SUMMER– 2017 EXAMINATION

Model Answer **Subject Code:** 17210

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 judgment 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.		**Attempt any NINE:**	**18**
	a)	**Define electric current and state its S.I. unit.**	**2**
		Definition	1
		Unit	1
		Electric current: The rate of flow of electric charge is called electric current.	
		Unit : ampere OR A	
	b)	**State and explain Ohm's law.**	**2**
		Statement	1
		Explanation	1
		Ohm's law: If physical state of the conductor remains same, the potential difference between two ends of the conductor is directly proportional to the current flowing through it. $I \alpha V$ $V \alpha I$ $V/I = \text{Constant} = R$	

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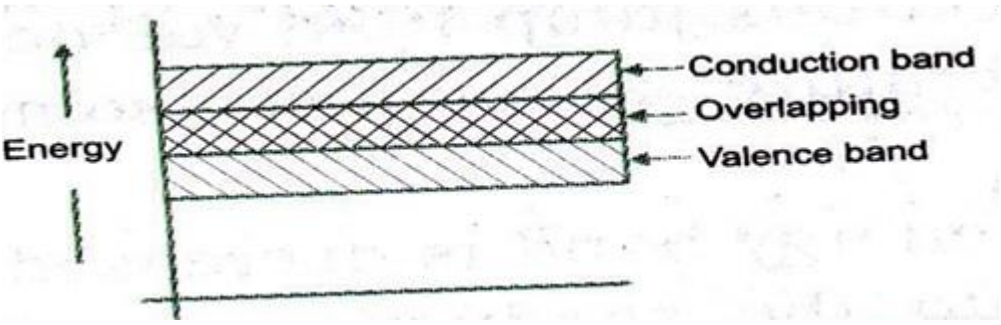
Q. No.	Sub Q.N.	Answer	Marking Scheme
1.	c)	**Define potential gradient. State its S.I. unit.** **Definition** **S.I.Unit** **Definition**: - Potential gradient is defined as the fall of potential per unit length of potentiometer wire. **OR** P.G. = Potential / Length **S.I. Unit :-** V/m.	**2** 1 1
	d)	**When a charge of 0.08 µC is given to a capacitor, its potential is raised to 200V. Find its capacitance.** **Formula with substitution** **Answer with unit** **Given** Q = 0.08 µC = 0.08 x 10^{-6} C V = 200 V C = ? We have C = Q/V = 0.08 x 10^{-6}/ 200 **C = 0.0004 x 10^{-6} F or C = 0.0004 µF**	**2** 1 1
	e)	**Define the term-Dopant, Extrinsic semiconductor.** **Each term** **Dopant: -** An element or compound used to dope a semiconductor is called dopant. **Extrinsic Semiconductor:-** In order to increase current carrying capacity some impurity are added in a semiconductor such semiconductor are called extrinsic Semiconductor.	**2** 1
	f)	**Draw energy band diagram for conductors and semiconductors.** **Each Band diagram** **Conductor:**  	**2** 1

