1. The figure below shows the Magic Formula

$$F_y(\alpha) = D\sin(C\arctan[B\alpha - E\{B\alpha - \arctan(B\alpha)\}])$$

plotted for three different sets of parameters

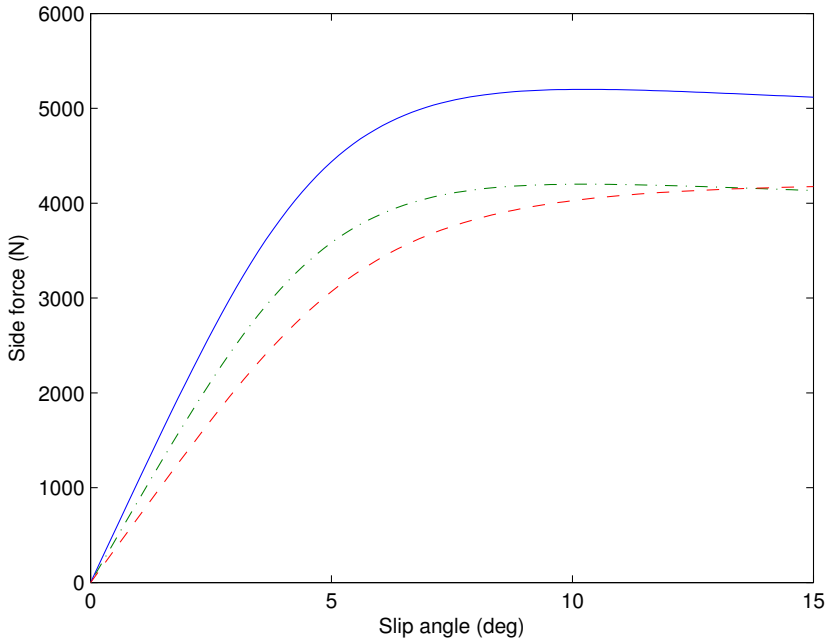
a) B=0.16, C= 1.3, D=5200, E=-1.6

b) B=0.15, C=1.1, D=4200, E=-1.6

c) B=0.16, C= 1.3, D=4200, E=-1.6

Which one is which?

Hint: You don't have to do any calculations or use a ruler to measure anything in the figure.



2. Consider a model with sprung and unsprung mass, without damping, and where $m_s = 1200$ kg, $m_{us} = 100$ kg, $k_s = 50$ kN/m, $k_{tr} = 500$ kN/m.

a) Calculate the natural frequencies with and without the approximations in the course book.

b) Calculate the amplitude of the masses if the car is traveling at 50 km/h over a sinusoidal road with a wavelength of 10 m and amplitude of 5 cm.

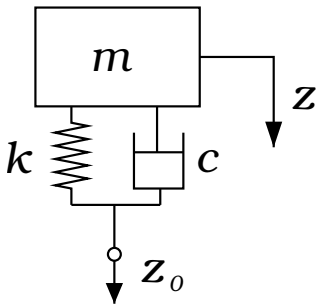
3. In this exercise pitch and bounce motions are studied. Consider a car that weighs $m_s = 1200$ kg, has the inertia $I_y = 1300$ kg·m^2, and has the wheelbase 230 cm. The center of gravity is 110 cm behind the front axle and the spring stiffnesses are $k_f = 25$ kN/m front and $k_r = 26$ kN/m rear.

   a) Calculate the natural frequencies.

   b) Determine where the corresponding oscillation centers are located.

   c) Assume that the car travels over a concrete highway with expansion joints 15 m apart. For what velocities are the bounce motion and pitch motion of the vehicle most likely to arise?

4. Consider a quarter-car model with a sprung mass $m_s = 400$ kg, a spring with stiffness $k = 30$ kN/m, and a damper with coefficient $c = 2$ kNs/m.



   The car is traveling at 70 km/h on a sinusoidal road with wavelength 15 m and amplitude of 10 mm. Determine the maximum force between tire and ground.

5. Consider a car with a rigid suspension and assume that the center of gravity of a car is located 500 mm above the ground and that the distance between the right wheels and the left wheels is 1500 mm. The car is turning fast in a sharp corner. Is there a risk that the car will roll over?

Answers

1. a) Solid line
   b) Dashed line
   c) Dash dotted line
2. a) 6.15 rad/s and 74.2 rad/s in both cases rounded to three significant digits.
   b) 50 mm and 41 mm
3. a) 1.03 Hz and 1.16 Hz
   b) -3.7 m and 0.30 m
   c) 55 km/h and 63 km/h
4. 4.47 kN.
5. No, not for reasonable values of the friction coefficient. (E.g., we can assume $\mu \approx 1$ for dry asphalt.)