REG. No.

Make-up

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL UNIVERSITY, MANIPAL

SECOND SEMESTER B.Tech. END-SEMESTER EXAMINATION - JULY 2016

SUBJECT: ENGINEERING PHYSICS (PHY1001)

Time: 3 Hrs. **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	Proton mass	$= 1.66 \times 10^{-27}$ kg
Boltzmann constant	$= 1.38 \times 10^{-23}$ J/K	Planck's constant	$= 6.63 \times 10^{-34}$ J.s

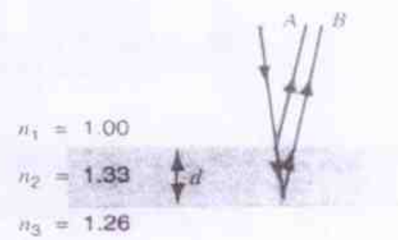
1A. Discuss qualitatively the diffraction at a single-slit. [5]

1B. Write the necessary condition on the path difference (and phase difference) between two waves that interfere (i) constructively and (ii) destructively? [2]

1C. A certain grating has 10^4 slits with a spacing of 2100 nm between the adjacent slits. It is illuminated with light of wavelength 589 nm. Find the angular position of all principal maxima observed. [3]

2A. Explain a wavepacket and represent it schematically. Explain group speed of a wavepacket. [3]

2B. If the wavelength of the incident light is $\lambda = 572$ nm, rays A and B in the figure are out of phase by $1.50\,\lambda$. Find the thickness d of the film. [2]



2C. It is entirely possible that techniques for modulating the frequency or amplitude of a laser beam will be developed so that such a beam can serve as a carrier for television signals, much as microwave beams do now. Assume also that laser systems will be available whose wavelengths can be precisely tuned to anywhere in the visible range (400 nm to 700 nm). If a television channel occupies a bandwidth of 10 MHz, how many channels could be accommodated with this laser technology? [2]

2D. The wave function for H-atom in 2s state is $\psi_{2S}(r) = \frac{1}{\sqrt{32\pi a_0^3}}\left(2-\frac{r}{a_0}\right)\exp\left(-\frac{r}{a_0}\right)$. Write the expression for the radial probability density of H-atom in 2s state. Sketch schematically the plot of this vs. radial distance. **[3]**

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

3B. Electrons are incident on a pair of narrow slits 0.060 μm apart. The 'bright bands' in the interference pattern are separated by 0.40 mm on a 'screen' 20.0 cm from the slits. Determine the potential difference through which the electrons were accelerated to give this pattern. **[3]**

3C. An electron has a kinetic energy of 3.0 eV. Find its de Broglie wavelength. **[2]**

4A. What are the differences between p-type and n-type semiconductors? Explain with band diagram, indicating the position of donor levels and acceptor levels. **[5]**

4B. A proton is confined to move in a one-dimensional "box" of length 0.20 nm. Find the lowest possible energy of the proton. What is the lowest possible energy for an electron confined to the same box? **[3]**

4C. 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]**

5A. Explain briefly the BCS theory of superconductivity in metals. **[3]**

5B. Copper has a Fermi energy of 7.0 eV at 300 K. Calculate the ratio of the number of occupied levels in copper at an energy of 8.50 eV to the number at Fermi energy. **[4]**

5C. For a spherically symmetric state of a H-atom the schrodinger equation in spherical coordinates is $-\frac{\hbar^2}{2\,m}\left(\frac{\partial^2\psi}{\partial r^2}+\frac{2}{r}\frac{\partial\psi}{\partial r}\right)-\frac{k_e e^2}{r}\psi = E\psi$. Show that the 1s wave function for an electron in H-atom $\psi_{1S}(r) = \frac{1}{\sqrt{\pi a_0^3}}\exp\left(-\frac{r}{a_0}\right)$ satisfies the schrodinger equation. Given: Bohr radius $a_o = \frac{\hbar^2}{mke^2}$, electrical constant: $k = \frac{1}{4\pi\varepsilon_o}$. ε_o= permittivity of free space. Energy of H-atom in 1s-state is $E = -\frac{ke^2}{2a_0}$. **[3]**
