JEPPIAAR ENGINEERING COLLEGE
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION OF INSTITUTION

To build Jeppiaar Engineering College as an institution of academic excellence in technology and management education, leading to become a world class University.

MISSION OF INSTITUTION

- To excel in teaching and **learning, research and innovation** by promoting the principles of scientific analysis and creative thinking.
- To participate in the production, **development, dissemination of knowledge** and interact with **national and international communities.**
- To equip students with ethical **values, and life skills** that would enrich their lives and enable them to meaningfully contribute to the **progress of the society.**
- To prepare students for **higher studies and lifelong learning,** enrich them with the **practical and entrepreneurial skills** necessary to excel as future professionals and contribute to **Nation's economy.**

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and

receive clear instructions.

11 **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

VISION OF THE DEPARTMENT

The Department of Electrical and Electronics Engineering strives to be a Centre of Excellence in education and technical research, in the endeavour of which the Department will continually update the teaching methodologies, progress in the emerging technologies and continue to play a vital role in the development of the society.

MISSION OF THE DEPARTMENT

M1	To develop the ability to **learn** and work creatively that would enhance the ability of both students and faculty to do **innovative research**.
M2	To **create** and maintain state-of-the art facilities which provide students and faculty with opportunities to analyse, apply and **disseminate knowledge globally**.
M3	To impart the knowledge in essential interdisciplinary fields which will enhance the **interpersonal skills**, team work, professional **ethics** and make them work effectively for their own benefit and the **betterment of the society**.
M4	Prepare students for **lifelong learning** of theoretical and **practical concepts** to face intellectual, **economical** and career challenges.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 01	Strengthen the knowledge in Electrical and Electronics Engineering to enable them **work** for modern industries by promoting energy conservation and sustainability.
PEO 02	Enrich analytical, creative and critical **logical reasoning** skills to solve problems faced by emerging domains of electrical and electronics engineering industries worldwide.
PEO 03	Develop effective communication and inter-personal skills to work with enhanced team spirit in multidisciplinary projects with a broader **ethical**, professional, economical and **social** perspective.
PEO 04	Prepare the students either to establish **start ups** or to pursue **higher education** at reputed institutions.

PROGRAM SPECIFIC OUTCOME (PSOs)

PSO 1	**Professional Skills:** Apply the knowledge of Mathematics, Science and Engineering to solve real time problems in the field of **Power Electronics, Electrical Drives, Power Systems, Control Systems and Instrumentation**.
PSO 2	**Research and Innovation:** Analyze and synthesize circuits by solving complex engineering problems to obtain the **optimal solution** using effective software tools and hardware prototypes in the field of robotics and renewable energy systems.
PSO 3	**Product development:** Develop concepts and **products** by applying ideas of electrical domain into other diversified engineering domains.

EE6703 SPECIAL ELECTRICAL MACHINES

UNIT I SYNCHRONOUS RELUCTANCE MOTORS

Constructional features – Types – Axial and Radial flux motors – Operating principles – Variable Reluctance Motors – Voltage and Torque Equations - Phasor diagram - performance characteristics – Applications.

UNIT II STEPPER MOTORS

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi stack configurations – Torque equations – Modes of excitation – Characteristics – Drive circuits – Microprocessor control of stepper motors – Closed loop control-Concept of lead angle– Applications.

UNIT III SWITCHED RELUCTANCE MOTORS (SRM)

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

UNIT IV PERMANENT MAGNET BRUSHLESS D.C. MOTORS

Permanent Magnet materials – Minor hysteresis loop and recoil line-Magnetic Characteristics – Permeance coefficient -Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations –Commutation - Power Converter Circuits and their controllers – Motor characteristics and control– Applications.

UNIT V PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM)

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

TEXT BOOKS:

1. K.Venkataratnam, „Special Electrical Machines‟, Universities Press (India) Private Limited, 2008.
2. T.J.E. Miller, „Brushless Permanent Magnet and Reluctance Motor Drives‟, Clarendon Press, Oxford, 1989.
3. 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.
4. E.G. Janardanan, „Special electrical machines‟, PHI learning Private Limited, Delhi, 2014.

Course Code& Name: EE6703 SPECIAL ELECTRICAL MACHINES

Degree/Programme: **B.E/EEE** Semester: **VII** Section: **A, B**

Duration: **JUNE-NOV 2018** Regulation: **2013/AUC**

Name of the Staff:

AIM: TO STUDY THE BEHAVIOUR OF VARIOUS SPECIAL ELECTRICAL MOTOR DRIVES.

OBJECTIVES: TO STUDY THE CONSTRUCTION, PRINCIPLE OF OPERATION AND PERFORMANCE CHARACTERISTICS OF ELECTRICAL MOTORS

COURSE OUTCOMES:

C	Course Outcomes
C4 3.1	Understand the Construction, principle of operation and performance of synchronous reluctance motors and control techniques
C4 3.2	Understand the Construction, principle of operation, control and performance of stepping motors and control techniques
C4 3.3	Understand the Construction, principle of operation, control and performance of switched reluctance motors and control techniques
C4 3.4	Understand the Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors and control techniques
C4 3.5	Understand the Construction, principle of operation and performance of permanent magnet synchronous motors and control techniques

Mapping of Course Outcomes(COs), Course(C),ProgramSpecificOutcomes (PSOs)with Program Outcomes. (POs)– [Levels of correlation:3 (High),2 (Medium), 1(Low)]

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
C4 3.1	2	3	3	2	-	2	1	-	-	-	1	3	3	-	2
C4 3.2	2	3	3	2	-	2	1	-	-	-	1	3	3	-	2
C4 3.3	2	3	3	2	-	2	1	-	-	-	1	3	3	-	2
C4 3.4	2	3	3	2	-	2	1	-	-	-	1	3	3	-	3
C4 3.5	2	3	3	2	-	2	1	-	-	-	1	3	3	-	2

UNIT – I	SYNCHRONOUS RELUCTANCE MOTORS					Target Periods: 9
Sl N o	**Contents**	**CO Statement**	**Book Reference & Page No**	**Delivery method**	**Delivery Periods**	**Knowledge Level**
1	Constructional features	C7 3.1	TB1:11-12	Chalk & board / PPT	**1**	R & U
2	Types	C7 3.1	TB1:31	Chalk & board / PPT	**1**	R & U
3	Axial and Radial flux motors	C7 3.1	TB1:30-30	Chalk & board / PPT	**1**	R, U, An
4	Operating principles	C7 3.1	TB1:32	Chalk & board / PPT	**2**	R, U, An
5	Variable Reluctance Motors	C7 3.1	TB1:32	Chalk & board / PPT	**1**	R, U, An
6	Voltage and Torque Equations	C7 3.1	TB2:36-37	Chalk & board / PPT	**2**	R,U, A
7	Phasor diagram	C7 3.1	TB: 39-40	Chalk & board / PPT	**2**	An, E
8	performance characteristics and Applications.	C7 3.1	TB2:42	Chalk & board / PPT	**2**	R, U, An

