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MODEL ANSWER

SUMMER – 2018 EXAMINATION

Subject: Basic Electronics **Subject Code: 22225**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q.N.	Answer	Marking Scheme
1.	 **(a)** **Ans.**	**Attempt any FIVE of the following:** **List any four specifications of resistors.** **Specifications of resistors:** • Resistance Value / Resistivity • Tolerance • Power Rating • Thermal Stability • Maximum operating temperature • Maximum operating voltage	**10** **2M** ***Any four specifications ½M each***
	(b) **Ans.**	**State the need of filters in a regulated DC power supply.** **Need of filters:** The output of a rectifier contains dc component as well as ac component. The presence of the ac component is undesirable and must be removed so that pure dc can be obtained. Filter circuits are used to remove or minimize this unwanted ac component of the rectifier output and allows only the dc component to reach the load.	**2M** ***Relevant need 2M***

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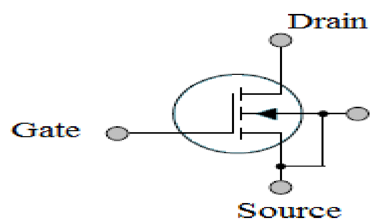
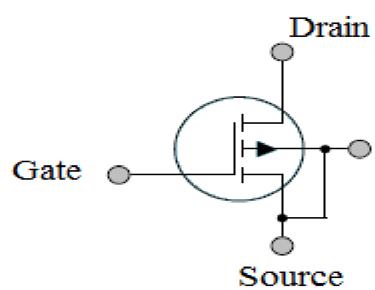
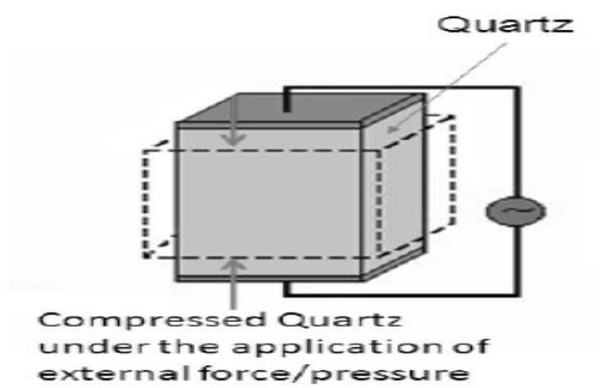
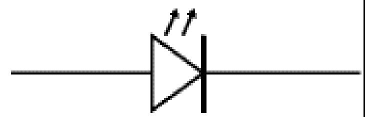
	(c) **Ans.**	**Define α and β of transistor.** **α (Alpha)** : This is the Common Base dc current gain. It defined as the ratio of collector current (I_C) to emitter current (I_E). $\alpha = \frac{I_C}{I_E}$ **β (Beta):** This is the Common Emitter dc current gain. It is defined as the ratio of collector current (I_C) to the base current (I_B). $\beta = \frac{I_C}{I_B}$	**2M** ***Each definition 1M***
	(d) **Ans.**	**Draw the symbol of N-channel and P-channel enhancement type MOSFET.** **Symbol of N- Channel Enhancement MOSFET:**  **Symbol of P- Channel Enhancement MOSFET:**  	**2M** ***Each symbol 1M***
	(e) **Ans.**	**List the types of signals.** **Types of signals:** 1. Analog signal 2. Digital signal 3. AC signal 4. DC signal 5. Sinusoidal signal 6. Triangular signal 7. Square signal	**2M** ***Any 2 types 1M each***

	(f) Ans.	**Draw constructional diagram of piezoelectric transducer.** ***(Note: Any other suitable diagram shall be considered for awarding marks)*** **Constructional diagram of piezoelectric transducer:**  	**2M** ***Diagram 2M***
	(g) Ans.	**State the function of proximity sensors and photodiode.** **Functions of Proximity Sensors:** 1. Detect the presence of an object through change in the current in its coil. 2. Measure the small changes in displacement/ movement through changes in current. **Function of Photodiode:** It converts the light energy into current or voltage in reverse bias condition.	**2M** ***Any one function 1M each***
2.	 (a) Ans.	**Attempt any THREE of the following:** **State the advantages of integrated circuits over circuits with discrete components.** **Advantages of Integrated circuits:** • Small in size due to the reduced device dimension. • Low weight due to very small size. • Low power requirement due to lower dimension and lower threshold power requirement. • Low cost due to large-scale production. • High reliability due to the absence of a solder joint. • Increased response time and speed. • Easy replacement instead of repairing as it is economical. • Higher yield, because of the batch fabrication.	**12** **4M** ***Any 4 1M each***

