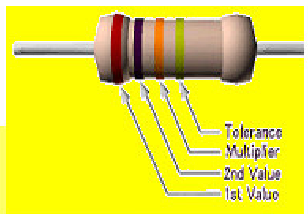
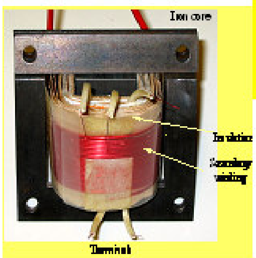
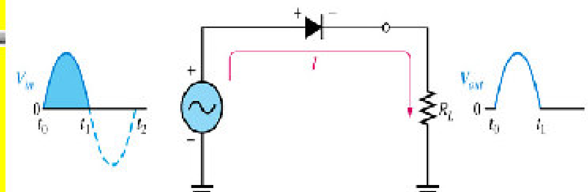
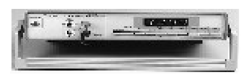
BASIC ELECTRONICS

Laboratory Manual









Seat No.:_______________

Name of the student:_________________________________

INDEX

20.	To obtain characteristics of field effect transistor (FET)	
21.	To measure gain FET common source (CS) amplifier	
22.	To test individual circuit prepared by the student (Get circuit from the faculty, build it, draw circuit diagram and test it in the laboratory. Write test results in this practical)	

Instructions to the students:

- Draw circuit diagram of your practical in the given space as per circuit available in your laboratory
- Write readings in the observation table
- Draw waveforms in the given space
- Simulate circuit using circuit simulator if hardware is not available in the lab
- Every student must construct at least one circuit as per his choice or as given by the faculty
- Write answers of the questions given in lab manual in worksheet section. Use text book, reference book or internet to find out answers of the questions

Suggest list of circuits that student will build individually

- DC power supply using IC 7805, 7812 or LM 317
- Burglar alarm
- Automatic street light switch
- Siren using LM-555 timer
- Automatic water tank overflow alarm
- Automatic Emergency light
- Sinusoidal waveform generator
- RC coupled CE amplifier
- IR (Infrared) Switch
- Overvoltage under-voltage protection switch
- Simple intercom circuit
- DTMF Encoder/decoder circuit
- Telephone ring generator circuit

EXPERIMENT NO. 1

AIM: To observe sine wave, square wave, triangular wave and ramp waveforms on the C.R.O. and to measure amplitude and frequency of the waveforms.

Introduction:

C.R.O. (Cathode Ray Oscilloscope) is the instrument which is used to observe signal waveforms. Signals are displayed in time domain i.e. variation in amplitude of the signal with respect to time is plotted on the CRO screen. X-axis represents time and Y-axis represents amplitude. It is used to measure amplitude, frequency and phase of the waveforms. It is also used to observe shape of the waveform. C.R.O. is useful for troubleshooting purpose. It helps us to find out gain of amplifier, test oscillator circuits. We can measure amplitude and frequency of the waveforms at the different test points in our circuit. Thus, it helps us for fault finding procedure. In dual channel C.R.O. X-Y mode is available which is used to create Lissajous patterns

Latest digital storage oscilloscope display voltage and frequency directly on the LCD and does not require any calculations. It can also store waveform for further analysis. More detailed study on C.R.O. will be covered in EMI laboratory (SEM-V). In this practical, we will measure amplitude and frequency of the different waveforms like sine wave, square wave, triangular wave and ramp wave.

Procedure:

1. Connect function generator output at the input of C.R.O. at channel 1 or at channel 2
2. Select proper channel i.e. if signal is connected to channel 1 select CH1 and if signal is connected to channel 2 select CH2
3. Adjust Time / Div knob to get sufficient time period displacement of the wave on the CRO screen.
4. With fine tuning of time/ Div make the waveform steady on screen.
5. Use triggering controls if waveform is not stable
6. Keep volt/ div knob such that waveform is visible on the screen without clipping
7. Measure P-P reading along y-axis. This reading multiplied with volt/ div gives peak to peak amplitude of the ac i/ p wave.
8. Measure horizontal division of one complete cycle. This division multiplied by time/ div gives time period of the i/ p wave.
9. Calculate frequency using formula f = 1/ T.
10. Note down your readings in the observation table

11. Draw waveforms of sine, square, ramp and triangular in the given space.

:: WORKSHEET ::

Observation table:

Function	Vertical Division (a)	Volt/div (b)	Amplitude (p-p) V=a*b	Horizontal Div (c)	Time/div (d)	Time T =c*d	Freq. F=1/T
Sine wave							
Square Wave							
Triangular Wave							
Ramp Wave							

Draw observed waveforms:

Sine wave: (Amplitude : ________ Frequency: _____________)

Square wave: (Amplitude : ________ Frequency: _____________)

Triangular wave: (Amplitude : ________ Frequency: _____________)

Ramp: ((Amplitude : ________ Frequency: _____________)

Conclusion:

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Questions:

[1] What is the use of C.R.O. ?

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[2] What is the highest frequency that can be measured by C.R.O. available in your laboratory?

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[3] What is highest voltage that can be measured by C.R.O. available in your laboratory?

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____
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[4] What you will do to measure voltage which is greater than voltage limit of the C.R.O.?

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____
____

[5] Why AC/ DC input coupling push-button switch is given?

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[6] What do you mean by dual channel C.R.O.

[7] What type of deflection mechanism used in C.R.O. to deflect electron beam?

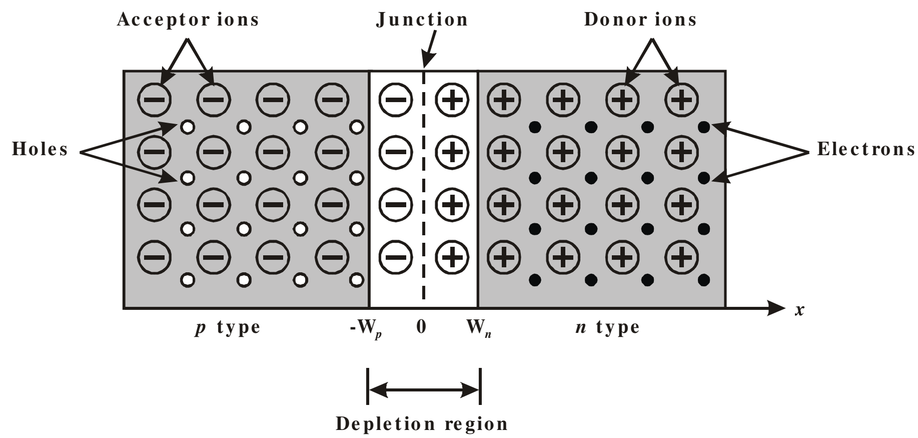
[8] How to test whether C.R.O. probe is in working condition or not?

EXPERIMENT NO. 2

AIM: To obtain V-I characteristics of PN junction diode

Introduction:

The semiconductor diode is formed by doping P-type impurity in one side and N-type of impurity in another side of the semiconductor crystal forming a p-n junction as shown in the following figure.



At the junction initially free charge carriers from both side recombine forming negatively charged ions in P side of junction(an atom in P-side accept electron and becomes negatively charged ion) and positively charged ion on n side(an atom in n-side accepts hole i.e. donates electron and becomes positively charged ion)region. This region deplete of any type of free charge carrier is called as depletion region. Further recombination of free carrier on both side is prevented because of the depletion voltage generated due to charge carriers kept at distance by depletion (acts as a sort of insulation) layer as shown dotted in the above figure.

Working principle:

When voltage is not applied across the diode, depletion region forms as shown in the above figure. When the voltage is applied between the two terminals of the diode (anode and cathode) two possibilities arises depending on polarity of DC supply.

[1] Forward-Bias Condition: When the +Ve terminal of the battery is connected to P-type material & -Ve terminal to N-type terminal as shown in the circuit diagram, the diode is said to be forward biased. The application of forward bias voltage will force electrons in N-type and holes in P-type material to recombine with the ions near boundary and to flow crossing junction. This reduces width of depletion region. This further will result in increase in majority carriers flow across the junction. If forward bias is

further increased in magnitude the depletion region width will continue to decrease, resulting in exponential rise in current as shown in ideal diode characteristic curve.

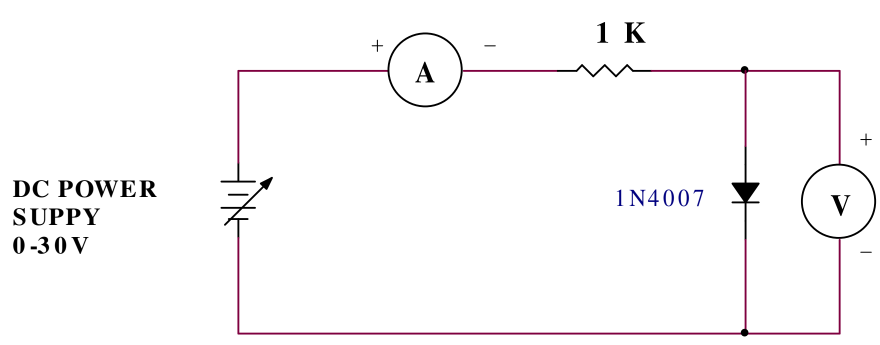
[2]Reverse-biased: If the negative terminal of battery (DC power supply) is connected with P-type terminal of diode and +Ve terminal of battery connected to N type then diode is said to be reverse biased. In this condition the free charge carriers (i.e. electrons in N-type and holes in P-type) will move away from junction widening depletion region width. The minority carriers (i.e. –ve electrons in p-type and +ve holes in n-type) can cross the depletion region resulting in minority carrier current flow called as reverse saturation current(Is). As no of minority carrier is very small so the magnitude of Is is few microamperes. Ideally current in reverse bias is zero.

In short, current flows through diode in forward bias and does not flow through diode in reverse bias. Diode can pass current only in one direction.

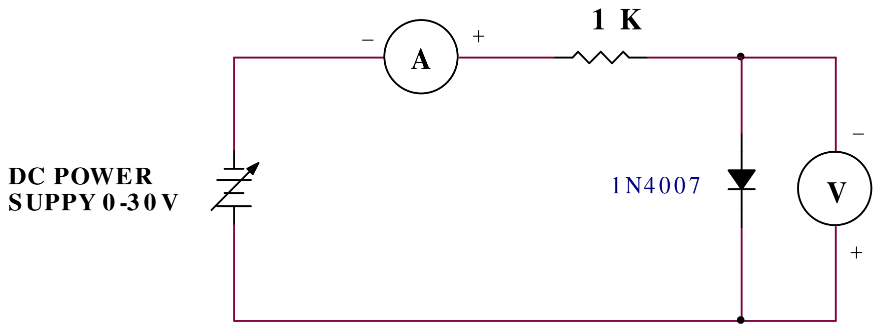
Experiment Procedure:

- Connect the power supply, voltmeter, current meter with the diode as shown in the figure for forward bias diode. You can use two multimeter (one to measure current through diode and other to measure voltage across diode)
- Increase voltage from the power supply from 0V to 20V in step as shown in the observation table
- Measure voltage across diode and current through diode. Note down readings in the observation table.
- Reverse DC power supply polarity for reverse bias
- Repeat the above procedure for the different values of supply voltage for reverse bias
- Draw VI characteristics for forward bias and reverse bias in one graph

Circuit diagram (forward bias):



Circuit diagram (reverse bias):



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Observation table: (Forward bias)

Sr. No.	Supply voltage (Volt)	Diode voltage (Vd)	Diode current (Id)
1.	0		
2.	0.2		
3.	0.4		
4.	0.6		
5.	0.8		
6.	1		
7.	2		
8.	4		
9.	6		
10.	8		
11.	10		
12.	15		
13.	20		

Observation table: (Reverse bias)

Sr. No.	Supply voltage	Diode voltage (Vd)	Diode current (Id)
1.	0		
2.	2		
3.	5		
4.	10		
5.	15		
6.	20		
7.	25		
8.	30		

Draw V-I characteristics of PN junction diode:

Conclusion:

Questions:

[1] List important specifications of the diode

[2] What is breakdown voltage? What is the breakdown voltage of diode 1N4001 and 1N4007?

[3] What is the highest forward current in the diode 1N4007 and 1N5002?

[4] List different types of the diode

[5] List applications of the diode?

[6] How to check diode with help of multimeter?

[7] What is the reason for reverse saturation current ?

[8] What is the forward voltage drop of silicon diode and germanium diode?

[9] Draw ideal characteristics of diode.

EXPERIMENT NO. 3

AIM: To obtain V-I characteristics of Zener diode

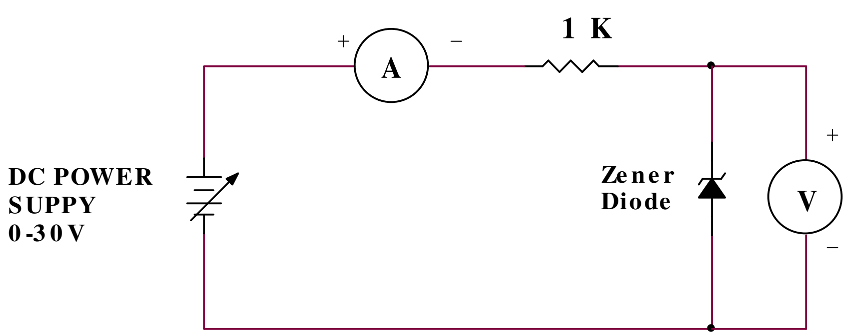
Introduction:

The Zener diode is designed to operate in reverse breakdown region. Zener diode is used for voltage regulation purpose. Zener diodes are designed for specific reverse breakdown voltage called Zener breakdown voltage (V_Z). The value of V_Z depends on amount of doping. Breakdown current is limited by power dissipation capacity of the zener diode. If power capacity of the Zener is 1 W and Zener voltage is 10V, highest reverse current is 0.1A or 100 mA. If current increases more than this limit, diode will be damaged. Forward characteristics of the Zener diode is similar to normal PN junction diode.