UNIT II	STEPPER MOTORS					Target Periods:9
Sl No	**Contents**	**CO Statement**	**Book Reference & Page No**	**Delivery method**	**Delivery Hrs**	**Knowledge Level**
1	Constructional features	C7 3.2	TB1:53	Chalk & board / PPT	**1**	R, A, An
2	Principle of operation	C7 3.2	TB1:60-62	Chalk & board / PPT	**1**	R, U, A, An
3	Variable reluctance motor	C7 3.2	TB1:68-73	Chalk & board / PPT	**1**	R, U, A, An
4	Hybrid motor – Single and multi stack configurations	C7 3.2	TB1:76-77	Chalk & board / PPT	**1**	R, U, A, An
5	Torque equations	C7 3.2	TB1:79	Chalk & board / PPT	**1**	R, U, A, An
6	Modes of excitation	C7 3.2	TB1: 79-86	Chalk & board / PPT	**2**	R, A, An
7	Characteristics and Drive circuits	C7 3.2	TB1:91-101	Chalk & board / PPT	**1**	A, An, E

8	Microprocessor control of stepper motors	C7 3.2	TB1:102-104	halk & board / PPT	**1**	R, U, A, An
9	Closed loop control-Concept of lead angle– Applications.	C7 3.2	TB1:111-116	halk & board / PPT	**1**	R, A, An

UNIT III **SWITCHED RELUCTANCE MOTORS (SRM)** **Target Periods: 9**

Sl No	**Contents**	**CO Statement**	**Book Reference & Page No**	**Delivery method**	**Delivery Hrs**	**Knowledge Level**
1	Constructional features	C7 3.3	RB1:157-159	Chalk & board / PPT	**1**	R, U, An
2	Rotary and Linear SRM	C7 3.3	RB1:161-162	Chalk & board / PPT	**2**	R, U, A, An
3	Principle of operation	C7 3.3	RB1:161-165	Chalk & board / PPT	**2**	R, U, A, An
4	Torque production – Steady state performance prediction	C7 3.3	RB1:225-232	Chalk & board / PPT	**1**	R, A,
5	Analytical method	C7 3.3	RB1:259-263	Chalk & board / PPT	**1**	R, U, A,
6	Power Converters and their controllers	C7 3.3	RB1:233-235	Chalk & board / PPT	**2**	R, U, A, An
7	Methods of Rotor position sensing – Sensor less operation	C7 3.3	RB1:233-235	Chalk & board / PPT	**2**	R, U, A, An
8	Characteristics and Closed loop control– Applications.	C7 3.3	RB1:15-16	Chalk & board / PPT	**1**	R, U, An

UNIT IV **PERMANENT MAGNET BRUSHLESS D.C. MOTORS** **Target Periods:9**

Sl No	**Contents**	**CO Statement**	**Book Reference & Page No**	**Delivery method**	**Delivery Hrs**	**Knowledge Level**
1	Permanent Magnet materials	C7 3.4	RB2:888-890	Chalk & board / PPT	**1**	R, U
2	Minor hysteresis loop and recoil line	C7 3.4	RB2:890-895	Chalk & board / PPT	**2**	R, U, A, An
3	Magnetic Characteristics – Permeance coefficient	C7 3.4	RB2:896-910	Chalk & board / PPT	**2**	R, U, A, An

4	Principle of operation	C7 3.4	RB2:911-914	Chalk & board / PPT	**1**	R, U, A, An
5	Types – Magnetic circuit analysis	C7 3.4	RB2:914-924	Chalk & board / PPT	**1**	R, U, A, An
6	EMF and torque equations	C7 3.4	RB2:938-945	Chalk & board / PPT	**1**	R, U, A, An
7	Commutation - Power Converter Circuits and their controllers	C7 3.4	RB2:938-945	Chalk & board / PPT	**1**	R, U, A, An
8	Motor characteristics and control– Applications.	C7 3.4	RB2:946-951	Chalk & board / PPT	**1**	R, U, A, An

UNIT V **PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM)** **Target Periods: 9**

Sl No	Contents	CO Statement	Book Reference & Page No	Delivery method	Delivery Hrs	Knowledge Level
1	Principle of operation of PMSM	C7 3.5	TB2:996-1014	Chalk & board / PPT	**2**	R, U, A, An
2	Ideal PMSM	C7 3.5	TB2:1015-1027	Chalk & board / PPT	**1**	R, U, A, An
3	EMF and Torque equations	C7 3.5	TB2:1031-1061	Chalk & board / PPT	**2**	R, U, A, An
4	Armature MMF – Synchronous Reactance	C7 3.5	TB2:1061-1031	Chalk & board / PPT	**1**	R, U, A, An
5	Sine wave motor with practical windings	C7 3.5	TB2:1062-1073	Chalk & board / PPT	**1**	R, U, A, An
6	Phasor diagram	C7 3.5	TB2:1092-1111	Chalk & board / PPT	**1**	R, U, A, An
7	Torque/speed characteristics- Power controllers	C7 3.5	TB2:1092-1111	Chalk & board / PPT	**1**	R, U, A, An
8	ConverterVolt-ampere requirements– Applications.	C7 3.5	TB2:1092-1111	Chalk & board / PPT	**1**	R, U, A, An

R- Remember, U- Understand, A- Apply, An- Analyze, E- Evaluate & C- Create.

Books:Text/Reference:

S.No		Title of the Book	Author	Publishe	Year
1	**TB1**	Special Electrical Machines	K.Venkataratnam	Universities Press (India) Private Limited	2008
2	**RB1**	Special electrical machines	E.G. Janardanan	PHI learning Private Limited, Delhi	2014

Comments Given by the Scrutinizing Committee Members	
Signature of the Scrutinizing	
Signature of the HOD	

QUESTION BANK

UNIT-I - SYNCHRONOUS RELUCTANCE MOTOR

1. What is synchronous reluctance motor? NOV/DEC-2015 NOV/DEC 2016

- A **reluctance motor** is a type of synchronous electric motor which induces non-permanent magnetic poles on the ferromagnetic rotor. Torque is generated through the phenomenon of magnetic reluctance.

- The stator consists of multiple salient (ie. projecting) electromagnet poles, similar to a wound field brushed DC motor. The rotor consists of soft magnetic material, such as laminated silicon steel, which has multiple projections acting as salient magnetic poles through magnetic reluctance.

- The number of rotor poles is typically less than the number of stator poles, which minimizes torque ripple and prevents the poles from all aligning simultaneously -- a position which can not generate torque.

2. Define the characteristics of synchronous reluctance motor.

The synchronous reluctance motor is not self starting without the squirrel cage. During run up it behaves as an induction motor but as it approaches synchronous speed, the reluctance torque takes over and the motor locks into synchronous speed.

3. Write the applications of SYRM. APR/MAY-2017 NOV/DEC 2016

Used where regulated speed control is required in applications suc as metering pumps and industrial process equipment.

4. What are the classification of SYRM

Axially laminated
Radially laminated

5. What are the primary design considerations of SYRM?

High o/p power capability
Ability of the rotor to withstand high speed.
High reliability
Low cost
High efficiency

6. Define power factor of SYRM

PF max=(Ld/Lq-1)/(Ld/Lq+1)

Higher Ld/Lq ratios yield higher power factors, which corresponds to reduced I^2R losses and reduce volt ampere ratings of the inverter driving the machine.

7. What are the applications of the torque – speed characteristics of sysrm? APR/MAY-2018

Comparable power density but better efficiency than induction motor
Slightly lower power factor
Sensorless control is much easier due to motor saliency.

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8. What are advantages of syrm over pm machine?

More reliable than PM machine

There need not be any excitation field as torque is zero, thus eliminating electromagnetic spinning losses.

