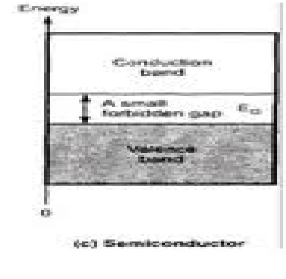
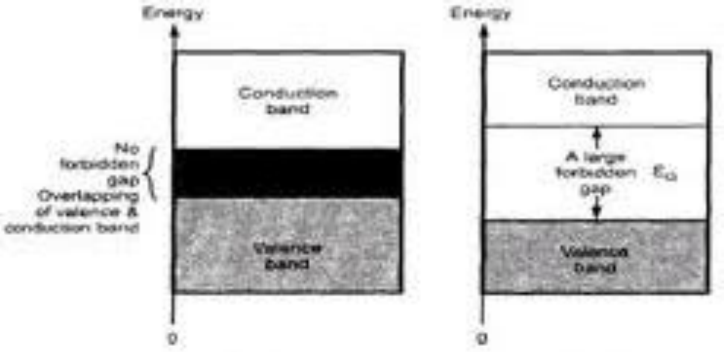
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
		Important Instructions to examiners: 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme. 2) The model answer and the answer written by candidate may vary but the examiner may try to assess 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.		

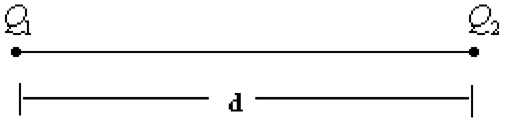
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)		**Solve any nine of the following.**		18
	a)	**Define one coulomb charge in static electricity.** **Definition –** If two equal strength charges are placed in air 1m apart from each other and if they exert a force of 9 X 10^9 N on each other, then each charge is said to be a unit charge or charge of one coulomb.	2	2
	b)	**State the terms:** 1. Potential difference. 2. Absolute electric potential. **Each term** **Potential difference:** The potential difference between two points in an electric field is the amount of work-done in carrying a unit positive charge from one point to another point against the electric field. **Absolute electric potential:** Absolute electric potential at a point is defined as the amount of work done in carrying a unit positive charge from infinity to that point against the electric field.	1	2
	c)	**For an optically transparent medium the critical angle is 41^0 calculate the refractive index of the medium.** **Formula & substitution** **Answer with unit** Given $\theta_c = 41^0$ Refractive index of air $n_2 = 1$ Refractive index of medium n_1 =? $\sin\theta_c = \frac{n_2}{n_1}$ $n_1 = \frac{n_2}{\sin\theta_c}$ $n_1 = \frac{1}{\sin 41}$ $n_1 = 1.52$	1 1	2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
	d)	State any two applications of optical fiber. **Any two applications –** i) To carry telex signals ii) To carry FAX signals. iii) Used in internet to carry signals iv) To carry telephone signals in telephone department. v) To carry T.V. Cable signals. vi) In military it is used in land – based system airborne system, undersea system etc. vii) It has applications in space, computer industry and also in photoreceptor optics. *(Any other relevant application)*	2	2
	e)	**Define :** **1) Capacitance of conductor.** **2) Farad.** **Each Definition –** Capacitance of conductor – The capacitance of a conductor is defined as the ratio of charge on the conductor to its potential. OR The capacitance of a conductor is also defined as the charge required to increase its potential by unity. Farad – One farad of capacitance is defined as the capacitance of a conductor the potential of which is increased by 1 volt by a charge of 1 coulomb. OR If one coulomb charge is required to raise the potential of the conductor by 1 volt, then the capacity is said to be one farad.	1	2
	f)	**Define Fermi energy. Draw energy band diagram of a semiconductor.** **Definition –** **Diagram –** Fermi energy : The Fermi energy level as that Value of energy at which the probability of occupying the level by an electron i.e. f(E) is 50% i.e. F(E) = ½  (c) Semiconductor	1 1	2