	(b)	**Define the following terms with respect to rectifier:** **(i) Ripple factor** **(ii) Rectification efficiency (η)** **(iii) Transformer Utilization Factor (TUF)** **(iv) Peak Inverse Voltage (PIV)**	**4M**
	Ans.	**(i) Ripple factor:** The factor which represents ac component present in the rectifier output, with respect to dc component is called Ripple Factor. **OR** The ratio of r.m.s. value of a.c. component to the d.c. component in the rectifier output is known as ripple factor. Mathematically, $\gamma = \frac{rms\ value\ of\ ac\ component}{dc\ component}$ $\gamma = \frac{V_{rms}}{V_{dc}} = \frac{I_{rms}}{I_{dc}}$ **(ii) Rectification efficiency (η):** This is defined as the ratio of dc power delivered to the load to the ac input power from the secondary winding of the transformer. Mathematically, $\eta = \frac{dc\ power\ delivered\ to\ the\ load}{ac\ input\ power\ from\ the\ transformer\ secondary} = \frac{P_{dc}}{P_{ac}}$ **(iii) Transformer Utilization Factor (TUF):** It is the ratio of dc power delivered to the load and the ac rating of the transformer secondary. $TUF = \frac{dc\ power\ delivered\ to\ the\ load}{ac\ rating\ of\ the\ transformer\ secondary} = \frac{P_{dc}}{P_{ac\ (rated\ )}}$ **(iv) Peak Inverse Voltage (PIV):** The maximum value of reverse voltage (for the diode in a rectifier) occurring at the peak of the negative cycle of the input cycle is called Peak Inverse Voltage.	***Each term definition 1M***
	(c) **Ans.**	**Draw construction of LED and explain working principle.**	**4M**

Working principle:

A PN junction diode, which emits light when forward biased, is known as a Light Emitting Diode (LED). The emitted light may be visible or invisible. The amount of light output is directly proportional to the forward current. Thus, higher the forward current, higher is the light output.



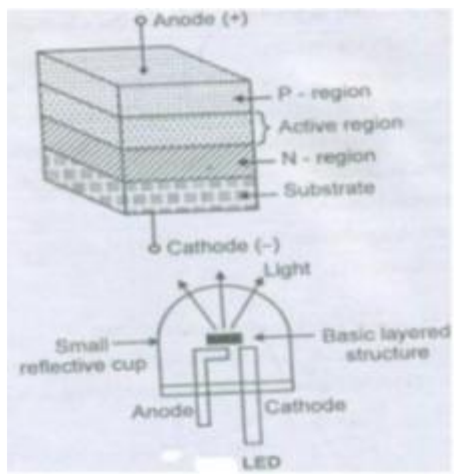


Diagram 2M

When the LED is forward biased, the electrons and holes move towards the junction and the recombination takes place. After recombination, the electrons, lying in the conduction bands of N region, fall into the holes lying in the valence band of a P region. The difference of energy between the conduction band and valence band of a P region is radiated in the form of light energy. The semiconducting materials used for manufacturing of Light Emitting Diodes are Gallium Phosphide and gallium Arsenide Phosphide. These materials decide the colour of the light emitted by the diode.

Explanation 2M

(d) Compare CB, CE and CC configuration on the basis of: **4M**

(i) Input impedance (ii) Output impedance

(iii) Current gain (iv) Application

Ans.

Factor	CB	CE	CC
Input Impedance	Low **OR** 50Ω	Medium **OR** 600 Ω to 4K Ω	High **OR** 1M Ω

Output Impedance	High **OR** 50 K Ω	Medium **OR** 10K Ω to 50K Ω	Low **OR** 50 Ω	***Correct comparison 1M each***
Current Gain	Less than or equal to 1 **OR** $\alpha = \frac{I_C}{I_E}$	High (100) **OR** $\beta = \frac{I_C}{I_B}$	High (100) **OR** $\gamma = \frac{I_E}{I_B}$	
Application	High frequency Circuits	Audio frequency circuits (Amplifiers)	Impedance Matching	

3. **Attempt any THREE of the following:** **12**

(a) **Draw and explain the construction of N-channel JFET.** **4M**

Ans.

