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BMS College of Engineering, Bangalore-560019

(Autonomous Institute, Affiliated to VTU, Belgaum)

December 2016 Semester End Main Examinations

Course: FIELDS AND WAVES — Duration: **3 hrs**
Course Code: **15ES3GCFAW** — Max Marks: **100**

Date: 22.12.2016

Instructions: Answer 5 full questions.

UNIT 1

1	a	Point charges 1mC and -2mC are located at (3, 2, -1) and (-1, -1, 4) respectively. Calculate the electric force on a 10nc charge located at (0, 3, 1) and the electric field intensity at that point.	6
	b	Define EFI, also derive an expression for EFI at a general point due to point charge in vector form.	10
	c	Given that $D = z\rho\cos^2\phi\ a_z\ C/m^2$, calculate the charge density at $(1, \pi/4, 3)$ and the total charge enclosed by the cylinder of radius 1m with $-2 \le z \le 2$m.	4

OR

2	a	Two point charges -4μC and 5 μC are located at (2,-1, 3) and (0, 4,-2) respectively. Find the potential at (1, 0, 1) assuming zero potential at infinity.	5
	b	Given the potential $V = \frac{10}{r^2}\ sin\theta\ cos\phi$, (a) Find the electric flux density D at (2, π/2,0) and (b) Calculate the work done in moving a 10 μC charge from point A$(1,30^0,120^0)$ to B $(4,90^0,60^0)$.	5
	c	Discuss the boundary conditions of a dielectric to dielectric interface.	6
	d	Determine the capacitance of a coaxial capacitor.	4

UNIT 2

3	a	A circular loop located on $x^2 + y^2 = 9, z = 0$ carries a direct current of 10A along a_ϕ. Determine H at (0,0,4) and (0,0,-4).	5
	b	Determine the magnetic field intensity of an infinite sheet of current using Ampere circuit law.	7
	c	Given the magnetic vector potential A=$-\frac{\rho^2}{4}\ a_z$ Wb/m, calculate the total magnetic flux crossing the surface $\phi = \frac{\pi}{2}, 1 \le \rho \le 2m, 0 \le z \le 5m$.	3
	d	Determine the force exerted on a charged particle.	5

UNIT 3

4	a	A parallel plate capacitor with plate area of 5cm^2 and plate separation of 3mm has a voltage $50\sin10^3$t volts applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$.	4
	b	Explain the concept of displacement current density and show that for time varying fields, $\nabla \times H = J + \frac{\partial D}{\partial t}$	8

	c	Write the Maxwell's equations in integral form and differential form for time varying fields.	4
	d	In a medium characterized by $\sigma = 0, \mu = \mu_0, \epsilon_0$, and E=20sin($10^8$t-βz)$a_y$ V/m. Calculate H.	4

UNIT 4

5	a	Discuss the wave propagation in good conductors.	8
	b	A uniform plane wave propagating in a medium has E=$2e^{-\alpha z}\sin(10^8 t - \beta z)\, a_y$ V/m. If the medium is characterized by $\mu_r = 20, \epsilon_r = 1\ and\ \sigma = 3\ mhos/m$, find α, β and H.	7
	c	State the poynting theorem and prove that $P_{avg}(z) = \frac{1}{2}\,\mathrm{Re}(E \times H^*)$	5

UNIT 5

6	a	Given a uniform plane wave in air as $E_i = 40\cos(\omega t - \beta z)\,\hat{a}_x + 30\sin(\omega t - \beta z)\hat{a}_y$ V/m. (a) Find H_i (b) If the wave encounters a perfectly conducting plate normal to the z axis at z=0, find the reflected wave E_r and H_r. (c) What are the total E and H fields for $z \leq 0$ (d) Calculate the time average pointing vectors for $z \leq 0$ and $z \geq 0$.	10
	b	Explain the terms reflection coefficient and transmission coefficient and obtain the relationship between them.	4
	c	In free space ($z \leq 0$), a plane wave with $H = 10\cos(10^8 t - \beta z)\,\hat{a}_x$mA/m is incident normally on a lossless medium ($\mu = 8\mu_0, \epsilon = 2\epsilon_0$) in region $z \geq 0$. Determine the reflected wave H_r and E_r.	6

OR

7	a	A uniform plane wave in air with $E = 8\cos(\omega t - 4x - 3z)\,\hat{a}_y$ V/m is incident on a dielectric slab $z \geq 0$ with $\mu_r = 10, \epsilon_r = 2.5\ and\ \sigma = 0$. Find (a) The polarization of the wave (b) The angle of incidence (c) The reflected E field (d) The transmitted H field	10
	b	Discuss the reflection of a plane wave at oblique incidence angles.	10

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