Roll No.

B. Tech. (All Sections) Semester- I

End Semester Examination 2023-24

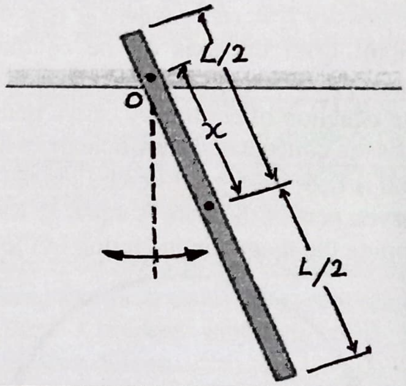
Course Name: Engineering Physics-I | **Paper Code : ASB-101**

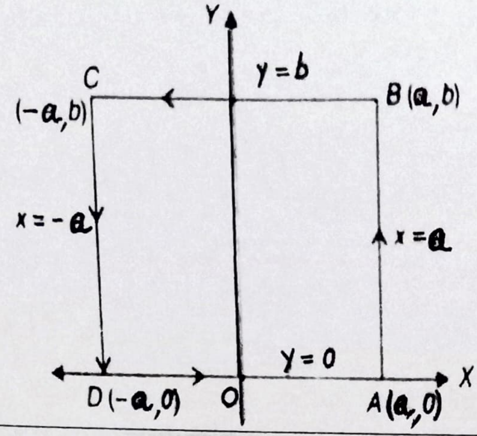
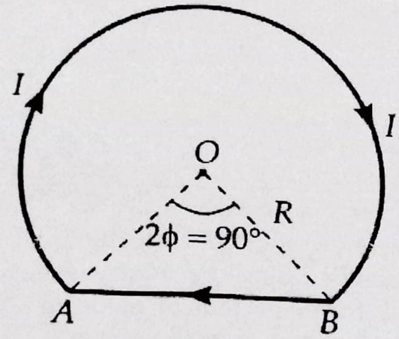
Maximum Marks: 45 | **Duration: 3 Hours**

Instruction to the candidates

Write your Roll No. on the top immediately on receipt of the question paper.

Attempt any <u>three parts</u> of each question. All questions carry equal marks

Q. No.	Questions	Marks	CO
	Unit - 1		
Q1.			
(a)	Write down the difference between simple and compound pendulum. formulate the equation of motion of simple pendulum.	**3**	**CO-1**
(b)	A stick of length $L = 1.85\ m$ oscillates as a compound pendulum. Determine (a) the value of distance x between the stick`s centre of mass and its pivot point O gives the least period (b) the least time period. 	**3**	**CO-1**
(c)	Calculate the moment of inertia of a solid cylinder (i) about its own axis (ii) about an axis passing through its centre and perpendicular to its axis.	**3**	**CO-1**
(d)	An underdamped harmonic oscillator has its amplitude reduced to $1/10^{th}$ of its initial value after 100 oscillations. If its time-period be 1.15 sec, calculate (i) the damping constant (ii) the relaxation time. If the observed value of the first amplitude of the oscillator be 2 cm, what would be its value in the absence of damping?	**3**	**CO-1**
	Unit - 2		
Q2.			
(a)	Convert the following vector into cylindrical and spherical systems $$F = \frac{x\hat{x} + y\hat{y} + 4\hat{z}}{\sqrt{x^2 + y^2 + z^2}}$$	**3**	**CO-2**
(b)	Solve the value of n for which the vector $r^n\vec{r}$ is solenoidal, where $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$.	**3**	**CO-2**
(c)	A solid sphere of radius R has a charge Q distributed in the volume with a charge density $\rho = kr^a$, where k and a are constants and r is the	**3**	**CO-2**

