Class Project Directions

The overall goal of this project is to design a virtual working tractor, using MATLAB SIMULINK software. Each group will have responsibility to design and simulate all important systems of the tractor. These systems must then be linked together to simulate the complete operation of the tractor pulling an implement through the soil. The instructor will provide the components for the implement and draft/depth control.

The following subsystems must be included in the model

1) Governor Subsystem
   a) The Governor system must accept a desired ground speed from the operator (use a constant block), the actual engine speed (from the engine subsystem) and present gear ratio (from transmission subsystem) and any other information needed (i.e. tire diameters) to determine the Engine set speed and output the Fuel injection rate (to engine subsystem)
2) Engine Subsystem
   a) The engine system must determine the actual engine speed based on the fuel injection rate (from governor subsystem, air consumption based on a constant volumetric efficiency and/or constant boost pressure, inlet air temp and pressure, and engine load torque (from axle torque via the transmission subsystem), and any other information needed. The outputs from the system should be Engine Speed (to Governor and Transmission system). In addition, Engine power and torque (Fuel Equivalent, Indicated, Brake and Friction), all temp & pressures assuming a dual cycle, and relevant efficiencies for display.
3) Transmission Subsystem
   a) The transmission subsystem must provide automatic gear ratio control to attempt to reach the desired ground speed while preventing engine overload. The inputs are Engine Speed (from Engine), axle torque (from traction subsystem) and the critical outputs are engine load torque (to engine subsystem), axle speed (to traction subsystem), and gear ratio (to governor subsystem). You may select any transmission type.
4) Weight Transfer subsystem
   a) The weight transfer system must determine reaction forces on front and rear axis for any slope and pull combination. The inputs to the system are draft forces and position (from Draft Control subsystem) and the outputs are reaction forces at the tires (to traction subsystem). This system must ensure that it provides correct reaction forces if tires leave the ground. You may select any static weight distribution for your tractor to that matches to engine power selected
5) Traction subsystem
   a) The weight transfer system must determine slip, gross traction forces, towed forces and actual vehicle speed for any pull and reaction force combination. The inputs to the system are draft forces and reaction forces on the tires (from Draft and weight transfer subsystems) and the axle speed (from the transmission subsystem). The outputs are axle torque (to transmission subsystem), slip and vehicle speed (to draft subsystem). You may select any tire combination to match your tractor.
6) Draft Control and Draft Subsystems
   a) The Draft Control and Draft Subsystems will be provided by the instructor. The inputs required for these two systems are vehicle speed (from Traction subsystem) and you may select different width implements to match your tractor. The desired depth will be an operator input and draft control setting will also be an operator input. The outputs are vertical and horizontal forces at the top and bottom hydraulic link arms and the position of the link arms. This information will be required for weight transfer.

You have complete control of the approach they take to designing and “building” the individual parts of the system.

This project will require many assumptions and simplifications in the development of each model. You must justify the decisions you make. These justifications could range from; a “complex component” would not substantially increase the “quality” of the overall system and therefore is not justified, to the fact that the resources (in your case time, which in industry relates to money) are not available to develop a more complex system even if there are significant improvement in the product. There is no right/wrong “design,” just good and bad justifications for the simplifications and assumptions made. Of course, oversimplification of your project until very little work is required will be reflected in the grade.

Expectations:

Initial Report (Exam 2): The initial report on the Governor and engine subsystems are due **Friday 18th April.** This report will require electronic submission of a working model, and a brief report (about 5 pages and appendix with specifications of engine). The report should be similar to in structure to that given for the final report below. I assume that this initial report will also be part of the final report. I expect you to show that you understand the principles of each subsystem and the justification of your approach is an important part of the reports.

Final Project Report: The initial report on the Governor and engine subsystems are due **Friday 30th April.** Final Report will be a formal report and must include the following. (although not necessarily under these headings)

Introduction (Brief Introduction to the project goals and criteria)

Literature Review. (A review of the history and state of the art. You must clearly show that you understand the background, issues and theory.)

Approach to Problem. (The approach and theory used to implement your models)

Alternative approaches. (Other methods that may also be applicable)

Justification of your approach and potential weaknesses to your approach. (Justify your approach and any assumptions or simplification you made. The justification may be more important than the decisions you made)

Main Body of your report (Description of your model and how each sub-section operates.)

Results, Discussion & conclusions. (Results and proof that you tested your model.)

Comments on the value of this project on learning and how it may be improved. Any other comments.

Grade Matrix:

Model Complexity and Accuracy	30% of total
Introduction and Lit review	15% of Total
Approach & Principles	30% of total
Report Quality	25% of total