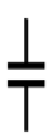
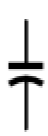
SUMMER – 2022 EXAMINATION

Subject Name: **Basic Electronics** **Model Answer** **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.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE of the following:**	**12 M**
	a)	**Draw the symbols of resistor & capacitor. State the unit of measurement of resistance & capacitor.**	**2 M**
	Ans	Symbol of resistor  Symbol of capacitor  **OR**  Unit of resistance: ohm (Ω) Unit of capacitance: farad (F)	Each symbol ½ M, each Unit ½ M
	b)	**Give two points of distinction between half wave & full wave rectifier.**	**2 M**
	Ans		Each point 1 M

Parameter	Half wave rectifier	Full wave rectifier	
		Centre tapped	**Bridge**
No. of diode	1	2	4
PIV	Vm	2Vm	Vm
Rectification efficiency	40.6%	81.2%	81.2%
Ripple frequency	f	2f	2f
Ripple factor	1.21	0.482	0.482
TUF	0.287	0.693	0.812
DC voltage	Vm/π	2Vm/π	2Vm/π
DC load current	Im/π	2Im/π	2im/π

	c)	**Define α & β of a transistor.**	**2 M**

Ans

Each Definition 1 M

COMMON BASE D.C CURRENT GAIN (α): `

The ratio of collector current I_C to emitter current I_E in the CB configuration is called alpha (α)

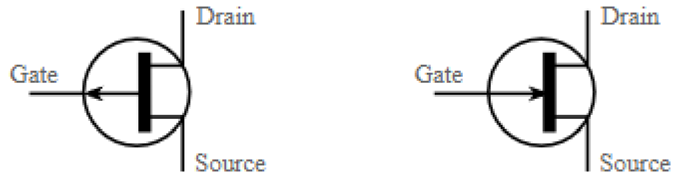
$$\alpha = I_C / I_E$$

COMMON EMITTER D.C CURRENT GAIN (β) :

The ratio of collector current I_C to base current I_B in the CE configuration is called beta (β)

$$\beta = I_C / I_B$$

	d)	**Draw the symbols of N channel & P channel JFET.**	**2 M**
	Ans		Each symbol 1 M



P-Channel N-Channel

e) Give two points of distinction between active & passive components. **2 M**

Ans (Each point 1 M)

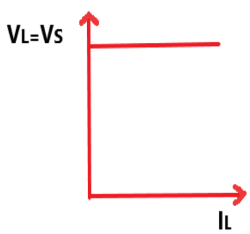
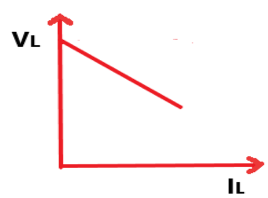
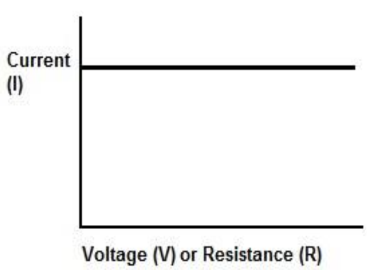
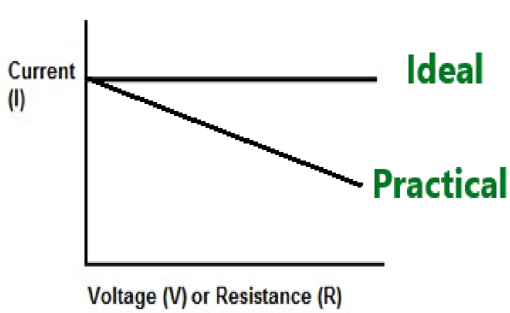
Passive components	Active components
Components which are not able to amplify or processing electrical signals are called passive components	Components which are able to amplify or processing electrical signals are called active components
They do not introduce any gain	They may introduce gain
They are bidirectional	They are unidirectional
Eg. Resistor, capacitor, inductor, sensors, transformer	Eg: diode, transistor, IC, FET, MOSFET, logic gates, triode vacuum tubes (valves)

