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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL UNIVERSITY, MANIPAL

SECOND SEMESTER B.Tech. END-SEMESTER EXAMINATION - APR 2017

SUBJECT: ENGINEERING PHYSICS (PHY1001)

Time: 3 Hrs. 26-04-2017 **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. Obtain an expression for the intensity in single-slit diffraction pattern, using phasor-diagram. **[5]**

1B. A soap film (refractive index =1.33) in air is 320 nm thick. It is illuminated with white light at normal incidence. What is the wavelength in the reflected light in the visible range (400 nm to 700 nm). **[3]**

1C. Given a grating with 400 ruling/mm, how many orders of the entire visible spectrum (400 nm-700 nm) can be produced? **[2]**

2A. By solving the schrödinger equation, obtain the wave-functions for a particle of mass m in a one-dimensional "box" of length L. **[5]**

2B. Electrons are ejected from a metallic surface with speeds up to 4.60×10^{5} m/s when light with a wavelength 625 nm is used. What is the work function of the surface? **[3]**

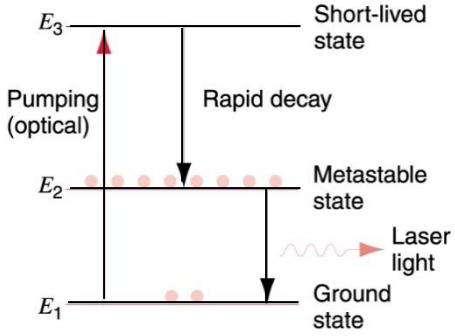
2C. An FM radio transmitter has a power output of 150 kW and operates at a frequency of 99.7 MHz. How many photons per second does the transmitter emit? **[2]**

3A. Explain the physical significance of radial probability density.
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. **[5]**

3B. A 30-eV electron is incident on a square barrier of height 40 eV. What is the probability that the electron will tunnel through the barrier if its width is 0.10 nm? **[3]**

3C. X-rays of wavelength 0.200000 nm are scattered from a block of material. The scattered X-rays are observed at an angle of 45.0° to the incident beam. Calculate their wavelength. **[2]**

4A. A pulsed ruby laser has a ruby rod (Al_2O_3 doped with Cr_2O_3) as an active medium, which is 6 cm long and 1 cm in diameter.
There is one chromium ion (active centre, with energy levels of the type shown in the figure) for every 3500 aluminium ions. The ruby laser light has a wavelength of 694.4 nm. Suppose that all the chromium ions are in metastable state (E_2) and none are in ground state (E_1). How much energy is there in a single laser pulse if all these ions come down to ground state in a single stimulated emission chain reaction episode?



Density of Al_2O_3 is 3700 kg/m^3. Molar mass of Al_2O_3 is 0.102 kg/mol. **[5]**

4B. Write the expression for Fermi-Dirac distribution function. Sketch schematically the plots of this function for zero K and for temperature above zero K. **[3]**

4C. Why the electrical resistivity of an intrinsic semiconductor decreases with increasing temperature? Explain. **[2]**

5A. Draw the band energy diagrams of intrinsic semiconductor, n-type semiconductor, p-type semiconductor.
The energy gap for silicon at 300 K is 1.14 eV. Find the lowest frequency-photon that can promote an electron from the valence band to the conduction band. Also find the wavelength of this photon? **[5]**

5B. Explain Meissner effect. **[3]**

5C. Each atom of gold contributes one free-electron to the metal. The concentration of free-electron in gold is 5.90 x 10^{28}/m^3. Compute the Fermi Energy of gold at zero K.
Total number of conduction electrons per unit volume in a metal is given by

$$n_e = \frac{8\sqrt{2}\pi m^{3/2}}{h^3}\int_0^\infty \frac{E^{1/2}dE}{\exp\left(\frac{E-E_F}{kT}\right)+1}\ .$$ **[2]**

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