FLIGHT MECHANICS AND DYNAMICS
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AERO3640 COURSE OUTLINE

COURSE STAFF

Contact details of academic staff involved

Zoran Vulovic (course convener, Module C lecturing, flight simulation and flight experiments)
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Tel (02) 9385 6261
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John Page (flight experiments)
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Dr Peng’s consultation time is Tuesday 2 – 5 PM. Consultation times with other staff members will be announced later.

Consultations are possible outside the set times, but a prior appointment with the lecturer will be appreciated. Face-to-face consultations are the preferred form, telephone is acceptable, while Blackboard Learn discussions, or email should only be used as a last resort and only for resolving simple or more general issues.

COURSE DETAILS

Units of credit

This is a 6 unit-of-credit (UoC) course, and involves 7 hours per week (h/w) of face-to-face contact. In addition, you will do a 30-minute flight simulation, as well as a five-day flight exercise during the mid-session break in September 2013.

UNSW expects that you will put in, on average, 40 h/w for 24 UoC (including both in-class and out-of-class time) for an effective 16 weeks of the session. This means that, for
this course, you should aim to spend not less than an additional four hours per week of your own time. This should be spent in making sure that you understand the lecture material, further reading about the course material, and revising and learning for the examinations.

AERO3640 is an important stepping stone in aerospace engineering education. Module A of the course is a sequel to MMAN1300 Engineering Mechanics. In MMAN1300, you learned about statics - the equilibrium of bodies under the action of forces and dynamics - the motion of particles. This module covers engineering mechanics, the emphases of which is the plane dynamics of rigid bodies and practical applications. Modules B and C are closely related to AERO3630 and AERO3650 where you learn how aerodynamic forces and moments are generated, while in this course you use those forces and moments to analyse performance and stability of aircraft. The knowledge gained here is crucial for AERO4110 and AERO4120, as well as for the career of an aerospace engineer. In addition, the stability analysis of flying vehicles presented in Module C is based on methods learned in MMAN3200 Linear Systems and Control.

**Expected student learning outcomes**

By the end of this course it is expected that you will:

- Be able to solve kinematics and kinetics problems on rigid bodies and analyse the given mechanism;
- learn how to calculate relevant flight parameters based on basic aircraft data;
- fully understand the concept of static stability and the factors that affect it;
- learn how to analyse dynamic stability of aircraft based on its response to controlled inputs as well as external perturbations.

**Graduate attributes**

UNSW’s graduate attributes are shown at [https://my.unsw.edu.au/student/atoz/GraduateAttributes.html](https://my.unsw.edu.au/student/atoz/GraduateAttributes.html) and are:

1. * the skills involved in scholarly enquiry;
2. * an in-depth engagement with the relevant disciplinary knowledge in its interdisciplinary context;
3. * the capacity for analytical and critical thinking and for creative problem solving;
4. the ability to engage in independent and reflective learning;
5. * information literacy — the skills to locate, evaluate and use relevant information;
6. the capacity for enterprise, initiative and creativity;
7. an appreciation of, and respect for, diversity;
8. * a capacity to contribute to, and work within, the international community;
9. the skills required for collaborative and multidisciplinary work;
10. an appreciation of, and a responsiveness to, change;
11. a respect for ethical practice and social responsibility; and
12. * the skills of effective communication.
These broad graduate attributes are contextualised for the discipline of engineering and shown at


In this course you are expected to improve Attributes 1, 2, 3, 5, 8 and 12.

Parallel teaching

Module A will be delivered simultaneously with the Module A of MMAN3300.

COURSE MODULES

The course comprises three separate parts: Plane Dynamics of Rigid Bodies (Module A) Flight Mechanics and Performance (Module B) and Flight Dynamics and Stability (Module C). These three parts will be presented in separate sections of this document. In addition, there will be a practical module consisting of Flight Simulation and Flight Experiments.

Module A

The teaching approaches that will be used include:
- Presentation of the material (derivations and examples) in lectures
- Tutorials to help students to understand and solve problems
- Laboratory experiments to assist in understanding the fundamentals taught in lectures
- Series of quizzes which require students to regularly study their lecture material.

The Module assessment will consist of the following components:

<table>
<thead>
<tr>
<th>Component</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1</td>
<td>4</td>
</tr>
<tr>
<td>Lab exercise</td>
<td>8</td>
</tr>
<tr>
<td>Quiz 1 (Week 4)</td>
<td>4</td>
</tr>
<tr>
<td>Mid-session test (Week 6)</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total for Module A</strong></td>
<td><strong>31</strong></td>
</tr>
</tbody>
</table>

Late submission of the assignment will incur a 10% penalty per day.

