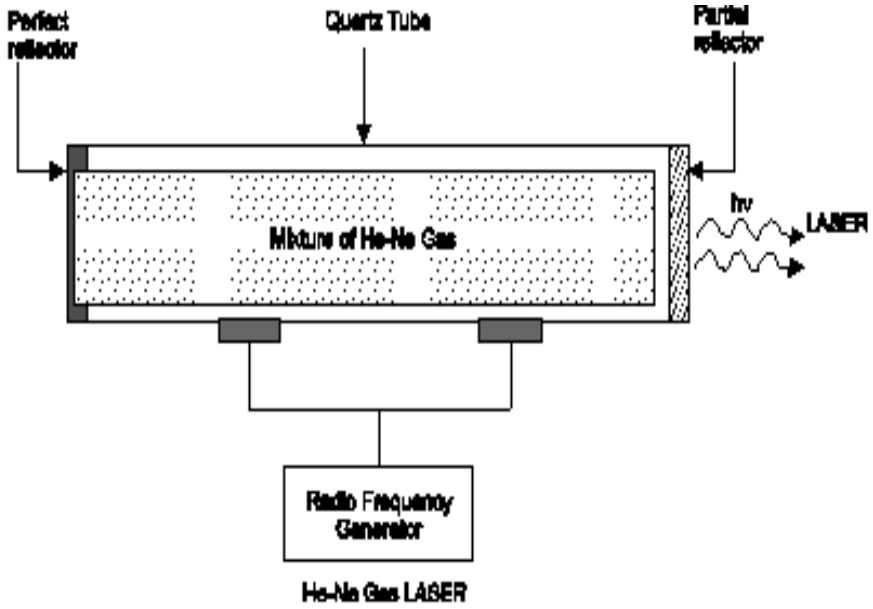
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
		Important Instructions to examiners: 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme. 2) The model answer and the answer written by candidate may vary but the examiner may try to assess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

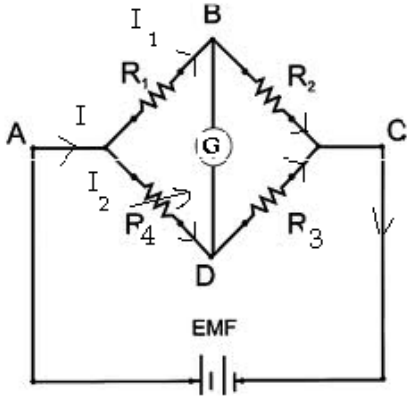
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1		**Attempt any Nine of the following:**		18
	a)	**State the unit of electric current and define it.**		2
		Unit	1	
		Definition	1	
		Unit : ampere OR A		
		Ampere : When 1 coulomb charge flows through the circuit for 1 second , the current flowing through the circuit is called 1 ampere		
		OR		
		Electric current : The rate of flow of electric charge is called electric current.		
	b)	**State the principle of potentiometer.**		2
		Principle	2	
		The fall of potential is directly proportional to the length of conducting wire.		
		$V \alpha L$		
		OR		
		The potential difference between two points of conductive wire is directly proportional to the length/distance between the two points.		
	c)	**Define one farad capacity of the condenser**.		2
		Definition	2	
		One farad capacity: One farad capacity is the capacitance of a conductor, if 1 coulomb charge increases its potential by 1 volt.		
	d)	**Separate out following materials as P-type impurity and N-type impurity**		2
		Boron , Aluminium , Antimony , Indium , Arcenic and Gallium		
		Separation	2	
		P-type impurity : **Boron , Aluminium , Indium , Gallium**		
		N-type impurity : **Arcenic , Antimony**		

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	e)	**Calculate the frequency of an accelerated electron if its energy is 5.296×10^{-15} joule and plank's constant h = 6.62×10^{-34} Js.** **Formula** **Answer with unit** **Given :** E = 5.296×10^{-15} joule h= 6.62×10^{-34} Js Required : ν = ? $E = h\nu$ $\nu = E/h$ $\nu = 5.296 \times 10^{-15} / 6.62 \times 10^{-34}$ $\nu = 0.8 \times 10^{19}$ Hz	 1 1	2
	f)	**Define i) Photoelectric work function ii) Threshold frequency** **Each definition** **Photoelectric work function** : The amount of energy required to detach the electron from metal surface is called Photoelectric work function. **Threshold frequency** : The minimum frequency of incident radiation at which emission of photoelectrons starts is called Threshold frequency.	 1	2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	g)	**Give the full form of LASER.** **Full form** Light Amplification by Stimulated Emission of Radiation.	2	2
	h)	**What is photoelectric effect?** **Definition** **Photoelectric effect:** When light radiations of frequency greater than threshold frequency incident on metal surface it emits electrons this effect is called photoelectric effect.	2	2
	i)	**What is optical pumping?** **Definition** **Optical pumping:** Making the population of higher energy level more than population of lower energy level by using light energy is called optical pumping**.**	2	2
	j)	**An electric heater draws a current of 15 A when connected across 220 volt supply. What current it draw when connected across 440 volt supply?** **Formula** **Answer with unit** Given : $I_1 = 15$ A , $V_1 = 220$ volt , $V_2 = 440$ volt Required: $I_2 = ?$ $V_1 / I_1 = V_2 / I_2$ $I_2 = I_1 V_2 / V_1$ $I_2 = 15 \times 440 / 220$ $I_2 = 30$ A	1 1	2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	k)	**Draw the neat diagram of He-Ne gas laser.** **Diagram with labels**  He-Ne Gas LASER	2	2
	l)	**State any two engineering applications of nanotechnology.** **Any two engineering applications** 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. 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. **Any other relevant application**	2	2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)		**Solve any Four of the following:**		16
	a)	**Obtain 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.

