit pattern diagram sheet and the carbon paper fixed on the clad.

8 Check if the all traced impression of the pattern on the copper clad is clearly visible. If not touch up using a sharp tip 2B pencil such that the impression is clearly visible.

9 Using etch-resist ink pen or a fine painting brush and Indian ink/ enamel paint, ink the pattern as in Fig 3.

Fig 3



If the ink flows slightly beyond the traced pattern circles and lines, do not try to correct it.

10 Allow the ink to dry for 5 to 10 minutes.

11 Correct the excessive paint flows outside the intended pattern by using a sharp tip knife or half shaving blade. Allow the pattern to dry up in sunlight for atleast 3 to 4 hours.

The drying period depends on the ink/paint used. Consult your instructor.

12 Get your work checked by your instructor.

TASK 2: **Etch the painted laminate board and drill holes on PCB**

1 Take about half litre of luke warm water in a plastic tray of approximately 30 cm x 15 cm.

Do not take an excessively large tray as you may have to make large quantity of etching solution which has to be thrown once the etching is completed.

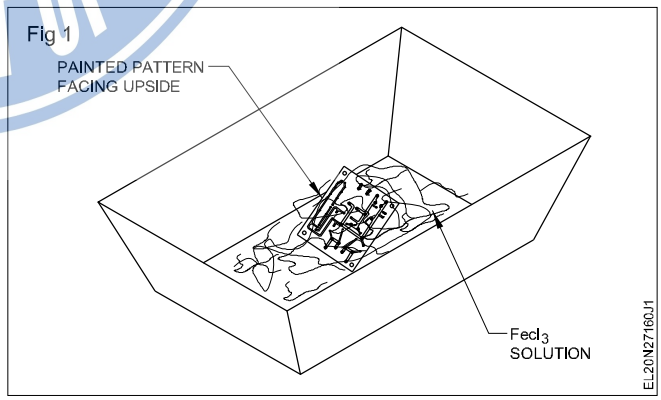
2 Put on hand gloves. Add three spoonful of $FeCl_3$ etchant to water and stir the solution using a glass rod.

$FeCl_3$ solution is injurious to bare skin.

3 Slide the painted copper clad board PCB-1 (made in Task 1) into $FeCl_3$ and water solution with the copper clad side facing upward and visible. (Fig 1)

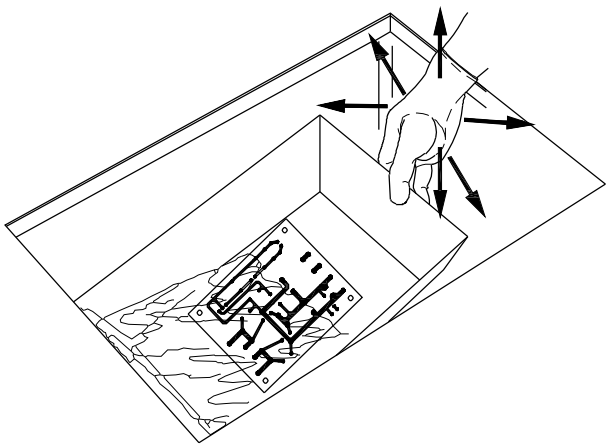
4 Move the tray up and down, left and right (Fig 2) such that the solution is agitated adequately in increasing the etching process.

Fig 1



Do not agitate the solution very fast as this may sometimes peel off the paint and etch the required patterns also.

Fig 2



EL20N27160J2

5 Repeat step 4 for 10-15 minutes and observe the unpainted portion of the copper clad getting etched OFF.

Once the etching is complete the unpainted portion of the board looks brown or the colour of the board.

6 Take out the board from the $FeCl_3$ solution and check visually if the unpainted copper is completely etched. If not, put the board back into solution and allow the board to remain in the solution for 5-10 minutes.

Depending on the concentration of the $FeCl_3$ solution, the etching time may vary from 10 to 30 minutes.

7 Take out the board from the $FeCl_3$ solution and wash the board thoroughly in running water.

8 Apply a small quantity of detergent powder and wash it again in running water.

9 Allow the board to dry in open air or by placing it in front of a fan.

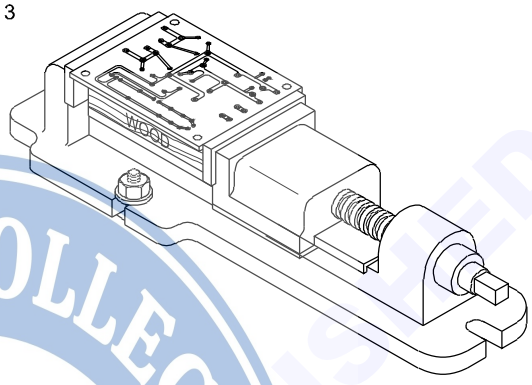
10 Using a thick brush apply thinner or alcohol or petrol on the painted side of the board and remove the ink using a dry cloth.

11 Repeat step 10 till the paint is completely removed and the copper pattern is clearly visible.

12 Wash the printed circuit board with water and dry it using a piece of cloth.

13 Fix the board with a wooden block on a vice as shown in Fig 3.

Fig 3



EL20N27160J3

14 Using a hand-drill/push-drill-gun fitted with a 0.8 mm drill bit, drill holes at the punched points at the centre of circular patterns.

Drill slowly and steadily. Careless drilling may pull the complete circular copper pattern away.

15 Drill holes at the corner mounting points by use a drill bit of 2 mm.

16 Clean the drilled board from burn and other dirt using cloth or a brush.

17 Get your work checked by your instructor.

Construct simple circuits containing UJT for triggering and FET as an amplifier

Objectives: At the end of this exercise you shall be able to
- **construct UJT relaxation oscillator for triggering and test**
- **identify the terminals with specification of JFET and test a N-channel JFET**
- **construct an AC voltage amplifier using JFET and find the gain**
- **plot the graph of gain of the amplifier at different frequencies.**

Requirements

Tools/Equipments/Instruments

- Trainee tool kit - 1 No.
- Dual channel oscilloscope 20 MHZ - 1 No.
- Power supply unit 0-30V 2A variable - 1 No.
- Function generator 2 to 200Hz - 1 No.

