Problem 1

Two uniform vector fields are given by E= -5 a_r +10 a_ϕ + 3a_z and F= a_r +2 a_ϕ - 6a_z

Calculate | ExF|

a. 35
b. 67.33
c. 44.12
d. 74.06
e. None of the above

Problem 2

A unit normal vector to the cylindrical surface r=4 is:

a. a_r
b. a_ϕ
c. a_z
d. a_ϕ+ a_r
e. None of the above

Problem 3

If vector A = 4 a_r -3 a_ϕ + 5a_z. At point (1, $\pi/2$, 0), the component of A parallel to surface r=1 is:

a. 4a_r
b. -3a_ϕ+5 a_z
c. 5a_z
d. 5a_ϕ+3 a_z
e. None of the above

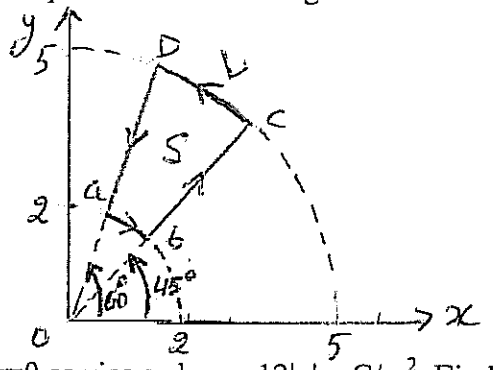
Problem 4

Determine the divergence of the vector: Q = r sinφ a_r + r^2z a_ϕ + z cos φ a_z

a. 2 sin φ + 3 cos φ
b. 2 sin φ + cos φ
c. sin φ + 2cos φ
d. sin φ + cos φ
e. None of the above

Problem 5

If $A = r\cos\varphi\, a_r + \sin\varphi\, a_\varphi$, evaluate $\oint A.dl$ around the path shown in the figure.



a) (27/4) (√3 -1)
b) (27/2) (√2 -1)
c) (27/3) (√3 -1)
d) (27/4) (√2 -1)
e) None of the above

Problem 6

A square plate described by $-2 \le x \le 2$, $-2 \le y \le 2$, $z=0$ carries a charge $12|y|$ mC/m^2. Find the total charge on the plate.

a) 192 mC
b) 233 mC
c) 89 mC
d) 167 mC
e) None of the above

Problem 7

A point Charge of 30 nC is located at the origin while plane y=3 carries charge 10 nC/m^2. Find D at (0,4,3)

a) $2.12a_y+0.09\ a_z\ nC/m^2$
b) $3.14a_y+0.02a_z\ nC/m^2$
c) $5.076a_y+0.0573\ a_z\ nC/m^2$
d) $1.7a_y+0.136\ a_z\ nC/m^2$
e) None of the above

Problem 8

A charge distribution in free space has $\rho_v = 2r$ nC/m^3 for $0 \le r \le 10m$ and zero otherwise. Determine E at r=2m.

a) 15.3 a_r V/m
b) 226 a_r V/m
c) 354 a_r V/m
d) 3.927 a_r V/m
e) None of the above

Problem 9

If Electric potential $V = x - y + xy + 2z$ (V). Find E at point (1,2,3).

a) $3a_x - 2a_z$ V/m
b) $3a_x + 2a_z$ V/m
c) $-3a_x + 2a_z$ V/m
d) $-3a_x - 2a_z$ V/m
e) None of the above

Problem 10

Two homogeneous dielectrics meet on plane z=0. For $z \geq 0$, $\varepsilon_{r1}=6$ and for $Z \leq 0$, $\varepsilon_{r2}=3$. A uniform electric field $E_1= 5a_x - 2a_y + 3a_z$ kV/m exists for $z \geq 0$. Find E_2 for $z \leq 0$.

