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. Symmetrical component theory of induction motors, 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: ee&tview. Students will be expected to bring the printed lecture notes, tutorial sheets or laboratory sheets into the lecture/tutorial room or laboratory, as appropriate. You are 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, as applicable, 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.

<table>
<thead>
<tr>
<th>Course Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Introduction to Electrical Drives</strong></td>
<td>3</td>
</tr>
<tr>
<td>Rotational Systems, Load couplings, Energy relationship</td>
<td></td>
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<td>Quadrant operation</td>
<td></td>
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<td>Steady-state and dynamic operation</td>
<td></td>
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<tr>
<td><strong>2. DC motor drives</strong></td>
<td>5</td>
</tr>
<tr>
<td>Review of dc motors and characteristics</td>
<td></td>
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<tr>
<td>Single- and three-phase thyristor converter circuits.</td>
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<td>Switched-mode PWM converters.</td>
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<tr>
<td>Analysis of converter and dc motor circuits.</td>
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<tr>
<td>Effects of discontinuous conduction on drive.</td>
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<td><strong>3. Brushless DC drives</strong></td>
<td>3</td>
</tr>
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<td>Analysis of torque and machine back emf.</td>
<td></td>
</tr>
<tr>
<td>Ideal back emf and current waveforms</td>
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</tr>
</tbody>
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Sensor requirements

4. Synchronous motor drives 5
   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
   Load commutated drive.

6. Induction motor drives 5
   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

7. Machine representation in orthogonal axes 3
   Representation of machine dynamics; Stator, synchronous
   Rotor reference frames. General orthogonal set and
   Representation of torque and fluxes in reference
   frames.

8. Field oriented control of induction motor drives 3
   Space-vector representation of machine mmfs, voltages, and currents.
   Dynamic analysis of the induction motor using the synchronously
   rotating reference frame; Condition for alignment of the direct-axis with
   rotor-flux axis. Indirect rotor-flux oriented control structure.
   Effect of rotor time-constant on FOC.

9. Controller design for electrical drives 3

Tutorial

There will be a one-hour tutorial class each week, to be attended by students enrolled in even and
odd weeks. Tuesday 10-11am, in room Quad G034. 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 1.

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 student 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 bring and submit to the lab supervisor the
signed Laboratory Safety Declaration form when you start your first laboratory experiment.
Quiz/Hand-in-assignment

There will be one quiz/hand-in assignment test. Quiz/Assignment will consist of numerical problem solving and descriptive parts. This test will be held under normal examination-like conditions, tentatively in week 7. 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.

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 at and adequate laboratory work in each is worth 2.5 marks per laboratory experiment. 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 later.

The final score for this course will thus will be:

- Conduct of laboratory (compulsory) 10 marks
- Laboratory reports (2) 10 marks
- Quiz/Hand-in assignment 10 marks
- Final examination 70 marks

Text Books and References

Lecture notes as pdf files are available via the School webpage for Lecture Notes. For further reading, the following books may be consulted: