Subject Code: BEE301

PAPER ID-311626

Roll No: | | | | | | | | | | | | | |

BTECH
(SEM III) THEORY EXAMINATION 2024-25
ELECTROMAGNETIC FIELD THEORY

TIME: 3 HRS **M.MARKS: 70**

Note: Attempt all Sections. In case of any missing data; choose suitably.

SECTION A

1. Attempt *all* questions in brief. **2 x 07 = 14**

Q no.	Question	CO	Level
a.	For the scalar field $\emptyset(x,y) = x^2 sin5y$, calculate gradient of $\emptyset$.	1	K1
b.	Convert the cylindrical coordinates (3, 20°, 4) into its equivalent spherical coordinates.	1	K3
c.	What is the physical significance of Poisson and Laplace equation?	2	K1
d.	What is the magnetic flux density equation?	3	K1
e.	What is magnetic moment and torque?	4	K1
f.	Give applications of Smith chart.	5	K1
g.	What is displacement electric current?	5	K1

SECTION B

2. Attempt any *three* of the following: **7 x 3 = 21**

Q no.	Question	CO	Level
a.	Given point p (-2, 6, 3) and vector $\overrightarrow{\boldsymbol{a}}$ = yax (x z)ay, express **p** and $\overrightarrow{\boldsymbol{a}}$ in cylindrical and spherical coordinates. Evaluate $\overrightarrow{\boldsymbol{a}}$ at p in the Cartesian, cylindrical, and spherical systems.	1	K3
b.	A point charge Q is placed at the origin. Find the electrostatic energy stored outside the sphere of radius R centered at the origin	2	K2
c.	A single-turn circular coil of 50 m diameter carries a direct current of 28×10^4 A. Assuming Laplace's expression for the magnetizing force due to a current element, determine the magnetizing force at a point on the axis of the coil and 100 m from the coil. The relative permeability of the space surrounding the coil is unity.	3	K4
d.	Derive the expression for magnetic force on a current carrying loop, kept within the magnetic field.	4	K3
e.	A uniform plane wave propagating in a medium has $E = 2e^{-az}\sin(10^8t - \beta z)j$ V/m. If a medium is characterized by $\varepsilon_r = 1$, $\mu_r = 20$ and σ= 3 S/m, determine α, β and H.	5	K4

SECTION C

3. Attempt any *one* part of the following: **07 x 1 = 07**

Q no.	Question	CO	Level
a.	Show that the vector field $\mathbf{F} = yz^2\mathbf{i} + (xz^2+2)\mathbf{j} + (2xyz-1)\mathbf{k}$ is conservative by finding a scalar potential.	1	K1
b.	Given $A = r^2 a_r + \sin\theta a_\Phi$, determine the net outward flux through the closed hemispherical surface defined by ($0 \le r \le 5$), ($0 \le \theta \le 2$) and ($0 \le \Phi \le 2\pi$).	1	K3

PAPER ID-311626

Roll No: | | | | | | | | | | | | | |

BTECH
(SEM III) THEORY EXAMINATION 2024-25
ELECTROMAGNETIC FIELD THEORY

TIME: 3 HRS **M.MARKS: 70**

4. Attempt any *one* part of the following: 07 x 1 = 07

Q no.	Question	CO	Level
a.	A metallic sphere of radius 2 m is charged in air to a potential of 3000 V. Calculate the energy stored in the sphere.	2	K3
b.	A wire of diameter 1 mm and conductivity 5 x 10^7 S/m has 1029 free electrons per cubic meter when an electric field of 10 mV/m is applied. Find: - (i) Charge density of free electrons (ii) Current density (iii) Current in the wire	2	K4

5. Attempt any *one* part of the following: 07 x 1 = 07

Q no.	Question	CO	Level
a.	A 100 turn closely wound circular coil of radius 10 cm carries a current of 3.2 A. The coil has a moment of inertia 0.1 kg $(m)^2$. The coil is placed in a vertical plane and is free to rotate about a horizontal axis which coincides with its diameter. A uniform magnetic field of 2 T in the horizontal direction exists such that initially the axis of coil is in the direction of the field. The coil rotates through an angle of 90 degrees under the influence of magnetic field. What is the angular speed acquired by the coil when it has rotated by 90 degrees?	3	K4
b.	How did the Biot-Savart law state that B is directly proportional to the sin of the angle θ between the line joining the point?	3	K3

6. Attempt any *one* part of the following: 07 x 1 = 07

Q no.	Question	CO	Level
a.	The direction of the current in a copper wire carrying a current of 6.00 A through a uniform magnetic field with a magnitude of 2.20T is from the left to the right of the screen. The direction of the magnetic field is upward-left, at an angle of θ = 3π/4 radians from the current direction. Determine the magnitude and direction of the magnetic force acting on a 0.100 m section of the wire.	4	K4
b.	Explain the ampere circuital law. Derive two applications of ampere circuital law. Also, derive modified Maxwell's equations	4	K3

7. Attempt any *one* part of the following: 07 x 1 = 07

Q no.	Question	CO	Level
a.	The sinusoidal electric field with E_0 = 250 v/ m and frequency f= 1 G Hz exists in a lossy dielectric medium with E_r = 2.5 and loss tangent of 0.001. Find the average power dissipated in the medium per cubicmeter.	5	K4
b.	Derive and explain the mathematical form of Poynting theorem.	5	K3