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PES UNIVERSITY

PES University, Bangalore

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UE14EC205

END SEMESTER ASSESSMENT (ESA) B.TECH. III SEMESTER- Dec. 2015

UE14EC205- ELECTROMAGNETIC FIELD THEORY

Time: 3 Hrs | Answer All Questions | Max Marks: 100

1.	a)	Obtain the vector in Cartesian coordinates that extends from P(r=4,θ=20°,φ=10°) to Q (r=7,θ=120°,φ=75°) and then find the unit vector $\mathbf{a}_{PQ}$.	4
	b)	State Coulomb's law along with mathematical expression and find the electric field intensity **E** at a point on y axis due to an infinite line charge of charge density ρ_LC/m placed on z axis.	5
	c)	State Gauss's law along with mathematical expression and use the same to find the electric flux density **D** at r ≥ a and r ≤ a due to a charged sphere of radius 'a' with uniform charge density of ρ_0 C/m^3 .	5
	d)	What is an electric dipole and dipole moment? Assuming an electric dipole at the origin obtain an expression for potential V at a far off point P(r,θ,φ) and then find **E** at P.	6
2.	a)	Derive Continuity Equation from the principle of conservation of charges and obtain expression for relaxation time after defining the same.	5
	b)	Consider the interface between conductor and dielectric having permittivity ε. Assuming the conductor to be perfect obtain the boundary conditions for both tangential E and normal component of electric flux density D. Obtain also the boundary conditions for Conductor and free space interface.	6
	c)	Find the capacitance of two concentric spherical shells filled with a dielectric of ε_r=9 between the shells, the radii of the inner shell being a= 2cm and that of the outer shell b= 6cm.	4
	d)	Verify Laplace's Equation given the potential field V= 100(ρ-(1/ρ))cosφ volts.	5
3.	a)	State Biot Savart Law and derive the mathematical expression assuming vector potential $A=\int_L \mu_0 Idl/(4\pi R)$ where R is the distance vector for the line element dl' at the source point (x',y',z') to the field point (x,y,z)	6
	b)	Evaluate both sides of Stoke's Theorem for the magnetic field **H** =10sinθ$\mathbf{a}_\varphi$ A/m. The surface is specified by r=3,0 ≤ θ ≤ π/2 ; 0 ≤ φ ≤ π/2; closed path forming its perimeter is composed of three circular arcs; θ= π/2, φ=0toπ/2; θ=0toπ/2, φ= π/2; θ=0 to π/2, φ= 0; at r=3.	8
	c)	A certain magnetic field intensity in free space is given by **H**= $(x\mathbf{a}_x+y\mathbf{a}_y) / (x^2+y^2)$ A/m. Find the current density **J** and magnetic vector potential **A** if i) $A_x = A_y=0$, and ii) A_z=0 at P(1,1,1) .	6
4.	a)	A point charge Q= 5x10^{-18}C is moving through an uniform field **B**= - 0.4$\mathbf{a}_x$ + 0.2$\mathbf{a}_y$ - 0.1$\mathbf{a}_z$ Wb/m^2 with a velocity of **v** = (2$\mathbf{a}_x$ - 3$\mathbf{a}_y$ + 6$\mathbf{a}_z$)x10^5 m/s at t=0. i)Find the electric field intensity **E** at t=0 if the net force on the charge is zero ii) If **E** is entirely in x direction and the magnitude of the net force is 2pN at t=0 find E_x.	5
	b)	In a magnetic boundary problem given that $\mathbf{H}_1$= - 2$\mathbf{a}_x$+ 6$\mathbf{a}_y$ + 4$\mathbf{a}_z$ A/m in the region y–x–2 ≤ 0 where μ_1=5 μ_0. Calculate i) Magnetization $\mathbf{M}_1$ and $\mathbf{B}_1$ and ii) $\mathbf{H}_2$ and $\mathbf{B}_2$ in the region y–x–2≥ 0 where μ_2=2 μ_0.	6
	c)	Derive the expression for displacement current density starting from Ampere's Law and list the Maxwell's Equations in differential form.	5
	d)	In free space the magnetic field of an EM wave is given by **H**=0.5ωε$_0$cos(ωt-50x) $\mathbf{a}_z$ A/m. Find the displacement current density.	4
5.	a)	An Electromagnetic wave propagating in a lossy dielectric medium is characterized by μ_r=4, ε_r=2.5 , σ = 10^{-3} mho/m at 10 MHz. Find attenuation constant α, phase constant β, velocity of propagation v and wave impedance η.	6
	b)	Derive Poynting Theorem starting from Maxwell's Equations for an Electromagnetic Wave propagating in a medium	5
	c)	What is skin depth and obtain its relation with attenuation and phase constants α and β. Calculate the skin depth of copper σ= 5.8x10^7 S/m at 10 GHz.	5
	d)	A plane wave propagating along z direction is incident **normally** on the boundary z=0 between medium 1 (z < 0) characterized by σ_1=0, ε_{r1}=9 , μ_{r1} =1 and medium2 (z>0) which is free space. Determine the transmission and reflection coefficient at the boundary.	4