SYLLABUS: ELECTRIC MACHINE AND DRIVES

Date / Revision August 22, 2017 / 22.08.17 /MaS
Faculty Engineering
Study Programs Mechatronics

SUBJECT: Electric Machine and Drives

1 Basic Information

1.01	**Subject Name**	**Electric Machine and Drives**
1.02	**Semester**	6
1.03	**Level**	1
1.04	**SKS**	3
1.05	**Mandatory / Curriculum**	Mandatory /D-13
1.06	**Subject Code**	ELEC
1.07	**Subject Code**	MTE-D-ELEC-6113
1.08	**Year**	2017 (7)
1.09	**Quality Control**	Final Test, see evaluation
1.10	**Limitations**	Min 12 and Max 32 students in one class
1.11	**Combined with**	ELE, INE
1.12	**Perquisite**	Electrical Engineering 1,2 and Power Electronics
1.13	**Responsible**	Dean of Engineering Faculty
1.14	**Revision**	22-08-2017/MaS

2 Description of Subject

The purpose of the course is to teach principles of DC and AC motors and generators, and AC transformers and how they work. Basic concepts of electromagnetic circuits as they relate to voltages, currents, and physical forces induced in conductors are covered, including application to practical problems of machine design. Practical analytical models for most types of motors, generators, and transformers commonly used in industry are developed, and the models are used to analyze power requirements, power capability, efficiency, operating characteristics, control requirements, and electrical demands of these machines.
This course is also a "writing-intensive" course that teaches students to prepare formal, written technical documents. This goal is accomplished through extensive writing exercises performed in the context of laboratory exercises that accompany the course.

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3 Objectives

- introduce the Induction machines, synchronous machines, DC machines, salient poles, time harmonics, models for electrical machines under steady state and transient conditions, vector representation of AC machines, control of torque, speed and position for variable-speed AC and DC motor drives

4 Competency

After having the course, students are expected have to:

- Describe the fundamental parts of electrical drives including converter, electrical machine and load.
- Explain the operating principles of induction machines, synchronous machines and dc machines
- Identify parameters in models of electrical machines
- Use equivalent circuits to analyze electrical machines in steady state
- Construct phasor diagrams for different loads and to use the vector method for analysis of AC machines
- Describe the design of a simple three-phase ac winding and explain the concepts of pole number and winding factor
- Explain the background to voltage harmonics and estimate their influence on e.g. losses in electrical machines
- Use dynamic simulation software to analyze vector control of induction motors.

5 Learning Approach / Methodology

- Lectures/ Class contact (time-tabled) supplemented with interactive questions and answers;
- Discussion, sample problem, group work, Laboratory experiments, writing report;
- Student Study Effort: homework/assignment; preparation for test/quizzes/ examination.

6 Evaluation

5.1	**Absence maximum**	25%
5.2	**Participation in Discussion**	05 Points
5.3	**Homework / Classwork**	05 Points
5.4	**Presentation /Simulation**	10 Points
5.5	**Daily Quiz**	20 Points
5.6	**Final Examination**	60 Points
	Total	100 Points

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7 Text Book and Reference

1	**Main Text Book:** **"***Electric Machinery*. 6th ed", **Authors**: Fitzgerald, A. E., Charles Kingsley, Jr., and Stephen D. Umans, **Publisher**: McGraw-Hill, 2007, **ISBN**: 9780071230100
2	**Supplementary Text books:** • "Fundamental of Electric Circuit-6Ed,", **Authors**: Christopher K. Alexander and Matthew N.O. Sadiku, **Publisher**: McGraw-Hill, 2007, **ISBN**: 978-1-259-25132-0 • "Principle and Applications of Electrical Engineering, 6Ed", **Authors**: Giorgio Rizzoni, **Publisher**: McGraw-Hill, 2016, **ISBN**: 978-981-4577-41-0

8 Content / Topics of Lecture

Week	Content/ Topics of Lecturing	Text Book	Remark
1	**Magnetic Circuits and Magnetic Materials** • Introduction to Magnetic Circuits • Flux Linkage, Inductance, and Energy • Properties of Magnetic Materials • AC Excitation • Permanent Magnets • Application of Permanent Magnet Materials	CH-01	
2-3	**Transformers** • Introduction to Transformers • No-Load Conditions • Effect of Secondary Current; Ideal Transformer • Transformer Reactances and Equivalent Circuits • Engineering Aspects of Transformer Analysis • Autotransformers; Multiwinding Transformers • Transformers in Three-Phase Circuits • Voltage and Current Transformers • The Per-Unit System	CH-02	Quiz-1
4-5	**Electromechanical-Energy-Conversion Principles** • Forces and Torques in Magnetic • Field Systems • Energy Balance • Energy in Singly-Excited Magnetic Field Systems • Determination of Magnetic Force and Torque from Energy • Determination of Magnetic Force and Torque from Coenergy • Multiply-Excited Magnetic Field Systems • Forces and Torques in Systems with Permanent Magnets • Dynamic Equations • Analytical Techniques	CH-03	Quiz-2

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6-7	**Introduction to Rotating Machines** • Elementary Concepts • Introduction to AC and DC Machines • MMF of Distributed Winding • Magnetic Fields in Rotating Machinery • Rotating MMF Waves in AC Machines • Generated Voltage • Torque in Nonsalient-Pole Machines • Linear Machines • Magnetic Saturation and Leakage Flux	CH-04	Quiz-3
8	**MIDTERM SEMESTER BREAK**		
9	**Synchronous Machines** • Introduction to Polyphase Synchronous Machines • Synchronous-Machine Inductances; Equivalent Circuits • Open- and Short-Circuit Characteristics • Steady-State Power-Angle Characteristics • Steady-State Operating Characteristics • Effects of Salient Poles; Introduction to • Direct- and Quadrature-Axis Theory • Power-Angle Characteristics of Salient-Pole Machines • Permanent-Magnet AC Motors	CH-05	
10	**Polyphase Induction Machines** • Introduction to Polyphase Induction Machines • Currents and Fluxes in Polyphase Induction Machines • Induction-Motor Equivalent Circuit • Analysis of the Equivalent Circuit • Torque and Power by Use of Thevenin's Theorem • Parameter Determination from No-Load and Blocked-Rotor Tests • Effects of Rotor Resistance; Wound and Double-Squirrel-Cage Rotors	CH-06	
11	**DC Machines** • Introduction • Commutator Action • Effect of Armature MMF • Analytical Fundamentals: Electric-Circuit Aspects • Analytical Fundamentals: Magnetic-Circuit Aspects • Analysis of Steady-State Performance • Permanent-Magnet DC Machine • Commutation and Interpoles • Compensating Windings • Series Universal Motors	CH-07	
12	**Electric Drives Laboratory** • Experiment DC – Motor and induction motor • Leybold - COM3LAB : Electric Machine • Leybold - Drive control with TP	Supplement Instruction Manual	

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13	**Variable-Reluctance Machines and Stepping Motors** • Basics of VRM Analysis • Practical VRM Configurations • Current Waveforms for Torque Production • Nonlinear Analysis • Stepping Motors	CH-08	
14	**Single-and Two-Phase Motors** • Single-Phase Induction Motors: Qualitative Examination • Starting and Running Performance of Single-Phase Induction and Synchronous motors • Revolving-Field Theory of Single-Phase Induction Motors • Two-Phase Induction Motors	CH-09	
15	**Speed and Torque Control** • Control of DC Motors • Control of Synchronous Motors • Control of Induction Motors • Control of Variable-Reluctance Motors	CH-11	
16	**Final Examination**		

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