

MCE 503: Modeling and Simulation of Mechatronic Systems  
Final Projects - Spring 2009  
-Paper Option-

**Written reports are due on May 8th, 2006. Two papers require oral presentation, see below.**

1. Margolis, D. and Shim, T., “A bond graph model incorporating sensors, actuators, and vehicle dynamics for developing controllers for vehicle safety”, Journal of the Franklin Institute, v.338, 2001, pp. 21-34.

Two different assignments are available:

Assignment A

- a. Write a 5-page summary of the article, analyzing its objectives, methodology and main contributions. Do not reproduce the list of bibliographic references as part of your summary.
- b. Consider the electric brake subsystem shown in Fig. 3. Suppose the longitudinal velocity  $V_L$ , the motor current  $i_c$  and the engine torque  $\tau_a$  are inputs (from sources). Derive the state equations for this subsystem. To simplify, consider the normal force  $N$  to be 1/4 of the vehicle weight and take formula (3) to be

$$F_L = S_L s N$$

Take the constitutive equation for the brake resistor to be  $\tau_b = \phi(N_b)$ .

- c. Suppose  $i_c$ ,  $V_L$  and  $\tau_a$  are constants. Integrate the state equation to give a solution for wheel velocity as a function of time, assuming an initial wheel velocity  $w_w(0)$ .

Assignment B

- a. Write a 5-page summary of the article, analyzing its objectives, methodology and main contributions. Do not reproduce the list of bibliographic references as part of your summary.
- b. Consider the suspension subsystem shown in Fig. 5. Take  $v_v$ ,  $v_i$  and  $F_c$  to be inputs (from sources). Derive the state equations for this subsystem and put them in standard state-space matrix form.
- c. Take all initial conditions to be zero,  $v_v = 0$  and  $F_c = 0$  at all times and  $v_i = \sin(t)$ . Using the numerical parameters from the table in the paper, simulate the system in Matlab/Simulink for a time span of your choice.

2. Vaz, A. and Hirai, S., “A Bond Graph Approach to the Analysis of Prosthesis for a Partially Impaired Hand”, ASME Journal of Dynamic Systems, Measurement, and Control, v. 129, 2007, pp. 105-113.

- a. Write a 5-page summary of the article, analyzing its objectives, methodology and main contributions. Do not reproduce the list of bibliographic references as part of your summary.
- b. Prepare a 30 to 40-minute oral presentation, more in a lecture-style than a general overview (detailed explanations of schematics and operating principles and special emphasis on explaining Figures 6 and 7.). Short equation derivations should be included if helpful.

**3.** Le Rolle, V. *et. al.*, “A bond graph model of the cardiovascular system”, *Acta Biotheoretica*, v. 53, N.4, 2005, pp. 295-312.

- a. Write a 5-page summary of the article, analyzing its objectives, methodology and main contributions. Do not reproduce the list of bibliographic references as part of your summary. Also, exclude the general introductory sections on bond graph theory (but do discuss Section 2.3).
- b. Prepare a 30 to 40-minute oral presentation, more in a lecture-style than a general overview (detailed explanations of schematics and operating principles and special emphasis on explaining Figures 5 and 8.). Discuss the prediction qualities of the simulations shown towards the end of the paper.

**Oral presentations will take place the week before finals week.**