BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2023-24
EEE/INSTR/ECE F212 ELECTROMAGNETIC THEORY
MID SEMESTER TEST (CLOSED BOOK)

Date : 10/11/2023 **Duration : 90 Minutes** **Max marks : 60**

Name :	**ID :**	**Tut sec :**

Instruction: Answers should be presented in a clear and legible manner, to be considered for evaluation

Q1A) For a distortionless transmission line, the voltage wave is given by $v(-l, t) = 120\, e^{+0.0025\times l}\cos(10^8 t + 2l) + 60\, e^{-0.0025\times l}\cos(10^8 t - 2l)$, where l is the distance from the load which is located at $z = 0$. If $Z_L = 300\ \Omega$, find the following for the line:

(i) Propagation constant, phase velocity, and characteristic impedance
(ii) Expression for the current wave in time-domain form **[8]**

Q1B) A lossless transmission line shown in Fig. 1 is $50\ cm$ in length and operates at a frequency of $100\ MHz$. The line parameters are $L = 0.2\ \mu H/m$, and $C = 80\ pF/m$. The line is terminated in a short circuit at $z = 0$. Further, there is an impedance $Z = 50 + j20\ \Omega$ connected across the line at location $z = -20\ cm$. If $100\angle 0°\ V$ (peak) is applied to the line as shown, find the following:

(i) Characteristic impedance, phase velocity of the line
(ii) Input impedance seen by the source at plane AA'
(iii) Average power delivered to impedance Z **[12]**

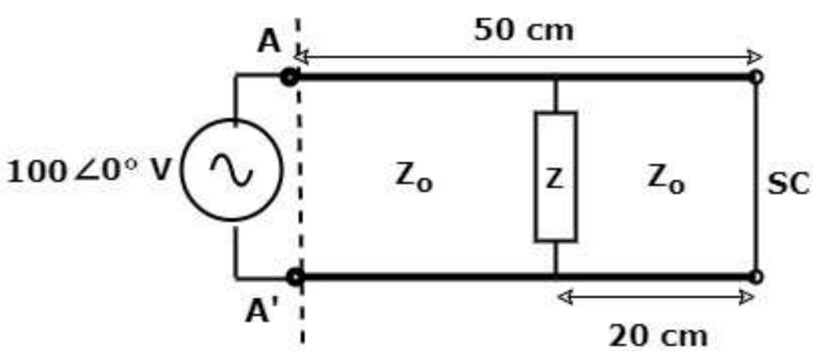

Fig.1 (Q1B)

Q2A)

(i) Write down Stoke's theorem in integral form (ii) Test if Stoke's theorem is satisfied by $\vec{A} = r \cos\phi \, a_r + \sin\phi \, a_\phi$ over the path shown in Fig.2 **[12]**

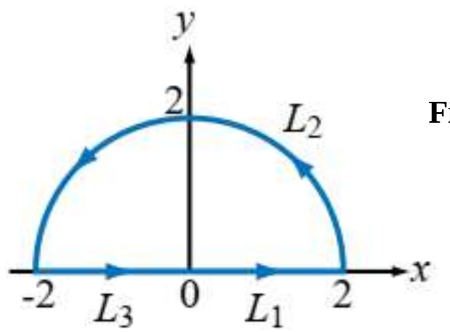

Fig.2 (Q2A)

Q2B) Given a vector field $\vec{C} = r^2 \sin\phi \, a_r + z \cos\phi \, a_\phi + rz \, a_z$. Check the solenoidal and irrotational nature of this field at point P(1 m, 90^0,4 m) **[8]**

Q3A) In free-space, there exists an electrostatic potential field V=80R^2cos(θ) and a point P (2.5 m, 30^0, 60^0). Calculate the following for point P,

(i) Electric flux density

(ii) Magnitude of the maximum space rate of change of V

(iii) Unit normal to the equipotential surface

(iv) Volume charge density that produces V **[10]**

Q3B) Fig.3 shows Region 1, defined by $x < 0$, is free-space, while region 2, $x > 0$, is a good dielectric material for which $\varepsilon_{r2} = 2.4$. Given $\vec{D} = 3a_x - 4a_y + 6a_z$ (C/m^2) in region 1. Find $\vec{E}$ in region 2 and the angles θ_1 and θ_2. **[10]**

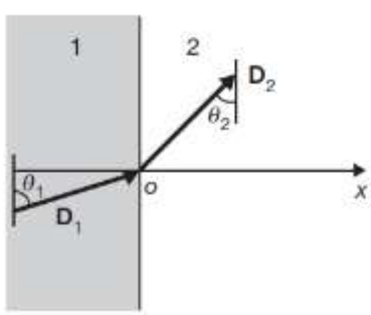

Fig.3 (Q3B)

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