WINTER– 16 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 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.		**Attempt any NINE of the Following:**	**18**
	a)	**Define (i)Electric current (ii) 1 Ω**	**2**
		Each Definition	1
		(i) **Electric Current**: The rate of flow of electric charge is called electric current.	
		(ii) **1 Ω:** If a potential difference of 1 volt applied across a conductor and it produces a current of 1 ampere through it, then the resistance of conductor is said to be one ohm.	
	b)	**State the principle of potentiometer.**	**2**
		Principle	2
		The fall of potential is directly proportional to the length of conducting wire.	
		$V \propto L$ OR	
		The potential difference between two points of conductive wire is directly proportional to the length/distance between the two points.	

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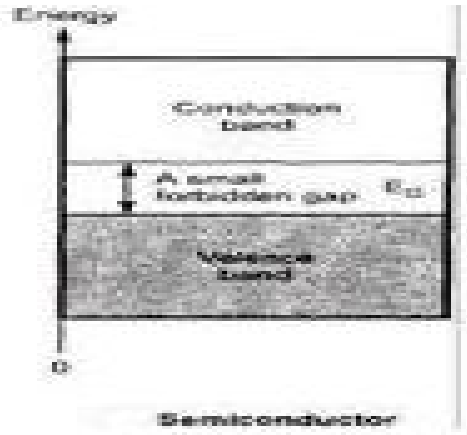
1.	c)	**Calculate the potential drop across a potentiometer wire of length 200 cm so as to have potential gradient of 10^{-3} V/m.** **Formula** **Answer with unit** Given : L= 200 cm = 2m P.G = 10^{-3} V/m Potential drop =? We have, Potential drop = P.G x length of wire(L) = 10^{-3} x 2 **Potential drop = 2 x 10^{-3} V**	**2** 1 1
	d)	**The p.d of 60 volt is applied across a condenser of capacitance 20 µF. Calculate the charge on each plate of the condenser.** **Formula and substitution** **Answer with unit** Solution: Given : V= 60 V, C= 20 µF = 20 x 10^{-6} F Q=? We have C = Q/V Q = C.V Q = 20 x 10^{-6} x 60 **Q = 1200 x 10^{-6} = 1.2 x 10^{-3} C** **Q = 1.2 mC**	**2** 1 1
	e)	**Draw neat labeled energy band diagram of semiconductor.**  	**2**

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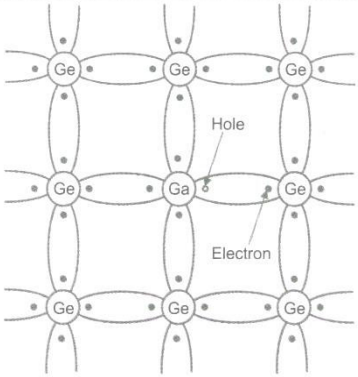
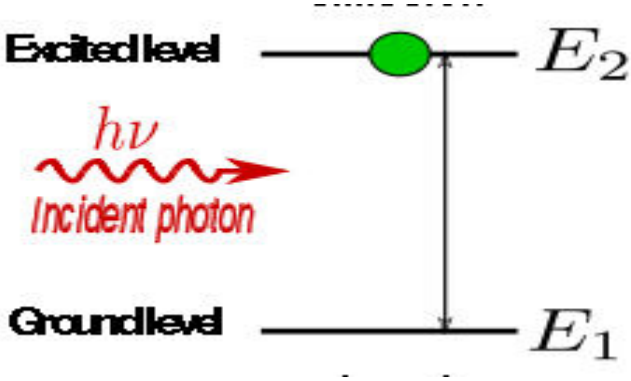
Q. No.	Sub Q.N.	Answer	Marking Scheme
1.	f)	**Explain the p-type semiconductor.**  1) Trivalent impurity is added to a pure semiconductor it is called P-type semiconductor. 2) Some trivalent impurities are gallium , indium ,boron, aluminium etc. These impurities provide large number of holes.threrefore they are called acceptor impurities. 3) Above diagram is of p-type of semiconductor .Consider a pure **Germanium crystal** , it has four valance electrons which forms covalent bonds. 4) When **gallium** is added out of four electrons of Ge only three forms the covalent bonds with creating one hole as shown above. 5) The current in it is predominantly by holes(positive charge)So they are called as majority carriers and electrons are called minority charge carriers.	**2**
	g)	**State Planck's Hypothesis** **Planck's Hypothesis:** Planck's proposed the quantum theory for explanation of energy distribution in a black body radiation. According to this theory energy is not emitted or absorbed continuously but in a discrete units or packets called photon or quanta. The photons are electrically neutral and traveled with speed of light i.e. the radiation considers as shower of photons. The energy E associated with photon is directly proportional to frequency of light.	**2**
	h)	**Define (i) Intrinsic semiconductor (ii)Fermi energy level** **Each definition** (i) **Intrinsic semiconductor:** The semiconductor in extremely pure form is called as intrinsic semiconductor. (ii) **Fermi energy level :** The energy difference between conduction band and valence band is called as fermi energy level.	**2** 1

