

# GUJARAT TECHNOLOGICAL UNIVERSITY

## POWER ELECTRONICS & ELECTRICAL DRIVES (45)

MODELING AND ANALYSIS OF ELECTRICAL MACHINES

SUBJECT CODE: 2714504

M.E. 1<sup>st</sup> SEMESTER

**Type of course:** Engineering Science (**ELECTRICAL**)

**Prerequisite:** N.A.

**Rationale:** N.A.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	PA (V)		PA (I)			
					ESE	OEP	PA	RP		
3	2	0	4	70	30	30	0	20	0	150

**Content:**

Sr. No.	Topics	Teaching Hrs.	Module Weightage
<b>1</b>	<b>PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION</b> General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system.	4	10
<b>2</b>	<b>BASIC CONCEPTS OF ROTATING MACHINES</b> Calculation of air gap MMF and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine, three phase symmetrical induction machine and salient pole synchronous machines in phase variable form.	6	15
<b>3</b>	<b>INTRODUCTION TO REFERENCE FRAME THEORY</b> Static and rotating reference frames, transformation relationships, examples using static symmetrical three phase R, R-L, R-L-M and R-L-C circuits, application of reference frame theory to three phase symmetrical induction and synchronous machines, dynamic direct and quadrature axis mode in arbitrarily rotating reference frames, voltage and torque equations, derivation of steady state phasor relationship from dynamic model, generalized theory of rotating electrical machine and Kron's primitive machine..	10	30
<b>4</b>	<b>ANALYSIS OF INDUCTION MACHINES</b> Induction machine equations in phase quantities assisted by space vectors-Sinusoidal distributed winding; stator single-phase magnetizing and mutual inductance; per-phase magnetizing inductance; equivalent winding in a squirrel-cage rotor and rotor inductances; review of space vectors; flux-linkage and voltage equations in terms of space vectors. Dynamic analysis in terms of dq windings-stator and rotor dq windings and inductance-flux linkage and voltage equations in dq coordinates, electromagnetic torque; dq equivalent circuits; computer simulation.	10	30
<b>5</b>	<b>SPECIAL MACHINES</b> Permanent magnet synchronous machine: Surface permanent magnet	10	15

	(square and sinusoidal back emf type) and interior permanent magnet machines. Construction and operating principle, dynamic modeling and self controlled operation; Analysis of Switched Reluctance Motors.		
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**Reference Books:**

1. Paul C. Krause, Oleg Wasynczuk, Scott D , “Analysis of Electric Machinery and Drive Systems
2. Charles Kingsley, Jr., A.E. Fitzgerald, Stephen D.Umans “Electric Machinery”, Tata McGraw Hill, Fifth Edition, 1992.
3. R. Krishnan, “Electric Motor & Drives: Modeling, Analysis and Control”, Prentice Hall of India,2001.
4. Ned Mohan, “Advanced electrical drives Analysis, Control and Modeling using Simulink”,MNPERE, Minneapolis, USA, 2001.
5. C.V.Jones, “The Unified Theory of Electrical Machines”, Butterworth, London, 1967.
6. Miller, T.J.E. “Brushless permanent magnet and reluctance motor drives” Clarendon Press, Oxford, 1989.

**Course Outcomes:**

After learning the course the students should be able to:

1. Understand significance of electromagnetic energy conversion.
2. Find different mathematical parameters of rotating machine.
3. Understand reference frame theory and its significance.
4. Develop mathematical model of an electric machine.
5. Analyze the performance of different types of electrical machine and its design parameters.