SUMMER – 2016 EXAMINATION

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)		**Attempt any NINE of the following:**		18
	a)	**State Hooke's Law of elasticity.** **Statement** Hooke's Law Within elastic limit, stress is directly proportional to strain.	2	2
	b)	**Define compressibility. State its SI unit.** **Definition** **Unit** **Compressibility:** The reciprocal of bulk modulus of elasticity is called as compressibility. **OR** The property on account of which the body can be compressed by the application of external force is called compressibility. **S.I. Unit:- m^2/N**	1 1	2
	c)	**Define velocity gradient and state its unit.** **Definition** **Unit** **Velocity Gradient:** It is defined as the change in velocity per unit change in vertical distance of the layer from the fixed layer. **Unit** = per second OR 1/ sec	1 1	2
	d)	**A water tank having capacity to store 1000 cm^3 of water is filled one-third.calculate pressure at the bottom of water tank. (Given:- Density of water = 10^3 kg /m^3, g = 10 m/s^2)** **Formula** **Answer with unit** The shape of water tank is not given properly whether it is cubical or rectangle or trangle in shape i.e. **insufficient data is given**. But by considering the shape of water tank is cubical then we can solve this problem as Capacity = 1000 cm^3 = 10 x 10 x 10 = (l x b x h) h = 10 cm = 10 x 10^{-2}m water tank filled one-third of its height h = 10 x 10^{-2} / 3 **h = 3.33 x 10^{-2}m** $\rho = 10^3$ kg /m^3 g = 10 m/s^2 P = h ρ g P = 3.33x 10^{-2} x 10^3x10 P = 3.33 x 10^{-2} x 10^4 **P = 3.33 x 10^2 N/m^2** **P = 333.33 N/m^2**	1 1	2

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1)	e)	**Define i) Adhesive force ii) Cohesive force.**		
		Each Definatition	1	2
		i) Adhesive force : It is the force of attraction between two molecules of different substance.		
		ii) Cohsive force : It is the force of attraction between two molecules of same substance.		
	f)	**What is Absolute scale of temperature?**		
		Definition	2	2
		Absolute scale of temperature: It is the scale of temperature in which the lower fixed point is -273^0 K and upper fixed point is 373^0 K and it is then divided into 100 equal parts , each part is one degree Kelvin or degree absolute.		
	g)	**Explain why C_p is greater than C_v ?**		
		Explanation	2	2
		C_v is the specific heat of gas at constant volume. It is utilized only to increase the **temperature** of the gas. **But**		
		C_p is the specific heat of a gas at constant pressure. It is utilized by two way i.e. To increase the temperature of the gas and to maintain constant pressure (i.e. increase in volume).		
		Therefore C_p is greater than $C_{v.}$		
	h)	**Define the two specific heats of gas.**		
		Each definition-	1	2
		Specific heat of a gas at constant volume- Specific heat of a gas at constant volume is defined as the amount of heat required to increase the temperature of unit mass of a gas by one degree at constant volume.		
		Specific heat of a gas at constant pressure- Specific heat of a gas at constant pressure is defined as the amount of heat required to increase the temperature of unit mass of a gas by one degree at constant pressure.		

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1)	i)	**Define transverse wave. Give one example.**		
		Definition	1	2
		One example	1	
		Transverse waves: The wave in which direction of vibration of particles of material medium is perpendicular to the direction of propagation of wave is called transverse wave.		
		Example: Light wave, electromagnetic waves etc.		
	j)	**The wave travels with speed of 3 x 10^8 m/s and frequency 90 MHz. Calculate its wavelength.**		2
		Formula and substitution	1	
		Answer with unit	1	
		Given $v = 3 \times 10^8$ m/s $n = 90$ MHz $= 90 \times 10^6$ Hz $\lambda = ?$		
		We have, $v = n\lambda$ $\lambda = v / n$ $= 3 \times 10^8 / 90 \times 10^6$ $\lambda = 0.033 \times 10^2$ m.		
	k)	**Define the principles of superposition of waves.**		
		Definition	2	2
		Principle of superposition of wave:		
		When two waves travelling through a medium arrive at a point simultaneously, each wave produces its own displacement at that point. The resultant displacement at that point is equal to the vector sum of the individual displacement of the two waves.		
	l)	**Define Resonance.**	2	2
		Definition		
		Definition: When the frequency of the external periodic force applied to a body is exactly equal to (matches) natural frequency of body, the body vibrates with maximum amplitude, the effect is known as resonance.		