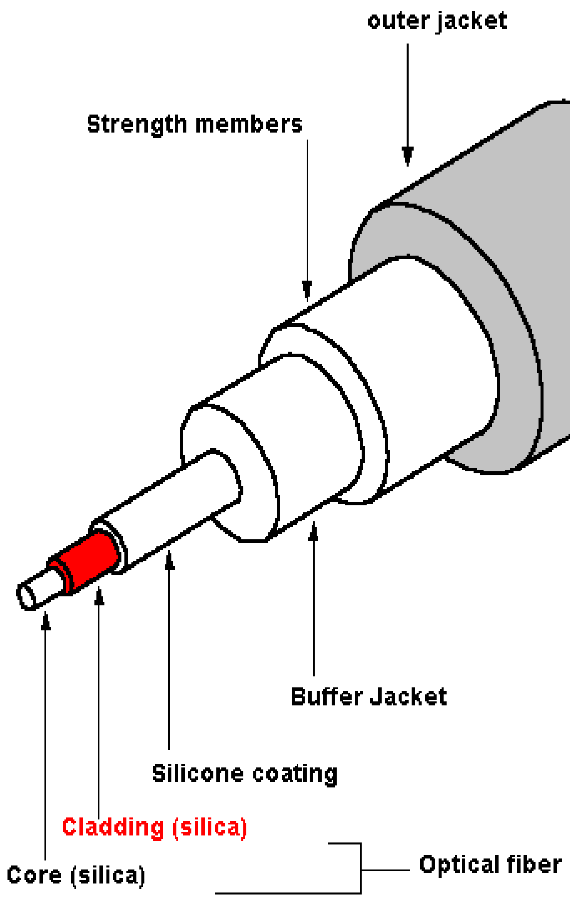
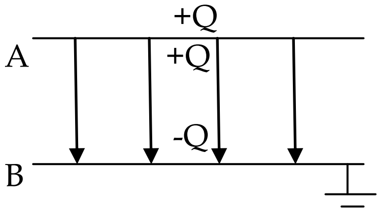
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	g)	**Give four trivalent impurities** **Each impurity –** i) Boron (B) ii) Gallium (Ga) iii) Aluminium (A1) iv) Indium (In)	½	2
	h)	**Define the term nano-material –** **Definition –** Nano materials are those with at least one dimension falling in nanometer scale and include nanoparticles (including quantum dots.) OR Nanomaterial may be defined as those materials which have structed components with size less than 100 nm at least in one dimension.	2	2
	i)	Calculate the force of repulsion between two similar charges of 100 μC separated by a distance of 0.1 meter. **Formula & substitution** **Answer with unit** Given $Q_1 = 100\mu C = 100\times10^{-6}C$ $Q_2 = 100\mu C = 100\times10^{-6}C$ $d = 0.1m$ $k = 1$ $F = ?$ $F = \frac{1}{4\pi\varepsilon_0 k}\frac{Q_1Q_2}{kd^2}$ $F = 9\times10^9\frac{Q_1Q_2}{kd^2}$ $F = 9\times10^9\frac{100\times10^{-6}\times100\times10^{-6}}{1\times(0.1)^2}$ $F = 9\times10^3 N$	 1 1	 2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	j)	**State the effective capacitance of condensers when they are connected in i) series ii) parallel.** **Effective capacitance for series** **Effective capacitance for parallel** Effective capacitance for series $\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + ...$ Effective capacitance for parallel $C_p = C_1 + C_2 + C_3 + ...$	 1 1	 2
	k)	**Draw a neat band diagram for :** **i) Good conductor** **ii) Insulator** **Each diagram**  (a) Conductor (b) Insulator	 1	 2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)		**Attempt any four**		16
	a)	**Define** **i) Electric Field.** **ii) Electric field intensity.** **iii) Electric flux.** **iv) Electric flux density.** **Each definition –**	1	4
		i) Electric field – The electric field is defined as the space around the charge in which electric effects such as attraction or repulsion due to the charge can be observed. OR Electric field of a charge is the space around the charge where force of attraction or repulsion due to a charge is present.		
		ii) Electric field intensity – Electric field intensity at a point is defined as the force acting on unit positive charge placed at that point.		
		iii) Electric Flux – The total number of electric lines of force starting from a charge is called electric flux		
		iv) Electric Flux density – Electric flux density is defined as the number of electric lines of force crossing unit area held perpendicular to the electric lines of force which pass through the center of area.		
	b)	**A sphere of radius 20cm is given a charge of 1600 micro-coulomb placed in air. Find electric potential at a point** **i) On the surface of sphere.** ii) **60 cm from the center of the sphere**.		
		Two formulae with substitution	2	
		Two answer with unit	2	4

