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18PHY12/22

First/Second Semester B.E. Degree Examination, Feb./Mar. 2022 Engineering Physics

Time: 3 hrs.

Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.

2. Physical constants : Velocity of light, $c = 3 \times 10^8$ m/s

Planck's constant, $h = 6.625 \times 10^{-34}$ JS

Boltzmann's constant, $K = 1.38 \times 10^{-23}$ J/K

Avogadro's number, $N_A = 6.02 \times 10^{26}$ /Kmole

Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg

Charge of electron, $e = 1.602 \times 10^{-19}$ C

Relative Permittivity of vacuum, $\epsilon_0 = 8.854 \times 10^{-12}$ Fa/m

Module-1

- 1 a. Define simple harmonic motion. Derive the equation for simple harmonic motion using Hooke's law. Mention any five characteristics of simple harmonic motion. (10 Marks)
- b. State the laws of conservation of mass, momentum and energy along with the equations. (06 Marks)
- c. A mass of 5 kg is suspended from the free end of a spring. When set for vertical oscillations, the system executes 100 oscillations in 40 seconds. Calculate the force constant of the spring. (04 Marks)

OR

- 2 a. What are forced vibrations? Obtain an expression for amplitude of a body undergoing forced vibration. (10 Marks)
- b. Distinguish between subsonic and supersonic waves. Mention any two applications of shock waves. (06 Marks)
- c. Calculate the resonance frequency of a spring of force constant 1974 N/m, carrying a mass of 2000 gm. (04 Marks)

Module-2

- 3 a. State and explain Hooke's law. Define Young's modulus, Bulk modulus, Rigidity modulus and derive the respective equations. (08 Marks)
- b. Derive the relation y , η and σ . (08 Marks)
- c. Calculate the torque required to twist a wire of length 1.5 m, radius 0.0425×10^{-2} m, through an angle $(\pi/45)$ radian, if the value of rigidity modulus of its material is 8.3×10^{10} N/m². (04 Marks)

OR

- 4 a. Define bending moment. Derive the expression for the bending moment of a beam in terms of moment of inertia. (09 Marks)
- b. Define the terms elasticity and plasticity. Explain the stress-strain curve. (07 Marks)
- c. A rod of cross section of area 1 cm × 1 cm is rigidly planted into the earth vertically. A string which can withstand a maximum tension of 2 kg is tied to the upper end of the rod and pulled horizontally. If the length of the rod from the ground level is 2 meters, calculate the distance through which its upper end is displaced just before the string snaps. (y for steel = 2×10^{11} N/m² and $g = 9.8$ m/s²) (04 Marks)

Module-3

- 5 a. Explain the concept of divergence of a vector and its physical significance. State and derive Gauss divergence theorem. (10 Marks)
- b. Obtain an expression for numerical aperture in an optical fiber. (06 Marks)
- c. Find the attenuation in an optical fiber of length 500 m when a light signal of power 100 mW emerges out of the fiber with a power 90 mW. (04 Marks)

OR

- 6 a. What is attenuation and attenuation coefficient? Explain different attenuation mechanisms. (08 Marks)
- b. List the four Maxwell's equations for time-varying condition. Derive the wave equation for electromagnetic waves using Maxwell's equations. (08 Marks)
- c. Find the divergence of the vector field \vec{A} given by $\vec{A} = 6x^2\hat{a}_x + 3xy^2\hat{a}_y + xyz^3\hat{a}_z$ at a point P(1, 3, 6). (04 Marks)

Module-4

- 7 a. State and explain Heisenberg's uncertainty principle. Using this principle, prove that an electron does not exist inside the nucleus. (08 Marks)
- b. Derive the expression for energy density of radiation in terms of Einstein's coefficients. (08 Marks)
- c. A particle of mass $0.5 \text{ Mev}/c^2$ has kinetic energy 100 eV. Find its de-Broglie wavelength. (04 Marks)

OR

- 8 a. Find the expression for Eigen value and Eigen function for a particle in uninfinte potential well. (10 Marks)
- b. What is a laser range finder? Describe how it is made use in defense. (06 Marks)
- c. The average output power of a laser source emitting a laser beam of wavelength 6328 \AA is 5 mW. Find the number of photons emitted per second by the laser. (04 Marks)

Module-5

- 9 a. Define Fermi factor. Discuss the dependence of Fermi factor on temperature and energy. (08 Marks)
- b. What is internal field? Derive Clausius-Mossotti equation. (08 Marks)
- c. The Hall coefficient of a material is $-3.68 \times 10^{-5} \text{ m}^3/\text{c}$. Identify the type of charge carriers and calculate the carrier concentration. (04 Marks)

OR

- 10 a. Derive the expression for electrical conductivity of a semiconductor. (08 Marks)
- b. What are the main assumptions of quantum free electron theory and describe how quantum free electron theory has been successful in overcoming the failures of classical free electron theory. (08 Marks)
- c. If a NaCl crystal is subjected to an electric field of 1000 V/m and the resulting polarization is $4.3 \times 10^{-8} \text{ C/m}^2$, calculate the dielectric constant of NaCl. (04 Marks)

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