Ministry of Higher Education and Scientific Research Faculty of Engineering Kafrelsheikh University	كلية الهندسة	وزارة التعليم العالي و البحث العلمى كلية الهندسة جامعة كفر الشيخ

First-term Examination of Academic Year 2019/2020		
Department: Electrical Engineering	**Year: Second year**	**Total Marks: 90**
Course Title: Electromagnetic Fields	**Course Code: EPM 2103**	**Term: First Term**
Date: Jan 6 - 2020	**Number of questions: 5**	**Allowed Time:** 180 Minutes

Answer the following questions

Illustrate your answers with sketches when necessary

Question 1 (15 Marks)

A. Three vertices of a triangle are located at A $(5, 0^o, 3)$, B $(5, 45^o, 3)$, and C $(5, 90^o, 3)$ and are expressed in cylindrical coordinates. Find a unit vector perpendicular to the plane in which the triangle is located in Spherical coordinates. (5 Marks)

B. A vector field $\underline{S}$ is expressed in rectangular coordinates as $\underline{S} = \{100/[(x-1)^2 + (y-2)^2 + (z+1)^2]\}\{(x-1)\hat{\underline{a}}x + (y-2)\hat{\underline{a}}y + (z+1)\hat{\underline{a}}z\}$.

I. Determine a unit vector that gives the direction of S at P (2, 4, 3). (5 Marks)

II. Specify the surface $f(x, y, z)$ on which $|\boldsymbol{S}| = 1$. (5 Marks)

Question 2 (20 Marks)

A. Find $\underline{E}$ at the origin caused by four charges of −0.3μC, 5μC, 0.3μC, and 5μC located at $r\varphi$ and $\theta = 90^o$ plane at points, $P1(5, 0^o), P2(5, 90^o), P3(5, 180^o), and\ P4(5, 270^o)$ in cm and degrees, respectively. Assuming free space (8 Marks)

B. Assume a straight-line charge extending along the x axis in a cylindrical coordinate system from $-\infty$ to ∞. Drive the electric field intensity $\underline{E}$ at point (0,y,0) resulting from a uniform line charge density ρ_L. (7 Marks)

C. Find the equation of that streamline that passes through the point P(1, 4, −2) in the field $\underline{E} = \frac{-8x}{y}\hat{a}_x + \frac{4x^2}{y^2}\hat{a}_y$ (5 Marks)

Question 3 (20 Marks)

A. Volume charge density is located in free space as $\rho_v = 2e^{-1000r}\ nC/m^3\ for\ 0 < r < 1\ mm$, and $\rho v = 0$ elsewhere. Calculate the value of D_r on the surface $r = 1$ mm. (10 Marks)

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B. Given the potential field, $V = 2x^2 - 5yz$, and a point P(−4, 3, 6), find the following values at point P: the potential V, the electric field intensity $\underline{\boldsymbol{E}}$, the direction of $\underline{\boldsymbol{E}}$, the electric flux density $\underline{\boldsymbol{D}}$, and the volume charge density ρ_v . (10 Marks)

Question 4 **(20 Marks)**

A. Concentric conducting spheres are located at $r_1 = 10$ mm and $r_2 = 20$ mm. The region between the spheres is filled with dielectric with $\varepsilon_r = 3$. If the inner sphere is at $V_o = 100\ V$ and the outer sphere is at 0 V. Using Laplace equation, drive and find the capacitance between the two spheres and the location of the 20 V equipotential surface. (10 Marks)

B. For the finite current element of length l cm on the x axis, where $-\frac{l}{2} \leq x' \leq \frac{l}{2}$, use Biot-Savart law to find the magnetic field at point P (0,0, z). (10 Marks)

Question 5 **(15 Marks)**

A. Applying both Gauss's and Ampere's circuital law, drive the proper boundary conditions to apply to B and H at the interface between two different magnetic materials. Illustrate your answers with sketches (5 Marks)

B. Assume that $\mu = \mu 1 = 45\mu H/m$ in region 1 where $z > 0$, whereas $\mu 2 = 8\mu H/m$ in region 2 wherever $z < 0$. Moreover, let $\boldsymbol{K} = 70\ \boldsymbol{a}_x\ A/m$ on the surface $z = 0$. a field, $\boldsymbol{B}_1 = 2\boldsymbol{a}_x - 2\boldsymbol{a}_y + \boldsymbol{a}_z\ mT$ is established in region 1. Find the value of $\boldsymbol{B}_2$. (5 Marks)

C. Drive the time variant Maxwell's equations in point (differential) and integral form (consider both Faraday's and Ampere's laws). (5 Marks)

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