	distance from the centre. If the electric field at $r = \frac{R}{2}$ is $\frac{1}{8}$ times that at $r = R$, determine the value of a.		
(d)	Evaluate $\oint \vec{F}.\vec{dr}$ by Stoke`s theorem, where $\vec{F} = (x^2 + y^2)\hat{\imath} - 2xy\hat{\jmath}$ and C is the boundary of the rectangle $x = \pm a, y = 0$ *and* $y = b$. 	3	CO-2
	Unit – 3		
Q3.			
(a)	Consider an infinitely long, cylindrical conductor of radius R with non-uniform current density $\boldsymbol{J} = \boldsymbol{\alpha} \boldsymbol{r}^2$, where $\boldsymbol{\alpha}$ is a constant and r is the distance of a point from the axis of the conductor. Determine the magnetic field inside and outside the conductor.	3	CO-3
(b)	Starting from the equation of continuity, show that $\nabla.\boldsymbol{J} = 0$, for steady state case. Discuss the concept and significance of displacement current.	3	CO-3
(c)	A current $I = 5.0\ A$ flows along a thin wire shaped as shown in fig. The radius of the curved part of the wire is equal to R= 120 mm, the angle $2\theta = 90^o$. Compute the magnetic induction of the field at the point O. 	3	CO-3
(d)	(i) A battery of emf 2V is connected in series with a resistance box and a 10 m long potentiometer with resistance $1\ \Omega/m$. A potential difference of 10 mV is balanced across the entire length of wire. Calculate the current flowing in wire and resistance in resistance box. (ii) Resistances of the ratio arms of a Wheatstone bridge are 300 Ω ,each. The fourth arm is connected to an unknown resistor. Evaluate the value of the unknown resistance if the third arm has a resistance of 250 Ω in a balanced condition?	3	CO-3

	Unit – 4		
Q4.			
(a)	Examine the shortcomings of classical laws to explain experimental blackbody radiation spectrum. Explain how Planck's hypothesis able to rectify these inadequacies. Provide the mathematical evidence.	**3**	**CO-4**
(b)	How does the utilization of Heisenberg's uncertainty principle offer insights into determining the radius of the first Bohr orbit, highlighting the interplay between particle position and momentum uncertainties? An electron has a speed of $6.6 \times 10^{4} m/s$ with an accuracy of 0.01%. Calculate the uncertainty in the position of an electron.	**3**	**CO-4**
(c)	Show that the change in wavelength of photon scattered in Compton experiment is dependent on the angle of scattering. X-rays of wavelength 0.2 Å are scattered from a target. Calculate the wavelength of X-ray scattered through 45^{o}. Also find the maximum kinetic energy of the recoil electron.	**3**	**CO-4**
(d)	Calculate the energy in eV corresponding to a wavelength of 1 Å for electron also find the potential difference by which the electron is accelerated associated with a de Broglie wavelength 0.1 Å .	**3**	**CO-4**

	Unit – 5		
Q5.			
(a)	There are 13.13×10^{28} free electrons per m^{3} of Zn. Calculate the Fermi energy and average energy at 0K. Also, determine at what temperature there is a 10% probability that electrons in Zn have an energy 1% above the Fermi energy.	**3**	**CO-5**
(b)	Based on the Fermi-Dirac statistics, formulate the relation for the Fermi energy and average energy of free electrons at absolute 0K.	**3**	**CO-5**
(c)	Why did classical free electron theory of metals fail to explain the heat capacity of conduction electrons? Discuss briefly. A uniform aluminum wire of length 5 m and resistance 0.06Ω carrying a current of 15 A, assuming that each aluminium atom contributes 3 free electrons for conduction. Compute mobility, drift velocity and relaxation time of the electron. Given: Resistivity of aluminium = $2.7 \times 10^{-8}\ \Omega m$ $Atomic\ weight = 26.98$ $Density = 2.7 \times 10^{3}\ kg/m^{2}$ $Avagadro\ number = 6.025 \times 10^{23}$	**3**	**CO-5**
(d)	Deduce the Bragg`s condition for the reinforcement of diffracted X-rays from a set of crystal planes. The spacing between the successive planes in NaCl crystal is 2.82 Å. X-rays incident on this crystal give rise to first-order reflection at grazing incidence of $8^{o}35^{`}$. Calculate the wavelength of X-rays and the angle of second order and third order reflections. Calculate the longest wavelength that can be analysed by the crystal (Sin $8^{o}35^{`}$= 0.1492).	**3**	**CO-5**