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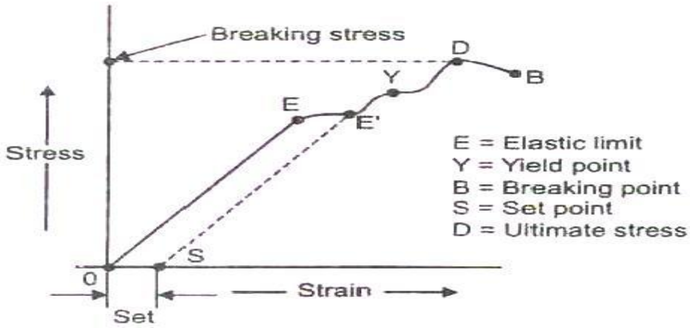
2)		**Attempt any four of the following:**		16
	a)	**Explain stress-strain diagram for a wire under continuously increasing load.**		4
		Neat labeled diagram	2	
		Explanation	2	
				
		A graph or diagram of stress and strain is shown as above.		
		OE Portion is straight line which indicates that stress is proportional to strain. Therefore the wire obeys Hooke's law upto the point E this point is called elastic limit.		
		EE' Portion is curved towards strain axis this shows that increase in strain is more, than increase in stress. In this region stress is not proportional to strain. Between any point E and E' if all load is removed then some permanent elonganation/ Expansion / increase in length takes place in the wire this is called set. When wire is again loaded, a new straight line SE' is obtained which obey Hooke's law.		
		Some portion after the point Y is almost parallel to strain axis this shows that strain increases without increase in stress just like wire flows. This is called plastic flow. The point at which the plastic flow begins is called yield point.		
		During the plastic flow the wire becomes thin and thin. Some weak points called neck are formed in the wire. At weakest point (neck), wire breaks.		
		The maximum stress upto which wire can be loaded or wire can bear is called breaking stress. Point B is breaking point.		
		Before point B the point D is ultimate stress point. It is the max. stress the wire is capable of with standing.		

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2)	b)	**Calculate Young's modulus of elasticity for material of wire having length 2m, 0.6 mm diameter, if weight applied is 100 N which elongates the wire by 1 mm.**		4
		Conversion and Formula	2	
		Answer with Units	2	
		Given, Y = ? L = 2 m Dia.= 0.6 mm = 0.6×10^{-3} m. Radius = 0.3×10^{-3} m. F = 100 N l = 1 mm = 1×10^{-3} m. $Y = \frac{FL}{Al} = \frac{FL}{\pi r^2 l}$ $= \frac{(100 \times 2)}{(3.14 \times (0.3 \times 10^{-3})^2 \times 1 \times 10^{-3})}$ **$Y = 7.077 \times 10^{11}\ N/m^2$**		
	c)	**State Newton's law of viscosity. Define coefficient of viscosity and state its SI unit.**		4
		Statement	2	
		Definition	1	
		SI Unit	1	
		Newton's law of viscosity: **Statement:** The viscous force (F) developed between two liquid layers is **i.** directly proportional to surface area of liquid layer, (A) i.e. [F α A] **ii.** directly proportional to velocity gradient i.e. [F α (dv/dx)] F α A dv/dx F = η A dv/dx Where, η is the coefficient of viscosity of the liquid. **Coefficient of viscosity:-** The coefficient of viscosity η is defined as the viscous force developed between two liquid layers of unit surface area in contact which maintains unit velocity gradient. **SI Unit :- Ns / m^2**		

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2)	d)	**Define. i) Streamline flow ii) Turbulent flow** **Give significance of Reynold's number.** **Two definatitions** **Significance** **i) Streamline flow** The flow of liquid in which every particle of liquid moves in the same direction of flow of liquid is called streamline flow. **ii) Turbulent flow** The flow of liquid in which every particle is not moving in line and they move in random direction is called turbulent flow. **Significance :** (1) When R is less than 2000 liquid flow is streamline. (2) When R is between 2000 to 3000 liquid flow is unstable. (3)When R is greater than 3000 liquid flow is turbulent.	 2 2	 4
	e)	**Explain Laplace's molecular theory of surface tension of liquid.** **Diagram** **Explanation** **Laplace's molecular theory of surface tension** 1. Consider three molecules A, B & C of the liquid. A sphere of influence is drawn as shown in fig. 2. The sphere of influence of molecule 'A' is completely inside the liquid, so it is equally attracted in all directions by the other molecules lying within its sphere. Hence the resultant force acting on it is zero. 3. The part of the sphere of influence of molecule 'B' lies outside the liquid & the major part lie inside the liquid. Therefore resultant force acting on it is directed downward. 4. For Molecule 'C' half of its sphere of influence lies inside the liquid and half lies outside the liquid. So, the maximum resultant downward force is acting on molecule 'C	 1 3	 4