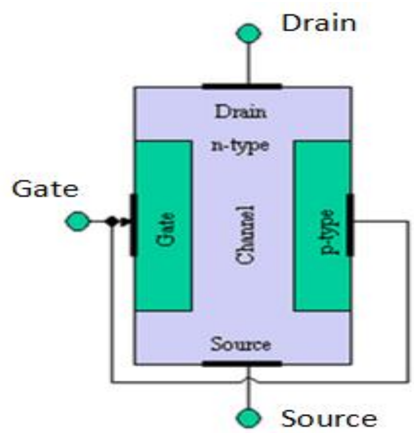


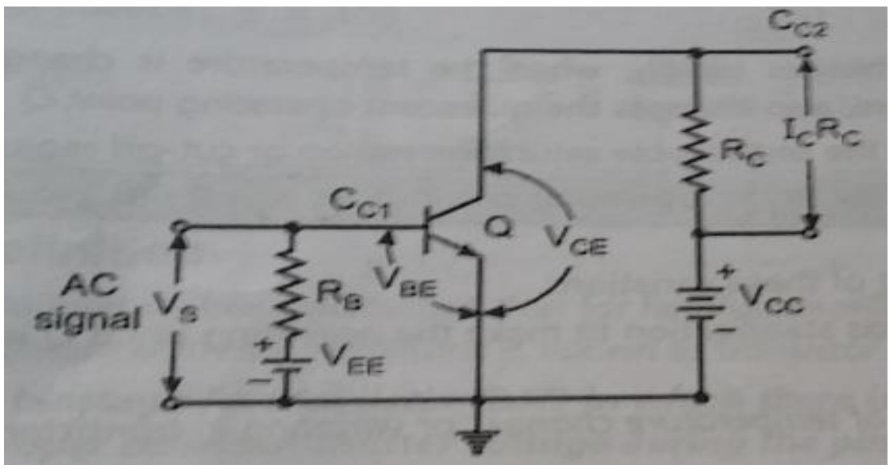
Diagram 2M

Construction Details:

A JFET consists of a p-type or n-type silicon bar containing two PN junctions at the sides as shown in fig. The bar forms the conducting channel for the charge carriers. If the bar is of p-type, it is called p-channel JFET and if the bar is of n-type, it is called n-channel JFET as shown in fig. The two PN junctions forming diodes are connected internally and a common terminal called gate is taken out. Other terminals are source and drain taken out from the bar as shown in fig.1.Thus a JFET has three terminals such as, gate (G), source (S) and drain (D).

Explanation 2M

	(b) **Ans.**	**State any four selection criteria for transducers.** **Selection criteria for transducers are:** 1. Operating range 2. Operating principle 3. Sensitivity 4. Accuracy 5. Frequency response and resonant frequency 6. Errors 7. Environmental compatibility 8. Usage and ruggedness. 9. Electrical aspect. 10. Stability and Reliability 11. Loading effect 12. Static characteristics 13. General selection criteria	**4M** ***Any four points 1M each***
	(c) **Ans.**	**Determine the value of resistance with the following colour code:** **(i) Red, Red, Orange, Gold (ii) Brown, Black, Black, Silver** **(i) Red, Red, Orange, Gold** Red → 2, Red → 2, Orange → x 1000, Gold → $\pm$ 5% = 22 x 1000$\pm$ 5% Value of resistor is 22 KΩ + 5% OR 22000Ω + 5% **(ii) Brown, Black, Black, Silver** Brown → 1, Black → 0, Black → x 1, Silver → $\pm$10% = 10 x 1 $\pm$ 10% Value of resistor is 10 Ω $\pm$ 10%	**4M** ***Each bit 2M***

	(d)	**Explain the concept of DC load line and operating point for biasing circuit.**	**4M**
	Ans.	**DC load line**: The straight line drawn on the characteristics of a BJT amplifier which give the DC values of collector current I_C and collector to emitter voltage V_{CE} corresponding to zero signal i.e. DC conditions is called DC load line.	***1M***
			***1M***
		To plot $I_{C(MAX)}$, $V_{CE\ (MAX)}$ on output characteristics: Get $V_{CE\ (MAX)}$ by putting $I_{c} = 0$ $V_{CE} = V_{CC} - I_c\ R_c$ $V_{CE\ (MAX)} = V_{CC}$ since $I_c = 0$ Get $I_{C(MAX)}$ by putting $V_{CE} = 0$ $I_{C(MAX)} = \frac{V_{CC}}{R_C}$	