The submission of assignments and lab reports should have a standard School cover sheet. All submissions are expected to be neat and clearly set out. Assignments and reports should be submitted directly to the assignment box for AERO3640 by the due date.

Classes will be organised in Weeks 1 - 6 as follows:

**Lectures:**
- Tuesday 12:00 – 14:00 Mathews Theatre A
- Thursday 14:00 – 16:00 CLB 7

**Tutorials:**
- Thursday 9:00 – 11:00 ME203, OMB145
The following course schedule is an indication only.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>References</th>
<th>Assessment</th>
<th>Graduate attributes assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Part A</strong>: Plane kinematics of rigid bodies - Velocity analysis</td>
<td>Chapter 5/1-5/5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Method of instantaneous centres</td>
<td>Meriam &amp; Kraige</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chapter 4</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Waldron &amp; Kinzel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Acceleration analysis - Review of acceleration - &quot;Coriolis type&quot; problems</td>
<td>Chapter 5/6-5/7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meriam &amp; Kraige</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Kinetics of rigid bodies</td>
<td>Chapter 6/2 -6/6</td>
<td>Assignment 1</td>
<td>1(c), 1(d)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meriam &amp; Kraige</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Impulse and momentum methods</td>
<td>Chapter 6/8</td>
<td>Quiz 1</td>
<td></td>
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<tr>
<td>5</td>
<td>Contingency time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Contingency time</td>
<td></td>
<td>-Mid-semester</td>
<td>1(f), 2(c), 3(a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>test</td>
<td>Lab 1</td>
<td></td>
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</table>

The following recourses are available:

**Textbooks**


These books are available in the UNSW library and bookshop

**Suggested additional reading**


**Additional materials provided in Moodle and Blackboard:**

This course has a website which includes:
• copies of assignments;
• laboratory experiment handout;
• a discussion forum.

The discussion forum is intended for you to use with other students enrolled in this course. The course convenor will occasionally look at the forum, monitor the language used and take note of any frequently-asked questions, but will not respond to questions on the forum. If you want help from the convenor then direct contact is preferred.

Other resources

If you wish to explore any of the lecture topics in more depth, then other resources are available and assistance may be obtained from the UNSW Library.

One starting point for assistance is:

info.library.unsw.edu.au/web/servicesfor/index.html

Module B

The Flight Mechanics and Performance part deals with aircraft performance calculations. This module will attempt to develop your analytical skills in order to solve a variety of problems related to aircraft’s performance.

The mark for Module B will be derived from the following components:

<table>
<thead>
<tr>
<th>Assignment (due week 12)</th>
<th>15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final examination</td>
<td>16%</td>
</tr>
<tr>
<td><strong>Total for Module B</strong></td>
<td><strong>31%</strong></td>
</tr>
</tbody>
</table>

There will be one hour of lectures/tutorials (in weeks 1 – 6) on Wednesdays 10:00 – 11:00 and three hours of lectures/tutorials (in weeks 7 – 12) on Wednesdays 10:00 – 11:00 and Thursdays 9:00 – 11:00.

Flight Mechanics Topics:

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2</td>
<td>Introduction, The Atmosphere, Units</td>
</tr>
<tr>
<td>3, 4</td>
<td>Airspeed, Airfoils</td>
</tr>
<tr>
<td>5, 6</td>
<td>Lift and Drag</td>
</tr>
<tr>
<td>7</td>
<td>Force Balance &amp; Power for Un-accelerated Flight</td>
</tr>
<tr>
<td>7, 8</td>
<td>Climbing Flight</td>
</tr>
<tr>
<td>8</td>
<td>Energy Height</td>
</tr>
<tr>
<td></td>
<td>Range and Endurance</td>
</tr>
<tr>
<td>----</td>
<td>---------------------</td>
</tr>
<tr>
<td>9</td>
<td>Landing Distances</td>
</tr>
<tr>
<td>9, 10</td>
<td>Helicopter Performance &amp; Estimation</td>
</tr>
<tr>
<td>10</td>
<td>Descending Flight</td>
</tr>
<tr>
<td>11</td>
<td>Flight Maneuvers</td>
</tr>
<tr>
<td>11, 12</td>
<td>Take-Off Distances</td>
</tr>
</tbody>
</table>

For this component, no lecture notes will be provided. Students should make reference to the various texts available in the library on the subject. Recommended texts are:


**Module C**

This module of the course covers the stability and control of aircraft. At the end of the module you will be able to, based on relevant parameters, analyse static and dynamic stabilities of aerial vehicles. Topics covered include:

1. Static stability
2. Longitudinal Dynamics
3. Handling Qualities
4. Autopilots for Longitudinal Dynamics
5. Lateral Dynamics
6. Autopilots for Lateral Dynamics
7. Introduction to Practical Aspects of Aircraft Control
8. Introduction to Gust Modeling and Analysis

The mark for Module C will be derived as follows:

- Test (week 11) 10%
- Final examination 21%

**Total for Module C 31%**

The textbook for this component is:

(Copies of the book are available in the library)

Recommended texts are:

3. Course handouts provided on Blackboard Learn.

Four lectures/tutorials will be delivered on Tuesdays 12:00 – 14:00 and Thursdays 14:00 – 16:00 (all in weeks 7 – 12).