9. What are applications of syrm? APR/MAY-2015 / NOV-DEC-2016

Synthetic fiber manufacturing equipment
Wrapping and folding machine
Auxiliary time mechanism
Synchronized conveyors
Metering pumps

10. What is vernier motor?

It is an unexcited reluctance type sync. Motor the peculiar feature of this motor is that a small displacement of the rotor produces a large displacement of the axis of maximum and minimum permeance.

11. What are the advantages of syrm ?

a. Freedom from pm
b. Ability to maintain full load torque at zero speed
c. A wide speed range at constant power.

12. What are the classifications of SYRM?

Rotor configuration

i) cage rotor for line start
ii) cageless-rotors for variable speed

Stator windings

Stator current controlled mode

13. What are the rotor configurations of SYRM?

Rotor configuration
i)cage rotor for line start
ii)cageless-rotors for variable speed

14. What is meant by Slow-speed synchronous timing motorsAPRIL/MAY 2017

Representative are low-torque synchronous motors with a multi-pole hollow cylindrical magnet (internal poles) surrounding the stator structure. An aluminum cup supports the magnet. The stator has one coil, coaxial with the shaft. At each end of the coil are a pair of circular plates with rectangular teeth on their edges, formed so they are parallel with the shaft. They are the stator poles. One of the pair of discs distributes the coil's flux directly, while the other receives flux that has passed through a common shading coil. The poles are rather narrow, and between the poles leading from one end of the coil are an identical set leading from the other end. In all, this creates a repeating sequence of four poles, un shaded alternating with shaded, that creates a circumferential traveling field to which the rotor's magnetic poles rapidly synchronize. Some stepping motors have a similar structure.

15. What is meant by Watt hour-meter motors?

These are essentially two-phase induction motors with permanent magnets that retard rotor speed, so their speed is quite accurately proportional to wattage of the power passing through the meter. The rotor is an aluminum-alloy disc, and currents induced into it react with the field from the stator. One phase of the stator is a coil with many turns and a high inductance, which causes its magnetic field to lag almost 90 degrees with respect to the applied (line/mains) voltage. The other phase of the stator is a pair of coils with very few turns of heavy-gauge wire, hence quite-low inductance. These coils are in series with the load.

16. How does the Watt hour-meter motors look like?

The core structure, seen face-on, is akin to a cartoon mouth with one tooth above and two below. Surrounding the poles ("teeth") is the common flux return path. The upper pole (high-inductance winding) is centered, and the lower ones equidistant. Because the lower coils are wound in opposition, the three poles cooperate to create a "sidewise" traveling flux. The disc is between the upper and lower poles, but with its shaft definitely in front of the field, so the tangential flux movement makes it rotate.

17. Electronically commutated motors? APR/MAY-2018

Such motors have an external rotor with a cup-shaped housing and a radially magnetized permanent magnet connected in the cup-shaped housing. An interior stator is positioned in the cup-shaped housing. The interior stator has a laminated core having grooves. Windings are provided within the grooves. The windings have first end turns proximal to a bottom of the cup-shaped housing and second end turns positioned distal to the bottom. The first and second end turns electrically connect the windings to one another. The permanent magnet has an end face rom the bottom of the cup-shaped housing. At least one galvano-magnetic rotor position sensor is arranged opposite the end face of the permanent magnet so as to be located within a magnetic leakage of the permanent magnet and within a magnetic leakage of the interior stator. The at least one rotor position sensor is designed to control current within at least a portion of the windings. A magnetic leakage flux concentrator is arranged at the interior stator at the second end turns at a side of the second end turns facing away from the laminated core and positioned at least within an angular area of the interior stator in which the at least one rotor position sensor is located

18. What is meant by repulsion motor? NOV/DEC 2016 APRIL/MAY 2017

Repulsion motors are wound-rotor single-phase AC motors that are similar to universal motors. In a repulsion motor, the armature brushes are shorted together rather than connected in series with the field. By transformer action ,the stator induces currents in the rotor, which create torque by repulsion instead of attraction as in other motors. Several types of repulsion motors have been manufactured, but the *repulsion-start induction-run* (RS-IR) motor has been used most frequently. The RS-IR motor has a centrifugal switch that shorts all segments of the commutator so that the motor operates as an induction motor once it has been accelerated to full speed. Some of these motors also lift the brushes out of contact with the commutator once the commutator is shorted. RS-IR motors have been used to provide high starting torque per ampere under conditions of cold operating temperatures and poor source voltage regulation

19. Define Slip.

If the rotor of a squirrel runs at high speed, the flux in the rotor at any given place on the rotor would not change, and no current would be created in the squirrel cage. For this reason, ordinary squirrel-cage motors run at some tens of rpm slower than synchronous speed, even at no load. Because the rotating field (or equivalent pulsating field) actually or effectively rotates faster than the rotor, it could be said to slip past the surface of the rotor. The difference between synchronous speed and actual speed is called slip, and loading the motor increases the amount of slip as the motor slows down slightly.

20. Write the formula for the speed of the AC motor.

The speed of the AC motor is determined primarily by the frequency of the AC supply and the number of poles in the stator winding, according to the relation:

$N_s = 120F / p$

Where

N_s = Synchronous speed, in revolutions per minute F = AC power frequency

p = Number of poles per phase winding

21. Define : Magnetic flux

The amount of magnetic lines of force setup in a magnetic circuit is called magnetic flux. It is analogous to electric current in electric circuit.

22. Define : Reluctance

The opposition offered to the magnetic flux by a magnetic circuit is called its reluctance.

23. Define : Permeance

It is a measure of the ease with which flux can be setup in a material. It is the reciprocal of the reluctance of the material.

24. List out any four features of synchronous reluctance motors.

Better efficiency, high cost, low power factor, used for low and medium power application

25. List the applications of Linear Induction motor. (May 12)

Magnetic Levitation, linear propulsion, and linear actuators. They have also been used for pumping liquid metals

26. Give some potential application of synchronous reluctance machine(Dec 12)

It is used for constant speed applications i.e. timing devices, signaling devices, recording instruments and phonograph, it is used in automatic processors such as in food processing and packaging industries. Used in high speed applications, Synthetic fiber manufacturing equipment, Wrapping and folding machines, synchronized conveyors.

27. Write the various design parameters of a synchronous reluctance motor(Dec 12)

Power factor, Copper loss and core loss, Cost, Efficiency

28. What are the merits of 3-phase brushless permanent magnet synchronous motor? (Dec 2013)

Robust, compact and less weight, No field current or rotor current in PMSM, unlike in induction motor, Copper loss due to current flow which is largest loss in motors is about half that of induction motor, High efficiency.

29. What are SYNREL motors? (Dec 2013) APR/MAY-2017

Synchronous reluctance motor is similar to three – phase Synchronous motor except the rotor are demagnetized and made with saliency to increase the reluctance power. It is a motor which develops torque due to the difference in reluctance of the two axes, namely quadrature and direct axis.

30. What are the characteristics of Synchronous reluctance motor?

It has combined reluctance and magnetic alignment torque, It has field weakening capability (to get higher synchronous speed), Under excited operation for most load conditions, High inductance, High speed capability, High temperature capability

PART_B

1. Explain the constructions and working principle of synchronous reluctance motor. (16) **NOV/DEC-2015** APR/MAY-2018 APR/MAY-2017
2. Explain in detail about classification of synchronous reluctance motor. (16)
3. Draw the phasor diagram of synchronous reluctance motor. (16)NOV/DEC 2016
4. Derive the torque equation of synchronous reluctance motor. (16) APR/MAY-2017
5. Draw and explain the characteristics of synchronous reluctance motor. (16) APR/MAY-2017NOV/DEC2016
6. Explain in detail about vernier motor. (16)

UNIT – II - STEPPER MOTORS

31. What is stepper motor? May -2018. **APRIL/MAY 2017**
1.

A stepper motor is a digital actuator whose input is in the form of programmed energization of the stator windings and whose output is in the form of discrete angular rotation.