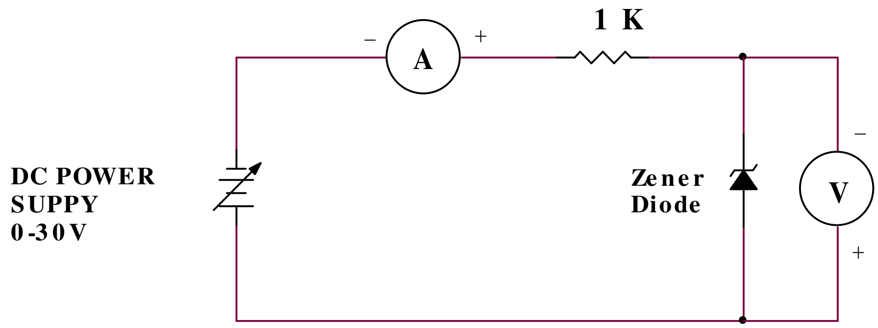
Experiment Procedure:

- Connect the power supply, voltmeter, current meter with the diode as shown in the figure for reverse bias. You can use two multimeter (one to measure current through diode and other to measure voltage across diode)
- Increase voltage from the power supply from 0V to 20V in step as shown in the observation table
- Measure voltage across diode and current through diode. Note down readings in the observation table.
- Reverse DC power supply polarity for forward bias
- Repeat the above procedure for the different values of supply voltage for reverse bias
- Draw VI characteristics for reverse bias and forward bias in one graph

Circuit diagram (reverse bias):



Circuit diagram (forward bias):



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Observation table: (Reverse bias)

Sr. No.	Supply voltage (Volt)	Diode voltage (Vz)	Diode current (Iz)
1.	0		
2.	1		
3.	2		
4.	5		
5.	8		
6.	10		
7.	12		
8.	15		
9.	18		
10.	20		
11.	22		
12.	25		
13.	30		

Observation table: (Forward bias)

Sr. No.	Supply voltage (Volt)	Diode voltage (Vd)	Diode current (Id)
1.	0		
2.	0.2		
3.	0.4		
4.	0.6		
5.	0.8		
6.	1		
7.	5		
8.	10		
9.	15		
10.	20		
11.	25		

Draw V-I characteristics of Zener diode:

Conclusion:

Questions:

[1] What is the breakdown voltage of Zener diode used in your practical? What is the power capacity. What is the maximum current that you can pass through it?

[2] Can we operate normal PN junction diode in breakdown region for longer duration? Give reason

[3] What is the specialty of Zener diode so as we can operate it in breakdown region for longer duration

[4] What is the difference between Zener breakdown and Avalanche breakdown?

[5] Draw Zener regulator circuit to obtain regulated DC voltage 6.8 V. Considering input DC voltage in the range from 10V to 30V. Consider load resistance of 10KΩ.

[6] Determine maximum and minimum value of Zener current if value of series resistance is 1 K, load resistance is 2K and input varies from 10V to 30V. Zener voltage is 5 V.

[7] Draw output waveform in the circuit of question 5, if we apply AC wave of 10V at the input.

EXPERIMENT NO. 4

AIM: To obtain characteristics of light dependant resistor (LDR)

Introduction:

Light dependant resistor is device in which resistance depends on intensity of light. Resistance of LDR decreases as light intensity increases. Typical example of LDR is Cadmium Sulfide photo cell. Typical resistance for bright light is 200 Ω and for dark condition it is around 10 MΩ. However, these values depends on size and material used for the construction of LDR. LDR can be used as a light sensor. We can construct automatic street light controller, burglar alarm, automatic brightness controller for television etc. applications using LDR.

Procedure :

- Connected the circuit as per instruction from the faculty
- Connect the variable AC supply to the lamp. See as we change AC supply, light intensity changes.
- Now adjust the lamp in such a way that its maximum light falls on LDR.
- Vary AC supply which will change the light intensity and record the resistance value in the observation table
- Draw the AC Voltage versus current flowing through LDR & calculate the dynamic resistance of LDR for each setting of AC voltage.

:: WORKSHEET ::

Circuit diagram:

(Draw circuit that you have used during practical)

Observation table:

Resistance at dark condition: ______________________

Resistance at normal light: ________________________

Sr no.	AC Voltage (Lamp intensity)	Resistance of LDR
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

Conclusion :

____
____
____
____
____
____
____

Draw graph of Intensity variation versus resistance

Questions:

[1] What is unit of Light? How you measure Light?

[2] What do you mean by photoconductive cell?

[3] List any two practical applications of LDR.

EXPERIMENT NO. 5

AIM: To build and test practical circuit of LDR (Measure voltage at different points)

Circuit diagram:

(Draw circuit diagram available in your laboratory)

Observations:

Voltage on the terminal of the LDR when relay is OFF:

V_1 = ________________ V_2 = ________________

Voltage on the terminal of the LDR when relay is ON:

V_1 = ________________ V_2 = ________________

Explain circuit operation in brief:

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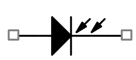
____
____
____
____
____
____
____
____
____
____

EXPERIMENT NO. 6

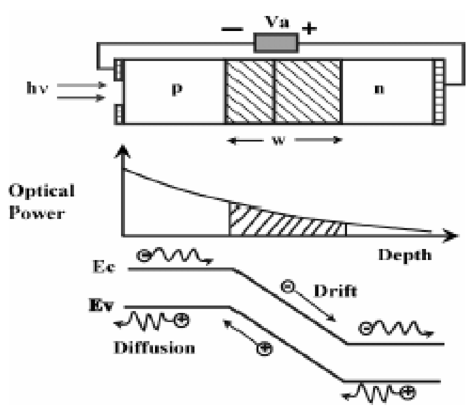
AIM: To obtain characteristics of semiconductor photo diode

Introduction:

The semiconductor photodiode is a light detector device which detects presence of light. It is used to convert optical power into electrical current. PN junction Photo diode have P type and N type semiconductor forms junction. Thin P type layer is deposited on N type substrate. P-N junction has a space charge region at the interface of the P and N type material. Light enters through P-layer as shown in the following figure. This diode has relatively thin depletion region around the junction. It is reverse biased to increase width of the depletion region. Photons of light entering in P-layer ionize electron-hole pair. Photon generates electron-hole pair in the depletion region that moves rapidly with the drift velocity by the electric field.



PHOTODIODE

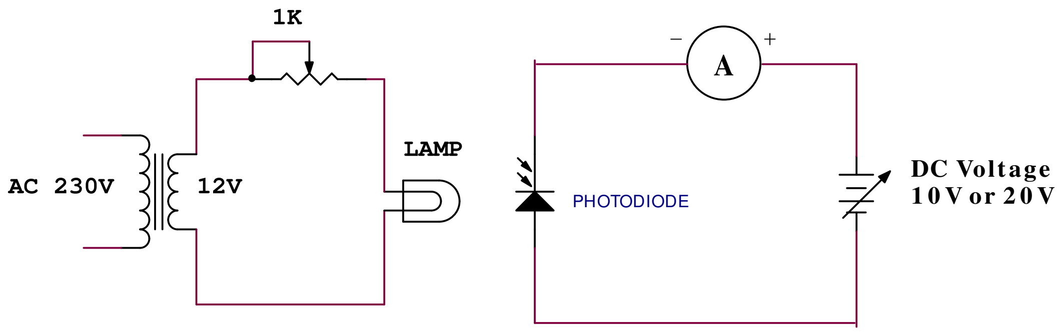


Responsivity is important technical term related to the photodiode. It is ratio of photocurrent to incident optical power. Responsivity of the photodiode is proportional to width of the junction. Photo diode is used in fiber optic communication at receiver side. It detects incoming light from the fiber end and convert it into electrical signal. It can be also used in remote control receiver.

Experiment Procedure:

- Connect the power supply, voltmeter, current meter with the photodiode as shown in the figure
- Apply 10V from the DC power supply
- Increase AC power given to lamp to increase intensity
- Measure reverse leakage current (photo current) of photodiode for different light intensity
- Draw graph of light intensity versus photocurrent.

Circuit diagram:



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Observation table:

Sr no.	AC Voltage (Lamp intensity)	Photocurrent
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

Draw graph of Light versus photocurrent :

Conclusion:

Questions:

[1] What is the difference between LDR and photodiode? What type of conversion takes place in photodiode?

[2] Is photocurrent depends on wavelength of incident light?

EXPERIMENT NO. 7

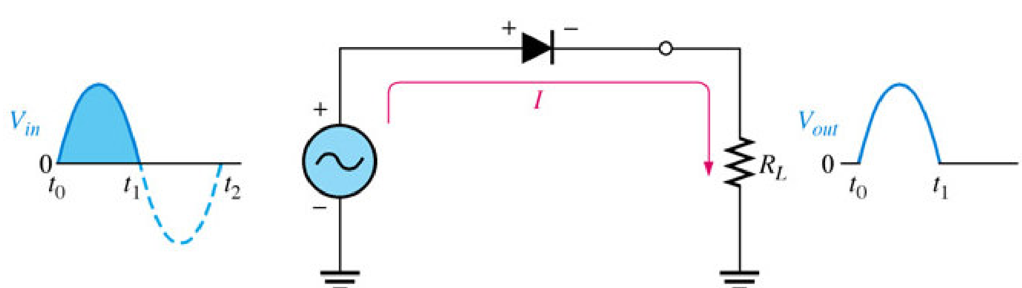
AIM: To observe waveform at the output of half wave rectifier with and without filter capacitor. To measure DC voltage, DC current, ripple factor with and without filter capacitor

Introduction:

One of the very important applications of diode is in DC power supply as a rectifier to convert AC into DC. DC Power supply is the important element of any electronic equipment. This is because it provides power to energize all electronic circuits like oscillators, amplifiers and so on. In electronic equipments, D.C. power supply is must. For example, we can't think of television, computer, radio, telephone, mobile as well as measuring instruments like CRO, multi-meter etc. without DC power supply. The reliability and performance of the electronic system proper design of power supply is necessary. The first block of DC power supply is rectifier. Rectifier may be defined as an electronic device used to convert ac voltage or current into unidirectional voltage or current. Essentially rectifier needs unidirectional device. Diode has unidirectional property hence suitable for rectifier. Rectifier broadly divided into two categories: Half wave rectifier and full wave rectifier. In this experiment, you will construct half wave rectifier.

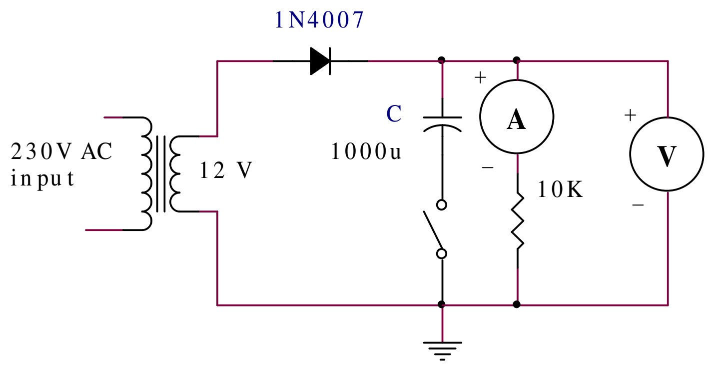
Working principle of half wave rectifier:

In half wave rectifier only half cycle of applied AC voltage is used. Another half cycle of AC voltage (negative cycle) is not used. Only one diode is used which conducts during positive cycle. The circuit diagram of half wave rectifier without capacitor is shown in the following figure. During positive half cycle of the input voltage anode of the diode is positive compared with the cathode. Diode is in forward bias and current passes through the diode and positive cycle develops across the load resistance R_L. During negative half cycle of input voltage, anode is negative with respected to cathode and diode is in reverse bias. No current passes through the diode hence output voltage is zero.



Half wave rectifier without filter capacitor convert AC voltage into pulsating DC voltage. Filter capacitor is used to obtain smooth DC voltage. Construct following circuit to perform this practical.

Practical Circuit diagram:



List of components:

[1] Transformer Input: 230V AC, output: 12V AC, 500 mA [2] Diode 1N4007

[3] Resistor 10K [4] Capacitor 1000µF [5] Toggle Switch

Construct circuit on the general purpose PCB. Keep toggle switch OFF to perform practical of half wave rectifier without filter capacitor and ON to connect filter capacitor.

:: WORKSHEET ::

Waveforms: [1] Without filter capacitor:
Input Waveform at secondary of transformer:

Output waveform:

[2] With filter capacitor:

Input Waveform at secondary of transformer:

Output waveform:

Observations:

[1] Without filter capacitor

AC Input voltage (rms) Vrms= ___________

DC output voltage V_{DC} = ___________

DC current: I_{DC} =______________

AC output voltage (Ripple voltage) Vr: __________

Ripple factor: (Vr/ V_{DC}) = ______________

[2] With filter capacitor

AC Input voltage (rms) Vrms= ___________

DC output voltage V_{DC} = ___________

DC current: I_{DC} =______________

AC output voltage (Ripple voltage) Vr: __________

Ripple factor: (Vr/ V_{DC}) = ______________

Conclusion:

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Questions:

[1] Define ripple factor

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[2] What is the effect of load resistance on ripple voltage in presence of filter capacitor?

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____
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[3] What is the effect of value of filter capacitor on ripple voltage?

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____
____
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[4] What is the PIV necessary for the diode if transformer of 24V is used ?

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____
____
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[4] What is the mathematical relationship between rms input AC voltage and DC output voltage in half wave rectifier with and without filter capacitor?