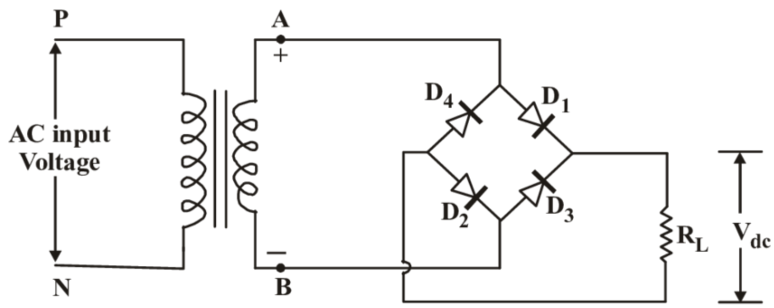
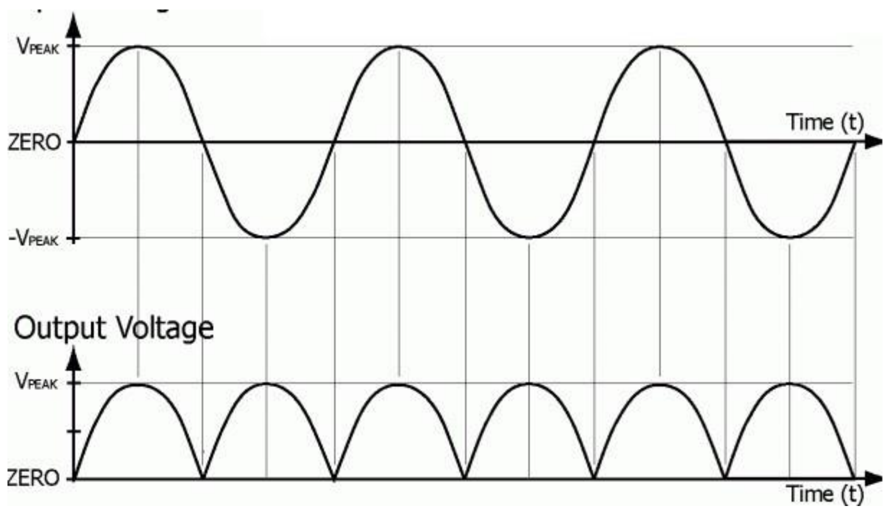
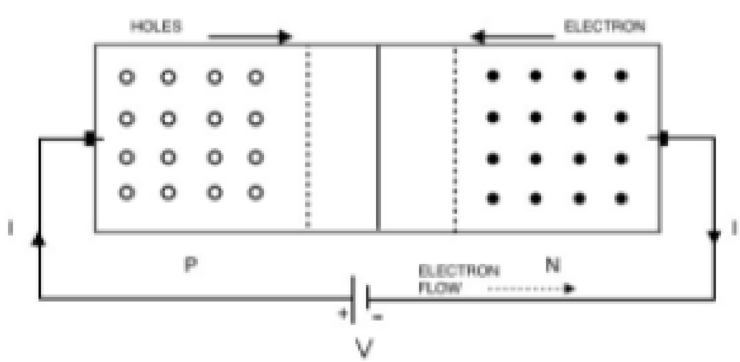
f) Give two points of distinction between active & passive transducers. **2 M**

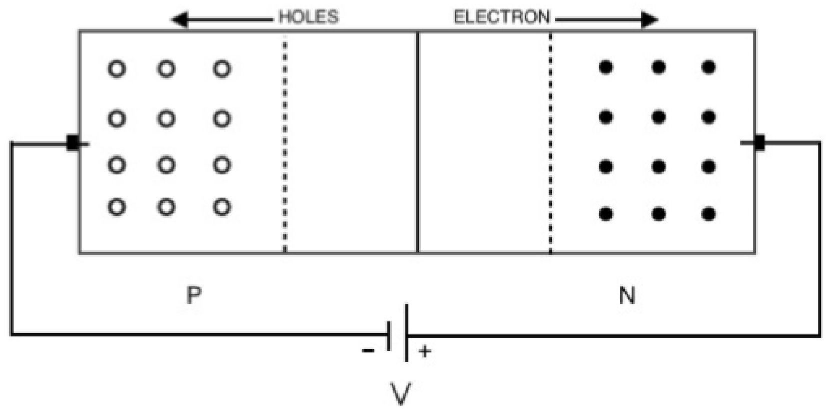
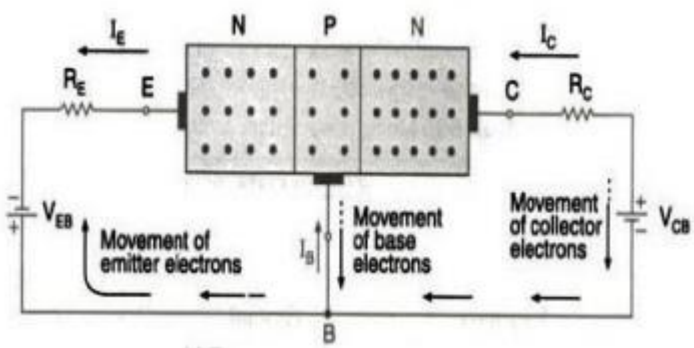
Ans (Each point 1 M)

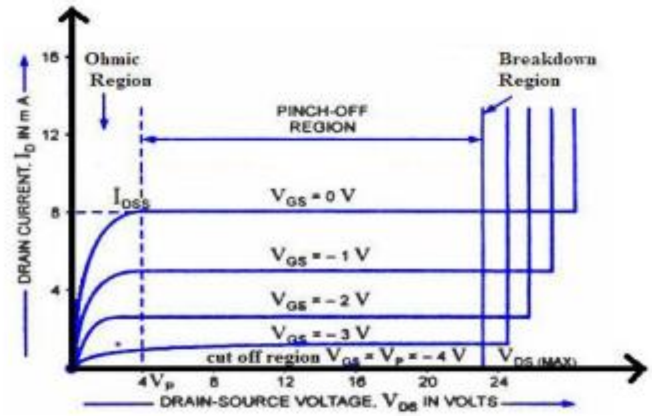
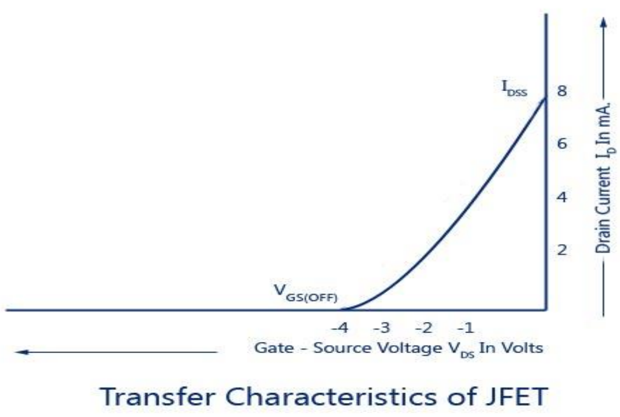
Parameter	Active transducer	Passive transducer
Working Principle	It operates under energy conversion principle.	It operates under energy controlling principle.
Advantages	They do not require external power supply for their operation	They require external power supply for their operation
output	They produce voltage/current proportional to the physical quantities	They produce change in resistance, capacitance in the response to the physical quantity.
Example	Eg. Thermocouple, photocell, piezoelectric transducer, Photovoltaic cell	Eg. Thermistor, LVDT, LDR, phototransistor, capacitive transducer
Application	Used for measurement of Surface roughness in accelerometers and vibration pickups.	Used for measurement of power at high frequency