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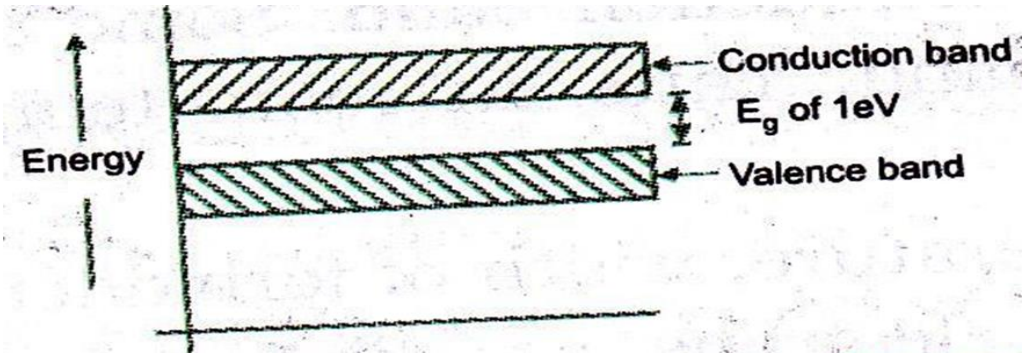
Q. No.	Sub Q.N.	Answer	Marking Scheme
1.	f)	**Semiconductor:** 	
	g)	**An X-ray tube is operated at 40kV. Calculate the minimum wavelength of x-rays emitted by it.** **Formula with substitution** **Answer with unit** **Given :** V =40kV = 40 x 10^3 V λ = ? λ = 12400 / V =12400 / 40 x 10^3 **λ =0.31 A^0 =0.31x10^{-10} m**	**2** 1 1
	h)	**State any two applications of LDR.** **Each application** **LDR** are used in alarm clocks. **LDR** are used in street lights. **LDR** are used in light intensity meters. **LDR** are used in burglar alarm. **LDR** are used in light sensors	**2** 1
	i)	**Which property of lasers enables the medicals practitioners to use them for performing cataract operations? Explain.** **Properties** **Explanation** Laser properties like **high intensity** and **unidirectionality** are used in Cataract operation. Highly intense unidirectional LASER beam can be focused at a particular point without damaging other parts of eye.	**2** 1 1

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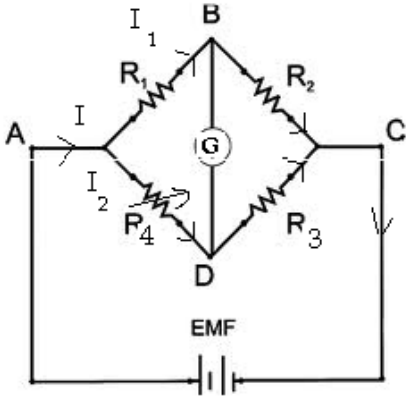
Q. No.	Sub Q.N.	Answer	Marking Scheme
1.	j)	**Define: i) Optical pumping ii) Population Inversion**	**2**
		Each definition	1
		Optical pumping: - The process of raising the atoms from lower energy state to higher energy state using light medium is called optical pumping.	
		Population inversion: - Making the population of higher energy level more than population of lower energy level by using light energy is called population inversion.	
	k)	**What is nanotechnology? Define Nano-scale.**	**2**
		Each definition	1
		Nanotechnology:-The branch of science that deals with material having one or more dimensions smaller than 100 nm is called nanotechnology.	
		Nanoscale:-The scale range from 1nm to 100 nm is called nanoscale.	
		Any relevant answer may be considered.	
	l)	**Mention Nano-material of one dimension and two dimensions.**	**2**
		Each example	1
		Nano material of one dimension	
		Carbon nanotube, nanofiber etc**.**	
		Nano material of two dimension	
		Nano thin films, nanolayers, nanosheets, nanowalls etc.	
2.		**Attempt any FOUR:**	
	a)	**Calculate the resistance and conductance of 2 m length of wire having diameter 0.4 mm and specific resistance 0.45 x 10^{-6} Ω-m.**	**4**
		Each formula	1
		Each answer with unit	1
		Given : L = 2m	
		Diameter = 0.4mm	
		Radius = r = 0.2 x 10^{-3} m	
		$\rho = 0.45 \times 10^{-6}$ Ω-m.	
		R = ?	
		G = ?	
		We have $\rho = RA/L$	
		$R = \rho L / A = \rho L / \pi r^2$	
		$R = (0.45 \times 10^{-6} \times 2) / 3.14 \times (0.2 \times 10^{-3})^2$	

Q. No.	Sub Q.N.	Answer	Marking Scheme
2.	a)	$R = 0.9 \times 10^{-6} / 0.1256 \times 10^{-6}$ **$R = 7.1656\ \Omega$** $G = 1/R = 1/7.1656$ **$G = 0.139$ S/m**	
	b)	**State and explain the balancing condition of Wheatstone's network.** **Condition** **Diagram** **Explanation**	**4** 1 2 1



In this network R_1, R_2, R_3 are kept constant and R_4 is so adjusted that galvanometer shows zero deflection. When galvanometer shows zero deflection, network is said to be balanced.