**Practical module**

The practical part provides a crucial link between the theoretical knowledge gained during the class time and simulated or real flight situations. All three components largely contribute to developing necessary engineering skills and knowledge.

The simulation exercise will be carried out by each student individually on the P99L flight simulator in room L203. The exercise is booked by writing your name and surname on the list provided outside room L204 next to the time slot you chose. Please note that a successful completion of the flight simulation is a **pre-requisite** for the flight experiments.

Flight experiments will take place during the mid-session break of Semester 2 and more information will be provided in class towards the end of Session 1.

The mark for the practical module will consist of:

- Flight simulation: 2%
- Flight experiments (Session 2): 5%
- **Total for practical module**: 7%

**COURSE ASSESSMENT**

In order to pass the course, you must achieve a total mark of 50%, **but you must attain 40% minimum in each of Modules A, B and C.**

In addition, in order to qualify for flight exercises you must meet two requirements: a minimum total mark of 46 (out of 95) during the first session, and a completed simulation session.

The total mark for AERO3640 will be composed from the following components:

- Module A: 31%
- Module B: 31%
- Module C: 31%
- Practical Module: 7%
- **Total for the course**: 100%

It should be noted that a part of the assessment will be done in Semester 2, meaning that your marks will not be completed by July 2013. All of you whose score at the end of Semester 1 is between 46 and 95 (inclusive) will receive a grade of PE. If you happen to score 45 or less, that will be your final mark and your grade will be FL.

**Calculators**
A significant part of the final exam, mid-session tests and quizzes will require analytical work, which, in turn, will require the use of calculators. You will need to provide your own calculator, of a make and model approved by UNSW, for the examination. The list of approved calculators is shown at:
It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an “Approved” sticker for it from the School Office or the Engineering Student Centre prior to the examination. Calculators not bearing an Approved sticker will not be allowed into the examination room.

ACADEMIC HONESTY AND PLAGIARISM

What is Plagiarism?

Plagiarism is the presentation of the thoughts or work of another as one’s own.* Examples include:

• direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, website, Internet, other electronic resource, or another person’s assignment without appropriate acknowledgement;
• paraphrasing another person’s work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
• piecing together sections of the work of others into a new whole;
• presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
• claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

• correct referencing practices;
• paraphrasing, summarising, essay writing, and time management;
• appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.
Students are also reminded that careful time management is an important part of study and one of the
identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle
† Adapted with kind permission from the University of Melbourne.

CONTINUAL COURSE IMPROVEMENT

Periodically student evaluative feedback on the course is gathered, using among other means, UNSW’s Course and Teaching Evaluation and Improvement (CATEI) process. Student feedback is taken seriously, and continual improvements are made to the course based in part on such feedback.

In 2012 the response was overwhelmingly positive, but the negative comments were noted and attempts made at improving some of the aspects. Some of them, as the request for more flight simulation time, could not be addressed due to the technical and personnel limitations.

EXPECTATIONS OF STUDENTS

Attendance in lectures will not be recorded, but is strongly recommended.

As far as flight simulation is concerned students will be allowed to book their own times for the exercise. Once you book a simulation session it becomes compulsory. You are allowed to cancel the booking, otherwise you will lose marks for not turning up or for being late.

The flight exercises will require an extremely high level of punctuality and discipline. A special briefing session will be held on the first day of the exercise where you are going to be introduced with the rules governing in-flight and air-side behaviour. The most important part is to always obey instructions given by the flight personnel and your lecturers.

Special Consideration and Supplementary Assessment

For details of applying for special consideration and conditions for the award of supplementary assessment see Administrative Matters for All Courses, available from the School office as part of The Guide, or on the School website.

Information on relevant Occupational Health and Safety policies and expectations:
http://www.hr.unsw.edu.au/ohswc/ohs/ohs_home.html

Equity and Disability

Students who have a disability which requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer
(Disability) in the Student Equity and Disability Unit (SEADU) by phone on 9385 4734, email seadu@unsw.edu.au or via the website www.studentequity.unsw.edu.au/content/default.cfm?ss=0. The office is located on the Ground Floor of the Goodsell building (F20).

Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

December 2012

Zoran Vulovic