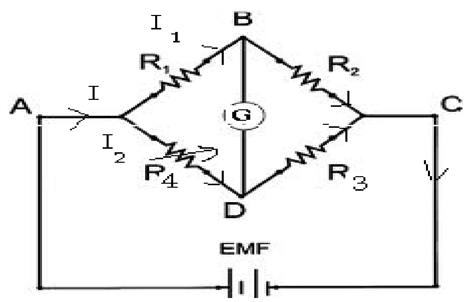
SUMMER– 18 EXAMINATION

Subject Name: Applied Physics **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)	**State Ohm's law with mathematical equation.** **Statement** **Mathematical equation** **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. V = IR	**2** 1 1
	b)	**Explain the principle of potentiometer.** **Principle and explanation** The fall of potential is directly proportional to the length of conducting wire.	**2** 2

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	b)	The potential difference between two points of conductive wire is directly proportional to the length/distance between the two points. $V \propto L$	
	c)	**Draw a neat diagram of Wheatstone's network.** **Diagram with labels** 	**2** 2
	d)	**When a charge of 0.05 µC is given to a conductor, its potential is raised to 100V. Find its capacitance.** **Formula with substitution** **Answer with unit** **Given** $Q = 0.05\ \mu C = 0.05 \times 10^{-6}$ C $V = 100$ V $C = ?$ We have $C = Q/V = 0.05 \times 10^{-6} / 100$ $\mathbf{C = 0.0005 \times 10^{-6}}$ **F or C = 0.0005 µF**	**2** 1 1
	e)	**Define conduction band & forbidden energy gap.** **Each definition** **Conduction band :**Range of energy possesed by conduction electrons is called **conduction band.** **Forbidden energy gap :** The energy difference between conduction band and valance band is called forbidden energy gap.	**2** 1

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1	f)	**State the values or range of values of energy band for conductor, semiconductor & insulator.** **Three values** **Conductor :** no gap **Semiconductor :** 1 eV **Insulator :** 5.5 eV	**2** 2
	g)	**State Planck's Hypothesis** **Statement** **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** 2
	h)	**An X-ray tube is operated at 50 kV.What will be the wavelength of x-rays emitted in it?** **Formula with substitution** **Answer with unit** **Given :** $V = 50\ kV = 50 \times 10^3\ V$ $\lambda = ?$ $\lambda = 12400 / V$ $= 12400 / 50 \times 10^3$ $\boldsymbol{\lambda = 0.248\ A^0 = 0.248 \times 10^{-10}\ m}$	**2** 1 1
	i)	**State two points of differentiation between spontaneous emission and stimulated emission.** **Two points**	**2** 2

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1	i)	(table below)	

Spontaneous emission	**Stimulated emission**
Excited atoms comes to ground state on its own accord	Excited atoms comes to ground state after interaction with incident photon.
Radiations are in random direction , phase and wavelength	Radiations are coherent , monochromatic and in same direction.
Independent of outside circumstances	Dependent of outside circumstances
No metastable state exist (ordinary exited state)	Metastable state exist
Number of photons emitted are less	Number of photons emitted are more

j) **Define: Optical pumping & 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.

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1	k)	**Define nanometer & nanoparticle.** **Each definition** **Nanometer:** A nanometer is a billionth of a meter. **Nanoparticle:** Nanoparticles are particles whose dimensions(any one or many) are between 1 and 100 nanometres (nm) .	**2** 1
	l)	**State two properties of nanoparticle.** **Any two properties** i. Mechanical property. ii. Structural property. iii. Thermal property. iv. Electric property. v. Magnetic property. vi. Optical property.	**2** 2