____
____
____
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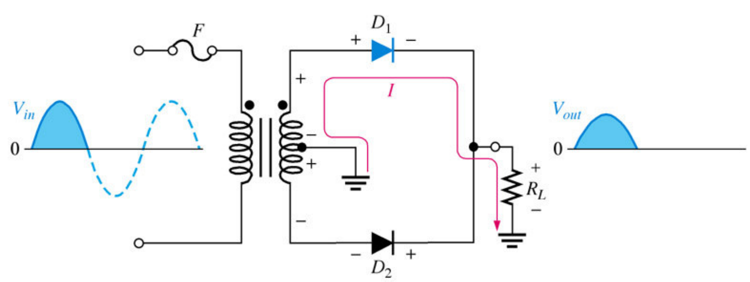
EXPERIMENT NO. 8

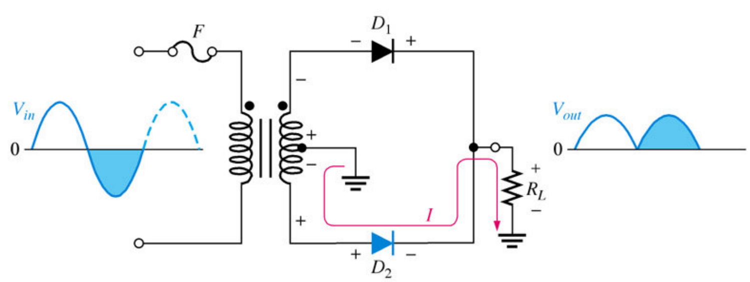
AIM: To observe waveform at the output of full wave rectifier with and without filter capacitor. To measure DC voltage, DC current, ripple factor with and without filter capacitor

Introduction:

Full wave rectifier utilizes both the cycle of input AC voltage. Two or four diodes are used in full wave rectifier. If full wave rectifier is designed using four diodes it is known as full wave bridge rectifier. Full wave rectifier using two diodes without capacitor is shown in the following figure. Center tapped transformer is used in this full wave rectifier. During the positive cycle diode D1 conducts and it is available at the output. During negative cycle diode D1 remains OFF but diode D2 is in forward bias hence it conducts and negative cycle is available as a positive cycle at the output as shown in the following figure. Note that direction of current in the load resistance is same during both the cycles hence output is only positive cycles.



(a) During positive half-cycles, D_1 is forward-biased and D_2 is reverse-biased.



(b) During negative half-cycles, D_2 is forward-biased and D_1 is reverse-biased.

Advantages of full wave rectifier over half wave rectifier:

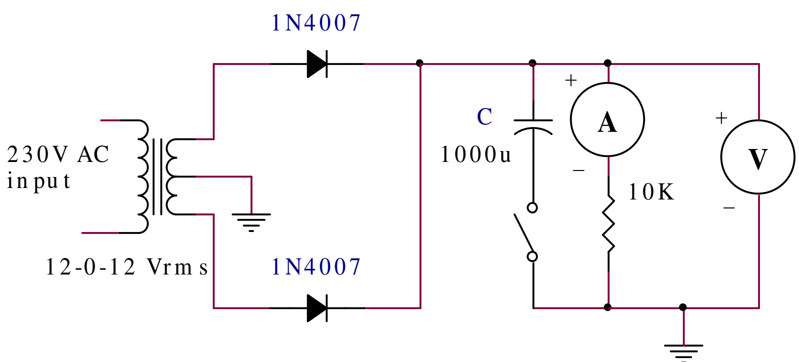
- The rectification efficiency is double than half wave rectifier
- Ripple factor is less and ripple frequency is double hence easy to filter out.
- DC output voltage and current is higher hence output power is higher.
- Better transformer utilization factor

- There is no DC saturation of core in transformer because the DC currents in two halves of secondary flow in opposite directions.

Disadvantages:

- Requires center tap transformer
- Requires two diodes compared to one diode in half wave rectifier.

Practical Circuit diagram:



List of components:

[1] Transformer (center tapped) 12-0-12 V AC, 500 mA

[2] Diode 1N4007 ---- 2 No. [3] Resistor 10K

[4] Capacitor 1000µF [5] Toggle Switch

Construct circuit on the general purpose PCB. Keep toggle switch OFF to perform practical of full wave rectifier without filter capacitor and ON to connect filter capacitor.

:: WORKSHEET ::

Waveforms:
[1] Without filter capacitor:
Input Waveform at secondary of transformer:

Output waveform:

[1] With filter capacitor:
Input Waveform at secondary of transformer:

Output waveform:

Observations:

[1] Without filter capacitor

AC Input voltage (rms) Vrms= ___________

DC output voltage V_{DC} = ___________

DC current: I_{DC} =______________

AC output voltage (Ripple voltage) Vr: __________

Ripple factor: (Vr/ V_{DC}) = ______________

[2] With filter capacitor

AC Input voltage (rms) Vrms= ___________

DC output voltage V_{DC} = ___________

DC current: I_{DC} =______________

AC output voltage (Ripple voltage) Vr: __________

Ripple factor: (Vr/V_{DC}) = ______________

Conclusion:

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Questions:

[1] What is the frequency of AC component at the output of full wave rectifier? Give reason.

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[2] What is the difference in DC output voltage in half wave and full wave rectifier for the same AC input?

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[3] What is the PIV necessary for the diode if transformer of 24-0-24 V is used ?

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[4] What is the mathematical relationship between rms input AC voltage and DC output voltage in half wave rectifier with and without filter capacitor?

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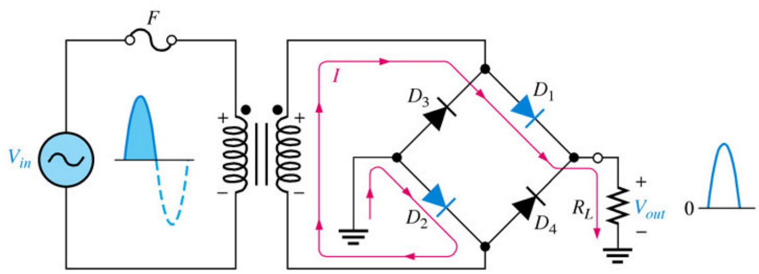
EXPERIMENT NO. 9

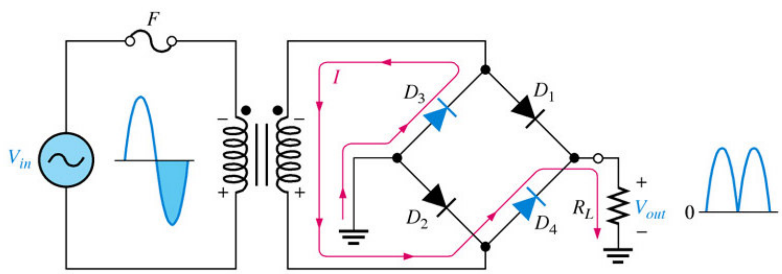
AIM: To observe waveform at the output of bridge rectifier with and without filter capacitor. To measure DC voltage, DC current, ripple factor with and without filter capacitor

Introduction:

The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier circuit is shown in the following figure.



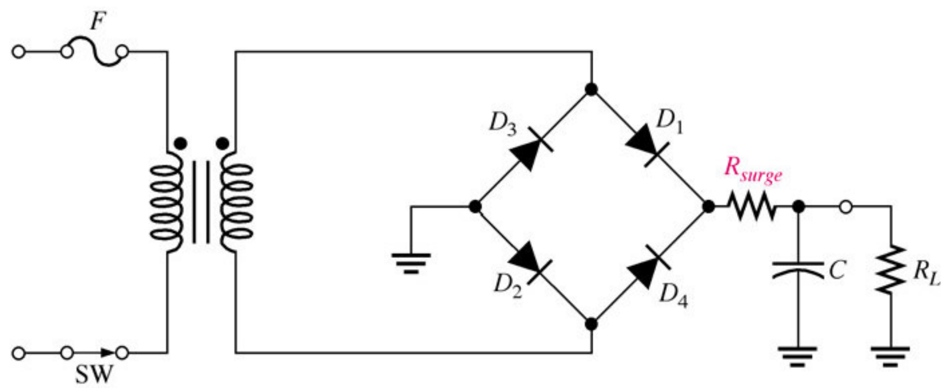
(a) During positive half-cycle of the input, D_1 and D_2 are forward-biased and conduct current. D_3 and D_4 are reverse-biased.



(b) During negative half-cycle of the input, D_3 and D_4 are forward-biased and conduct current. D_1 and D_2 are reverse-biased.

The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge. For the positive half cycle of the input ac voltage, diodes D1 and D2 conduct, whereas diodes D3 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance R_L and hence the load current flows through R_L. For the negative half cycle of the input ac voltage, diodes D3 and D4 conduct whereas, D1 and D2 remain OFF. The conducting diodes D3 and D4 will be in series with the load resistance R_L and hence the current flows through R_L in the same direction as in the previous half cycle. Thus a bi-directional wave is converted into a unidirectional wave.

The circuit diagram of the bridge rectifier with filter capacitor is shown in the following figure. When capacitor charges during the first cycle, surge current flows because initially capacitor acts like a short circuit. Thus, surge current is very large. If surge current exceeds rated current capacity of the diode it can damage the diode. To limit surge current surge resistance is used in series as shown in the figure. Similar surge resistance can be used in half wave as well as center-tapped full wave rectifier also.



Bridge rectifier package (combination of four diodes in form of bridge) is easily available in the market for various current capacities ranging from 500 mA to 30A. For laboratory purpose you can use 1A package.

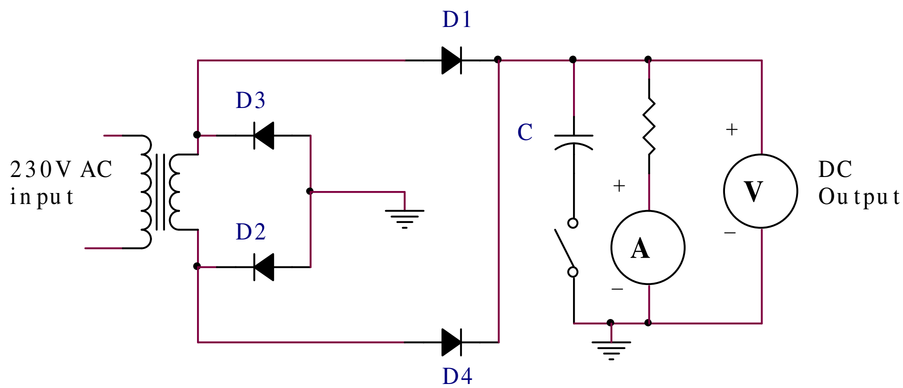
Advantages of bridge rectifier:

- No center tap is required in the transformer secondary hence transformer design is simple. If stepping up and stepping down not required than transformer can be eliminated. (In SMPS used in TV and computer, 230V is directly applied to the input of bridge rectifier).
- The PIV of the diode is half than in center tap full wave rectifier
- Transformer utilization factor is higher than in center tapped full wave rectifier
- Smaller size transformer required for given capacity because transformer is utilized effectively during both AC cycles.

Disadvantages of bridge rectifier:

- Requires Four diodes (But package is low cost)
- Forward voltage drop across two diodes. This will reduce efficiency particularly when low voltage (less than 5V) is required.
- Load resistance and supply source have no common point which may be earthed.

Practical circuit diagram:



List of components:

[1] Transformer 12 V AC, 500 mA

[2] Diode 1N4007 ---- 4 No. or 1 A bridge rectifier package

[3] Resistor 10K [4] Capacitor 1000µF [5] Toggle Switch

Construct circuit on the general purpose PCB. Keep toggle switch OFF to perform practical of full wave rectifier without filter capacitor and ON to connect filter capacitor.

:: WORKSHEET ::

Waveforms:
[1] Without filter capacitor:
Input Waveform at secondary of transformer:

Output waveform:

[1] With filter capacitor:
Input Waveform at secondary of transformer:

Output waveform:

Observations:

[1] Without filter capacitor

AC Input voltage (rms) Vrms= ___________

DC output voltage V_{DC} = ___________

DC current: I_{DC} =______________

AC output voltage (Ripple voltage) Vr: __________

Ripple factor: (Vr/ V_{DC}) = ______________

[2] With filter capacitor

AC Input voltage (rms) Vrms= ___________

DC output voltage V_{DC} = ___________

DC current: I_{DC} =______________

AC output voltage (Ripple voltage) Vr: __________

Ripple factor: (Vr/ V_{DC}) = ______________

Conclusion:

Questions:

[1] What is the mathematical expression for ripple factor. What is the ripple factor of bridge rectifier without filter capacitor?

[2] What is the mathematical relationship between rms AC input and DC output from the bridge rectifier with and without filter capacitor? If transformer of 24V is used, what is the DC output voltage with and without filter capacitor?

[3] What is the PIV necessary for the diode if transformer of 12-0-12 V is used ?

[4] What is the efficiency of full wave bridge rectifier?

EXPERIMENT NO. 10

AIM: To obtain characteristics of light emitting diode (LED)

Introduction:

LED is semiconductor junction diode which emits light when current passes through it in forward bias condition. P type of semiconductor consists of large number of holes while N type of semiconductor consists of large number of electrons. At zero bias (no voltage across junction), depletion region exists and it separate out two regions. When LED is forward biased, barrier potential reduces and depletion region becomes narrow. Electron crosses the depletion region and recombines with holes. Similarly holes crosses depletion region and recombine with electrons. Each recombination of hole and electron produces photon (light) The intensity of light emitted depends on the number of minority carriers available for recombination. Wavelength (or frequency) of emitted light depends on band-gap energy. The light emitting diode works by the process of spontaneous emission.

Light source material must have direct band gap. In a direct band gap semiconductor material electron and hole recombine directly across band gap without need of third particle to conserve momentum.

Light source materials are made from compound of group-III (Al,Ga,In) and group-V (P,As,Sb) element.The wavelength generated by the LED depends on bandgap energy and bandgap energy depends on doping level of above elements. Let us understand relation between frequency of emission and energy.