2. Define step angle. Apr/May-2017

Step angle is definrd as the angle through which the motor rotates for each command pulse.it is denoted as β.

β=(Ns-Nr/Ns.Nr)360 (or)360/(mNr)

3. Define slewing

The stepper motor operates at very high speed is called slew angle.i,e (25000 steps per sec).

4. Define resolution

It is defined as the no.of steps needed to complete one revolution of the shaft.

Resolution = no . of steps /revolution

5. Mention some applications of stepper motor

i. floppy disc drives
ii. qurtz watch
iii. camera shutter operation
iv. dot matrix and line printers
v. small tool application
vi. robotics

6. What are the advantages and disadvantages of stepper motor?

Adv:

1. it can be driven in open loop without feedback
2. it is mechanically simple
3. it requires little or no maintenance.

Disadv:

1.low efficiency 2.fixed step angle 3.limited power output

7. Define holding torque. Nov/Dec-2016

Holding torque is the maximum load torque which the energized stepper motor can withstand without slipping from equilibrium position

8. Define detent torque. Nov/Dec-2017

Detent torque is the maximum torque which the unenergised stepper motor can withstand without slipping. It is also known as cogging torque.

9. What is meant by full step operation?

Full step operation or single phase on mode is the one in which at a time only one phase winding is energized, due to which one stator winding is energized and causes the rotor to rotate some angle.

10. What is meant by two phase mode of operation?

Two phase on mode is the one in which two phase windings are energized at a time, due to which two stator windings are energized and causes the rotor to rotate through some angle.

11. Define pull in torque. May -2018.

It is the maximum torque the stepper motor can develop in start – stop mode at a given stepping rate Fs (step/sec) without losing synchronism.

12. Define pull out torque.

It is the maximum torque the stepper motor can develop in slewing mode at a given stepping rate Fs (step/sec) without losing synchronism.

13. What is synchronism in stepper motor?

It is the one to one correspondence between the number the number of pulses applied to the stepper motor and the number of steps through which the motor has actually moved.

14. Define mid frequency resonance in stepper motor.

The phenomenon at which the motor torque drops to a low value at certain input pulse frequencies.

15. Define static stiffness.

It is a measure of ability of the actuator to resist disturbing torques and forces and thereby to maintain position.it is defined as

S=torque / rad

16. Give the types of driver circuits. Apr/May-2017,2015

Resistance or L/R drive
Dual voltage or bilevel drive
Chopper drive

17. What is multi stack VR motor. May/June-2017

Multi stack VR motor is the one in which the stepper motor has three separate magnetically nisolated sections or stacks.here the rotor and stator teeths are equal.

18. What is meant by micro stepping in stepper motor. Apr/May-2015

The methods of modulating currents through stator windings so as to obtain rotation of stator magnetic field through a small angle to obtain micro stepping action is known as micro stepping.

19. What are the advantages of micro stepping?

Improvement in resolution.
Dc motor like performance
Elimination of mid frequency resonance
Rapid motion at micro stepping rate.

20. Define bandwidth in stepper motor.

It is a measure of the frequencies upto which the actuator or servo motor system can respond.

21. What are the different modes of excitation?(May 2018)

Single phase excitation, two phase excitation, Half step mode, Mini-step drive.

22. Compare closed loop control and open loop control in stepper motor.(May 2015)

Closed loop control is more accurate, oscillatory motions are avoided for certain speed ranges, Speed remains constant for high inertial load, follows the input pulses at stepping frequency are some of the advantages over open loop control. But it is costly and complex.

23. Calculate the stepping angle for a 3 phase, 24 pole permanent magnet stepper motor (Dec 12)

Step angle β = 360/(no. of stator phases * no. of rotor teeth)=5°

24. Define torque constant of a stepper motor(Dec 12)

The torque constant of the stepper motor is defined as the initial slope of the torque current curve of the stepper motor

25. What is the function of driver circuit in stepper motor (June 2013)

The stepper motor is a digital device that needs binary signals for its operation. The power driver is essentially a current amplifier, since the sequence generator can supply only logic but not any power.

26. Mention the different types of stepper motor?

Variable Reluctance stepper motor (Single stack, Multi stack), Permanent magnet stepper motor, Hybrid stepper motor, Outer rotor stepper motor

27. Mention the features of stepper motor? (Dec 2013)

Small step angle, High positioning accuracy, High torque inertia ratio, Stepping rate, Pulse frequency

28. Define: Step Angle of stepper motor?(June 2013, Dec 2013)

A stepping motor rotates through a fixed angle for every pulse. The rated value of this angle is called the step angle and expressed in degrees.

29. What are the various bipolar drives used for stepper motor?

Basic Bipolar drives, Bipolar L/R drives, bipolar chopper drives

30. What are the different modes of excitation used in variable reluctance stepping motors? Nov/Dec-2015

1 phase on or full step operation, 2 phase on mode, alternate 1 phase on and 2 phase on mode half step operation, micro stepping operation.

PART-B

1. Explain the construction and various modes of excitation of VR stepper motor. (16) (May -2014,2017) **May -2018.**
2. Explain the construction and various modes of excitation of PM stepper motor. (16)
3. Explain the construction and working principle of Hybrid Stepper motor. (16) **May -2017.**
4. State and explain the static and dynamic characteristics of a stepper motor. (16) (May-2015, nov-2016) **May -2017**
5. Explain in detail about different types of power drive circuits for stepper motor. (16) (May/june-2016)
6. Explain the mechanism of torque production in VR stepper motor. (16) **May -2018.**
7. Draw any two drive circuits for stepper motor. (16)

Unit-III -
Switched reluctance motor

1. What is srm?

It is a doubly salient , single excited motor. This means that it has salient poles on both rotor and the stator but only one member carries winding the rotor has no windings, magnets or case windings.

2. What are the advantages od SRM?

Construction is very simple
Rotor carries no winding
No brushes and requires less maintenance

3. What are the disadvantages of SRM?

It requires a position sensor
Stator phase winding should be capable of carrying magnetizing currents

4. Why rotor position sensor is essential for the operation of switched reluctance motor?

It is necessary to use a rotor position sensor for commutation and speed feedback. The turning on and off operation of the various devices of power semiconductor switching circuit are influenced by signals obtained from rotor position sensor.

5. What are the different power controllers used for the control of SRM? Nov-2015

Using two power semi conductors and two diodes per phase
Phase windings and bifilar wires
Dump – C converter
Split power supply converter

6. What are the applications of SRM? Nov-2016

Washing machines
Fans
Robotic control applications
Vacuum cleaner
Future auto mobile applications

7. What are the two types of current control techniques?

Hysteresis type control
PWM type control

8. What is meant by energy ratio?

Energy ratio = Wm/(Wm+R)=0.45
Wm=mechanical energy transformed
This energy cannot be called as efficiency. As the stored energy R is not wasted as a loss but it is feedback to the source through feedback diodes.

