B.E. end semester (1st Semester ETC, CST, EE, IT) Examination, 2013

PHYSICS (PH - 1201)

Full Marks: 70 **Time: 3 hrs.**

Group-A: *Answer all questions* 10X1=10

1. i) Show that $\vec{F} = (2xy + z^3)\hat{\imath} + x^2\,\hat{\jmath} + 3xz^2$ is a conservative force field.

   ii) Write down the differential form of Faraday's law.

   iii) Write down the Maxwell's equation that states "Magnetic monopoles do not exist."

   iv) Choose the correct alternative: In Fraunhofer diffraction the incident wave front is
   (a) cylindrical, (b) spherical, (c) plane, (d) none of these

   v) Choose the correct alternative: For population inversion to occur, a system must have at least
   (a) two energy levels, (b) three energy levels, (c) four energy levels, (d) any number of energy levels.

   vi) What do you mean by proper length?

   vii) What is the significance of negative sign of Q-value?

   viii) What is the momentum of a photon of wavelength λ?

   ix) Write down the unit cell characteristics of triclinic crystal system.

   x) Why X-rays are used in determining crystal structure instead of other electromagnetic waves.

Group-B: *Answer any two* 2X10=20

2. a) Find the directional derivative of $\emptyset = x^2yz + 4xz^2$ at (1, -2, -1) in the direction of $2\hat{\imath} - \hat{\jmath} - 2\hat{k}$.
   b) Prove that i) $\nabla^2\left(\frac{1}{r}\right) = 0$, ii) $\vec{\nabla} \times (\emptyset\vec{A}) = \vec{\nabla}\emptyset \times \vec{A} + \emptyset(\vec{\nabla} \times \vec{A})$

   c) Determine the constant "a" such that $\vec{v} = (x + 3y)\hat{\imath} + (y - 2z)\hat{\jmath} + (x + az)\hat{k}$ is solenoidal.

   d) State Gauss's divergence theorem for a vector $\vec{A}$. [2+(2×2)+2+2]

3. a) For N-slit Fraunhofer diffraction, find out the intensity distribution and hence explain the characteristics of principal maxima.
   b) What is the condition when two wavelengths are said to be just resolved by a grating. Obtain an expression for the resolving power of a grating.
   c) What is the difference between linearly polarized and circularly polarized light? [5+3+2]

4. a) μ Mesons have average life time of 2.00 μs. Two μ mesons are moving in opposite direction with constant speed of 0.95C after production at the same point as measured by an observer in the laboratory frame. Calculate the relative speed of one meson with respect to the other. Find the average life time of one Meson with respect to the other. What will be the distance between them before they decay?

b) Write down the relation between binding energy/ nucleon and mass defect/nucleon. Display graphically the variation of these quantities with mass number A and discuss the trends of variation. [(2+2+1)+(1+2+2)]

Group C: *Answer any four* 4X10=40

5. a) Write down Ampere's law in its integral form as well as in differential form. What was the inconsistency in Ampere's law? How it has been removed by Maxwell ?
b) Derive the electromagnetic wave equations in vacuum from Maxwell's equations.
c) State Poynting's theorem and write down its mathematical form and explain the terms involved. [(1+2+2.5)+2.5+2]

6. a) Define Einstein's A, B coefficients for spontaneous and stimulated emission. Calculate the ratio of the rate of spontaneous emission to the rate of stimulated emission.
b) Explain the working principle of a Helium-Neon Laser.
c) Plot the refractive index profiles for step and graded index optical fibers. Obtain an expression for the numerical aperture and acceptance angle of a step index fiber. [5 + 2 +(1+2)]

7. a) State Heisenberg's uncertainty principle.
b) An electron is confined in a box of length 10^{-9} m. Calculate the minimum uncertainty in measurement of its velocity. (Mass of electron is $9.1 \times 10^{-31} kg$)
c) Find an expression for Compton shift in wavelength of X-rays due to Compton process. [2+3+5]

8. a) Derive Bragg's law for X-ray diffraction from a crystal.
b) a beam of X-ray is incident on a sodium chloride crystal (lattice spacing 0.282 nm). The first order Bragg's reflection is observed at a glancing angle $8^0 35'$. What is the wavelength of X-ray. At what angle would the second order Bragg's reflection occurs? (2+1)
c) In a simple cubic crystal find the ratio of the intercepts on the three axis by (123) plane and find the ratio of the spacing of (110) and (111) planes. [4+(2+1)+3]

9. a) Consider a particle confined in a region between two rigid walls of infinitely high square well potential placed at x=0 and x=L. Write down the Schrödinger wave equation for that particle. Solve it to obtain normalized wave function.
b) What do you mean by ionic crystal? Give an example of such crystal. Show that the Madelung constant for a one dimensional ionic crystal is $2ln2$. [(2+3)+ (1+1+3)]