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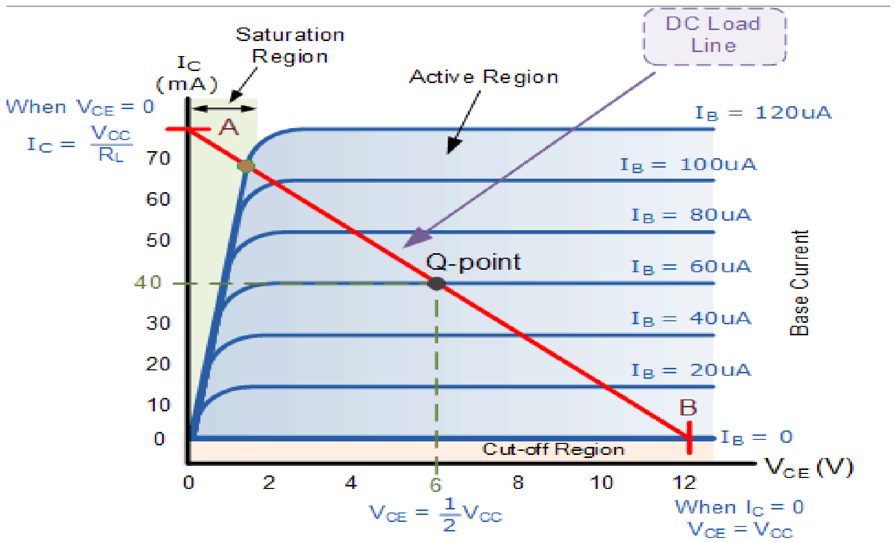
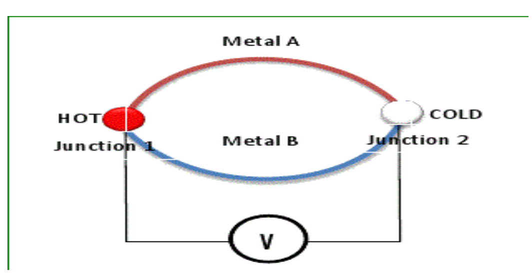
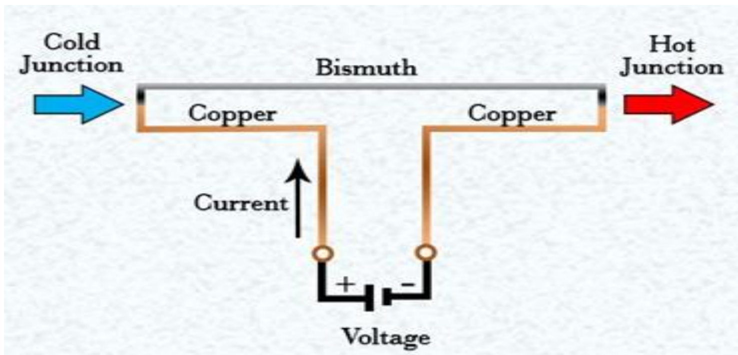
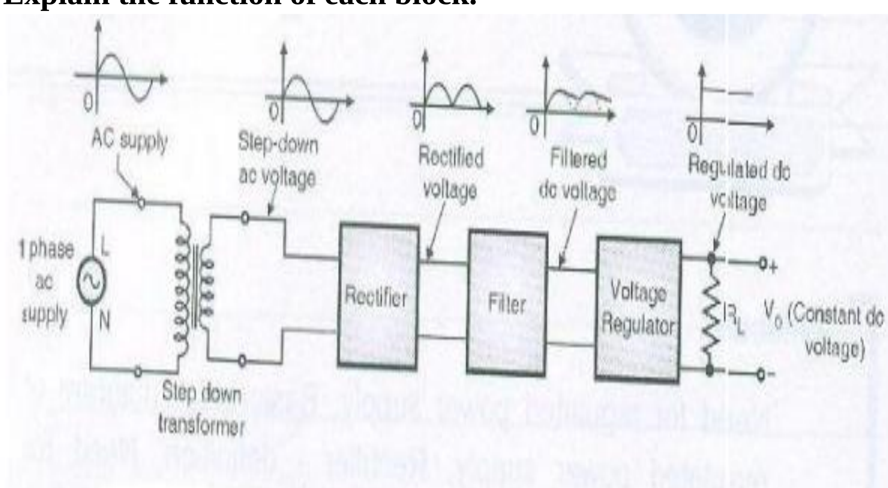
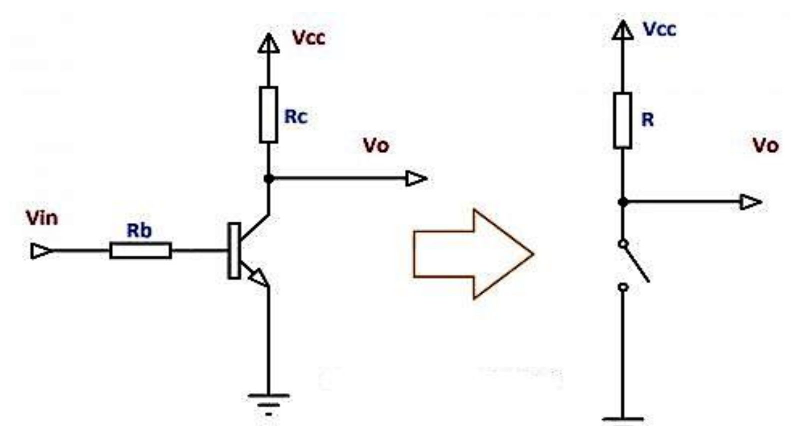
			***1M***
		Operating point or Q- point: The fixed levels of certain currents and voltages in a transistor in active region defines the operating point on the DC load line. For normal operation of the transistor, the Q- point is to be selected at the center of the load line.	***1M***
4.		**Attempt any THREE of the following:**	**12**
	(a)	**Explain:** **(i) Seebeck effect (ii) Peltier effect**	**4M**
	Ans.	**(i) Seebeck effect:** Seebeck effect states that whenever two dissimilar metals are connected together to form two junctions out of which, one junction is subjected to high temperature and another is subjected to low temperature then e.m.f is induced proportional to the temperature difference between two junctions.	***Seeback effect 2M***
		 **Fig. Seedback effect**	