a) $2a_x - 2a_y + 4a_z$ kV/m
b) $5a_x - 2a_y + 4a_z$ kV/m
c) $2a_x + 5a_y + 3a_z$ kV/m
d) $5a_x - 2a_y + 6a_z$ kV/m
e) None of the above

Problem 11

Region $y \leq 0$ consists of a perfect conductor while region $y \geq 0$ is a dielectric medium with $\varepsilon_{1r}=4$. If there is a surface charge of 2 nC/m^2 on the conductor. Determine E at (-4,1,5).

a) $18\pi\, a_y$ V/m
b) $36\pi\, a_y$ V/m
c) $2\, a_y$ V/m
d) $2\pi\, a_y$ V/m
e) None of the above

Problem 12

If the Charge density increases linearly with distance from the origin such that $\rho_v=0$ at the origin and $\rho_v=10$ c/m^3 at R=2m. Find the corresponding variation of D.

a. $a_r\,(5/4)\,R^2$ C/m^2
b. $a_r\,(2/5)\,R^2$ C/m^2
c. $a_r\,(5/3)\,R^2$ C/m^2
d. $a_r\,(3/5)\,R^2$ C/m^2
e. None of the above

Table 2-1: Summary of vector relations.

	Cartesian Coordinates	Cylindrical Coordinates	Spherical Coordinates
Coordinate variables	x, y, z	r, ϕ, z	R, θ, ϕ
Vector representation, A =	$\hat{\mathbf{x}}A_x + \hat{\mathbf{y}}A_y + \hat{\mathbf{z}}A_z$	$\hat{\mathbf{r}}A_r + \hat{\boldsymbol{\phi}}A_\phi + \hat{\mathbf{z}}A_z$	$\hat{\mathbf{R}}A_R + \hat{\boldsymbol{\theta}}A_\theta + \hat{\boldsymbol{\phi}}A_\phi$
Magnitude of A, $\lvert A\rvert$ =	$\sqrt[+]{A_x^2 + A_y^2 + A_z^2}$	$\sqrt[+]{A_r^2 + A_\phi^2 + A_z^2}$	$\sqrt[+]{A_R^2 + A_\theta^2 + A_\phi^2}$
Position vector $\overrightarrow{OP_1}$ =	$\hat{\mathbf{x}}x_1 + \hat{\mathbf{y}}y_1 + \hat{\mathbf{z}}z_1$, for $P(x_1, y_1, z_1)$	$\hat{\mathbf{r}}r_1 + \hat{\mathbf{z}}z_1$, for $P(r_1, \phi_1, z_1)$	$\hat{\mathbf{R}}R_1$, for $P(R_1, \theta_1, \phi_1)$
Base vectors properties	$\hat{\mathbf{x}} \cdot \hat{\mathbf{x}} = \hat{\mathbf{y}} \cdot \hat{\mathbf{y}} = \hat{\mathbf{z}} \cdot \hat{\mathbf{z}} = 1$ $\hat{\mathbf{x}} \cdot \hat{\mathbf{y}} = \hat{\mathbf{y}} \cdot \hat{\mathbf{z}} = \hat{\mathbf{z}} \cdot \hat{\mathbf{x}} = 0$ $\hat{\mathbf{x}} \times \hat{\mathbf{y}} = \hat{\mathbf{z}}$ $\hat{\mathbf{y}} \times \hat{\mathbf{z}} = \hat{\mathbf{x}}$ $\hat{\mathbf{z}} \times \hat{\mathbf{x}} = \hat{\mathbf{y}}$	$\hat{\mathbf{r}} \cdot \hat{\mathbf{r}} = \hat{\boldsymbol{\phi}} \cdot \hat{\boldsymbol{\phi}} = \hat{\mathbf{z}} \cdot \hat{\mathbf{z}} = 1$ $\hat{\mathbf{r}} \cdot \hat{\boldsymbol{\phi}} = \hat{\boldsymbol{\phi}} \cdot \hat{\mathbf{z}} = \hat{\mathbf{z}} \cdot \hat{\mathbf{r}} = 0$ $\hat{\mathbf{r}} \times \hat{\boldsymbol{\phi}} = \hat{\mathbf{z}}$ $\hat{\boldsymbol{\phi}} \times \hat{\mathbf{z}} = \hat{\mathbf{r}}$ $\hat{\mathbf{z}} \times \hat{\mathbf{r}} = \hat{\boldsymbol{\phi}}$	$\hat{\mathbf{R}} \cdot \hat{\mathbf{R}} = \hat{\boldsymbol{\theta}} \cdot \hat{\boldsymbol{\theta}} = \hat{\boldsymbol{\phi}} \cdot \hat{\boldsymbol{\phi}} = 1$ $\hat{\mathbf{R}} \cdot \hat{\boldsymbol{\theta}} = \hat{\boldsymbol{\theta}} \cdot \hat{\boldsymbol{\phi}} = \hat{\boldsymbol{\phi}} \cdot \hat{\mathbf{R}} = 0$ $\hat{\mathbf{R}} \times \hat{\boldsymbol{\theta}} = \hat{\boldsymbol{\phi}}$ $\hat{\boldsymbol{\theta}} \times \hat{\boldsymbol{\phi}} = \hat{\mathbf{R}}$ $\hat{\boldsymbol{\phi}} \times \hat{\mathbf{R}} = \hat{\boldsymbol{\theta}}$
Dot product, A · B =	$A_xB_x + A_yB_y + A_zB_z$	$A_rB_r + A_\phi B_\phi + A_zB_z$	$A_RB_R + A_\theta B_\theta + A_\phi B_\phi$
Cross product, A × B =	$\begin{vmatrix} \hat{\mathbf{x}} & \hat{\mathbf{y}} & \hat{\mathbf{z}} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$	$\begin{vmatrix} \hat{\mathbf{r}} & \hat{\boldsymbol{\phi}} & \hat{\mathbf{z}} \\ A_r & A_\phi & A_z \\ B_r & B_\phi & B_z \end{vmatrix}$	$\begin{vmatrix} \hat{\mathbf{R}} & \hat{\boldsymbol{\theta}} & \hat{\boldsymbol{\phi}} \\ A_R & A_\theta & A_\phi \\ B_R & B_\theta & B_\phi \end{vmatrix}$
Differential length, $d\mathbf{l}$ =	$\hat{\mathbf{x}}\,dx + \hat{\mathbf{y}}\,dy + \hat{\mathbf{z}}\,dz$	$\hat{\mathbf{r}}\,dr + \hat{\boldsymbol{\phi}}r\,d\phi + \hat{\mathbf{z}}\,dz$	$\hat{\mathbf{R}}\,dR + \hat{\boldsymbol{\theta}}R\,d\theta + \hat{\boldsymbol{\phi}}R\sin\theta\,d\phi$
Differential surface areas	$ds_x = \hat{\mathbf{x}}\,dy\,dz$ $ds_y = \hat{\mathbf{y}}\,dx\,dz$ $ds_z = \hat{\mathbf{z}}\,dx\,dy$	$ds_r = \hat{\mathbf{r}}r\,d\phi\,dz$ $ds_\phi = \hat{\boldsymbol{\phi}}\,dr\,dz$ $ds_z = \hat{\mathbf{z}}r\,dr\,d\phi$	$ds_R = \hat{\mathbf{R}}R^2\sin\theta\,d\theta\,d\phi$ $ds_\theta = \hat{\boldsymbol{\theta}}R\sin\theta\,dR\,d\phi$ $ds_\phi = \hat{\boldsymbol{\phi}}R\,dR\,d\theta$
Differential volume, $d\mathcal{V}$ =	$dx\,dy\,dz$	$r\,dr\,d\phi\,dz$	$R^2\sin\theta\,dR\,d\theta\,d\phi$