Department of Mechanical Engineering
University of Bath

ME40064: Systems Modelling & Simulation
ME50344: Engineering Systems Simulation

Assignment 3: Simulink Modelling of Dynamic Systems

The overall aim of this assignment is to develop, verify, and use a model of a ½ car system, building on the ¼ model in the tutorials.

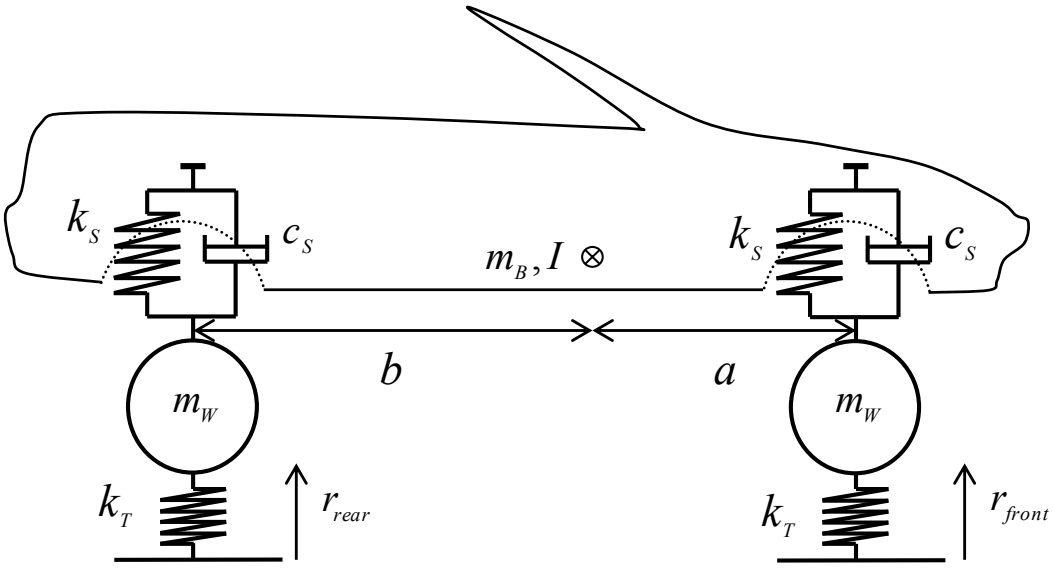

Figure 1: Representation of the 1/2 car model

Having completed Tutorial 9 you will have developed the suspension and wheel models. The main changes will be in the body model, which now represents ½ a car, and couples together the front and rear wheel assemblies. The equations of motion of the 1/2 car body are as follows:

$$m_B \ddot{s}_B = F_{front} + F_{rear} - m_B g$$
$$I\ddot{\theta} = aF_{front} - bF_{rear}$$

where s_B and **θ** are vertical (positive up) and pitch (anti-clockwise) displacements about the centre of mass, and F_{front}, F_{rear} are the upward forces exerted by the suspension systems on the body, at the front and rear, respectively. The equations for the wheel and suspension models are as before.

The parameters for this model are given below:

Wheel: $m_W = 20$ kg, $k_T = 14 \times 10^4$ N/m

Suspension: $k_S = 2 \times 10^4$ *N/m,* $c_S = 600$ *Ns/m* (under contraction) & *1200 Ns/m* (under extension). Spring hardening parameters: $k_{Sstiff} = 20k_S$, $x_0 = 0.2$

Body: $m_B = 500$ *kg,* $I = 600$ *kg/m*^{2}, $a = 1.25$*m,* $b = 1.4$*m*

Tasks:

(a) Present the verification results for the 1/4 car analysis of Tutorial 9 (body, suspension, wheel, and the complete 1/4 car), first for the linear versions, then including the nonlinear versions of spring stiffness, damping rate, and tyre stiffness (see Lecture 21 slides for details). **(10%)**
(b) Create an icon block for the 1/2 car body with suitable inputs (forces) and outputs (including vertical displacements/velocities at suspension points). Verify that your 1/2 car body model is correct and explain the reasoning behind your verification tests. **(15%)**
(c) Connect the suspension and wheel models to the 1/2 car body. Verify that the complete 1/2 car model is correct and explaining the reasoning behind your verification tests. **(15%)**
(d) Simulate the vehicle's transient response over a sinusoidal road of wavelength 1 m and height amplitude 0.01 m. Choose a range of speeds for your simulations. **(20%)**
(e) Simulate the 1/2 car going over a hump back bridge. Can you make the car fly? **(20%)**
(f) Any extra model features or simulations that you wish to present. **(20%)**

The assignment should be written up as a concise report showing your Simulink models, model verifications, simulation results and conclusions. All the results should be presented clearly and properly explained. Simulink diagrams should be neatly organised and easy to read.

See Lecture 21 slides for further details on the model and what is required. The humpback bridge input model will be available to download from Moodle.

Submission

Submit your report & Simulink models using the online submission on the unit's Moodle page. Please remember, as before, that this is an anonymous submission; therefore **do not** include your name in the report, Simulink models, or filenames, but **do include your candidate number**. There is a **word limit of 2000 words.**

Deadline: 4pm on Monday 14th January 2019.