INSTITUTE	**FACULTY OF TECHNOLOGY**
PROGRAM	**MASTER OF TECHNOLOGY in ELECTRICAL ENGINEERING**
SEMESTER	**1**
COURSE TITLE	**MODELING AND ANALYSIS OF ELECTRICAL MACHINES**
COURSE CODE	**01PE1108**
COURSE CREDITS	**1**

Objective:

1 The objective of this course is to introduce learner to dynamic modelling of electrical machine and implement computer-based model of machine

Course Outcomes: After completion of this course, student will be able to:

1 Develop mathematical model of different electrical machine.
2 Design mathematical model of machine in software tool
3 Analyse the generalised performance of machine in software
4 Analyse the performance of machine under various dynamics condition

Pre-requisite of course: Electrical Machine, MATLAB, Ordinary Differential Equations

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
0	0	2	0	0	0	25	25

Contents : Unit	Topics	Contact Hours
1	**Principles of Electromagnetic Energy Conversion:** Basics of magnetic circuits, , General expression of stored magnetic energy, co-energy and force/torque,, example using single and doubly excited system.	3
2	**Reference Frame Theory** Transformation of variables, three phase to two phase transformation, Static and rotating reference frames, transformation relationships,, examples using static symmetrical three phase R, R-L, R-L-L and R-L-C circuits,, application of reference frame theory to three phases symmetrical induction, synchronous machines and advance machine.	3

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Contents : Unit	Topics	Contact Hours
3	**Modelling of Induction Machines:** Voltage equation in machine variables, flux-linkage equation in machine variables, torque equation in machine variable, voltage equation in arbitrary reference frame, flux-linkage equation in arbitrary reverence frame, torque equation in arbitrary reference frame, dynamic dq equivalent circuit of induction machine, per unit representation of induction machine model, analysis of steady-state operation, free acceleration characteristics, computer simulation of induction machine in arbitrary reference frame.	12
4	**Modelling of Permanent Magnet Synchronous Machines** Construction and operating principle, Surface permanent magnet and interior permanent magnet machines, real-time model of a two-phase PMSM, transformation to rotor reference frames, three-phase to two-phase transformation, unbalanced operation, zero sequence inductance derivation, power equivalence, electromagnetic torque, steady-state torque characteristics, models in flux linkages, equivalent circuits	5
5	**Permanent Magnet Brushless DC Motor:** Construction and operating principle, PM Brushless DC Machine, Modelling of PM Brushless DC Motor, Normalized System Equations, The PMBLDC Motor Drive Scheme	5
Total Hours		**28**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment No. 01** Modelling and simulation of variable frequency oscillator in MATLAB	2
2	**Experiment No. 02** Modelling and simulation of series-parallel RLC circuit	2
3	**Experiment No. 03** To implement change of variables (3 – f to 2 – f) in MATLAB simulation	2
4	**Experiment No. 04** To implement change of variables (2 – f to 3 – f) in MATLAB simulation	2
5	**Experiment No. 05** To implement flux equation of induction machine in arbitrary reference frame in MATLAB simulation.	2
6	**Experiment No. 06** To implement current equation of induction machine in arbitrary reference frame in MATLAB simulation	2
7	**Experiment No. 07** To implement torque equations of induction machine in arbitrary reference frame variable in MATLAB	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
8	**Experiment No. 08** To simulate and observe free acceleration characteristics of induction machine	2
9	**Experiment No. 09** To observe dynamic performance of induction machine during sudden changes in load torque	4
Total Hours		**20**

Textbook :

1 Principles of Electromechanical Energy Conversion, J. Meisel, McGraw Hill, 1966

References:

1 Analysis of Electric Machinery and Drive Systems, Analysis of Electric Machinery and Drive Systems, Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, John Wiley & Sons, New York, 2004

2 Electric Machinery, Electric Machinery, Charles Kingsley,Jr., A.E. Fitzgerald, Stephen D.Umans, Tata McGraw Hill, Fifth Edition, 1992

3 Dynamic Simulation of Electric Machinery using MATLAB, Dynamic Simulation of Electric Machinery using MATLAB, ONG, Chee-Mun, Prentice Hall PTR, -

4 Generalized theory of electrical machines, Generalized theory of electrical machines, P S Bimbhra, Khanna Publishers Delhi, -

5 Electric Motor & Drives: Modeling, Analysis and Control, Electric Motor & Drives: Modeling, Analysis and Control, R. Krishnan, Prentice Hall of India, 2001

6 Advanced electrical drives Analysis, Control and Modeling using Simulink, Advanced electrical drives Analysis, Control and Modeling using Simulink, Ned Mohan, MNPERE, Minneapolis, USA, 2001

7 The Unified Theory of Electrical Machines, The Unified Theory of Electrical Machines, C. V. Jones, Butterworth, London, 1967

8 Brushless permanent magnet and reluctance motor drives, Brushless permanent magnet and reluctance motor drives, Miller, T.J.E., Clarendon Press, Oxford, 1989

9 Introduction to Generalized Machine Theory, Introduction to Generalized Machine Theory, O'Simmons and Kelly, McGraw-Hill, 1968

10 Matrix Analysis of Electric Machinery, Matrix Analysis of Electric Machinery, Hancock, Pergamon, Oxford, U.K., 1964

11 Electrical Machines : Modelling and Analysis, Electrical Machines : Modelling and Analysis, Mrittunjay Bhattacharyya, Prentice Hall, -

12 Principles of Electromechanical Energy Conversion, Principles of Electromechanical Energy Conversion, J. Meisel, McGraw Hill, 1966

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
5.00	10.00	15.00	30.00	20.00	30.00

Instructional Method:

1. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
2. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and classroom
3. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
4. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.

Supplementary Resources:

1. https://archive.nptel.ac.in/courses/108/106/108106023/

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