Benha University
Faculty of Engineering- Shoubra
Electrical Engineering Department
Second Year Communication

Final Term Exam
2016 - 2017
EM Fundamentals
Duration : 3 hours

- Answer all the following question
- Illustrate your answers with sketches when necessary.
- The exam. Consists of two pages
- No. of questions: 6
- Total Mark: 90 Marks
- The first page

1) a- If $\bar{A}$, $\bar{B}$, $\bar{C}$ are vectors, and d is a scalar.
Show why each of the following products is True or False.
(i) $\bar{A}.\bar{B}.\bar{C}$ (ii) $\bar{A}X\bar{B}X\bar{C}$ (iii) $\bar{A}.\bar{B}.d$ (iv) $\bar{A}X\bar{B}Xd$ (v) $(\bar{A}.\bar{B})d$

b- Define and explain the concept of $\nabla f, \nabla.\bar{F}, \nabla\times\bar{F}$, and then derive an expression for ∇f, showing its magnitude and direction at any point.

c- State and prove the first Maxwell's equation for electrostatic field.

d- A vector field is given by $\bar{F} = r\ \bar{a}_r$, show that if it is solenoidal or not. Verify the divergence theorem over the closed surface of a shpere of radious R.

(15 Marks)

2) a- A point charge Q_1 = 300 μc located at (1, -1, -3) m experiences a force: $\bar{F} = 8\bar{a}_x - 8\bar{a}_y + 4\bar{a}_z$ N, due to charge Q_2 at (3, -3, -2) m. Determine Q_2

b- A vector field is given by: $\bar{F} = r\cos\phi\ \bar{a}_r$, show that if it is rotational field or not, and then verify the Stokes' theorem over the surface enclosed by , $30^o \le \phi \le 60^o$, $2 \le r \le 5$, z = 0, and the circulation in the direction of positive z. Sketch the required surface.

c- A uniform line charge of 3 μc/m lies along z-axis, and a concentric circular cylinder of radius a = 2m, has (-1.5 / 4π) μc/m^2. Determine the electrostatic flux density at all regions. **(15 Marks)**

3) a- Develop an expression for the energy stored in static electric field.

b- A uniform plane charge with 40 μc/m^2 is located at z = -0.5 m and a uniform line charge of -6 μc/m lies along the y-axis. What net flux crosses the surface of a cube 2 m on an edge, centered at the origin.

c- If a ring of radius a is charged uniformly and lies on the z = 0 plane with its center at the origin. Show the potential and the electrostatic field intensity along the z-axis and then find the force on a point charge Q along the z-axis.

d- Determine the energy stored in a cube of 2 m side and its center lies on the origin and V=8x + 6y volt.

(15 Marks)

Good Luck
Dr. Hanaa M. Raafat

4) (a) Atomic hydrogen contains 5.5×10^{25} atoms/m^3 at a certain temperature and pressure. When an electric field of 4 kV/m is applied, each dipole formed by the electron and positive nucleus has an effective length of 7.1×10^{-19} m. Find
   1. The net dipole moment (P).
   2. The dielectric constant (ε_r).

   (b) For a point charge Q = 25 nC lies at (3,4,6)
   1. Find $\overline{E}$ at (2,1,0).
   2. Find ρ_s at (2,1,0) when a grounded conducting plate is places at z = 0.

   (c) Two perfect dielectrics have relative permittivities $\varepsilon_{r1} = 2$ and $\varepsilon_{r2} = 8$. The planar interface between them is the surface x – y + 2z = 5. The origin lies in region 1. If $E_1 = 100\hat{a}_x + 200\hat{a}_y - 50\hat{a}_z$ V/m, find E_2.

(15 Marks)

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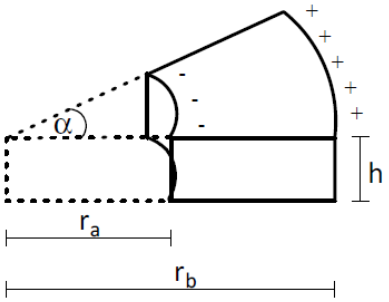
5) (a) The potential $V = 2x + 4y - 2z$ volt exists in free surrounding a perfectly conducting surface. Point P(4,3,2) lies on the surface.
   1. Give the equation of the surface.
   2. Find the unit vector normal to the surface at P.

   (b) Find the capacitance between the curved plates shown in the figure.



(12 Marks)

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6) (a) Discuss briefly Gauss' Law for the magnetic field, and then compare it with that of the electric field.
   (b) A current filament carrying 15 A in the $\boldsymbol{a}_z$ direction lies along the entire *z* axis. Find **H** in rectangular coordinates at point P (2,-4, 4).
   (c) Define the self-inductance, then derive an expression for the self-inductance of a long solenoid of *N* turns, radius *a*, and length *L*.

(18 Marks)

Good Luck
Dr. Sherif S. Hekal