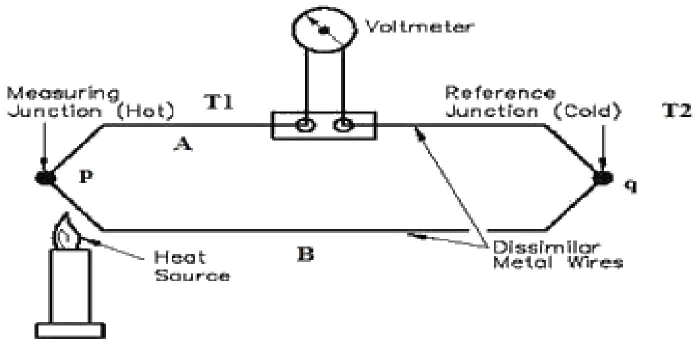
g) State the selection criterion of transducers. **2 M**

	Ans	➢ Operating Principle ➢ Operating range ➢ Accuracy ➢ Range ➢ Sensitivity ➢ Loading effect ➢ Errors ➢ Environmental compatibility ➢ Frequency response: Usage and Ruggedness ➢ (Or any relevant point)	Each point 1 M
2.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**With suitable graph, define voltage source & current source.**	**4 M**
	Ans	**Voltage Source:** It is the source which supplies electrical energy in the form of a voltage. OR It is a device which delivers variable or constant voltage.  Ideal voltage source  Practical voltage source **Current Source:** It is the source which supplies electrical energy in the form of an electrical current. OR It is a device which produces variable or constant current.  	Each definition 1 M, Each graph ½ M

		Ideal current source Practical current source	
	b)	**Draw a neat diagram of bridge rectifier. Draw input & output waveforms.**	**4 M**
	Ans	 	Diagram 2 M, Waveform 2 M
	c)	**With suitable diagram, explain the working of P-N junction diode.**	**4 M**
	Ans	 PN junction diode operated in forward bias and reverse bias condition. **Forward Bias:** In forward bias condition positive terminal of the battery is connected to	Any relevant diagram 2 M, Explanation 2 M

		P-side and negative terminal to N-side of the diode. Electrons from N-side and holes from P-side are pushed towards the junction. Due to this the depletion layer's width decreases, and the current starts flowing through the diode. The Diode conduct current if applied voltage is above 0.7V for silicon and 0.3V for germanium.  **Reverse Bias:** In reverse bias condition, positive terminal of the battery is connected to N-side and negative terminal to P-side of diode. Free electrons and holes move away from the junction. Hence, increasing the width of depletion layer. There is no current flowing in the PN junction diode. As the applied reverse voltage is increased, very small amount of current flows through the diode due to the minority charge carrier. This current is called reverse saturation current.	
	d)	**With suitable diagram, explain the working of NPN transistor.**	**4 M**
	Ans	 1. In this emitter-base junction is forward biased and collector-base junction is reverse biased. The forward bias causes the electrons in the emitter to flow towards the base. This constitutes the emitter current I_E. 2. As these electrons flow through the base they tend to combined with holes. As the base is lightly doped and very thin therefore only a few electrons (2%) combine with holes to constitute base current I_B. The remaining electrons (98%) cross over into the collector region to constitute collector current $I_{C.}$ This collector current is also called injected current.	Any other relevant diagram 2 M, Explanation 2 M

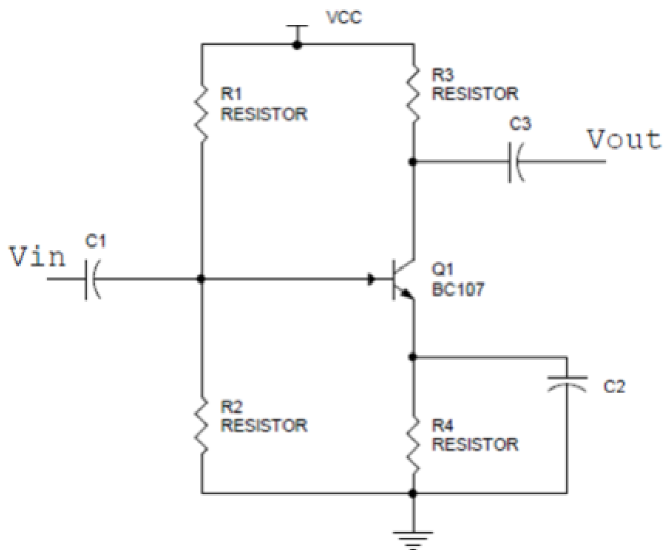
		3. The emitter current is sum of collector and base current. $I_E = I_B + I_C$ $I_E = I_C$ (I_B = small)	
3.		**Attempt any THREE of the following:**	**12 M**
	a)	**Draw the drain & transfer characteristics of JFET.**	**4 M**
	Ans	Drain characteristics of JFET  Transfer characteristics of JFET 	Drain characteristics of JFET 2M & Transfer characteristics of JFET 2M

