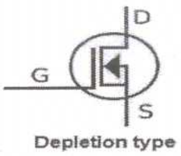
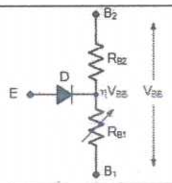
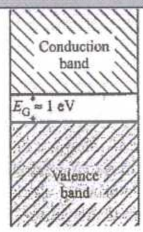
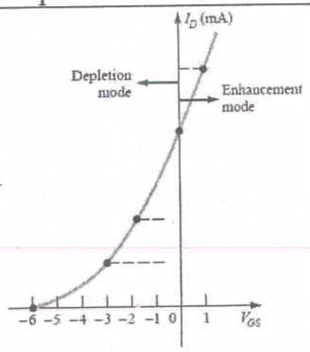
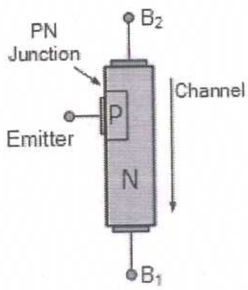
SCORING INDICATORS

Course Code: 2041 **Revision : 2021**

Course Title : BASIC ELECTRONICS **QID : 2106220058**

SET 2

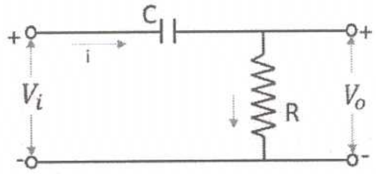
Qn. No.	Scoring Indicator	Split score	Sub Total	Total Score
	PART A			9
I.1	Phosphorus, Arsenic, Antimony, Bismuth [any two]	1	1	1
I.2	The maximum voltage a diode can withstand in the reverse bias condition before breakdown.	1	1	1
I.3	α is the ratio of transistor's collector current to emitter current.	1	1	1
I.4	saturation	1	1	1
I.5		1	1	1
I.6	Drain current is controlled by gate voltage.	1	1	1
I.7		1	1	1
I.8	Differentiator	1	1	1
I.9	1.21	1	1	1
	PART B			24
II 1	 Semiconductors	1	3	3
	The forbidden energy gap is not wide (for germanium Eg= 0.72 eV and for silicon Eg= 1.12 eV). The energy provided by heat at room temperature is sufficient to lift electrons from the valence band to the conduction band. Some electrons jump the gap and go to the conduction band. At room temperature, semiconductors are capable of conducting some electric current. At absolute zero temperature semiconductor acts like a perfect insulator.	2		
II 2	Static Resistance : The opposition offered by a diode to the direct current flowing in forward bias condition is known as its DC or static resistance	1	3	3
	Dynamic Resistance : The resistance offered by the diode to the ac signal is called its dynamic or ac resistance	1		
	Knee voltage : The minimum amount of forward voltage required for conduction of the diode	1		
II 3	Zener breakdown takes place in a very thin junction, i.e. for heavy doping under reverse bias. In the zener breakdown mechanism, the electric field becomes as high as 10^7 V/m in the depletion layer. In this process it becomes possible for some electrons to jump across the barrier from p-material to n-material.	3	3	3

