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| **EE2403** | **SPECIAL ELECTRICAL MACHINES** | **3 0 0 3** |

**AIM**

To expose the students to the construction, principle of operation and performance of special electrical machines as an extension to the study of basic electrical machines.

**1. SYNCHRONOUS RELUCTANCE MOTORS 9**

Constructional features – Types – Axial and Radial flux motors – Operating principles – Variable Reluctance and Hybrid Motors – SYNREL Motors – Voltage and Torque Equations - Phasor diagram – Characteristics.

**2. STEPPING MOTORS 9**

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi-stack configurations – Torque equations – Modes of excitations – Characteristics – Drive circuits – Microprocessor control of stepping motors – Closed loop control.

**3. SWITCHED RELUCTANCE MOTORS 9**

Constructional features – Rotary and Linear SRMs - Principle of operation – Torque production - Steady state performance prediction- Analytical method -Power Converters and their controllers – Methods of Rotor position sensing – Sensorless operation – Closed loop control of SRM - Characteristics.

**4. PERMANENT MAGNET BRUSHLESS D.C. MOTORS 9**

Permanent Magnet materials – Magnetic Characteristics – Permeance coefficient - Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations – Commutation - Power controllers – Motor characteristics and control.

**5. PERMANENT MAGNET SYNCHRONOUS MOTORS 9**

Principle of operation – Ideal PMSM – EMF and Torque equations – Armature reaction MMF – Synchronous Reactance – Sinewave motor with practical windings - Phasor diagram – Torque/speed characteristics - Power controllers - Converter Volt-ampere requirements.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

1. T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press,Oxford, 1989.
2. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London,1984.

**REFERENCES**

1. R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.
2. P.P. Aearnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus, London,1982.
3. T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.

# SUBJECT DESCRIPTION AND OBJECTIVES

## SUBJECT DESCRIPTION:

Day by day the interest on special machines increases, because these machines serve for several applications. For instance, the nanogenerator could drive biological sensors by making use of wind energy or water flow, and eliminating the need for external batteries. This not only reduces the device cost but also at the same time reduces the entire equipment size. Integrated starter generator which is used in electric vehicles acts as a bidirectional energy converter as a motor when powered by the battery or a generator when driven by the engine. Linear motors are used to propel high speed MagLev trains. A micro motor plays an important role in computer hard drives, optics, sensors and actuators. A special type of outer rotor motors used to drive the polygonal rotating mirrors which are mounted directly on the rotor in laser printers. The recent developed technology in special electrical machines is nanogenerators.

Non-traditional electrical motors such as stepper, switched-reluctance, brushless dc motors, etc., are being widely used today in position control systems, robotics, numerical control of machine tools and electrical vehicles, while linear induction and linear synchronous motors with or without levitation are being considered for very high-speed transportation. These developments owe largely to the development of high-speed switching devices and their amenability to digital control.

All these special machines play a key role in their respective fields. These machines reduce the time of operation of the system and at the same time provide smooth operation. The researchers of nanogenerator said, “You could envision having these nanogenerators in your shoes to produce electricity as you walk. This could be beneficial to soldiers in the field, who now depend on batteries to power their electrical equipment. As long as the soldiers were moving, they could generate electricity.”This statement indicates the importance of the special machines.

## OBJECTIVES

To impart knowledge on

1) Construction, principle of operation and performance of synchronous reluctance motors.
2) Construction, principle of operation, control and performance of stepping motors.
3) Construction, principle of operation, control and performance of switched reluctance motors.
4) Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.
5) Construction, principle of operation and performance of permanent magnet synchronous motors.

**SARDAR RAJA COLLEGE OF ENGINEERING**

DEPARTMENT OF EEE

**EE2403 – SPECIAL ELECTRICAL MACHINES**

**MICRO LESSON PLAN**

| Week | No of Hours | LECTURE TOPICS | TEXT / REF BOOKS |
|---|---|---|---|
| I | | **UNIT I SYNCHRONOUS RELUCTANCE MOTORS** | |
| | 1 | Constructional features (AV Class) | T1 |
| | 2 | Types – Axial and Radial flux motors | T1 |
| | 3 | Operating principles | T1 |
| | 4 | Variable Reluctance and Hybrid Motors | T1 |
| | 5 | SYNREL Motors | T1 |
| II | 6,7 | Voltage and Torque Equations | T1 |
| | 8 | Phasor diagram (AV Class) | T1 |
| | 9 | Characteristics | T1 |
| III | | **UNIT II STEPPING MOTORS** | |
| | 1 | Constructional features - Principle of operation (AV Class) | T1 |
| | 2 | Variable reluctance motor | T1 |
| | 3 | Hybrid motor | T1 |
| | 4 | Single and multi stack configurations | T1 |
| | 5 | Torque equations | T1 |
| IV | 6 | Modes of excitations | T1 |
| | 7 | Characteristics | T1 |
| | 8 | Drive circuits | T1 |
| | 9 | Microprocessor control of stepping motors – Closed loop control. (AV Class) | T1 |
| | | **UNIT III SWITCHED RELUCTANCE MOTORS** | |
| V | 1 | Constructional features - Rotary and Linear SRMs (AV Class) | T1 |
| | 2 | Principle of operation | T1 |
| | 3 | Torque production | T1 |
| | 4 | Steady state performance prediction- Analytical method | T1 |
| | 5 | Power Converters and their controllers | T1 |

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|---|---|---|---|
| VI | 6 | Methods of Rotor position sensing | T1 |
| | 7 | Sensor less operation (AV Class) | T1 |
| | 8 | Closed loop control of SRM | T1 |
| | 9 | Characteristics | T1 |
| VII | **UNIT IV PERMANENT MAGNET BRUSHLESS D.C. MOTORS** | | |
| | 1 | Permanent Magnet materials | T1 |
| | 2 | Magnetic Characteristics | T1 |
| | 3 | Permeance coefficient - Principle of operation | T1 |
| | 4 | Types (AV Class) | T1 |
| | 5 | Magnetic circuit analysis | T1 |
| VIII | 6 | EMF and torque equations | T1 |
| | 7 | Commutation | T1 |
| | 8 | Power controllers (AV class) | T1 |
| | 9 | Motor characteristics and control | T1 |
| IX | **UNIT V PERMANENT MAGNET SYNCHRONOUS MOTORS** | | |
| | 1 | Principle of operation – Ideal PMSM (AV Class) | T1 |
| | 2 | EMF and Torque equations | T1 |
| | 3 | Armature reaction MMF | T1 |
| | 4 | Synchronous Reactance | T1 |
| | 5 | Sine wave motor with practical windings | T1 |
| X | 6 | Phasor diagram | T1 |
| | 7 | Torque/speed characteristics | T1 |
| | 8 | Power controllers (AV Class) | T1 |
| | 9 | Converter Volt- ampere requirements. | T1 |

**Prepared By,**

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