Materials/Components

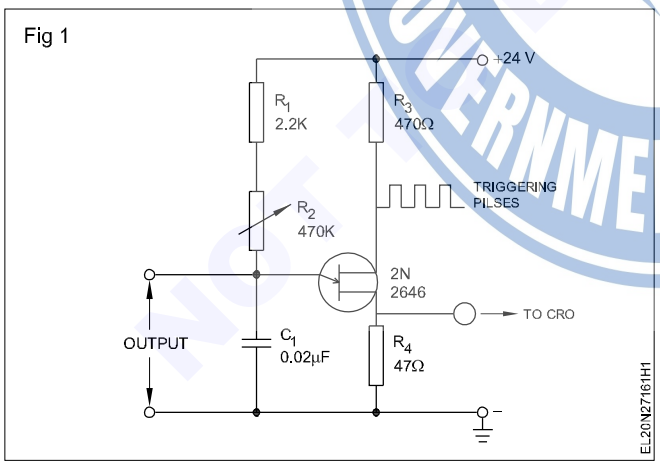
- General purpose PCB (4 x 8)cm - 1 No.
- UJT 2N2646 - 1 No.
- Carbon resistors - 1/4 watt
  47Ω - 1 No.
  470Ω - 1 No.
  2.2 KΩ, 470 KΩ - 1 No.
- Potentiometer 1/2 w, 470 KΩ - 1 No.
- Capacitor 0.02 µf, 25V - 1 No.
- Hookup wires - as reqd.
- Solder - as reqd.
- Assorted types of N-channel, JFET (JFET - BF 245 B/BFW 10) - 4 Nos.
- Sleeves - Red, Green, Yellow, Black (2 cm length each) - 4 Nos.
- Capacitors : 5.6 ηF -Disc type - 1 No.
  270 ηF - 1 No.
  6.8 µF/24V electrolyte - 1 No.
- Resistors - Carbon Film - 1/4 W
  1MΩ, 47KΩ, 10KΩ, 12 KΩ - 1 No. each

PROCEDURE

TASK 1: **Construct UJT relaxation oscillator for triggering and test it**

1 Assemble the relaxation oscillator on the general purpose PCB by referring the circuit diagram (Fig 1)

Fig 1



2 Get the wired oscillator checked by your instructor.

3 Energise the circuit with the stipulated DC.

4 Check the triggering pulses by using CRO between emitter and base and sketch these wave forms in Table 1.

5 Calculate the frequency from the reading taken at Table 1 and apply formulae given below. Keep the potentiometer at minimum, maximum and middle position, record the details of wave forms on Table 1.

Frequency = 1/t where 't' is the time period in seconds.

Time period (Condition 1) t = when C = 0.02 µFD and R_2 is at one extreme end (R_2 = 0)

Time seconds = (R_1 + R_2) x C

where R_1 & R_2 are in ohms

C in Farad

R_1 = 2K2 ohms and R_2 = 470 K ohms variable

Value of R_2 at middle = 235 K ohms

R_2 at other end = 470 K ohms

6 Get the work checked by your instructor.

Table 1

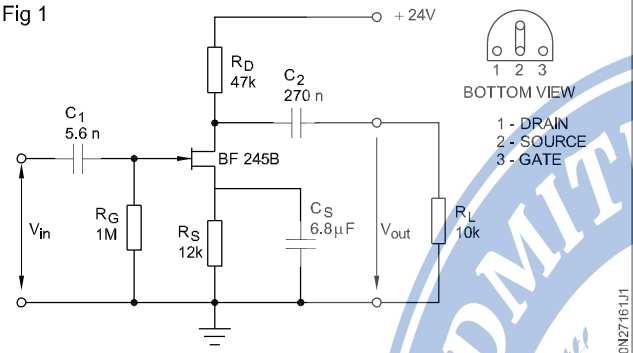
Sl. No.	Waveform at the output terminals	Amplitude	't' time period	Frequency
1	POT at one extreme end			
2	POT at middle position			
3	POT at other extreme end			

— — — — — — — —

TASK 2 : **Construct and test an AC/FET amplifier and plot the graph**

1 Refer Fig 1 and construct an AC voltage amplifier using a N-channel FET.

Fig 1



Construct the circuit on a bread board or on a GPCB. If you are wiring the circuit on a GPCB use base for the FET to ensure that it does not get damaged.

2 Get the wired circuit checked by your instructor.

3 Power ON wired circuit. Feed input, at 10 kHz and level from 1mV to 1V in steps of 100mV. Measure the corresponding output levels by using CRO and record in Table 1.

4 From the recorded readings at step 3, calculate and record gain of the amplifier.

5 Get the recorded readings checked by your instructor.

6 Calculate the gain of the amplifier with an input of 400 mV at frequencies 40 KHz, 80 KHz, 100 KHz, 120 KHz and at 150 KHz in Table 2.

7 Get the work checked by your instructor.

Table 1

Input frequency : 10 KHZ			Gain = $\frac{\text{Output voltage}}{\text{Input voltage}}$
Sl. No.	Input voltage	Output voltage	
1	100 mV		
2	200 mV		
3	300 mV		
4	400 mV		
5	500 mV		
6	600 mV		
7	700 mV		
8	800 mV		
9	900 mV		
10	1V		

Table 2

Input volt / Frequency kHz	Gain = $\frac{\text{Output voltage}}{\text{Input voltage}}$
40	
80	
100	
120	
150	

8 Plot the graph input/output voltage vs gain as in the first case and frequency vs gain in the second case.

9 Get the graph approved by instructor.

— — — — — — — —

Troubleshoot defects in simple power supplies

Objectives: At the end of this exercise you shall be able to
- **carry out step-by-step troubleshooting of a power supply having bridge rectifier and capacitor filter**
- **carry out a short cut method of troubleshooting of the power supply through problem tree and service flow diagram.**

Requirements

Tools/Equipments/Instruments
- Trainees kit - 1 No.

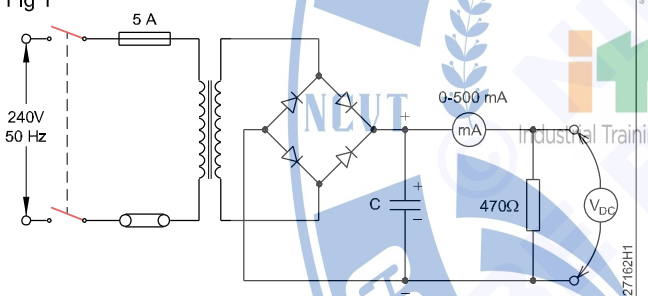
Materials/Components
- Bridge rectifier power supply circuit with filter - 1 No.
- Spare components - as reqd.

PROCEDURE

TASK 1 : **Troubleshoot defects in bridge rectifier power supply**

1 In the given power supply board, refer Fig 1. Check for any one of the physical defects listed below; Record the observed defect(s) in Table 1. Service the defect(s).

Fig 1



POWER SUPPLY HAVING BRIDGE RECTIFIER AND FILTER CAPACITOR

– Loose/open wire connections.

– Loose/open component lead connections.

– Dry solder points.

– Shorting of terminals due to solder spray or bad skinning/bending of wire ends or component leads.

2 Trace the circuit wiring and check the correctness of the following.

– Polarity of diodes

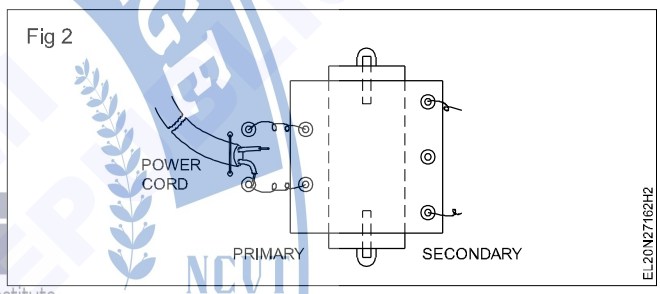
– Polarity of polarized capacitors.