	b)	**Give the steps followed to measure temperature of metal using given transducer. Draw suitable diagram.**	**4 M**
	Ans	**Note: Any other diagram with similar concept shall be considered** It is a mechanical device in which heat energy is converted into electrical energy.  **Construction** ➢ It consists of two different metal wires which are connected together so as to form two junctions. ➢ One junction is kept at constant temperature (cold junction) and other is heated (hot junction). ➢ Hot junction is called measuring junction and cold junction is called reference junction. ➢ The whole arrangement is enclosed in a tube made up of glass i.e., quartz. ➢ Materials used Bismuth-lead, iron constantan, bismuth-silver, copper-constantan alloy. Its working principle is based on seeback effect and peilter effect.	2 M for diagram 2 M for Explanation
	c)	**List two advantages of Integrated Circuits. Distinguish between analog & digital ICs.**	**4 M**
	Ans	• Its size is thousand times smaller than a discrete circuit. • Its weight is very less as compared to that of equivalent discrete circuits • In case of circuit failure, it is easy to replace Ic by new one • Due to smaller size, power consumption is less	Any 2 advantages 2 M Comparison (Any 2 points) 2 M

Items	Analog IC	Digital IC
Signal Characteristics	Continuous, such as light, sound, speed, temperature, etc.	Discrete, 0 and 1.
Technological Complexity	High entry barrier with 10~15 years learning curve	Relying on Computer Aided Design (CAD) tools with 3~5 year learning curve
Product Accreditation	More than 1 year	3~6 months
Substitution	Low	High
Product Portfolio	Low volume, High variety	High volume, Low variety
Applications	Power management, Audio amplification, Signal transformation and monitoring	Logic computation, Control, Digital signal coding/decoding
Price	Stable	Volatile

d) **With suitable diagram, explain the working of transistor as an amplifier.** **4 M**

Ans



Circuit diagram:2 M

Explanation 2 M

The signal is fed at the input terminal and output is taken from collector end. The total instantaneous output voltage Vce is given by

$V_{ce}=V_{cc}-I_c R_c$ -----(1)

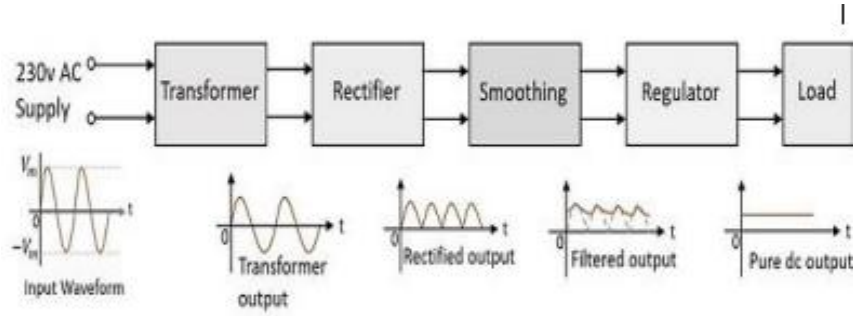
When the signal voltage increases in the positive half cycle, the base current also increases.

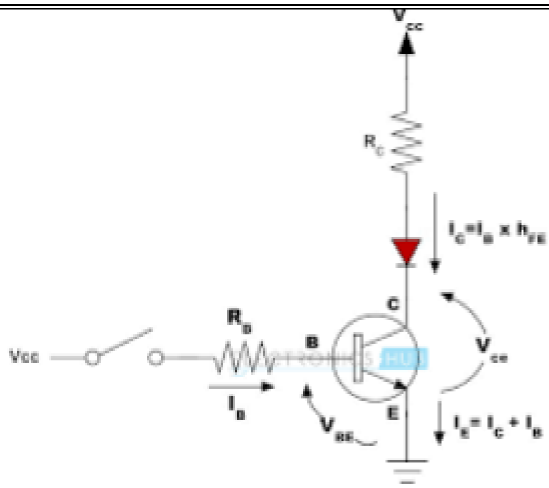
The result is that collector current and hence voltage drop IcRc increases.

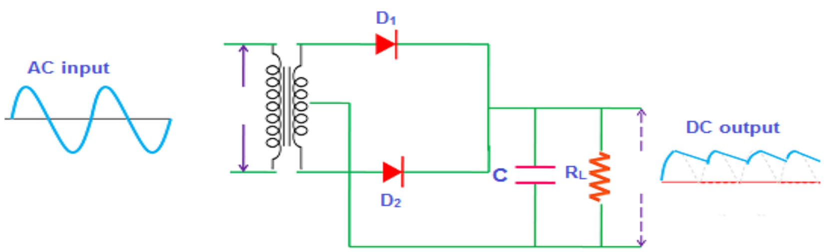
As Vcc is constant, therefore output voltage Vce decreases.

