Introduction To Engineering – Tutorial - 03

#	Student ID	Student Name	Grade (10)
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Q1

The radius, r, of a sphere can be calculated from its surface area, s, by:

$$r = \frac{\sqrt{s/\pi}}{2}$$

The volume, V, is given by:

$$V = \frac{4\pi r^3}{3}$$

Determine the volume of spheres with surface area of 50, 100, 150, 200, 250, and 300 ft^2. Display the results in a two-column table where the values of s and V are displayed in the first and second columns, respectively.

Sol 1

Script file:

```
clear, clc
s=50:50:300;
r=sqrt(s/pi)/2;
V=4*pi*r.^3/3;
table=[s' V']
```

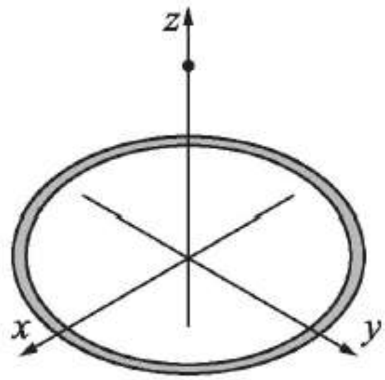
```
table =

   50.0000   33.2452
  100.0000   94.0316
  150.0000  172.7471
  200.0000  265.9615
  250.0000  371.6925
  300.0000  488.6025

fx >>
```

Q2

The electric field intensity, $E(z)$, due to a ring of radius R at any point z along the axis of the ring is given by:

$$E(z) = \frac{\lambda}{2\varepsilon_0}\frac{Rz}{(z^2+R^2)^{3/2}}$$

where λ is the charge density, $\varepsilon_0 = 8.85\times10^{-12}$ is the electric constant, and R is the radius of the ring. Consider the case where $\lambda = 1.7\times10^{-7}$ C/m and $R = 6$ cm.



(*a*) Determine $E(z)$ at $z = 0$, 2, 4, 6, 8, and 10 cm.

(*b*) Determine the distance z where E is maximum. Do it by creating a vector z with elements ranging from 2 cm to 6 cm and spacing of 0.01 cm. Calculate E for each value of z and then find the maximum E and associated z with MATLAB's built-in function `max`.

Sol 2

Script file:

```
clear, clc
e0=8.85e-12; lambda=1.7e-7; R=6;
disp('Part (a)')
z=0:2:10;
E=lambda*R*z./(2*e0*(z.^2+R^2).^(3/2))
disp('Part (b)')
z=2:.01:6;
E=lambda*R*z./(2*e0*(z.^2+R^2).^(3/2));
[m indx]=max(E);
maxE=m
at_z=z(indx)
```

```
Part (a)

E =

        0  455.5824  614.7264  565.9518  461.0169  363.3445

Part (b)

maxE =

  616.1301


at_z =

    4.2400
```

Q3

A vector $\mathbf{w}_L$ of length L in the direction of a vector $\mathbf{u} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$ can determined by $\mathbf{w}_L = L\mathbf{u}_n$ (multiplying a unit vector in the direction of $\mathbf{u}$ by L). The unit vector $\mathbf{u}_n$ in the direction of the vector $\mathbf{u}$ is given by $\mathbf{u}_n = \dfrac{x\mathbf{i} + y\mathbf{j} + z\mathbf{k}}{\sqrt{x^2 + y^2 + z^2}}$. By writing one MATLAB command, determine a vector of length 18 in the direction of the vector $\mathbf{u} = 7\mathbf{i} - 4\mathbf{j} - 11\mathbf{k}$.

Sol 3

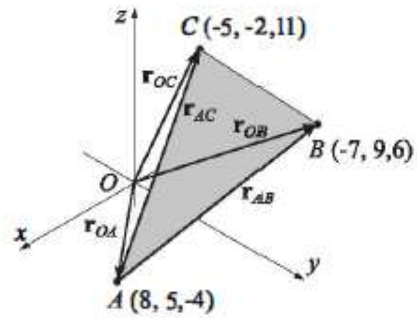
Script file:

```
clear, clc
u=[7,-4,-11];
vector=18*u/sqrt(sum(u.*u))
```

```
vector =

    9.2388   -5.2793   -14.5181

fx >>
```

Q4

The area of a triangle *ABC* can be calculated by $|\mathbf{r}_{AB} \times \mathbf{r}_{AC}|/2$, where $\mathbf{r}_{AB}$ and $\mathbf{r}_{AC}$ are vectors connecting the vertices *A* and *B* and *A* and *C*, respectively. Determine the area of the triangle shown in the figure. Use the following steps in a script file to calculate the area. First, define the vectors $\mathbf{r}_{OA}$, $\mathbf{r}_{OB}$ and $\mathbf{r}_{OC}$ from knowing the coordinates of points *A*, *B*, and *C*. Then determine the vectors $\mathbf{r}_{AB}$ and $\mathbf{r}_{AC}$ from $\mathbf{r}_{OA}$, $\mathbf{r}_{OB}$ and $\mathbf{r}_{OC}$. Finally, determine the area by using MATLAB's built-in functions `cross`, `sum`. and `sqrt`.



Sol 4

Script file:

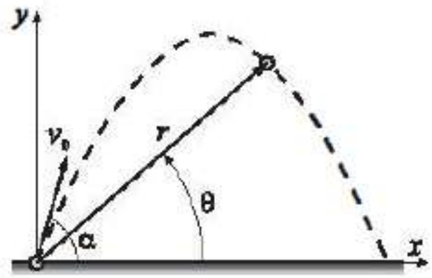
```
clear, clc
rOA=[8,5,-4]; rOB=[-7,9,6]; rOC=[-5,-2,11];
rAB = rOB-rOA; rAC=rOC-rOA;
Area = sqrt(sum(cross(rAB,rAC).^2))/2
```

```
Area =

  112.4433

fx >>
```

Q5

The position as a function of time $(x(t), y(t))$ of a projectile fired with a speed of v_0 at an angle α is given by

$$x(t) = v_0 \cos\alpha \cdot t \qquad y(t) = v_0 \sin\alpha \cdot t - \frac{1}{2}gt^2$$



where $g = 9.81\ \text{m/s}^2$. The polar coordinates of the projectile at time t are $(r(t), \theta(t))$, where $r(t) = \sqrt{x(t)^2 + y(t)^2}$ and $\tan\theta(t) = \frac{y(t)}{x(t)}$. Consider the case where $v_0 = 162\ \text{m/s}$ and $\alpha = 70°$. Determine $r(t)$ and $\theta(t)$ for $t = 1, 6, 11, \ldots, 31$ s.

Sol 5

Script file:

```
clear, clc
g=9.81; v0=162; alpha=70;
t=1:5:31;
x=v0*cosd(alpha)*t;
y=v0*sind(alpha)*t - g*t.^2/2;
r = sqrt(x.^2+y.^2)
theta = atand(y./x)
```

```
r =

  1.0e+003 *

    0.1574    0.8083    1.2410    1.4759    1.5564    1.5773    1.7176


theta =

   69.3893   65.7152   60.5858   53.0831   41.6187   24.0270    0.1812
```