VIT
Vellore Institute of Technology

Final Assessment Test – November 2019

Course: ECE1003 - Electromagnetic Field Theory

Class NBR(s): 0572 / 0575 / 0580 / 0586 / 0597 / 0599/ 6817 Slot: F1+TF1

Time: Three Hours Max. Marks: 100

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS EXAM MALPRACTICE

Answer ALL Questions

(10 X 10 = 100 Marks)

1. Let $\vec{A} = \rho \sin\phi \, \hat{a}_\rho + \rho^2 \hat{a}_\phi$. Verify the Stokes's theorem for the contour given in the Figure 1. [10]

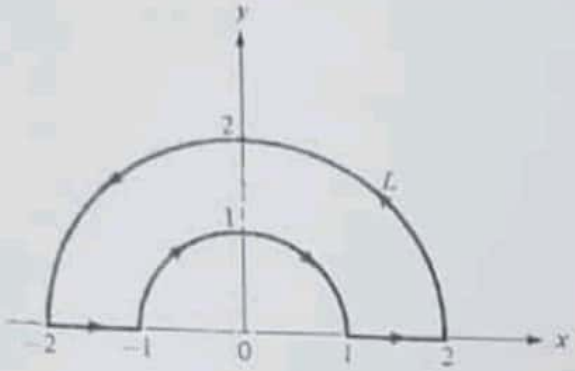

Figure 1

2. Calculate $\vec{D}$ in rectangular coordinates at point P(2,-3,6) produced by: [10]
   i) a point charge of 55 mC at Q (-2,3,-6);
   ii) a uniform line charge of 20 mC/m on the x axis;
   iii) uniform surface charge density of 120 μC/m² on the plane z = -5m.

3. a) If $V = 60\sin\theta/r^2$ V in free space and a point P located at r =3m, $\theta = 60^0$, $\phi = 25^0$, Find [5]
   i) V_p the potential at P, and
   ii) E_p the electric field at P.

   b) Find the energy stored in free space for the region, $0 < \rho < a$, $0 < \phi < \pi$, $0 < z < 2$, given the potential field in volts, $V = \frac{V_0 \rho}{a}$ [5]

4. Given a potential $V = x^2yz + Ay^3z$. Find the value of A so that Laplace equation is satisfied at (2,-2,1). Also find the electric field at this point. [10]

5. The interface between a dielectric medium having relative permittivity 4 and free space is marked by the y=0 plane. If the electric field in the free space region is given by $\vec{E} = 5\hat{a}_x + 12\hat{a}_y + \hat{a}_z$ V/m, determine: [10]
   i) The electric field on the other side of the interface,
   ii) Angle made by $\vec{E}$ with respect to normal to boundary.

6. Conducting cylinders lie at $\rho = 3$ and 12mm; both extend from z=0 to z=1m. Perfect dielectrics occupy the interior region: ε_r=1 for $3mm < \rho < 6$ mm, ε_r=4 for $6 < \rho < 9$ mm, and ε_r=8 for $9 < \rho < 12$ mm. Calculate the capacitance. [10]

7. An infinitely long conductor is bent into an *L* shape as shown in figure 2. If a direct current of 5A flows in the conductor, find the magnetic field intensity at the points [10]

i) (2,2,0)

ii) (0,-2,0).

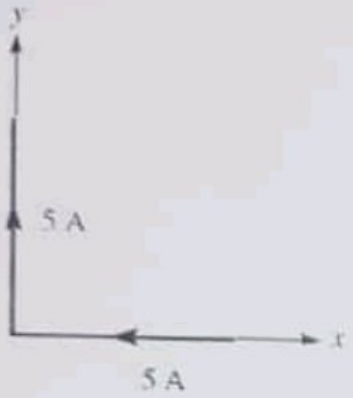

Figure 2

8. The solenoid shown in Figure 3 contains 400 turns, carries a current *I*=5A, has a length of 8cm, and a radius *a*=1.2 cm. [10]

i. Find $\vec{H}$ within the solenoid.

ii. If V_m=0 at the origin, specify $V_m(\rho,\phi,z)$ inside the solenoid.

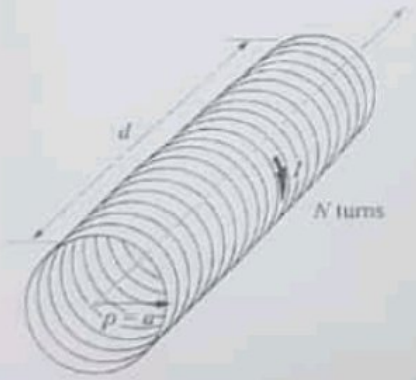

Figure 3

9. a) The magnetic flux density in a region of free space is given by $\vec{B} = -3x\hat{a}_x + 5y\hat{a}_y - 2z\hat{a}_z$ T. Find the total force on a rectangular loop which lies in the plane *z*=0 and is bounded by *x*=1, *x*=3, *y*=2, *y*=5 (all dimensions in *cm*) and which carries a current of 30 A. [6]

b) Find the magnetic field intensity within a magnetic material where: [4]

i. M=150 A/m and μ=1.5x10^{-5} H/m

ii. B=300 μT and χ_m=15

10. A plane wave in a nonmagnetic medium has $\vec{E} = 50\sin(10^8 t + 2z)\hat{a}_y$ V/m. Find [10]

i. The direction of wave propagation

ii. λ, f, and ε, wavelength, frequency and relative permitivity

iii. $\vec{H}$ magnetic field