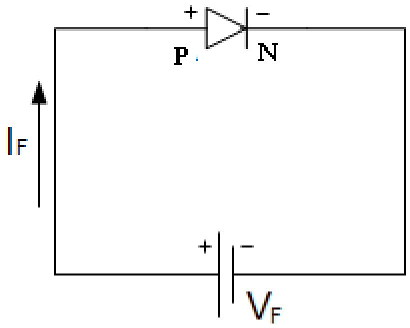
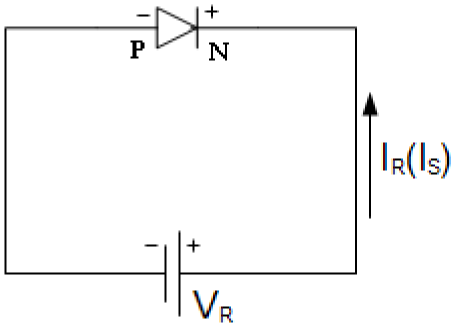
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	b)	Given: $Q = 1600\mu C = 1600 \times 10^{-6} C$ $r = 20cm = 0.20m$ $k = 1$ $V_A =$ Electric potential on the surface of sphere = ? $V_B =$ Electric potential 60 cm from the center of sphere = ? $V_A = 9 \times 10^9 \frac{Q}{kr}$ $V_A = 9 \times 10^9 \frac{1600 \times 10^{-6}}{1 \times 0.20}$ $V_A = 72 \times 10^6 Volts$ $V_B = 9 \times 10^9 \frac{Q}{kr}$ $V_B = 9 \times 10^9 \frac{1600 \times 10^{-6}}{1 \times 0.60}$ $V_B = 24 \times 10^6 Volts$		
	c)	**State and prove coulombs inverse square law.** **Statement –** **Diagram** **Explanation/ proof** Coulombs inverse square law – It states that the force of attraction or repulsion between two electric charges is directly proportional to the product of the strength of the two charges and inversely proportional to the square of the distance between them.  $Q_1 =$ Strength of the first charge $Q_2 =$ Strength of the second charge $d =$ Distance between two charges According to Coulombs inverse square law	1 1 2	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	c)	$F \alpha Q_1Q_2$ $F \alpha \frac{1}{d^2}$ $F \alpha \frac{Q_1Q_2}{d^2}$ $F = \frac{1}{4\pi\varepsilon_0 k}\frac{Q_1Q_2}{kd^2}$ Where, ε_0 =Permittivity of free space k =dielectric constant $F = 9\times10^9 \frac{Q_1Q_2}{kd^2}$ When k= 1 for air medium $F = 9\times10^9 \frac{Q_1Q_2}{d^2}$		
	d)	**Define the terms : -** **i) Volt** **ii) Dielectric Strength** **iii) Breakdwon potential** **iv) Potential due to charged sphere.** **Each definition –** **Volt –** The electric potential at a point is said to be one volt, if one joule of work is done in displacing a charge of one coulomb from infinity to that point, against the electric field. **Dielectric strength –** The magnitude of the electric field at which dielectric breakdown occurs in an insulating material is called dielectric strength of the material. **Breakdown potential –** Breakdown potential is the potential difference which when applied across a unit thickness of the insulating medium damages the insulation. **Potential due to charged sphere** Potential due to charged sphere is the amount of work done in carrying a unit positive charge from infinity to the surface of the sphere.	1	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	e)	**Draw a neat labeled diagram of optical fiber.** **Diagram with label**  	4	4
	f)	Show that $C = \frac{A\varepsilon_0 k}{d}$ in the case of parallel plate condenser where symbols have usual meaning draw the necessary diagram. **Diagram** **Equation with symbol meaning** **Final equation of capacity**  Consider two metal plates A and B as shown above, Let	1 2 1	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	f)	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) $\therefore \frac{Q}{A}=\varepsilon_0 kE$ $\therefore \frac{Q}{A}=\varepsilon_0 k\frac{V}{d}$ $\therefore \frac{Q}{V}=\varepsilon_0 k\frac{A}{d}$ $\because \frac{Q}{V}=C$ $\therefore C=\varepsilon_0 k\frac{A}{d}$		

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Stepwise Solution</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>3)</td><td></td><td>Attempt any Four of the following.</td><td></td><td>16</td></tr>
<tr><td></td><td>a)</td><td>What are the advantages of an optical fiber communication system over the conventional one?
Any four advantage
i) There is no signal leakage due to total internal reflection in fibre. So there is no loss
ii) The cost of the fiber cable is very low compared to metal cable.
iii) Optical fibres have no effect on temperature, moisture and chemical reaction.
iv) Optical fibers because of their light weight and flexibility can be handled very easily than that of heavy copper cables.
v) In case of optical fiber light is a signal carrier. Therefore communication is speedy.
vi) Light has high bandwidth i.e. extra information bandwidth, hence many signals can be sent through single fiber but in case of ordinary cable for every signal there may be different cables required. i.e. in future we may not find mesh of number of cables from terrace to terrace.
vii) As compare to ordinary cable optical fiber has longer life and easy maintenance,
<i>(Any other relevant advantage).</i></td><td>4</td><td>4</td></tr>
<tr><td></td><td>b)</td><td>Distinguish between n-type and p- type semiconductor
Any Four Points
<table>
<tr><th>Sr. No</th><th>N- type Semiconductor</th><th>P- type Semiconductor</th></tr>
<tr><td>1</td><td>When small amount of pentavalent impurity is added to a pure semiconductor it is called N-type semiconductor</td><td>When small amount of trivalent impurity is added to a pure semiconductor it is called P-type semiconductor</td></tr>
<tr><td>2</td><td>Impurity used for doping is arsenic, antimony, phosphorus</td><td>Impurity used for doping is gallium, indium, boron, aluminium</td></tr>
<tr><td>3</td><td>It is called donor impurity</td><td>It is called acceptor impurity</td></tr>
<tr><td>4</td><td>There are excess of electrons</td><td>There are shortage of electrons</td></tr>
<tr><td>5</td><td>The electrons are majority carriers</td><td>The holes are majority carriers</td></tr>
</table></td><td>4</td><td>4</td></tr>
</table>