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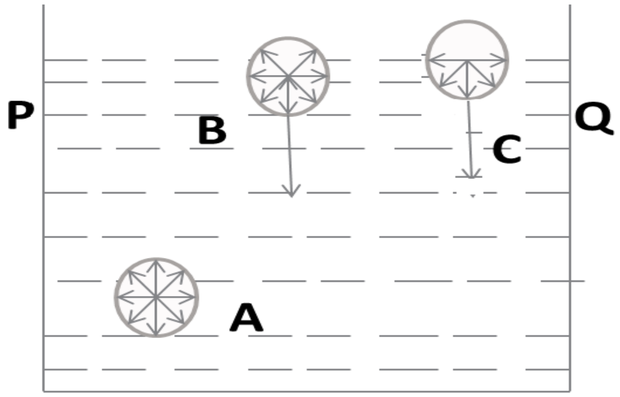
2)	e)	 5. Thus molecule A experiences zero resultant force, B experience downward resultant force, C experience more downward resultant force. In short molecules below imaginary line PQ experience zero resultant force and molecules about line PQ experience some or more downward resultant force. 6. Thus molecules which lie on the surface of liquid (surface film) experience downward resultant force and are being pulled inside the liquid. To balance this downward force, molecules come closer to each other. This reduces the surface area of liquid. 7. This gives rise to surface tension. It is the contraction force which decreases the surface area of the liquid.		
	f)	**A capillary tube of radius 0.1 mm is dipped into liquid of density 10^3 Kg/m^3 and angle of contact is 10^0 .If liquid rises to 20 mm in the tube . Find surface tension of the liquid.**		4
		Formula and Calculation	2	
		Answer with Unit	2	
		Given, radius r = **0.**1 mm.=0.1x 10^{-3} m rise of liquid h = 20 mm= 20 x 10^{-3} m. density $\rho = 10^3$ Kg/ m^3 gravitational acceleration g=9.8 m/sec.^{2} $\theta=10^0$ **we have** $T = \frac{(\mathbf{h}\,\rho\, g\, r)}{(2 \times \cos \Theta)}$ $T = \frac{(20 \times 10^{-3} \times 10^{3} \times 9.8 \times 0.1 \times 10^{-3})}{(2 \times \cos 10^0)}$ $\mathbf{T = 10 \times 10^{-3}\ N/ m^2}$		

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3)		**Attempt any FOUR of the following:**		16
	a)	**State law of thermal conductivity. Define coefficient of thermal conductivity.** **Statement** **Equation** **Definition** **Statement :** It states that the amount of heat flowing through metal rod at steady state is directly proportional to i) Cross-sectional area of rod (A) ii)Temperature difference between two surfaces of the conductor($\theta_1 - \theta_2$) iii) Time for which heat flows. (t) and inversely proportional to iv)Distance between two surfaces.(d) $Q \propto A$ $Q \propto (\theta_1 - \theta_2)$ $Q \propto t$ $Q \propto 1/d$ $Q \propto \frac{A(\theta_1 - \theta_2)t}{d}$ $Q = \frac{K \times A(\theta_1 - \theta_2) \times t}{d}$ $K = \frac{Q \times d}{A \times (\theta_1 - \theta_2) \times t}$ Where K = Coefficient of thermal conductivity. **Definition of K :** It is defined as the amount of heat conducted in one second, in steady state of temperature through unit cross-sectional area of an element of material of unit thickness with unit temperature difference between its opposite faces.	 2 1 1	
	b)	**Define isothermal process and adiabatic process. Give one example of each in engineering field.** **Two definatition** **One example each** **Isothermal Expansion** It is the expansion of gas while its temperature remains constant. **Adiabatic Expansion** It is an expansion of gas whiles its temperature changes. **Examples** **Isothermal Expansion: -** i) Melting of solids ii) Boiling of water. **Adiabatic Expansion:-** Bursting of cycle rubber tube.	 2 1	4

