Course code and name:	B38EM Introduction to Electricity and Magnetism
Type of assessment:	**Individual**
Coursework Title:	**Take home Assignment 1**
Student Name:	
Student ID Number:	

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Introduction to Electricity and Magnetism B38EM

Assignment 1

Name:_____ HWU ID:_____.

$\varepsilon_0 = 8.85\text{x}10^{-12}\ \text{Fm}^{-1}$, $e = 1.6\text{x}10^{-19}$ C, 1 nC = 10^{-9} C

1) Gradient of scalar function: Find the gradient of the following scalar function and then evaluate it at the given point.

$V_1 = 24V_0 \cos(\pi y/3) \sin(2\pi z/3)$ at (3, 2, l) in Cartesian coordinates.

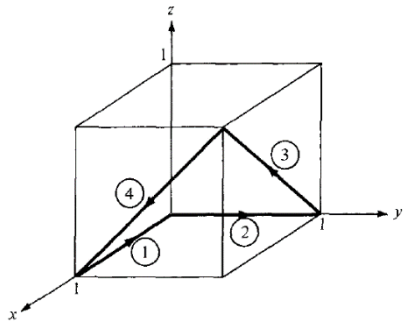
(3 marks)

2) Calculating the Divergence: Determine the divergence of the following vector field and then evaluate it at the indicated point:

$\mathbf{E} = \hat{\mathbf{x}}\, 3x^2 + \hat{\mathbf{y}}\, 2z + \hat{\mathbf{z}}\, x^2 z$ at (2, −2, 0) in Cartesian coordinates.

(3 marks)

3) Circulation: Given that $\mathbf{F} = x^2\mathbf{a}_x - xz\mathbf{a}_y - y^2\mathbf{a}_z$, calculate the circulation of **F** around the (closed) path shown in the Figure.



(3 marks)

4) In a certain region, the electric flux density is given by:

$\mathbf{D} = 2\rho(z+1)\cos\varphi\ \mathbf{a}_\rho - \rho(z+1)\sin\varphi\ \mathbf{a}_\varphi + \rho^2\cos\varphi\ \mathbf{a}_z\ \ \mu\text{C/m}^2$.

a) Show that the charge density is equal to $\rho_v = 3(z+1)\cos\varphi\ \ \mu\text{C/m}^2$

b) Calculate the total charge enclosed by the volume $0<\rho<2$, $0<\varphi<\pi/2$, $0<z<4$.

(5 marks)

5) A spherical shell with outer radius *b* surrounds a charge-free cavity of radius $a < b$ (Fig. 2). If the shell contains a charge density given by

$$\rho_V = -\frac{\rho_{V0}}{R^2}, \quad a \leq R \leq b,$$

where ρ_{V0} is a positive constant, determine the electric flux density D in all regions.

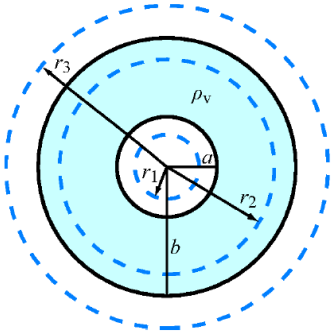


Fig. 2 for problem 5.

(5 marks)

6) Spherical Capacitor: Show that the capacitance of two concentric spherical metal shells with radii *a* and *b* is equal to $C = 4\pi\varepsilon_0[ab/(b-a)]$. Assume the inner shell has charge +Q and the outer -Q.

(3 marks)

7) Consider a straight non-magnetic conductor of circular cross-section and radius *a* carrying a current with uniform current density **J** (A/m^2) in the vertical direction. Using Ampere's law find the magnetic field inside and outside the conductor.

(3 marks)