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MANIPAL INSTITUTE OF TECHNOLOGY

MAHE, MANIPAL

FIRST SEMESTER B.Tech. END-SEMESTER EXAMINATION - DEC 2017

SUBJECT: ENGINEERING PHYSICS (PHY1001)

Time: 3 Hrs. 23-12-2017 **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	$= 3.00 \times 10^{8}$ m/s	Electron charge	$= 1.60 \times 10^{-19}$ C
Electron mass	$= 9.11 \times 10^{-31}$ kg	Avogadro number	$= 6.023 \times 10^{23}$ /mol
Boltzmann constant	$= 1.38 \times 10^{-23}$ J/ K	Planck's constant	$= 6.63 \times 10^{-34}$ J.s

1A. Discuss qualitatively the diffraction due to multiple slits (eg., 5 slits). **[4]**

1B. In a Newton's rings experiment, the radius of curvature of the lens is 5.0 m and its diameter is 20 mm. How many rings are produced? How many rings would be seen if the arrangement is immersed in water (refractive index = 1.33) (Assume wavelength = 589 nm). **[3]**

1C. Calculate, approximately, the relative intensities of the first three secondary maxima in the single-slit diffraction pattern. **[3]**

2A. Explain the construction and operation of ruby laser with necessary diagrams. **[5]**

2B. What requirements must be met for the central maximum of the envelope of the double-slit interference pattern to contain exactly 11 fringes? **[3]**

2C. Calculate the energy of a photon whose frequency is 46.0 MHz. Determine the wavelength of this photon. **[2]**

3A. What are the observations in the in the experiment on photoelectric effect? **[5]**

3B. Certain ocean waves of wavelength λ travel with a phase speed of $v_P = \sqrt{\frac{g\lambda}{2\pi}}$, where g is the acceleration due to gravity. Find the group speed of a wave-packet of these waves in terms of phase speed. **[3]**

3C. Find the peak wavelength of the blackbody radiation emitted by the human body when the skin temperature is 35°C. Wien's constant is 2.898×10^{-3} m.K. Sketch schematically the graph of intensity vs wavelength for this. **[2]**

4A. Apply the schrodinger equation to a particle in a one-dimensional "box" of length L and obtain the energy values of the particle. **[5]**

4B. An electron with kinetic energy of 5.0 eV is incident on a barrier with thickness 0.20 nm and height 10.0 eV. What is the probability that the electron will tunnel through the barrier? What is the probability that the electron will be reflected? **[3]**

4C. X-rays of wavelength 0.20000 nm are scattered from a block of material. The scattered X-rays are observed at an angle of 90° to the incident beam. Calculate their wavelength and momentum. **[2]**

5A. Assuming the Fermi-Dirac distribution function , obtain an expression for the density of free-electrons in a metal with Fermi energy E_F, at zero K and, hence obtain expression for Fermi energy E_F in a metal at zero K. [Given: density-of-states function $g(E)dE = \frac{8\sqrt{2}\pi m^{3/2}}{h^3} E^{1/2} dE$] **[5]**

5B. Consider a system of electrons confined to a three-dimensional box. Calculate the ratio of the number of allowed energy levels at 8.50 eV to the number at 7.00 eV. Copper has a Fermi energy of 7.00 eV at 300 K. Calculate the ratio of the number of occupied levels at an energy of 8.50 eV to the number at Fermi energy. **[3]**

5C. The longest wavelength of radiation absorbed by a certain semiconductor is 0.512 μm. Calculate the energy gap for this semiconductor. **[2]**

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