Network is balanced means points B and D are at equal potential. This is possible if ,
(P.D. across AB) =(P.D. across AD) and
(P.D. across BC)= (P.D. across DC)
Using Ohm's law,

$I_1R_1 = I_2R_4$ ……..(1)

$I_1R_2 = I_2R_3$ ……..(2)

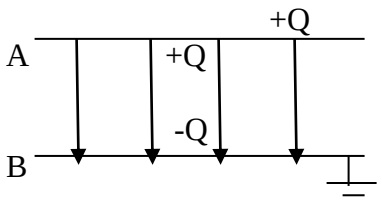
Dividing equation (1) by (2) we get

$$\frac{I_1R_1}{I_1R_2} = \frac{I_2R_4}{I_2R_3}$$

$$\frac{R_1}{R_2} = \frac{R_4}{R_3}$$

This is the balancing condition of Wheatstone's network.

Q. No.	Sub Q.N.	Answer	Marking Scheme
2.	c)	**Derive an expression for the capacitance of a parallel plate capacitor. State the factors on which it depends.**	**4**
		Diagram	1
		Expression	2
		Factors	1



Consider two metal plates A and B as shown above,
Let
A = Area of each plate
d= Distance between two plate
+Q = Charge given to A
-Q= Charge induce to inner side of B
V=P. D. between two electrode
k = Dielectric constant of the medium
Then,
The electric flux density D between the two plate is given by,

$D = \varepsilon_0 k.E$

Where,
E = Electric Intensity
ε_0 = Permittivity of free space
But,

$D = \frac{\Psi}{A} = \frac{Q}{A}$ (Where, Ψ is electric flux)

$$\therefore \frac{Q}{A} = \varepsilon_0 kE$$

$$\therefore \frac{Q}{A} = \varepsilon_0 k \frac{V}{d}$$

$$\therefore \frac{Q}{V} = \varepsilon_0 k \frac{A}{d}$$

$$\because \frac{Q}{V} = C$$

$$\therefore C = \varepsilon_0 k \frac{A}{d}$$

Q. No.	Sub Q.N.	Answer	Marking Scheme
2.	c)	The capacitance of a conductor depends upon 1. Area of plate 2. Dielectric material between them 3. Distance between the plates.	
	d)	**Three condensers with capacity 6 µF, 10 µF and 14 µF are connected in parallel in a circuit & a P.D. of 220 volts is applied across the combination. Calculate the charge on each capacitor & also total charge across the combination.**	**4**
		Three formulas with answer and unit (Each)	1
		Combination	1
		Given : Required: $C_1 = 6\mu F = 6 \times 10^{-6}$ F $Q_1 = ?$ $C_2 = 10\mu F = 10 \times 10^{-6}$ F $Q_2 = ?$ $C_2 = 14\mu F = 14 \times 10^{-6}$ F $Q_3 = ?$ V = 220 V	
		Formula: $C = Q/V$ $Q = C.V$	
		1) $Q_1 = C_1.V$ $Q_1 = 6 \times 10^{-6} \times 220$ $Q_1 = 1.32 \times 10^{-3}$ C	
		2) $Q_2 = C_2.V$ $Q_2 = 10 \times 10^{-6} \times 220$ $Q_2 = 2.20 \times 10^{-3}$ C	
		3) $Q_3 = C_3.V$ $Q_3 = 14 \times 10^{-6} \times 220$ $Q_3 = 3.08 \times 10^{-3}$ C	
		$Q = Q_1 + Q_2 + Q_3 = 1.32 \times 10^{-3} + 2.20 \times 10^{-3} + 3.08 \times 10^{-3}$ **$Q = 6.6 \times 10^{-3}$ C**	

