Name & Roll No.:

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL
Department of ECE
Mid Examinations : AY 2023-24 –Feb./Mar. 2024

Date: 28/02/2024 Marks: 30 Duration: 120 min

Program: BTech, ECE	**Class:** II year II Sem	**Section: A**
Course Name: Electromagnetic Fields and Waves	**Course Code:** EC253	

Note: Attempt all the questions. Each question carries equal marks.

1. Three identical small spheres of mass m are suspended from a common point by threads of negligible masses and equal length ℓ. A charge Q is divided equally among the spheres, and they come to equilibrium at the corners of a horizontal equilateral triangle whose sides are d. show that

$$Q^2 = 12\pi\varepsilon_o mgd^3\left[\ell^2 - \frac{d^2}{3}\right]^{-1/2}$$

where g = acceleration due to gravity [05 M]

2. Planes $x = 2$ and $y = -3$, respectively, carry charges of 10 nC/m^2 and 15 nC/m^2. If the line $x = 0,\ z = 2$ carries charge of 10π nC/m, calculate **E** at (1, 1, -1) due to the three charge distributions. [05 M]

3. Two dipoles with dipole moments $-5a_z\ nC/m$ and $9a_z\ nC/m$ are located at points $(0, 0, -2)$ and $(0, 0, 3)$, respectively. Find the potential at the origin. [05 M]

4. For a polarized dielectric, derive the expression for bound surface and volume charge densities.

$$\rho_{ps} = \mathbf{P} \cdot \mathbf{a}_n$$
$$\rho_{pv} = -\nabla \cdot \mathbf{P}$$

[05 M]

5. Derive the expressions for tangential and normal components of electric field **E** and electric flux density **D** at conductor-dielectric boundaries. [05 M]

6. Two conducting cones ($\theta = \pi/10$ *and* $\theta = \pi/6$) of infinite extent are separated by an infinitesimal gap at r = 0. If $V(\theta = \pi/10) = 0$ and $V(\theta = \pi/6) = 50\,V$, find V and **E** between the cones. [05 M]

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Date: 28/02/2024 Marks: 30 Duration: 120 min
10:00AM – 12:00 NOON

Program: BTech, ECE	**Class:** II year II Sem	**Section: B**
Course Name: Electromagnetic Waves and Fields	**Course Code:** EC253	

Note:
1. Answer all questions
2. Assume necessary data

1 a) A uniform line charge density of positive polarity ρ_l characterizes a ring of charge of radius b. The ring resides in free space and is positioned in the x-y plane. Determine the electric field intensity at a point (0, 0, h) along the axis of the ring at a distance h from its center. 4M

b) A 50-cm length of coaxial cable has an inner radius of 1 mm and an outer radius of 4 mm. The space between conductors is assumed to be filled with air. The total charge on the inner conductor is 30 nC. Determine the charge density on each conductor, E field, and flux density. 4M

c) Explain the significance of Grad and Divergence operators. 2M

2 a) Verify the divergence theorem for the vector field D leaving the cube's surfaces, given $D = xy^2 a_x + y^3 a_y + y^2 z a_z$. The cube has one corner at (0,0,0) and a diagonally opposite corner at (1,1,1). 4M

b) Explain the electrostatic boundary conditions at the dielectric-dielectric interface. 6M

3 a) Derive the expression for the point form of Kirchhoff's current law. 4M

b) A long coaxial cable is filled with a dielectric of permittivity $\varepsilon = 2\varepsilon_0$. The radii of the inner and outer conductors of the cable are $a = 0.5$ mm and $b = 3$ mm, respectively. If the potential difference between the inner and outer conductors is $V = 10$V, determine the capacitance for a cable of 1m in length, current density, and dissipated energy per unit length of the cable. 6M

Program: BTech, ECE	Class: II year II Sem	Section: C
Course Name: Electromagnetic Fields and Waves	Course Code: EC253	

Answer ALL questions
(Any missing data assume appropriately)

1	Medium 1 $(z<0)$ is filled with a material whose $\varepsilon_r = 4$, and medium 2 $(z>0)$ is filled with a material whose $\varepsilon_r = 6$. The electric field density in medium 2 is $E_2 = 5a_x + 10a_z\ V/m$. Find E_1 and D_1 in medium 1.	5M
2	Derive the boundary condition for static electric field and steady magnetic field for dielectric- dielectric and conductor and dielectric boundary conditions.	5M
3	Derive poisons and Laplace equations. Find the capacitance, potential difference, electric field intensity, electric flux density for the boundary conditions at ϕ=0deg, V=0 volts and at ϕ=45deg, V=5volts.	5M
4	A charge distribution with spherical symmetry has volume charge density given below. Find E every where $\rho_v = \frac{5r}{R}$ 0<r<R, $\rho_v = 0$ $r \geq R$	5M
5	Define and derive potential gradient. Given the potential V =($10/r^2$)sin θ cos ϕ, Find the electric flux density D at (2, π/2, 0).	5M
6	Define amperes law and verify. Planes Z = 0 and Z= 4 carry current K = -10a_x A/m and K = 10a_x A/m, respectively. Determine H at (a) (1,1,1) (b) (0, -3 , 10)	5M

NATIONAL INSTITUTE OF TECHNOLOGY, WARANGAL
(An Institution of National Importance)
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGG
MID SEMESTER EXAMINATION, MARCH 2023
II B. Tech. ECE - II semester (Sec A and B)
ELECTROMAGNETIC FIELDS AND WAVES

Date: 29-03-2023 Time: 5.30 PM - 7.00 PM Max. Marks: 30

N.B.: Answer ALL questions
Answers to all parts of each question should be at one place.
Do not leave the examination room before 7:00 PM

1 Medium 1 ($z < 0$) is filled with a material whose $\varepsilon_r = 4$, and medium 2 ($z > 0$) is filled with a material whose $\varepsilon_r = 6$. The electric field density in medium 2 is $E_2 = 5a_x + 10a_z\ V/m$. Find E_1 and D_1 in medium 1. 5M

2 State and mention Maxwell's equations in differential and integral forms. 7.5M

3 Define the attenuation constant, propagation constant, wavelength, phase velocity, and intrinsic impedance of a plane wave for a good conductor. 10M

A large copper conductor ($\sigma = 58MS/m \quad \varepsilon_r = 1, \mu_r = 1$) supports a 60Hz plane wave. Compute the attenuation constant, propagation constant, intrinsic impedance, wavelength, and phase velocity of propagation

4 Define and derive the Poynting vector and Poynting theorem. 7.5M

In free space, E= $5cos(\omega t - \beta x)a_y$ V/m. Find the total power passing through a circular disk of radius 5 cm on x=1 plane

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