

Semester: July 2023 – December 2023		
Maximum Marks: 50	Examination: End-Semester Examination	Duration: 2 Hrs.
Programme code: <u>06</u>	Class: FY	Semester: <u>1</u> (SVU 2023)
Programme: UG - <u>B.Tech</u>		
Name of the College: K. J. Somaiya College of Engineering	Name of the department: Science and Humanities	
Course Code: 216U06C101	Name of the Course Applied Mathematics – I	
Instructions: 1) Draw neat diagrams 2) All questions are compulsory 3) Assume suitable data wherever necessary		

Que. No.	Question Statement	Max. Marks
Q.1	Attempt any TWO.	10
i)	Prove that $\log[1 + e^{2i\theta}] = \log(2\cos\theta) + i\theta$	05
ii)	Solve $(4x^3y^3 + \frac{1}{x})dx + (3x^4y^2 - \frac{1}{y})dy = 0$	05
iii)	If $u = (1 - 2xy + y^2)^{-\frac{1}{2}}$ , prove that $x\frac{\partial u}{\partial x} - y\frac{\partial u}{\partial y} = y^2u^3$	05
Q.2	Attempt any ONE from i) and ii)	10
i)	a) If $u = \tan^{-1}\left(\frac{x^3+y^3}{2x+3y}\right)$ then prove that $x^2\frac{\partial^2 u}{\partial x^2} + y^2\frac{\partial^2 u}{\partial y^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} = \sin 4u - \sin 2u$  b) A chain coiled up near the edge of a smooth table starts to fall over the edge. The velocity $v$ when a length $x$ has fallen is given by $xv\frac{dv}{dx} + v^2 = gx$ . Solve the differential equation to express $v$ in terms of $x$ .	05
Or		
ii)	a) If $u + iv = \operatorname{cosec}\left(\frac{\pi}{4} + ix\right)$ , prove that $(u^2 + v^2)^2 = 2(u^2 - v^2)$	05
	b) Find the value of $\lambda$ for which the matrix $A = \begin{bmatrix} 3 & \lambda & \lambda \\ \lambda & 3 & \lambda \\ \lambda & \lambda & 3 \end{bmatrix}$ has (i) rank 1, (ii) rank 2, (iii) rank 3.	05
Q.3	Attempt any ONE	10
i)	Solve $\frac{d^3y}{dx^3} + 2\frac{d^2y}{dx^2} + 3\frac{dy}{dx} = e^x + \sin 5x - x^2 + 3$	10
ii)	Investigate for what values of $p$ and $q$ , the equations $x + 2y + z = 8$ , $2x + 2y + 2z = 13$ , $3x + 4y + pz = q$ have (i) no solution, (ii) unique solution, (iii) infinitely many solutions. Also find the infinite solution for this system of equations.	10
Q.4	Divide 24 into three parts such that the product of the first, square of the second and cube of the third is maximum.	10
Q.5	Attempt the following	10
	a) Solve $x^6 - i = 0$	05
	b) If $u = x^3 \sin^{-1}\left(\frac{y}{x}\right) + x^4 \tan^{-1}\left(\frac{y}{x}\right)$ then find value of $x^2\frac{\partial^2 u}{\partial x^2} + y^2\frac{\partial^2 u}{\partial y^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$ at $x = 1, y = 1$	05

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Programme code: <u>06</u> Programme: B. Tech.	Class: FY	Semester: I (SVU 2023)
Name of the College: K. J. Somaiya College of Engineering	Name of the department: AIDS/IT/MECH/RAI/CCE	
Course Code: 216U06C102	Name of the Course: Engineering Physics	
<b>Instructions:</b> 1) Draw neat diagrams 2) All questions are compulsory 3) Assume suitable data wherever necessary		

