SCHOOL OF MECHANICAL AND MANUFACTURING ENGINEERING

THE UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF MECHANICAL AND MANUFACTURING ENGINEERING

AERO3640

FLIGHT MECHANICS AND DYNAMICS

SEMESTER 1  2012
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COURSE STAFF

Contact details and consultation times for course convener

Zoran Vulovic (lecturer-in-charge, Module C lecturing, flight simulation and flight experiments)
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John Page (flight experiments)
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Fax (02) 9663 1222
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Consultation times with individual 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, while Blackboard Learn discussions, phone or email should only be used as a last resort and only for resolving simple or more general issues.

Consultations with other staff members will have to be arranged separately.
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 2010.

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.

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 are to a large extent independent from each other and 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 module constitutes an important component of the basic engineering sciences. It is also academically demanding. In view of these points appropriate attention should be paid to this course, and it is very important not to fall behind.

There will be four hours per week of lectures (Monday and Thursday 09:00 – 11:00) and two hours per week for tutorials (Thursday 14:00 – 16:00) in weeks 1 - 6. An outline of the lecture component is shown in table 1. Two quizzes will be held during the first half of the session with weightings as indicated below. The dates for the quizzes will be announced in the class. There will be one mid-session test for Module A which will be held in week 8.

The experiment (compulsory for ALL STUDENTS) will require 2 half-hour experiments (a total attendance of one hour) in the laboratory. The outline of the laboratory component is detailed on page 6. Your lecturer will organise your laboratory attendance. You must attend the laboratory at the times and dates that are scheduled for you.

The assessment of this module will be based on the quizzes, laboratory work and test (week 8). The marks for the various components are:
Weights and pulleys experiment 4
2 Quizzes (3.5 marks each) 7
Mid-session test (week 7) 20
Total for Module A 31

Check the Blackboard site (http://lms-blackboard.telt.unsw.edu.au/webapps/portal/frameset.jsp) regularly as laboratory attendance schedules, marks and solutions to quizzes will be posted on the site.

The lecture topics and suggested problems are shown below. The sequence and time allocation of the various topics may be altered by your lecturer.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Lecturer: Dr. SS Leong</td>
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<table>
<thead>
<tr>
<th>WEE K</th>
<th>TOPICS</th>
<th>REFERENCES</th>
<th>PROBLEMS</th>
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<tbody>
<tr>
<td>1</td>
<td>Kinematics &amp; Kinetics of a Single Particle and Two Connected Particles Kinetics of Systems of Particles Mass Moment of Inertia</td>
<td>1/1-7. 2/1-6, 8-10 3/1-12, 14-15 4/1-5 B/1</td>
<td>2/10, 18, 33, 50, 89, 103, 128, 132, 161, 192, 200, 228, 230 3/24, 61, 67, 140, 143, 153, 167, 212, 216, 224, 265, 322, 323 4/4, 10, 11, 21, 22, 24, 26, 27 B/1, 5, 8, 13, 21, 29</td>
</tr>
<tr>
<td>2-3</td>
<td>Plane Kinematics of Rigid Bodies</td>
<td>5/1 - 7</td>
<td>5/12, 17, 35, 47, 48, 56, 57, 78, 85, 87, 88, 91, 96, 97, 111, 116, 118, 123, 139, 145, 152, 159, 173, 184</td>
</tr>
<tr>
<td>4</td>
<td>Kinetics of a Rigid Body in Plane Motion</td>
<td>6/2 – 5</td>
<td>6/4, 13, 15, 17, 28, 37, 44, 51, 63, 68, 70, 72, 75, 77, 83, 88, 101, 104</td>
</tr>
<tr>
<td>5</td>
<td>Work &amp; Energy for a Rigid Body in Plane Motion and Acceleration of a Rigid Body in Plane Motion from Work-Energy</td>
<td>6/6-7</td>
<td>6/118, 123, 129, 148, 152, 157, 166, 172</td>
</tr>
<tr>
<td>6</td>
<td>Impulse &amp; Momentum for a Rigid Body in Plane Motion</td>
<td>6/8.</td>
<td>6/173, 174, 180, 185, 192, 195, 205, 207</td>
</tr>
</tbody>
</table>

N.B. Problems indicated by **boldface** type are considered essential and a mastery of these is required to obtain a pass in the course.

The weights and pulley experiment involves two visits to the Applied Mechanics/Acoustics and Vibrations Laboratory (L206). The visits should be less than 30 minutes each.

1. **INTRODUCTION**

   In this experiment you will:
   
   (i) Note the dimensions of several pulleys.
   (ii) Weigh the pulleys and some masses.
   (iii) Measure the friction torque exerted by a pair of bearings on a shaft.
(iv) **Calculate** the times taken for one of the weights to fall certain distances.
(v) **Measure** the times taken for one of the weights to fall certain distances.

Each student will conduct his/her own experiment. Twelve different pulleys and four different sets of weights are available.

2. **PRIOR TO YOUR FIRST VISIT:**
   
   You should review Section 6/4 and in particular Sample Problem 6/3 in Meriam "Dynamics". This will include Section B/1 in Meriam on "Mass Moments of Inertia".

3. **DURING YOUR FIRST VISIT:**

   You will be assigned a unique configuration of weights and pulleys which will be used in your experiment. You should fit the pulleys to the shaft and measure the friction torque exerted by the bearings. The demonstrator will help you with this. The dimensions of the pulleys that will be needed to calculate their mass moments of inertia should be ascertained. You will also need to note the dimensions of the shaft and the central aluminium pulley to which it is fixed so that you can estimate the mass moments of inertia of these elements. Finally, you should weigh the pulleys and the weights.

4. **PRIOR TO YOUR SECOND VISIT:**

   Calculate the angular rotation-time relationship for your configuration and use it to determine the position-time relationship for the fall of the weight attached to the central pulley. Calculate and plot the times taken for this weight to fall 0.25 m, 0.5 m, 0.75 m and 1.0 m. The measurements taken during your first visit, your calculations and a plot of the position-time relationship must be **NEATLY** laid out in **BLACK INK**. Any work not meeting this specification will be rejected and you will receive a mark of zero.

5. **DURING YOUR SECOND VISIT:**

   The calculations should be presented to the demonstrator. If these are approved, the experiment should be done in the demonstrator's presence. Measure the times taken for the weight attached to the central pulley to fall 0.25 m, 0.5 m, 0.75 m and 1.0 m. (Note: In some configurations, it is not possible to measure a fall of 1.0 m). Make sure that your demonstrator has recorded a mark from 0 to 6 and also writes the mark on the laboratory sheet and signs it.
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>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Assignment (due week 12)</td>
<td>15%</td>
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<tr>
<td>Final examination</td>
<td>16%</td>
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<tr>
<td><strong>Total for Module B</strong></td>
<td><strong>31%</strong></td>
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</table>

There will be one hour of lectures/tutorials (in weeks 1 – 6) on Tuesdays 1:00 – 2:00 and three hours of lectures/tutorials (in weeks 7 – 12) on Tuesdays 1:00 – 2:00 and Thursdays 9:00 – 11:00.

Flight Mechanics Topics:

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

2. Etkin and Reid, Dynamics of Flight-Stability and Control, Wiley & Sons 3rd Ed.
3. Course handouts provided on Blackboard Learn.

Four lectures/tutorials will be delivered on Mondays 9 – 11 and Thursdays 2:00 – 4:00 (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 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 2010. 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;

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*Includes, but is not limited to, reproducing passages from books, articles, reports, websites, etc., without proper attribution.

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• 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 2010 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/ohswe/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 convenor 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.

February 2012

Zoran Vulovic