9. Write the torque equation of SRM?

$T=1/2(i^2 dL/d\theta)$

10. What is phae winding?

Stator poles carrying field coils the field coils of opposite poles are connected in series such that mmfs are additive and they are called „‟ phase winding‟‟ of SRM.

11. Write the characteristics of SRM. Apr-2015, 2017

Lowest construction complexity, many stamped metal elements
Like a BLDC or stepper without the magnets
High reliability (no brush wear), failsafe for Inverter but...acoustically noisy
High efficiency

12. Write the voltage, power range of SRM.

Industrial

Voltage	Motor Power	Speed Range
100 - 240 Vac	50W - 10'sKW	0 - 60,000 RPM

Automotive

Voltage	Motor Power	Speed Range
12 - 42Vdc	50W -1kW	0 - 20,000 RPM

.

13. Define the control system of SRM.

The control system is responsible for giving the required sequential pulses to the power circuitry in order to activate the phases as required. There are two options for producing the sequence including a microcontroller to produce the signal or a timer circuit which could also produce the desired signal

14. Define the timer circuit of SRM.

The use of a timer circuit would be very effective in producing the necessary signal in which to control the circuit. As the required signal is very simple it could easily be implemented by digital timer, such as the 555 timer. A digital timer is more precise than any other form of timer, such as a mechanical timer. With the widespread use of digital logic within integrated circuits the cost of these timers has reduced considerably. The latest controllers in use incorporate programmable logic controllers (PLC‟ s) rather than electromechanical components in its implementation. Within PLC‟ s, the timers are normally simulated by the software incorporated in the controller; the timer is therefore controlled by the software. There are obvious advantages to this system, although the control of a soft start could be hard to implement in this way.

15. Write the soft starters of SRM.

Mechanical – come in the form of torque limiters utilizing clutches and various couplings,

Electrical – these soft starters alter the power supply to the motor to reducing the torque and current demand. This is normally performed either by reducing the supply voltage, or controlling the frequency of excitation. Since switched reluctance motors are driven by a controlled pulsed supply, frequency control is an obvious choice in this case.

16. What are the goals to contro, soft starting?

Fixed start-up time - the start up will be controlled to achieve full speed within a fixed time

Current limit - the motor current can be monitored and the start up controlled to keep it below a specified limit

Torque limit - an intelligent starter can calculate the motor torque based on the current and voltage demand and control the start up to provide a constant starting torque

17. What are the major advantages of frequency control of SRM?

This has a major advantage of being easily controlled and changed at any point by simply altering the programming. By using this method the development time is reduced and the number of modules to implement is also reduced.

18. Define the isolation of SRM.

The electrical isolation of the control and power circuitry modules is very important and is used so that the control electronics are protected from any voltage fluctuations in the power circuitry. The major method of isolation used today are opto isolators, these isolators use short optical transmission paths to transfer a signal from one part of a circuit to another. The isolator incorporates a transmitter and a receiver, the signal therefore converts from electrical to optical before converting back to electrical thereby breaking any electrical connection between input and output.

.

19. Define the power circuitry of SRM.

1. The most common approach to the powering of a switched reluctance motor is to use an asymmetric bridge converter.
2. There are 3 phases in this in an asymmetric bridge converter corresponding to the phases of the switched reluctance motor. If both of the power switches either side of the phase are turned on, then that corresponding phase shall be actuated. Once the current has risen above the set value, the switch shall turn off. The energy now stored within the motor winding shall now maintain the current in the same direction until that energy is depleted.
3. N+1 Switch And Diode
4. This basic circuitry may be altered so that fewer components are required although the circuit shall perform the same action. This efficient circuit is known as the (n+1) switch and diode configuration.
5. A capacitor can be added to either configuration, and is used to address noise issues by ensuring that the switching of the power switches shall not cause fluctuations in the supply voltage.

20. What are the current control schemes?

Hysteresis type current regulator
PWM type current regulator

21. Why SR machines popular in adjustable speed drives?(Dec 16)

Rotor is simple and it tends to have a low inertia, The stator is simple to wind, In most applications the bulk of the losses appear on the stator, which is relatively easy to cool, Due to the absence of magnet the maximum permissible rotor temperature may be higher than in PM motors, Under fault conditions the open circuit voltage and short circuit current are zero or varying small, Extreme by high speeds are possible

22. Mention some position sensors used in switched reluctance motor (MAY 2017)

Optical encoder, resolver, Speed sensors, hall effect sensor

23. What is the significance of closed loop control in switched reluctance motor(Dec 2016)

Switched reluctance motor is always operated with closed loop control. Normally we have to use a rotor position sensor for commutation and speed feedback. Here the phase windings are energized by by using power semiconductor circuit. He turning on and off operation of the various semiconductor devices are influenced by signals obtained from rotor position sensor. It is the main significance of closed loop control in SR motor

24. What are the merits of Dump C – Converter?

This topology uses lower number of switching devices and has only one switch voltage drop, the converter has full regenerative capability, and there is faster demagnetization of phases during commutation

25. What are the merits of split power supply Converter?

It requires lower number of switching devices, there is faster demagnetization of phases during commutation

26. What are the merits of classic converter or power controller in SRM? (May 17)

Control of each phase is completely independent of the other phases; the energy from the off going phase is feedback to the source, which results in useful utilization of the energy.

27. What are the different power converters used for the control of switched reluctance motor?

Classic converter, (n+1) power semiconductor switch, phase windings using bifilar wires, split power supply converter, dump c converter.

28. Explain torque speed characteristics of Switched Reluctance motor.

For speed below ωb the torque is limited by the motor current. Up to base speed it is possible to maintain the torque constant by means of the regulators. In the speed range below ωb the firing angles can be chosen to optimize efficiency of minimum torque ripple. The corner point or base speed wb is the highest speed at which maximum current can be supplied at rated voltage with fixed firing angle. If these angles are still kept fixed, then the maximum torque at rated voltage decreased with speed squared. However if the conduction angle is increased there is a considerable speed range over which maximum current can still be forced into the motor and thus sustain the torque at a level high enough to maintain constant power change. This is shown between points B and P. The angle D is dwell or conduction angle of the main switching device in each phase. It should generate can be possible to maintain constant power up to 2.3 times base speed.

29. What are the types of power controllers used for Switched Reluctance motor?

Using two power semiconductors and two diodes per phase, (n + 1) power switching devices and (n + 1) diodes per phase, Phase windings using Bifilar wires , Dump – C – converter, Split power supply converter

30. Why rotor position sensor is essential for the operation of Switched Reluctance motor? (Dec 15, 2016)

It is normally necessary to use a rotor position sensor for communication and speed feedback. The turning ON and OFF operation of the various devices of power semiconductor switching circuit are influenced by signals obtained from rotor position sensor.

PART – B

1. Explain the construction and working principle of switched reluctance motor. (16) **Nov-2015, Apr-2015**

2. Describe the various power controller circuits applicable to switched reluctance motor and explain the operation of any one scheme with suitable circuit diagram. (16) **May -2017 May -2018**

3. Draw a schematic diagram and explain the operation of a „C‟ dump converter used for the control of SRM. (16)

4. Derive the torque equation of SRM. (16) **Nov-2016, Apr-2015**

5. Draw and explain the general torque-speed characteristics of SRM and discuss the type of control strategy used for different regions of the curve. Sketch the typical phase current waveforms of low speed operation. (16) **Nov-2016 May -2018**

6. Describe the hysterisis type and PWM type current regulator for one phase of a SRM. (16) **May - 2017**

UNIT -4 -PERMANENT MAGNETS AND BRUSHLESS DC MOTORS

1. What are the advantages of brushless dc motors drives? **Nov-16**

Regenerative braking is possible
Speed can be easily controllable

2. What are the disadvantages of brushless dc motors drives?

It requires a rotor position sensor
It requires a power semiconductor switching circuits.