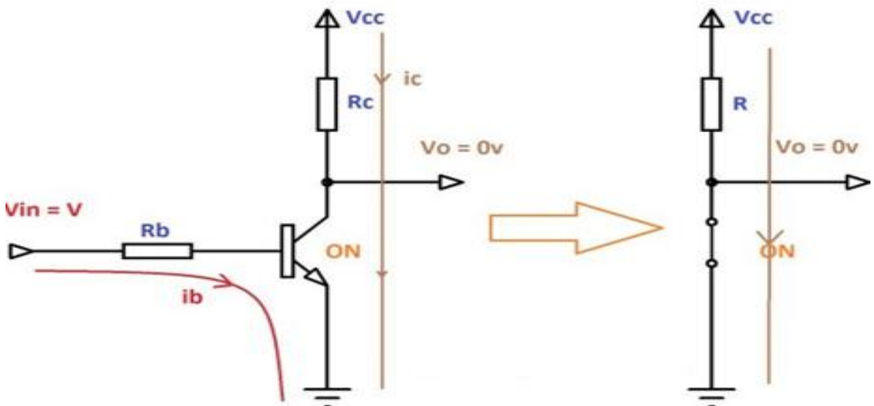
		(ii) Peltier effect: Peltier effect state that for two dissimilar metals closed loop, if current forced to flow through the closed loop then one junction will be heated and other will become cool.  	***Peltier effect 2M***
	(b) **Ans.**	**Draw the basic block diagram of regulated DC power supply. Explain the function of each block.**  **Block diagram of regulated power supply** 1.TRANSFORMER:Transformer works on the basis of ELECTROMAGNETIC INDUCTION and they are mainly classified into two: i. STEP UP TRANSFORMER ii. STEPDOWN TRANSFORMER Step up transformer up convert the input voltage where step down transformer down converts. For a DC Power Source we have to use	**4M** ***Diagram 2M*** ***Explanation 2M***

