

[Total No. of Questions - 5] [Total No. of Printed Pages - 4]  
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B. Tech 5th Semester Examination  
Electromagnetic Field Theory (OS)

EC-5002

Time : 3 Hours

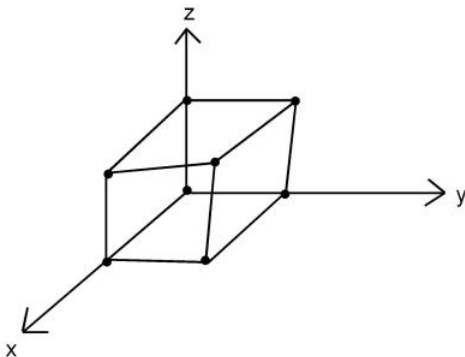
Max. Marks : 100

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt five questions in all selecting one question from each of the Sections A, B, C, and D and all the subparts of questions in Section E.

SECTION - A

1. Test the divergence theorem for the function  $\vec{V} = (xy)\hat{i} + (2yz)\hat{j} + (3zx)\hat{k}$ . Take as your volume the cube shown in Figure, with side length 2. (20)



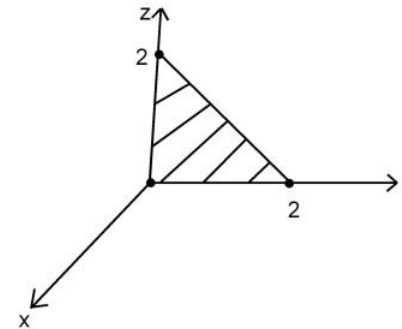
OR

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Test Stoke's theorem for the function  $\vec{V} = (xy)\hat{i} + (2yz)\hat{j} + (3zx)\hat{k}$ , using the triangular shaded area of figure. (20)



SECTION - B

2. (a) State the Coulomb's law. (5)  
(b) Find the energy of a uniformly charged spherical shell of total charge  $q$  and radius  $R$ . (5)  
(c) Show that the capacitance of an isolated sphere of radius  $R$  is  $4\pi \epsilon_0 R$  farads. (10)

OR

- (a) Derive an expression for the energy density of the steady magnetic fields. (10)  
(b) The  $y$ - and  $z$ -axis, respectively, carry filamentary currents 10A along  $\hat{a}_y$  and 20A along  $-\hat{a}_z$ . Find  $\vec{H}$  at  $(-3, 4, 5)$ . (10)

SECTION - C

3. (a) What is the continuity equation? Derive it from the basics and describe all its forms. (10)

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- (b) A plane wave travelling in free space has an average poynting vector of  $5W/m^2$ . Find the average density. (10)

OR

- (a) What is the significance of Maxwells equation? Mention them in their various forms. (10)
- (b) A conductor with cross-sectional area of  $10\text{ cm}^2$  carries a conduction current  $0.2 \sin 10^9t$  mA. Given that  $\sigma=2.5 \times 10^6$  s/m and  $\epsilon_r=6$ , Calculate the magnitude of the displacement current density. (10)

**SECTION - D**

4. (a) Derive the wave equations of a transmission line. Write down their general solution. (10)
- (b) A transmission line operating at 500 MHz has  $Z_0 = 80\Omega$ ,  $\alpha=0.04$  Np/m,  $\beta=1.5$  rad/m. Find the line parameters R, L, G and C. (10)

OR

- (a) Derive from its definition, the relation between characteristic impedance and primary constants. (10)
- (b) A  $500\Omega$  lossless line has  $V_L=10e^{j25^\circ}$  V,  $Z_L=50e^{j30^\circ}$ . Find the current at  $\lambda/8$  from the load. (10)

**SECTION - E**

5. (i) Write down the relation for the Cartesian to cylindrical transformation.
- (ii) Write the expression of gradient in spherical coordinate system.

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- (iii) Define line charge density.
- (iv) What are the limitation of Gauss law?
- (v) Write the relation between potential V and field intensity  $\vec{E}$ .
- (vi) Find the capacitance of a spherical conductor.
- (vii) How much is the energy stored in the capacitor?
- (viii) Write the Ampere's circuital law in differential form.
- (ix) Write the wave equations.
- (x) What is impedance matching? (2×10=20)