

--	--	--	--	--	--	--	--	--	--

Fourth Semester B.E. Degree Examination, Dec.2018/Jan. 2019

Field Theory

Time: 3 hrs.

Max. Marks:100

Note: Answer any FIVE full questions, selecting at least TWO questions from each part.

PART – A

- 1
 - a. State and explain Gauss's law. (06 Marks)
 - b. A line charge densities of 24 nc/m is located in free space on the line $y = 1, z = 2$.
 - i) Find E at p(6, -1, 3)
 - ii) What point charge Q_A should be located at Q(-3, 4, 1) to cause E_y to be equal to zero at point P. (08 Marks)
 - c. A vector field $\bar{D} = \left(\frac{5r^2}{4}\right) \bar{a}_r$ given in spherical coordinates. Evaluate both sides of divergence theorem for the volume enclosed between $\theta = 0^\circ$ to $\theta = \frac{\pi}{4}$ and $r = 4m$. (06 Marks)
- 2
 - a. Show that the vector electric field intensity E is the negative gradient of scalar electric potential V. (06 Marks)
 - b. Obtain the boundary conditions between the two dielectric materials of permittivities ϵ_1 and ϵ_2 . (08 Marks)
 - c. Give $V = 2x^2y - 5z$ at point p(-4, 3, 6). Find the potential, electric field intensity and volume charge density. (06 Marks)
- 3
 - a. State and prove uniqueness theorem. (08 Marks)
 - b. Two concentric conducting spheres have radius of 3cm and 5cm. The region between them is filled with a homogeneous dielectric for which $\epsilon_r = 5$. If the potential of the inner sphere is 100 volts while that of the outer sphere is -100 volts, find :
 - i) V
 - ii) \bar{E}
 - iii) \bar{D}
 - iv) the value of r at which $V = 0$. (08 Marks)
 - c. If a potential $V = x^2yz + Ay^3z$, find :
 - i) The value of 'A', so that V satisfies the Laplace's equation
 - ii) With the value of 'A' determine electric field at (2, 1, -1). (04 Marks)
- 4
 - a. Using Biot-Savart law, obtain the magnetic field intensity expression due to an infinite length conductor carrying current I amps along Z – direction. (06 Marks)
 - b. Discuss the concept of scalar and vector magnetic potential. (08 Marks)
 - c. In cylindrical coordinates a magnetic field is given as $H = [2\rho - \rho^2] \bar{a}_\phi$ A/m.
 - i) Determine the current density
 - ii) What total current passes through the surface $z = 0, 0 \leq \rho \leq 1$ in the \bar{a}_z direction. (06 Marks)

PART – B

- 5 a. Derive an expression for the force on a differential current carrying element. (06 Marks)
- b. A current filament carrying 8 A in the \bar{a}_z direction lies along the entire z – axis in free space. A rectangular loop connecting A(0, 0.2, 0) to B(0, 0.2, 0.3) to C(0, 0.7, 0.3) to D(0, 0.7, 0.2) to A lies in the $x = 0$ plane. The loop current is 3mA and it flows in the \bar{a}_z direction in the AB segment.
- Find F on the AB segment
 - Find F on the side DA
 - Find F_{total} on the loop. (08 Marks)
- c. Define mutual inductance. Calculate the inductance of 400 turns wound on a solenoid with 10cm diameter and 50cm length. Assume that solenoid is in air. (06 Marks)
- 6 a. What is inconsistency of Ampere's law with the equation of continuity? Derive the modified form of Ampere's law of Maxwell. (08 Marks)
- b. Starting from Faraday's law of electromagnetic induction derive $\nabla \times \bar{E} = -\frac{\partial \bar{B}}{\partial t}$. (06 Marks)
- c. For the lossy dielectric $\sigma = 5$ s/m and $\epsilon_r = 1$. The electric field intensity is $E = 100 \sin 10^{10}t$. Find J_C , J_D and frequency at which both have equal magnitude. (06 Marks)
- 7 a. Determine the relation between E and H of an EM wave travelling in z – direction. (10 Marks)
- b. Obtain the solution of wave equation for uniform plane wave propagating in free space. (10 Marks)
- 8 a. With necessary equations, explain standing wave ratio. (10 Marks)
- b. A 100 V/m, 3 GHz wave is propagating in material having $\epsilon_{R1} = 4$, $\mu_{R1} = 1$ and $\sigma = 0$. It is normal to another perfect dielectric in region 2, $z > 0$, where $\epsilon_{R2} = 9$, $\mu_{R2} = 1$. Calculate, phase constants, coefficient of reflection, transmission and standing wave ratio. (10 Marks)