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)

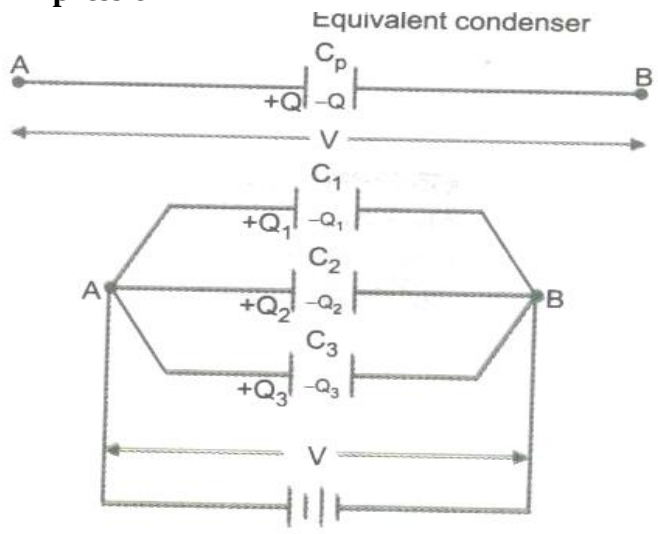
$I_1R_2 = I_2R_3$ ……..(2)

Dividing equation (1) by (2) we get

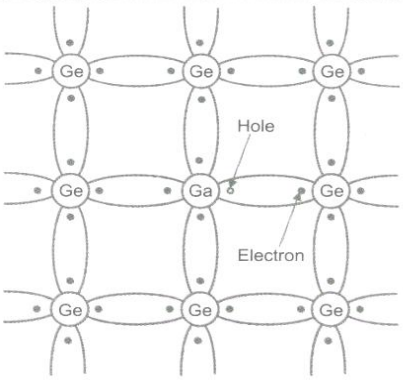
$$\frac{I_1R_1}{I_1R_2} = \frac{I_2R_4}{I_2R_3}$$

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

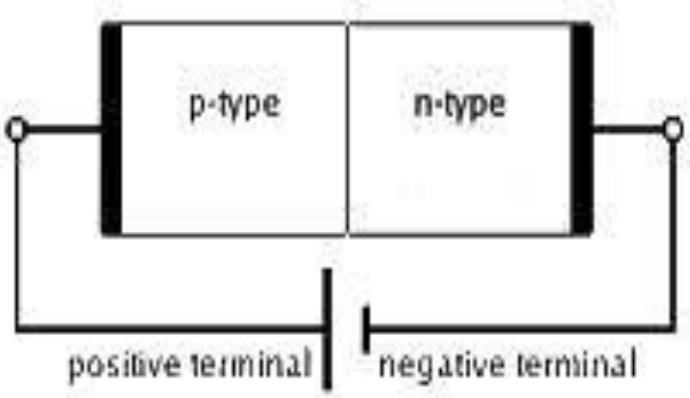
This is the balancing condition of Wheatstone's network

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	b)	**Coils of resistances 40 Ω , 60 Ω and 30 Ω are connected in the arms of AB, BC and CD of Wheastone's network respectively . Calculate the i) resistance of the coil that should be connected in arm AD of wheatstone's network to balance the network.**		4
		Formula with substitution	2	
		Answer with unit	2	
		Given : $R_1 = 40\ \Omega$, $R_2 = 60\ \Omega$, $R_3 = 30\ \Omega$		
		Required = R_4 = ?		
		$$\frac{R_1}{R_2} = \frac{R_4}{R_3}$$		
		$R_4 = R_1 x\ R_3 / R_2$		
		$R_4 = 40 \times 30 / 60$		
		$R_4 = 20\ \Omega$		
	c)	**Obtain the expression for effective capacitance when three capacitors are connected in parallel.**		4
		Well Labeled Diagram	1	
		Explanation & Substitution	2	
		Final Expression	1	
				