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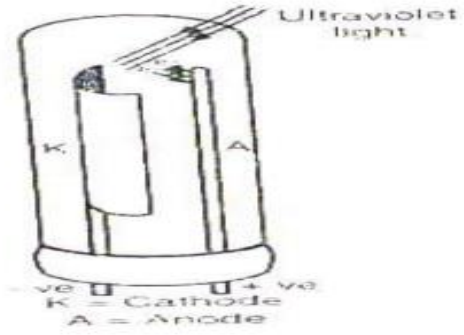
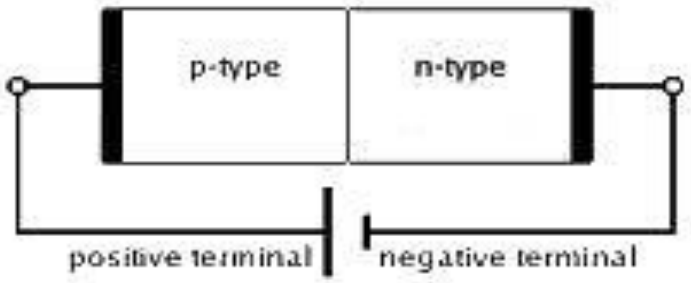
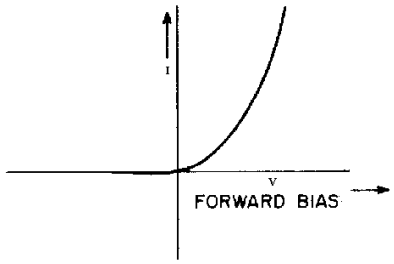
Q. No.	Sub Q.N.	Answer	Marking Scheme
2.	e)	**Distinguish between P-type and N-type semiconductors. (Any four points)**	**4**

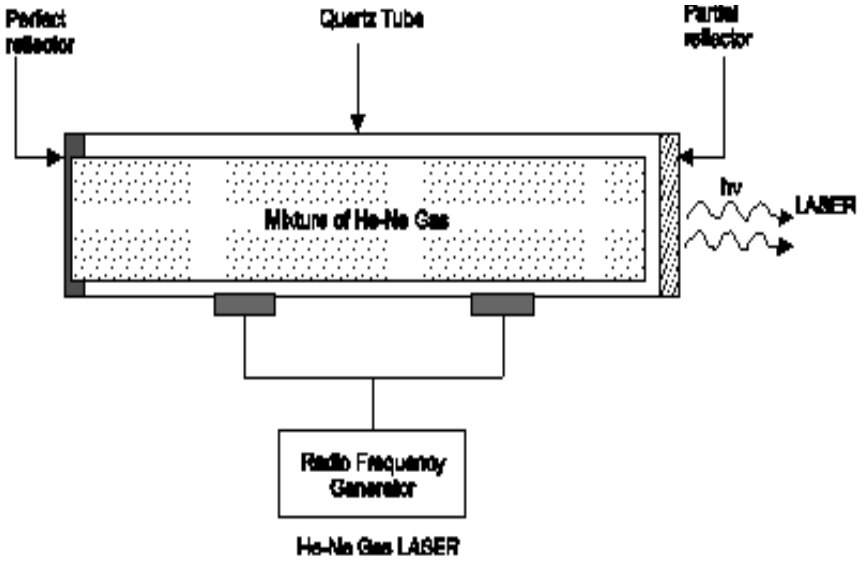
Sr. No	**N- type Semiconductor**	**P- type Semiconductor**
1	When small amount of pentavalent impurity is added to a pure semiconductor is called N-type semiconductor	When small amount of trivalent impurity is added to a pure semiconductor is called P-type semiconductor
2	Impurity is used for doping is arsenic, anatomy, phosphorus	Impurity is used for doping is gallium, indium, boron, aluminium
3	It is called donor impurity	It is called acceptor impurity
4	There are excess of electrons	There are shortage of electrons
5	The electrons are majority carriers	The holes are majority carriers