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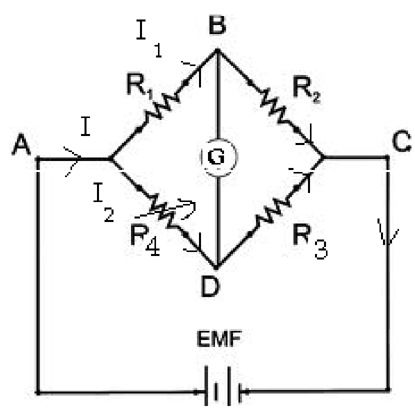
Q. No.	Sub Q. N.	Answer	Marking Scheme
2.		**Attempt any FOUR of the following:**	**16**
	a)	**The specific resistance of the material of the wire is 3 x 10^{-7} Ω-m. If the resistance of the wire is 4 Ω and radius of the wire is 0.6 mm, calculate the length of wire**	**4**
		Formula with substitution	2
		Answer with unit	2
		Given : L = ? Radius = r = 0.6 x 10^{-3} m $\rho = 3 \times 10^{-7}$ Ω-m. R = 4 Ω We have $\rho = RA/L$ $L = RA/\rho = 4 \times 3.14 \times (0.6\times10^{-3})^2 / 3 \times 10^{-7}$ **L = 15.07 m**	
	b)	**State and explain the balancing condition of Wheatstone's network.**	**4**
		Diagram	2
		Explanation	2
			
		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.	

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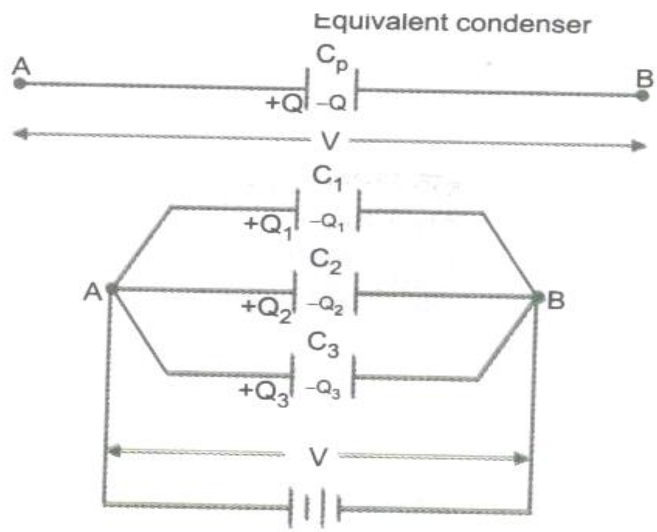
2.	b)	Network is balanced means points B and D are at equal potential. This is possible if , (P.D. across AB) =(P.D. across AD) and (P.D. across BC)= (P.D. across DC) Using Ohm's law, $I_1R_1 = I_2R_4$ ………..(1) $I_1R_2 = I_2R_3$ ………..(2) Dividing equation (1) by (2) we get $\frac{I_1R_1}{I_1R_2} = \frac{I_2R_4}{I_2R_3}$ $\frac{R_1}{R_2} = \frac{R_4}{R_3}$ This is the balancing condition of Wheatstone's network.	
	c)	**Obtain the expression for equivalent capacitance of capacitors are connected in parallel combination.**	**4**
		Well Labeled Diagram	2
		Explanation & Substitution	1
		Final Expression	1
			

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Q. No.	Sub Q. N.	Answer	Marking Scheme
2.	**c)**	**Resultant Capacitance when three Condensers are Connected in parallel :** Consider three condensers C_1, C_2 & C_3 are connected in **parallel** between two points AB with potential difference of V volt. When condenser are connected in **parallel** the **total potential difference across each condenser remains the same V and the charge on each condenser gets divided** into three parts Q_1, Q_2 & Q_3 which depends on values of capacitor $Q = Q_1 + Q_2 + Q_3$ ....(1) But $C = \frac{Q}{V}$ Therefore, $Q = CV$ Charge on C_1 is $Q_1 = C_1V$ Charge on C_2 is $Q_2 = C_2V$ Charge on C_3 is $Q_3 = C_3V$ Substituting above values in equation (1) $CV = C_1V + C_2V + C_3V$ $CV = V(C_1 + C_2 + C_3)$ $C = C_1 + C_2 + C_3$	
	d)	**Area of parallel plate condenser is 1.6 m^2 and distance between the two plates is 1.2 mm. Dielectric constant of the material between the two plates is 3.Find capacitance of the condenser.(ε_0= 8.85x10^{-12})** **Formula and substitution** **Answer with unit** Given:- A= 1.6 m^2 d = 1.2 mm= 1.2x10^{-3} m	**4** 2 2

