Advanced Design Methods I 
(3-3-4)

COURSE OUTLINE

I. Textbook and Class Materials

A. Primary Text (PT):
Reading assignments will be provided in class

B. Course Notes (CN):
Numerous handouts will be given out in class or referenced to the web to complement the text materials

II. Professors/Instructors

A. Primary Instructor:
Dr. Dimitri N. Mavris, Room 301A SST Bldg, e-mail: dimitri.mavris@aerospace.gatech.edu, tel. (404) 894-1557

B. Other Instructors:
Dr. Michelle R. Kirby, Room 306A SST Bldg.
e-mail: michelle.kirby@aerospace.gatech.edu, tel. (404) 385-2780

III. Grading

A. Exams
1) Two Exams will be given worth 50% (25% each).
   Exam #1: October 28th (Subject to change)
   Exam #2: November 25th (Subject to change)
2) Team Project (including presentations and written reports) will be included throughout the course worth 45%. Details regarding the projects and due dates will be given at a later time and will be given in increments.
   *Application of TIES to a commercial fixed wing vehicle, formal report and presentation*
3) Homework assignments worth 5%

IV. Class Topic

1. Traditional development process: performance driven
   a. Definition of the process and the components
   b. Why this doesn’t work: shortcomings of the traditional approach
      i. Unforeseen design flaws
      ii. Historical data reliance doesn’t work for new innovative systems
      iii. Throw it over the wall mentality of engineer’s to manufacturing
2. Establishing the need for a paradigm shift in Design:
   a. Comparison of Toyota and Ford and the number of design changes into the design cycle and the cost to do those changes (supplemental notes)
   b. Introduction to Taguchi methods and Design for quality (supplemental notes)
   c. Motorola's Six Sigma Process (Chap 1)
3. Paradigm Shift: quality and affordability driven to make the right decisions early on (supplemental notes)
1. Phases in the Acquisition process
   a. Distribution of knowledge between the disciplines as a function of time into design/acquisition process
   b. Define Affordability: Commercial and Military (in terms of weapon's systems effectiveness) example
      i. Balancing multiple and conflicting objectives, which requirement is more important
      ii. Defining important metrics
      iii. Roadmap to Affordability
         1. Physics based design through sizing and synthesis
         2. Importance of level of fidelity: how to increase the level of fidelity: direct linking, offline integration, or RSEs
         3. Rationale for an integrated Virtual, Stochastic, Life Cycle Design Environment (VSLCDE)
      iv. Description of needed elements

4. Introduction to the Taguchi Approach and Design of Experiments (Chaps 27,28,29,30,31)
   a. Taguchi approach:
      i. Control variables, Noise variables, Signal to noise ratios, Robust design
      ii. Analysis of Variance: single factor (Chap 24 - p 374-393); two factor (Chap 25 - p 394-401); multiple regressions (Chap 26 - p402-406)
   b. Screening Test
      i. Pareto Analysis (supplemental notes)
   c. Response Surface Methodology (Chap 33 - p493-516)
      i. Fundamentals for execution:
         1. Types of DoE's
         2. Correlation and Simple Regression (Chap 23 - p360-p372)
            a. Residuals, Sum of Squares, R^2, etc.
         3. Resolution of DoEs (p 434)
      ii. HSCT Example (supplementary notes)

Test #1

5. Introduction to Uncertainty and Risk in Design: reiterate the paradigm shift and how uncertainty fits into the paradigm shift and Design for Affordability (Background statistical info in Chap 6, 7, 8 – excluding 8.5,8.6)
   a. Robust Design Simulation (supplementary notes): include responses as a function of requirements, design, techs, and noise: analogy to early phases of design
   b. Types of uncertainty
   c. Fundamentals of uncertainty analysis
      i. Random or noise variables:
      ii. Results of probabilistic analysis (PDF and CDF) – review Chap 8 info
      iii. Process capability (Cp and Cpk) (Chap 11 p186-221)

6. Approaches for probabilistic design (supplemental notes)
   a. MC+Analysis tool; Analysis tool+RSM+MC; Analysis tool+FPI
   b. Sampling methods

7. Using probabilistic techniques in Systems Design (supplemental notes)
   a. Economic uncertainty
   b. System feasibility through design space exploration

8. Infusion of new technologies: Technology Push v. Technology Pull
   a. Forecasting methods (Normative and exploratory)
   b. Technology development trends: the S-curve
      i. Physics driven (rise), programmatic (run)
      ii. Evolutionary versus revolutionary
      iii. Disruptive versus continuous
Test #2

V. Miscellaneous

Text readings and homework will be given in class
Tutorial labs on tools and programs will be announced in class

VI. Suggested Readings

All papers can be found at http://www.asdl.gatech.edu/


