Ex/UG/SC/PHY/TH/08/2019

BACHELOR OF SCIENCE EXAMINATION, 2019

(2nd Year, 2nd Semester)

PHYSICS

Paper : CORE - 8

Time : Two hours Full Marks : 50

GROUP - A (25 marks)

Answer any ***two*** questions.

1. A dc source of voltage is suddenly applied to a circuit consisting of a resistor R and a capacitor C in series.

   (i) Investigate the variation of voltage across the capacitor and the resistor.

   (ii) Estimate the current flowing through the circuit.

   (iii) Show graphically the voltage across the capacitor if the dc source is replaced by a square pulse.

   (iv) Prove that the Joule heat dissipated in the resistance R due to the charging current plus the energy stored in the capacitor is equal to the energy supplied by the driving battery. $4+2+1^{1}/_{2}+5$

2. (i) Explain that at a frequency ω below the resonant frequency (ω_0), the reactance of a series resonant circuit is capacitative, but above ω_0 it is inductive. How does the phase angle vary with frequency ? Does

this variation depend on Q factor of the circuit ? Give an explanation to support your answer.

(ii) What are current and voltage resonance in a series LCR circcuit ? Find the corresponding resonance frequencies. Under what condition these two frequencies merge with each other ?

((3$^1/_2$+1+2)+(5+1))

3. (a) In an ideal transformer, the primary consists of an inductance L_1 and resistance R_1 and the secondary has an inductance L_2 and resistance R_2. The mutual inductance between them is M. A sinusoidal voltage $V_{(t)}$ is applied across the primary and a load resistance R_1 is applied across the secondary. Calculate the transferred resistance and reflected inductance from the secondary to the primary.

(b) What is the use of Wien bridge ? Find out the balance condition for Wien bridge. Discuss what would happen if the applied voltage is not pure sinusoidal. 6+6$^1/_2$

4. (i) Mention two important methods of network analysis. Discuss any one.

(ii) Define the Z parameters of a two port network and hence derive T-π transformation relationships.

(b) What is an interval ? Show that the interval between two events is invariant. Explain the principle of causality. 2+3

10. A large mass M, moving at speed V, collides and sticks to a small mass m, initially at rest. What is the mass of the resulting object ? Use the approximation M >> m. Further, show that the resulting mass is the sum of the individual masses using the non-relativistic approximation. 4+1

11. A beam of identical unstable particles flying at a speed βc is sent through two counters separated by a distance L. It is observed that N_1 particles are recorded at the first counter and N_2 at the second counter. The reduction in number ($N_1 > N_2$) is being solely due to the decay of the particles in flight. Show that the lifetime of the particles at rest is given by $\tau = L / \ln \frac{N_1}{N_2} \sqrt{\gamma^2 - 1} \times c$.. 5

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velocity of CM (Centre of Mass) system. Calculate the energy available in the CM system for relativistic and non-relativistic case. 3+2

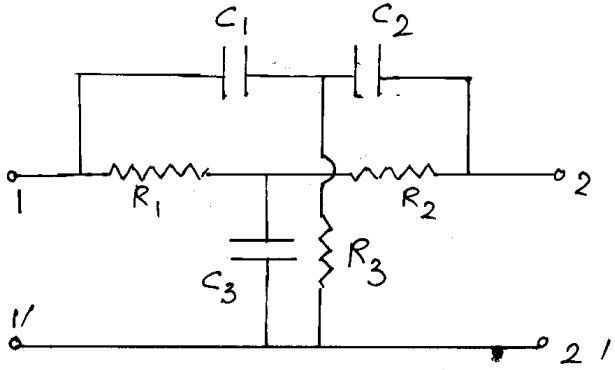
7. Show that the D'Alembert operator operator, $\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}-\frac{1}{c^2}\frac{\partial^2}{\partial t^2}$ is invariant under Lorentz transformation. 5

8. (a) On the basis of Galilean transformation, show that the force acting on a particle is independent of the inertial frame in which it is measured.

   (b) What was the objective of the Michelson-Motley experiment? In this experiment, (l_1+l_2) was 22 m and the wavelength of light used was 6000 A. They assumed that either is fixed relative to the sun so that the earth and the interferometer move through the ether at a velocity $\upsilon = 3 \times 10^4$ m/s which is the orbital speed of the earth about the sun. Calculate the fringe shift they expected to observe. 2+1+2

9. (a) Show that two successive Lorentz transformation corresponding to speeds υ_1 and υ_2 are equivalent to a single Lorentz transformation corresponding to a speed of $\upsilon = (\upsilon_1+\upsilon_2)\Big/\left(1+\frac{\upsilon_1\,\upsilon_2}{c^2}\right)$.

(iii) Transform the following two parellel T network into an equivalent π network. $3^1/_2$+5+4



GROUP - B (25 marks)

Answer any ***five*** questions.

5. A train with proper length L moves at speed c/2 with respect to the ground. A ball is thrown from the back to the front, at speed c/3 with respect to the train. How much time does this take, and what distance does the ball cover, in (a) The train frame? (b) The ground frame? (c) The ball frame? 1+2+2

6. Consider a collision between two particles with mass M_1 and M_2. Let particle M_1 is moving with velocity u in the laboratory system and particle M_2 is in rest. Calculate the