Correct the polarities if found defective and record the defect observed and polarity corrected in Table 1.

3 Open one of the wire ends of the power cord connected to the power supply. (Fig 2)

This will disconnect the transformer primary from the power cord.

Fig 2



4 Using a continuity tester, check the power cord for any one of the following defects and record the defect observed if any;

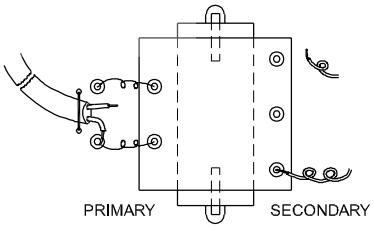
– Open or shorted wires in the plug.

– Open or shorted wires in the 2-core cable.

5 Check the continuity of transformer primary winding. If found open or short the coils record defect.

6 Remove the wires soldered at the secondary winding terminals of the transformer (Fig 3).Check the continuity of the secondary windings. Record your observation.

Fig 3

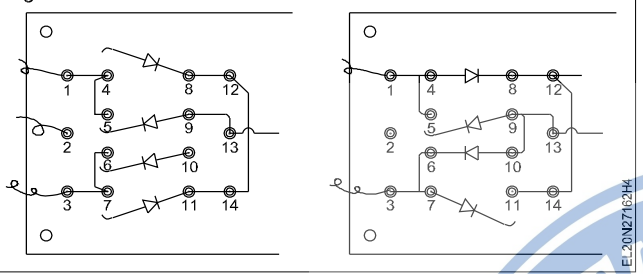


7 Open one lead of each diode (Fig 4). Check the condition of the diodes. Record your observation in Table 1.

Table 1

Sl.No.	Name of the defective component	Nature of defect observed	Specification the component to be replaced	Equivalents, if any, for the components to be replaced	Specification of the component to be replaced
Sample	Soldered point	Dry solder	.....	.....	De-soldered

Fig 4



8 Open one of the leads of the capacitor. Check the condition of the filter capacitor by carrying out the capacitor action test. Record your observation in Table 1.

9 Check the condition of the bleeder/load resistor. Record your observations in Table 1.

10 Get the defects recorded in steps above, checked by your instructor. Get his approval to replace the components found defective.

11 Collect and test the new components to replace the identified defective components.

12 Replace the defective components with the new components and solder back all connections opened while testing.

13 Connect serviced power supply to AC mains and switch ON mains supply. Check and record the output condition in Table 2 under the heading final condition after servicing.

If there is no output from the PSU even after carrying out the laid procedure of servicing, consult your instructor.

The output may have problems other than the one for which it is serviced. Record the problem as it is observed.

14 Get the work checked by your instructor.

Final condition of power supply after servicing

a) Output voltage level

b) Ripple voltage $V_{r(p-p)}$ in output DC

— — — — — — — —

TASK 2 : **Troubleshoot defects in power supply using shortcut/logical approach method**

1 Switch 'ON' the given defective power supply unit and record the identified defect in record sheet.

2 Refer the problem tree corresponding to the identified defect.

3 Refer the service flow sequence (SFS-1) or (SFS-2) depending on the identified defect of power supply. Follow the logical sequence to service the defective power supply.

4 Record the identified component defects and remedial measure taken in Table 1 of record sheet.

Whenever any component is found defective, record its type, cause of defect and other details in the Table 1 of record sheet.

Whenever any component is replaced, record the specification of the replaced component in Table 1 of the record sheet.

5 Get your work checked by your instructor.

6 Final condition of power supply after servicing.

a) Output voltage level :

b) Ripple voltage $V_{r(p-p)}$ in output DC :

7 Refer service flow chart 1 & 2 and follow the sequence of approach.

8 Interpret the problem Tree-Chart 1 & 2 (PTC-1 & PTC -2) and locate the exact fault / repair.

Table 1

Sl. No.	Name of the defective component	Nature of defect observed	Possible cause(s) of the defect	Specification of the component to be replaced	Equivalents, if any, for the components replaced	Specification of the component replaced

— — — — — — — —

Construct power control circuit by SCR, DIAC, TRIAC and IGBT

Objectives: At the end of this exercise you shall be able to
- **assemble and test a lamp dimmer-cum-fan speed regulator using TRIAC and DIAC**
- **construct and test a power control circuit using SCR**
- **construct and test a power control circuit using IGBT.**

Requirements

Tools/Instruments/Equipments

- Soldering iron - 25W/240V - 1 No.
- Trainees tool kit - 1 No.
- Lamp load (60 watts 240V) - 1 No.
- Table fan, 80 watts 240V - 1 No.
- Hand drilling machine with bit (8mm) - 1 No.
- Universal motor 500W/240V - 1 No.

Materials

- Triggering pulse module for pulse generator - 1 No.
- Printed circuit board - 1 No.
- Resistors
  – 180 ohms 1w ±5% - 1 No
  – 4K7 12 w 5% - 1 No
  – 470 K Ohms 1/4w 5% - 1 No.
- Potentiometer linear 250K, 16 mm plastic shaft - 1 No.
- Capacitor 0.1 µF 415 Volts - 4 Nos.
- Solder (Resin) 60:40 - as reqd.
- Soldering flux (Resin) 60:40 - as reqd.
- IGBT - HGTG 12N 60- (pack) - 1 No.
- General purpose PCB - 1 No.
- TRIAC BT 136 or equivalent - 1 No.
- DIAC D3202 or equivalent - 1 No.
- Inductor (25 SWG, 40 turns on 10mm ferrite rod with former made of leatheroid paper) - 1 No.
- Resistors - 10K, 2W - 1 No.
  470 Ω - 1 No.
  1 KΩ - 2 Nos.
- Pot Meters, 1KΩ, 1W - 1 No.
- Capacitors - 2.2 K PF Disc - 1 No.
  100 PF
- SCR - C 106D or equivalent - 1 No
- Transistor - BD 135 - 1 No.
  BD 136 - 1 No.
- Diode - 1 N 4007 - 6 Nos.
- Connecting cables - 1sq.mm/650V - as reqd.

PROCEDURE

TASK 1: **Construct power control circuit using TRIAC and DIAC**

1 Clean the Printed Circuit Board (PCB). Check the circuit components and confirm their working condition.

2 Assemble the control circuit referring to the circuit schematic diagram shown in Fig 1a & 1b and PCB layout diagram. (Fig 2)

Use multi strand flexible insulated wire for these connections as these wires will carry A.C mains voltage and large current of the order of a few hundred milli amperes.

3 Keep the PCB on any insulated material. Keep the Potentiometer (POT) in mid position. Put AC mains Single Pole Single Throw (SPST) switch mounted on the gang box to 'OFF'.

4 Connect a test lamp at the mains output socket (mounted on the gang box).

5 Connect AC mains supply to the wired circuit. Put the SPST switch mounted on the gang box to ON. Check if the lamp glows.

Fig 1

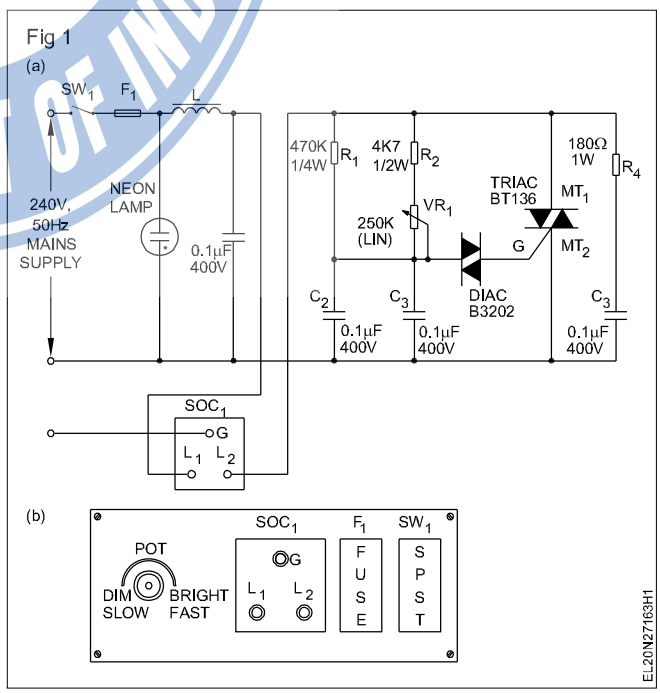
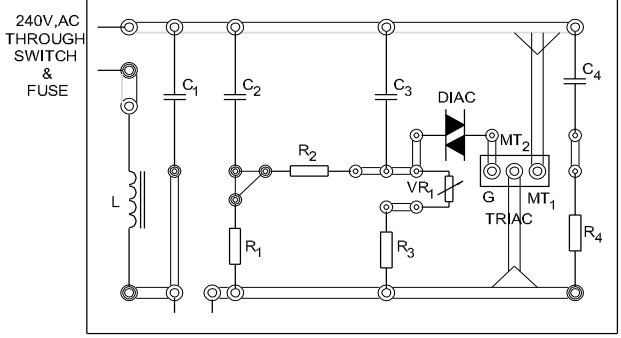


Fig 2



COMPONENT SIDE LAYOUT

EL20N27163H2

If the lamp is not glowing, switch off mains supply and consult your instructor.

6 Vary POT position such that, the light intensity of the output lamp gradually decreases and becomes minimum/zero. Record the status of the lamp intensity at one extreme position of the POT. (Refer Table 1)

Table 1

Status of the lamp intensity when the POT (VR_1) is at one extreme position _____
Light intensity may be recorded as very dim, off or such

TASK 2: **Construct power control circuit using Silicon Controlled Rectifier (SCR)**

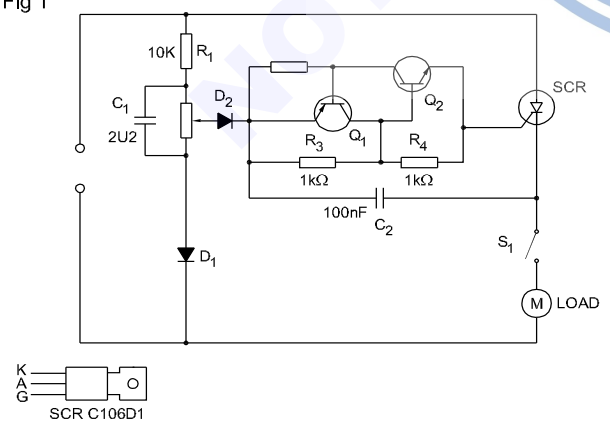
1 Prepare a PCB for the given dimensions. Check the sizes of the components with the soldering position on the PCB. If necessary slightly alter the dimensions of the PCB track.

2 Check the PCB tracks and clean PCB.

3 Test the components to confirm its working condition.

4 Wire the power control circuit on the PCB referring to the circuit schematic (Fig 1) and the PCB layout diagram. Get the wired circuit checked by your instructor.

Fig 1



CIRCUIT DIAGRAM OF THE DRILL POWER CONTROLLER

EL20N27163J1

7 Increase the intensity of lamp gradually by turning the POT from minimum position to maximum position. Check and record the light intensity at other extreme position of the POT. (Refer Table 2)

Table 2

Status of the lamp intensity when the POT VR,is at other extreme position _____
Light intensity may be recorded as very dim, off or such

8 Repeat steps 6 and 7 a few more times to confirm that the wired lamp dimmer circuit is working satisfactorily. Get it checked by your instructor.

9 Remove the lamp load connected at the controlled output of the lamp dimmer circuit. Connect a table fan to the controlled AC output of the wired circuit.

10 Switch 'ON' AC mains supply to the circuit. Vary the POT from one end to the other. Observe and record the speed of the fan at minimum, middle and maximum position of the POT.

The Lamp dimmer-cum-fan speed controller is a very versatile and very useful gadget. You can make use of this project constructed for any useful purpose and assembled in a suitable box with all mandatory control and protecting devices.

11 Get your work checked by your instructor.

5 Using suitable wires make connections for the POT, switch, 6A flush type socket, 3 core cable mains 3-pin top with the wired circuit on PCB. Get the wiring checked by your instructor.

The wire connections made is to test the wired power control circuit. Keep sufficient wire lengths in all connections made for the purpose of safety and ease of testing.

6 Test the working of wired circuit by connecting a test lamp load at the output of the speed controller circuit. Find the lamp glow bringing the two extreme positions of the speed.

7 Test the speed controller using table fan as load and record your observation.

8 Assemble the PCB and other associated items, so that the wired speed controller is ready for use. Get it checked by your instructor.

This wired circuit can be effectively used for a control circuit to use for any speed control purpose. Kept in a box with all mandatory controlling and protecting devices.

9 Get your work and recorded readings checked by your instructor.

The wired and tested universal speed controller can be effectively used for any practical applications. So, preserve the project work made and use it whenever required.

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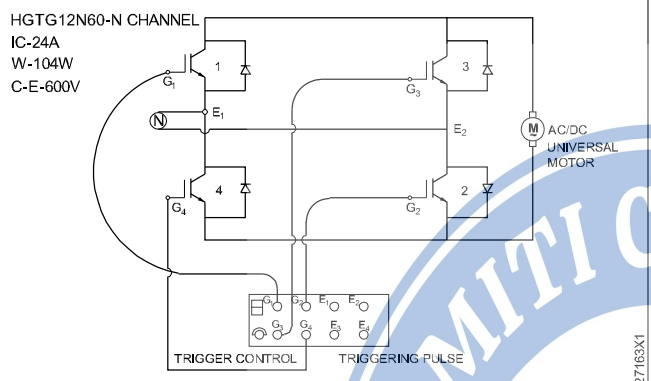
TASK 3: **Construct power control circuit using Insulated Gate Bipolar Transistor (IGBT)**

1 Wire the circuit as per the diagram. (Fig 1)

Fig 1



UNIVERSAL MOTOR CONTROL USING IGBT

Solder the components on a general purpose PCB and connect the cables for connection.