		step down transformers, to covert the high voltage AC supply to low voltage DC. 2. RECTIFIER: Rectifiers are used to convert the sinusoidal AC voltage to non-sinusoidal pulsating DC. The main component used in Rectifiers are diodes due to its switching action. They will conduct Current only in one direction, hence the voltage. So we can use them as rectifiers to make the alternating Current unidirectional. Rectifiers are classified into Three :- i. HALF WAVE RECTIFIERS ii. FULL WAVE RECTIFIERS iii. BRIDGE RECTIFIERS 3. FILTERS: Filters are used to eliminate or filter-out the unwanted ripples from the rectified output. Filters play an important role in dc Power supplies, they make the pulsating dc steady. 4. VOLTAGE REGULATOR: Voltage Regulators are used to regulate the output Voltage over load. They make the Voltage unvaried with load connected to it. This will eliminates the remaining ripples from the filter output. The output from Voltage Regulator may be the required DC. Voltage Regulators includes some safety measures such as Current Limiting, short circuit etc.	
	(c) **Ans.**	**Describe the working of transistor as a switch with circuit diagram.**  **Transistor as a Switch Circuit Diagram**	**4M**

From the above circuit we can see that the control input Vin is given to base through a current limiting resistor Rb and Rc is the collector resistor which limits the current through the transistor. In most cases output is taken from collector but in some cases load is connected in the place of Rc.

- ON = Saturation
- OFF = Cutoff

Transistor as a Switch – ON:



Transistor as a Switch ON

Transistor will become ON (saturation) when a sufficient voltage V is given to input. During this condition the Collector Emitter voltage Vce will be approximately equal to zero, ie the transistor acts as a short circuit. For a silicon transistor it is equal to 0.3v. Thus collector current Ic = Vcc/Rc will flows.

ON switch 2M

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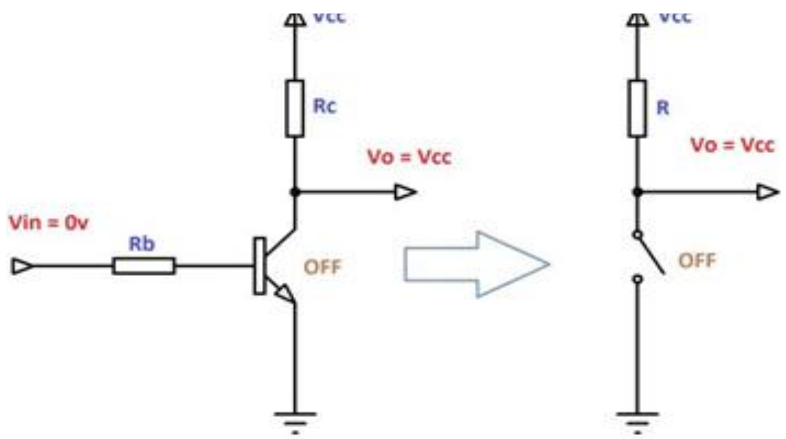
		Transistor as a Switch – OFF:  **Transistor as a Switch OFF** Transistor will be in OFF (cutoff) when the input Vin equal to zero. During this state transistor acts as an open circuit and thus the entire voltage Vcc will be available at collector.	***OFF switch 2M***
	(d) **Ans.**	**A JFET has a drain current of 5 mA. If I_{DSS} = 10mA and $V_{GS(OFF)}$ = -6V. Find the value of** **(i) V_{GS}** **(ii) V_P** Given: $I_D = 5mA$ $I_{DSS} = 10mA$ $V_{GS(OFF)} = -6V$ $V_{GS} = ?$ $V_P = ?$ $I_D = I_{DSS} \cdot \left(1 - \frac{V_{GS}}{V_{GS\,(OFF)}}\right)^2$ $V_{GS} = \left(1 - \frac{\sqrt{I_D}}{\sqrt{I_{DSS}}}\right) X\ V_{GS\ OFF}$	**4M** ***Formula for I_D 1M***

$$V_{GS} = \left(1 - \frac{\sqrt{5mA}}{\sqrt{10mA}}\right) X - 6$$

$$\boxed{V_{GS} = -1.756V}$$

V_{GS} calculation 2M

$$V_P = V_{GS(OFF)}$$

$$\therefore \boxed{V_P = -6V}$$

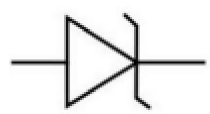
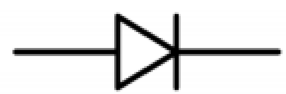
V_P calculation 1M

(e) Compare P-N junction diode and zener diode on the basis of **4M**

(i) Symbol (ii) Direction of conduction

(iii) Reverse breakdown (iv) Application

Ans.

