

End-Term Examination, November – December, 2024

Programme : B.Tech.

Year/Semester : 1st / 2nd

Course Name : Applied Physics

Course Code : AS1108

Time : 2:30 Hours

Maximum Marks : 30

Important Notes:

- The candidates, before starting to write the solutions, should check the question paper for any discrepancies and also ensure that they have delivered the question paper with the correct course code.
- All symbols, unless stated, have their usual meaning in the context of the course.
- If any additional data is required, *assume suitably and state clearly*.

Q. No.	Question	Marks/ CO(s)
Q 1.	An athlete doing agility training starts at point A and runs to point B and then turns and runs back to point A and turns again and runs back to point B. The position function for the athlete at time t is given by $s(t) = t^3 - 6t^2 + 9t - 2$. i. Identify time intervals on which velocity is positive. In which direction is the athlete running during these time intervals? ii. Identify the points where the velocity is zero. Give an interpretation of the athlete's movement at these points.	2.5+2.5 AS1108.1
Q 2.	A 3 grams bullet travelling with a velocity of 800 m/s is fired into a 500 grams box of sand that is at rest on a horizontal, frictionless surface. The bullet passes through the sand and emerges with a velocity of 200 m/s at the other side. i. Find the impulse delivered to the sand. ii. If the bullet was inside the box for 0.020 s, find the average force exerted on the block.	2.5+2.5 AS1108.1 AS1108.2
Q 3.	(a) The voice coil of a speaker has a diameter of $d = 0.025$ m, contains 55 turns of wire, and is placed in a 0.10-T magnetic field. The current in the voice coil is 2.0 A. (i) Determine the magnetic force that acts on the coil and cone. (ii) The voice coil and cone have a combined mass of 0.020 kg. Find their acceleration. (b) An armature coil of a motor has an area of $2.0 \times 10^{-4} \text{ m}^2$, consists of 100 loops or turns, and contains a current of 0.045 A. The coil is placed in a uniform magnetic field of magnitude 0.15 T. (i) Determine the magnetic moment of the coil. (ii) Find the maximum torque that the magnetic field can exert on the coil.	2.5+2.5 AS1108.2

Q 4.	(a) Magnetic resonance imaging (MRI) is a technique that creates internal body images using a strong magnetic field. A safety concern is the effect of an equipment failure that suddenly shuts off the magnetic field, potentially inducing an emf that causes charged particles in body fluids to flow, creating an electric current. Suppose the largest surface of the body through which flux passes has an area of 0.032 m^2 and a normal that is parallel to a magnetic field of 1.5 T. Determine the smallest time period during which the field can be allowed to vanish if the magnitude of the average induced emf is to be kept less than 0.010 V. (b) A small rubber wheel on the shaft of a bicycle generator presses against the bike tire and turns the coil of the generator at an angular speed that is 38 times as great as the angular speed of the tire itself. Each tire has a radius of 0.300 m. The coil consists of 125 turns, has an area of $3.86 \times 10^{-3} \text{ m}^2$, and rotates in a 0.090-T magnetic field. The bicycle starts from rest and has an acceleration of 0.55 m/s^2. What is the peak emf produced by the generator at the end of 5.10 s?	2.5+2.5 AS1108.3
Q 5.	Using Bohr's hydrogen spectrum model, calculate the followings and explain physical significance of your results: - Energy of electron in first orbit of a hydrogen atom. - Radius of the first orbit of a hydrogen atom. You may use the following formulas and constant values: Potential energy: $E = \frac{1}{2} mV^2 - \frac{e^2}{4\pi\epsilon_0 r} = -\frac{me^4}{8\epsilon_0^2 h^2 n^2}$ Force balance: $\frac{mV^2}{r} = \frac{e^2}{4\pi\epsilon_0 r^2}$ Planck's constant $h = 6.63 \times 10^{-34} \text{ J/s}$ Mass of electron $m = 9.11 \times 10^{-31} \text{ kg}$; Speed of light $C = 3 \times 10^8 \text{ m/s}$ Charge on electron $e = 1.6 \times 10^{-19} \text{ C}$; $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ Permittivity of free space $\epsilon_0 = 8.85 \times 10^{-12} \text{ m}^{-3} \text{ kg}^{-1} \text{ s}^4 \text{ A}^2$	2+3 AS1108.4
Q 6.	Light was widely accepted as wave till early 1900s. Name the critical experimental phenomena (only names, no explanation) which helped in establishing the quantum behavior of the light. A parallel beam of light with a wavelength of 550 nm and power of 40 W is incident normally on a perfectly absorbing surface. - Calculate number of photons hitting surface per second. - Determine force exerted by the light beam on the surface.	1+2+2 AS1108.4