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
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 3.21 m^2 and distance between the two plates is 0.1 mm.Find the dielectric constant if capacity of it is 1.99µF.(ε_0= 8.9x10^{-12})** **Formula and substitution** **Answer with unit** Given:- A= 3.21 m^2 d = 0.1mm= 0.1x10^{-3} m	2 2	4

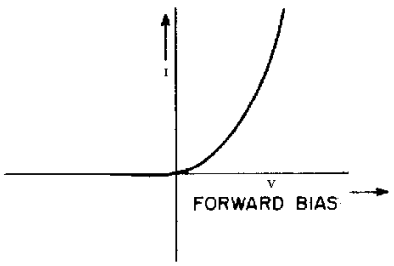
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2	d)	$\varepsilon_0 = 8.9 \times 10^{-12}$ $C = 1.99\ \mu F = 1.99 \times 10^{-6}\ F$ Required: k= ? $\therefore C = \varepsilon_0 k \frac{A}{d}$ $k = C\,d / \varepsilon_0 A$ $k = 1.99 \times 10^{-6} \times 0.1 \times 10^{-3} / 8.9 \times 10^{-12} \times 3.21$ $k = 6.96$		
	e)	**Describe P-type of semiconductor with diagram in detail.** **Diagram** **Explanation**  • Trivalent impurity is added to a pure semiconductor it is called P-type semiconductor. • Some trivalent impurities are gallium , indium ,boro, aluminium etc. These impurities provide large number of holes.Threrefore they are called acceptor impurities. • Above diagram is of p-type of semiconductor .Consider a pure **Germanium crystal** , it has four valance electrons which forms covalent bonds. • When **gallium** is added out of four electrons of Ge only three forms the covalent bonds with creating one hole as shown above. • 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 2	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	f)	**Explain p-n junction diode in forward biased mode with diagram.**		4
		Each diagram	1	
		Explanation:	2	



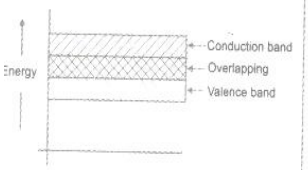
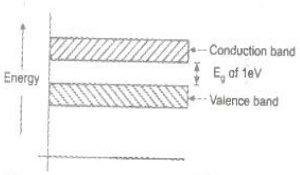
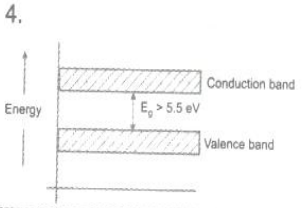
Explanation:

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.

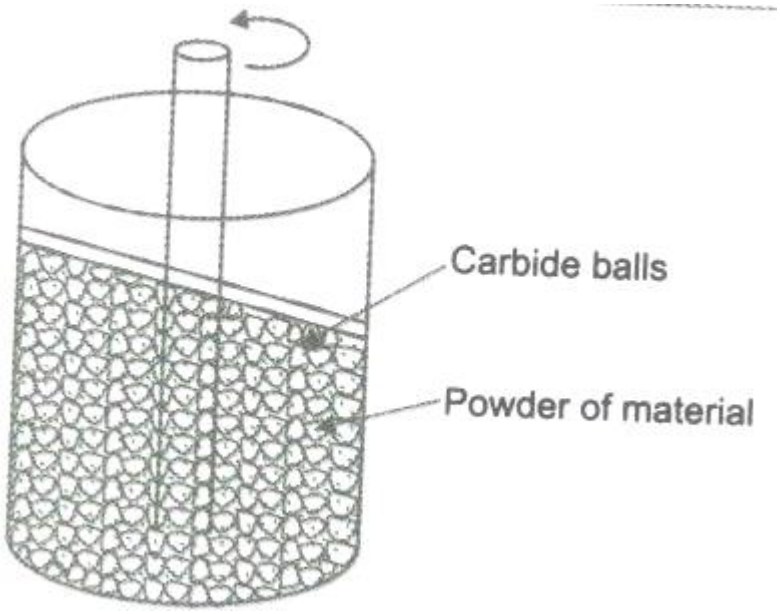


Voltage-current characteristic for a p-n junction.

