SUBJECT INFORMATION – THERMODYNAMICS & PROPULSION

Learning Objectives:

To be able to:

1) Use the First Law of Thermodynamics to estimate the potential for thermo-mechanical energy conversion in aerospace power and propulsion systems;
2) Use the Second Law of Thermodynamics to evaluate the limitations on thermal-mechanical energy conversion in aerospace power and propulsion systems;
3) Estimate heat transfer rates in simple engineering situations such as a convectively cooled turbine blade;
4) Carry out conceptual design of basic aerothermal components and systems.

Measurable outcomes [assessment method]:

Be able to:

1) To be able to state the First Law and to define heat, work, thermal efficiency and the difference between various forms of energy; [quiz, homework, PRS]
2) To be able to identify and describe energy exchange processes (in terms of various forms of energy, heat and work) in aerospace systems; [quiz, homework, PRS]
3) To be able to explain at a level understandable by a high school senior or non-technical person how various heat engines work (e.g. a refrigerator, an IC engine, a jet engine); [quiz, PRS]
4) To be able to apply the steady-flow energy equation or the First Law of Thermodynamics to a system of thermodynamic components (heaters, coolers, pumps, turbines, pistons, etc.) to estimate required balances of heat, work and energy flow; [homework, quiz, PRS]
5) To be able to apply ideal cycle analysis to simple heat engine cycles to estimate thermal efficiency and work; [quiz, homework, PRS]
6) Explain the physical content and implications of the second law in non-mathematical terms; [quiz, homework, PRS]
7) Define entropy [quiz, homework];
8) Use entropy calculations as a tool for evaluating irreversibility (lost work) in engineering processes; [quiz, homework]
9) Obtain a basic physical intuition for the thermodynamic performance of real power and propulsion devices as indicated by recognition of what good, average, and poor performance is (metrics and numbers) for engineering power and propulsion devices [homework, PRS];
10) Estimate heat transfer rates for aerospace vehicle conditions [quiz, homework, PRS];

Other information

Web Page: Lecture schedule and reading assignments can be found at
http://web.mit.edu/16.unified/www/FALL/thermodynamics/

Texts:

1) *Thermodynamics and Propulsion Notes 2008 - 2009*
2) *Understanding Thermodynamics*, by Van Ness, H. C., Dover Press Publishers
3) *Fundamentals of Thermodynamics*, Sonntag, R. E., Borgnakke, C, and Van Wylen, G. J., John Wiley Publishers, 1998
4) *Mechanics and Thermodynamics of Propulsion*, by Hill, P., and Peterson, C., Addison-Wesley Publishing Company, 2nd Edition, 1992.

Some Notes on Teaching & Learning Methods

1) Discussion of material during lectures (following course notes) and concept questions using person response system (PRS);
2) Reading assignments and reviewing the lecture material on a regular basis; taking notes in class helps to process the material; reading and reviewing course notes / books / handouts helps to further digest the material and to acquire fluency in using thermo concepts (reflect on what things *mean* rather than memorize equations);
3) Homework, homework, homework … It is crucial that you spend "soak" time with the material to internalize the concepts and their application. The homework also helps to develop and to strengthen your problem solving skills. It is strongly suggested that you first try to solve the problems by yourself and then discuss challenges in groups or in office hours if necessary (start early to allow time to discuss challenges and questions). The Unified Engineering collaboration rules apply (see Unified Engineering Course Facts for details);
4) Quizzes to assess individual performance (versus that of a study group);
5) Recitations to review the material from previous lectures and to introduce relevant examples (may be related to the assigned homework);
6) Office hours and study groups to discuss concepts, approaches and methods after individual engagement with the material and problem sets and to clarify conceptual questions and problems. The Unified Engineering collaboration rules apply (see Unified Engineering Course Facts for details).