EE 2403- SPECIAL ELECTRICAL MACHINES

UNIT I – SYNCHRONOUS RELUCTANCE MOTOR

1. **What is a synchronous reluctance motor?**

It is the motor driven by reluctance torque which is produced due to tendency of the salient rotor poles to align them selves with synchronously rotating field produced by stator.

In this motor, the magnets are left out of the rotor or they are demagnetized. The rotor of the SyRM has salient poles but neither have field windings nor permanent magnets.

2. **What are the types of synchronous reluctance motor?**

The main types are 1. Cageless. 2. Line-start.

According to the magnetization 1. Radial type. 2. Axial type.

3. **What are the types of rotor in synchronous reluctance motor?**

- ✓ Salient rotor
- ✓ Radially laminated rotor
- ✓ Axially laminated rotor.

4. **Mention some applications of synchronous reluctance motor.**

- ✓ Fiber spinning mills
- ✓ Industrial process equipment
- ✓ Metering pumps
- ✓ Wrapping and folding machines.

5. **What are the advantages of increasing Ld/Lq ratio in SyRM?**

1. Motor power factor ioncreases.
2. I2R Losses reduced.
3. Reduced volt ampere ratings of the inverter driving the machine.

6. **What is Vernier motor.**

Vernier motor is a PM motor and has a high torque at low speed. It operates on the principles of a vernier.

7. **Compare SyRM and Induction motor.**

S.No	SyRM	Induction motor
1.	Better efficiency	Efficiency is low compared with SyRM.
2.	High Cost	Low cost
3.	Low power factor	High power factor
4.	Used for low and medium power application	Used for high power application

8. What is the application of a Vernier motor.

The vernier motor is mainly used where require low speed and high torque.

9. Write down any two properties of SyRM.

- ✓ High output power capability
- ✓ Ability of the rotor to withstand high speeds.
- ✓ Negligible zero-torque spinning loss.
- ✓ High reliability.

10. What is reluctance torque in SyRM.

The torque exerted by the reluctance motor because of the tendancy of the salient poles to align themselves in the minimum position. This torque is called reluctance torque.

11. What are the design considerations in SyRM.

- ✓ Power factor. 2. Copper loss and core loss. 3.Cost. 4.Efficiency.

12. Mention the advantages of SyRM.

- ✓ There is no concern with demagnetization, hence synchronous reluctance.
- ✓ There need be no excitation field at zero torque, thus eliminating electromagnetic spinning losses.
- ✓ SyRM rotor can be constructed entirely from high strength, low cost materials.
- ✓ Lower torque ripple.

13. Mention the Disadvantages of SyRM.

- ✓ Compared to induction motor it is slightly heavier and has low power factor.
- ✓ High cost than induction motor.
- ✓ Need speed synchronization to inverter output frequency by using rotor position sensor and sensor less control.

14. Define –Torque angle.

In reluctance type synchronous motor, when the load is increased lightly, the rotor momentarily slows down, causing the salient poles of the rotor to lag the rotating field. This angle of lag is called the torque angle.

15. What is meant by flux concentrating design SyRM.

In a six pole circumferentially magnetized SyRM, the design is such that the magnet pole area exceeds the pole area at the air gap, producing an air gap flux density higher than that in the magnet. This arrangement is known as flux concentrating or flux focusing design.

16. What are the factors to be considered while designing a vernier motor?

- ✓ The air gap permeance wave should have the same number of poles as the stator mmf wave.
- ✓ The number of stator (N1) and rotor slots(N2) should be such that N1=N2+P, Where P is the number of poles of the rotating magnetic field.

17. When does a PM synchronous motor operate as a SyRM.

If the cage winding is induced in the rotor and the magnets are left out or demagnetized, a PM SyRM operates as a SyRM.

18. Write the draw backs of Vernier Motor.

- ✓ Low speed.
- ✓ Design factors.

19. Write the operating principle of SyRM.

When a piece of magnetic material is free to move in a magnetic field, it will align itself with the magnetic field to minimize the reluctance of the magnetic circuit.

20. What are the two types of stator current modes.

- ✓ Unipolar current modes.
- ✓ Bipolar current modes.

