Engineering Faculty Document No.: 24-02
Date: December 12, 2002

TO: Faculty of Schools of Engineering
FROM: Faculty of the School of Aeronautics and Astronautics
SUBJECT: New Undergraduate Course

The Faculty of the School of Aeronautics and Astronautics has approved the new course listed below. This action is now submitted to the Engineering Faculty with a recommendation for approval.

AAE 418, Zero-Gravity Flight Experiment
Sem. 1, Class 1, Lab 4, cr. 3.
Co-requisite: AAE 333 or consent of instructor.

Course Description:
Team-based design-build-test engineering experience to maximize the benefits of student participation in the NASA *Reduced Gravity Student Flight Opportunity Program* (or similar). Gravity, orbits, and weightlessness. Low-gravity capillary fluid physics, scaling laws, and components. Experiment design for multiple short zero gravity test times. Technical proposal writing, design for manufacturability, experiment fabrication, planning, testing, and execution.

Reason:
An extra-curricular Purdue University undergraduate team participating in the NASA *Reduced Gravity Student Flight Opportunity Program* in 1997 demonstrated the great engineering educational benefits of the program. Participation was then classified as AAE 490, *Directed Study* for 1998 and 1999. This course was created in 2000 to best capture and enhance the long-term, team-based, open-ended, multi-disciplinary, design-build-test experiences required for the students to create a successful research proposal and then build and perform the experiment in weightlessness on board a NASA astronaut-training aircraft. The student team writes and submits their proposal to NASA and builds the experiment. If the proposal is selected for flight test, then the students travel to the NASA Johnson Space Center and fly with their experiment. Every proposal submitted by students in the previous offerings of the course has been selected by NASA. This fine metric is a result of a course that teaches technical proposal writing and creates an environment that enables student success. The class was taught in Spring 2000, Spring 2001, and Fall 2002 as AAE 490G with enrollment of 7, 12, and 15, respectively. An Honors Freshman analogue was taught coincident with AAE 490G in Spring 2000 (HONR 199E) and Spring 2001 (HONR 199I) with 11 and 6 students, respectively.

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

AAE 418, Zero-Gravity Flight Experiment

- **Course Instructor:** Professor Steven H. Collicott

- **Course Description:**
  Team-based design-build-test engineering experience to maximize the benefits of student participation in the NASA *Reduced Gravity Student Flight Opportunity Program* (or similar). Gravity, orbits, and weightlessness. Low-gravity capillary fluid physics, scaling laws, and components. Experiment design for multiple short zero gravity test times. Technical proposal writing, design for manufacturability, experiment fabrication, planning, testing, and execution.

- **Course outline:**
  1. Review of gravity, orbits, and weightlessness. [2 hours]
  2. Capillary fluid physics relevant to spaceflight systems.
     a. Surface tension. [2 hours]
     b. Contact angle: static and dynamic. [2 hours]
     c. Bubbly flow. [1 hour]
     d. History of liquid propellant control in space by surface tension. [3 hours]
     e. Unsolved issues in the field as a source of experiment topics. [3 hours]
  3. Proposal writing: teaming, responding to a Request for Proposals, effective creation and use of illustrations, proofreading, and writing for a reviewer to read. [14 hours]
  4. Experiment design:
     a. time, space, mass, and power requirements dictated by flight safety. [2 hours]
     b. experimenter interaction versus automation. [2 hours]
     c. design for manufacturability. [3 hours]
     d. budgeting. [1 hour]
     e. determining and then meeting requirements for resolution, dynamic range, etc., in data acquisition and post-processing. [4 hours]
     f. NASA Flight Safety Regulations – materials, electrical power, crashworthiness, strength, pressure vessels, toxins, containment. [3 hours]
  5. Hardware design, mechanical drawing, materials selection. [4 hours]
  6. CNC and manual machining. [6 hours]
  7. Experiment fabrication (specific experiences vary by student interest). [20 hours]
  8. Experiment pre-flight testing. [3 hours]

  Total in-class hours: 15 weeks * 5 hours = 75 hours.

- **Text:** Reports from aerospace industry and the American Institute of Aeronautics and Astronautics (AIAA) as best suited for the experiment topic. NASA technical reports plus the flight-test requirements and safety documents that dictate experiment safety and procedures in the aircraft.