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Q. No.	Sub Q. N.	Answer	Marking Scheme
2.	**d)**	$\varepsilon_0 = 8.85 \times 10^{-12}$ k = 3 Required: C=? $\therefore C = \varepsilon_0 k \dfrac{A}{d}$ $C = 8.85 \times 10^{-12} \times 3 \times 1.6 / 1.2 \times 10^{-3}$ $C = 3.54 \times 10^{-8}$ F	
	e)	**Distinguish between P-type and N-type semiconductor.** **Any four points**	**4** 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, antimony, 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

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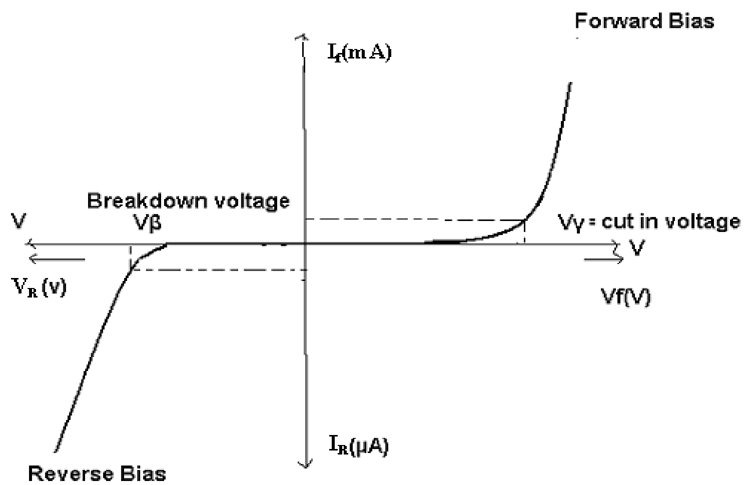
Q. No.	Sub Q. N.	Answer	Marking Scheme
2.	f)	**Plot and explain I -V characteristics of a PN junction diode**. **Diagram** **Explanation**  In forward bias mode P-type of semiconductor is connected to positive terminal and N-type of semiconductor is connected to negative terminal of battery. As voltage 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 as shown above. In reverse bias mode P-type of semiconductor is connected to negative terminal and N-type of semiconductor is connected to positive terminal of battery. In this current produced is due to minority charge carriers. This current is called leakage current. As the reverse biased voltage is increased at a critical voltage V_{BR} , the reverse current through the diode increases sharply. Most of the diodes have breakdown voltage more than 50 V.	**4** 2 2

