Department of Physics, Bennett University

EPHY105L (I Semester 2021-2022)

Tutorial Set-2

1. **Express the unit vectors $(\hat{r},\ \hat{\theta},\ \hat{\phi})$ in spherical polar coordinates in terms of the unit vectors $(\hat{x},\ \hat{y},\ \hat{z})$ in Cartesian coordinate system. Invert these equations to express the unit vectors $(\hat{x},\ \hat{y},\ \hat{z})$ in the spherical polar coordinate system.**

2. **Express the unit vectors $(\hat{s},\ \hat{\phi},\ \hat{z})$ in cylindrical coordinates in terms of the unit vectors $(\hat{x},\ \hat{y},\ \hat{z})$ in Cartesian coordinate system. Invert these equations to express the unit vectors $(\hat{x},\ \hat{y},\ \hat{z})$ in the cylindrical coordinate system.**

3. **Express the following points given in Cartesian coordinates $(\hat{x},\ \hat{y},\ \hat{z})$ in the spherical polar coordinate system $(\hat{r},\ \hat{\theta},\ \hat{\phi})$ (all values in meters):**
   (a) $x = 10$, $y = 0$, $z = 0$
   (b) $x = 0$, $y = 0$, $z = 5$
   (c) $x = 5$, $y = 2$, $z = 0$
   (d) $x = 0$, $y = 3$, $z = 3$
   Express the unit vector $\hat{r}$ in terms of the Cartesian unit vectors at the above points.
   Notice that the direction of unit vector in spherical polar coordinates depends on the coordinates of the point.

4. **Express the following points given in spherical polar coordinates $(\hat{r},\ \hat{\theta},\ \hat{\phi})$ in the Cartesian coordinate system $(\hat{x},\ \hat{y},\ \hat{z})$ (all values in meters):**
   (a) $r = 5$, $\theta = \frac{\pi}{2}$, $\phi = \frac{\pi}{4}$
   (b) $r = 3$, $\theta = \frac{\pi}{4}$, $\phi = 0$
   (c) $r = 8$, $\theta = \frac{\pi}{2}$, $\phi = \pi$

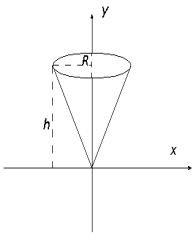
5. **Evaluate the line integral $\int \vec{F}.\vec{dl}$ where, $\vec{F} = (x^2 - y)\hat{x} + (y^2 + x)\hat{y}$ and $\vec{dl} = dx\hat{x} + dy\hat{y}$ along**
   (a) A straight line from (0,1) to (1,2)
   (b) Straight lines from (0,1) to (1,1) and then from (1,1) to (1,2)

6. **Calculate the surface integral for vector $\vec{F} = x\hat{x} + y\hat{y} + z\hat{z}$ over a disc of radius 5 unit lying in the plane $z = 10$. The center of the disc coincides with the z-axis.**

7. **Evaluate the volume integral $\int T d\tau$, where $T = 8xyz$ and $d\tau = dxdydz$. The volume integral is to be performed over a cube with sides of unit length. The cube has one of its corners at the origin and its edges are parallel to the three axes and lying in the first octant.**

8. **Calculate the area of a sphere of radius R from $\theta = 0$ to $\theta\theta_0$ using spherical polar coordinate. Note that, θ indicates the polar angle. Verify the derived formula for $\theta = 90^\circ$ and $\theta = 180^\circ$.**

9. **Calculate the total surface area and volume of a circular cone of height h and radius R as shown below using spherical polar coordinates.**



10. Calculate the surface area of a cylinder of length l and radius R having circular cross-section as shown below.