Ref. No: Ex/ET/PC/B/T/211/2023

B.E.Tel.E. 2nd YEAR EXAMINATION, 2023
(1st Semester)

ELECTRO MAGNETIC THEORY

Time: Three hours | Full Marks 100

No. of questions		Marks

Answer any *five* questions.
Consider $\varepsilon_0=8.854X10^{-12}$F/m and $\mu_0=4\pi X10^{-7}$H/m
Values of other universal physical constants may be assumed, if necessary.

1.(a)	Discuss the physical significance of "Divergence" operation.	8
(b)	Hence find an appropriate expression of the divergence of a vector in cylindrical coordinates.	12
2.(a)	Two point charges of equal mass m and charge Q are suspended from a common point by two threads of negligible mass and length l. Find the inclination angle α with respect to the vertical made by each thread at equilibrium. Assume α to be very small.	8
(b)	Determine the electrostatic pressure on a conducting surface carrying a surface charge density ρ_s suspended in a medium of permittivity ε.	12
3.(a)	A point charge Q is located at the origin of spherical coordinate system. Calculate the electric flux crossing the portion of a spherical shell described by $\alpha\leq\theta\leq\beta$.	10
(b)	Comment on the result obtained for $\alpha=0$ and $\beta=\pi/2$.	2
(c)	A total charge of 40 nC is uniformly distributed on a circular disk. Determine the potential at a point 2m distant from the disk along its axis.	8
4.(a)	Consider a single turn rectangular coil in the z=0 plane carrying a current I having dimensions w and l along x and y axes respectively. If a uniform magnetic field B exists in the +x direction, how much is the torque rotating the coil?	10
(b)	Using the definition $\mathbf{B}=\nabla X\mathbf{A}$, derive an expression for magnetic vector potential from Biot Savart Law.	10
5.(a)	Assume that a material behaves as a good conductor if the displacement current through it is at least 10 times the conduction current. For sea water, $\varepsilon_r=81$ and $\sigma=20$S/m. What is the maximum frequency up to which sea water may be treated as a good conductor?	4
(b)	For such good conductors, how do you evaluate the skin depth and the phase velocity?	8
(c)	Discuss the concept of surface impedance and its significance therein.	8
6.(a)	State and prove Poynting theorem.	6
(b)	Using it, determine the reflection coefficient at a dielectric-dielectric interface in terms of the material properties for both the cases of horizontal and vertical polarizations.	8
(c)	Hence discuss the phenomenon of total internal reflection.	4
7.(a)	For a current sheet $\mathbf{K}=9.0\mathbf{a}_y$ A/m is located at z=0, the interface between region 1 (z<0) with $\mu_r=4$ and region 2 (z>0) with $\mu_r=3$. Given that $\mathbf{H}_2=14.5\mathbf{a}_x+8.0\mathbf{a}_z$ Am, find $\mathbf{H}_1$.	10
(b)	Prove that for uniform plane waves, the mode of propagation is always TEM.	10
8.(a)	What do you understand by retarded potential approach?	4
(b)	Elaborate its usage in determining the radiated fields from a time varying current source.	16