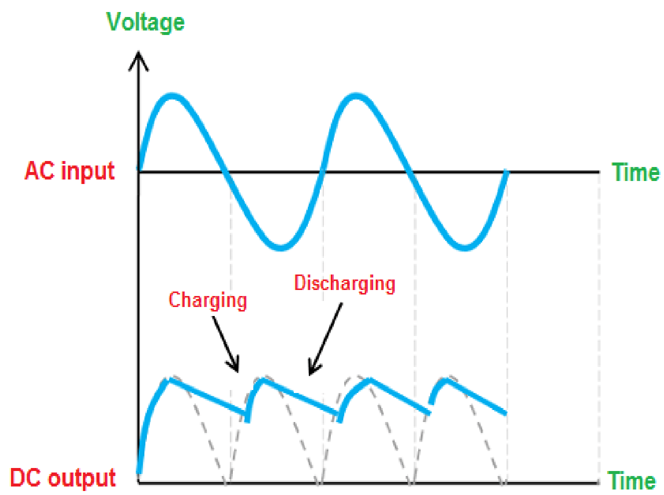
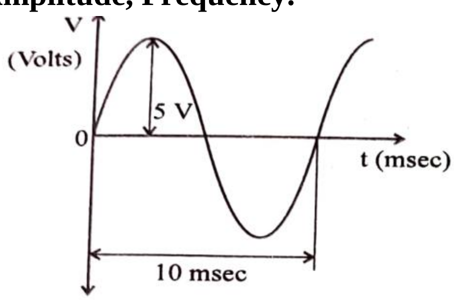
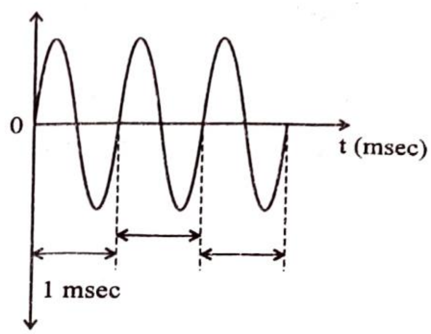
As the signal voltage is increasing in the positive half cycle, the output voltage is increasing in the negative sense i.e. output is 180 degree out of phase with input.

Therefore in a CE amplifier the positive half cycle of the signal appears as amplified negative half cycle in the output and vice versa.

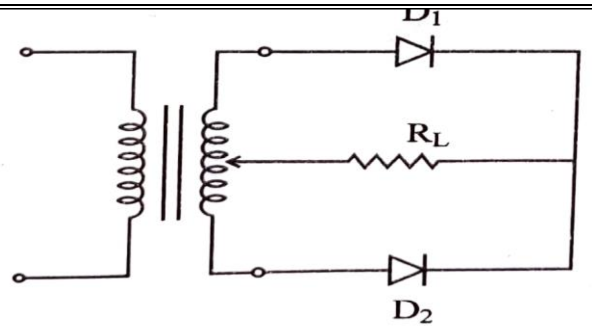
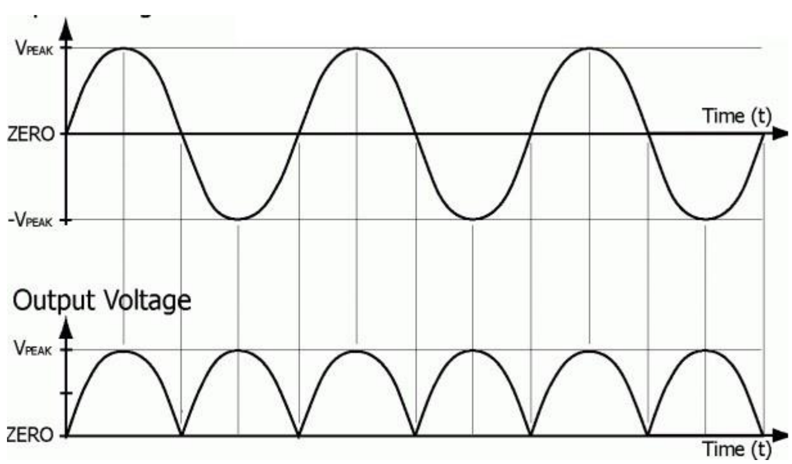
4.		**Attempt any THREE of the following:**	**12 M**
	a)	**Explain:** **(i) Seebeck effect** **(ii) Peltier effect**	**4 M**
	Ans	**Seebeck effect:** This states that whenever two dissimilar metals are connected together to form two junctions out of which, one junction is subjected to high temperature and another is subjected to low temperature then e.m.f is induced and it is proportional to the temperature difference between two junctions. **Peltier effect:** This states that for two dissimilar metals in a closed loop, if current is forced to flow through, then one junction will be heated and other will become cool.	Each explanation : 2 M
	b)	**Draw block diagram of regulated power supply. Explain function of each block.**	**4 M**
	Ans	**Note: Any other block diagram with similar blocks shall be considered** The block diagram of a Regulated Power supply unit is as shown below.  A typical Regulated Power supply unit consists of the following. **Transformer** − An input transformer *for the stepping down of the 230v AC power supply*. ***Rectifier*** *− A Rectifier circuit to convert the AC components present in the signal to DC components.* ***Smoothing*/Filter** − A filtering circuit to smoothen the variations present in the rectified output. **Regulator** − A voltage regulator circuit in order to control the voltage to a desired output level. **Load** − The load which uses the pure dc output from the regulated output.	Diagram 2 M Working of each block : 2 M
	c)	**With suitable diagram, explain the working of transistor as a switch.**	**4 M**

