LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **PHYSICS**

FIRST SEMESTER – **NOVEMBER 2022**

PPH1MC02 – ELECTRODYNAMICS

Date: 25-11-2022 Dept. No. Max. : 100 Marks

Time: 01:00 PM - 04:00 PM

	SECTION A			
	Answer ALL the questions			
1	**State True or False**		**(5 x 1 = 5)**	
a)	The theory of steady currents is called magnetostatics.		K1	CO1
b)	The magnetic field of a point charge is not always perpendicular to the electric field and to the vector from the retarted point.		K1	CO1
c)	Electromagnetic fields not only carry energy, they also carry momentum.		K1	CO1
d)	For high values of velocities, the Lorentz transformation approach Galilean.		K1	CO1
e)	The trajectory of a particle on a Minkowski diagram is called Earth line.		K1	CO1
2	**Match the following**		**(5 x 1 = 5)**	
a)	I > 0	TE waves	K2	CO1
b)	Ez = 0	Space like interval	K2	CO1
c)	E.J	Electrostatics	K2	CO1
d)	Radiation fields	Power delivered per unit volume	K2	CO1
e)	Stationary Charges	Charged particles	K2	CO1
	SECTION B			
	Answer any THREE of the following in 500 words		**(3 x 10 = 30)**	
3	(a) Find the electric field at a distance z above the midpoint of a straight line segment of length 2L, which carries a uniform line charge λ. (5 marks) (b) Use Gauss law to find the electric field inside a uniformly charged sphere (charge density ρ). (5 marks)		K3	CO3

4	(a) Calculate the power flow for a plane wave using the Poynting theorem. (5 marks) (b) Find the energy of a uniformly charged spherical shell of total charge q and radius R. (5 marks)	K3	CO3
5	(a) Calculate the percentage contraction in the length of a rod moving with a velocity 0.8 c in a direction inclined at 60° to its own length. (6 marks) (b) Find the velocity at which the mass of a particle is double its rest mass. (4 marks)	K3	CO3
6	Derive Abraham-Lorentz formula for the radiation reaction force.	K3	CO3
7	Derive expressions for energy and momentum in electromagnetic waves.	K3	CO3
	SECTION C		
	Answer any TWO of the following questions in 500 words **(2 x 12.5 = 25)**		
8	(a) Calculate the work done to assemble n number of point changes. (6.5 marks) (b) Three equal charges +q each are situated at three corners of a square of side a. (i) How much work does it take to bring another charge +q from far away and place it in the fourth corner? (ii) How much work it takes to assemble the whole configuration of four charges? (6 marks)	K4	CO3
9	(a) Explain in detail the invariant interval. (8.5 marks) (b) Event A happens at point (x_A=5, y_A=3, z_A=0 at time t_A given by ct_A=15, event B occurs at (10, 8, 0) and ct_B=5, both in system S. What is the invariant interval between A and B? (4 marks)	K4	CO3
10	What are retarted potentials? Derive expressions for retarded scalar and vector potentials.	K4	CO3
11	(a) Show by direct application of Lorentz transformation $x^2+y^2+z^2-c^2t^2$ is invariant. (7.5 marks) (b) Find the velocity that an electron must be given so that its momentum is 10 times its rest mass times the speed of light. What is the energy at this speed? (5 marks)	K4	CO3
	SECTION D		
	Answer any ONE of the following questions in 1000 words **(1 x 15 = 15)**		
12	Derive Lienard-Wiechart potentials for a moving point charge.	K5	CO4
13	Point out that TEM waves cannot occur in a hollow wave guide. Also show that a coaxial transmission line of inner and outer radius a and b respectively admit waves with $E_z = 0$ and $B_z = 0$.	K5	CO4

SECTION E			
Answer any ONE of the following questions in 1000 words			**(1 x 20 = 20)**
14	(a) Categorize the complete set of transformation rules for E and B. Show that (E.B) and $(E^2-C^2B^2)$ is relativistically invariant. (15 marks) (b) A Pion at rest decays into a muon and neutrino. Find the energy of the outgoing muon in terms of the two masses, m_π and m_μ. Also find the velocity of the muon. (5 marks)	K6	CO5
15	(a) Obtain the general expression for electric and magnetic field components for an EM wave propagating along the z-axis of a waveguide. Hence derive an expression for the cutoff wavelength for a TM mode of propagation in a rectangular waveguide. (15 marks) (b) Calculate the cut-off frequency for TE_{01}, TE_{11} and TE_{10} modes for a rectangular wave guide of dimensions 2cm x 1cm. (5 marks)	K6	CO5

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