Photon energy is related to the emitted frequency by the LED.

$$\text{Photon energy } E = hf = \frac{hc}{\lambda}$$

$$\left(\text{because } f = \frac{c}{\lambda} = \frac{\text{Velocity of light}}{\text{wavelength}}\right)$$

Where h = Plank's constant = 6.625×10^{-34} J-S

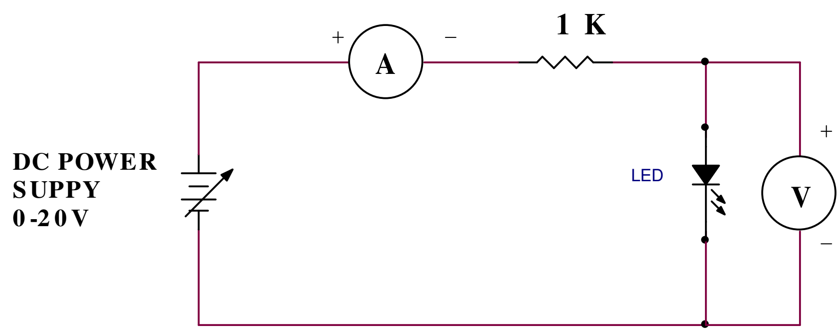
c = Velocity of the light = 3×10^{8} m/s

λ = Wavelength of emitted light

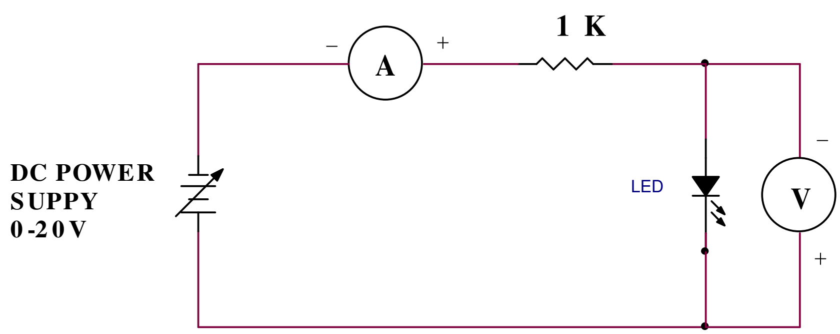
Experiment Procedure:

- Connect the power supply, voltmeter, current meter with the LED as shown in the circuit diagram.
- Increase voltage from the power supply from 0V to 20V in step as shown in the observation table
- Measure voltage across LED and current through the LED. Note down readings in the observation table and also observes light coming from LED.
- Reverse DC power supply polarity for reverse bias
- Repeat the above procedure for the different values of supply voltage for reverse bias
- Draw VI characteristics for forward bias and reverse bias in one graph

Circuit diagram (forward bias):



Circuit diagram (reverse bias):



:: WORKSHEET ::

Observation table: (Forward bias)

Sr. No.	Supply voltage (Volt)	Diode voltage (Vd)	Diode current (Id)
1.	0		
2.	0.5		
3.	1		
4.	2		
5.	5		
6.	10		
7.	15		
8.	20		

Observation table: (Reverse bias)

Sr. No.	Supply voltage	Diode voltage (Vd)	Diode current (Id)
1.	0		
2.	2		
3.	5		
4.	10		
5.	15		
6.	20		

Draw V-I characteristics of the LED:

Conclusion:

Questions:

[1] What are the applications of LED?

[2] On which factors color emitted from the LED depends?

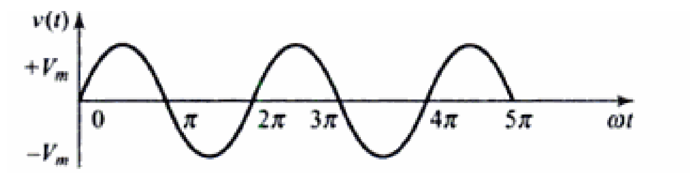
[3] Give typical values of LED voltage and current?

EXPERIMENT NO. 11

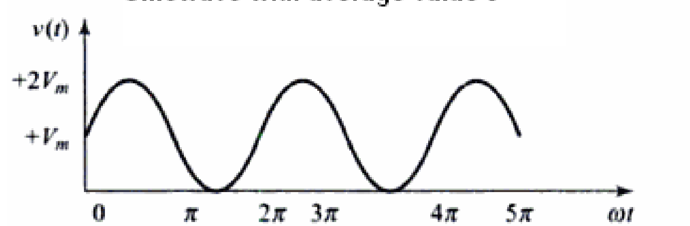
AIM: To observe waveforms at the output of clamper circuits

Introduction:

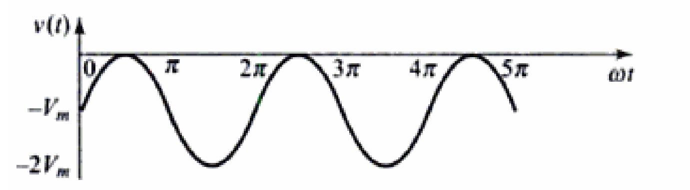
Diodes are widely used in clipping and clamping circuits. Clamping circuits are used to change DC level (average level) of the signal which adds or subtracts DC value with the signal. In clamping, shape of waveform remains same only offset value (DC level) will change. Positive clamping adds positive DC level in the signal while negative clamping adds negative DC level in the signal. Capacitor is widely used in the clamping circuit. Typical clamping waveforms for the sinusoidal signal is shown below for positive clamping and negative clamping.



Sinewave with average value 0



Sine wave clamped to postive level Vm



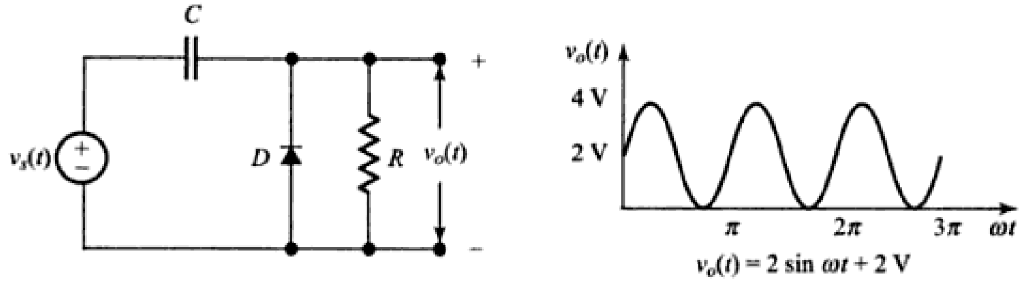
Sine wave clamped to negative level -Vm

Clamping circuit is used in video amplifier of television receiver to restore DC level of video signal to preserve overall brightness of the scene. Clamping circuit is also used in offset control of function generator. Zero offset means no DC value is added in the AC signal.

Circuit operation:

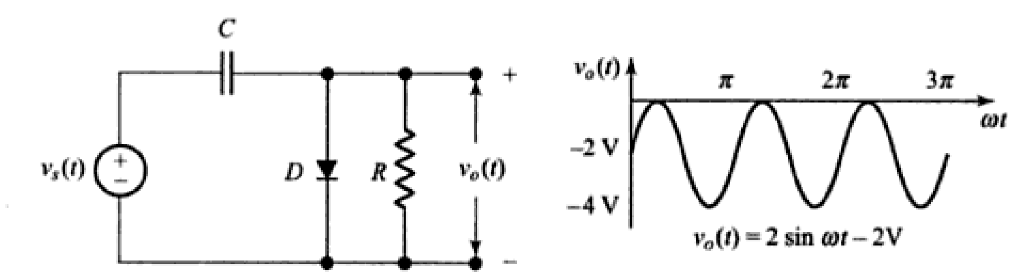
Typical circuit operation of the positive clamping and negative clamping is given below.

Positive clamping:



Consider that 4V peak to peak signal with zero offset is applied at the input of the clamping circuit. On the first negative half cycle of the input signal, diode D turns ON because anode voltage is greater than cathode voltage. Capacitor charges to the negative peak voltage let us say -2V in our example. The value of R should be high so that it will not discharge the capacitance. After completion of negative cycle, positive cycle starts and diode turns OFF. Capacitance voltage is in series with the input voltage. As per the Kirchoff's law output voltage will be addition of input voltage and capacitance voltage. Input signal is positive swing of +2V and capacitor voltage is +2V. Thus during the positive peak of the input voltage total output voltage will be +4V. We can consider that during the positive cycle capacitor acts like a battery and adds +2V in the input. Waveforms are drawn here considering ideal diode, no leakage in the capacitance under ideal situations which will be different in practical situations.

Negative clamping:



In a negative clamping circuit polarity of diode is reverse than in positive clamping. In our signal input swings from -2V to +2V (peak to peak 4V). Diode turns ON during the positive cycle and charge is stored in the capacitor. Capacitor will charge up to +2 V in our example. During the negative cycle this voltage will be in series with the input voltage and gives total output -4V during negative peak of the input signal.

Experiment Procedure:

- Connect function generator with CRO. Set sine wave with 4V peak to peak. Ensure that offset voltage is 0.
- Connect the function generator at the input of the clamping circuit
- Observe output waveforms on the CRO for different clamping circuits and draw output waveforms.

:: WORKSHEET ::

Draw circuit diagrams (as per circuit available in the laboratory or circuit connected on breadboard):

Waveforms:

[1]Input Waveform:

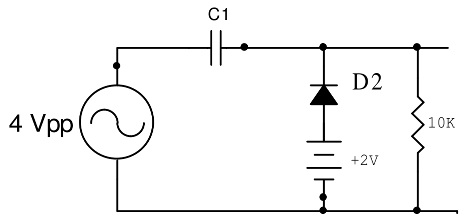
Output waveform for circuit 1:

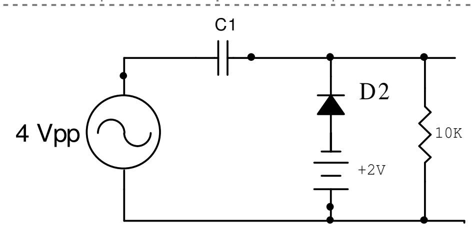
Output waveform for circuit 2:

Conclusion:

Questions:

[1] Draw output waveform for the following circuits if input of 4V peak-to-peak with zero offset is applied.





EXPERIMENT NO. 12

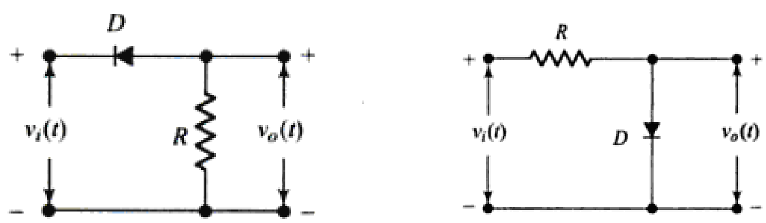
AIM: To observe waveforms at the output of clipper circuits

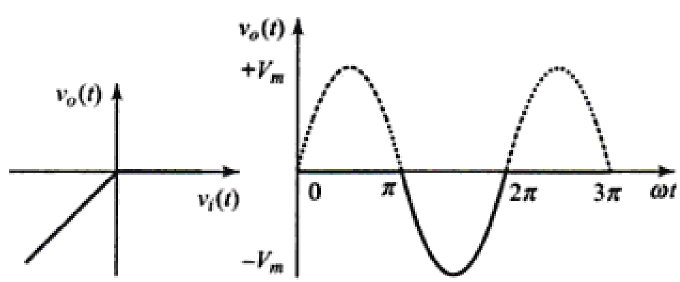
Introduction:

Clipping circuit is used to select for transmission that part of an arbitrary waveform which lie above or below some reference level. Clipping circuit "clips" some portion of the waveform. Clipping circuit are also referred to as voltage limiters. Clamping circuit preserves shape of the waveform while clipping circuit does not preserve shape of waveform. Clipping circuit uses some reference level. Waveform above or below this reference level is clipped. Clipping circuits are also known as voltage limiter or amplitude limiter or slicers. Some clipper circuits are explained here.

Positive cycle clipper circuits:

Positive cycle clipper circuits are shown in the figure with series and shunt diode. Transfer characteristics and output waveform for sinusoidal input is shown.





For series diode:

- When $v_i(t)<0$, Diode D is in ON condition, input waveform is available at the output.
- When $v_i(t)>0$, Diode D is in OFF condition, input waveform is not available at the output and output remains zero.

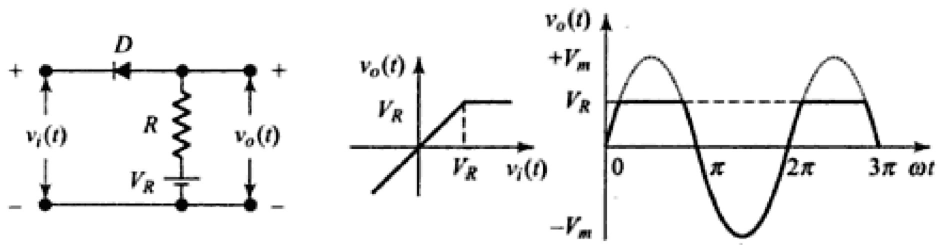
For shunt diode:

- When $v_i(t)<0$, Diode D is in ON condition which bypass the signal to the ground and hence input waveform is not available at the output.
- When $v_i(t)>0$, Diode D is in OFF condition and acts like a OFF switch, input waveform is available at the output.

For negative cycle clipper, polarity of diode is reverse.

Series diode positive clipping with positive reference:

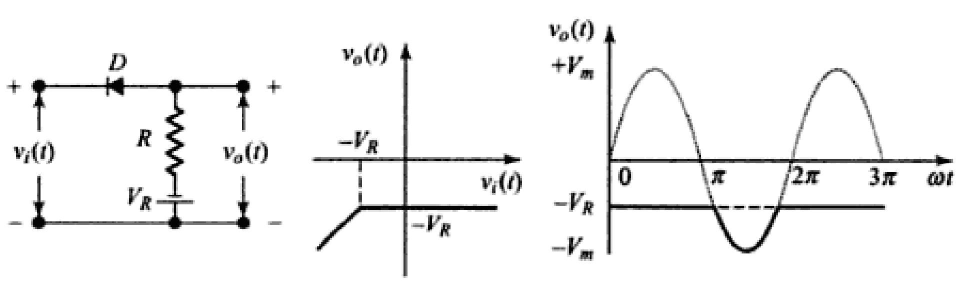
In the circuit shown in the following figure, DC reference voltage is used. This is useful of we do not want to clip entire positive cycle but some portion of positive half cycle.