3. Define mechanical commutators? Apr-2017, Nov-16

Its arrangement is located in the rotor
No commutator segments are very high.

4. Define electronic commutators? Apr-2017, Nov-17

Its arrangement is located in the stator
No of switching devices limited to six

5. Mention some applications of PMBL DC motor?

Power alternators
Automotive applications
Computer and Robotics applications
Textile and Glass industries

6. What are conventional Dc motor?

Field magents on the stator
Maintenance is high

7. What are PMBL DC motor?

Field magents on the rotor
Low maintanace

8. Why is the PMBLDC motor called electronically commutated motor? Nov-2015 Nov-17

The PMBL DC motor is also called electronically commutated motor because the phase windings of PLMBL DC motor is energized by using power semiconductor switching circuits here the power semiconductor switching circuits act as a commutator.

9. What are the classification of BLPM DC motor?

BLPM square wave motor
BLPM sine wave motor

10. What are the two types of BLPM SQW DC motor?

180"polerarc BLPM SQW motor
120"polearc BLPM SQW motor

11. What are the two types of rotor position sensors?

Optical position sensor
Hall effect position sensor

.

12. What are the materials used for making Hall IC pallet?

Indiem-antinomy
Gallium-arsenide

13. What are applications of stator?

Automotive applications
Veticular electric drive motors

14. What are the classification of BLPM dc motor? May-2015

One phase winding and one pulse BLPM dc motor
One phase winding and two pulse BLPM dc motor
Two phase winding and two pulse BLPM dc motor
Three phase winding and three pulse BLPM dc motor
Three phase windings and six pulse circuits

15. What are the features of one phase winding and one pulse BLPM dc motor?

It is inertia should be high,such that rotor rotates continuously
Utilization of transistor and windings are less

16. What are the features of one phase winding and two pulse BLPM dc motor?

In this case winding utilization is better,however transistor utilization is less.
Torque developed is more uniform

17. What are the features of two phase winding and two pulse BLPM dc motor?

Winding utilization is only 50%which is less
It provide better torque waveforms

18. What are the features of three phase windings and 6 pluse circuits?

Utilization factor of winding will be better
Torque pulse and ripple frequency components are less

21. What is meant by self control?

Self control ensures that for all operating points the armature and rotor fields move exactly at the same speed.

22. What is meant by vector control?

PMSM are employed for variable speed applications. The process of controlling voltage and frequency to get the desired speed and torque is known as vector control of PMSM

23. What is meant by multiphase brushless motors?(May 15)

A multi-phase brushless motor including a stator having a plurality of drive coils each corresponding to a specific phase and a rotor having a plurality of field magnet poles of successively alternating polarity. The stator further has a plurality of Hall generators for detecting the positions of the rotor and a speed sensor for detecting the rotational speed of the rotor.

24. Give the uses of sensors in motors. (May 15)

It is used to identify the position of the rotor and to excite the coils in proper manner.

25. A permanent magnet DC commutator motor has a stalling torque of 1Nm. The stall current is 5A. compute the motors no-load speed if it is fed with 28V DC supply. (Dec16)

N=1336.9rpm

26. What is commutation(June 17)

Because of hetropolar magnetic field in the airgap of DC machine the emf induced in the armature conductors is alternating in nature. This emf available across brushes as unidirectional emf because of commutator and brushes arrangement.

27. What are the various kinds of permanent magnets?

There are basically three different types of permanent magnets which are used in small DC motors Alnico magnets, Ferrite or ceramic magnet, and Rare - earth magnet (samarium – cobalt magnet)

28. Give the expression for self and mutual inductances of a BLDC motor.

Self inductance is given by Lg = (ψ/i) = (πμ0 N2lr1)/(2g||) where g|| = g‟ + lm/ μrec , g‟ = Kcg, N = Number of conductors in the slot, I = current, lm = magnet length in radial direction , g‟ = air gap, g|| = air gap including radial thickness of the magnet, μrec = relative recoil permeability, Mutual inductance is given by Mg = - (1/3) Lg

29. What are the types of sensors used with PMBLDC motors?

Hall effect sensors are most commonly used for speed, position sensing with PMBLDC motors. Optical Disc based sensors are also used. Presently rotor position sensors are avoided by using alternative methods called as Sensor less control methods, which uses terminal emf measurement, third harmonic voltage measurement, flux estimation and neuro – fuzzy techniques etc.

30. Why MOSFET or IGBTs are used in inverters for PMBLDC motors?

These devices operate at very high switching frequencies for PWM method of operation. The duty cycle of the PWM decides the average voltage applied to the motor and hence the speed is adjusted. These devices are easy to commutate by using microprocessor or microcontroller based software. (Base drive)

PART – B

1. Sketch the structure of controller for PMBLDC motor and explain the functions of various blocks. (16) **Apr-2017, Nov-2016**

2. Explain the closed loop control scheme of a permanent magnet brushless dc motor drive with a suitable schematic diagram. (16) Nov-17MAY 18

3. Drive the expressions for the emf and torque of a PMBLDC motor. (16) **May-14, Apr-17,Nov-15**

4. Draw the diagram of electronic Commutator. Explain the operation of electronic Commutator. (16) **May-2015NOV 2016**

5. Discuss the use of Hall sensors for position sensing in PMBLDC motor. (16) MAY 18

6. Sketch the torque-speed characteristics of a PMBLDC motor. (16) NOV 2016 Nov-17

UNIT -5
PERMANENT MAGNETS AND SYNCHRONOUS MOTORS

1. Define stator?

Stator is made up of silicon steel stampings.stator slots carry a balanced 3phase armature winding, wound for a specified even number of poles.The ends of the armature windings are connected to the terminals of the motor.

2. Define rotor?

Rotor is made up of forged steel with outward projected poles.The number of rotor poles must be same as that of stator.These rotor poles carry field coils.They aare suitably connected to form a field winding.The ends of the field windings are connected to the two slip rings which are also mounted on to the same shaft.

3. What are merits of 3phase BLPM synchronous motor?MAY 2018

It runs at a constant speed.
No sliding contacts so it requires less maintenance.

4. What are the demerits of 3 phase BLMP synchronous motor?

Power factor of operation cannot be controlled as field current can‟ t be controlled.

5. What are the rotor configurations?

Peripheral
Interior
Claw-pole or Lundell

6. What are the advantages of load commutation? MAY 2017

It does not require commutation circuits
Frequency of operation can be Transverse higher

7. What are the applications of load commutation?

Some prominent applications of this drive are high speed and high power drives for compressors, blowers, conveyers, steel rolling.

8. What are advantages of synchronous motor?

Four quadrant operation with regenerative braking is possible
High power ratings(up to 100MW)and run at high speeds(6000rpm)

9. What are the applications of synchronous drive?

High speed and high power drives for compressors, blowers, fans, pumps, aircraft test facilities.