21. What are the types of Stator in Vernier motor.

1. Split pole type.
2. Open slot type.

22. Differentiate SRM and SyRM.

S.No	SRM	SyRM
1.	In order to have self starting capability and bidirectional control, the rotor of a SRM has Lesser poles than the stator.	The motor has the same number of Poles on stator and rotor.
2.	The stator of SRM has salient poles with concentrated coils Like ad.c motor.	The stator of SRM is cylindrical type With distributed winding.
3.	Like ad.c motor. The stator of SRM is cylindrical type With distributed winding. 3. In SRM, both stator and rotor Have salient poles.	The stator has a smooth bore except fro slotting.
4.	Excitation is a sequence of current pulses applied to each phase in turn	Excitation is a set of polyphase balanced sine wave currents.

23. What are the features of PM synchronous motor?

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

24. Differentiate the SyRM and PMSM.

S.No	*SyRM*	*PMSM.*
1.	Rotor has no permanent magnet	Rotor has permanent magnet
2.	Less cost	High cost
3.	Low efficiency	High efficiency

25. What are the applications of PMSM?

- ✓ Used as a direct drive traction motor.
- ✓ Used as high speed and high power drives for compression, blowers, conveyors, fans, pumps, conveyors, steel rolling mills, main line traction, aircraft test facilities.
- ✓ Fiber spinning mills.

UNIT II – STEPPING MOTORS

1. What is stepper motor?

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 the term step angle. (β)

Step angle is defined as the angle through which the stepper motor shaft rotates for each command pulse.

3. Define Slewing.

The stepper motor may be operating at very high stepping rates. i.e 25000 steps per second. A stepper motor operates at high speeds is called slewing.

4. Define Revolution.

It is defined as the number of steps needed to complete one revolution of the rotor shaft.

5. State some applications of stepper motor.

Floppy disk drives, Quartz watches, Camera shutter operation, Dot matrix and line printers, Robotics, Machine tool applications.

6. What are the advantages of stepper motor?

1. It can driven open loop without feedback.
2. It is mechanically simple.
3. It requires little or no maintenance.
4. Responds directly to digital control signals, so stepper motors are natural choice for digital computer controls.

7. What are the disadvantages of stepper motor?

1. Fixed step angle.
2. Limited power output and sizes available.

3. Limited ability to handle large inertia load.
4. Low efficiency with ordinary controller.

8. What are the different types of stepper motor?

1. Variable reluctance stepper motor.
2. Permanent magnet stepper motor.
3. Hybrid stepper motor.

9. What are the different modes of excitation in a stepper motor?

1. 1-phase on or full step operation.
2. 2- phase on mode.
3. Half step operation.
4. Micro stepping operation.

10. What is meant by full step operation?

It is the one-phase on mode operation. It means, at that time only one winding is energized. By energizing one stator winding, the rotor rotates some angle. It is the full step operation.

11. What is meant by half step operation?

It is the alternate one phase on and 2 phase on mode operation. Here the rotor rotate an each step angle is half of the full step angle.

12. What is meant by micro stepping in stepping in stepper motor?

Micro stepping means, the step angle of the VR stepper motor is very small. It is also called mini stepping. It can be achieved by two phases simultaneously as in 2 phases on mode but with two currents deliberately made unequal.

13. What are the main applications of micro stepping VR stepper motor?

Micro stepping is mainly used where very fine solution is required. The applications are printing and prototype setting. AVR stepper motor with micro stepping provides very smooth low speed operation and high resolution.

14. What is a multi-stack VR stepper motor?

Micro stepping of VR stepper motor can be achieved by using multistack VR stepper motion. It has three separate magnetically isolated sections or stacks. Here the rotor and stator teeths are equal.

15. What are the advantages of VR stepper motor?

1. Low rotor inertia. 2. Light weight 3. Ability to free wheel 4. High torque to inertia ratio. 5. Ability to free wheel.

16. What are the disadvantages of VR stepper motor?

1. Normally available in 3.60 to 30 step angles.
2. No détente torque available with windings de energized.

17. What are the disadvantages of PM stepper motor?

1. Motor has higher inertia.
2. Slower acceleration

18. What are the advantages of PM stepper motor?

1. Low power requirement.
2. Rotor do not require external exciting current.
3. It produces more torque per armature stator current.
4. High détente torque as compared to VR motor.

