



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Subject Code: ME02000641

Course / Subject Name: Modeling of Electrical Machines and Drives

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Fundamentals of Electrical Machines, Power Electronics
Rationale:	This course covers the mathematical modelling of electrical machines and drives, which is necessary in assessing dynamic response and stability in power systems. Combining electric drives improves student ability to simulate and analyze performance in industrial and automotive applications, with emphasis put on control strategies and optimization. This gives them some tools for solving real life challenges and advancing electric drive technology through multidisciplinary projects.

Course Outcome:

After Completion of the Course, the student will be able to:

No	Course Outcomes
01	Derive the models of electrical machines for transient analysis
02	Analyze the dynamic behaviour of symmetrical induction machine and synchronous machine
03	Evaluate the performance of special electric machines
04	Demonstrate the knowledge of electrical machine modelling in different electric drives.

Teaching and Examination Scheme:

Teaching Scheme (in			Total Credits	Assessment Pattern and Marks				Total Marks
L	T	PR		Theory		Tutorial / Practical		
			C	ESE	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Basic principles for Electrical Machine Modeling: Introduction magnetically coupled circuits, Electromechanical energy conversion, Machine Windings & Airgap MMF, Winding Inductances & Voltage Equations.	07	15
2.	Reference frame theory: Introduction, Equations of transformation-change of variables, Stationary circuit variables transformed to the arbitrary reference frame, commonly used reference frames and transformation between reference frames, Transformation of a balanced set, Balanced steady state phasor relationships and voltage equations, Variables observed from various frames of reference.	08	10



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3.	Symmetrical Induction machines: Voltage and torque equations in machine variables, Equation of transformation for rotor circuits, Voltage & torque equations in arbitrary reference frame variables, Per unit system, Analysis of steady state equations, Free acceleration characteristics viewed from various reference frames, Dynamic model and analysis for sudden change in load torque, Dynamic model & analysis during three phase fault at the machine terminals, Unbalanced operation of symmetrical Induction Machines, Symmetrical component theory and analysis of unbalanced stator voltages, Analysis of steady state operation with unbalanced rotor conditions, Induction motor drives, Direct Torque Control and Vector control Drives.	10	25
4.	Synchronous machines: Voltage & torque equations in machine variables, Stator voltage equations in arbitrary reference frame variables, Voltage equations in rotor reference frame variables-Park's transformation, Torque equation in transformed variables, rotor angle and angle between rotors, Per unit system, analysis of steady state operation, Dynamic performance during a sudden change in input torque, excitation, load. Analysis of the machine with fault at the machine terminals, Synchronous motor drives, Direct Torque Control and Vector control Drives for synchronous motor.	10	25
5.	Modeling and Analysis of Special Machines: Permanent magnet synchronous machines, Surface Permanent Magnet (square and sinusoidal back emf type) and Interior Permanent Magnet machines, Switched Reluctance Motors, Brushless D.C. Motor, Electric drives applications for PMSM, SRM and BLDC motor	10	25
Total		45	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
30	20	20	20	10	0

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) **Books:**

1. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, New York
2. Charles Kingsle, Jr., A.E. Fitzgerald, Stephen D. Umans, "Electric Machinery", Tata Mcgraw Hill
3. R. Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India
4. Miller, T.J.E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press



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5. Chee-Mun, “Dynamic Simulation of Electric Machinery using MATLAB”, Prentice Hall PTR
6. K. R. Padiyar, “Power System Dynamics Stability and Control”, B S Publications
7. P. Kundur, “Power System Stability & Control”, Tata Mcgraw hill

(b) Open-source software and website:

1. <https://nptel.ac.in/>

Suggested Course Practical List:

The following list is for suggestions only. The subject teacher can modify the list according to the availability of resources.

1. Prepare a simulation/program to transform a 3-phase balanced system into dq0 variables.
2. Prepare a simulation/program to transform a 3-phase unbalanced system into dq0 variables.
3. Prepare a simulation/program to observe the effect of reference frame transformation on the frequency of the transformed variables.
4. Prepare a simulation/program to convert variables from one reference frame to another.
5. Prepare a simulation of induction machine in qd0 form and analyze the transient response with different disturbances like step change in load, unbalanced voltages etc.
6. Prepare a simulation of synchronous machine in qd0 form and analyze the transient response with different disturbances like step change in input torque, excitation, load etc.
7. Obtain the transient response using the simulation of synchronous machine in dq0 form for the short circuit at its terminals.
8. Prepare the simulation to control Surface Permanent Magnet and Interior Permanent Magnet machines
9. Prepare the simulation of Switched Reluctance Motor (SRM) drive.
10. Prepare the simulation of Brushless DC (BLDC) motor drive.

List of Laboratory/Learning Resources Required:

Simulation software like MATLAB along with necessary toolbox, PSIM, PSCAD or Scilab

Any Other:

E-materials available at the website of NPTEL- <http://nptel.ac.in/>

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