- When $v_i(t)<V_R$, Diode D is in ON condition, input waveform is available at the output.
- When $v_i(t)> V_R$, Diode D is in OFF condition, input waveform is not available at the output and output remains zero. Thus portion of output cycle clips as shown in the waveform.

Series diode positive clipping with negative reference:

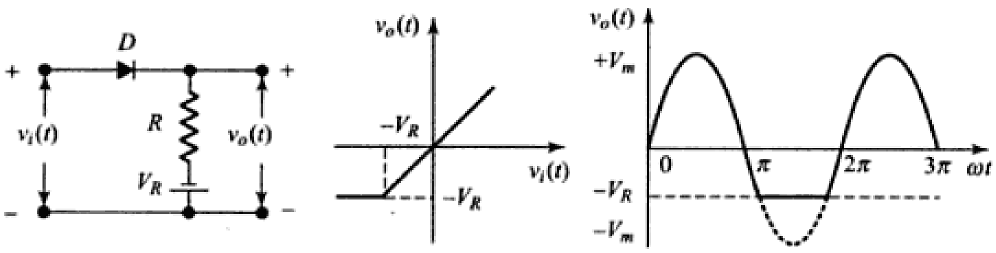
If want to clip entire positive half cycle along with some portion of the negative cycle then negative DC reference can be used as shown in the following figure. In this case only some portion of negative cycle passes to the output.



- When $v_i(t)<-V_R$, Diode D is in ON condition, input waveform is available at the output.
- When $v_i(t)> -V_R$, Diode D is in OFF condition, input waveform is not available at the output and output remains constant equal to V_R. Thus entire positive cycle and some portion of negative cycle below $-V_R$ clips.

Series diode negative clipping with reference:

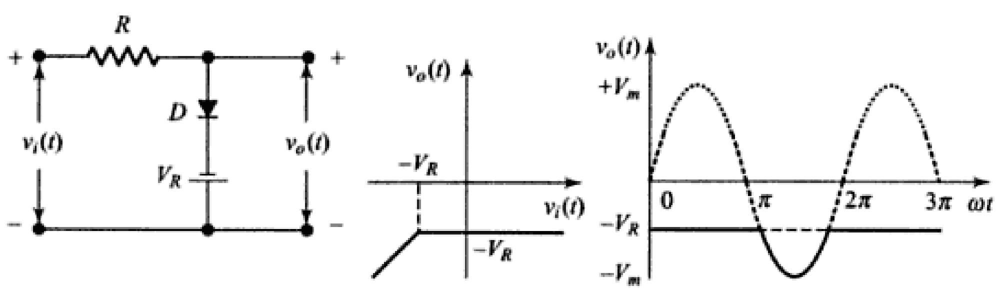
Negative clipping can be achieved by changing polarity of the diode. Negative clipper with negative reference voltage is shown in the following figure. This will clip some portion of negative cycle.



- When $v_i(t)>-V_R$, Diode D is in ON condition, input waveform is available at the output.
- When $v_i(t)< -V_R$, Diode D is in OFF condition, input waveform is not available at the output and output voltage remains constant which is equal to $-V_R$.

Shunt diode positive clipping with negative reference voltage:

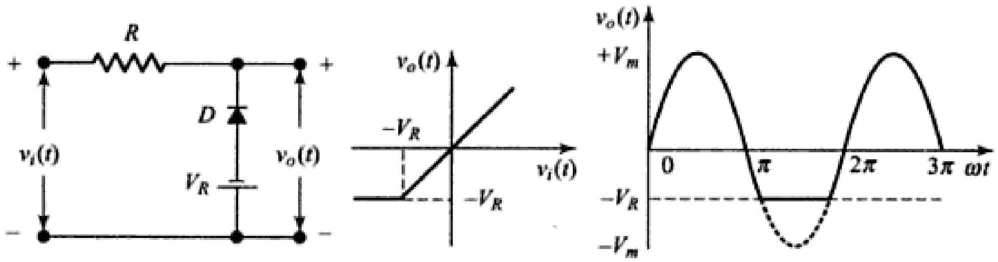
Shunt diode positive clipping with negative reference voltage is as shown in the following circuit. This will clip entire positive cycle and some portion of negative cycle as shown in the waveform.



- When $v_i(t)<-V_R$, Diode D is in OFF condition (open circuit) and input waveform is available at the output.
- When $v_i(t)> -V_R$, Diode D is in ON condition, input waveform is not available at the output and negative voltage $-V_R$ is extended to the output. Output voltage remains constant equal to V_R. Thus entire positive cycle and some portion of negative cycle below $-V_R$ clips.

Shunt diode negative clipping with negative reference:

Negative clipping with negative reference voltage can be achieved by reversing polarity of the diode. Some portion of negative cycle clips.



- When $v_i(t) > -V_R$, Diode D is in OFF condition (open circuit) and input waveform is available at the output.
- When $v_i(t) < -V_R$, Diode D is in ON condition, input waveform is not available at the output and negative voltage $-V_R$ is extended to the output. Output voltage remains constant equal to V_R. Thus entire positive cycle and some portion of negative cycle below $-V_R$ clips.

Experiment Procedure:

- Connect function generator with CRO. Set sine wave with 6V peak to peak. Ensure that offset voltage is 0.
- Connect the function generator at the input of the clipping circuit
- Observe output waveforms on the CRO for different clipping circuits and draw output waveforms.

:: WORKSHEET ::

Draw circuit diagrams (as per circuit available in the laboratory or circuit connected on breadboard):

Circuit 1:

Circuit 2:

Circuit 3:

Circuit 4:

Waveforms:

[1]Input Waveform:

Output waveform for circuit 1:

Output waveform for circuit 2:

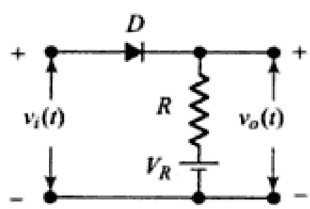
Output waveform for circuit 3:

Output waveform for circuit 4:

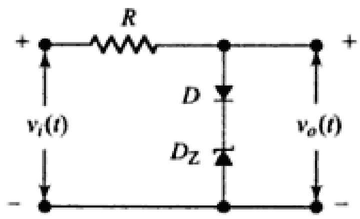
Conclusion:

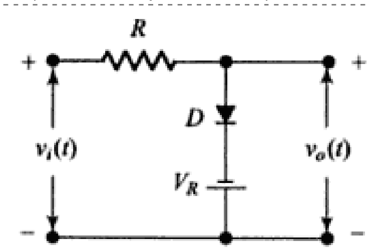
Questions:

[1] Draw output waveform for the following circuits if sinusoidal signal of 6V peak-to-peak with zero offset is applied at the input. Consider reference voltage $V_R = +2V$



Consider Zener voltage 2.5V





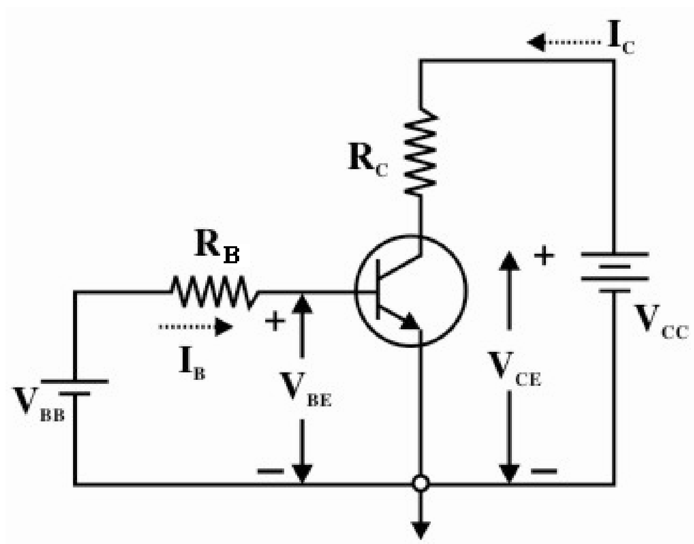
$V_R = -3$ V

EXPERIMENT NO. 13

AIM: To obtain common emitter characteristics of NPN transistor

Introduction:

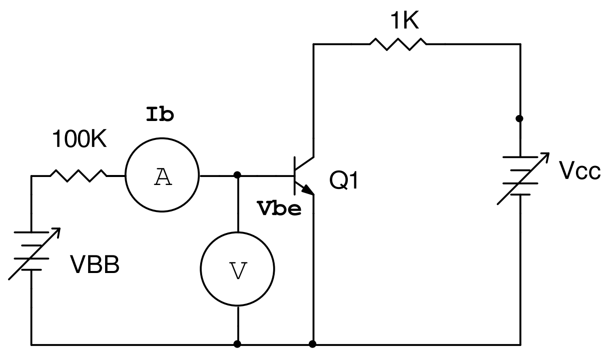
Transistor is three terminal active device having terminals collector, base and emitter. Transistor is widely used in amplifier, oscillator, electronic switch and so many other electronics circuits for variety of applications. To understand operation of the transistor, we use three configurations common emitter, common base and common collector. In this practical, we will understand common emitter configuration. As the name suggest, emitter is common between input and output. Input is applied to base and output is taken from collector.



We will obtain input characteristics and output characteristics of common emitter (CE) configuration. We will connect variable DC power supply at V_{BB} and V_{CC} to obtain characteristics. Input voltage in CE configuration is base-emitter voltage Vbe and input current is base current Ib. Output voltage in CE configuration is collector to emitter voltage V_{CE} and output current is collector current Ic. We will use multi-meter to measure these voltages and currents for different characteristics. Collector to emitter junction is reverse biased and base to emitter junction is forward biased. The CE configuration is widely used in amplifier circuits because it provides voltage gain as well as current gain. In CB configuration current gain is less than unity. In CC configuration voltage gain is less than unity. Input resistance of CE configuration is less than CC configuration and more than CB configuration. Output resistance of CE configuration is more than CC configuration and less than CB configuration.

:: WORKSHEET ::

Circuit setup for input characteristics:



Experiment Procedure:

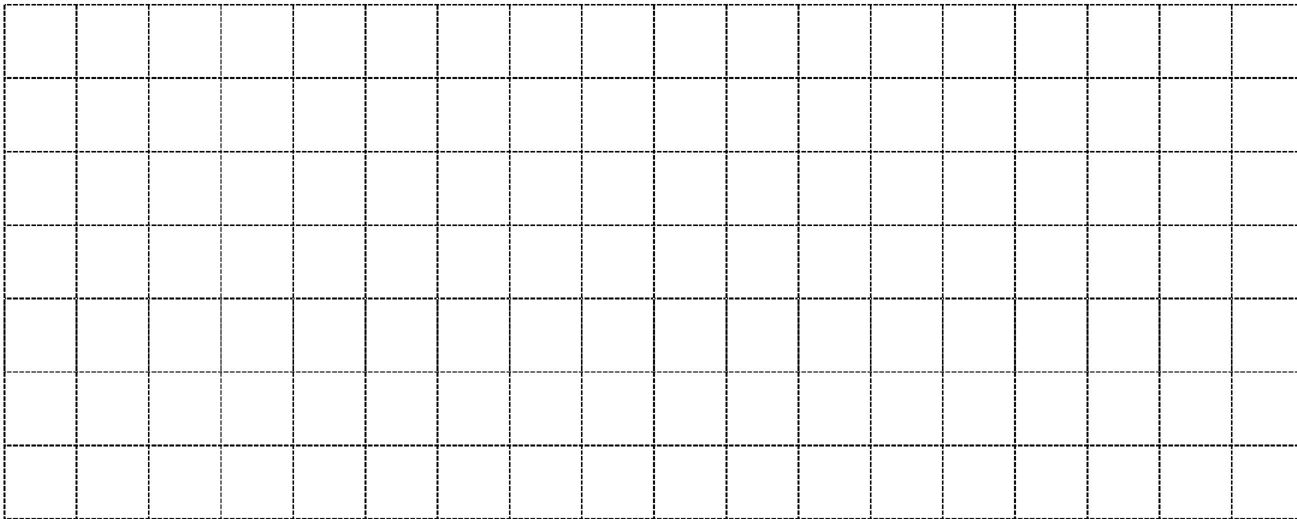
- Connect circuit as shown in the circuit diagram for input characteristics
- Connect variable power supply 0-30V at base circuit and collector circuit.
- Keep Vcc fix at 0V (Or do not connect Vcc)
- Increase V_{BB} from 0V to 20V, note down readings of base current Ib and base to emitter voltage Vbe in the observation table.
- Repeat above procedure for Vcc = +5V and Vcc = +10V
- Draw input characteristics curve. Plot Vbe on X axis and Ib on Y axis.

Observation table:

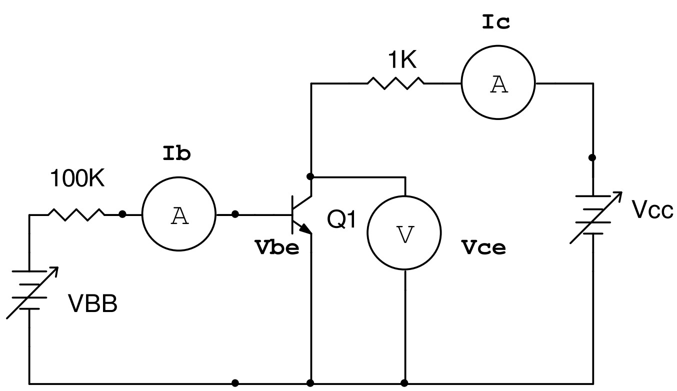
Transistor: __________

Sr. No.	**Vcc = 0V**		**Vcc = +5V**		**Vcc=+10V**	
	Vbe	**Ib**	**Vbe**	**Ib**	**Vbe**	**Ib**
1						
2						
3						
4						
5						
6						

Input Characteristics:



Circuit setup for output characteristics:



Experiment Procedure:

- Connect circuit as shown in the circuit diagram for output characteristics
- Connect variable power supply 0-30V at base circuit and collector circuit.
- Keep base current fix (Initially 0)
- Increase V_{CC} from 0V to 30V, note down readings of collector current Ic and collector to emitter voltage Vce in the observation table.
- Repeat above procedure for base currents Ib = 5μA, 50 μA, 100 μA. Increase base current by increasing V_{BB}.
- Draw output characteristics curve. Plot Vce on X axis and Ic on Y axis.

