Homework #1 - due Tuesday, 1/23 by 4:00 pm
bonus problems - due Thursday, 1/25 by 4:00 pm

Readings for this homework assignment and upcoming lectures

1. Read lecture notes:
   - Part 1. Introduction to Energy
   - Part 2. Energy Perspectives
   - Part 3. Growth Rate and Hubbert's Peak
2. Watch the sequence of videos on Prof. Bartlett's lecture on Arithmetic, Population, and Energy; the link to the videos is on the course website and on Canvas.

   link to Prof. Bartlett's Lectures

Homework Submission

For this first assignment, the homework is to be worked and submitted individually either in class or by dropping off at my office (MEEM 905).

Cite your sources of information for each problem.

Homework #1 – Tuesday, 1/23 by 4:00 pm

1. How many pounds of coal is equivalent to a million BTUs? [cite your sources]
2. How many gallons of gasoline is equivalent to a million BTUs? [cite your sources]
3. How many therms of natural gas is equivalent to a million BTUs? [cite your sources]
4. Weston 1.19
5. Weston 1.21
6. Explain why is the magnitude of g_c equal to 1 for all of the common engineering unit systems except the English Engineering system? What is another set of common units for which g_c does not have a magnitude equal to 1.
7. Determine the energy and power equivalent of gasoline: [cite your sources of information]
   (a) Calculate the energy in 25 gallons of gasoline in terms of kJ, Btu's, and tons of TNT using the average API gravity in your calculation. Gasoline has an average API (American Petroleum Institute) gravity of 70 °API.
   (b) If it takes 5 minutes to transfer 25 gallonsof gasoline. What is the equivalent power during this transfer in kW and hp?
8. A 2400-MW_e power plant has the following power demand for a given day:

12-5 a.m.:	850 MW	9-12 a.m.:	2150 MW	5-6 p.m.:	2430 MW
5-7 a.m.:	1250 MW	12-1 p.m.:	2040 MW	6-8 p.m.:	1850 MW
7-8 a.m.:	1840 MW	1-4 p.m.:	2500 MW	8-10 p.m.:	1500 MW
8-9 a.m.:	1960 MW	4-5 p.m.:	2450 MW	10-12 p.m.	1150 MW

   Find the total power output in:
   (a) MW_e·days/day, (b) kW_e·h/day, (c) MeV_e/day, (d) J_e/day, and (e) Btu_e/day.

   Assume that the plant burns coal with a heating value (energy content) of 26,400 kJ/kg with an overall efficiency of 32%. Determine (f) the total mass of coal, in short tons consumed during the day's operation, and find (g) the maximum design coal rate, in short tons per hour, required for proper operation of the unit. Also evaluate (h) the heat rate of the unit in Btu/kWh, (i) the capacity factor of the unit for one day's operation, and (j) the load factor for the same period of operation.
9. Determine the area of solar cells required to drive a commuter electric car if the overall conversion efficiency of the propulsion system, including the electromagnetic-electric-mechanical conversion is 13 percent. Assume that the car requires 24 hp and that the average gross solar input is 650 W/m^2. If the system can store energy while sitting in the parking lot and is storing energy at a rate of 4 hours for each hour of operation, find the required area of the solar-cell array. Assume the storage efficiency of the batteries is 60 percent.

Homework #1 – 5290 only

10. Weston 1.18

11. A 2007 Associated Press article states that Ann Arbor will replace street lights with Light-Emitting Diodes (LED's). The article states:
    (a) LED technology uses half the energy of traditional bulbs,
    (b) the change could save Ann Arbor $100,000 per year,
    (c) lighting consumes 22% of the electricity in the United States,
    (d) Ann Arbor's lighting conversion will reduce the city's production of carbon dioxide and gases that contribute to global warming in an amount equal to taking 400 cars of the road.

    Making reasonable engineering assumptions, evaluate if these are legitimate claims or a gross exaggerations. [cite your sources of information]

bonus problems – Thursday, 1/25 by 4:00 pm

12. The world's nuclear arsenal has been estimated to be 13,000 megatons of TNT. Determine the minutes of equivalent sunshine that would yield the same amount of energy to the earth. Also evaluate the length of time this stockpile could supply one hundred 1000-MW_e power reactors with a thermal efficiency of 34 percent and a capacity factor of 70 percent.

13. Weston 1.15