SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology

B.Tech. Semester VI

Subject Name: Modeling of Electrical Machines **Subject Code: BTEL14634**

Type of course: **Professional Elective Courses**
Prerequisite: **Electrical Machines- I and Electrical Machines- II**
Rationale: Electrical drives are abundantly used in the industries and therefore design of these rives require the mathematical modeling of the various machines so used. This subject primarily provides mathematical treatment to all the electrical motors namely DC and ac motors. Especially the dynamical model is given thorough treatment since its knowledge is required while the drives acceleration, deceleration and steady state operation.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
3	0	2	4	60	25	15	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**BASIC PRINCIPLE FOR ELECTRICAL MACHINE ANALYSIS** Introduction, magnetically coupled circuits, electromechanical energy conversion, Machine Windings & Air gap MMF, Winding Inductances & Voltage Equations.	05	10 %
2.	**DC MACHINE MODELING** DC Machine modeling: Mathematical model of separately excited D.C motor –Steady State analysis - Transient State analysis – Sudden application of Inertia Load - Transfer function of Separately excited D.C Motor - Mathematical model of D.C Series motor, Shunt motor -	06	13%
3.	**REFERENCE FRAME THEORY** Introduction, equations of transformation-change of variables, Stationary circuit variables transformed to the arbitrary	06	15%

PEC: Professional Elective courses

	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.		
4.	**INDUCTION MACHINE MODELING** Stator and rotor voltage equation and torque equation in machine variables, Derivation of induction motor modeling in stator reference frame, rotor reference frame, synchronous reference frame and arbitrary reference frame, Free acceleration characteristics of induction motor, Dynamic performance of induction motor during sudden changes in load torque	**10**	**22 %**
5.	**SYNCHRONOUS MACHINE MODEI1NG** Voltage and torque equation of salient pole synchronous machine including damper winding in machine variables, Stator voltage equations in arbitrary reference frame, Voltage and torque equations in rotor reference frame, Dynamic performance of synchronous motor during sudden changes in load torque	**11**	**24 %**
6.	**PERMANENT MAGNET MACHINE MODELING** Voltage and torque equation of permanent magnet machine in machine variables, Voltage and torque equation of permanent magnet machine in rotor reference frame	**07**	**16 %**

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**20**	**20**	**20**	**20**	**00**

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels **(Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students andteachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcome:

Sr. No.	**CO Statement** **After learning this subject, students will be able to**	**Marks % weightage**
CO-1	Explain the basic principle of electrical machines using principle of electromagnetic energy conversion	15%
CO-2	Explain various reference frame theories for modeling of electric machines	20%
CO-3	Deduce the mathematical model of induction, synchronous and permanent	25%

PEC: Professional Elective courses

	magnet synchronous machines based on reference frame theory	
CO-4	Analyze the performance of electric machines based on the derived mathematical models	20%
CO-5	Simulate various electric machines based on mathematical models	20%

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	3	3	3	3	3				2	3	3	2	3	3	-
CO-2	3	3	3	3	3				2	3	3	2	3	3	-
CO-3	3	3	3	3	3				2	3	3	2	3	3	-
CO-4	3	3	3	3	3				2	3	3	2	3	3	-
CO-5	3	3	3	3	3				2	3	3	2	3	3	
Rationale *															

Rationale*: Explaining why it is matching this particular program outcome

LIST OF PRACTICALS: (Minimum ---8--- performed.)

1. Modeling of DC motor
2. Induction Machine Modeling in ‘abc’ Reference Frame.
3. Simulation of Park Transformation And Clarke Transformation.
4. Simulation of Inverse Park Transformation And Inverse Clarke Transformation.
5. Simulation of Park and Clarke Transformation during Unbalance condition
6. Determination of Park Transformation during Unbalance Condition.
7. Induction machine Modeling in Synchronous Rotating Reference Frame
8. Free Acceleration Characteristics of Induction Machine in abc and dqo Reference Frame
9. Dynamic Performance of Induction Machine due to Sudden Change in Load Torque
10. Modeling of Synchronous Machine
11. Dynamic Performance of Synchronous Machine due to Sudden Change in Load Torque
12. Modeling of Permanent Magnet Synchronous Machine

Reference Text Books:

1. P. C. Krause, Oreg Wasynczuk, Scott D. Sudhoff, Analysis of Electric Machinery and drive systems, Wiley Interscience, 2nd Edition, 2010.
2. P. S. Bimbhra, Generalized theory of Electrical MIC, Khanna Publication, 2000.
3. S. K. Sen, Electrical Machinery, Khanna Pub., 2012.
4. Mrittunjay Bhattacharya, Electrical Machines: Modelling and Analysis, PHI, 2016.

PEC: Professional Elective courses

5. R. Ramanujam, Modelling and Analysis of Electrical Machines, Wiley, 2019.

Major Equipment:
Matlab Simulation Software

List of Open Source/learning website:

- https://nptel.ac.in/courses/108/106/108106023/
- https://nptel.ac.in/courses/108/108/108108076/