Observation table:

Transistor: __________

Sr. No.	Ib = 0		Ib = 5µA		Ib = 50µA		Ib = 100µA	
	Vce	**Ic**	**Vce**	**Ic**	**Vce**	**Ic**	**Vce**	**Ic**
1								
2								
3								
4								
5								
6								
7								
8								

Output Characteristics:

Conclusion:

Questions:

[1] How to check transistor with help of multimeter?

[2] How to check type of transistor (NPN or PNP) with help of multimeter?

[3] Define current gain of the transistor in CE configuration. What is the DC current gain you obtain in this practical?

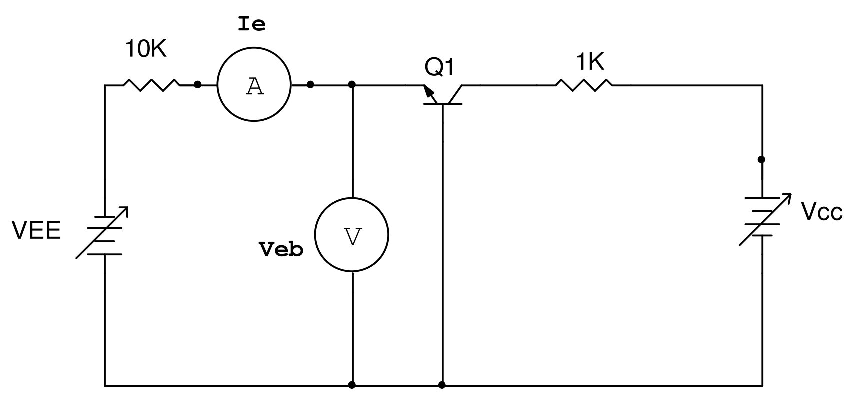
EXPERIMENT NO. 14

AIM: To obtain common base characteristics of NPN transistor

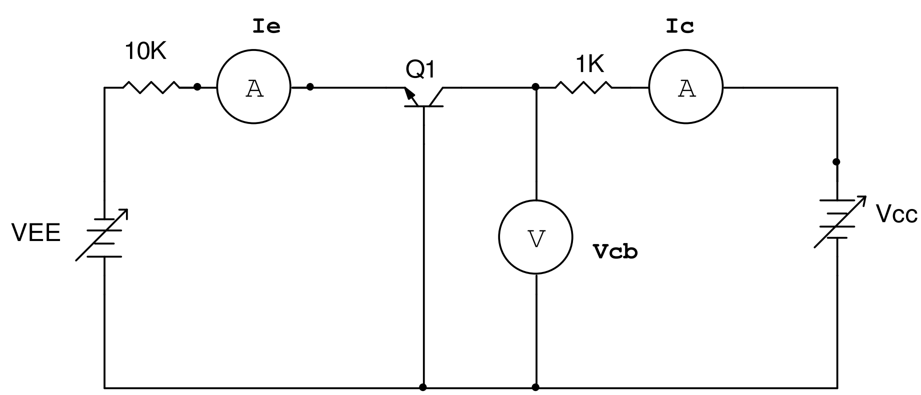
Introduction:

In a common base configuration, base terminal is common between input and output. The output is taken from collector and the input voltage is applied between emitter and base. The base is grounded because it is common. To obtain output characteristics, we will measure collector current for different value of collector to base voltage (V_{CB}). Input current is emitter current Ie and input voltage is Veb. To plot input characteristics we will plot Veb versus Ie. Current gain for CB configuration is less than unity. CB configuration is used in common base amplifier to obtain voltage gain. Output impedance of common base configuration is very high. CB amplifier is used in multi-stage amplifier where impedance matching is required between different stages.

Circuit diagram to obtain input characteristics:



Circuit diagram to obtain output characteristics:



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Experiment Procedure to obtain input characteristics:

- Connect circuit as shown in the circuit diagram for input characteristics
- Connect variable power supply 0-30V (V_{EE}) at emitter base circuit and another power supply 0-30V at collector base circuit (Vcc).
- Keep Vcc fix at 0V (Or do not connect Vcc)
- Increase V_{EE} from 0V to 20V, note down readings of emitter current Ie and emitter to base voltage Veb in the observation table.
- Repeat above procedure for Vcc = +5V and Vcc = +10V
- Draw input characteristics curve. Plot Veb on X axis and Ie on Y axis.

Experiment Procedure to obtain output characteristics:

- Connect circuit as shown in the circuit diagram for output characteristics
- Connect variable power supply 0-30V at emitter circuit and collector circuit.
- Keep emitter current fix (Initially 0)
- Increase V_{CC} from 0V to 30V, note down readings of collector current Ic and collector to base voltage Vcb in the observation table.
- Repeat above procedure for base currents Ie = 1mA, 5 mA and 10mA. Increase emitter current by increasing V_{EE}.
- Draw output characteristics curve. Plot Vcb on X axis and Ic on Y axis.

Observation table for input characteristics:

Transistor: __________

Sr. No.	**Vcc = 0V**		**Vcc = +5V**		**Vcc=+10V**	
	Veb	**Ie**	**Veb**	**Ie**	**Veb**	**Ie**
1						
2						
3						
4						
5						
6						

Input Characteristics:

Observation table for output characteristics:

Transistor: __________

Sr. No.	Ie = 0		Ie = 1 mA		Ie = 5 mA		Ie = 10 mA	
	Vcb	Ic	Vcb	Ic	Vcb	Ic	Vcb	Ic
1								
2								
3								
4								
5								
6								
7								
8								

Output Characteristics:

Conclusion:

Questions:

[1] What is early effect? Have you observed early effect in your experiment?

[2] Compare common base and common emitter configuration

[3] Justify the statement: Common base amplifier is used as buffer

[3] What is the value of phase shift between input and output signal in common base and common emitter amplifier?

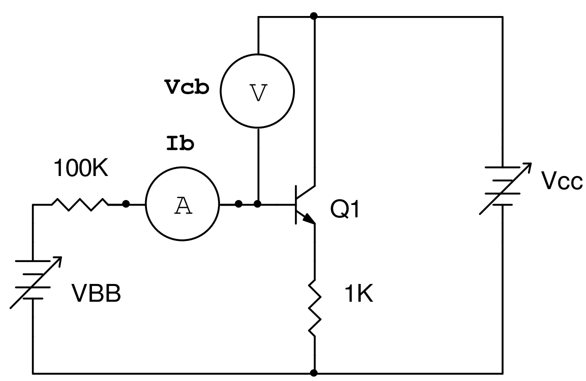
EXPERIMENT NO. 15

AIM: To obtain common collector characteristics of NPN transistor

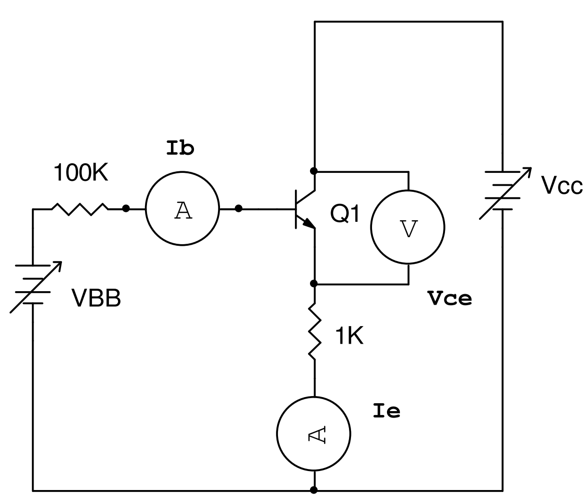
Introduction:

In common collector configuration, collector terminal is common between input and output. Input is applied between base and collector. Output is taken from emitter and collector. Voltage gain of CC configuration is less than unity. CC amplifier is used to provide current gain. It has very high input impedance and very low output resistance hence it is used to connect low impedance load to source which is having high output impedance. Thus, it can be used as impedance matching. Emitter current is approximately equal to collector current, hence output characteristics of CC configuration is very much same as CE configuration. However, input characteristics of CE and CC are quite different.

Circuit diagram to obtain input characteristics:



Circuit diagram to obtain output characteristics:



:: WORKSHEET ::

Experiment Procedure to obtain input characteristics:

- Connect circuit as shown in the circuit diagram for input characteristics
- Connect variable power supply 0-30V (V_{BB})at base-emitter circuit and another power supply 0-30V at collector emitter circuit (Vcc).
- Keep Vce fix at 0V (Or do not connect Vcc)
- Increase V_{BB} from 0V to 20V, note down readings of base current Ib and collector to base voltage (Vcb) in the observation table.
- Repeat above procedure for Vce = +1V and Vce = +2V
- Draw input characteristics curve. Plot Vcb on X axis and Ib on Y axis.

Experiment Procedure to obtain output characteristics:

- Connect circuit as shown in the circuit diagram for output characteristics
- Connect variable power supply 0-30V at base circuit and collector circuit.
- Keep base current fix (Initially 0)
- Increase V_{CC} from 0V to 30V, note down readings of emitter current Ic and collector to emitter voltage Vce in the observation table.
- Repeat above procedure for base currents Ib = 10μA, 50 μA and 100μA. Increase base current by increasing V_{BB}.
- Draw output characteristics curve. Plot Vce on X axis and Ie on Y axis for different values of base currents.

Observation table for input characteristics:

Transistor: __________

Sr. No.	**Vce = 0V**		**Vce = +1V**		**Vce=+2V**	
	Vcb	**Ib**	**Vcb**	**Ib**	**Vcb**	**Ib**
1						
2						
3						
4						
5						
6						

Input Characteristics:

Observation table for output characteristics:

Transistor: __________

Sr. No.	Ib = 0 µA		Ib = 10 µA		Ib = 50 µA		Ib = 100 µA	
	Vce	**Ie**	**Vce**	**Ie**	**Vce**	**Ie**	**Vce**	**Ie**
1								
2								
3								
4								
5								
6								
7								
8								

Output Characteristics:

Conclusion:

Questions:

[1] What is the input and output impedance of CC configuration compared to CE and CB configuration?

[2] Justify: It is better to use common-collector amplifier between common emitter amplifier and load-speaker.

[3] Compare voltage gain and current gain of CC amplifier with CB and CE amplifier.

[4] What is emitter follower?

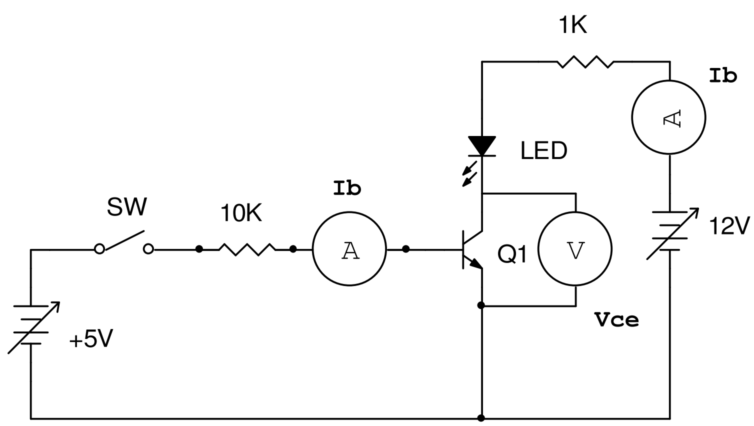
EXPERIMENT NO. 16

AIM: To understand working of transistor as a switch. To draw DC load line for given circuit

Introduction:

Transistor can be operated in three region: cut-off region, active region and saturation region. While using transistor in amplifier circuit, we are using active region. If transistor operated in cut-off and saturation region in amplifier, clipping of waveforms will occur. When we use transistor as a switch, only two regions cut-off and saturation are used. In saturation region transistor acts as ON switch. In cut-off region, transistor acts as OFF switch. We are using only two points of DC load line while using transistor as a switch.

Circuit diagram:



Experiment Procedure to obtain input characteristics:

- Connect circuit as shown in the circuit diagram for input characteristics
- Adjust collector supply Vcc = +12V and base supply V_{BB}=+5V
- You may use base voltage supply switch instead of switch shown in the circuit diagram.
- Measure base current when switch is OFF (It will be zero). Measure collector current and voltage between collector and emitter. LED is off because transistor is in cut-off region,
- Now apply base voltage +5V, LED will be ON. Measure collector current and collector-emitter voltage. Transistor is in saturation region.

:: WORKSHEET ::

Observations:

[1] Switch off (V_{BB}=0): Ib = ________ V_{CE} = __________ Ic = ________

[2] Switch ON (V_{BB}=+5V): Ib = ________ V_{CE} = __________ Ic = ________

Draw DC load line and show saturation and cut off points:

Conclusion:

____

____

____

____

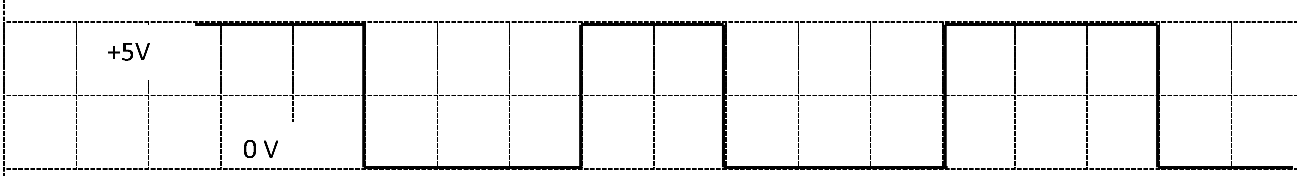
Questions:

[1] What are the applications of transistor as a switch?

[2] What should be ratio of collector resistance to base resistance while designing transistor switch? What is hard saturation?

