Mansoura University
Faculty of Engineering
Dept. of Electrical Engineering

First Year Electrical (old)
Electromagnetic Fields (1)
Time: THREE Hours

امتحان تخلفات يونيو ٢٠١١

الامتحان من جزأين: من فضلك أجب كل جزء من الامتحان فى اتجاه مختلف من ورقة الإجابة

Answer the following questions

First Question (Total 20 marks)

Answer only TWO of the following questions

1-a) A two plate capacitor, has an angle between the plates equal to $\pi/4$. The potential of one plate is V_0, while the other plate is earthed ($V = 0$). Calculate:
   i) the electric potential and the electric field intensity, everywhere inside the capacitor,
   ii) the capacitance per unit length, and
   iii) the energy stored per unit length.

1-b) A rectangular coordinate system is divided into two regions. Region 1 has $y<0$ band is occupied by a dielectric having relative permittivity $\varepsilon_{r1} = 2$ whereas region 2 has $y>0$ and is occupied by a dielectric having relative permittivity $\varepsilon_{r2} = 9$. If the electric field in region 1 at $y = 0$ is given by $E = 2a_x + 3a_y - 4a_z$. Determine E and D in region 2 at the interface

1-c) A coaxial power cable, having a core radius of r_1, is filled with two concentric layers of dielectric ε_1, ε_2 with radius r_2 and r_3 (r_3 is the outer radius of the cable). If the inner conductor have a surface charge density ρ_s C/m^2 and the outer conductor have a surface charge density $-\rho_s$ C/m^2.
   Calculate the electric flux density **D**, the electric field intensity **E**, and the electric potential **V**, everywhere.

1-d) A charge density of ρ_s C/m^2 is uniformly spread over the area of a disk of radius a. Evaluate the electric potential function at any point placed a distance from the center of the disk and on a line that is perpendicular to the disk.

Second Question (Total 18 marks)

2-a) **State** Gauss' Law, and **express** it in a mathematical form

2-b) **Prove** Poisson's Equation for a homogeneous region. **State** the uniqueness theorem for solving the equation

2-c) **State:** a) the divergence theorem   b) the Stokes' theorem.
   Express both theorems in mathematical form.

Third Question (Total 18 marks)

3-a) Verify the divergence theorem for a vector field given by: $A = 4xy\, a_x + 2a_y + z^2 y\, a_z$ over a cube with sides of unit area and its bottom corner lies on the origin (0,0,0).

3-b) Consider the vector field $F = a_x + z\, y^2\, a_y$. **Verify the Stokes' theorem** for this vector field and the flat surface in the y-z plane bounded by [0,0,0], [0,1,0], [0,1,1], and [0,0,1].

3-c) A volume charge distribution is contained in a region defined in cylindrical coordinates as $0 < z < 2$ m, $0 < r < 1$ m and $45^o < \phi < 90^o$. Determine the total charge contained in the region.

Best Wishes

Prof. Dr. Magdi El-Saadawi