10. What are the features of permanent magnet synchronous motor?

Robust, compact and less weight
High efficiency

11. What are the advantages of load commutation?

It does not require commutation circuits
Frequency of operation can be higher

12. What are the applications of PMSM? NOV 2016 MAY 2018

Used as a direct drive traction motor
Used as high speed and high power drives for compressors, blowers, conveyors

13. What are features of closed-loop speed control of load commutated inverter fed synchronous motor drive?

High efficiency
Four quadrant operation with regeneration braking is possible

14. What are the merits of PMSM? NOV 2016

It runs at constant speed

No field winding, no field loss, better efficiency

15. What are the demerits of PMSM?

Power factor of operation cannot be controlled as field winding cannot be controlled It leads to losses and decreases efficiency

16. what are assumptions made in derivation of emf equation for PMSM? NOV 2016

Flux density distribution in the air gap is sinusoidal

Armature winding consists of full pitched, concentrated similarly located coils of equal number of turns

17. Why PMSM operating in self controlled mode is known commutator less dc motor?

Load side controller performs some what similar function as commutator in a dc machine. The load side converter and synchronous motor combination function similar to a dc machine.

First, it is fed from a dc supply and secondly like a dc machine. The stator and rotor field remain stationary with respect to each other at all speeds. Consequently, the drive consisting of load side converter and synchronous motor is known as "Commutator less dc motor".

18. what is"pulsed mode"?

For speeds below 10%of base speed, the commutation of load side converter thyristors Is done by forcing the current through the conducting thyristors to zero

This is realized by making source side converter to work as inverter each time load side converter thyristors are to be turned off Since the frequency of operating of load side converter is very low compared to the source frequency.Such an operation can be realized. The operation of inverter is termed as "Pulsed mode"

19. What is load commutation?

Commutation of thyristors by induced voltages of load is known as "Load commutation". Here, frequency of operation is higher and it does not require commutation circuits.

20. What is meant by synchronous reactance? NOV 2016

It is the sum of armature leakage reactance and fictitious reactance.

Xs=Xt+Xa

21. Brief-up the advantages of load commutation in permanent magnet synchronous motor(Dec 15)

Commutation of thyristors by induced voltages of load is known as ―load commutation‖. Here, frequency of operation is higher and it does not require commutation circuits.

22. What is meant by self control? (Dec 15)

The objective of self control is to make the armature (stator) and rotor fields of brushless synchronous motor drive to move in synchronism for all operating points

23. Define synchronous reactance (June 16)

Synchronous reactance is the sum of armature leakage reactance and fictious reactance.

S M l X □ *X* □ *X* , Xs = Synchronous reactance

24. State the two classifications of PMSM?

Sinusoidal PMSM, Trapezoidal PMSM

25. Write down the expressions for the self and synchronous reactance of PMSM?

Xs = (3 π μ0 Ns2 l r1 ω) / 8 p2 g2 Ω

26. What are advantages and disadvantages of PMSM? (May 12)

Advantages:

Elimination of field copper loss, High power density, Lower rotor inertia, Robust construction of rotor, High efficiency

Disadvantages:

Loss of flexibilities of field flux control, Demagnetization effect, High cost

27. Write down the emf expressions of PMSM?(Dec 16)

Eph = 4.44 f Φm Kw1 Tph volts, This is the rms value of induced emf per phase, where f = Frequency in Hertz, Φm = flux per pole, Kw1 = Winding factor, Tph = Turns per phase

28. What is load commutation?

Commutation of thyristors by induced voltages of load is known as ―load commutation‖. Here, frequency of operation is higher and it does not require commutation circuits.

29. What is meant by slotless motor?

In slotless motor, the stator teeth are removed and resulting space is partially filled with addition copper.

30. Name the two commutators used in the power controllers of permanent magnet brushless DC motors. Dec 16

Mechanical and electronic commutators

PART – B

1. Explain the construction and operation of PMSM. (16) **May-2018**

2. Explain the principle of operation of a sine wave PM synchronous machine in detail. Draw its phasor diagram and derive its torque equation. (16)dec 15

3. Derive the emf equation of PMSM. (16)**Nov-2016, 15 May-2017**

4. Write about Self control of PMSM. (16) **May-2017**

5. Derive the expressions for power input and torque of a PMSM. Explain how its torque speed characteristics are obtained. (16) **Nov-2016, 15 May-2018**

6. Explain in detail the vector control of permanent magnet synchronous motor. (16) dec 15

Reg. No. : [| | | | | | | | | | | |]

Question Paper Code : 71786

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Seventh Semester

Electrical and Electronics Engineering

EE 6703 — SPECIAL ELECTRICAL MACHINES

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the types of rotor available in synchronous reluctance motor?

2. What are the applications of synchronous reluctance motor?

3. Draw the equivalent circuit of winding in stepper motor.

4. What are the applications of stepper motor?

5. Define energy ratio.

6. Draw the Torque — Speed characteristics of SRM.

7. What is electronic commutator?

8. Write the EMF equation of a P.M. Brushless D.C Motor?

9. What are the types of materials used in permanent magnet motor?

10. What is self control in PMSM?

PART B — (5 × 16 = 80 marks)

11. (a) Explain the working principle and construction details of different types of Synchronous reluctance motor. (16)

Or

(b) (i) Derive the torque equation of a Synchronous Reluctance motor and draw the Torque- Angle characteristic. (8)

(ii) Derive the expression for d-axis synchronous reactance of a permanent magnet Synchronous reluctance motor. (8)

12. (a) Describe construction and working of variable reluctance stepper motor with neat diagram. (16)

Or

(b) (i) Explain in detail the power driver circuits of stepper motor. (10)

(ii) Write in detail the microprocessor based closed loop operation of stepper motor. (6)

13. (a) (i) Explain in detail the power controllers for switched reluctance motor. (10)

(ii) Explain the role of microprocessors in control of switched reluctance motor.

Or

(b) (i) Describe the construction and working principle of SRM. (12)

(ii) What are the applications and advantages of SRM? (4)

14. (a) Derive the emf and torque equation of a Brushless permanent magnet square wave motor. (16)

Or

(b) Explain the construction of PMBLDC motor also compare conventional dc motor and PMBLDC motor. (16)

15. (a) Describe the construction and performance of PMSM with neat diagram. (16)

Or

(b) Derive the emf and torque equation of a Brushless permanent magnet since wave DC motor. (16)

Reg. No. : [| | | | | | | | | | | |]

Question Paper Code : 80387

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Seventh Semester

Electrical and Electronics Engineering

EE 6703 — SPECIAL ELECTRICAL MACHINES

(Regulations 2013)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by reluctance torque in synchronous reluctance motor?

