MAE 467 – Fall 2009
Introduction to Flight Simulation
Department of Mechanical and Aerospace Engineering

CATALOG DESCRIPTION:
This course is designed to give aerospace engineering undergraduate students the fundamental concepts of flight simulations through interaction with computer simulation tools of different levels of complexity starting with simplified linear and non-linear models, continuing with PC-based simulation packages with high accuracy aerodynamic models and advanced graphics, and ending with a six degrees-of-freedom motion based flight simulator.

INSTRUCTOR: Dr. Mario Perhinschi
Phone: 304-293-3301
E-mail: Mario.Perhinschi@mail.wvu.edu
Room 521 ESB

OFFICE HOURS: Tuesday and Thursday 9.00-10.00am and 3.30-5.00pm. Other visits by appointment via e-mail. However, I am happy to see you in my office and will try to accommodate “drop in” visitors.

CREDIT: 3 hrs.

PRE-REQUISITE: MAE 365

TEXTBOOK: Class notes and/or handouts provided by the instructor
Recommended additional bibliography (optional):
B. L. Stevens, F. L. Lewis, “Aircraft Control and Simulation”,

FORMAT: The class format will be in the form of lectures for the entire class followed by laboratories with small groups of students (2-3).

WEB SITE ACCESS: To access your grades and course materials, you can go to any computer that is connected to the network. Open your web browser and point to: http://eCampus.wvu.edu/. Use your MIX
account ID and password to get access.

**CLASS COMMUNICATIONS:** We will use email extensively for class communications within the *eCampus* environment. The messages are not forwarded automatically to your MIX account, you have to set-up *eCampus* to forward. Access *eCampus* often and check your email regularly for news about the class. I’ll try to answer your email as expeditiously as possible. Please send your messages to me *ONLY* through *eCampus* or to the address above.

**COURSE OBJECTIVES:** The students will be taught basic skills for implementing aircraft mathematical models within a modern flight simulator. In addition, the students will be exposed to recent trends in the aviation industry for the hardware and software components of flight simulators. The Flight Dynamics and Control (FDC) Matlab/Simulink toolbox will first be introduced; next the students will be introduced to D-Six, a very detailed flight simulation package produced by Bihrle Applied Research (BAR). Special emphasis will be placed on the assessment of the aircraft handling qualities from flight simulations and sensitivity analysis of the handling qualities with respect to critical aerodynamic characteristics of the aircraft. Finally, the students will be introduced to the WVU 6DOF motion base flight simulator. The course will emphasize the complete design and execution of simulation tests and the processing of data for performance and handling qualities assessment.

**LEARNING OUTCOMES:**

At the end of this course, the students are expected to be able to:
- use the fundamental theorems of Mechanics to derive the 6DOF equations of motion for an aircraft;
- express/calculate the aerodynamic forces and moments using experimental and analytical methods and incorporate them in a simulation package;
- assess aircraft handling qualities through numerical simulations;
- identify the effects of geometric, inertial, aerodynamic, and thrust parameters on the handling qualities and the dynamic response of the aircraft;
- use the FDC toolbox and the D-Six simulation package;
- use the WVU 6DOF simulator to obtain data for aircraft handling qualities and dynamic performance analysis;
- design a simulation experiment, perform it, and process the data for aircraft handling qualities and dynamic performance analysis.

**GRADING PROCEDURE:**

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<tr>
<th>Component</th>
<th>Weightage</th>
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<tr>
<td>Quizzes/Tests (3-4)</td>
<td>15 %</td>
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<tr>
<td>Homework and Technical Reports (7)</td>
<td>55 %</td>
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<tr>
<td>Mid Term (1)</td>
<td>15 %</td>
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<tr>
<td>Final Exam</td>
<td>15 %</td>
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The final grade in this course will be assigned using the scale:
90-100 = A; 80-89 = B; 70-79 = C; 60-69 = D, <60 = F.
Class attendance is strongly recommended.
Do not count on getting curve points—they are fairly rare.

**Tentative Course Schedule:**

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<tr>
<th>Week #</th>
<th>Topic</th>
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<tr>
<td>Week #1</td>
<td>Review of equations of motion, kinematic equations, and flight path equations.</td>
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<tr>
<td>Week #2</td>
<td>Modeling of the aerodynamic characteristics of an aircraft.</td>
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<td>Week #3</td>
<td>Review of longitudinal and lateral-directional dynamic characteristics from transfer functions.</td>
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<tr>
<td>Week #4</td>
<td>Introduction to the WVU 6DOF flight simulator, general architecture and operation.</td>
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<tr>
<td>Week #5</td>
<td>Flight Dynamics Control (FDC) toolbox: modeling issues and capabilities.</td>
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<tr>
<td>Week #6</td>
<td>D-Six Flight Simulation package: modeling issues and capabilities. Review for Midterm Exam.</td>
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<td>Week #7</td>
<td>Integration of modules within a comprehensive flight simulation environment. Midterm Exam.</td>
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<td>Week #8</td>
<td>Customizing a flight simulation experiment. Data manipulation within D-Six.</td>
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<td>Week #9</td>
<td>Assessment of the longitudinal handling qualities from D-Six simulations. Sensitivity analysis of the longitudinal stability derivatives with respect to short period and phugoid characteristics.</td>
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<tr>
<td>Week #10</td>
<td>Assessment of the lateral directional handling qualities from D-Six simulations. Sensitivity analysis of the lateral directional stability derivatives with respect to rolling, Dutch roll, and spiral characteristics</td>
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<tr>
<td>Week #11</td>
<td>Customizing a flight simulation experiment. Instrument panel development within D-Six.</td>
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Week #12  Design of a simulation experiment for handling qualities evaluation using the WVU 6DOF flight simulator.
Week #13  Performing the simulation experiments in the WVU 6DOF flight simulator, data acquisition, and processing.
Week #14  Thanksgiving break.
Week #15  Use of simulation data for handling qualities assessment. Analysis of the simulator experiment results and open discussion on the three aspects of the process: design, execution, and data processing and analysis.
Week #16  Conclusion of the course and review for Final Exam.
Week #17  Final Exam.

POLICIES:
It is expected that technical reports and other assignments are prepared in a professional manner with a detailed documentation of the work. Reports are due at the beginning of the class period on the day they are due. Late reports are not accepted. A make-up test shall be given only if the student can show valid reason as per WVU rules. This has to be established before the regularly scheduled test.

STATEMENT ON SOCIAL JUSTICE:
WVU is committed to social justice. The instructor of this course concurs with WVU's commitment and expects to maintain a positive learning environment based upon open communication and mutual respect and nondiscrimination. Our University does not discriminate on the basis of race, sex, age disability, veteran status, religion, sexual orientation, color, or national origin. Any suggestions as to how to further such a positive and open environment will be appreciated and given serious consideration. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise the instructor and make appropriate arrangements with Disability Services (293-6700).