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Roll No. | | | | | | | | | | |

B.Tech
(SEM III) THEORY EXAMINATION 2017-18
ELECTROMAGNETIC FIELD THEORY

Time: 3 Hours ***Total Marks: 100***

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.
2. Assume **bold** letters as vector quantity.

SECTION A

1. Attempt *all* questions in brief. 2 x10 = 20

a. State the divergence theorem. Calculate divergence of $\mathbf{P} = x^2yz\,\boldsymbol{a}_x + xz\,\boldsymbol{a}_z$
b. State the Gauss's law and derive the related Maxwell Equation.
c. Explain the circulation of Vector field.
d. Explain Electric potential. Write the relation between electric potential and electric field intensity.
e. What is Strokes's theorem? Write its mathematical interpretation.
f. Give the wave equation in terms of electric field and magnetic field.
g. Define Skin Depth and skin effect
h. Define and explain the term displacement current.
i. Explain voltage reflection coefficient and Define SWR or standing wave ratio.
j. What is a transmission line? Explain with examples.

SECTION B

2. Attempt any *three* of the following: 10 x 3 = 30

a) (i) Transform the vector 10 a_z at M(r=4, θ =110^0, $\phi = 120^0$) to spherical co-ordinate system.
(ii) Find the curl of a vector A= $(e^{-r}/r)a_\theta$.
(iii) The three vertices of a triangle are located at A(6,-1,2), B(-2,-3,-4) and at C (-3,1,5). Find the vector projection of $\mathbf{R_{AB}}$ on $\mathbf{R}_{AC}$.

b) Derive the expression using Gauss's Law for capacitance of a coaxial cylindrical capacitor having a charge Q uniformly distributed.

c) (i) Given the vector current density $\mathbf{J} = 10\rho^2 z\,\bar{a}_\rho - 4\rho\cos^2\phi\,\bar{a}_\phi$ mA/m^2, find
1) The current density at P(ρ=3, ϕ=30^0, z=2)
2) The total current flowing outward through the circular band ρ=3, 0<ϕ<2 π, 2<z<2.8.
(ii) Derive the Poisson's and Laplace's equations from Gauss's law for a linear material medium. Write the Laplace's equation in Cartesian, cylindrical, or spherical coordinates.

d) (i) Discuss some of the applications of transmission lines.
(ii) Given the electric flux density $\mathbf{D} = 0.3r^2\,\bar{a}_r$ nC/m^2 in free space:
1) Find **E** at point P(r=2, θ=25^0, ϕ=90^0)
2) Find the total charge within the sphere r=3
3) Find the total electric flux leaving the sphere r=4.

e) (i) State and explain the Maxwell's equation in differential and integral form.
(ii) A parallel-plate capacitor with plate area of 5 cm^2 and plate separation of 3 mm has a voltage 50 sin 10^3 t V applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\,\varepsilon_o$.

SECTION C

3. Attempt any *two* part of the following: 5 x 2 = 10

a) Express vector $\mathbf{B} = 10/r\ \boldsymbol{a}_r + r \cos 6\ \boldsymbol{a}_\theta + \mathbf{a}_\phi$ in Cartesian coordinate system.

b) Derive and obtain the differential normal areas in spherical coordinates.

c) Use the cylindrical Coordinate system to find the area of a curved surface on the right circular cylinder having radius 3m and height 6m, $\pi/3 <= \varphi <= 2\pi/3$.

4. Attempt any *one* part of the following: 10 x 1 = 10

a) Derive the various boundary conditions for static electric fields in the general form at the interface between two different dielectric media.

b) An infinite long line charge of uniform density ρ_L C/ cm is situated along the z-axis. Obtain the expression for the electric field intensity due to this line charge.

5. Attempt any *two* parts of the following: 5 x 2 = 10

(a) Explain and derive the **H** (or **B**) field must satisfy at the boundary between two different media 1 and 2, characterized respectively by μ_1 and μ_2 .

(b) Derive an expression for energy in a magnetostatic field in terms of **H** (or **B**) using the magnetic energy in the field of an inductor.

(c) A charged particle of mass 2 Kg and charge 1 C starts at the origin with velocity 3 $\mathbf{a}_y$ m/sec and travel in a region of B=10$\mathbf{a}_z$ T. at t= 4 sec. Calculate

(i) The velocity and the acceleration of the particle

(ii) The magnetic Force on it.

6. Attempt any *one* part of the following: 10 x 1 = 10

(a) Discuss the concept of Transformer and motional Electromotive forces.

(b) Explain the reflection of plane wave for the normal incidence. Define the Reflection and Transmission coefficient for **E** and **H**.

7. Attempt any *one* part of the following: 10 x 1 = 10

a) A 30m long lossless transmission line with $Z_o = 50\ \Omega$ operating at 2 MHz is terminated with a load $Z_L = 60 + j40\Omega$. If $u = 0.6c$ on the line, find

(i) The reflection coefficient Γ

(ii) The standing wave ratio s

(iii) The input impedance

b) What is Smith Chart? Using Smith Chart, find the input impedance of 75 Ω loss less transmission line of length 0.1λ, when the load is a short.