2 Set the input AC single phase supply to 120V and connect to the supply points E_1 & E_2 through a various.

3 Switch 'ON' the triggering pulse generator and set the pulse control minimum position.

4 Switch 'ON' the variac.

5 Increase the triggering pulse control to rotate the AC/DC motor.

Universal motor rotates slowly with abnormal sound.

6 Switch 'OFF' both the control circuit and triggering pulse circuit.

7 Set the variac voltage 240V and switch 'ON' the triggering pulse.

8 Reduce the speed by controlling trigger control knob. If motor rotates with high speed.

Switch OFF both the circuits. Universal motor not allow to run without load.

Ensure the motor rpm varies as per the variation of trigger pulse control.

9 Get it checked with your instructor.

— — — — — — — —

Construct variable DC stabilized power supply using IC

Objectives: At the end of this exercise you shall be able to
- **construct and test a variable IC regulated power supply**
- **test the voltage regulation at various load and ripple rejection.**

Requirements

Tools/Equipments/Instruments

- Trainees kit - 1 No.
- Soldering iron 25W/250V - 1 No.
- Digital multimeter - 1 No.

Materials

- General purpose PCB - 1 No.
- Step down transformer, 240 V : 24 V, 12-0-12, 24VA - 1 No.
- Diodes, 1N4002 or BY127 or equivalent - 6 Nos.
- Capacitors
  2200 µF, 50V, electrolytic - 1 No.
  25 µF, 50V, electrolytic - 1 No.
  10 µF, 50V, electrolytic - 1 No.
  100 µF, ceramic disc - 1 No.
- LED, Red - 1 No.
- Resistors
  4K7, potentiometer, carbon, rotary - 1 No.
  2K2, carbon, 1/2W - 1 No.
  220W, carbon, 1/4W - 1 No.
- 3-terminal voltage regulator, LM317T, To - 220 package - 1 No.
- 1A, slow blow fuse with fuse holder - 1 No.
- Hook up wires - as reqd.
- Resin cored solder - 20 cms.
- Heat sink for TO-220 package - 1 No.
- Rheostat 100Ω 1 A - 1 No.

PROCEDURE

1 Test all the components to confirm their good working condition. Record the specifications of IC LM317T.

2 Check the given general purpose PCB for the following defects and correct them or take a new board;
- Broken tracks
- Joined tracks
- Closed holes

3 Clean the copper side of the PCB using alcohol or other cleaning agents. Wash, wipe and dry the PCB.

4 Construct a variable regulated output power supply on the given general purpose PCB, referring to the circuit schematic shown in Fig 1.

All components except the transformer to be mounted on GEN-PCB. Use suitable heat sink with IC 317 T.

Note : Solder all components except the fuse and transformer on the given PCB

5 Get the correctness and neatness of wiring checked by your instructor.

6 Connect the secondary of (240:24V) transformer to the wired circuit. Switch ON mains supply.

Switch OFF main supply immediately if burning, smoking overheating, sparks are observed in any of the components, and report to your instructor. Check the IC and ensure that it is not heated-up.

7 Measure and record the unregulated dc input and the minimum, maximum variable voltage of the regulator under no-load condition.

8 Set the output to +15 volts and load the output using a loading rheostat in steps of 200 mA up to 600 mA. In each step measure and record the output voltage and the ripple voltages.

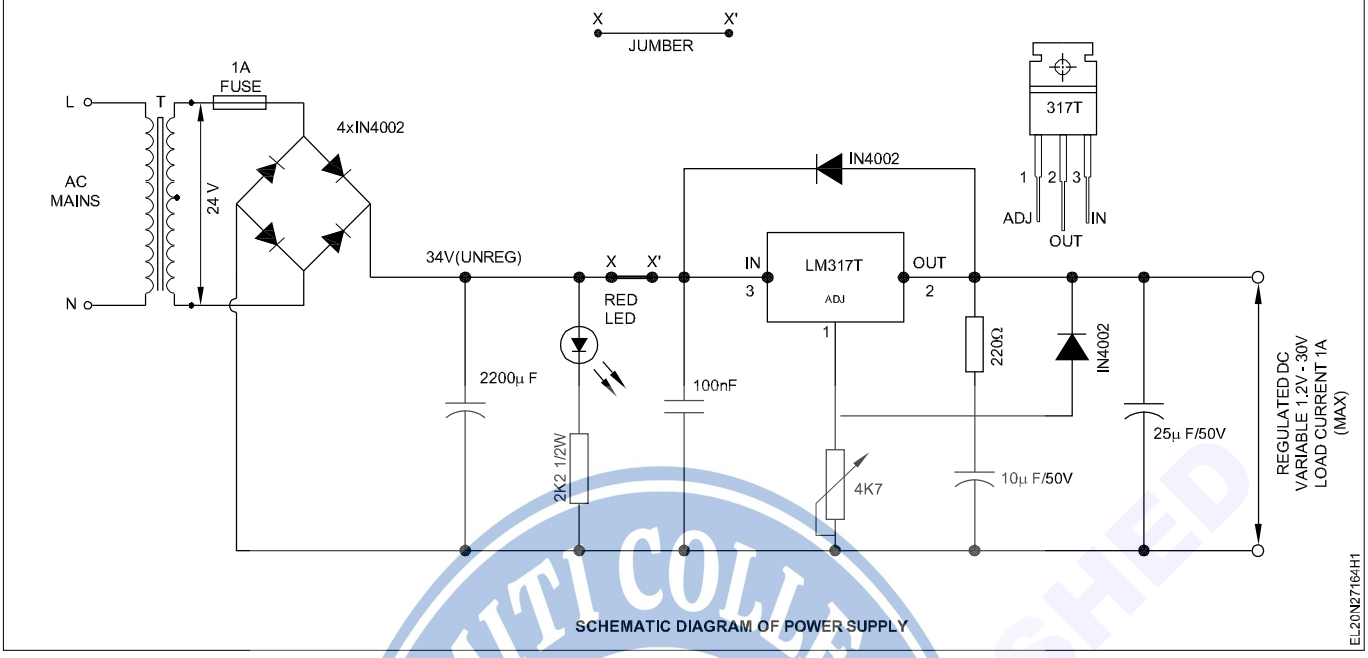
Load current is restricted to 600mA as heat-sink is provided to the IC may not be the ideal one.

9 Calculate and record the output regulation and ripple rejection of the regulator.

10 Short the load terminals momentarily by using a DC current meter (0-1A range) and record the short circuit fold back protection current level.

11 Get the readings checked by your instructor.

Fig 1



SCHEMATIC DIAGRAM OF POWER SUPPLY

Observation & tabulation sheet

1 Specification of the given 3-terminal regulator IC

Type number	Package type	Output voltage		Max. output current
		Min.	Max.	

