# AuE-ME 4600-6600 (Fall 2022) – Homework Assignment #4

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Reference: Chapter 5 (Milliken, Race Car Vehicle Dynamics)

Due Date: 10/20/22, at midnight

## *Problem 1 (25 pts.)*

Given a vehicle with wheelbase l = 3.05 m and a CG position with a/l = 0.45.

A) Determine the error in the Ackermann steering angle if you use the small angle approximation while cornering with a radius of 105m.

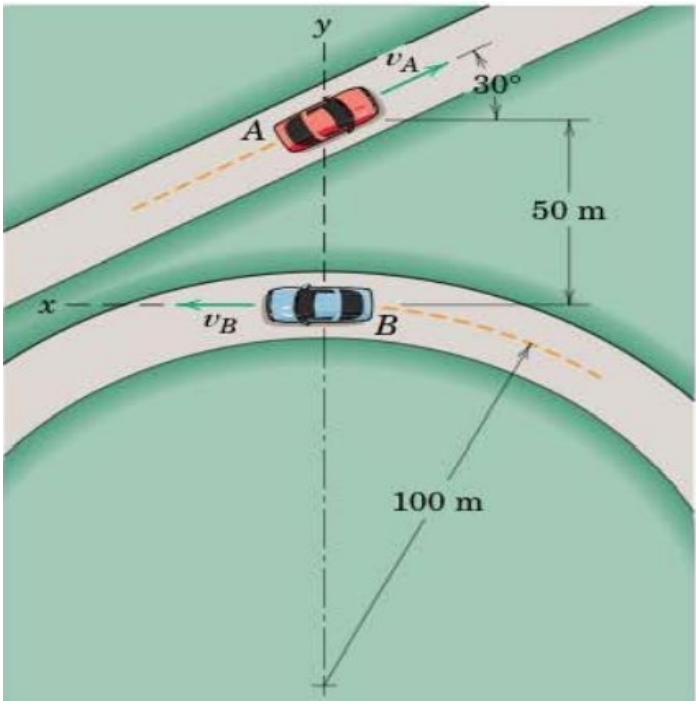
B) Determine the yaw velocity and the lateral acceleration of a vehicle which travels on circular track with radius 620 ft and a velocity of 70 mph.

C) Suppose that now the vehicle has a wheelbase of 2.7 m, a mass of 105 slugs and the location of the center of gravity is given by a/l=0.5. Determine the vehicle's slip angle. The cornering stiffness at the front and rear wheels amounts to 750 N/deg when the vehicle is driven with 111 km/h on a circular path of radius 232 m. Compare this vehicle slip angle with the vehicle slip angle $\beta_0$ for force-free rolling.

## *Problem 2 (25 pts.)*

Each of the two cars A and B is travelling with a constant speed of 90 km/h.

1. Determine the velocity and acceleration of car A as seen by an observer moving and rotating with car B when the cars are in the position shown. The x-y axes are attached to car B.
2. Is this apparent velocity the negative of the velocity which B appears to have to a nonrotating observer in car A. If not, Explain the reason ?

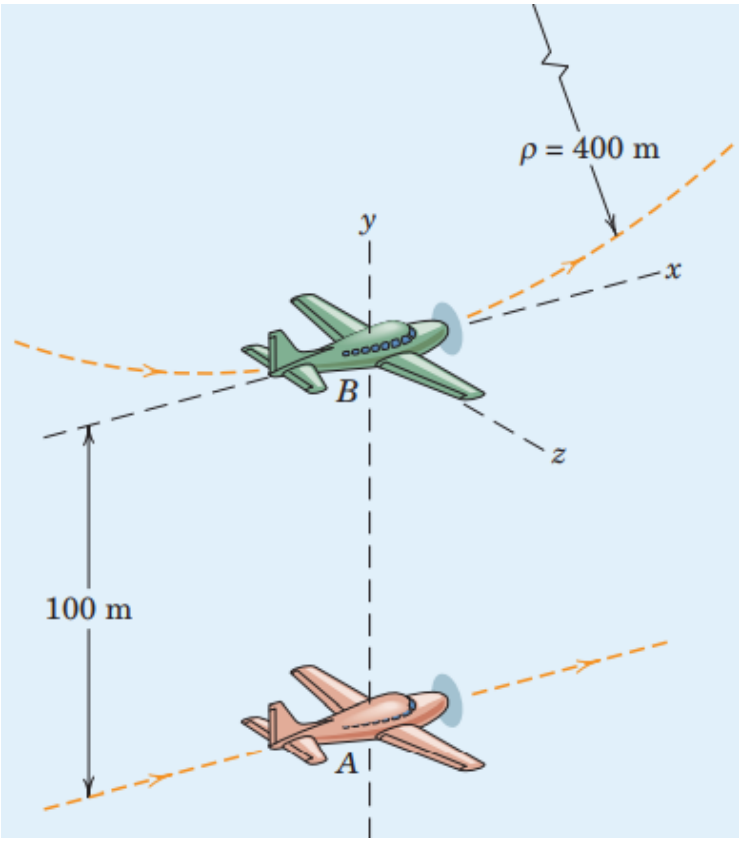


## *Problem 3 (25 pts.)*

Aircraft B has a constant speed of 150 m/s as it passes the bottom of a circular loop of 400-m radius. Aircraft A flying horizontally in the plane of the loop passes 100 m directly below B at a constant speed of 100 m/s.

a) Determine the instantaneous velocity and acceleration which A appears to have to the pilot of B, who is fixed to his rotating aircraft.

b) Compare your results for part (a) with the case of erroneously treating the pilot of aircraft B as nonrotating.



## *Problem 4 (25 pts.)*

Consider the following Bicycle Model vehicle:

| | |
|---|---|
| *Mass:* | 2100 kg |
| *Wheelbase:* | 3.3 m |
| *Weight Distribution:* | Defined below. |
| *Front Cornering Stiffness:* | −78.9 kN/rad |
| *Rear Cornering Stiffness:* | −77.5 kN/rad |

*This vehicle is being driven on a 144 m radius (left turn) skid pad at ever increasing speed, from zero to 78 mph.*

For the weight distributions 38% front (a=2.046 m, b=1.254 m), 50% front (a=1.65 m, b=1.65 m), and 62% front (a=1.254 m, b=2.046 m), answer the following:

A. Plot Front Slip Angle vs. Lateral Acceleration
B. Plot Rear Slip Angle vs. Lateral Acceleration
C. Plot Vehicle Sideslip Angle (β) vs. Lateral Acceleration
D. Plot Steer Angle vs. Lateral Acceleration

***You should plot the results for all three models in one figure for each of the questions.***