2. Write down the applications of synchronous reluctance motor.

3. Define lead angle.

4. What is the need of suppressor circuits in stepper motor?

5. What is the need of a rotor positioning sensor in Switched Reluctance Motor?

6. Write any four applications of SRM.

7. What are the merits of the brushless dc motor drives?

8. Write the difference between electronic and mechanical commutator.

9. Classify the different types of PMSM.

10. Differentiate square wave and sine wave motor.

PART B — (5 × 16 = 80 marks)

11. (a) Explain with neat diagram, the construction, working principle and types of synchronous reluctance motor. (16)

Or

(b) Draw the steady state phasor diagram of synchronous reluctance motor and derive the expression for torque of synchronous reluctance motor. (16)

12. (a) (i) Explain in detail the multi stack construction of stepper motor. (8)

(ii) Explain the modes of excitation of a stepper motor with neat diagram. (8)

Or

(b) (i) A stepper motor has resolution of 180 steps/rev. Find the pulse rate required in order to obtain a rotor speed of 2400 rpm. (8)

(ii) Explain in detail, the static and dynamic characteristics of a stepper motor. (8)

13. (a) (i) Explain with neat diagram, the microprocessor based control of Switched reluctance motor. (10)

(ii) Derive the expression for static torque in SRM. (6)

Or

(b) (i) Explain with the neat diagram any two converter topologies for SRM. (8)

(ii) Explain the torque speed characteristics of SRM in detail. (8)

14. (a) Explain the construction and principle of operation of PMBLDC motor. (16)

Or

(b) (i) Explain in detail, the power controllers for PMBLDC. (8)

(ii) A BLPM motor has a no load speed of 6000 rpm when connected to a 120 V DC supply. The armature resistance is 2 Ω. Rotational and iron losses may be neglected. Determine the speed when the supply voltage is 60 V and the torque is 0.5 N-m. (8)

15. (a) Derive the Torque equation of PMSM along with the phasor diagram. (16)

Or

(b) (i) Derive the EMF equation of PMSM. (10)

(ii) Explain the torque speed characteristics of PMSM. (6)

Reg. No. :

Question Paper Code : 50495

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017

Seventh Semester

Electrical and Electronics Engineering

EE 6703 – SPECIAL ELECTRICAL MACHINES

(Regulations 2013)

Time : Three Hours

Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Compare synchronous reluctance motor and induction motor.
2. Classify the different types of synchronous reluctance motor.
3. Name the various modes of excitation in stepper motor.
4. Distinguish the half step and full step operations of a stepper motor.
5. Illustrate the different modes of operation of switched reluctance motor.
6. Give the advantages of sensorless operation of switched reluctance motor.
7. What is the principle of operation of PMBLDC motor.
8. Write down the torque equation of PMBLDC motor.
9. What are the types of PMSM ?
10. State the power controllers for PM synchronous machines.

PART – B (5×16=80 Marks)

11. a) i) Discuss in detail about the construction and working of synchronous reluctance motor with neat diagrams. **(8)**

ii) Draw and explain phasor diagram with characteristics of synchronous reluctance motor. **(8)**

(OR)

b) Describe the constructional features and operation of variable reluctance synchronous reluctance motor. **(16)**

12. a) Draw and explain the drive circuits and their performance characteristics for stepper motor. **(16)**

(OR)

b) With a neat block diagram explain microprocessor control of stepper motor. **(16)**

13. a) Explain with a neat circuit any two configuration of power converters used for the control of switched reluctance motor. **(16)**

(OR)

b) Explain with a neat diagram the constructional details and working of rotary switched reluctance motor. **(16)**

14. a) Discuss in detail about magnetic circuit analysis of PMBLDC motor. Also draw its characteristics. **(16)**

(OR)

b) Prove that the torque equation in BLDC motor is similar to that of conventional DC motor. **(16)**

15. a) Derive the expression for power input and torque of a PMSM. Explain how its torque speed characteristics is obtained. **(16)**

(OR)

b) Explain the construction and working principle of operation of PMSM. **(16)**

Reg. No. :

Question Paper Code : 41013

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018

Seventh Semester

Electrical and Electronics Engineering

EE6703 – SPECIAL ELECTRICAL MACHINES

(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Mention any two advantages of synchronous reluctance motors.
2. Define 'Reluctance Torque' with reference to synchronous reluctance motor.
3. What are the different modes of excitation in a stepper motor ?
4. What is meant by Lead angle in stepper motors ?
5. What is the need for shaft position sensor for Switched Reluctance Motor ?
6. Draw the speed-torque characteristics of Switched Reluctance Motor.
7. List any four permanent magnet materials.
8. State some important applications of Permanent Magnet Brushless DC Motors.
9. Write the important features of Permanent Magnet Synchronous Motor.
10. State the types of power controllers for Permanent Magnet Synchronous Motor.

PART – B (5×16=80 Marks)

11. a) Explain the constructional details and working principle of synchronous reluctance motor with neat diagrams. (10+6)

(OR)

b) Explain the phasor diagram and characteristics of synchronous reluctance motor. (10+6)

12. a) i) Describe the principle of operation of hybrid stepper motor. (8)

ii) Explain briefly a closed-loop operation system using a microprocessor for a hybrid stepping motor. (8)

(OR)

b) i) Explain the mechanism of static torque production in a variable reluctance stepping motor. (10)

ii) Describe the dynamic characteristics of a variable reluctance stepper motor. (6)

13. a) Draw the cross sectional view of switched reluctance motor and explain the principle of operation. State the advantages of switched reluctance motor. (10+6)

(OR)

b) Draw and explain four converter topologies for a 3-phase SRM. Write the merits and demerits of each topology. (16)

14. a) i) Explain the magnetic circuit analysis of permanent magnet brushless DC motor on open-circuit. (10)

ii) Derive the EMF equation of permanent magnet brush less DC motor. (6)

(OR)

b) i) Draw and explain the general structure of a controller for a permanent magnet brush less DC motor. (8)

ii) Describe the torque/speed curve of the ideal burshless DC motor. (8)

15. a) For an ideal sine wave permanent magnet motor, derive the EMF and Torque equations. (8+8)

(OR)

b) i) Describe the construction of phasor diagram of surface-magnet sine wave motor. (8)

ii) Explain the torque/speed characteristic of sine wave motor. (8)

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Reg. No. : [| | | | | | | | | | |]

Question Paper Code : 71517

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Seventh Semester

Electrical and Electronics Engineering

EE 2403/EE 73/10133 EEE 25 — SPECIAL ELECTRICAL MACHINES

(Regulation 2008/2010)

(Common to PTEE 2403/10133 EEE 25 – Special Electrical Machines for B.E. (Part-Time) Sixth/Seventh Semester – EEE – Regulation 2009/2010)

Time : Three hours — Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List the applications of synchronous reluctance motors.
2. Draw the voltage and torque characteristics of Synchronous reluctance motor.
3. Define the micro stepping mode of Stepper motor.
4. Name the various driver circuits used in stepper motor.
5. State the reluctance principle.
6. List the characteristics of switched reluctance motor.
7. Classify the types of BLDC motor.
8. How the demagnetization occurs in PMBLDC motor?
9. Define the term load angle.
10. Write the draw backs in PM synchronous motor.

PART B — (5 × 16 = 80 marks)

11. (a) Explain the construction and operation of Axial and Radial flux motors with neat diagram. (16)

Or

(b) (i) Derive the expression the torque equation for the synchronous reluctance motor. (8)

(ii) Investigate the performance of the synchronous reluctance motor with neat phasor diagram. (8)

12. (a) Construct and evaluate the operation of single stack and multi-stack stepper motor with neat diagram. (16)

Or

(b) Compare the static and dynamic characteristics of stepper motor with necessary diagrams. (16)

13. (a) Construct and demonstrate the operation of switched reluctance motor with neat diagram. (16)

Or

(b) (i) Derive the voltage and torque equations of SRM. (12)

(ii) Discuss the need of rotor position sensor in SRM. (4)

14. (a) Discuss the hysteresis type current regulation of PMBLDC motor with neat diagram. (16)

Or

(b) Analyze the operation of electronic commutator in PMBLDC motor with neat diagram. (16)

15. (a) Write short note on :

(i) Armature reaction in PMSM

(ii) Synchronous Reactance. (8 + 8)

Or

(b) Draw and discuss the various power controllers used in PMSM with neat diagram. (16)

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