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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

II Semester B.Tech. – END SEMESTER EXAMINATION - APRIL 2018

SUBJECT: ENGINEERING PHYSICS (PHY1001)

Time: 3 Hrs. 26-04-2018 Max. Marks: 50

Note:

Answer **ALL** the questions. Each question carries **10** marks
Answer all the sub questions of a main question in a continuous sequence.
Write specific and precise answers. Any missing data may suitably be assumed.
Write question number on the margin only. Draw neat sketches wherever necessary.

Physical Constants:

Speed of light in vacuum = 3.00×10^{8} m/s Electron charge = 1.60×10^{-19} C
Electron mass = 9.11×10^{-31} kg Permeability of free space = $4\pi \times 10^{-7}$ Tm/A
Boltzmann constant = 1.38×10^{-23} J/ K Planck's constant = 6.63×10^{-34} J.s

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1A. Explain the term diffraction of light. What are the factors that determine single-slit diffraction pattern. Draw a schematic plot of the intensity of light in single slit diffraction against phase difference. **[5]**

1B. A diffraction grating has 10^4 rulings uniformly spaced over 25.0 mm. It is illuminated at normal incidence by white light from mercury vapor lamp which contains two closely spaced yellow lines of wavelengths 577.0 nm and 579.0 nm. What is the angular separation between the first order maxima of these lines? **[3]**

1C. Calculate the minimum thickness of an antireflection coating of MgF_2 (refractive index 1.38) on a lens of glass (refractive index 1.50). Take the wavelength of light at the centre of the spectrum (550 nm). **[2]**

2A. Briefly explain the different types of optical fibers with necessary diagrams. **[5]**

2B. An atom has two energy levels with a transition wavelength of 582 nm. At 300 K, 4.0×10^{20} atoms are in the lower state. How many occupy the upper state under conditions of thermal equilibrium ? **[3]**

2C. The numerical aperture of an optical fibre is 0.2 when surrounded by air. Determine the refractive index of its core. The refractive index of the cladding is 1.59. **[2]**

3A. Write the assumptions made in Planck's hypothesis of blackbody radiation. Explain Planck's radiation law. Sketch schematically the graph of wavelength vs intensity of radiation from a blackbody. **[5]**

3B. Two light sources are used in a photoelectric experiment to determine the work function for a metal surface. When green light from a mercury lamp (λ = 546.1 nm) is used, a stopping potential of 0.376 V reduces the photocurrent to zero. What is the work function of this metal? What stopping potential would be observed when using the yellow light from a helium discharge tube (λ = 587.5 nm)? **[3]**

3C. Ripples on water (wavelength = λ) travel with a phase speed of $v_P = \sqrt{\frac{2\pi T}{\rho\lambda}}$, where T = surface tension of water, ρ = density of water. Find the group speed (v_G) of a wave-packet of these waves in terms of v_P . **[2]**

4A. Give a brief account of quantum model of H-atom. Sketch schematically the plot of the radial probability density vs. radial distance for H-atom in 1s-state and 2s-state. **[5]**

4B. A free electron has a wave function $\psi(x) = A \exp[i(5.0 \times 10^{10})x]$ where x is in meters. Find its de Broglie wavelength, its momentum, and its kinetic energy in electron volts. **[3]**

4C. An electron is confined between two impenetrable walls 0.20 nm apart. Determine its energy and its de Broglie wavelength in the ground state. **[2]**

5A. Derive the density-of-states function. **[5]**

5B. A thin cylindrical rod of superconducting material 2.50 cm long is placed into a 0.540-T magnetic field with its cylindrical axis along the magnetic field lines. Sketch the directions of the applied field and the induced surface current. Find the magnitude of the surface current on the curved surface of the rod. **[3]**

5C. Most solar radiation has a wavelength of 1 μm or less. What energy gap should the material in solar cell have in order to absorb this radiation ? Is silicon (E_g= 1.14 eV) appropriate ? **[2]**

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