Q. No.	Sub Q.N.	Answer	Marking Scheme
1.	i)	**State any two engineering applications of X-rays.** **Any two applications** 1) X- rays are used to detect the cracks in the body of aero plane or motor car 2) X- rays are used to detect the manufacturing defects in rubber tyres or tennis ball in quality control 3) X – rays are used to detect flaws or cracks in metal jobs. 4) X- rays are used to distinguish real diamond from duplicate one 5) X- rays are used to detect smuggling gold at airport and docks (ship) yard. 6) X-rays are used to detect cracks in the wall 7) X- ray radiography is used to check the quality of welded joints.	**2** 2
	j)	**Explain the term stimulated absorption in lasers** When the photon of energy (E= hν) is incident on an atom then the atom get excited i.e Moves from lower energy state to higher energy state is called as stimulated absorption 	**2**
	k)	**Classify nanomaterials according to their dimensions.** 1) Nano material of zero dimension : Nanoclusters 2) Nano material of one dimension: Carbon nanotube (CNT), nanofiber etc. **Any relevant may consider.**	**2**
	l)	**State any two engineering applications of nanomaterials.** **Applications of nano-material 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 nanomaterial in energy sector – The conventional energy sources like coal, fuel are depleting day by day, thus use of alternative energy source is inevitable. 3. Application in automobiles- High mechanical strength material but light in weight can be produced by using nanotechnology. Nanopainting materials can be used to get uniform layer of coating on the vehicle body.	**2**

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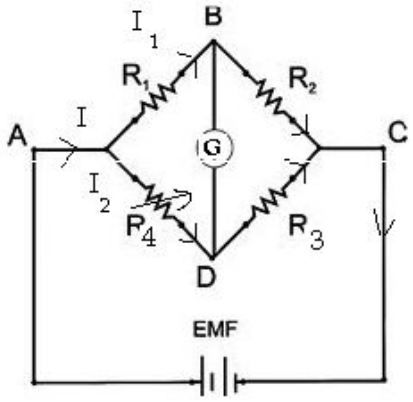
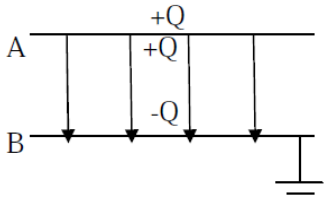
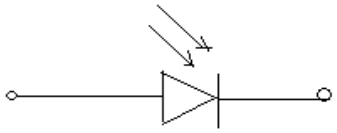
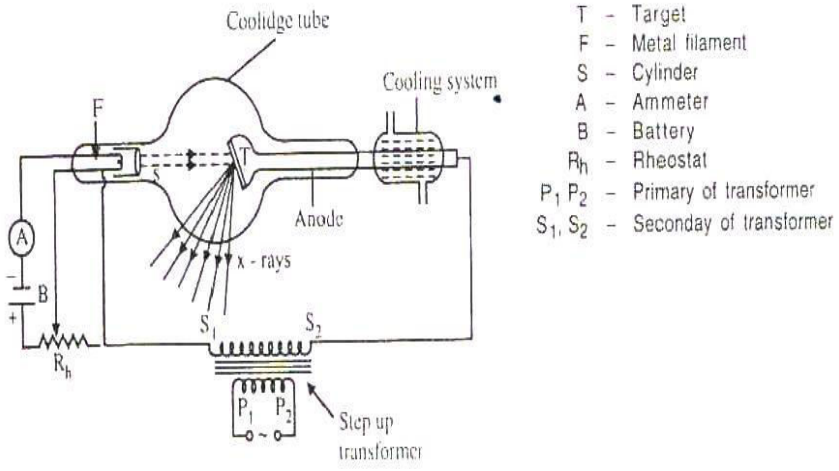
1.	l)	4) Application in consumer goods – Nanotechnology has wide applications in cosmetics, domestics products and textiles. Using nanomaterial fiber, one can get comfort of cotton clothes.	
2.	a)	**Attempt any FOUR of the following:**	**16**
		(i) Define resistivity and state its SI unit.	**4**
		(ii) A metal wire 3 m long has a diameter of 0.36 mm. if its resistance is 0.9 Ω, calculate the resistivity of the wire.	
		Definition	1
		Unit	1
		Formula	1
		Answer with unit	1
		It is defined as a resistance of wire of unit length and unit cross-sectional area. **OR** The resistance of 1m long conductor having $1m^2$ area of cross-section. **SI unit :** ohm-meter **OR** Ω-m	
		ii)Given L =3m, diameter=0.36 mm, radius(r) =0.18×10^{-3} m R = 0.9 Ω, Resistivity(ρ) =? $\rho = RA/L$ $\rho = R\Pi r^2/L$ $\rho = 0.9 \times 3.14 \times (0.18 \times 10^{-3})^2 / 3$ **$\rho = 0.0305 \times 10^{-6}$ Ωm**	
	b)	**State and explain the balancing condition of Wheatstone's network.**	**4**
		Condition	1
		Diagram	1
		Explanation	2
		Condition : The balancing condition Wheatstone's network is given as follows. $\frac{R_1}{R_2} = \frac{R_4}{R_3}$	