Practice on various logics by use of logic gates and circuits

Objectives: At the end of this exercise you shall be able to
- **construct an OR gate using lamp and switches and verify its truth table**
- **construct an OR gate using IC-7432 and verify its truth table**
- **construct AND gate using lamps and switches**
- **construct AND gate using IC-7408 and verify its truth table**
- **construct NOT gate and verify truth table using transistor.**
- **construct NOT gate using IC 7404 and verify its truth table.**

Requirements

Tools/Equipments/Instruments/Materials

- Trainees kit - 1 No.
- Regulated DC power supply unit 5V/500mA - 1 No.
- DC voltmeter (MC) 0-10V/multimeter - 1 No.
- Data Manual - 1 No.
- Digital IC tester - 1 No.

Materials/Components

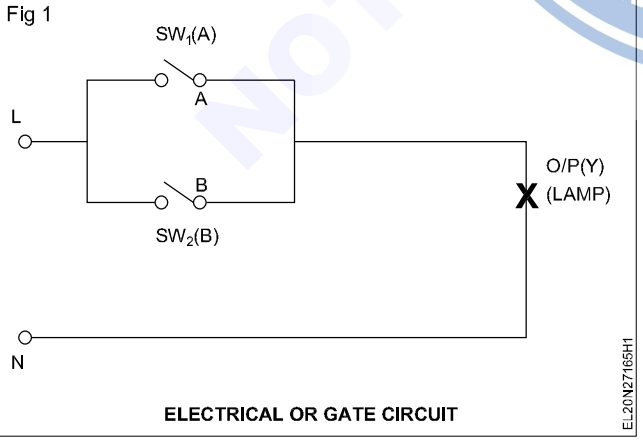
- Single pole switch any type/ Toggle switch 240V/6A - 2 Nos.
- Lamp - 250V/100W - 1 No.
- LED, Red (5mm) - 2 Nos.
- ICs
  7408 QUAD AND gate - 1 No.
  7432 - 1 No.
- Connecting wires - as reqd.
- Solder, flux - as reqd.
- IC base, 14 pin - 2 Nos.
- DC power supply 5V - 1 No.
- SPDT switches (miniature toggle) - 2 Nos.
- General purpose IC test board/Pin Board - 1 No.
- Transistor BC 147 - 1 No.
- Resistors, carbon film, 1/4w
  1KW - 2 Nos.
  330W - 2 Nos.
- LED (t5mm)
  Green - 2 Nos.
- IC 7404 (Hex inverter) - 1 No.
- IC 4049 (Hex inverter) - 1 No.
- IC base 14-pin - 2 Nos.
- Hookup wire
  Red 50cm - as reqd.
  Black 50 as reqd.cm - as reqd.

PROCEDURE

TASK 1: **Construct an OR gate using two switches with lamp and verify its truth table**

1 Refer Fig 1 and wire an OR gate circuit on a test board/pin board.

Fig 1



ELECTRICAL OR GATE CIRCUIT

2 Apply logic level inputs to A and B of the circuit as given in Table 1. Record the output lamp condition in each case and verify its truth table.

3 Get the recorded readings checked by your instructor.

Table 1

Truth table of OR-gate using switches and lamp

Logic input		Logic output
A SW1	**B SW2**	**Y = A + B lamp**
0	0	
0	1	
1	0	
1	1	

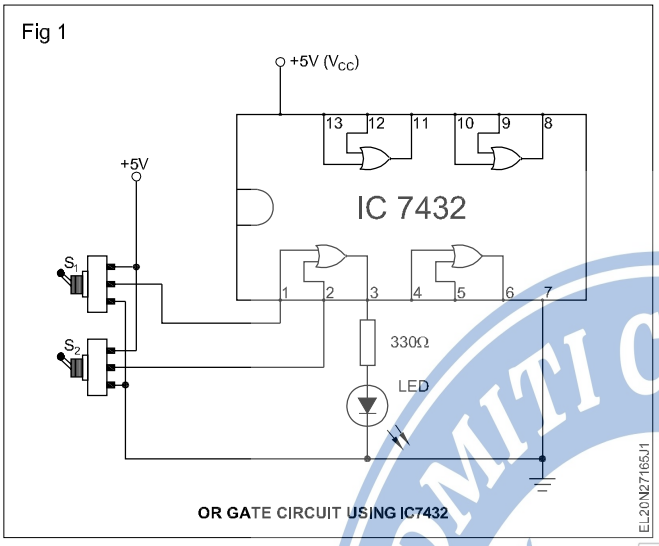
TASK 2 : **Construct a Quad two input OR gate using IC-7432**

1 Record the details of the given IC-7432 in Table 1 of record sheet referring to data manual.

2 Insert the IC-7432 into the IC base of the general purpose IC test board.

3 Make other circuit connections to the IC in Fig 1.

Fig 1



4 Set switches SW_1 and SW_2 to apply input logic levels as in Table 3 to the first OR gate (Fig 1). Record the output logic level and verify its truth Table 2.

5 Repeat step 4 for the other three OR gates of the IC.

6 Write your conclusion about the condition of each OR gate in Table 3 based on the recorded output of gates.

7 Get the recorded readings checked up by your instructor.

Disconnect connections made at input and output of the gates. Allow the IC 7432 to remain plugged on the board for subsequent tasks.

Table 2

Truth table of OR-gate using IC7432

Logic Input		Output logic at Pin No.			
A	B	3 Gate-1	6 Gate-2	8 Gate-3	11 Gate-4
0	0				
0	1				
1	0				
1	1				
Condition of gate in the IC :					

Table 1

I.C No.	Type of package	Total no. of pins	Input voltage		Output voltage		V_{CC}/V_{DD}		Status	Temperature of IC range
			Logic- 0	Logic- 1	Logic- 0	Logic - 1	max.	min.		
7432										
7402										

TASK 3 : **Construct AND gate using two switches with lamp and verify its truth table**

1 Refer Fig 1 and construct the AND gate circuit using on a board switches and lamp test.

2 Get wired circuit checked by your instructor.

3 Apply different logic levels to the inputs A & B as given in Table 4 . Record the corresponding output logic level and lamp status.