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)		Solve any **Four** of the following		16
	a)	**Distinguish between conductor , insulator and semiconductor substances.** **Each point**	1	4

Conductor	Semiconductor	Insulator
1. A material that conducts electric current through it.	1. Conductivity of semiconductor is less than conductor and more than insulator.	1. Insulator does not conduct electric current through it.
2. It consists of large number of free electrons.	2. It consists of few number of free electrons (less than that of conductor).	2. It consists of no free electrons.
3. Valence band and conduction band overlap each other. i.e. no forbidden energy gap.	3. Forbidden energy gap i.e. band gap between valence band and conduction band is of the order of 1 eV.	3. Forbidden gap is greater than 5.5 eV.
4. 	4. 	4. 
5. Examples : Copper, aluminium	5. Examples : Silicon, germanium.	6. Examples : Wood, plastic.

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	b)	**Define i) Specific resistance ii) Potential gradient iii) Stopping potential iv) Photon** **Each Definition** **Specific resistance**: Specific resistance of a given material of wire is defined as a resistance of a wire of unit length and unit cross-sectional area. **Potential gradient**: It is defined as the potential drop per unit length of the wire. **Stopping potential** : Stopping potential of a photoelectric cell is the negative potential given to the cell at which photoelectric current becomes zero. **Photon** : The light packets or bundles are called photon.	1	4
	c)	**What are X-rays? Mention its engineering applications.** **Definition** **Any three** **X-rays :** Electromagnetic radiations of very short wavelength are called X-rays. 1) X- rays are used to detect the cracks in the body of aero plane 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 flows 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.	1 3	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	d)	**Name the different methods of synthesis of nanoparticles. Explain physical method of synthesis of nanoparticles in detail.**		4
		Any four Methods	2	
		Explanation of any one physical method given below.	2	
		Methods of synthesis of nanoparticles: Physical method ,Chemical , Biological , Hybrid , Mechanical Vapour deposition , Colloids , Sol-gel , Ball milling , Melt mixing, PVD , Sputtering. **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**.  		

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	d)	**Principle:** • Harden carbide balls are kept in the rotating container along with powder of material whose nanoparticles are to be formed. **Procedure:** • Heavy carbide balls are put along with powder of material of interest. The size of the powder is about 50µm. • The container is now closed with tight lid. • The container is again filled with inert gas and rotated at few hundreds of rpm. • Heavy milling balls increase the impact energy on collision. • The cooling system is used t odissipate the heat. • The powder gets converted to nanosized particles. • Nanoparticles of Co , Ag-Fe , Al-Fe etc are made by using ball milling. B) **Melt mixing method** : **Principle:** • Nanoparticles of desired meal can be arranged during the formation of the glass. **Procedure:** • Glass consist of heterogeneous elements**.** • In molten material of the glass the stream of desired metal is passed with very high velocity. • The melt of the glass material and desired nanoparticle material is homogenized before cooling. • The different colours of the glass are due to different nanoparticles of the metals added. **OR Explanation of any other method listed above**.		

<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>e)</td><td>Distinguish between spontaneous emission and stimulated emission.

Any four point

<table>
<tr><th>Spontaneous emission</th><th>Stimulated emission</th></tr>
<tr><td>Excited atoms comes to ground state on its own accord</td><td>Excited atoms comes to ground state after interaction with incident photon.</td></tr>
<tr><td>Radiations are in random direction , phase and wavelength</td><td>Radiations are coherent , monochromatic and in same direction.</td></tr>
<tr><td>Independent of outside circumstances</td><td>Dependent of outside circumstances</td></tr>
<tr><td>No metastable state exist
(ordinary exited state)</td><td>Metastable state exist</td></tr>
<tr><td>Number of photons emitted are less</td><td>Number of photons emitted are more</td></tr>
</table>
Any other relevant point or diagram can be considered.</td><td>4</td><td>4</td></tr>
<tr><td></td><td>f)</td><td>The photoelectric work function of a metal is 5 eV. Calculate the threshold frequency and threshold wavelength if h = 6.6 x 10^{-34} Js , c = 3 x 10^{8} m/s.

Each Formula
Each answer with unit</td><td>

1
1</td><td>4</td></tr>
</table>

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	f)	Given : $W_0 = 5\ eV = 5 \times 10^{-19}\ J$ $h = 6.6 \times 10^{-34}\ Js$ $c = 3 \times 10^{8}\ m/s$ Required : $\nu_0 = ?$ $\lambda_0 = ?$ $W_0 = h\nu_0$ $\nu_0 = W_0 / h$ $\nu_0 = 5 \times 10^{-19} / 6.6 \times 10^{-34}$ **$\nu_0 = 7.5 \times 10^{14}$ Hz** $c = \nu_0 \lambda_0$ $\lambda_0 = c / \nu_0$ $\lambda_0 = 3 \times 10^{8} / 7.5 \times 10^{14}$ **$\lambda_0 = 4 \times 10^{-7}$ m = 4000 A.U.**		4