[3] Draw output waveform when following waveform is applied at the base circuit.

Input waveform applied at base:



Output waveform:

EXPERIMENT NO. 17

AIM: To observe input-output waveforms of common emitter (CE) amplifier. To measure gain of amplifier at different frequencies and plot frequency response

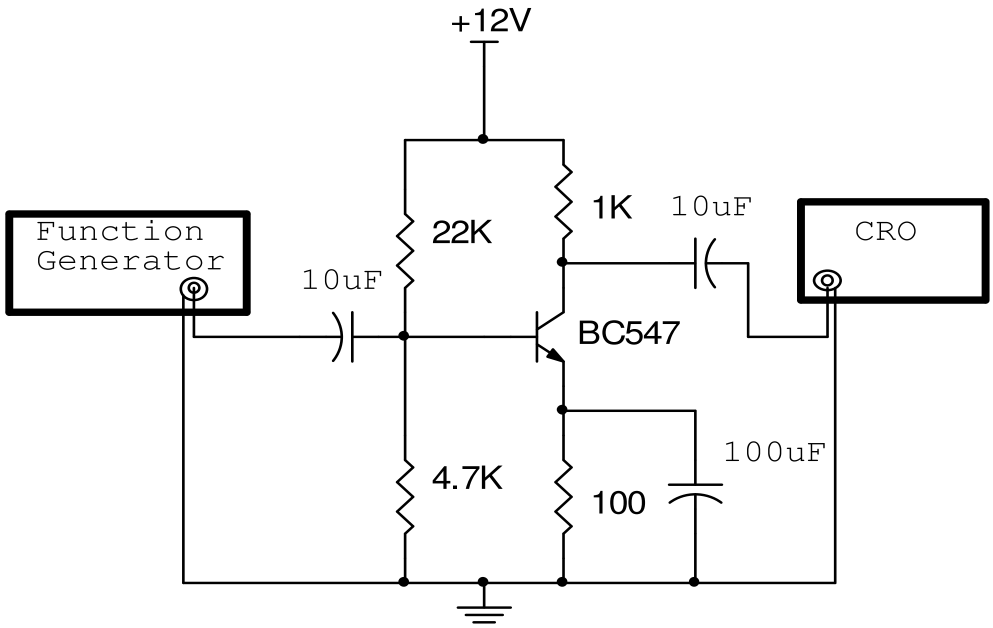
Introduction:

Common emitter amplifier is used to amplify weak signal. It utilizes energy from DC power supply to amplify input AC signal. Biasing of transistor is done to tie Q point at the middle of the load line. In the circuit shown, voltage divider bias is formed using resistors 10K and 2.2K. During positive cycle, forward bias of base-emitter junction increases and base current increases. Q point moves in upward direction on load line and collector current increases β times than base current. (β is current gain). Collector resistor drop IcRc increases due to increase in collector current Ic. This will reduce collector voltage. Thus during positive input cycle, we get negative output cycle. When input is negative cycle, forward bias of base-emitter junction and base current will reduce. Collector current reduces (Q point moves downside). Due to decrease in collector current, collector resistance voltage drop IcRc reduces and collector voltage increases. Change in collector voltage is much higher than applied base voltage because less base current variation causes large collector current variation due to current gain *B*. This large collector current further multiplied by collector resistance Rc which provides large voltage output. Thus CE amplifier provides voltage gain and amplifies the input signal. Without emitter resistance gain of amplifier is highest but it is not stable. Emitter resistance is used to provide stability. To compensate effect of emitter resistance emitter bypass capacitor is used which provides AC ground to the emitter. This will increase gain of amplifier.

CE amplifier does not provide constant voltage gain at all frequencies. Due to emitter bypass and coupling capacitors reduces gain of amplifier at low frequency. Reactance of capacitor is high at low frequency, hence emitter bypass capacitor does not provide perfect AC ground (Emitter impedance is high). There is voltage drop across coupling capacitor at low frequency because of high reactance at low frequencies. Gain of CE amplifier also reduces at very high frequency because of stray capacitances. Audio frequency transistors like AC127, AC128 works for audio frequency range. It does not provide large voltage gain for frequency greater than 20 KHz. Medium frequency transistors are BC147/ BC148/ BC547/ BC548 provides voltage gain up to 500 KHz. High frequency transistors like BF194/ BF594/ BF200 provides gain at radio frequencies in the MHz range.

If we apply large signal at the input of CE amplifier, transistor driven into saturation region during positive peak and cut-off region during negative peak (Q point reaches to saturation and cut-off points). Due to this clipping occurs in amplified signal. So we have to apply small signal at the input and ensure that transistor operates in active region.

Circuit diagram:



Experimental procedure:

- Connect function generator at the input of the amplifier circuit.
- Set input voltage 10 mV and frequency 100 Hz.
- Connect CRO at the output of the amplifier circuit.
- Observe amplified signal and measure output voltage
- Increase frequency from the function generator and repeat above step
- Note down readings of output voltage in the observation table for frequency range from 100 Hz to 10 MHz
- Calculate voltage gain for different frequencies and gain in dB. Plot frequency response.

:: WORKSHEET ::

Draw circuit diagram from the board available in the laboratory:

Observation table:

Input voltage: Vi = 10 mV

Sr. No.	Frequency at the input	Output voltage Vo	Gain A = Vo/ Vi	Gain in dB= 20log10(A)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				

Draw frequency response of CE amplifier (you can also use logarithmic graph or use log scale)

Conclusion:

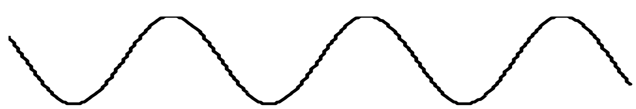
Questions:

[1] What will be emitter current in the given circuit diagram in absence of input AC signal?

[2] Draw DC load line of CE amplifier circuit. Show Q point on it.

[3] Draw output waveform when following waveform is applied at the CE amplifier circuit

Input waveform applied at base: (Peak to peak voltage is 2V)



Output waveform:

[4] What is bandwidth? What is the approximate bandwidth of CE amplifier that you have used during your practical.

[5] What is the effect on gain of amplifier if value of Rc increases?

[6] What are the different biasing methods?

[7] What happens if emitter bypass capacitor is removed from the circuit?

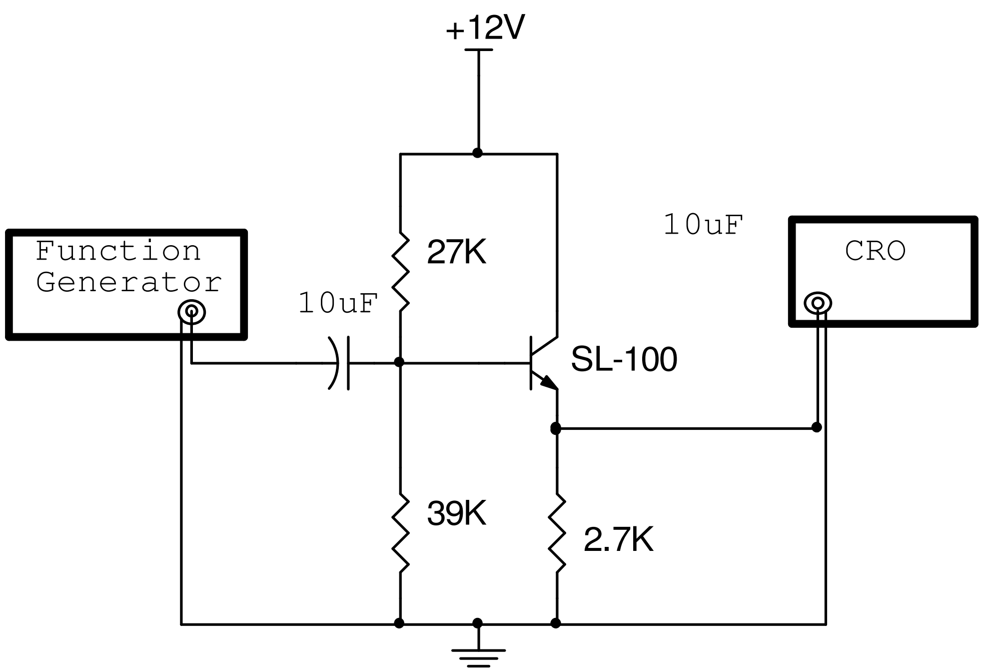
EXPERIMENT NO. 18

AIM: To observe input-output waveforms of common collector(CC) amplifier. To measure gain of amplifier at different frequencies and plot frequency response

Introduction:

The common collector (CC) amplifier is also known as emitter follower. It is used as a current amplifier. Voltage gain of CC amplifier is less than unity while current gain is (β+1). CC amplifier has high input impedance and low output impedance. There is no phase reversal between input and output.

Circuit diagram:



Experimental procedure:

- Measure Emitter voltage in absence of input AC signal.
- Connect function generator at the input of the amplifier circuit.
- Set input voltage 1V and frequency 100 Hz.
- Connect CRO at the output of the amplifier circuit.
- Observe output signal and measure output voltage
- Draw input and output signal

:: WORKSHEET ::

Draw circuit diagram from the board available in the laboratory:

Observations:

DC Voltage in absence of input signal: V_E = ______ V

AC Input voltage: Vi = 1 V

Input Waveform																	

Output Waveform																	

Conclusion:

____

____

____

____

Questions:

[1] What will be emitter voltage and current in the given circuit diagram in absence of input AC signal?

____

____

____

____

____

____

____

____

[2] What is the equation of current gain in CC amplifier? What is the current gain of CC amplifier used in laboratory?

____

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____

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____

____

____

[3] Can we connect loud speaker instead of emitter resistance?

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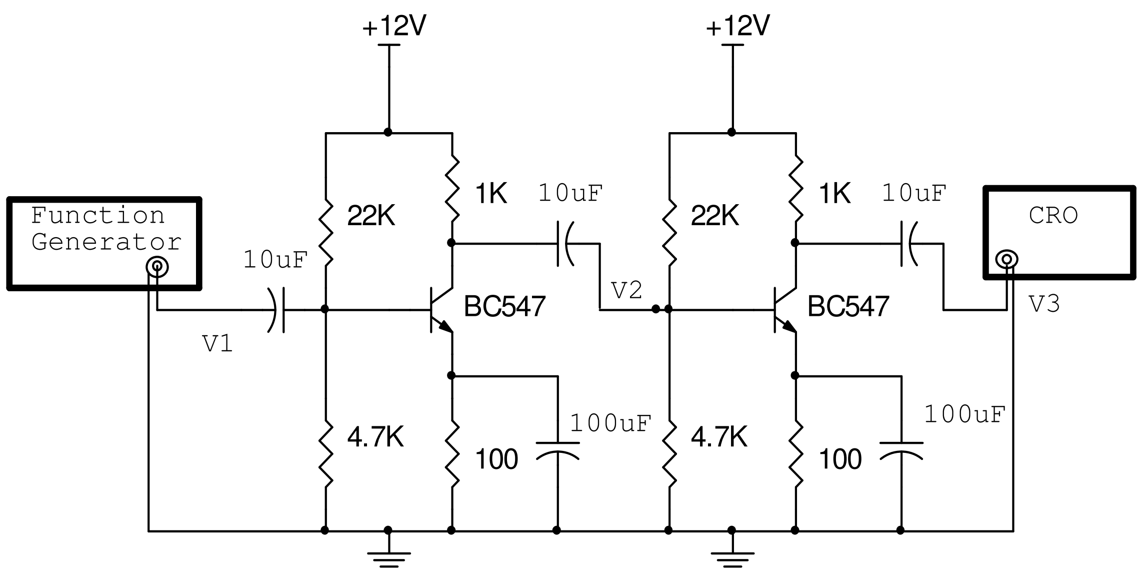
EXPERIMENT NO. 19

AIM: To measure gain of two stage RC coupled amplifier

Introduction:

To achieve higher gain, we can use multi-stage amplifier where output of one amplifier is connected to input of next amplifier. Amplifiers are connected in cascade arrangement so it is also called cascade amplifier. Output of first amplifier is connected to input of second amplifier by coupling device like coupling capacitor. Direct coupling or transformer coupling is also used. Capacitor coupling is used to couple AC signal from output of first amplifier to input of second amplifier. Coupling capacitor does not pass DC signal so DC biasing of second stage is not affected by first stage and vice-versa. In this practical, we will use capacitor coupling which is also known as two stage RC coupled amplifier. Typical circuit diagram is shown below:



In this circuit diagram, output of first stage is connected to input of the second stage by coupling capacitor of 10 μF. RC network is formed by this coupling capacitor and voltage divider bias of the next stage. Input signal V1 is amplified by first amplifier. Amplified signal from first amplifier is V2 which is further amplified by second amplifier. Output signal from the second amplifier is V3. If gain of amplifier 1 is A_1 then $V2=A_1V1$. If gain of amplifier 2 is A_2 then $V3=A_2V2$. From this relationship, $V3=A_1A_2V1$. This theoretical overall gain of cascade amplifier is $A = V3/V1 = A_1A_2$. However practically overall gain is slightly less than A1A2 because of loading effect of second stage on the first stage. Overall bandwidth of amplifier will decrease.

Experimental procedure:

- Connect function generator at the input of the amplifier circuit.
- Set input voltage V1=1 mV and frequency 100 Hz.
- Connect CRO at the output of the first amplifier circuit at point V2.
- Observe amplified signal and measure output voltage at V2
- Find out gain of first amplifier A_1=V2/ V1.
- Observe amplified signal at the output of second amplifier and measure output voltage at V3
- Find out gain of second amplifier A_2=V3/ V2.
- Find overall gain of amplifier A = V3/ V1= $A_1 A_2$
- Increase frequency from the function generator and repeat above steps
- Note down readings of output voltage in the observation table for frequency range from 100 Hz to 10 MHz
- Calculate voltage gain A1 and A2 for different frequencies and gain in dB. Plot frequency response.

