Question Paper

Exam Date & Time: 28-Nov-2018 (08:30 AM - 11:30 AM)

MANIPAL INSTITUTE OF TECHNOLOGY
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MANIPAL INSTITUTE OF TECHNOLOGY
FIRST SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV 2018

Engineering Physics [PHY 1051 - 2018 -PHY]

Marks: 50 **Duration: 180 mins.**

PART A

Answer all the questions.

Missing data may be suitably assumed.
Write specific and precise answers.
Draw neat sketches wherever necessary.

1) A) Obtain an expression for the radius of $\mathbf{m^{th}}$ order bright ring in the case of Newton's rings. (4)

B) A diffraction grating has 10^4 rulings uniformly spaced over 25.0 mm. It is illuminated at normal incidence by yellow light from sodium vapor lamp which contains two closely spaced lines of wavelengths 589.00 nm and 589.59 nm. At what angle will the first order maximum occur for the first of these wavelengths? What is the angular separation between the first order maxima of these lines? (3)

C) Two slits are separated by 0.180 mm. An interference pattern is formed on a screen 80.0 cm away by 656.3 nm light. Calculate the ratio of intensity at a distance y = 0.600 cm to that at the central maximum, neglecting diffraction effects. (3)

2) A) Sketch the potential-well diagram of finite height **U** and length **L**, obtain the general solution of the Schrödinger equation for a particle of mass **m** in it. (5)

B) A 0.00160 nm photon scatters from a free electron. For what photon scattering angle does the recoiling electron have kinetic energy equal to the energy of the scattered photon? Compton wavelength = 2.43 pm. Planck's constant = 6.63×10^{-34} J-s, Speed of light in vacuum = 3.00×10^{8} m/s (3)

C) Explain the law of Malus for polarized light with a diagram. (2)

3) A) Explain the physical significance of radial probability density. (5)
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.

B) An α- particle in a nucleus can be modeled as a particle moving in a *box* of length 1.0×10^{-14} m. Using this model, estimate the energy and momentum of an α- particle in its lowest energy state. How much will be its energy in the first excited state? Planck's constant = 6.63×10^{-34} J-s, Mass of an α- particle is = $4 \times 1.66 \times 10^{-27}$ kg. (3)

C) Show that the group speed of a wavepacket is equal to the particle speed for a free non- relativistic quantum particle. (2)

4) A) Write expression for total energy (vibrational and rotational) of a molecule. Sketch schematically these energy levels for a diatomic molecule for the lowest two vibrational energy values, indicating the possible transitions. Write the expressions for the energy of the emitted photon in this molecular energy transitions. (5)

B) The K series of the characteristic x -ray spectrum of tungsten contains wavelengths of 18.5 pm, 20.9 pm, and 21.5 pm. The K-shell ionization energy is 69.5 keV. Determine the ionization energies of the L, M, and N shells. Draw a diagram of the transitions. Planck's constant = 6.63×10^{-34} J-s, Speed of light in vacuum = 3.00×10^{8} m/s. (3)

C) The radius of our Sun is 6.96×10^{8} m, and its total power output s 3.77×10^{26} W. Assuming that the Sun's surface emits as a black body, calculate its surface temperature. Stefan constant, $\sigma = 5.67 \times 10^{-8}$ SI units. (2)

5) A) Write the expression for density-of-states function. Calculate the ratio of the number of allowed energy levels at 8.50 eV to the number at 7.00 eV, for a (5)

system of electrons confined to a three-dimensional box. If 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 in copper. Boltzmann constant = 1.38×10^{-23} J/K.

B) Draw the energy band diagram for p-type and n-type semiconductors. (3)
A light-emitting diode (LED) made of the semiconductor GaAsP emits red light (λ = 650nm). Determine the energy-band gap E_g in the semiconductor. Planck's constant = 6.63×10^{-34} J-s, Speed of light in vacuum = 3.00×10^{8} m/s

C) A ruby laser emits light at wavelength 694.4 nm. If this ruby laser pulse is emitted for 12 ps and the energy released per pulse is 150 mJ, how many photons are there in each pulse? Planck's constant = 6.63×10^{-34} J-s, Speed of light in vacuum = 3.00×10^{8} m/s. (2)

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