Registration No.: | | | | | | | | | | |

Total Number of Pages: 02 **Course: Integrated Dual Degree (B.Tech and M.Tech)**
Sub_Code: REL4D001/ REE4D001/ REC4C001

4th Semester Regular/Back Examination: 2023-24
SUBJECT: Electro Magnetic Theory
BRANCH(S): ELECTRICAL, EEE, ECE, ETC
Time: 3 Hour
Max Marks: 100
Q.Code: P090

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Answer the following questions:** **(2 x 10)**

a) D = (x + z) ay. Transform the vector to cylindrical and spherical coordinates.
b) State and prove divergence theorem.
c) State Gauss law and its application.
d) The finite sheet $0 \le x \le 1$, $0 \le y \le 1$ on the $z = 0$ plane has a charge density $\rho_s = xy(x^2 + y^2 + 25)^{3/2}$ nC/m^2. Find the total charge on the sheet.
e) Define a dielectric material and under what conditions it will be linear, homogeneous and isotropic.
f) What is equipotential surface and what is its use.
g) State Ampere circuit law. Using stoke theorem derive maxwell's third equation.
h) What are the boundary conditions that H or B must satisfy at the interface between two different media.
i) What is meant by skin effect? Mention its significance.
j) Describe in brief how an antenna radiates?

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 × 8)**

a) Define a vector. Given vectors $A = 3a_x + 4a_y + a_z$ and $B = 2a_y - 5a_z$. Find the angle between A and B.
b) Three field quantities are given by $P = 2a_x - a_z$, $Q = 2a_x - a_y + 2a_z$, $R = 2a_x - 3a_y + a_z$. Determine
(I) (P + Q) x (P – Q)
(II) Q.R x P
(III) The component of P along Q.
c) Define coulomb's law. Derive the force and electric field intensity on a point charge Q_2 due to the point charge Q_1.
d) Briefly explain any two applications of Gauss law.
e) Find the resistance of a spherical capacitor having inner radius 'a' and outer radius 'b', filled with a lossy dielectric having material parameters σ and ε.

f) A coaxial cable contains an insulating material of conductivity σ. If the radius of the central wire is 'a' and that of the sheath is 'b'. Show that the conductance of the cable per unit length is $G = 2\pi\sigma / \ln(b/a)$.

g) State and explain Poynting theorem.

h) Write Maxwell's Equations in Integral Form. Given the magnetic vector potential $A = \rho^2/4a_z$ Wb/m. Calculate the total magnetic flux crossing the surface $\phi = \pi/2$, $1 \le \rho \le 2m$, $0 \le z \le 5$.

i) If a transmission line of characteristic impedance 50 Ω is terminated in complex impedance 25 + j100 Ω, what will be the reflection coefficient and the VSWR of the line?

j) Suppose the input impedance to a line is $Z_{in} = (20 - j40)\Omega$ and the load impedance is $Z_L = (20 + j40)\Omega$. If the line has a characteristic resistance $R_C = 100\Omega$ and velocity of propagation of u = 250 m/μs and is operated at a frequency of 30 MHz, determine the length of the line using Smith chart.

k) A center-fed dipole antenna with a *z*-directed current has electrical length $L/\lambda << 1/30$.
(*a*) Show that the current distribution may be assumed to be triangular in form.
(*b*) Find the components of the vector magnetic potential **A**.

l) Determine the gain, beam width and capture area for a parabolic reflector antenna with 10 m diameter dish and dipole feed at 10GHz.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 Given point P(–2, 6, 3) and vector A = yax+ (x + z) ay, express P and A in cylindrical and spherical coordinates. Evaluate A at P in the Cartesian, cylindrical, and spherical systems. Express the vector $B = (10/r)a_r + r\cos\theta a_\theta + a_\phi$ in Cartesian and cylindrical coordinates. **(16)**

Q4 Describe the electric and magnetic boundary conditions in various interfaces. **(16)**

Q5 Derive the parameters related to the wave propagation in lossy and lossless dielectrics. How the polarization of a TEM wave is obtained? **(16)**

Q6 A 250 MHz 40 V peak signal is incident on a 72 Ω transmission line. The velocity factor for this line is 0.91. The line is 250m long and is terminated in a 200 Ω load. **(16)**

(a) Find the wavelength of the signal on line.
(b) What is the length of the line in wavelength?
(c) What is the SWR for this situation?
(d) Find the reflection coefficient.
(e) Calculate the peak value of reflected voltage.
(f) What percent of incident power is returned as reflected power?
(g) Find the peak values of incident and reflected currents and peak values of the currents at nodes and antinodes.
(h) Determine the peak values of the voltage standing wave at voltage nodes and antinodes.