Parameter	Zener Diode	PN Diode
Symbol		
Direction of conduction	It conducts in both directions.	It conducts only in one direction.
Reverse breakdown	It has quite sharp reverse breakdown.	It has no sharp reverse breakdown.
Application	Commonly used for voltage regulation	commonly used for rectification

Each Point 1M

5. Attempt any TWO of the following: **12**

(a) Calculate peak-to-peak amplitude, frequency and wavelength of waveforms shown in Fig.1. **6M**

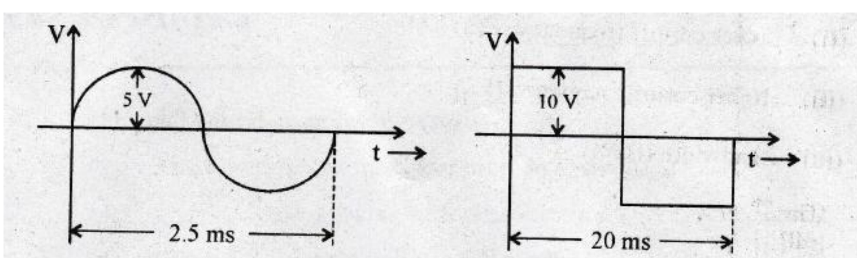


Fig. 1

Ans.

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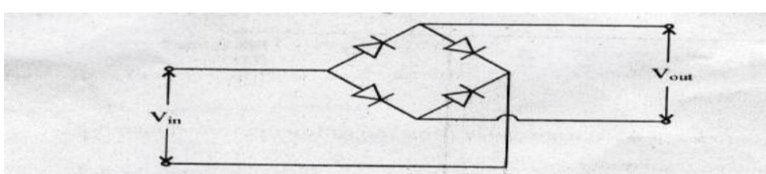
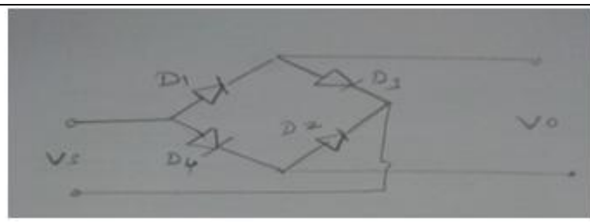
		For sine waveform: 1. Peak to peak amplitude =10 V 2. Frequency=1/T =1/(2.5ms) = 400 Hz 3. wavelength λ = Vc/f =$(3*10^8)/400$ =750000 m **For square waveform:** 1. Peak to peak amplitude =20 V 2. Frequency=1/T =1/(20 ms) = 50 Hz 3. wavelength λ = Vc/f =$(3*10^8)/50$ =6000000 m	***Each calculation 1M***
	(b) **Ans.**	**In CE configuration, if β = 100, leakage current I_{CEO} = 150 µA. If the base current is 0.2 mA, calculate the value of I_C, I_E and α.** ***(Note: Marks should be given for correct formula)*** Given data:-β =100, I_{CEO} = 150 µA. I_B is 0.2mA , To find I_C, I_E and α. **Solution :-** We know 1) $\alpha = \beta / (\beta + 1)$ = 100/(100+1)= 0.99 2) I_C is given as, $I_C = \beta * I_B + I_{CEO}$ $= (100*0.2*10^{-3}) + 150*10^{-6}$ =20.150 mA. 3) I_E is given as, $I_E = I_C + I_B$ =(20.150 +0.2) mA =20.35 mA	**6M** ***2M for correct calculation of each parameter (Formula 1M, Calculation -1M)***
	(c) **Ans.**	**Identify the circuit shown in Fig. 2 and explain working with input-output waveforms for a sinusoidal input.**  Fig. 2 **The given circuit is Bridge rectifier**– (with diodes numbered)	**6M**



Correct Identification 2M

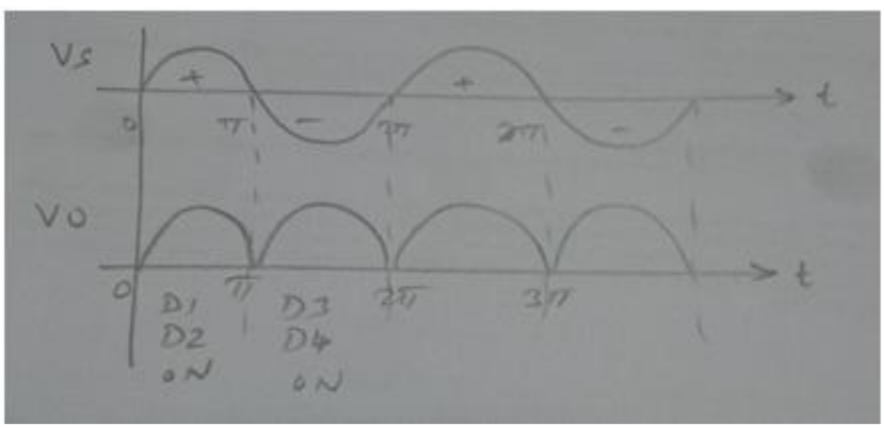
Working :-
The four diodes labelled D1 to D4 are arranged in "series pairs" with only two diodes conducting current during each half cycle.

