

Subject Description Form

Subject Code	BSE2123
Subject Title	Power and Machines
Credit Value	3
Level	2
Pre-requisite Co-requisite Exclusion	BSE2122 Electrical Technology Nil Nil
Objectives	<ol style="list-style-type: none"> a. To provide students with sufficient understanding of the fundamentals of electrical power conversion and rotating machines for analyse of their performance in building electrical systems. b. To enable students to understand the main operating characteristics and functions of electrical and electronic power equipment used in electrical systems and sub-systems in buildings. c. To enable students to adequately model rotating electrical machines, e.g. equivalent circuits, and to use such models in problem solving, with due regard to the limitations of given solutions.
Intended Learning Outcomes	<p>Upon completion of the subject, students will be able:</p> <ol style="list-style-type: none"> a. to analyse the operating characteristics and functions of electrical and electronic power equipment related to buildings electrical systems; b. to adequately model rotating electrical machines, e.g. equivalent circuits, and to use such models in problem solving; c. to recognize and analyze the operating modes of electrical machines in building services systems and equipment, such as pumps, fans and chiller drives; and d. to model and analyse the performance of machines as part of electrical installations in buildings under various conditions, e.g. steady state, starting, overload and short circuit characteristics.
Subject Syllabus	<p><u>Induction</u> - overview of electricity supply, distribution and utilisation in high-rise and large buildings.</p> <p><u>Single phase transformers</u> – Ideal and practical transformers. Construction. Self, mutual and leakage reactance. Losses. Equivalent circuits. Short-circuit and open-circuit testing. Efficiency and voltage regulation.</p> <p><u>Three-phase transformers</u> – Constructions and applications. Connections, vector grouping. Equivalent circuits and per unit system values. Efficiency and voltage regulation. Modelling for system analysis.</p> <p><u>Induction motors</u> - size, rating, application. Performance equations. Equivalent circuit parameters and testing. Thermal, mechanical and environmental aspects of performance. Effects of supply and load changes. Analysis of starting and speed control methods.</p> <p><u>Synchronous generators</u> - performance equations and analysis. Equivalent circuit parameters and testing. Synchronous performance and characteristics. Effects of load changes. Voltage and frequency control.</p> <p><u>DC machines</u> - including DC motor and generator. Focus on the application, construction, performance characteristics and the control.</p> <p><u>Electronic devices</u> - transistors, thyristors, etc. for switching, rectification, power conversion, power control applications, and soft starting of motors, etc.</p>
Teaching/ Learning Methodology	<p><u>Teaching approach</u> emphasises the development of system models, and the realisation of system parameters from design or test data. The operation of equipment is examined as part of a system, with real and interdependent connections to input and output ports. Models of systems so developed are subject to qualitative and quantitative analysis, with due account for practical constraints and limitations appropriate to building services systems and equipment. Internal design detail of plant is not considered in detail, except insofar as it affects the students understanding of electro-mechanical, thermal and environmental aspects of performance.</p> <p><u>Lecture</u> - 13 sessions of 2-hour lecture are provided. Lectures are to introduce students the basic concepts and relevant theory of each topic, and are taught in whole class.</p>

Tutorial - 11 sessions of 1-hour tutorial with a group size of no more than 40 students are provided. Tutorials mainly focus on problem solving based on examination type questions, practical examples and related laboratory work.

Laboratory work - 2 sessions of 3-hour laboratory work associated with the subject are provided with a group size of about 3. Laboratory works aim to help students in well-understanding of the lecture contents through practical operation and testing of relevant electrical system. It includes:

Lab 1 - Equivalent Circuit and Operating Characteristics of a Contactor

Lab 2 - Polyphase Induction Motors, Including Single Phasing Conditions

Lab 3 - Polyphase Transformer Phasors Diagrams and Equivalent Circuit

Lab 4 - Operation, Accuracy, Sensitivity and Repeatability of Transducers

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)					
		a	b	c	d		
Coursework	40	✓	✓	✓	✓		
End-of-semester examination	60	✓	✓	✓	✓		
Total	100						

Coursework is made up from two in-class tests (25%) and the laboratory works (15%).

Test 1 - held in first half of the semester to assess outcomes a) & b) and to get feedback for teaching improvements.

Test 2 – held in second half of the semester to assess outcomes c) & d) and to find out the aspects that need to be strengthened further in teaching.

Laboratory work – assess the students’ skills of recognizing, operating and testing of particular electrical components of a building electrical system.

Examination - held in the end of the semester with questions aligned with the intended subject learning outcomes.

Student Study Effort Expected

Class contact:	39 Hrs.
▪ Lectures	26 Hrs.
▪ Tutorials	11 Hrs.
▪ In-class assessment	2 Hrs.
Laboratory sessions:	6 Hrs.
Other student study effort:	75 Hrs.
Total student study effort	120 Hrs.

Reading List and References

- 1) Transformer engineering: design and practice, S.V. Kulkarni, S.A. Khaparde and S.V. Kulkarni, editors. New York: Marcel Dekker, Inc., c2004 (Circulation Coll TK2551 .K96 2004).
- 2) Rotating electric machinery and transformer technology, Donald V. Richardson, Arthur J. Caisse, Jr Richardson, Donald V, Upper Saddle River, N.J: Prentice Hall, c1997, 4th ed. (Circulation Coll TK2181 .R48 1997).
- 3) Rotating electrical machines and power systems, Dale R. Patrick, Stephen W. Fardo, Lilburn, Ga.: Fairmont Press, c1997, 2nd ed. (Circulation Coll TK2000 .P35 1997).
- 4) Study guides prepared by the Department of Building Services Engineering:
 - Transformers;
 - Induction Motors;

	- Synchronous generators; - D.C Machines (motor & generator)
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