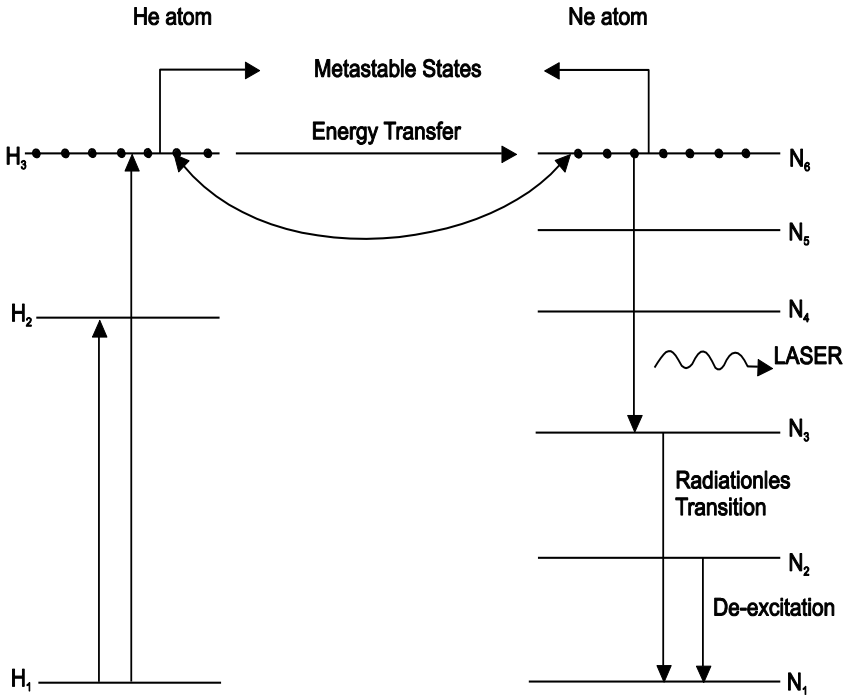
f) **Explain the construction and working of a photoelectric cell with a neat diagram.** **4**
Diagram 1
Construction 1½
Working 1½



Q. No.	Sub Q.N.	Answer	Marking Scheme
2.	f)	**Construction:** 1. It consists of evacuated glass bulb having cathode (K) and anode (A). 2. The semi cylindrical cathode coated with photosensitive material from inner side. 3. The anode is platinum rod. 4. The cathode is connected to negative terminal of battery and anode is connected to positive terminal of battery. **Working:** When light of suitable frequency is allowed to fall on cathode it emits Photoelectrons. These photoelectrons are attracted by anode. The photoelectric current flows through the circuit &millimeter shows the deflection.	
3.		**Attempt any FOUR:**	
	a)	**State any four characteristics of photoelectric effect.**	**16**
		Any four characteristics	4
		i) A metal emits electrons only when the incident (light) radiation has frequency greater than critical frequency (υ0) called threshold frequency. Threshold frequency different for different metals. ii) Photoelectric current is directly proportional to intensity of light and independent of frequency. iii) The velocity of photoelectron is directly proportional to the frequency of light. iv)For a given metal surface, stopping potential is directly proportional to the frequency and is not dependent on intensity light. v)The rate of emission of photoelectrons from the photocathode is independent of its Temperature. vi) The process is instantaneous.	4
	b)	**The threshold wavelength of silver is 3800A^0. Calculate the maximum energy of photoelectrons emitted in eV if ultraviolet light of wavelength 2600A^0 is incident on it. (Plank's constant h= 6.625 x 10^{-34} J-sec; Speed of light C= 3 x10^8 m/sec)**	**4**
		Formula and Substitution	2
		Answer with unit	2
		Given: **Required:** $\lambda_0 = 3800A^0 = 3800 \times 10^{-10}$ m E = ? $\lambda = 2600A^0 = 2600 \times 10^{-10}$ m $c = 3 \times 10^8$ m/s $h = 6.625 \times 10^{-34}$ Js $E = h c (1/\lambda - 1/\lambda_0)$	

