Homework Assignment #4
(due July 13th)

1. Road Load Power
Using the following parameters for the UI Hybrid FSAE (powered by the YZ250), produce a plot of ground power and wheel torque required as a function of vehicle speed. Do this from 0 mph to the top speed listed in the table. Draw curves for climbing 0% and 2% grades. Assume a wheel diameter of 20 inches. Thoroughly discuss your findings.

Parameter	**Value**
Frontal area	7 sq ft
Vehicle weight	760 lbf (includes 200 lb driver)
C_d	0.45
C_r	0.04
Top Speed	60 mph
Cruise Speed	30 mph

2. Comparative Analysis of Engines
Rank a **chainsaw** (2-stroke SI), **mini-van** (4-stroke naturally aspirated SI), and a **semi-truck** (4-stroke turbocharged CI) from LEAST to GREATEST <u>at their maximum torque point</u> based on each of the following performance parameters. <u>Explain the reasoning for your order.</u>

- **Brake Power (example)**
  <u>ranking:</u> Chainsaw < Mini-Van < Semi-Truck
  <u>rationale:</u> size of the engine and magnitude of load associated with each application

- **Engine Speed**

- **Bmep**

- **Air/Fuel Ratio**

- **Brake Specific Fuel Consumption**

- **Mechanical Efficiency**

- **Volumetric Efficiency**

3. Predicting Trends in Engine Performance
a) Write an expression for bmep in terms of the thermal efficiency, mechanical efficiency, volumetric efficiency, and combustion efficiency, as well as other engine design parameters. Group terms together that are related to engine thermochemistry, engine fluid mechanics, and engine kinematics/machine design. Identify each of these groupings.

b) Write an expression for the brake specific fuel consumption in terms of the mechanical efficiency, thermal efficiency, and combustion efficiency as well as the heating value of the fuel.

c) Reasoning with your equations, indicate the <u>sign (+, -, or 0)</u> of the likely change in **bmep** and also in **bsfc** based on modification of the design or operating parameter. <u>Assume that all other design/operating conditions remain the same.</u> Provide a short rationale for each answer.
- Increasing ambient temperature
- Decreasing ambient pressure
- Increasing engine displacement
- Increasing the air/fuel ratio
- Using a lower viscosity lubricant
- Improving intake/exhaust tuning

4. System Modeling/Energy Balancing
The fuel chemical energy entering an engine per unit time is 200 kW. The arbitrary efficiency (i.e. fuel conversion efficiency) of the engine is 32.5%. The mechanical efficiency is 90%. The combustion efficiency is 95%. Heat losses to the coolant and oil (removed by the radiator and oil cooler combined) are 55 kW. Heat conducted to engine surfaces and convected/radiated away to ambient is estimated to be 10 kW. **<u>What percentage of the incoming fuel chemical energy becomes each of the following?</u>** Outline any assumptions you make and provide supporting calculations, diagrams, or discussion as needed. **HINT: Draw a control volume around the engine and keep track of all energy flows entering/leaving. Note that some quantities refer to entities that do not leave the engine directly (i.e. they are transformed into something else).**

a) Brake work (leaving via the output shaft)
b) Indicated work (predicted by in-cylinder pressure/volume data)
c) Friction work (dissipated between moving parts within the powertrain
d) Rejected heat to the coolant and oil (removed by radiators)
e) Rejected heat to ambient by/from non-radiator surfaces
f) Exhaust chemical energy (leaving the engine in the form of unburned fuel)
g) Exhaust sensible energy (leaving the engine in the form of elevated gas temperature)

5. **Literature Searching/Information Processing**
Locate 5 substantive articles on your approved ME 433 research project. Give the citation and abstract for each source. Write a 2-3 sentence summary that explains how contents of each article will help you address at least one of your project research questions.