Explanation 2M

During the positive half cycle of the supply:- diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load for the period o to π

During the negative half cycle of the supply:- diodes D3 and D4 conduct in series, but diodes D1 and D2 switch "OFF" as they are now reverse biased. The current flowing through the load is the same direction as before for the period π to 2π.

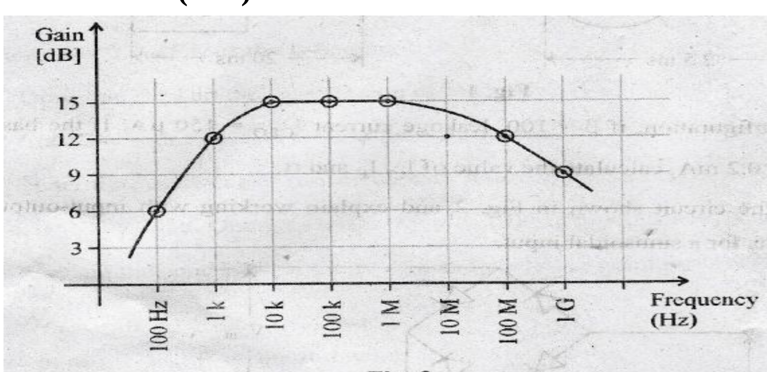
Waveforms:-



Waveforms 2M

Q. No.	Sub Q.	Answer	Marks
6.		**Attempt any TWO of the following:**	**12**
	(a)	**The following readings were obtained experiment from JFET.**	**6M**

V_{GS}	**0 V**	**0 V**	**-0.2 V**
V_{DS}	**7 V**	**15 V**	**15 V**
I_D	**10 mA**	**10.25 mA**	**9.65mA**

	Ans.	**Determine:** **(i) AC drain resistance** **(ii) Transconductance** **(iii) Amplification factor** ***(Note: Formula should be given marks)*** **(i) AC drain resistance** is given as, $r_d = \frac{\Delta V_{DS}}{\Delta I_D}$ at V_{GS} constant $\frac{15V-7V}{10.25-10mA} = \frac{8V}{0.25mA} = 32K\Omega$ **(ii) Transconductance** gm is given as , $g_m = \frac{\Delta I_D}{\Delta V_{GS}}$, V_{DS} at constant $\frac{10.25mA-9.65mA}{0-(-0.2V)} = \frac{0.6mA}{0.2V} = 3m$ Mho **(iii) Amplification factor** μ μ = r_d x g_m = 32 KΩ x 3m Mho = 96	***2M for each (1M for Formula, 1M for calculation)***
	(b) Ans.	**Observe the given frequency response of RC coupled amplifier in Fig. 3** **Calculate:** **(i) Lower cut-off frequency (F_L)** **(ii) Higher cut-off frequency (F_H)** **(iii) Bandwidth (BW)**  **Fig. 3**	**6M**

		As maximum gain is 15 dB, 3 dB down gain is 12 dB. So, (i) The lower cut-off frequency F_L= 1KHz (ii) Higher cut-off frequency F_H =100 MHz (iii) Bandwidth (BW) = F_H - F_L =(100000 -1)KHz = 99999 KHz	***2M for each proper answer***
	(c)	**Identify active and passive transducer from the following transducers:** **(i) Capacitive transducer** **(ii) Photovoltic cells** **(iii) Piezoelectric transducer** **(iv) Strain gauge** **(v) Thermocouple** **(vi) Thermisters**	**6M**
	Ans.	(i) Capacitive transducer-passive transducer (ii) Photovoltaic cells- active transducer (iii) Piezoelectric transducer–active transducer. (iv) Strain gauge-passive transducer (v) Thermocouple- active transducer (vi) Thermisters- passive transducer	***1M each for right answer***