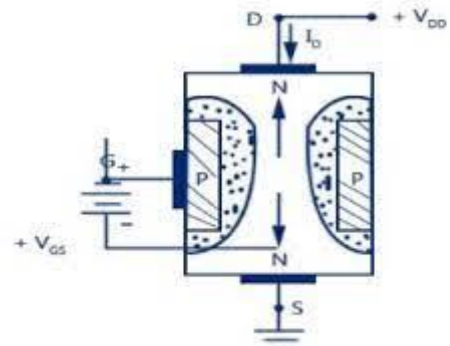
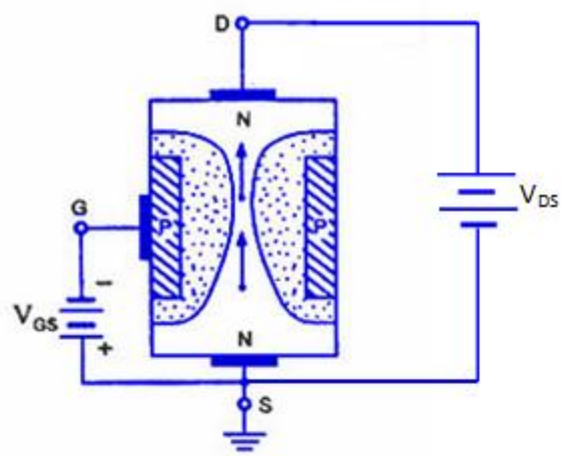
	Ans	 a) When both junctions are forward bias, it works in saturation region & act as closed switch. b) When both junctions are reverse biased, it works in cutoff region & act as open switch. c) If input is not given to base, transistor remains off. Diode will be off. IC=0, Acts as open switch. d) When input is applied to base above 0.7V, transistor becomes ON, Diode is ON. Current starts flowing, Transistor acts as close switch.	2 M for diagram 2 M for Explanation
	d)	**A JFET has a drain current of 3 mA. If I_{DSS} is 10 mA & V_{GS} (OFF) is – 6V. Find V_{GS} & V_P.**	**4 M**
	Ans	Given I_{DSS} = 10mA V_{GS}(OFF) = -6V Find V_{GS} ? Vp ? $\mathrm{ID} = \mathrm{IDSS}\left(1-\frac{\mathrm{VGS}}{\mathrm{VGS(OFF)}}\right)^2$ $\mathrm{VGS} = \left(1-\frac{\sqrt{\mathrm{ID}}}{\sqrt{\mathrm{IDSS}}}\right) \times V_{GS}(\mathrm{OFF})$ $\mathrm{VGS} = \left(1-\frac{\sqrt{3\mathrm{mA}}}{\sqrt{10\mathrm{mA}}}\right) \times (-6)$ V_{GS} = 2.7136V	Formula for ID : 1 M VGS calculation:2 M Vp calculation : 1 M

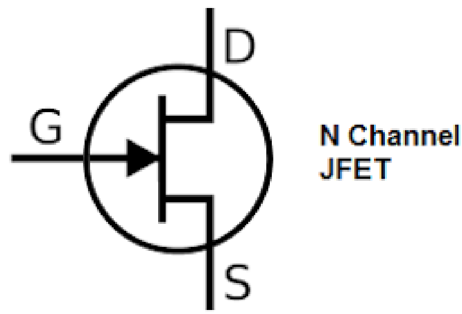
		$V_p = V_{GS}(OFF)$ $\therefore V_p = -6V$	
	e)	**With suitable diagram, explain the working of capacitor filter with full wave rectifier. Draw i/p & o/p waveforms.**	**4 M**
	Ans	 Full wave rectifier with capacitor filter During the positive half cycle, the diode (D1) current reaches the filter and charges the capacitor. However, the charging of the capacitor happens only when the applied AC voltage is greater than the capacitor voltage. Initially, the capacitor is uncharged. That means no voltage exists between the plates of the capacitor. So when the voltage is turned on, the charging of the capacitor happens immediately. During this conduction period, the capacitor charges to the maximum value of the input supply voltage. The capacitor stores a maximum charge exactly at the quarter positive half cycle in the waveform. At this point, the supply voltage is equal to the capacitor voltage. When the AC voltage starts decreasing and becomes less than the capacitor voltage, then the capacitor starts slowly discharging. The discharging of the capacitor is very slow as compared to the charging of the capacitor. So the capacitor does not get enough time to completely discharged. Before the complete discharge of the capacitor happens, the charging again takes place. So only half or more than half of the capacitor charge get discharged. When the input AC supply voltage reaches the negative half cycle, the diode D1 is reverse biased (blocks electric current) whereas the diode D2 is forward biased (allows electric current). During the negative half cycle, the diode (D2) current reaches the filter and charges the capacitor. However, the charging of the capacitor happens only when the applied AC voltage is greater than the capacitor voltage. The capacitor is not completely uncharged, so the charging of the capacitor does not happens immediately. When the supply voltage becomes greater than the capacitor voltage, the capacitor again starts charging.	Diagram : 1 M Explanation : 2 M Waveform :1M

