Physics 3344 Professor Olness
Homework 8 Due: October 14, 2020

Chapter 9:

Non-inertial frame: Taylor Ch.9

1,2,3,4) Problems: 8,9,13,27

9.8 ★ What are the directions of the centrifugal and Coriolis forces on a person moving **(a)** south near the North Pole, **(b)** east on the equator, and **(c)** south across the equator?

9.9 ★ A bullet of mass m is fired with muzzle speed v_o horizontally and due north from a position at colatitude θ. Find the direction and magnitude of the Coriolis force in terms of m, v_o, θ, and the earth's angular velocity Ω. How does the Coriolis force compare with the bullet's weight if $v_o = 1000$ m/s and $\theta = 40$ deg?

9.13 ★ Show that the angle α between a plumb line and the direction of the earth's center is well approximated by $\tan\alpha = (R_e\Omega^2 \sin 2\theta)/(2g)$, where g is the observed free-fall acceleration and we assume the earth is perfectly spherically symmetric. Estimate the maximum and minimum values of the magnitude of α.

9.27 ★★ In Section 9.8, we discussed the path of an object that is dropped from a very tall stepladder above the equator. **(a)** Sketch this path as seen from a tower to the north of the drop and fixed to the earth. Explain why the object lands to the east of its point of release. **(b)** Sketch the same experiment as seen by an inertial observer floating in space to the north of the drop. Explain clearly (from this point of view) why the object lands to the east of its point of release. [*Hint:* The object's angular momentum about the earth's center is conserved. This means that the object's angular velocity $\dot{\phi}$ changes as it falls.]

Problem 5)

a) Use Mathematica (or equivalent) to make a parametric plot of Eq.9.67.
The x is the real part, and the y is the imaginary part.
To keep it simple, plot this for $\Omega z = \Omega$ Cos[θ] where θ is the colatitude,
and set $\Omega = 2\pi$, set $\omega_0 = 16\ \Omega$, and plot for t=[0,1/4].
Do this for colatitudes of {0, π/4, π/2, 3π/4, π}. Explain where on the earth each colatitude is, and comment on the result of the plot.

b) Repeat the above for the colatitude for Dallas. How long will it take for the pendulum to make a complete revolution. [Use real numbers for this part.]

Chapter 9:

Some warm-up exercises for Chapter 9. (These are very simple.)

Problem 6) Find the eigenvalues and eigenvectors for the matrix:

$$\begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$$

Problem 7) Find the eigenvalues and eigenvectors for the matrix:

$$\begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Problem 8) Find the eigenvalues ONLY for the matrix:

$$\begin{bmatrix} 5/4 & -\sqrt{3}/4 \\ -\sqrt{3}/4 & 7/4 \end{bmatrix}$$