II 4	Forward voltage drop – The voltage dropped across a conducting, forward-biased diode is called the forward voltage drop. Power rating - The Power Rating is defined as the maximum power that a PN junction or diode can dissipate without damaging the device itself. The power dissipated is equal to the product of junction current and the voltage across the junction. Reverse saturation current - It is the part of the reverse current in a semiconductor diode which is caused by the diffusion of minority carriers from the neutral regions to the depletion region.	1 1 1	3	3
II 5	Relation between α and β $\beta_{ac} = \frac{\Delta I_C}{\Delta I_B}$ ……….(1) $\alpha_{ac} = \frac{\Delta I_C}{\Delta I_E}$ ……….(2) • $I_E = I_B + I_C$ ….(3) • $\Delta I_E = \Delta I_B + \Delta I_C$ …..(4) • Dividing eqn 4 by ΔI_C • $(\Delta I_E / \Delta I_C) = (\Delta I_B / \Delta I_C) + (\Delta I_C / \Delta I_C)$ • $(1/\alpha_{ac}) = (1/\beta_{ac}) + 1$ • Rearranging the equations, we get $\alpha_{ac} = \frac{\beta_{ac}}{1+\beta_{ac}}$ • and $\beta_{ac} = \frac{\alpha_{ac}}{1-\alpha_{ac}}$ • Similarly $\alpha_{dc} = \frac{\beta_{dc}}{1+\beta_{dc}}$ and $\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$	2 1 [eqn.]	3	3
II 6	Pinch off voltage refers to the voltage applied between Drain and Source (with the Gate voltage at zero volts) at which maximum current flows. Operating with the Drain/Source voltage below this value is classed is the "Ohmic Region" as the JFET will act rather like a resistor. Operating with the Drain Source voltage above Pinch Off is known as the "Saturation Region" as the JFET is acting like a saturated transistor; that is any increase in voltage does not produce a relative increase in current.	3	3	3
II 7		3	3	3
II 8	Structure  Emitter junction becomes forward biased when V_E>Vp. Positive voltage is applied at the emitter terminal and Base 2 is made positive with the Base1. The majority carrier which is the holes in the P type enters the N channel and since Base 2 is positive it gets repelled and attracted towards Base1 terminal. So the resistance decreases. The Emitter current increases and reaches the peak and starts decreasing. After it reaches the valley point again it starts increasing.	1 2	3	3

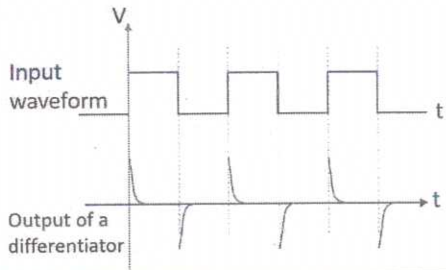
II 9 — 6x0.5 marks | 3 | 3

BJT	FET
Bipolar	Unipolar
Operation depends on both majority charge carriers and minority charge carriers.	Operation depends on majority charge carriers
Input impedance very less	Input impedance is very large.
Current control device.	Voltage-controlled device.
Noisy	Less noisy.
Less temperature stability	Better temperature stability.
Cheaper.	costlier than BJT
It has more gain.	It has less gain.
Bigger in size	Smaller in size
Its switching time is medium.	Its switching time is fast.
It consumes more power.	It consumes less power

II 10 — 2 | 3 | 3



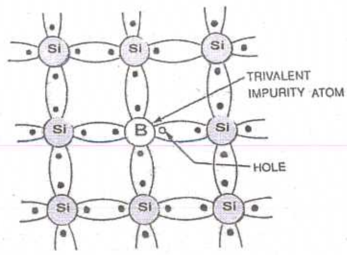
1



PART C — 42

III 1. — 7 | 7

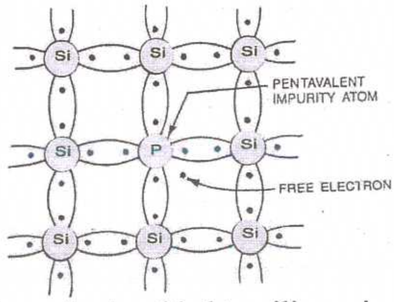
Diagram – P type — 2



1.5

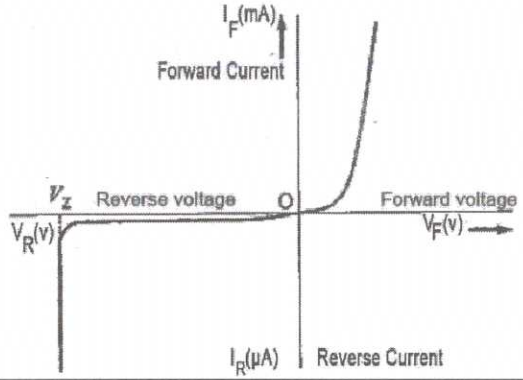
When a trivalent an acceptor impurity is added to silicon, impurity atom replaces a silicon atom - Valence electrons of impurity form covalent bonds with the three neighbouring silicon atoms - The fourth silicon atom is unable to form a covalent bond - There is a deficiency of an electron

Diagram - N type — 2

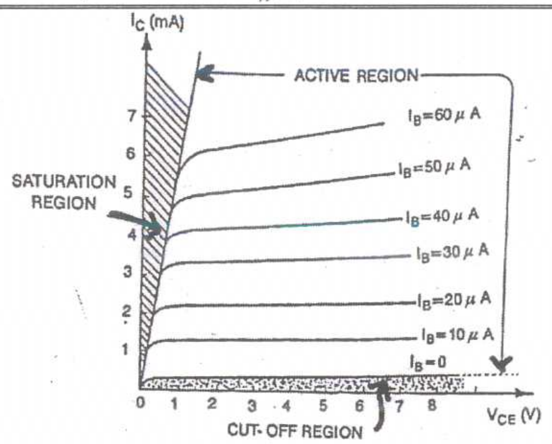


1.5

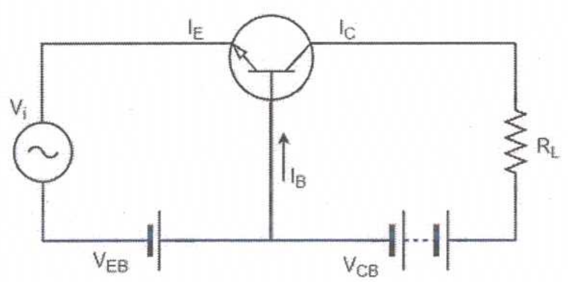
When a pentavalent impurity is added to silicon, impurity atom replaces a silicon atom. Four of these form covalent bonds with the surrounding four silicon atoms. The fifth electron is not associated with any covalent bond and is quite far from the nucleus.

<table>
<tr><td>III 2.</td><td>FORWARD BIAS : positive terminal of a battery to p-type, and the negative terminal to n-type - establishes an electric field which reduces the field created due to potential barrier - Once the potential barrier is eliminated, a conducting path is established for the flow of current - a large current starts flowing through the junction.
REVERSE BIAS : positive terminal of a battery to n-type, and the negative terminal to p-type - majority carriers are drawn away from the junction - widens the depletion region and increases the barrier potential - establishes an electric field which increases the field due to the potential barrier - prevents the flow of majority charge carriers across the junction - practically no current flows

</td><td>2

2

3</td><td>7</td><td>7</td></tr>
<tr><td>III 3.</td><td>

Value of Ic increases with the increase in V_{CE} at constant I_B, the value of β also increases (as $\beta = I_C/I_B$) - When V_{CE} falls below a few tenths of a volt, I_C decreases rapidly as V_{CE} decreases - When V_{CE} drops below the value of V_{BE}, the collector-base junction becomes forward biased - In this condition, both junctions of the transistor are forward biased - In the active region, the collector current is β times greater than the base current - Thus, small input current I_B produces a large output current I_C - When $I_B = 0$, I_C is not zero but equal to the reverse leakage current I_{CEO}</td><td>4

3</td><td>7</td><td>7</td></tr>
<tr><td>III 4.</td><td>

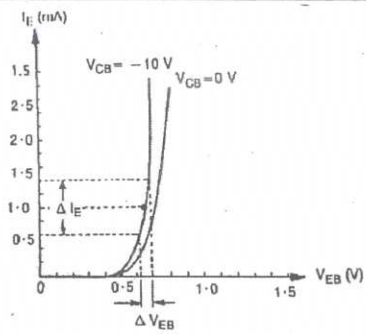
Low resistance in input circuit, lets any small change in input signal to result in an appreciable change in the output. The emitter current caused by the input signal contributes the collector current, which when flows through the load resistor R_L, results in a large voltage drop across it.
[CE configuration can also be used for explanation]</td><td>4

3</td><td>7</td><td>7</td></tr>
</table>

III 5. (Marks: 7 | 7 | 7)

S. No.	Characteristics	Common-base configuration	Common-emitter configuration	Common-collector configuration
1.	*Input resistance*	Low (50 Ω)	*Low (1 kΩ)	Very high (750 kΩ)
2.	*Output resistance*	Very high (500 kΩ)	High (10 kΩ)	Low (50 Ω)
3.	*Current gain*	Less than unity (0.98)	High (100)	High (100)
4.	*Voltage gain*	Small (150)	High (500)	Less than one
5.	*Leakage current*	Very small (5 μA for Ge 1 μA for Si)	Very large (500 μA for Ge 20 μA for Si)	Very large (500 μA for Ge 20 μA for Si)
6.	*Applications*	For high frequency applications	For audio frequency applications	For impedance matching
7.	Phase between input and output	0°	180°	0°

