Engineering Faculty Document No.: 5-00
Date: September 18, 2000

TO: Faculty of Schools of Engineering

FROM: Faculty of the School of Aeronautics and Astronautics

SUBJECT: New Course (result of splitting AAE 451 into two courses)

The faculty of the School of Aeronautics and Astronautics has approved the new course listed below. This new course is a result of splitting AAE 451 into two courses (AAE 451 will be submitted as a course description change EFD 6-00). This action is now submitted to the Engineering Faculty with a recommendation for approval.

AAE 450 Spacecraft Design
Sem. 1 and 2, Class 2, lab. 3, cr. 3
Prerequisites: AAE 251, 334, 340, 352, 364 and 439
Corequisite: AAE 440

Course Description: Senior students perform a team-based spacecraft design, requiring application of the education and skills developed in the aerospace curriculum. Components include analysis methods for preliminary design, development of an initial vehicle concept, and development of a complete numerical model of the mission, culminating in oral and written reports by the teams.

Reason: Students may take either aircraft design or spacecraft design to fulfill the capstone design requirement. Having separate course numbers is a necessary part of the School's astronautics initiative.

Thomas N. Farris, Professor and Head
School of Aeronautics and Astronautics

APPROVED FOR THE FACULTY
OF THE SCHOOLS OF ENGINEERING
BY THE COMMITTEE ON
FACULTY RELATIONS

CFR Minutes #929

Date 10/11/00

Chairman CFR C. D. Sutton

AAE 450

Spacecraft Design

1. **Justification:** Students may take either aircraft design or spacecraft design to fulfill the capstone design requirement. Having separate course numbers is a necessary part of the School's astronautics initiative.

2. **Level:** Senior

3. **Prerequisites:** AAE 251, 334, 340, 352, 364, and 439.
   Corequisite: AAE 440

4. **Course Description**

   Senior students perform a team-based spacecraft design, requiring application of the education and skills developed in the aerospace curriculum. Components include analysis methods for preliminary design, development of an initial vehicle concept, and development of a complete numerical model of the mission, culminating in oral and written reports by the teams.

5. **Course Instructor:** Steven P. Schneider

6. **Course Outline**

a. Analysis Methods to be used for Preliminary Spacecraft Design

Loads, mass distribution, and center of gravity. Simplified estimation of structural weight. Orbital mechanics above a spherical rotating earth. Newtonian aerodynamics. Skin friction and heat transfer using simplified correlations. Static stability. Lumped heat-capacity model for thermal protection system. Selection among existing propulsion systems. Boost trajectory analysis. Use and adaptation of existing software.

b. Development of an Initial Vehicle Concept

Selection is based on historical background and engineering judgement, plus qualitative studies of vehicle requirements, mission goals, and possible vehicle concepts. The vehicle concept will include a number of free parameters, such as vehicle length, slenderness, mass, tank position, and so on. First formal report.

c. Development of a Numerical Model for the Vehicle Concept

Based on sections (a) and (b), a numerical model must be coded and checked. The concept in section (b) must be simple and specific, so that it is feasible to develop this model in the time available. Validation of model for second formal report.

d. Configure Vehicle using Trade Studies based on the Simulations

Quantitative trade studies performed using the model. Selection of final configuration. Reporting of vehicle characteristics and performance. Final report.

7. Text (Principal References)

J.D. Anderson, *Hypersonic and High-Temperature Gas Dynamics*, AIAA Publications, Washington, DC, 2000.

H. Ashley, *Engineering Analysis of Flight Vehicles*, Dover, New York, 1992.

R.D. Bate, D.D. Mueller, and J.E. White, *Fundamentals of Astrodynamics*, Dover, New York, 1971.

M.D. Griffin and J.R. French, *Space Vehicle Design*, AIAA Education Series, 1991.

R.W. Humble, G. N. Henry, and W.J. Larsen, *Space Propulsion Analysis and Design*, McGraw-Hill, New York, 1995.

S.P. Schneider and W. Gustafson, *Methods for Analysis of Preliminary Spacecraft Designs*, a handout currently running 37 pages.

G.P. Sutton, *Rocket Propulsion Elements*, John Wiley and Sons, New York, 1992.

N. X. Vinh, A. Busemann, and R.D. Culp, *Hypersonic and Planetary Entry Flight Mechanics*, Univ. of Michigan Press, 1980.