The University Of Sheffield.

Electronic & Electrical Engineering.

EEE6203 MOTION CONTROL AND SERVO DRIVES

Credits: 15

Course Description including Aims

This unit builds upon the second year unit EEE223, "Electrical Energy Management and Conversion", to investigate in more detail the performance and operational characteristic of both modern a.c. and d.c. variable speed drives and actuation systems, as well as their applications in electric/hybrid vehicle traction. The unit also complements the module EEE307 "Power Electronics".

1. To introduce d.c. drives and permanent magnet brushless a.c. drives.
2. To examine in more detail the operational requirements of induction motors at variable speeds under scalar and vector controlled modes of operation.
3. To introduce power electronic inverters and develop control strategies and switching schemes for inverter fed drives.
4. To develop techniques for modelling the performance of drive systems and for their control system design.
5. To introduce electric and hybrid drive-trains and their components.
6. To demonstrate the need for modelling and simulation in order to assess the benefits of a particular component and/or drive

Outline Syllabus

Introduction to servo drive systems: Drive system configuration, characteristics of mechanical loads, velocity profiles, matching motor and load, and criteria for selecting drive components. **D.C. machine drives**: Review of d.c. servo drive characteristics (4 quadrant operation), speed control, development of transfer function for both motor and drive subsystems, design techniques for current and speed control loops, power electronic converters for d.c. drives, supply considerations. **Permanent magnet brushless a.c. drives**: Rotating magnetic field of AC windings, operational characteristics of permanent magnet brushless motors, d-q axis transformation, and modelling and field-oriented control of permanent magnet a.c. machines. **Voltage source Inverters**: Inverter topology, review of operation, sinusoidal PWM modulation, switching harmonics, over modulation and six-step operation, space vector modulation and their implementation in a digital controller. **Induction motor drives**: Review of operation, development of phasor diagram and lumped circuit model, operational characteristics, speed control, scalar and vector control schemes. **Electric Traction**: Electric and hybrid drive-trains, modelling of drive-train components, vehicle kinematics, assessment of drive-train performance and efficiency, driving cycles and simulation.

Time Allocation

36 lectures plus 12 hours of support material.

Recommended Previous Courses

Background knowledge equivalent to EEE223 “Electrical Energy Management and Conversion”, ACS342 “Feedback Systems Design” and EEE307 “Power Electronics”

Assessment

3-hour examination, answer 4 questions from 6.

Recommended Books

Williams B.W.	*Power Electronics - Devices, Drivers & Applications*	Macmillan
Miller T.J.E.	*Brushless Permanent-Magnet and Reluctance Motor Drives*	OUP
Leonhard, W.	*Control of Electrical Drives*	Springer
Mohan, N., Undeland, T.M. & Robbins, W.P.	*Power Electronics: Converters, Applications and Design*	John Wiley
Bose, B.K.	*Electronics and Variable Frequency Drives*	IEEE Press
I. Husain	*Electric and hybrid vehicles*	CRC Press, 2003
S.K. Sul	*Control of Electric Machines Drive Systems*	IEEE Press, 2011

Objectives

By the end of this module successful students will be able to

1. Describe alternative drive technologies for motion control systems.
2. Demonstrate detailed understanding of the operational characteristics of variable speed drive systems.
3. Use standard techniques for drive system modelling and control system design.
4. Display in-depth knowledge of power electronic converters/inverters used in modern drive systems, and their modulation schemes and control strategies.
5. Explain the principles of electric and hybrid drive-train architectures and their components.
6. Model the components of electric and hybrid drive-trains.
7. Calculate the losses and efficiency of electric and hybrid drive-trains.
8. Assess the performance of vehicles equipped with electric and hybrid drive-trains.