AUE-ME 4600/6600 (Fall 2022) – Homework Assignment #3

References: Chapters 2 and 14, Milliken, Race Car Vehicle Dynamics
Chapter 3, Pacejka, Tyre and Vehicle Dynamics

Due Date: 10/06/22, midnight

There are 3 problems in this assignment.

- Graduate students (enrolled in AuE/ME 6600) are required to do problems 1 and 2.
- Undergraduate students (ME 4600) are required to do problem 2 only but any interested student may attempt problem 1 to enhance their understanding of the corresponding topic.
- Problem 3 is a bonus problem that anyone could attempt. The secured points for this problem will be added to the midterm exam grades.

The point distribution for this assignment is as follows:

Problem #	AuE/ME 4600	AuE/ME 6600
Problem 1	N/A	25
Problem 2	100	75

Problem 1

Based on the brush model, the load of the tire is 5200 N, the contact patch length of the tires is 10 cm, the lateral slip is 0.0775, and the lateral stiffness of the tire is c_y = 1250 N/cm^2. Assume a friction coefficient of μ=0.91.

A. Calculate the force, F_y, under this lateral slip assuming a sinusoidal pressure distribution as shown below. Comment on the potential position of x_s and is there a discontinuity?

B. Compare this resulting lateral force with the one resulting from the parabolic model. Plot the lateral force F_y, over a range of slip angles, for both pressure distributions.

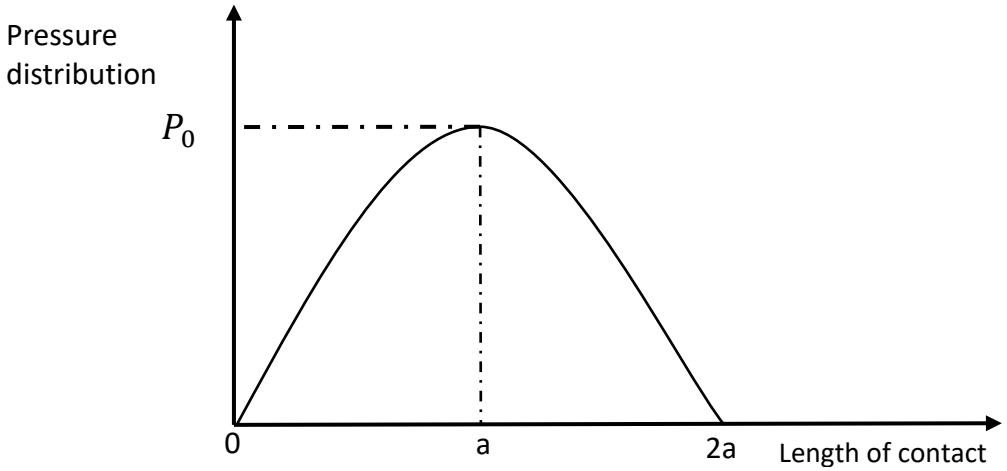

Figure 1 Sinusoidal Pressure distribution

C. Comment about the transition point for the following bilinear distribution (Fig 2) and how it affects sliding region

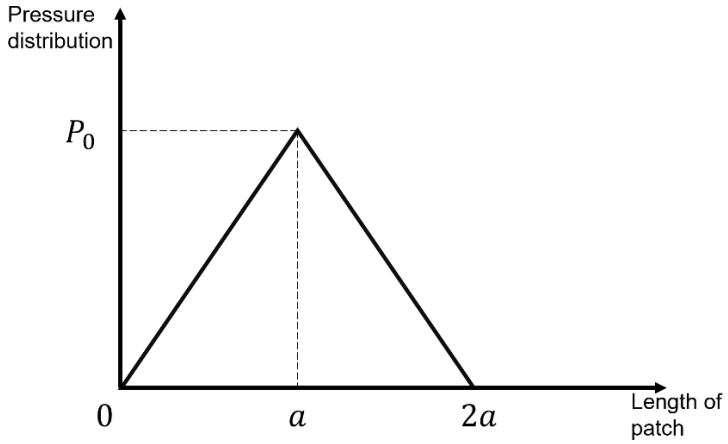

Figure 2 Bilinear pressure distribution

Problem 2

This problem asks you to fit the same tire data that was used in Homework Assignment #2 with a version of the Nondimensional Tire Model described in class and in chapter 14. Do the following for data at 0 deg inclination angle, 12 psi inflation pressure, 25 mph roadway speed and positive slip angles (i.e., left turn data only):

1. Apply Nondimensional Tire Model transformations to lateral force and slip angle. Plot nondimensional lateral force vs. nondimensional slip angle.
2. Add a plot of the Magic Formula over the data in question #1. Use the following coefficients:
   B = 0.6000
   C = 1.6667
   D = 1.0000
   E = 0.2000
3. How do these coefficients compare with the one derived from the plot in question #1 and from the relationships given in class?
4. Expand the Nondimensional Model at the five measured normal loads. Create a plot of lateral force vs. slip angle, showing both the measured data and the model predictions.
5. Also expand the Nondimensional Model at –200, –300 and –400 lb normal load. Plot the result on the same figure as question #4