RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

B.A./B.SC. FIFTH SEMESTER EXAMINATION, DECEMBER 2013

THIRD YEAR

Date : 21/12/2013 **PHYSICS (Honours)**

Time : 11 am – 1 pm Paper : VI Full Marks : 50

Group – A

(*Answer **any two** of the following*)

1. a) Write down the Maxwell's equations both in integral and differential forms and explain physical origin of each equation. [6]

   b) Consider a charged parallel plate capacitor (neglect the edge effects) immersed in sea-water. The charge on the plates is $q = q_0 \sin(2\pi\nu t)$ C, where $\nu = 4\times10^8$ Hz. At this frequency sea-water has permitivity $\in = 81\in_0$, permeability $\mu = \mu_0$ and resistivity $\rho = 0{\cdot}23$ ohm-meter. Compare the conduction and displacement currents. [2+2]

2. a) Show that the space and time dependent magnetic field B in free space satisfies a wave equation. Prove that it normal to both wave vector and accompanying electric field. [5]

   b) Show that according to Maxwell's theory, the refractive index of a linear homogeneous medium $(\mu = \mu_0)$ is given by the square root of the dielectric constant of the material. [2]

   c) Show that in a conductor, the electric and the magnetic field of propagating e.m. wave are no longer in phase. [3]

3. a) A plane electromagnetic wave in free space has its electric field amplitude 100V/m. Find the average intensity and magnitude of Poynting vector. [5]

   b) A plane electromagnetic wave is incident normally at air-water interface. Derive a relation between reflection coefficient R and refractive index n and estimate fraction of transmission. (Refractive index of water = 1·33). [5]

4. a) A plane electromagnetic wave is incident normally at metal surface (conductivity σ). Find an expression for the penetration depth. In order to shield radio wave of frequency (10^7Hz) how thick a copper sheet is needed? (conductivity = 6×10^6 S-m). [5]

   b) In an optical medium the dielectric constant and refractive index are found to be complex. What is the physical consequences due to complex character of these? Why radio wave can not be effectively used in satellite communication? [3+2]

Group – B

(*Answer **any three** of the following*)

5. a) Explain the classification of power amplifiers. [3]

   b) Calculate the efficiency of a class B type power amplifier. [4]

   c) If V_1 and V_2 are two voltages (with respect to ground), how would you construct an OP AMP circuit to get the voltage $V_0 = 2V_1 - V_2$? [3]

6. a) Give the circuit diagram and the truth table of a SR flip-flop. [1+1]

   b) How a SR flip-flop is modified to JK flip-flop, explain with truth table. [1+3]

   c) Draw the circuit diagram of any common type of digital to analog convertor. [4]

7. a) Find an expression of shot circuit current gain of a npn transistor and comment on which factors the high frequency response of a transistor depends. [4+1]

   b) Find an expression for low frequency voltage gain in a small signal common emitter transistor amplifier, with an input capacitor, and emitter short circuited to ground. If in this circuit emitter is

connected to the ground through a combination of resistance and capacitor in parallel, what will be the change of lower cutoff frequency. [4+1]

8. a) What is modulation index in an AM wave? Show that an AM wave contains one carrier and two side frequencies at equal interval. [1+3]
   b) Draw a simple linear diode detector circuit and explain its operation. What is diagonal clamping? [2+1]
   c) The peak-to-peak value of an AM voltage has a maximum value of 5V and a minimum value of 1V. If the depth of modulation is 0·7, what is the amplitude of the unmodulated carrier voltage? [3]

9. a) i) Explain the function of sweep generator in a CRO.
      ii) Find the deflection sensitivity of a CRT in which the length of the deflection plates is 2·0 cm, spacing between the plates in 4 mm, the distance of the screen from the centre of the plates is 20 cm and anode voltage is 1000V. [3+2]
   b) Derive the expression for oscillation frequency of a Wien-Bridge oscillator. [3]
   c) What is meant by the frequency stability of an oscillator. [2]