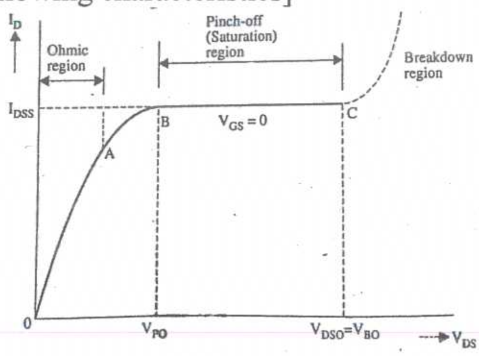
III 6. (Marks: 4 | 7 | 7)



For a specific value of V_{CB}, the curve is a diode characteristic in the forward region - This is because the PN emitter junction is forward biased - When V_{CB} increases, the value of emitter current increases slightly - The junction behaves like a better diode as V_{CB} increases - The emitter current I_E increases rapidly with the small increase in V_{EB} (3)

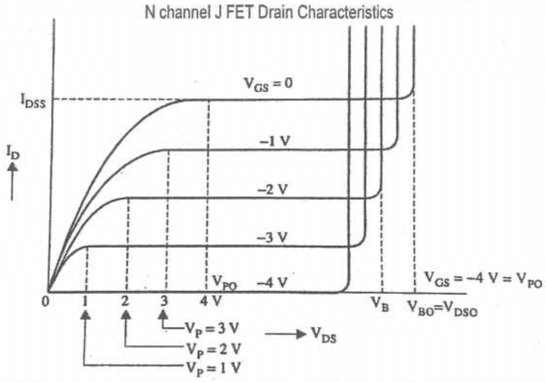
III 7. (Marks: 4 | 7 | 7)

[Any one of the following characteristics]

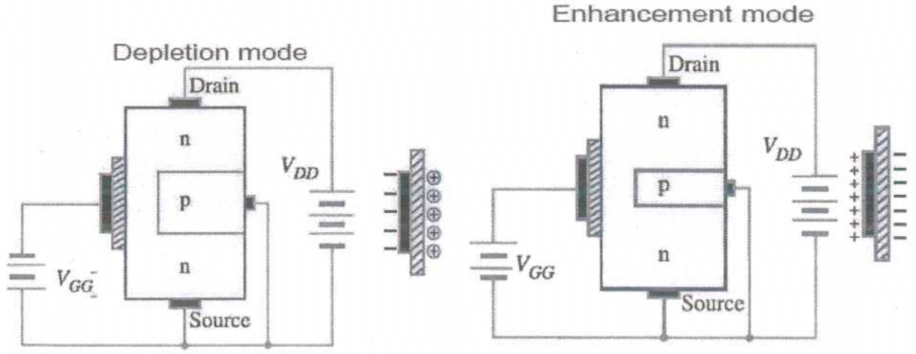


N channel J FET Drain Characteristics

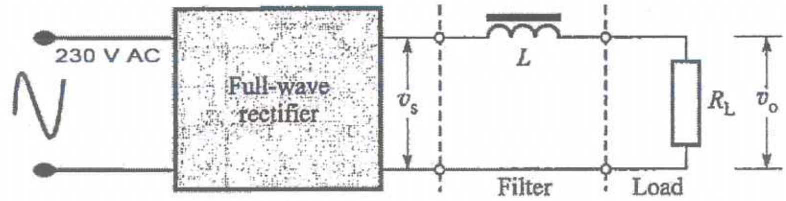
N channel J FET Drain Characteristics

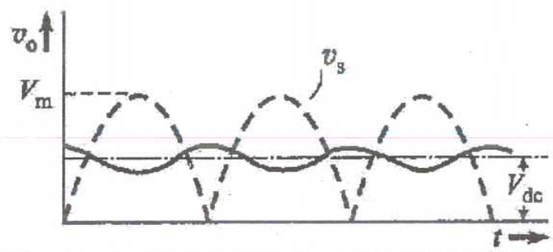


Ohmic Region OA – current proportional to voltage –
V_{DS} corresponding to point B is the pinch off voltage.
Pinch off region/Amplifier region BC – I_D is independent of V_{DS} – As V_{DS} increases, channel resistance also increases -
Breakdown region – After C, JFET enters into breakdown region – I_D increases to excessive value.
As V_{GS} is decreased to negative values, pinch off voltage and breakdown voltage is decreased (3)