		In both positive and negative half cycles, the current flows in the same direction across the load resistor RL. 	
5.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a)	**i) From the sinusoidal wave given below, in fig. (i) & fig. (ii) calculate Amplitude, Frequency.**  **Fig. (i)**  **Fig. (ii)** **(ii) Give the value of resistance for the following colour codes - Red Blue Green Gold.**	**6 M**
	Ans	i) Fig.I -Solution: ▪ Amplitude =5 V ▪ Frequency=1/T =1/ (10ms) = 100 Hz Fig.II-Solution: ▪ Assume(any value) Amplitude =10 V ▪ Frequency=1/T =1/ (1ms) = 1000 Hz=1KHz	For i : 3M For ii : 3M

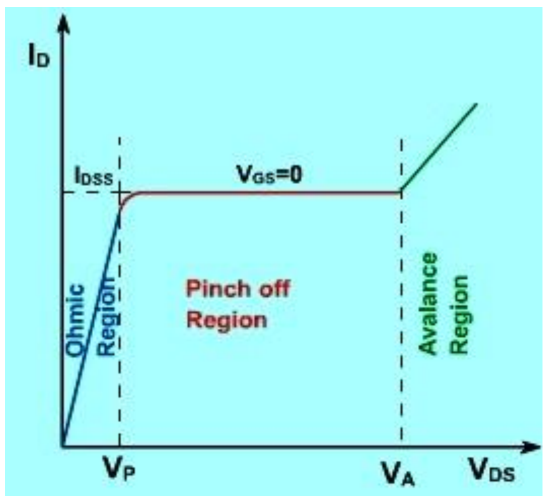
		(ii) Red= 2, Blue=6, Green=$*10^5$ and Gold=+-5% $26*10^5 = 2600000\Omega = 2.6M\Omega$	
	b)	**(i) In NPN transistor,** **I_{CEO} = 1000 μA, β= 50, I_B = 10 μA** **Find Ic & I_E** **(ii) Define operating point of a transistor.**	**6 M**
	Ans	i)I_{CEO}= 1000 μA= $1000 \times 10^{-6} = 10^{-3}$A β = 50 I_B= 10 μA = $10 \times 10^{-6} = 10^{-5}$A Ic=? Ic= $\beta I_B + I_{CEO}$ = $50 \times 10^{-5} + (10^{-3})$ =0.0015 =1.5mA IE= IC+IB = $0.0015 + 10^{-5}$ =0.00151 =1.51 mA ii) Definition: The point which is obtained from the values of the I_C **(**collector current) or V_{CE} (collector-emitter voltage) when no signal is given to the input is known as the operating point or Q-point in a Transistor. It is called operating point because variations of I_C (collector current) and V_{CE} (collector-emitter voltage) takes place around this point when no signal is applied to the input.	Problem Solution: 4 M Definition Operating Point: 2 M
	c)	**(i) Identify the given circuit in fig. (iii) and explain its working.** **(ii) Draw the input and output for the same circuit.**	**6 M**

		 **Fig. (iii)** **(iii) State application for the given circuit.**	
	Ans	i) Center tapped full wave rectifier ii) **Working:** • During the positive half cycle of the input voltage, the point A at the transformer secondary becomes positive. This makes the diode D1 forward biased. Hence current I1 f**lows through the load resistor.** • When the negative half cycle of the input voltage is applied, the point A at the transformer secondary becomes negative. This makes the diode D2 forward biased. Hence current I2 flows through the load resistor. ii) Input- Output Waveform:  (iii) State application for the given circuit: • The conversion between high AC to low DC can be done by using this type of rectifiers. • The efficiency is high in these circuits make it capable of using it as a basic component in the power supply units. • In the criteria of powering on the devices like LED's or it may be motors this	Identify:1M Working, Waveform:3M Application: 2M

		type of rectifiers are preferred.	
6.		**Attempt any TWO of the following:**	**12 M**
	a)	**Draw suitable diagrams showing depletion regions before & after pinch-off for N channel JFET.**	**6 M**
	Ans	Depletion regions before pinch-off for N channel JFET  N-channel JFET Depletion regions after pinch-off for N channel JFET. 	Diagram depletion regions before N channel JFET:3M Diagram Depletion regions after N channel JFET:3M



Pinch off voltage: Pinch off voltage is the drain to source **voltage** after which the drain current becomes almost constant and **JFET** enters into saturation region and is defined only when gate to source **voltage** is zero.



b)	**Distinguish between CB, CC, CE (four points). Explain why CE configuration is the most preferred combination.**	**6 M**
Ans		Comparison Each Point:1M Explanation CE configuration is the most preferred:2M

Parameter	Common Base	Common Emitter	Common Collector
Voltage Gain	High, Same as CE	High	Less than Unity
Current Gain	Less than Unity	High	High
Power Gain	Moderate	High	Moderate
Phase inversion	No	Yes	No

Input Impedance	Low (50 Ohm)	Moderate (1KOhm)	High (300 KOhm)
Output Impedance	High (1 M Ohm)	Moderate (50 K)	Low (300 Ohm)

•CE is most widely used because it provides the voltage gain required for most of the day to day applications of preamp and power amps. This is not possible in CB mode.

