University of New South Wales  
School of Electrical Engineering & Telecommunications  
ELEC4613 - ELECTRIC DRIVE SYSTEMS  
Course Outline

**Brief Syllabus:**
Elements of drive systems; requirements of industrial drives. Drive representation, quadrant operation, dynamic and regenerative braking. DC motors, converters for dc drives, drive performance analysis. Performance analysis of synchronous motor drives with variable or current source and variable frequency supply. Performance analysis of induction motor drives with variable voltage or current source and variable frequency supply. Field oriented (or vector) control of induction motor drives; Computer aided design.

**Course Webpage:**
All lecture notes, assignments, tutorial and laboratory sheets for this subject can be found on the school webpage, via Current Students → Study Notes → Lecture Notes. You may have to enter username: (your student number) and password: eetview. Students will be expected to bring the printed lecture notes, tutorial sheets or laboratory sheets into the lecture/tutorial room or laboratory, as appropriate. They are also expected to visit this site regularly to keep up-to-date on Lecture Notes, Tutorial and Laboratory sheets, submission dates for Laboratory and Technical Reports and Assignments, and to know of recent announcements about this course.

**Lecture Content/Schedule**
There will be three hours of lecture per week. The total number of lecture hours over the 12-week session will about 30, the remaining 6 hours will comprise of problem solving/tutorial/computer modelling sessions in lieu of formal lectures. The third hour of lecture in even weeks will be used for these sessions. Lecture notes are available from the course Lecture Notes webpage.

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<th>Course Content</th>
<th>Hours</th>
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<td>1. Introduction to Electrical Drives</td>
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<td>Rotational Systems, Load couplings, representation of torque referred to motor and load shafts; Energy relationship.</td>
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<td>Quadrant operation</td>
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<td>Steady-state and dynamic operation</td>
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<td>2. DC motor drives</td>
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<tr>
<td>Review of dc motors and characteristics</td>
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<td>Single- and three-phase thyristor converter circuits.</td>
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<td>Switched-mode PWM converters.</td>
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<td>Analysis of converter and DC motor circuits.</td>
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<td>Effects of discontinuous conduction on drive.</td>
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<td>DC machine dynamics</td>
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3. **Brushless DC drives**

BLDC machine fundamentals; Analysis of machine back emf and torque; Ideal back-emf and current waveforms, Sensor requirements

4. **Synchronous motor drives**

Review of synchronous motors and characteristics
Salient and non-salient pole machines; Reluctance motors
Performance under Voltage Source Inverter (VSI) drive
Performance under Current Source Inverter (CSI) drive
Operation with maximum torque, field-weakening and Unity power factor.

5. **Induction motor drives**

Drive characteristics using equivalent circuit representation
Parameter determination of induction machines
Voltage and current source drives
Characteristics with VSI-VF inverter and CSI-VF drive
Static Scherbius drive
Effect of harmonics on drive performance

6. **Machine representation in orthogonal axes**

Representation of machine dynamics; Stator, synchronous Rotor reference frames. General orthogonal set; representation of AC machines in orthogonal reference frames. Representation of synchronous machine dynamics in the stator and rotor reference frames; d- and q-axes currents and fluxes; the developed torque and rotor flux oriented control (RFOC).

Representation of induction machine dynamics in the stator and synchronously rotating reference frame; Condition for alignment of the direct-axis with rotor-flux axis. Indirect rotor-flux oriented control (RFOC) structure; effect of rotor time-constant on RFOC.

7. **Controller design for electrical drives**

Role of various control loops in drive systems; drive system damping; torque, speed and position control loops; hierarchy of control loops; Typical controllers; design considerations for each control loop.

| Total hours | 30 |

**Tutorial**

There will be a one-hour tutorial class each week. Tutorial sheets are available on the webpage for this course. Solution of all tutorials will be posted on the course webpage progressively, sometime after the material for each tutorial has been covered in tutorial class.

Tutorial classes will start in week 2.
Laboratory

The laboratory for this course consists of four experiments, E1 – E4, which will be conducted in room EE119. There are two laboratory sets for each experiment. A maximum of two students can be accommodated for each set. Laboratory will start in week 2 or 3 for students enrolled in even and odd weeks, respectively. Laboratory sheets are available from the course website. **Students are required to read the School Safety Manual for Laboratory and Laboratory Safety Instructions for Laboratory for this course, and submit the signed Laboratory Safety Declaration form to the lab supervisor when you start your first laboratory experiment.**

Quiz/Hand-in-assignment

There will be one Mid-session Test (closed-book) in week 6. It will consist of numerical problem solving and descriptive parts based on material covered up to week 5. Time and location of the test will be announced in due course. This test will be held under normal examination-like conditions. Mark scored in this test (out of 10) should be indicative of the level of understanding of and proficiency in the topics covered prior to submission of the assignment.

Students will also be expected to submit a Technical Report on a topic assigned to each, in week 11. The class will be divided into groups, each comprised of two students, and each group will be assigned a topic for in-depth study and evaluation. One report from each group will need to be submitted. Topic allocation and guidelines for each report will be posted on the course webpage in due course.

Assessment

The final examination at the end of the session will account for 70% of the total marks.

20% of the final mark for the undergraduates are allocated to laboratory. Conduct of the four laboratory experiments, which is a compulsory part of this course, will count for 10 marks. Attendance, and adequate laboratory work, in each of the four experiments is worth 2.5 marks. The remaining 10 marks for laboratory are assigned to the two laboratory reports, 5 marks each. Due dates for the lab reports will be announced via the course webpage in due course.

The final score for this course will thus will be:

| Conduct of laboratory (compulsory) | 10 % |
| Laboratory reports (2)            | 10 % |
| Mid-session Test                  | 10 % |
| Technical Report                  | 10 % |
| Final examination                  | 60 % |

**Total 100 %**
Text Books and References

Lecture notes in pdf format are available via the School webpage for Lecture Notes. The following books may be consulted for further reading: