DEPARTMENT OF ELECTRICAL ENGINEERING

Subject Code: 01PEED0109

Subject Name: Computer Aided Modelling and Analysis of Electrical Machine

MTech. Year – 1 (Semester – 1)

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

Credits Earned: 1 Credits

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

- **Develop** mathematical model of different electrical machine.
- **Design** mathematical model of machine in software tool
- **Analyse** the generalised performance of machine in software
- **Analyse** the performance of machine under various dynamics condition

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

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	Mid Sem (M)	Internal (I)	Viva (V)	Term work (TW)	
0	0	2	1	0	0	0	25	25	50

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
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	12

	acceleration characteristics, computer simulation of induction machine in arbitrary reference frame.	
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

References:

1. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, “Analysis of Electric Machinery and Drive Systems”, John Wiley & Sons, New York, 2004.
2. Charles Kingsley,Jr., A.E. Fitzgerald, Stephen D.Umans “Electric Machinery”, Tata McGraw Hill, Fifth Edition, 1992.
3. ONG, Chee-Mun, "Dynamic Simulation of Electric Machinery using MATLAB", Prentice Hall PTR
4. Generalized theory of electrical machines by P S Bimbhra, 5th edition, Khanna Publishers Delhi
5. R. Krishnan, “Electric Motor & Drives: Modeling, Analysis and Control”, Prentice Hall of India,2001.
6. Ned Mohan, “Advanced electrical drives Analysis, Control and Modeling using Simulink”,MNPERE, Minneapolis, USA, 2001.
7. C.V.Jones, “The Unified Theory of Electrical Machines”, Butterworth, London, 1967.
8. Miller, T.J.E. “Brushless permanent magnet and reluctance motor drives” Clarendon Press, Oxford, 1989.
9. O'Simmons and Kelly, "Introduction to Generalized Machine Theory". McGraw-Hill, 1968
10. Hancock, "Matrix Analysis of Electric Machinery". Pergamon, Oxford, U.K., 1964
11. Mrittunjay Bhattacharyya, "Electrical Machines : Modelling and Analysis" Prentice Hall
12. J. Meisel, “Principles of Electromechanical Energy Conversion” McGraw Hill, 1966.

Suggested Theory distribution:

The suggested theory distribution as per Bloom’s taxonomy is as per 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	Understand	Apply	Analyze	Evaluate	Create
5%	10%	15%	30%	20%	30%

Suggested List of Experiments:

1. Modelling and simulation of variable frequency oscillator in MATLAB
2. Modelling and simulation of series-parallel RLC circuit
3. To implement change of variables (3 – φ to 2 – φ) in MATLAB simulation
4. To implement change of variables (2 – φ to 3 – φ) in MATLAB simulation
5. To implement flux equation of induction machine in arbitrary reference frame in MATLAB simulation.
6. To implement current equation of induction machine in arbitrary reference frame in MATLAB simulation
7. To implement torque equations of induction machine in arbitrary reference frame variable in MATLAB
8. To simulate and observe free acceleration characteristics of induction machine
9. To observe dynamic performance of induction machine during sudden changes in load torque
10. Simulation of BLDC motor
11. Analyze the dynamic performance of PMSM

Web-Link

1. nptel.ac.in/courses/108106023/
2. http://people.ece.umn.edu/users/riaz/