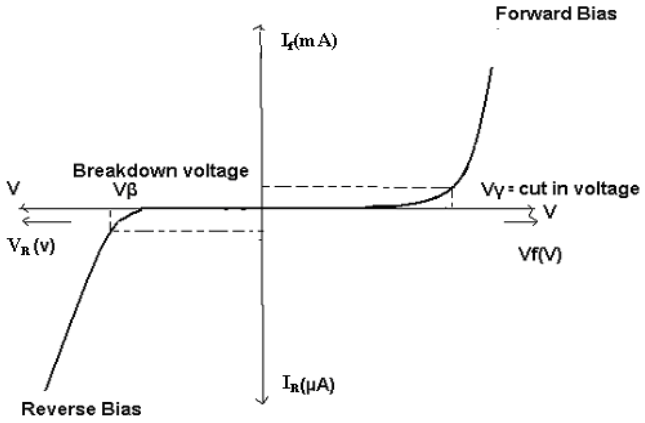
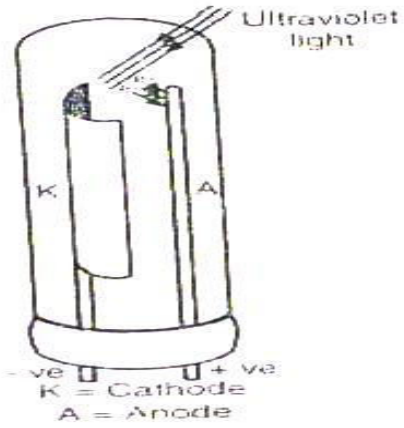
Q. No.	Sub Q.N.	Answer	Marking Scheme
2	b)	 In this network R_1,R_2,R_3 are kept constant and R_4 is so adjusted that galvanometer shows zero deflection. When galvanometer shows zero deflection, network is said to be balanced. Network is balanced means points B and D are at equal potential. This is possible 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 of the balancing condition Wheatstone's network.**	
	c)	**Derive the formula for capacitance of parallel plate condenser. State the factors on which it depends.** **Derivation** **Factors** 	**4** 3 1

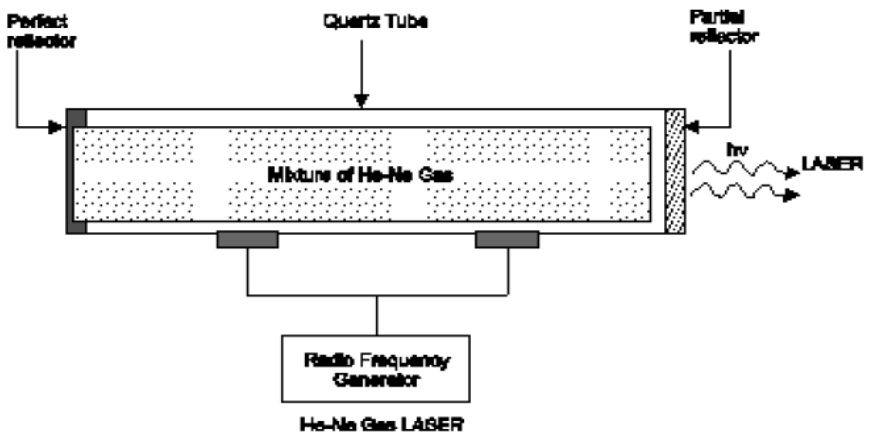
Q. No.	Sub Q.N.	Answer	Marking Scheme
2	c)	Consider two metal plates A and B as shown above, Let A = Area of each plate d= Distance between two plate +Q = Charge given to A -Q= Charge induce to inner side of B V=P. D. between two electrode k = Dielectric constant of the medium Then, The electric flux 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) $\therefore \frac{Q}{A} = \varepsilon_0 kE$ $\therefore \frac{Q}{A} = \varepsilon_0 k \frac{V}{d}$ $\therefore \frac{Q}{V} = \varepsilon_0 k \frac{A}{d}$ $\because \frac{Q}{V} = C$ $\therefore C = \varepsilon_0 k \frac{A}{d}$ **Factors affecting on parallel plate condenser** A = Area of each plate d= Distance between two plate k = Dielectric constant of the medium ε_0 = Permittivity of free space	
	d)	**(i) Draw the symbol of a photodiode and state the principle on which it works.** **(ii) State any two applications of photodiode.** **Symbol of Photodiode** **Principle** **Any two applications**	**4** 1 1 2

Q. No.	Sub Q.N.	Answer	Marking Scheme
2		**Symbol of Photodiode**  **Principle of the photodiode:** When light is incident on suitably arranged semiconductor diode, then it produces current in the circuit. Light energy → Electrical energy **Application of photodiode** 1. It is used as light sensor in remote controlled television set. 2. It is used as light sensor in remote controlled air conditioner 3. It is used as object counter to count object, cards etc. 4. It is used as smoke detector. 5. It is used as encoder. 6. It is used as position sensor. **Note: Any relevant applications can be given credit.**	
	e)	**When light of wavelength 4000A^0 is incident on a metal plate, electrons are emitted with zero velocity. Calculate the threshold frequency and photoelectric work function of the metal.(Given, h= 6.625 x 10^{-34} J-sec, C =3 x 10^8 m/sec)**	**4**
		Each Formula	2
		Each Answers with unit	2
		Given: $\lambda = 4000\ A^0 = 4000 \times 10^{-10}$ m As v=0, K.E.=0 $h = 6.625 \times 10^{-34}$ J-sec $c = 3 \times 10^8$ m/sec ν_0= ? W_0=?	

Q. No.	Sub Q.N.	Answer	Marking Scheme
2	e)	I) $h\nu = W_0 + K.E.$ $h\nu = W_0 + K.E.$ $h\nu = W_0 + 0$ $h\nu = W_0$ $W_0 = h\nu = hc/\lambda$ $W_0 = 6.625x10^{-34}x3x10^{8}/ 4000x10^{-10}$ $W_0 = 4.968 \times 10^{-19}$ J $W_0 = 4.968 \times 10^{-19}/1.6X10^{-19}$ **$W_0 = 3.105$ eV.** II) $W_0 = h\nu_0$ $\nu_0 = W_0/h = 4.968 \times 10^{-19}/6.625x10^{-34}$ **$\nu_0 = 0.749 \times 10^{15}$ Hz**	
	f)	**Explain the production of X-rays using Coolidge tube with a neat labeled diagram.** **Diagram** **Explanation**  **Principle:** When fast moving electrons are suddenly stopped then X- rays are produced.	**4** 2 2

Q. No.	Sub Q.N.	Answer	Marking Scheme
2	f)	**Working:** When the cathode is heated by electric current it produced electron due to thermionic emissions. The beam of electron is then focused on the anode (target). The electrons from cathode are accelerated by applying of high voltage between cathode & anode using step up transformer. When these fast moving electrons are suddenly stopped by tungsten anode, they lose their kinetic energy and x rays are produced from the target. Some amount of Kinetic energy is converted to large amount of heat. By controlling the filament current, the thermionic emission of electron hence intensity of X-rays can be controlled.	
3.		**Attempt any <u>FOUR</u> of the following:**	**16**
	a)	**Three condensers are connected in series across 220 V supply. If the voltage drops across the condensers are 50 V, 60 V and 110 V respectively and the charge on each condenser is 6μF, Calculate the capacitance of each condenser and hence the effective capacitance of the combination.**	**4**
		Capacity of each Condenser	1
		Capacity of combination	1
		Given V_1= 50V; V_2= 60V; V_3= 110V and Q = 6 μF We have , C = Q /V $C_1 = Q / V_1 = 6 / 50 = 0.12$ μF $C_2 = Q / V_2 = 6 / 60 = 0.1$ μF $C_3 = Q / V_3 = 6 / 110 = 0.0545$ μF These three condenser are connected in series therefore their effective capacitance of the combination is C_s given by $1/Cs = 1/C_1 + 1/C_2 + 1/C_3$ $= 1/0.12 + 1/0.1 + 1/0.0545$ $= 8.33 + 10 + 18.34$ $1/Cs = 36.67$ **Cs = 0.0272 μF**	
	b)	**Explain the I-V characteristics of a P-N junction diode in detail when it is forward biased and reverse biased.**	**4**
		I -V characteristics.	2
		Each Explanation	1