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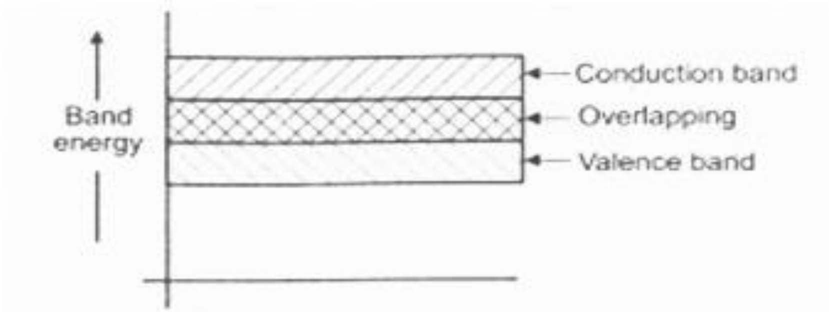
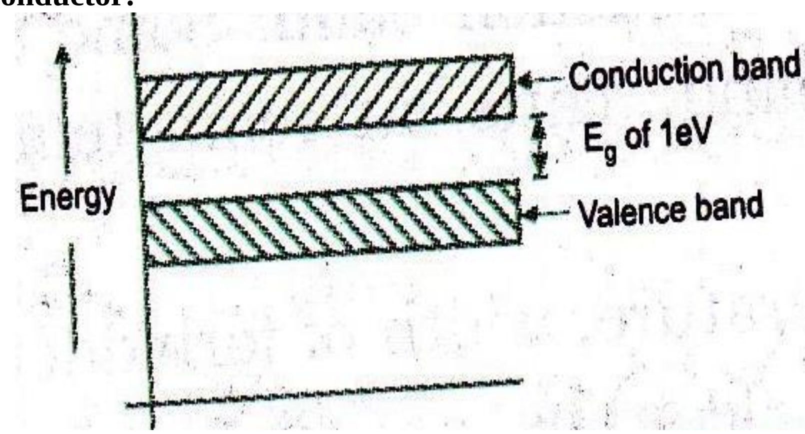
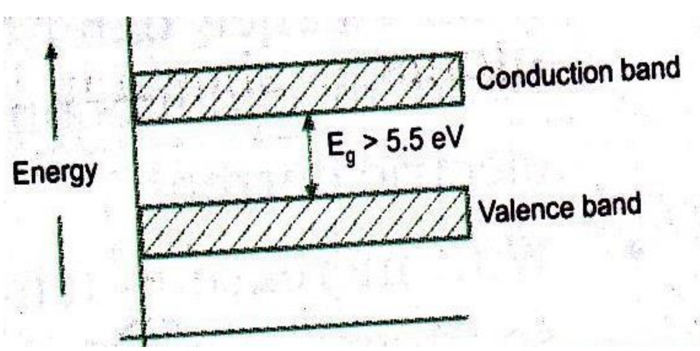
<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td>3.</td><td>a)</td><td>Attempt any FOUR of the following:
Draw the energy band diagram for conductor , semiconductor & insulator.
Three Diagrams with label
Conductor:


Semiconductor:


Insulator:

</td><td>16
4
4</td></tr>
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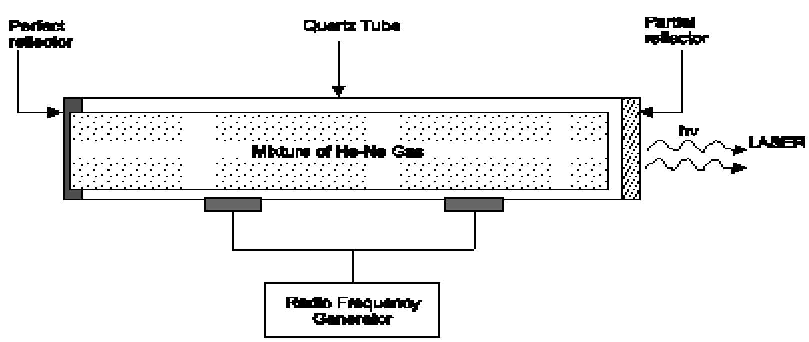
3.	b)	**The threshold frequency of a metal is 1.2 x 10^{15} Hz. If the light of frequency 1.5x 10^{15} Hz is made incident on the metal plate , Calculate the maximum K.E. of the ejected photoelectron. (h= 6.625 x 10^{-34} J-sec)**	**4**
		Formula and Substitution	2
		Answer with unit	2
		Given: $\upsilon_0 = 1.2 \times 10^{15}$ Hz $\upsilon = 1.5\times 10^{15}$ Hz $h = 6.625 \times 10^{-34}$ Js **Required:** E = ?	
		$E = h(\upsilon - \upsilon_0) = 6.625 \times 10^{-34}(1.5\times 10^{15} - 1.2 \times 10^{15})$ $\mathbf{E = 1.995 \times 10^{-19}\ J = 1.24\ eV}$	
	c)	**State four properties of X-rays.**	**4**
		Any four Properties i. They are electromagnetic waves of very short wavelength ii. They travel with speed of light. iii. They affect photographic plates. iv. They produce fluorescence in many substances. v. They can be reflected or refracted under certain conditions. vi. They are not deflected by magnetic or electric field. vii. They have high penetrating power. viii. They produce photoelectric effect. ix. They are invisible to eyes. x. X-ray kill some form of animal cell	4
	d)	**Explain with the help of neat & labeled diagram the working of He-Ne laser.**	**4**
		Each diagram	1
		construction	1
		working	1
		 He-Ne Gas LASER	

