Problem # 1: (8 points)

A car of mass"$\boldsymbol{m}$" is going around a curve of radius "$\boldsymbol{r}$"**,** banked at an angle of "$\boldsymbol{\theta}$" to the horizontal, at a constant speed "$\boldsymbol{v}$"**.** The road has a coefficient of static friction "$\boldsymbol{\mu_s}$" **,** and a coefficient of kinetic friction of "$\boldsymbol{\mu_k}$". Find an expression for the minimum and maximum speeds "$\boldsymbol{v}$" that the car can travel around the curve at so as not to slide up or down the road. Your answer should be expressed in terms of one or more of the following: $\boldsymbol{\mu_{k,}\, \mu_k,\ r, tan\theta, m, g}$**.** *Your answer should NOT contain any other variables.* Draw the freebody diagrams for the minimum and maximum speed scenarios. Choose an appropriate set of coordinate axes and explain your choice. Draw corresponding diagrams where you show forces or their component such that all forces are along the axes chosen.

Problem # 2. (10 points).

You are going to analyze normal forces two people experience while taking a 28 person swing ride in an entertainment park. The ride consists of a 14 cabins with each cabin consisting of a wide seat with high side-rests that can accommodate two people side-by side with no partition in between them. The seating unit is suspended by means of a strong steel arm (that can tilt to the vertical while rotation). Assume that all 14 hanging arms tilt by the same angle to the vertical. The passengers can hold on to a horizontal steel bar at the front. Assume that their arms are tangential to the circle of rotation at all times. The swing ride starts at rest and accelerates uniformly to a rotational speed of 8.40 rpm in 1 minute.

A father weighing 100 kg and his daughter weighing 25 kg decide to take a ride. When the ride is operational, it is to be expected that both passengers will slide outward so that the passenger that is sitting closer to the center (of the circle) will not make contact with the side wall (or side-rest) of the seat and will only make contact with the other passenger. The father decides that the he will make his daughter sit away from the center so that she has two surfaces to protect her – a) the side rest of the seat and, b) himself. You want to analyze to see if this makes sense in terms of the magnitude of the forces involved. Consider the instant of time when the ride is moving at a speed of 5.0 rpm when the steel arm is tilted at an angle of $5^0$to the vertical.

I. Choose an set of axes and draw *appropriate views (e.g. side, top etc.) of* the freebody diagram and show the following forces:
   a. The normal force from the bottom surface of the seat
   b. The normal force from the back of the seat

c. The normal force from the side walls of the seat
d. The normal force between the father and the daughter (use notation for all forces such as N_{FD} represents the force from the father on the daughter).
e. Tension force on the hands (consider them as one unit) from holding the bar.

Ignore forces on the bottom surface of the feet, force of static friction from the seat on the body. Do not forget that the seat is tilted to the vertical. Pay close attention to the angles your forces make with the axes. If any of your free-body diagrams contain forces that are at an angle to the axes, draw another picture where all forces or components are along the axes chosen. The effective length of the hanging arms is 5m and the arms are attached to the body of the ride at a point at the top that is at horizontal distance of 4m from the center.

II. Use Newton's laws to figure out all the forces making the assumption that the tension on the hands from holding the bar is equal to the normal force from the back of the seat.
III. Now recalculate the forces in the situation where the daughter is sitting closer to the center. If you want the daughter to feel the least amount of force, which scenario is preferable?