PC3261
Classical Mechanics II

Worksheet 2

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Exercise 1.2. Show that the acceleration of a particle moving along a trajectory $\mathbf{r}(t)$ is given by

$$\mathbf{a}(t) = \frac{dv(t)}{dt}\hat{\mathbf{e}}_T + \frac{v^2(t)}{\rho}\hat{\mathbf{e}}_N, \tag{1}$$

where $\rho \equiv \frac{1}{\kappa}$ is its radius of curvature.

Solution:

Exercise 1.3. Find the tangent, normal and binormal vectors, as well as, curvature and torsion for the circular helix.

Solution:

Exercise 1.4. Establish the relationship between unit basis vectors $(\hat{\mathbf{e}}_\rho,\ \hat{\mathbf{e}}_\phi)$ of the polar coordinate system and the unit basis vectors $(\hat{\mathbf{e}}_x,\ \hat{\mathbf{e}}_y)$ of the Cartesian coordinate system.

Solution:

Exercise 1.5. Express the velocity and acceleration vectors in 2D polar coordinates.

Solution:

Exercise 1.6. Express the spherical unit basis vectors $(\hat{\mathbf{e}}_r,\ \hat{\mathbf{e}}_\rho,\ \hat{\mathbf{e}}_\phi)$ in terms of Cartesian unit basis vectors $(\hat{\mathbf{e}}_x,\ \hat{\mathbf{e}}_y,\ \hat{\mathbf{e}}_z)$.

Solution: