

## AuE-ME 4600/6600 (Fall 2022) – Bonus Problem #1

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Reference: Lecture notes

Due Date: 11/12/2022, at midnight

### **Bonus Problem (7.5 pts.):**

When a vehicle is running on a wet surface, a hydroplaning phenomenon can easily occur when the speed of the vehicle reaches certain values. Such a condition is always extremely dangerous. Therefore, analyze the variation in the tire side force and the aligning torque when the hydroplaning phenomenon occurs. (Assume the slip angle  $\alpha$  is constant.)

**Hint:** You can follow and adapt the steps of the elastic lateral force model with parabolic pressure distribution as discussed in class and as practiced one by one. You should consider an area of waterskiing starting from the leading edge of the tire print and extending a length  $l_w$  into the patch. In this waterskiing area zero adhesion can be assumed.

Calculate the side force and the total aligning torque using the following parameter:

- The vertical load is  $F_z = 4000$  N
- Slip angle is 4 degrees
- Coefficient of friction is 0.6
- Length of the contact patch,  $2a = 0.16$  m
- Lateral stiffness of the rubber layer,  $C_y = 3.5 \times 10^6$  N/m<sup>2</sup>

The above calculation will depend on the length of the waterskiing area  $l_w$ . Produce the following plots:

- Side force vs. waterskiing area in percent
- Total aligning torque vs. waterskiing area in percent
- Pneumatic trail vs. waterskiing area in percent.

Comment on the results.