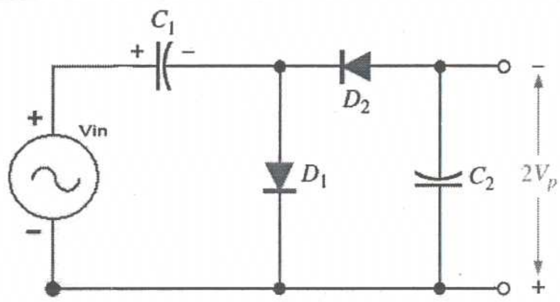
<table>
<tr><td>III 8.</td><td>

(i) Depletion mode. – Gate is negative - Electrons on the gate repel the free electrons in the n-channel, leaving a layer of positive ions in channel - depleted the n-channel of some of its free electrons - lesser number of free electrons are available for current conduction through channel - resistance of the channel is increased –greater the negative voltage on the gate, lesser is the current
(ii) Enhancement mode – Gate is positive –induce negative charges in the n-channel - free electrons are added to those already in the channel - enhances the conductivity of the channel. The greater the positive voltage on the gate, greater the conduction</td><td>4

3</td><td>7</td><td>7</td></tr>
<tr><td>III 9.</td><td>

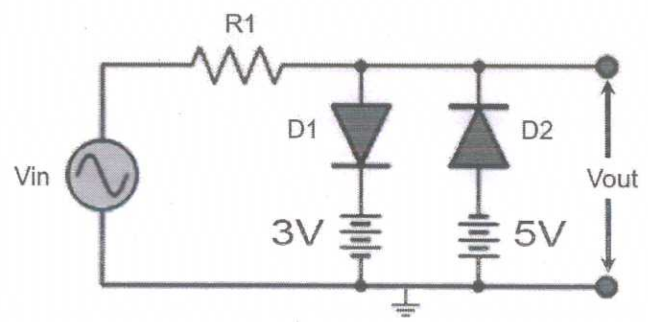
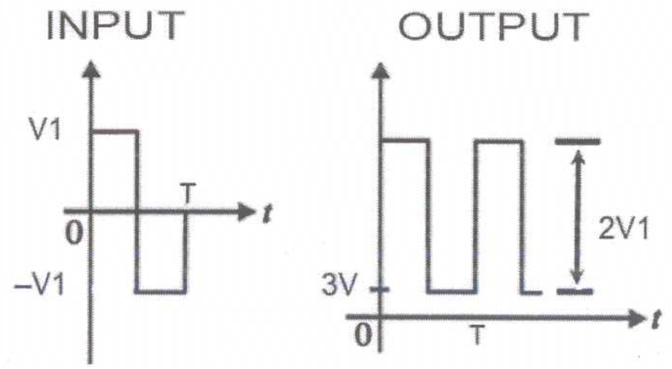
Inductor opposes any change in current that flows through it. This property is used in the series inductor filter. Reactance of the inductor is more for ac components and it offers more opposition to them. Inductor blocks the ripples and allows only dc component to flow through R_L

</td><td>3

2

2</td><td>7</td><td>7</td></tr>
<tr><td>III 10.</td><td>

During the positive half-cycle, D1 is forward biased and D2 is reverse-biased. C1 is charged to the peak of the input voltage (Vp) less the diode drop. During negative half-cycle, D2 is forward-biased and D1 is reverse-biased. Peak voltage on C1 adds to the input voltage to charge C2 to approximately 2Vp.</td><td>4

3</td><td>7</td><td>7</td></tr>
</table>

III 11.	 ▪ When the input voltage is greater than 3V, D1 is forward biased and D2 is reversed biased - limits the output voltage at 3V ▪ When the input voltage is less than –5V, D2 is forward biased and D1 is reversed biased - limits the output voltage at –5V ▪ When the input voltage is between 3V and –5V, both the diodes are reversed biased - During this time, output=input	4 3	7	7
III 12.	 During negative cycle of input, C charges through diode and dc source till (V1+3) volts with positive polarity of the capacitor at right. Charging is limited to (V1+3). Capacitor acts as a dc source in series with the input. Then output = (V1+3) + input	4 3	7	7