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I SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: ENGINEERING PHYSICS (PHY1001)
REVISED CREDIT SYSTEM

Time: 3 Hrs. **Date: 04-12-2015** **Max. Marks: 50**

Instructions to Candidates:

- **Answer ALL the questions. Each question carries 10 marks**
- **Missing data may suitably be assumed.**
- **Answer all the sub questions of a main question in a continuous sequence.**
- **Write question number within the margin. Draw neat sketches wherever necessary.**

Physical Constants:

Speed of light in vacuum = 3.00×10^8 m/s
Avogadro constant = 6.023×10^{23} / mole
Planck's constant = 6.63×10^{-34} J.s
Permeability of free space, $\mu_0 = 4\pi \times 10^{-7}$ T - m/A
Electron charge = 1.60×10^{-19} C
Mass of electron = 9.11×10^{-31} kg
Boltzmann constant = 1.38×10^{-23} J/ K

1A Obtain an expression for the radius of **m^{TH}** order bright ring in the case of Newton's rings. **[4 M]**

1B Monochromatic light with wavelength **538 nm** falls on a slit with width **25.2 μm**. The distance from the slit to a screen is **3.48 m**. Consider a point on the screen **1.13 cm** from the central maximum. Calculate the ratio of the intensity at this point to the intensity at the central maximum. **[3 M]**

1C 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**, (i) What is the length of the pulse, and (ii) How many photons are there in each pulse? **[3 M]**

2A Discuss qualitatively, the diffraction due to multiple slits. **[3 M]**

2B A helium–neon laser having a wavelength of **633 nm** delivers **2.00×10^{18}** photon/s. If the beam shines perpendicularly onto a perfectly reflecting surface, what force does it exert on the surface? **[2 M]**

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

2D What is skip distance? With neat diagram, derive an expression for it. **[3 M]**

3A Sketch schematically the photoelectric current versus applied voltage graph for two different light intensities falling on a photo cathode in a photoelectric cell and explain the same. **[2 M]**

3B Solve the schrödinger equation for a quantum particle of mass **m** trapped in a one-dimensional infinite potential well (box) of length **L** and obtain the expressions for wave-functions of the particle. **[5 M]**

3C A beam of electrons is incident on a barrier **6.0 eV** high and **0.20** nm wide. Find the energy they should have if **1%** of them are to get through the barrier. **[3 M]**

4A The wave function for H-atom in ground state is $\psi_{1s}(r) = \frac{1}{\sqrt{\pi a_o^3}} e^{-\frac{r}{a_o}}$

Write the expression for the radial probability density of H-atom in this state. Calculate the probability that the electron in the ground state of H-atom will be found outside the Bohr radius (a_o). **[4 M]**

4B Write the expression for Fermi-Dirac distribution function. Sketch schematically the plots of this function for zero **K** and for temperature **>** zero **K**. **[2 M]**

4C Niobium metal becomes a super conductor when cooled below **9** K. When the surface magnetic field exceeds **0.100** T, its superconductivity is destroyed. Determine the maximum current a **2.00** mm diameter Niobium wire can carry and remain super conducting, in the absence of any external magnetic field. **[2 M]**

4D Sketch the probability densities for the lowest three energy states of a particle in a potential well of finite height. **[2 M]**

5A Explain the terms valence band (VB) and conduction band (CB) of a solid material. Draw the band energy diagrams for **(i)** intrinsic semiconductor, **(ii)** n-type semiconductor, and **(iii)** p-type semiconductor, showing VB and CB. Indicate clearly all the relevant energy levels. **[3 M]**

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. **[2 M]**

5C Explain Meissner effect. **[2 M]**

5D Sodium is a monovalent metal having a density of **971** kg/m^3 and a molar mass of **0.023** kg/mol. Use this information to calculate **(i)** the density of charge carriers and **(ii)** the Fermi energy.
The free electron density (n_e) in a metal, $n_e = \frac{8\sqrt{2}\,\pi\, m^{3/2}}{h^3} \int_0^{E_F} \frac{E^{1/2}\, dE}{\exp\left(\frac{E - E_F}{kT}\right) + 1}$

[3 M]