4 Get the work checked by your instructor.

Fig 1

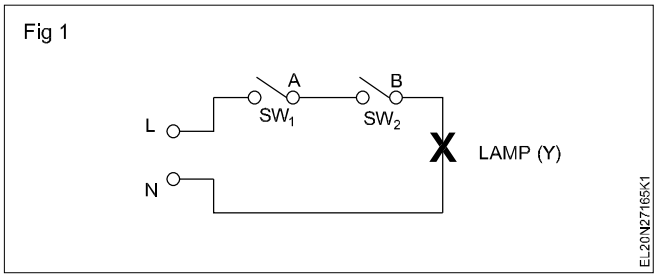


Table 1

Truth table of AND gate using switches and lamp

Input		Output				
Logic level		Equivalent voltage level given as inputs		Logic level	Voltage level	LED status (ON/OFF)
A	B	A	B			
0	0					
0	1					
1	0					
1	1					
open	open					

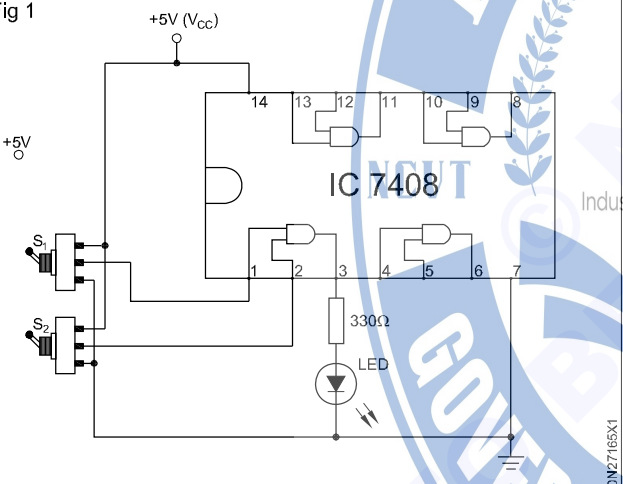
TASK 4 : **Construct and test an AND gate using IC (7408)**

1 Make circuit connections (Fig 1) using IC 7408 (AND).

2 Apply different logic levels to the inputs A and B to gate-1 (between pins 1 & 2) and record output (pin 3).

3 Repeat step 2 for the other AND gates in the IC 7408 by suitably modifying the circuit at input & output.

Fig 1



AND GATE CIRCUIT USING IC7408

4 Conclude the condition of the IC in sheet after verifying truth table at Table 1.

5 Get the work checked by your instructor.

Table 1

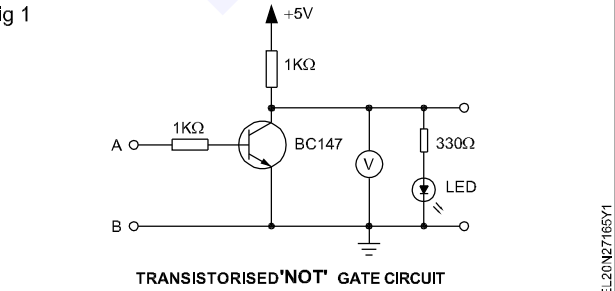
Truth table of AND gate IC-7408

Input		Output Y = A·B			
Logic level		Y_1 (pin 3)	Y_2 (pin 6)	Y_3 (pin 8)	Y_4 (pin 11)
A	B				
0	0				
0	1				
1	0				
1	1				
Condition of gate					

TASK 5 : **Construct a NOT gate using discrete components and verify its truth table**

1 Construct the NOT gate using discrete components as shown in Fig 1 on the general purpose PCB. Get it checked by your instructor.

Fig 1



TRANSISTORISED 'NOT' GATE CIRCUIT

2 Power ON the circuit, by applying 5V Fig 1. Apply logic level-0 to the input (see note below) and record the voltmeter reading, its equivalent logic level and the status of LED.

When the input terminal of the circuit is grounded, it is equivalent to applying logic 0. Note that keeping input terminals open is not equal to logic 0 level.

3 Apply logic level-1 to the input (see note below) and record the voltmeter reading, its equivalent logic level and the status of LED.

When the input of the circuit is connected to +5V, it is equivalent to applying logic 1.

4 Repeat steps 3 & 4 a few times to confirm the recorded values and to have a clear understanding of the logic levels and concept of inversion logic.

5 Get the working of the NOT gate and confirm the recorded readings (Table 1) checked by your instructor.

Table 1

Input		Output		
Logic level	Voltage level	Logic level	Voltage level	LED status ON/OFF

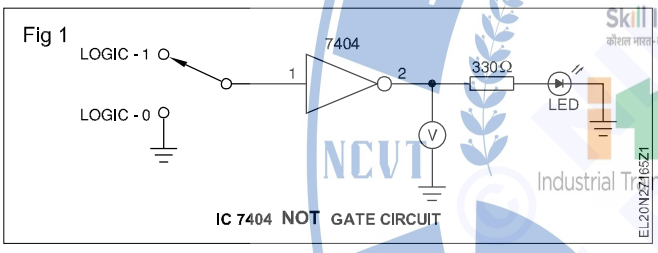
TASK 6 : **Verify the truth table of a Transistor-Transistor Logic (TTL) NOT gate IC 7404**

1 Record the following details for the given IC 7404.

- Manufacturer's name
- IC number
- Type of package
- IC family type
- Internal connection diagram with pin numbers.

Referring to Fig 1 of exercise and IC data book, note down the following readings in Table- 6

Fig 1



2 Construct the NOT gate test circuit shown in Fig 1 on the general purpose IC test board/pin board. Get the constructed circuit checked by your instructor.

3 Insert the IC in the IC base of the wired circuit. Make sure IC inserted as per circuit.

4 Switch on the DC supply (+ 5V) to the wired circuit and check if the IC is getting excessively heated-up. If the IC is getting heated up, switch-off power supply and consult your instructor.

5 Measure voltage level at V_{CC} and GND pins at the IC to confirm that supply is reaching the IC.

6 Apply Logic 0 (Low/Ground/ 0 volt) to the input of the inverter 1 of wired IC NOT circuit. Record the output voltage, corresponding logic level and status of LED.

7 Give logic 1 (High/+ 5V) at the input of the same inverter and record the outputs as done in step 8.

8 Get the recorded readings checked by your instructor.

9 Modify the wiring of the circuit to test the next NOT gate between pins 3 & 4. Get it checked by your instructor.

10 Repeat steps 8, 9 and 11 to test other NOT gates of the IC.

If any gate is found to be defective, record it and consult your instructor.

11 Get your work checked by your instructor.

Do not dismantle the circuit. This is required for next exercise.

12 Repeat steps 1 to 11 for the CMOS NOT gate IC, CD4079 following the instructions given below;

- Construct the circuit in a different place on the same board.
- After setting up the circuit get it checked before proceeding further.
- Use 12 volts DC for V_{CC}.
- For CMOS ICs, Logic-1 can be equal to V_{CC}.

The minimum logic-HIGH input voltage should be = 2/3 V_{CC}. and, maximum logic-LOW input voltage can be = 1/3 V_{CC}.

13 Get the work checked by your instructor.

Generate and demonstrate wave shapes for voltage and current of rectifier, single stage amplifier and oscillator, using CRO

Objectives: At the end of this exercise you shall be able to
- **construct a bridge rectifier test the output wave form**
- **test the wave shape without RC filter and with filter and calculate ripple factor**
- **test the wave shapes of a common smith amplifiers and distinguish with the input & output waves**
- **test the hartley oscillator output wave shape and identify the frequency.**

Requirements

Tools/Instruments

- Trainees kit - 1 No.
- Oscilloscope, 20MHz, dual trace - 1 No.
- Voltmeter MC 0-30V - 1 No.
- Multimeter - 1 No.
- Function generator - 1 No.
- Regulated DC power supply 12V/1A - 1 No.