- Fundamental Physical constants:

$$\text{Elementary charge } (q) = 1.6 \times 10^{-19} \text{ C}$$

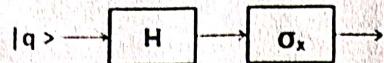
$$\text{Planck's constant } (h) = 6.63 \times 10^{-34} \text{ J-s}$$

$$\text{Boltzmann constant } (k) = 1.38 \times 10^{-23} \text{ J/K}$$

$$\text{Proton (rest) mass } (m_p) = 1.67 \times 10^{-27} \text{ kg}, \text{ mass of electron} = 9.1 \times 10^{-31} \text{ kg}$$

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$$

Que. No.	Question Statement	Max. Marks
Q.1	Attempt any two:	10 (2x5)
i)	Obtain the ratio of spontaneous to stimulated emission coefficients (Einstein's A to B ratio) using rate equations for emission and absorption processes for laser.	
ii)	An optical fibre has core radius of 5 μm. Will it act as a single mode fibre at 850 nm? Its core and cladding RI are 1.4 and 1.399 respectively.	
iii)	What do you understand by mode of propagation? What are single mode and multimode fibres? Which fibre offers minimum losses and why?	
Q.2	Attempt any one:	10
i)	Show that for intrinsic semiconductors, the Fermi level is located midway between the C.B. and V.B. Determine the intrinsic carrier concentration in Si at R.T. (300 K). Given effective densities of state in C.B and V.B as $2.82 \times 10^{19}/\text{cc}$ and $1.83 \times 10^{19}/\text{cc}$ respectively. Energy band gap for Si = 1.1 eV at R.T.	
ii)	a) What are different types of polarization that can take place in a dielectric material? State example for each. Draw suitable diagrams. b) Discuss classification and different phases of liquid crystals with suitable diagrams.	
Q.3	Attempt any one:	10
i)	a) Calculate de' Broglie wavelength of a proton accelerated through 100 kV potential difference. b) The 2023 Physics Nobel Prize is awarded for a critical work involving attoseconds measurements. Determine the spectral bandwidth (in GHz) and uncertainty in energy (in eV) corresponding to a 10 attosecond laser pulse.	
ii)	a) What is qubit? How it is different from conventional bits of classical computers? Which microscopic physical properties can possibly be used as qubits? b) Determine output of the following quantum circuit for q = 1;	



$$\text{Where, } H \equiv \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \text{ and } \sigma_x \equiv \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

**Q.4** Attempt the following: 10

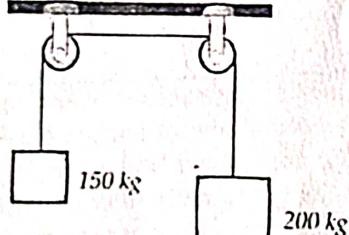
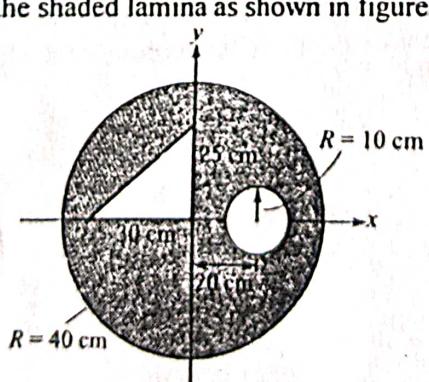
Obtain Gauss' law in differential form.

An electric field is given by  $\vec{E} = C(xy\hat{i} + 2yz\hat{j} + 3zx\hat{k})$  where,  $C$  is some arbitrary constant. Can it be an electrostatic field?

**Q.5** Attempt the following: 10

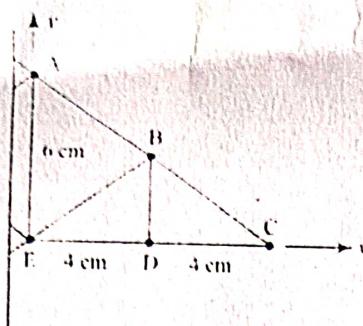
- (a) The thermo-emf of a Cu-Fe thermocouple is 2 mV when the cold junction is at 0°C and the hot junction at 200°C. Calculate the constants "a" and "b" if the neutral temperature is 300°C.
- (b) State different types of photodiodes and explain the construction and working of PIN photodiode in detail.

