Department of Physics, Shiv Nadar Institution of Eminence

Spring 2025

PHY102: Introduction to Physics-II

Tutorial – 3

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1. Find the work done in moving a particle around a circle C in the x-y plane, if the circle has a center at origin and radius 3 and if the force field is given by

$$\boldsymbol{F} = (2x - y + z)\hat{\boldsymbol{\imath}} + (x + y - z^2)\hat{\boldsymbol{\jmath}} + (3x - 2y + 4z)\hat{\boldsymbol{k}}$$

2. Find out the flux of vector field $\boldsymbol{A} = 4x\hat{\boldsymbol{\imath}} - 2y^2\hat{\boldsymbol{\jmath}} + z^2\hat{\boldsymbol{k}}$ taken over the region bounded by $x^2 + y^2 = 4$ and $z = 0$, and $z = 3$, that is a ***closed cylinder*** with a circular top and base of radius 2. [Hint: The flux of a vector field through a closed surface S is defined as $\iint_S \boldsymbol{F}.\boldsymbol{dS}$]

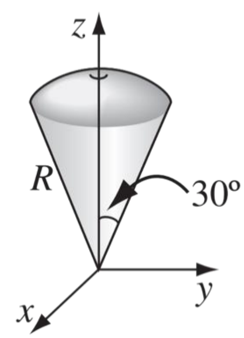
3. Evaluate the volume integral

$$\int_0^1 \int_0^{z^2} \int_0^3 y\cos\left(z^5\right)\, dx\, dy\, dz$$

4. Verify the divergence theorem for the function

$$\mathbf{v} = r^2 sin\theta\, \hat{\boldsymbol{r}} + 4r^2 cos\theta\, \hat{\boldsymbol{\theta}} + r^2 tan\theta\ \hat{\emptyset}$$

using the volume of the "ice-cream cone" shown below2 (the top surface is spherical, with radius R and centered at the origin).



5. An incompressible, steady velocity field is given by,

$$\vec{V} = (x^2 y - xy^2)\hat{i} + (\frac{y^3}{3} - xy^2)\hat{j}$$

For the plane shown below, show that the circulation around the boundary is equal to the surface integral of the curl of the velocity field over the surface (Verification of Stokes' Theorem).