# AA 242A Homework 2

**Assigned**: **Thursday, October 6th, 2022**

**Due**: **Thursday, October 13th, 2022**

1. Greenwood 2-6

   A satellite moves in a circular polar orbit of radius $r$ with a constant speed $v_0$. Assume that the orbital plane of the satellite is fixed in space while the earth of radius $R$ rotates at $\omega_e$ rad/sec. As the satellite moves toward the equator, it passes directly over a radar station at 30° north latitude. This station measures the satellite's relative velocity and acceleration. Find this relative velocity and acceleration, expressing the results in terms of $\mathbf{e}_r$, $\mathbf{e}_\theta$, $\mathbf{e}_\varphi$, where $\mathbf{e}_\theta$ points due south and $\mathbf{e}_\varphi$ due east.

   *Hint: Make sure to find the velocity and acceleration of the satellite in the reference frame of the ground station that rotates with the Earth, and not the inertial reference frame.*

2. Greenwood 2-8

   A cyclist rides around a circular track ($R$ = 30 m) such that the point of contact of the wheel on the track moves at a constant speed of 10 m/sec. The bicycle is banked at 15° inward from the vertical. Find the acceleration of a tack in the tire (0.4 m radius) as it passes through the highest point of its path. Use cylindrical unit vectors in expressing the answer.

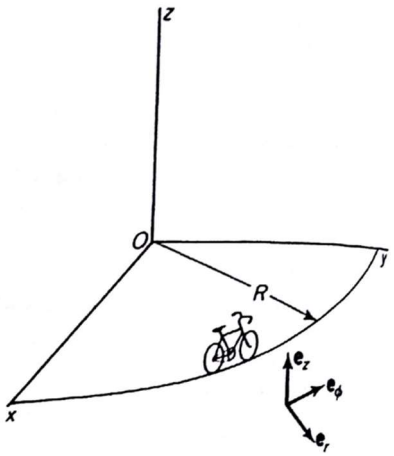



**Figure P2-8**

3. Greenwood 2-9

   An airplane flies with a constant speed $v$ in a level turn to the left at a constant radius $R$. The propeller is of radius $r$ and rotates about its axis in a clockwise sense (as viewed from the rear) with a constant angular velocity $\Omega$. Find the total acceleration of a point $P$ at the tip of the propeller, assuming that its axis is always aligned with the flight path. use cylindrical unit vectors and assume that the velocity of $P$ relative to the airplane is vertically upward at $t = 0$.

4. Greenwood 3-2

   A tube rotates in the horizontal $xy$ plane with a constant angular velocity $\omega$ about the $z$ axis. A particle of mass $m$ is released from a radial distance $R$ when the tube is in the position shown. If the tube is frictionless, find the direction and magnitude of the velocity of the particle as it leaves the tube.

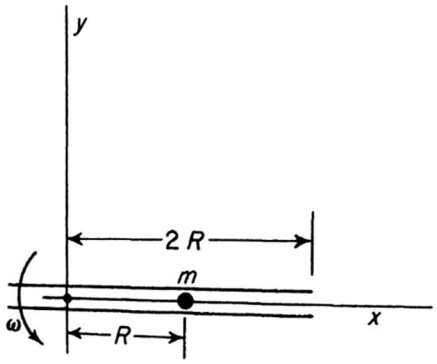
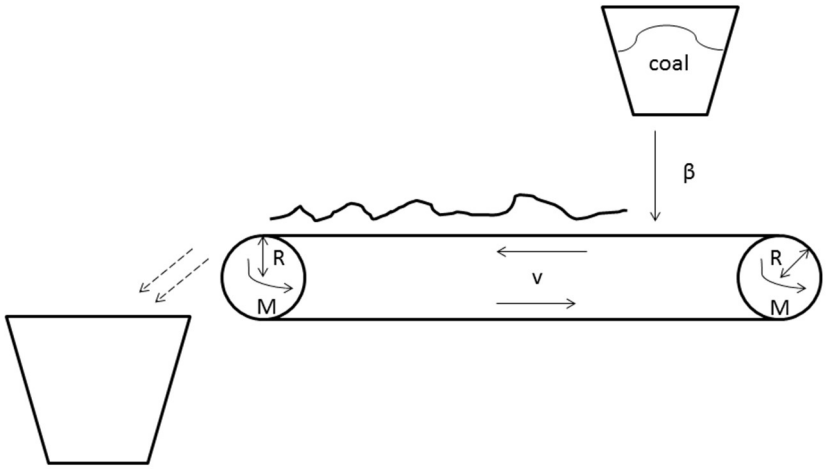



**Figure P3-2**

5. Conveyor Belt: chunks of coal are dumped onto a conveyor belt at a constant rate of **β** kg/s. They are in turn poured into a truck at the end of the belt. Assume that the conveyor belt has identical pulleys of radius **R** at each end that rotates the belt, what is the moment **M** that should be applied to each pulley to maintain the speed of the belt constant at **v**?




(A poorly drawn Question 5 set-up)

6. We will continue to define the Classical Dynamics problem that you chose and began last week. For this week, once again draw the picture and provide a short description of what you are trying to solve. Now also choose your reference frame and coordinate system and label it on your drawing. Explain why you chose what you did. Finally, identify and label all of the relevant forces (i.e. create a free-body-diagram, a.k.a. FBD)