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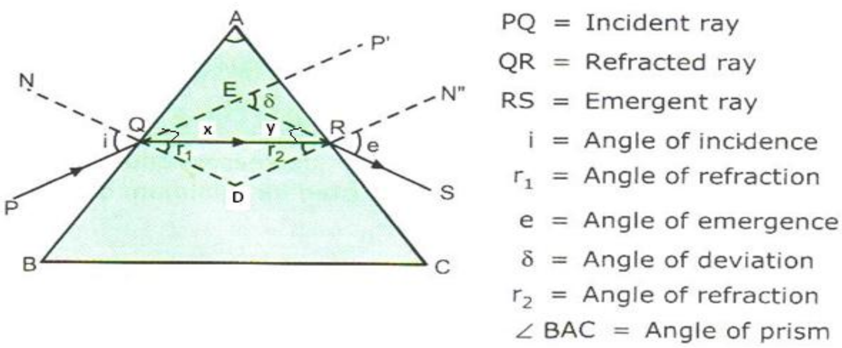
3)	c)	**State use of bad conductor in heat transfer.** **Four uses** **Uses :** • Ice box: use of thermocole to prevent melting if ice. • Handle of pressure cooker: Plastic material is used to prevent it getting heated so that we can handle it easily. • Refrigerators: Plastic pipeline insulation between expansion valve outlet and evaporator to avoid thermal loss. • Thermos flask: To maintain the constant temperature of the flask content it is double walled with air gap between them.	4	4
	d)	**Derive an equation for prism formula using neat labeled diagram.** **Diagram** **Derivation** **Prism formula**	1 2 1	4

Diagram



Let PQ be the incident ray obliquely incident on refracting face AB. At point Q the ray enters from air to glass therefore at Q the incident ray is refracted and travels along QR by making $\angle r_1$ as angle of refraction.

At point R the ray of light enter from glass to air and get refracted along RS.

From ΔEQR

$$\delta = x + y$$

$$\delta = (i - r_1) + (e - r_2)$$

$$\delta = (i + e) - (r_1 + r_2) ----(1)$$

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3)	d)	From ΔQDR $\angle r_1 + \angle r_2 + \angle QDR = 180^0$ ------------------(2) As AQDR is cyclic quadrilateral $\angle A + \angle QDR = 180^0$ ------------------------------(3) By comparing eq.(2) and(3) $A = r_1 + r_2$ ------------------------------(4) Substituting above value in eq.(1) Eq.(1) becomes $\delta = (i+e) - A$ $\delta + A = (i+e)$ ----------------------------(5) If $\delta = \delta m$ $i = e$ And $r_1 = r_2 = r$ Equation (5) Becomes $A + \delta m = i + i$ $A + \delta m = 2i$ $i = \frac{A + \delta m}{2}$ And equation (4) becomes $A = r + r$ $A = 2r$ $r = \frac{A}{2}$ According to Snell's law $\mu = \frac{\sin i}{\sin r}$ Substituting values of i and r in above equation $\mu = \frac{\sin\left(\frac{A + \delta m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$ Above formula is called as prism formula.		

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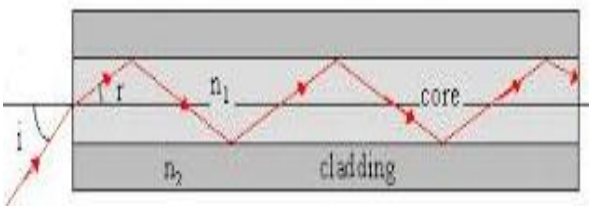
3)	e)	**Exaplain propagation of light wave through optical fiber with the help of neat labeled diagram.** **Diagram** **Exaplination**  Fig. shows a thin fiber optic cable. A beam of light is focused as shown. The angle of incidence is greater than critical angle. Therefor T.I.R.takes place. The beam flows zigzag path as shown in the fig.and emerge out from other end. During this, the angle of incidence is equal to angle of reflection. Due to this the light rays entering at different angles will take different paths through the cable.Therefor some light paths will be longer and some will be shorter.	 2 2	 4
	f)	**i) A particle performing SHM has period of 3 sec. Calculate its acceleration at 2 cm from mean position.** **Formula and Substitution** **Answer with unit** Given : Required: T= 3 sec. a = ? x = 2 cm = 2×10^{-2} m $a = \omega^2 x$ $a = (2\pi / T)^2 \cdot x$ $a = (2 \times 3.14 / 3)^2 \cdot (2 \times 10^{-2})$ $a = 0.087\ m/s^2$	 1 1	 2
		ii) A tuning fork of frequency 512 Hz resonates with an air column of length 14 cm. Calculate velocity of sound in air, if end correction is 26 mm. **Formula and Substitution** **Answer with unit** **Given** n = 512 Hz. l = 14 cm.= 14×10^{-2} m e = 26mm = 26×10^{-3} m v =? **Formula –** $v = 4n(l+e)$ $v = 4 \times 512 \times (14 \times 10^{-2} + 26 \times 10^{-3})$ v= 339.9 m/s	 1 1	 2