Ref. No: Ex/ET/PC/B/T/211/2024

B.E.Tel.E. 2nd YEAR EXAMINATION, 2024
(1^{st} 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.
All symbols carry their usual meanings.

1.(a)	For V= ln(1/r), determine $\nabla^2(1/r)$ where $r=\sqrt{(x^2+y^2+z^2)}$	8
(b)	Prove that $\nabla \times \nabla \times \vec{A} = \nabla(\nabla.\vec{A}) - \nabla^2\vec{A}$.	12
2.(a)	Two semi-infinite conducting planes at $\phi=0$ and $\phi=\pi/6$ are separated by an infinitesimal insulating gap. If V ($\phi=0$)=0 and V($\phi=\pi/6$)=100V calculate V and E in the regions between the plates.	8
(b)	Determine the capacitance per unit length between two infinitely long conducting cylinders of radii a and b respectively (a>b) carrying equal and opposite charge distributions.	12
3.(a)	Determine the magnetic field intensity everywhere inside and outside a wire of radius R carrying a current I distributed uniformly over its cross section.	6
(b)	Derive an appropriate expression for energy density in magentostatic field.	8
(c)	Find both magnetic field intensity and magnetic flux density in terms of magnitude and direction at the centre of a circular loop of diameter 1m carrying a steady current of 2A.	6
4.(a)	Consider two inductors of value L_1 and L_2 respectively connected first in series and then in parallel. Starting from Faraday's law of induction and the definition of inductance, determine the effective inductance in both cases.	8
(b)	A charged particle moves with uniform velocity $4\hat{x}$ m/s in a region where $\vec{E}=20\hat{x}$ V/m and $\vec{B}=B_0\hat{z}$ Wb/m. Determine B_0 such that the velocity of the particle remains unchanged.	6
(c)	Given $\vec{A}$=(y cos ax) $\hat{x}$+(y+e^x) $\hat{z}$. Find $\vec{B}=\nabla \times \vec{A}$ at the origin.	6
5.(a)	Given $\vec{E}$=A cos ω(t-z/c)$\hat{y}$ for a propagating electromagnetic wave in free space. Determine $\vec{H}$.	8
(b)	Further determine $\vec{E} \times \vec{H}$ and establish its physical significance with mathematical proof. What term is used to describe this vector?	8
(c)	A no. 10 copper wire carries a conduction current of 1A at 50 Hz. What is the displacement current in it? Assume that for copper $\mu=\mu_0$, $\varepsilon=\varepsilon_0$ and $\sigma=5.8X10^7$ S/m.	4
6.(a)	Describe time harmonic field.	4
(b)	For such a wave existing in a good conductor, derive suitable expressions for the attenuation constant, phase constant, intrinsic impedance and phase velocity. In this context, discuss what you mean by skin depth.	12
(c)	Explain how these quantities would have been modified for the case of a perfect conductor with physical explanation.	4

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7.(a)	Define polarization.	2
(b)	Discuss the conditions leading to various different states of polarization.	15
(c)	Which one amongst them is the most generalized? Explain your answer.	3
8.	Write notes on any *two* of the followings.	
(a)	Inconsistency of Ampere's law and its removal	
(b)	Brewster's angle phenomenon	
(c)	Lorentz Gauge condition	10 X 2