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	c)	**Using circuit diagrams show forwarded bias and reverse bias in the case of p-n junction diode.** **Forward bias circuit diagram –** **Reverse bias circuit diagram.** **Forward bias circuit diagram –**  **Reverse bias circuit diagram.** 	 2 2	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	d)	Give one application each of nano-technology in i) medicine ii) environmental technology iii) Electronics. iv) Space and defense Any one application of each field.	1	4
		Medical field: 1. Nanotechnology is used in drug delivery effectively. 2. Nanotechnology is used in the effective detection of cancer or tumors. 3. Nanotechnology reduces cost & human suffering. 4. DNA chips & arrays are useful in diagnostics & genetic research **Environmental technology** 1) Nanotechnology particle can be used to control the emission from the vehicles 2) Nanotechnology can help in fostering the green environment by reduction the pollution, finding the new renewable energy sources, reducing the global warming. **Electronic field** 1) The flat panel television or computer monitors are products of nanotechnology. 2) The coating used on screens of TV or monitors can be of nanoparticles, which have better properties in terms of colour quality and resolution. 3) Single electron transistor (SET) and magnetic tunnel junction (MTJ) are new devices based on nanotechnology; such devices are faster, compact and cheaper. 4) Or any other relevant factor **Space and defense** 1) Tough and light weight nanomaterial are replacing the conventional material used for space applications. e.g. light weight suits, jackets made up of nano-aerogels 2) Nanoparticles are used in solar cells for better efficiency. **Note: Any other relevant application related to other field.**		

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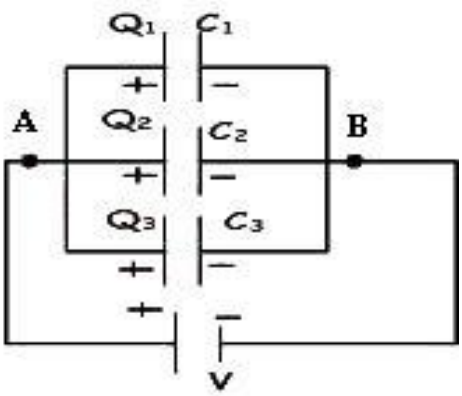
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	e)	For a silica optical fiber the refractive index of core is 1.56 and that of cladding is 1.35. Calculate its i) critical angle ii) Numerical aperture. i) Critical angle ii) Numerical aperture –		
		Critical angle	2	
		Numerical aperture	2	4
		We have, R. I. of core = n_1 = 1.56 R. I. of cladding = n_2 = 1.35 **Critical angle is given as** $\sin\theta_c = \frac{n_2}{n_1}$ $\theta_c = \sin^{-1}\frac{n_2}{n_1}$ $\theta_c = \sin^{-1}\frac{1.35}{1.56}$ $\theta_c = 59.92^0$ **Numerical aperture is given as** $N.A. = \sqrt{n_1^2 - n_2^2}$ $N.A. = \sqrt{(1.56)^2 - (1.35)^2}$ $N.A. = 0.78$		
	f)	**Obtain an expression for capacitors in parallel combination.**		
		Diagram –	1	
		Expression – (Derivation) –	3	4
				

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	f)	Consider three condensers of capacitances C_1, C_2, and C_3 connected in between the points A and B. Let V be the potential difference across the combination , Since the condensers are connected in parallel, the potential across each condenser is same. But the charge Q at point A splits into three parts say Q_1, Q_2 and Q_3. The distribution Q_1, Q_2 and Q_3 depends upon the values of C_1, C_2 and C_3 Thus, $Q = Q_1 + Q_2 + Q_3$ $But,$ $Q_1 = C_1V$ $Q_2 = C_2V$ $Q_3 = C_3V$ $Q = C_pV$ $C_pV = C_1V + C_2V + C_3V$ $C_pV = C_1 + C_2 + C_3 \ V$ $C_p = C_1 + C_2 + C_3$ Where, C_p = Equivalent capacitance of parallel combination Equivalent capacitance of the parallel combination is equal to the sum of capacitance of the condensers in parallel.		