Materials/Components

- Bread board - 1 No.
- Diode IN4007 - 4 Nos.
- Resistor 470Ω - 1 No.
- Step-down transformer, 240V 24V 500mA - 1 No.
- Multi strand wire, red, blue 19/0.3 of 600V grade - as reqd.
- 3 Pin plug 6A 250V - 1 No.
- Electrolytic capacitor 10 µFD/25V - 1 No.
- Resistor 10K/1W - 1 No.
- Transistor BF 195 - 1 No.
- Capacitors - 0.01and 0.1µfd - 3 Nos.
- Gang capacitor 25-2J - 1 No.
- Resistors - 82K, 18K, 3.9K, 390Ω/1/4W - 1 each
- Medium wave oscillator coil - 1 No.
- Transistor, SL 100 or equivalent Diode IN914/OA79 - 1 No.
- Capacitor, 100 µF/25 V, electrolytic, axial - 1 No.
- Capacitor, 25 µF/25 V, electrolytic, axial - 2 Nos.
- Resistors 1/4 W, carbon
  120 Ω - 1 No.
  470 Ω - 1 No.
  1.2 KΩ - 1 No.
  5.6 KΩ - 1 No.
- Hook-up wires - 20cms.

PROCEDURE

TASK 1:

For TASK 1 Refer Exercise No 2.7.155.

TASK 2: **Measure of ripple and calculate ripple factors in bridge rectifiers with RC filter**

1 Construct the filter circuit in the bridge rectifies already constructed. (Fig 1)

2 Repeat the steps 2 to 6 of task 1. Enter the measured values in Table 1 and 2.

Fig 1

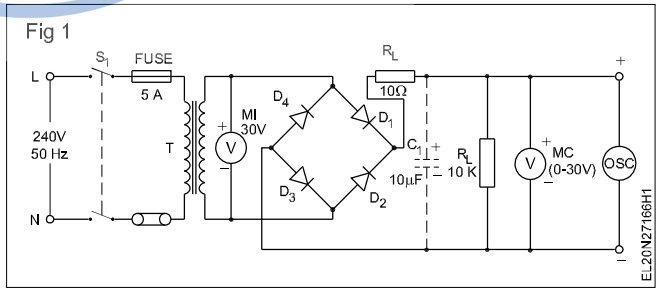


Table 1

Condition	Input AC	Output DC	AC ripple	Ripple factor $= \frac{\text{AC ripple voltage}}{\text{DC voltage}}$
Without RC filter				
With RC filter				

Table 2

Condition		
Output wave form without capacitor		
Output wave form with capacitor		

TASK 3 : **Determine the voltage gain A_2 of CE amplifier and distinguish input and output wave shapes**

1 Construct the circuit of CE amplifier in Fig 1.

2 Apply V_{cc} measure and record I_c and I_B in Table 1.

3 Apply input sinewave from function generator and measure voltage gain of using CRO. Observe the input and output waves.

4 Record the input and output wave shapes of the CE amplifiers.

5 Get it checked with your instructor.

Fig 1

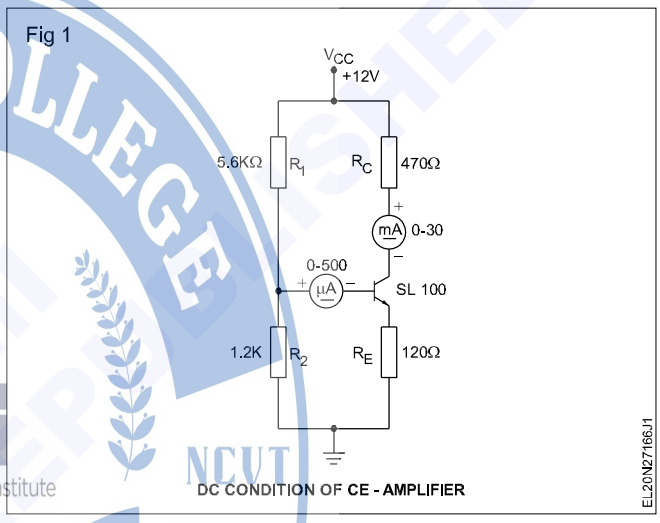


Table 1

Transistor Number	Collector I_C current	Base current I_B	V gain	Input wave shapes	Output wave shapes	Relation between input & output wave

TASK 4 : **Assemble a hartley oscillator and test the waves, find frequency with different capacitor values**

1 Test the components to confirm their good working condition.

2 Assemble the Hartley oscillator circuit referring to Fig 1.

3 Connect and switch ON + 12V-DC supply to the wired circuit. Check to ensure that the transistor is not getting heated-up.

If the transistor is getting heated-up, switch-OFF supply and consult your instructor.

4 Connect the secondary terminals of the MW OSC coil, to CRO set to measure the frequency.

5 Adjust CRO time-base to get a clear sinusoidal wave on the screen. Measure the amplitude and frequency of oscillations and record the observations below:

i) amplitude of oscillations

ii) Frequency of oscillations

If oscillations are not seen, tune the gang capacitor. If oscillations are still not seen, consult your instructor.

6 Get the working of the oscillator checked by your instructor.

7 Set the gang capacitor to one extreme end. Measure the amplitude and frequency of oscillations and enter in Table 1.

8 Set the gang capacitor to the other extreme end. Measure the amplitude and frequency of oscillations and enter in Table 1.

9 Set the position of the gang capacitor to approximately mid-position. Measure the amplitude and frequency of oscillations and enter in Table 1.

10 Get the recorded reading checked by your instructor.

Fig 1

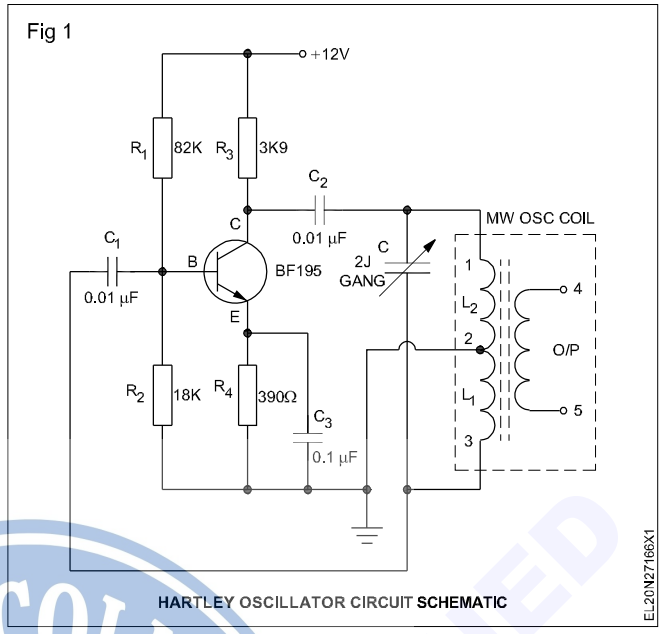


Table 1

Position of gang capacitor	Amplitude in volts peak to peak	Frequency in Hz
At one extreme end		
At other extreme end		
Mid position		