RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

B.A./B.Sc. FIFTH SEMESTER EXAMINATION, DECEMBER 2014

THIRD YEAR

Date : 23/12/2014 **PHYSICS (Honours)**

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

[Use a separate Answer book for each Group]

Group - A

*(Answer **any two** questions)* [2×10]

1. a) Show that the Ampere's law in material is given by $\vec{\nabla}\times\vec{H}=\vec{J}$. Is this relation describe all situations? [5]
   b) Derive an expression for the electric energy density in medium in terms of electric field and dielectric constant. [5]

2. a) Using the Maxwell equations show that the magnetic field B in free space satisfies equation $\nabla^2 B=\varepsilon_0\mu_0\frac{\partial^2 B}{\partial t^2}$. [5]
   b) What is pointing vector? The Pointing vector gives the instantaneous flow of Power per unit area. Establish. [1+4]

3. a) The amount of e.m. energy received per unit area of earth surface from the space is $10^{-3}W/m^2$. Find the amplitude of electric field of e.m wave. [3]
   b) A plane polarized light with $E=E_0e^{j(K\mathbb{Z}-\omega t)}\hat{i}$. Find B in terms of E and its amplitude. [3]
   c) Show that Snell's law follows from the boundary condition of electric fields at the interface of two dielectric media. [4]

4. a) A radio transmitter using frequency 10^7/s fails to communicate with Submarine deep inside the sea. Explain why. (conductivity of sea water 4S/m). [3]
   b) Show that normal dispersion relation follows from damped oscillating dipole. [5]
   c) Find the skin depth of copper at 10^4 MHz. The conductivity of copper is given by $5{\cdot}8\times10^7$ s/m. [2]

Group - B

*(Answer **any three** questions)* [3×10]

5. Draw the circuit diagram of a differential amplifier with two transistors. Draw the equivalent circuit of this amplifier. Derive expressions for difference mode and common mode voltage gain of this amplifier. Find an expression for common mode rejection ratio. How it is improved? [1+2+4+2+1]

6. a) What is the Barkhausen criterion? Explain under what condition a positive feedback amplifier gives oscillations. [2+2]
   b) Draw the circuit diagram of a Wien Bridge oscillator. Derive an expression for frequency of this oscillator. How frequency can be continuously changed in this oscillator. [2+3+1]

7. a) How can clocked R-S flip-flop converted into J-K flip-flop. Give its truth-table. [2+1]
   b) Design a MOD 10 asynchronous counter and show the wave forms at different flip-flop output. [2+2]
   c) What is a shift register? Draw the circuit diagram of a 4-bit shift register. [1+2]

8. a) What is frequency modulation? Derive an expression for an FM wave with sinusoidal modulation. [1+3]
   b) The peak to peak value of AM voltage has a maximum value of 5V and minimum value of 1V. If the depth of modulation is 0·7. Find the amplitude of the un-modulated carrier voltage. [2]
   c) Derive an expression for the deflection sensitivity for electrostatic deflection of an electron beam in CRT. [4]

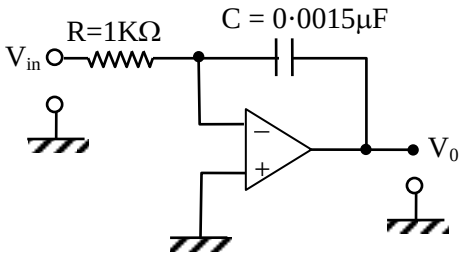
9. An op-amp is connected in a circuit as in diagram. Input impedance is very high and output impedance is very low, output saturate at +/– 12V, and open loop gain is very large.

a) Derive an expression for relating input and output voltages. Assuming capacitor is completely discharged initially. [3]

b) What is the input impedance of the circuit? [1]

c) If a voltage step of 20ms, 1 volt is applied on the input, draw the output voltage. [3]

d) If $V_0 \sin \omega t$ is applied at the input what will be the output voltage. [3]



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