• Common emitter is the most basic configuration for amplifier circuits. It also provides the maximum transconductance or voltage gain for a given load.

• The common emitter configuration has the highest power gain combined with medium voltage and current gain.

c) **With suitable diagram, explain how photodiode & phototransistor can be used as control device for the given application.** **6 M**

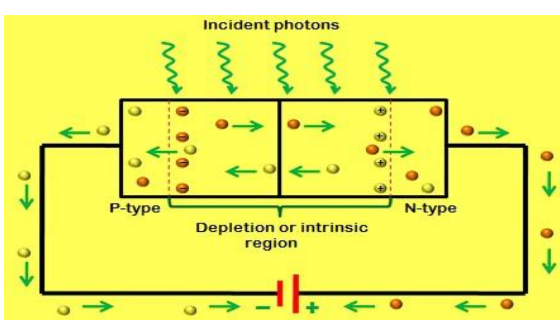
Ans **Note: Any other diagram with similar concept shall be considered**

Each explanation:3M

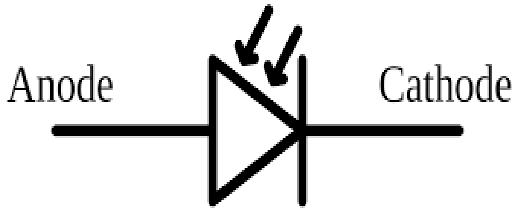
Photodiode:

It is a form of light sensor that converts light energy into electrical energy (voltage or current). Photodiode is a type of semi conducting device with PN junction. Between the p (positive) and n (negative) layers, an intrinsic layer is present. The photo diode accepts light energy as input to generate electric current.It is also called as Photodetector, Photo Sensor or Light Detector. Photodiode operates in reverse bias condition i.e., the p – side of the photodiode is connected with negative terminal of battery (or the power supply) and n – side to the positive terminal of battery.Typical photodiode materials are Silicon, Germanium, Indium Gallium Arsenide Phosphide and Indium gallium arsenide.

Internally, a photodiode has optical filters, built in lens and a surface area. When surface area of photodiode increases, it results in less response time. Few photo diodes will look like Light Emitting Diode (LED). It has two terminals as shown below. The smaller terminal acts as cathode and longer terminal acts as anode.



Symbol:



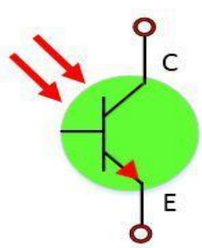
Applications of Photodiode

- Photodiodes are used in many simple day to day applications. The reason for their use is the linear response of photodiode to a light illumination. When more amount of light falls on the sensor, it produces high amount of current. The increase in current will be displayed on a galvanometer connected to the circuit.
- Photodiodes help to provide an electric isolation with help of optocouplers. When two isolated circuits are illuminated by light, optocouplers is used to couple the circuit optically. But the circuits will be isolated electrically. Compared to conventional devices, optocouplers are fast.
- Photodiodes are also used in safety electronics like fire and smoke detectors. It is also used in TV units.

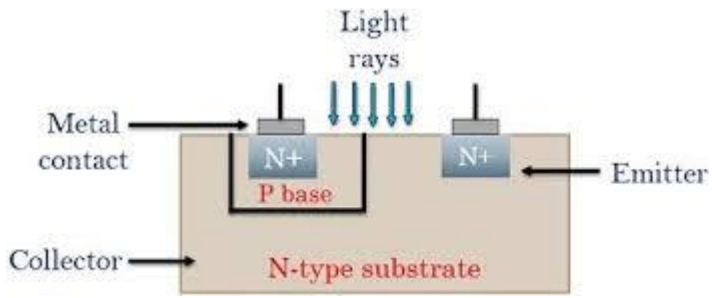
Phototransistor:

A phototransistor is similar to a regular BJT except that the base current is produced and controlled by light instead of a voltage source. The phototransistor effectively converts light energy to an electrical signal. In a phototransistor the base current is produced when light strikes the photosensitive semiconductor base region. The collector-base pn junction is exposed to incident light through a lens opening in the transistor package. When there is no incident light, there is only a small thermally generated collector-to-emitter leakage current, I_{CEO}; this dark current is typically in the nA range. When light strikes the collector-base pn junction, a base current is produced that is directly proportional to the light intensity. This action produces a collector current. Except for the way base current is generated, the phototransistor behaves as a conventional BJT. In many cases, there is no electrical connection to the base.

Symbol:



Construction:



A phototransistor can be either a two-lead or a three-lead device. In the three-lead configuration, the base lead is brought out so that the device can be used as a conventional BJT with or without the additional light-sensitivity feature. In the two-lead configuration, the base is not electrically available, and the device can be used only with light as the input. In many applications, the phototransistor is used in the two-lead version. Phototransistors are not sensitive to all light but only to light within a certain range of wavelengths. They are most sensitive to particular wavelengths in the red and infrared part of the spectrum.

Applications of Phototransistors

The Areas of application for the Phototransistor include:

- Punch-card readers.
- Security systems
- IR detectors photo
- electric controls
- Computer logic circuitry.
- Relays
- Lighting control (highways etc.)