NIRMA UNIVERSITY

Institute:	**Institute of Technology**
Name of Programme:	**BTech in Electrical Engineering**
Semester:	**VI**
Course Code:	**3EE104ME24**
Course Title:	**Special Electrical Machines**
Course Type:	**Department Elective-II**
Year of Introduction:	**2024 – 25**

L	T	Practical component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLOs):

At the end of the course, students will be able to -

1. examine the properties and characteristics of permanent magnet materials **(BL4)**
2. appraise constructional & operational aspects of special electrical machines **(BL3)**
3. analyse the characteristics of special electrical machines **(BL4)**
4. select the appropriate machine based on application requirements. **(BL5)**

Contents: **Teaching hours: 45**

Unit-I **Permanent Magnet Materials** **07**

Introduction, types of permanent magnets, properties of permanent magnets, features of permanent magnet excitation, magnetic circuit model, B-H characteristics & operating point, soft permanent magnet & hard permanent magnet, the effect of temperature rise on the performance of permanent magnets, sintered permanent magnet and bonded permanent magnet materials, mechanical properties & handling of permanent magnets.

Unit-II **Permanent Magnet Brushless Motors** **18**

Construction, operating principle & features of permanent magnet brushless (PMBL) motors, various types of PMBL motors, types of emf generated, equivalent magnetic circuit, armature reaction, derivation of emf and torque equation, emf constant & torque constant, performance characteristics, comparison between PMBLDC motor and PMSM, continuous & short-time operating regions, closed-loop control of PMBL motors, sensorless control of PMBL motors, slotless permanent magnet brushless motors, cogging torque & its effects, parameter sensitivity of PMBL motors, faults in PMBL motors & their diagnosis, case studies considering applications viz. electric vehicle, marine propulsion & PV fed water pumping, robotics, elevators, conveyor belt, torpedo, etc., advancements in topologies and reviews, generating action of PM machines.

Unit-III **Switched Reluctance Motors** **14**

Construction, operating principle and features of switched reluctance motors (SRM), configurations of SRM, magnetic equivalent circuit, inductance profile, equivalent electric circuit, derivation of torque equation and factors affecting torque, comparison of SRM with VRM, performance characteristics, control of SRM, various types of converters, closed-loop control of SRM, sensorless control of SRM, torque ripple & approaches for its reduction, case studies considering

applications viz. electric vehicle, washing machine, aerospace applications, coal mining application, etc., advancements in topologies and reviews.

Unit-IV **Synchronous Reluctance Motors** **06**

Construction, operating principle and features of synchronous reluctance motors (SynRM), per phase equivalent circuit, magnetic torque & reluctance torque, vector diagram, torque and power equation, performance characteristics, control of synchronous reluctance motors, line start synchronous reluctance motors, topological advancements and reviews, case studies considering applications viz. electric vehicles, submersible pump.

Self-Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:

This shall consist of at least 10 laboratory experiments / simulations based on the syllabus.

Suggested Readings:

1. Miller T. J. E., Brushless Permanent Magnet and Reluctance Motor Drives, Clarendon Press.
2. Venkatratnam K., Special Electric Machines, CRC Press.
3. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press.
4. R. Krishnan, Switched Reluctance Motor Drives, CRC Press.
5. Recent papers from reputed journals.

Suggested List of Experiments:

	Title of Experiment	Hrs.
1.	To obtain the inductance profile of the Switched Reluctance Motor.	02
2.	An introduction to MotorSolve software.	02
3.	To analyse the magnetic circuit of the Switched Reluctance Motor.	02
4.	To study and analyse converters for the Switched Reluctance Motor.	02
5.	To verify bidirectional control of variable reluctance motor drive.	02
6.	To control the speed of the Permanent Magnet DC motor.	02
7.	To analyse the magnetic circuit of the Permanent Magnet Brushless DC motor.	02
8.	To obtain back emf waveform of the PMBLDC machine and its validation with simulation results.	04
9.	To analyse the effect of the number of rotor poles on the torque profile of a PMBLDC motor.	04
10.	Demonstration of radial flux PMBLDC motor and axial flux PMBLDC motor.	02
11.	To control the speed of the Permanent Magnet Synchronous Motor.	02

L = Lecture, T = Tutorial, P = Practical, C = Credit