Maximum Marks: 50	Semester: July 2023 – December 2023 Examination: End-Semester Examination	Duration: 2 Hrs.
Programme code: 06 Programme: B. Tech.	Class: FY	Semester: I (SVU 2023)
Name of the College: K. J. Somaiya College of Engineering	Name of the department: All	
Course Code: 216U06C104	Name of the Course: Engineering Mechanics	
Instructions: 1) Draw neat diagrams 2) All questions are compulsory 3) Assume suitable data wherever necessary		

Que. No.	Question Statement	Max. Marks
Q.1	Attempt any two	
i)	A 5 Kg mass drops from 2 meters upon a spring whose modulus is 10 N/mm. What will be the speed of this mass when the spring is deformed by 100 mm?	05
ii)	Two masses are connected by a string as shown in the figure below. Neglecting the inertia and friction of both pulleys calculate acceleration $a_1$ of 150 Kg block when the system is released from rest. If a force of $(200 \times 9.81)$ N is applied in place of a 200 Kg block what would be the acceleration of 150 Kg?	05
		
iii)	Define the term coefficient of restitution. Discuss the different implications for each value of the coefficient of restitution. Write its formula.	05
Q.2	Attempt any one	10
i)	Find the centroid of the shaded lamina as shown in figure below.	
		



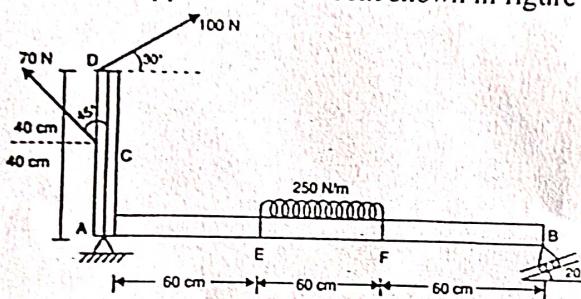
- ii) Locate the centroid of the plane truss shown in the figure below. Assume all the bars have the same weight per unit length. Assume the length of AB = BC = BE = 5 cm.



**Q.3 Attempt any one**

10

- i) Find the reactions at the supports of an L bent shown in figure below.

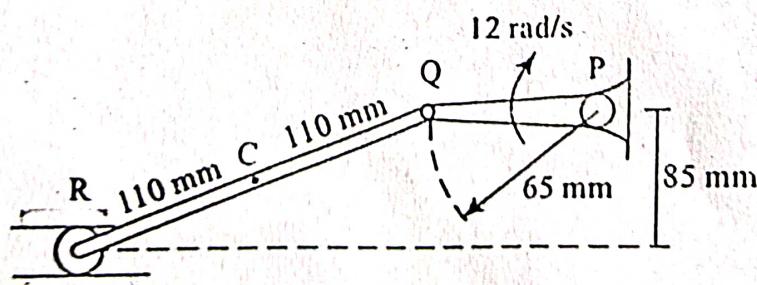


- ii) A uniform ladder of length 15 meters rests against a vertical wall making an angle of  $60^\circ$  with horizontal. The coefficient of friction between the wall and the ladder is 0.30 and between the ground and ladder is 0.25. A man weighing 500 N ascends the ladder. How long will he be able to go before the ladder slips? Find the weight that is necessary to be put at the bottom of the ladder to be sufficient to permit the man to go to the top. Assume the weight of the ladder to be 850 N.

**Q.4 Attempt the following**

10

- For the instant represented in the figure below, when the crank PQ passes the horizontal position determine the velocity of the center C of the link QR by the method of instantaneous center.





Q.5

Attempt the following

10

The figure shows the coplanar system of forces acting on a flat plate. Determine the resultant and x as well as y-intercept of the resultant.

