Subject Description Form

Subject Code	EE4003 / EE4003A
Subject Title	Electrical Machines
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisite for EE4003: EE3002 Pre-requisite for EE4003A: EE3002A
Objectives	1. After completing an elementary subject on electromechanical energy conversion, the students are exposed to more challenging topics such as electrical machine design methods, transient and unbalanced operations of electrical machines in this course. 2. This course is designed to ensure the students developing an in-depth understanding of various drive systems in industry. 3. To give the knowledge of various electrical machines such as power electronic driven AC motors.
Subject Intended Learning Outcomes	Upon completion of the subject, students will: a. Have acquired a good understanding of the basic design methods of electric machines. b. Have had experience in synchronous machines including load characteristics, oscillations equations, and displacement stability. c. Be able to analyse the unbalanced and dynamic operation, and condition monitoring for single and 3-phase induction machines. d. Be able to understand the drives for induction machines and their harmonics analysis for drives. Be aware of various switched-mode driven machines. e. Be capable to understand the control method for induction machines including closed loop and vector control.
Subject Synopsis/ Indicative Syllabus	1. ***Appreciation of machine design*:** Appreciation of basic technological factors. Main dimensions. Electric loading and magnetic loading. Magnetic circuit. Magnetomotive force produced in windings. 2. ***Reactances of AC machines and transformation*:** Inductance parameters. Winding Transformation. Circuit equations, conversion process. Electromagnetic torque, equation of motion. 3. ***Synchronous machines*:** Load characteristics of isolated generator. Linearized equations of small oscillations. Natural frequency. 4. ***Induction machines*:** Basic circuit model of induction motor. Performance analysis of single- and three-phase induction machines. Unbalanced operation. Dynamic Operation. Temperature-rise tests. 5. ***Drives for induction machines*:** Induction motor drives fed from PWM inverters. 6. ***Control of machines*:** Open loop and closed loop control. Concept of vector control, torque control. **Laboratory/Mini-project Experiments:** The students are required to team up to work on laboratory session or mini-project. The mini-project is problem-based learning type and they are required to research for information, and do the design and analysis on the topics selected.

Teaching/Learning Methodology

Lectures and tutorials are the primary means of conveying the basic concepts and theories. Experiences on analysis, control, design and practical applications are given through mini-projects, in which the students are expected to solve design and control problems with real-life constraints and to attain pragmatic solutions with critical and analytical thinking. The mini-projects are designed to supplement the lecturing materials so that the students are encouraged to take extra readings and to look for relevant information.

Teaching/Learning Methodology	Outcomes				
	a	b	c	d	e
Lectures	✓	✓	✓	✓	✓
Tutorials	✓	✓	✓	✓	✓
Mini-projects	✓	✓	✓	✓	✓

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed				
		a	b	c	d	e
1. Examination	60%	✓	✓	✓	✓	✓
2. Class test	24%	✓	✓			
3. Mini-project & report	16%	✓	✓	✓	✓	✓
Total	100%					

This subject discusses the specific topics of electrical machines. The outcomes on concepts, design and applications are assessed by usual means of examination and test whilst those on analytical skills, problem-solving techniques and practical considerations of electrical machine design, analysis and control, as well as technical reporting and teamwork, are evaluated by mini-project and the reports.

Student Study Effort Expected

Class contact:	
▪ Lecture/Tutorial	36 Hrs.
▪ Laboratory/Mini-project	3 Hrs.
Other student study effort:	
▪ Mini-project/report	15 Hrs.
▪ Self-study	51 Hrs.
Total student study effort	105 Hrs.

Reading List and References

Reference books:

1. B.K. Bose, Power Electronics and AC Drives, Prentice-Hall, 2002
2. P. Vas, Vector control of AC machines, Clarendon Press: Oxford University Press, 1990
3. D.W. Novotny and T.A. Lipo, Vector control and dynamics of AC drives, Oxford University Press, 1996
4. D. Hanselman, Brushless Permanent Magnet Motor Design, The Writers' Collective, 2003
5. Haitham Abu-Rub, Atif Iqbal, Jaroslaw Guzinski, High performance control of AC drives with MATLAB/Simulink models, Wiley, 2012