Q. No.	Sub Q.N.	Answer	Marking Scheme
3.	b)	 **Forward Bias Characteristic: -** If external voltage is increased from zero onwards , initially the forward voltage is increased and values of currents are recorded and the graph is plotted as shown above. Initially for increase in voltage there is no corresponding increase in current. Above barrier potential current increases rapidly and diode starts conducting current. **Reverse Bias Characteristics: -** As the reverse biased voltage is increased , at critical voltage V_{BR} the reverse current through the diode increases sharply. The corresponding voltage is called breakdown voltage	
	c)	**With neat labeled diagram, explain the working of photoelectric cell.** **Diagram** **Working**  **Working:** When light 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.	**4** 2 2

Q. No.	Sub Q.N.	Answer	Marking Scheme
3.	d)	**Calculate the minimum wavelength and maximum frequency of X-rays produced by an X-ray tube operating at 50kV.**	**4**
		[Given Velocity of light, c =3 X 10^8 m/sec)	2
		Each formula	2
		Each answer with unit	
		Given V=50kV=50X10^3V h = 6.63 X 10-^{34}Js e =1.6 X 10^{-19}C c =3 X 10^8 m/s We have, $\lambda_{min} = \frac{hc}{eV}$ $\lambda_{min} = \frac{(6.62\times10^{-34})(3\times10^8)}{(1.6\times10^{-19})(50\times10^3)}$ λ_{min} = **0.248 x 10^{-10} m.** λ_{min} = **0.248 A^0** $f = \frac{c}{\lambda_{min}}$ $f = \frac{(3\times10^8)}{(0.248\times10^{-10})}$ f = **120 x 10^{17} Hz.**	
	e)	**With neat labeled diagram, explain the working of He-Ne Laser.**	**4**
		Each Diagram	1
		Working	2
			

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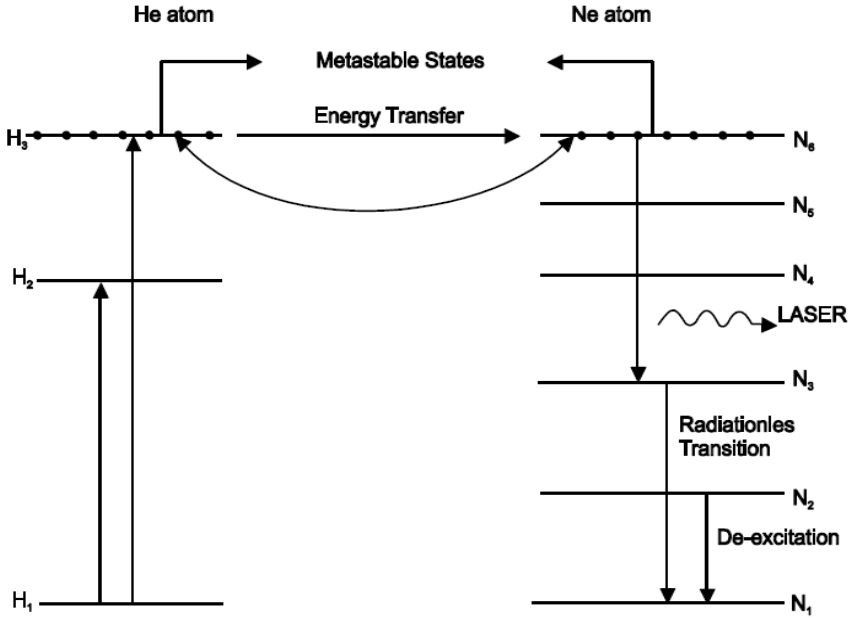
3.	e)	**Working:** (1) When electric discharge is produced in the tube, He and Ne gas atoms are excited. Some excited levels of helium are close to some excited levels of neon. Therefore these excited helium atoms collide with excited atoms of neon and transfer the energy to neon atoms. (2) The actual 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. 	
	f)	**Write the names of any four physical methods of synthesis of nanoparticles.** **Physical method :** There are two main types of physical methods. I) Mechanical method II) Vapour deposition method **In Mechanical method :** A) High Energy Ball Milling method. B) Melt mixing method : **In Vapour deposition method:** A) Physical vapour deposition(PVD) B) Sputtering	**4**