:: WORKSHEET ::

Draw circuit diagram from the board available in the laboratory:

Observation table:

Input voltage: V1 = 10 mV

Sr. No.	Freq. at the input	Output voltage V2	Output voltage V3	Gain A1=V2/V1	Gain A2=V3/V2	A=A1A2	A in dB
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

Draw frequency response of CE amplifier (you can also use logarithmic graph or use log scale)

Conclusion:

Questions:

[1] What are the advantages of multistage amplifier?

[2] What will happen if we increase input voltage in two stage RC coupled amplifier used in your practical to 10 mV?

[4] What are the different coupling methods? What is the advantage and disadvantage of direct coupling?

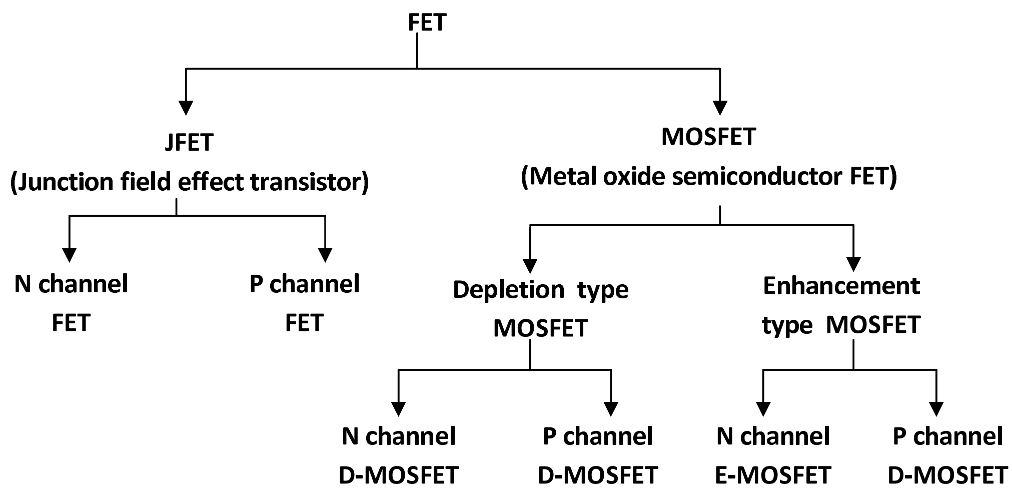
EXPERIMENT NO. 20

AIM: To obtain characteristics of field effect transistor (FET)

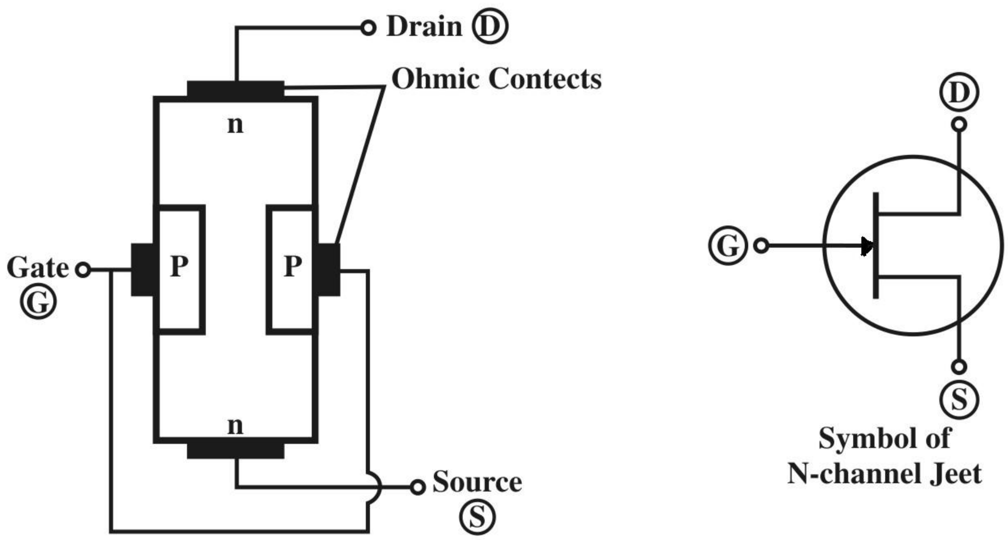
Introduction:

The Field Effect Transistor (FET) is a three terminal device. Three terminals are Drain (D), Source (S) and Gate (G). In FET, current flow is due to only one type of charge particles, either electrons or holes. So FET is known as unipolar device. The name "field effect" is derived from the fact that the current is controlled by an electric field set up in the device by an externally applied voltage. Thus FET is a voltage controlled device while bipolar transistor is current controlled device.

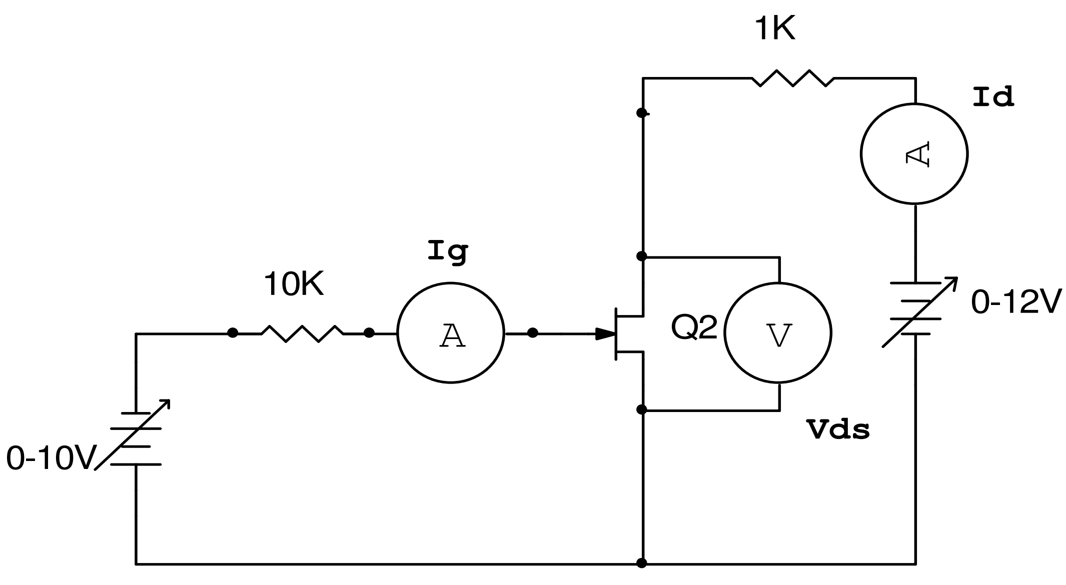
The Field Effect Transistor (FET) can be broadly classified into following categories:



In this experiment we will obtain output characteristics of N-channel FET using CS (Common source) Configuration. It is also known as drain characteristics. Basic construction of N-channel FET and its symbol are shown in the following figure. When gate to source voltage V_{GS} is zero, N type channel is open so drain current will flow through it. As we increase negative voltage on the gate terminal, V_{GS}=-1V, -2V, -3V etc., drain current reduces. The reduction in drain current is due to reduction in width of channel. As we increase negative gate voltage, width of depletion region spreads in the channel. Depletion region (generated field due to reverse bias) does not have charge carriers so width of channel will reduce. As we increase negative value of VGS, penetration of depletion region (field) will be more and more due to which channel becomes narrower. At one point drain current reduces to zero when entire channel will be closed due to penetration of depletion region. The value of V_{GS} at which drain current reduces to zero is called cut-off voltage $V_{GS(off)}$. Normally Drain current reduces to zero at V_{GS}=-Vp. Thus $V_{GS(off)}$ = -V_P where V_P is pinch-off voltage. Pinch-off voltage VP is the value of voltage V_{DS} at which drain current becomes constant.



Circuit diagram:



Experiment Procedure:

- Connect circuit as shown in the circuit diagram for output (drain) characteristics
- Connect variable power supply 0-10V at gate circuit and 0-12V at drain circuit.
- Keep gate to source voltage zero (V_{GS}=0).

- Increase drain supply Vdd from 0V to 12V, note down readings of drain current Id and drain to source voltage Vds in the observation table.
- Repeat above procedure for different gate to source voltages VGS = -1, -2, -3, -4 etc. Note down reading of Gate to source voltage at which drain current remains zero. This is cut-off voltage $V_{GS(off)}$.
- Note down pinch-off voltage for all values of V_{GS}.
- Draw output characteristics curve. Plot Vds on X axis and Id on Y axis.

:: WORKSHEET ::

Draw circuit diagram of the circuit available in the laboratory:

Observation table:

FET: __________

Sr. No.	**V_{GS}=0 V**		**V_{GS} = -1 V**		**V_{GS} = -2 V**		**V_{GS} = -4 V**	
	Vds	**Id**	**Vds**	**Id**	**Vds**	**Id**	**Vds**	**Id**
1								
2								
3								
4								
5								
6								
7								
8								
9								

Output Characteristics:

Conclusion:

Questions:

[1] Compare bipolar junction transistor (BJT) and field effect transistor (FET). Discuss relative advantages and disadvantages.

[2] What is pinch-off voltage? What is the relationship between drain current and pinch-off voltage?

[3] What is trans-conductance? Define trans-conductance for FET. Draw typical transconductance curve of FET from the observations you have taken for output characteristics.

____

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Transconductance curve:

[4] Find numbers of any two JFET and its specifications from the website

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EXPERIMENT NO. 21

AIM: To measure gain FET common source (CS) amplifier

Introduction:

Common source FET amplifier is used to amplify weak signal. Small AC signal is applied at gate terminal via coupling capacitor. Gate resistance provides self bias. Input AC signal provides variations in Gate to source voltage V_{GS}. Because of change in V_{GS}, drain current Id also changes. If we apply sinusoidal input signal, sinusoidal variation in drain current produces sinusoidal output at drain terminal. During positive input signal, V_{GS} increases which will cause increase in drain current. Drain voltage decreases due to drop across drain resistance increases. Thus we get 180^0 phase shift between input and amplified output signal.

Output voltage from FET amplifier can be given as:

$$Vout = -g_m Vgs R_D$$

Where, gm = transconductance of FET

R_D = Drain resistance

Vgs = Variation in gate to source voltage due to input signal

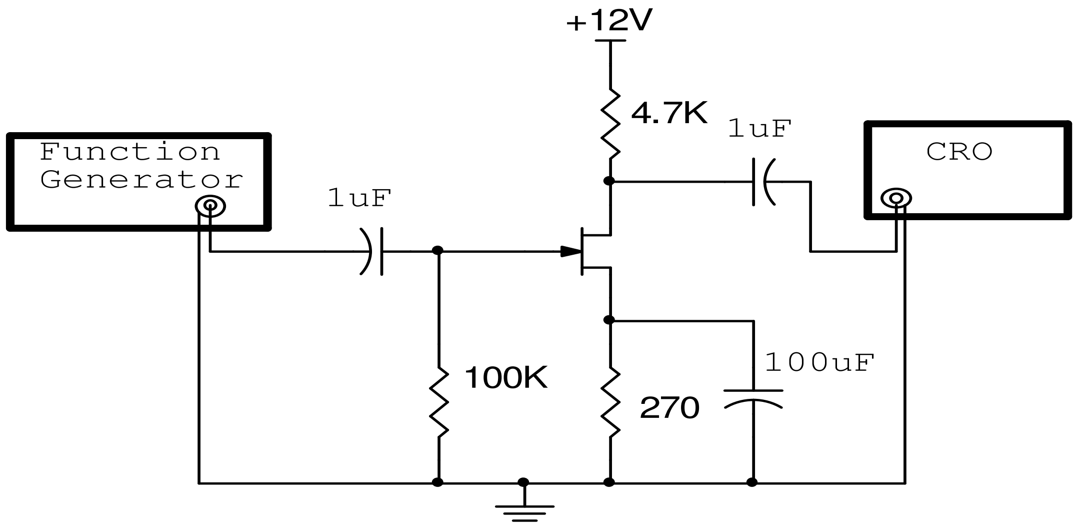
Minus sign in the equation indicates, 180^0 phase shift. Gain of amplifier is ratio of output voltage to input voltage.

$$A = \frac{Vout}{Vgs} = -g_m R_D$$

Because of the non-linear transconductance curve of FET, CS amplifier distorts large signals. It can amplify small signal without introducing non-linearity into it. For large signal, it introduces non-linearity called square law distortion. This is due to parabolic transconductance curve of FET. Swamping resistor can be used with source terminal to provide local feedback. This will swamp out non-linearity of the transconductance curve.

Different types of biasing techniques are used for CS amplifier. Gate bias is similar to base bias in BJT, self bias, voltage divider bias, current-source bias etc. Circuit diagram of CS amplifier with self bias is shown here.

Circuit diagram:



Experimental procedure:

- Connect function generator at the input of the amplifier circuit.
- Set input voltage 100 mV and frequency 100 Hz.
- Connect CRO at the output of the amplifier circuit.
- Observe output signal and measure output voltage
- Increase frequency of the input signal and repeat above steps for different frequencies

:: WORKSHEET ::

Draw circuit diagram from the board available in the laboratory:

Observation table:

Input voltage: Vi = 100 mV

Sr. No.	Frequency at the input	Output voltage Vo	Gain A = Vo/ Vi	Gain in dB= 20log10(A)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				

Draw frequency response of CS amplifier (you can also use logarithmic graph or use log scale)

Conclusion:

Questions:

[1] Why gate bias is not preferred for FET amplifier?

[2] From the datasheet of FET 2N5951 IDSS=10 mA and VGS=-3.5V. Calculate the drain current of FET for VGS=-1V, -2V and -3V ?

[3] Can we use FET as electronic switch? If yes how?

EXPERIMENT NO. 22

AIM: To test individual circuit prepared by the student

Name of the circuit:

Circuit diagram:

List of component used:

Total cost of component:

Quality of soldering:

(Remarks by the faculty)

Testing procedure:

____
____
____
____
____
____
____
____
____
____
____

Results:

(Results depends on circuit diagram, prepare observation table, draw waveforms as per your circuit diagram, attach more pages if needed)