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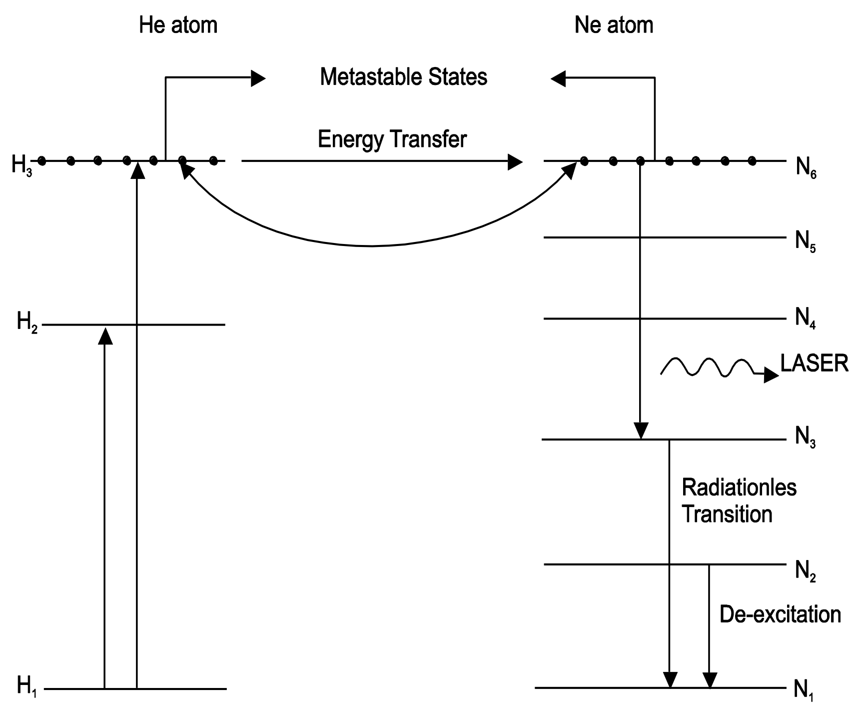
3.	d)	**Construction :** 1. It consists of a quartz tube of about 80 cm length and 1.5 cm diameter. 2. The tube is filled with mixture of helium (He) and neon (Ne) gas. 3. The mixture consists of 90% helium atoms and 10% neon atoms. 4. At one end perfect reflector is fixed and at the other end partial reflector is fixed. **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.  	

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Q. No.	Sub Q. N.	Answer	Marking Scheme
3.	e) i)	**State Einstein photo – electric equation of photo – electric emission with meaning of symbol**. **Equation** **Symbols** $E = h(\upsilon - \upsilon_0) = hc(1/\lambda - 1/\lambda_0)$ E= Kinetic energy , h = Plank's constant , υ = Frequency of incident light , υ_0 = Threshold frequency , λ = wavelength of incident light , λ_0 = Threshold wavelength , c = velocity of light.	**2** 1 1
	ii)	**State any two Engg. application 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.	**2** 1
	f)	**State any four applications of nanomaterial in engineering field.** **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. 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 nanomaterial fiber, one can get comfort of cotton clothes. **Note: Any other relevant application.**	**4** **1**