Q. No.	Sub Q.N.	Answer	Marking Scheme
3.	b)	$E = 6.625 \times 10^{-34} \times 3 \times 10^{8} (1/2600 \times 10^{-10} - 1/3800 \times 10^{-10})$ $E = 2.415 \times 10^{-19}$ J $E = 2.415 \times 10^{-19} / 1.6 \times 10^{-19}$ $E = 1.5$ eV	
	c)	**Explain the forward bias characteristics of a P-N Junction diode.** **Diagram** **Explanation** **Graph**  **Explanation:** Above circuit diagram shows PN junction diode in forward bias mode. In forward bias mode P-type of semiconductor is connected to positive terminal and N-type of semiconductor is connected to negative terminal of battery. As voltage increases current starts flowing through diode. When the voltage applied across PN junction reaches to 0.7V (Si) the current flows through the diode i.e. the diode start conducting current. Following graph shows current voltage characteristics of PN junction forward bias.  *Voltage-current characteristic for a p-n junction.*	**4** 1 2 1

Q. No.	Sub Q.N.	Answer	Marking Scheme
3.	d)	**State any four applications of X-Rays.** **Each application.** **Application of X-rays:** i) X- rays are used to detect the cracks in the body of aeroplane. ii) X- rays are used to detect the manufacturing defects in rubber tyres or tennis ball in quality control. iii) X – rays are used to detect flows or cracks in metal jobs iv) X- rays are used to distinguish real diamond from duplicate one. v) X- rays are used to detect smuggling gold at airport and docks (ship) yard. vi) X-rays are used to detect cracks in the wall. vii) X- ray radiography is used to check the quality of welded joints.	**4** 1
	e)	**Explain in detail the construction & working of He-Ne laser.** **Each diagram** **construction** **working** **Construction :** 1. It consists of a quartz tube of about 80 cm length and 1.5 cm diameter. 2. The tube is filled with mixture of helium (He) and neon (Ne) gas. 3. The mixture consists of 90% helium atoms and 10% neon atoms. 4. At one end perfect reflector is fixed and at the other end partial reflector is fixed.  	**4** 1 1 1

Q. No.	Sub Q.N.	Answer	Marking Scheme
3.	e)	**Working :** (1)When electric discharge is produced in the tube, He and Ne gas atoms are excited. Some excited levels of helium are close to some excited levels of neon. Therefore these excited helium atoms collide with excited atoms of neon and transfer the energy to neon atoms. (2) The actual lasing action is done by neon atoms. The neon atoms with extra energy from helium atom are forced to jump in ground state by emitting a photon. This produces the LASER light. The newly emitted photon triggers the next neon atom and increases the radiations. (3) Thus coherent, monochromatic, unidirectional LASER is produced by He-Ne gas LASER The energy level diagram of He-Ne LASER is shown below.  	

Q. No.	Sub Q.N.	Answer	Marking Scheme
3.	f)	**State any four applications of nano-materials in the field of engineering.** **Each application.** **Applications of nonmaterial in engineering field.** 1. **Data storage system –** Semiconductor material in the form of film can be deposited on substrate to form the chip. 2. **Use of nonmaterial in energy sector** – The conventional energy sources like coal, fuel are depleting day by day, thus use of alternative energy source is inevitable. The efficiency of PV cells can be increased by coating the surfaces by nanothin films. 3. **Application in automobiles-** High mechanical strength material but light in weight can be produced by using nanotechnology. Nano painting materials can be used to get uniform layer of coating on the vehicle body. 4. **Application in consumer goods –** Nanotechnology has wide applications in cosmetics, domestic's products and textiles. Using nonmaterial fiber, one can get comfort of cotton clothes. **Note: Any other relevant application.**	**4** 1