Homework #9 - due Wednesday, December 16, 2015 by 5:00 pm
bonus problems - due Thursday, December 17, 2015 by 5:00 pm

Readings for this homework assignment and upcoming lectures

- Download & read lecture notes:
  - Part 11a. Solar Energy - Insolation
  - Part 11b. Solar Energy - Collectors
  - Part 11c. Solar Energy - Storage
  - Part 12. Solar Energy - Photovoltaics
  - Part 14. Wind Energy
  - Watch Wind Energy Lecture: [Wind Energy](#)
    The lecture begins approximately 3 minutes into the video.

- Review Appendix M. Solar Constants (for Northern Latitudes)

- Review Appendix N. Solar Position and Irradiation Values

- Review Appendix O. Variation of Solar Radiation with Latitude

Homework Submission

- For this assignment, the homework is to be worked as a group assignment and submitted as a group in class or by dropping off at my office (room 831). If you use EES for this assignment, then print a copy of the code and solution and include with the homework.

- Bonus problems are always to be worked and submitted individually.

- **At the end of each problem, rank your confidence in the answer from 1 to 5; 5 being very confident and 1 being ‘a guess’**.

- PLEASE include the course number (MEEM4200, MEEM5290) in the subject line of any email correspondence.
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1. A solar collector is designed to track the sun so that the collector surface is always perpendicular to the sun’s rays. The collector is located at 50°N and 88°W.
   
   (a) Determine the tilt and azimuth angles of the collector necessary for proper tracking at 9:00 am, local time on May 10th.
   
   (b) Determine the combined beam (direct) and diffuse-scattered solar insolation if the sky is clear at the same time and date.

2. A 7.5-cm-diameter circular photovoltaic solar cell is exposed to a solar energy flux of $2.5 \times 10^{17}$ photons/cm² s at an average photon wavelength of 0.0868 µm. Calculate the solar insolation on the cell in W/m². This is a group assignment.

3. A 550 nm, monochromatic 1 mW light source is incident on a silicon wafer.
   
   (a) Determine the number of photons per second impinging on the wafer.
   
   (b) Determine the maximum possible efficiency of conversion to electricity.

4. Determine the maximum mechanical power output for a 17-m-diameter, 20-m-high Sandia Vertical Axis Wind Turbine operating at 50 rpm in 40 km/hr steady winds. The mechanical efficiency of the running gear is 0.85.

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5. What should the overhang $h$ be so that the south-facing window is shaded at solar noon on June 21? The house is located in Houghton, Michigan at an elevation of 600 feet above sea level.

6. A manufacturer provides the following “name plate” data for a silicon solar cell at 27°C:
   
   - short-circuit current density, $j_s = 158$ A/m²
   - reverse-saturation current density, $j_o = 8 \times 10^{-8}$ A/m²

   (a) For maximum power, determine the solar cell area required to deliver 1 kW_e (DC).
   
   (b) Estimate the conversion efficiency for an incident solar flux of 1200 W/m².