19. What is hybrid stepper motor?

A hybrid stepper motor combines the features of both PM and VR stepping motors.

20. What are the advantages of hybrid stepper motor?

1. Less tendency to resonate.
2. Higher holding torque capability.
3. High stepping rate capability.

21. What are the disadvantages of hybrid stepper motor?

1. Higher inertia and weight due to presence of rotor magnet.
2. Performance affected by change in magnetic strength.

22. Define holding torque.

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

23. Define Détente torque.

It is the maximum load torque which is unenergized stepper motor can with stand without slipping. It is also known as cogging torque.

24. Define torque constant.

It is defined as the initial slope of the torque-current curve of the stepper motor. It is also called as torque sensitivity.

25. Define pull in torque.

It is the maximum torque the stepper motor can develop in start-stop mode at a given stepping rate, without losing synchronism.

26. Define Pull-out torque.

It is the maximum torque the stepper motor can develop at a given stepping rate, without losing synchronism.

27. Define Pull-in rate.

It is the maximum stepping rate at which the stepper motor will start or stop, without losing synchronism, against a given load torque.

28. Define Pull-out rate.

It is the maximum stepping rate at which the stepper motor will slow, without losing synchronism, against a given load torque.

29. What is a response range?

It is the range of stepping rates at which the stepper motor will start or stop, without losing synchronism, against a given load torque.

30. What is a slewing range?

It is the range of stepping rate at which the stepper motor can run in the slowing mode , with losing synchronism, against a given load torque.

31. What is synchronism in stepper motor?

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

32. What is mid frequency response in stepper motor.

In the pull in curve of a stepper motor, suddenly dips very low in particular range of stepping rates. This phenomenon is known as mid frequency resonance. This phenomenon is a manifestation of instability of motor operation.

33. What is logic sequencer?

Logic sequence generator generates programmed logic sequences required for operation of a stepper motor.

34. What is the use of current suppression circuit?

This circuit is used to ensure fast decay of current through the winding when the transistor is turned off.

35. What is meant by power drive circuit in stepper motor?

The output from the logic sequence generator signals are low level signals which are too weak to energize stepper motor windings. To increase the voltage, current and power levels of the logic sequence output by using power semiconductor switching circuit. This circuit is called power drive circuit.

36. What are the types of current suppression circuits?

1. Diode suppression.
2. Diode-resistor suppression
3. Diode-zener diode suppression.
4. Active suppression.

37. How is the step of PM stepper motor controlled?

The step of the PM stepper motor is controlled by energization of phase winding with positive or negative current.

UNIT III – SWITCHED RELUCTANCE MOTORS

1. What are the types of power controllers used for SRM?

1. Using two power semiconductors and two diodes per phase.
2. (n+1) power switching devices and (n+1) diodes per phase.
3. Phase windings using bifilar wires.
4. Dump –C-converter.
5. Split power supply converter.

2. List the disadvantages of a switched reluctance motor?

1. Stator phase winding should be capable of carrying magnetizing current.
2. For high speed operation developed torque has undesirable ripples is a result develops undesirable noises or acoustic noises.
3. It requires position sensors.

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

It is normally necessary to use a rotor position 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.

4. What are the advantages of Switched reluctance motor?

- ✓ Construction is simple and robust.
- ✓ There is no permanent magnet.
- ✓ Rotor carries no windings, no slip rings, no brushes, less maintenance
- ✓ Power semiconductor switching circuitry is simpler.

5. What are the applications of SRM?

- ✓ Washing Machines.
- ✓ Vacuum cleaners.
- ✓ Fans
- ✓ Future auto mobile applications.
- ✓ Robotics control applications.

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

- ✓ Hysteresis type model
- ✓ PWM type control.

7. What is meant by energy ratio?

Energy ratio = Wm / (Wm + R) = 0.45

Wm = mechanical energy transformed.

This energy ratio cannot be called as efficiency. As the stored energy R is not wasted as a loss but it is feed back to the source through feed back diodes.

8. What is the Phase winding?

Stator poles carrying field coils. The field coils of opposite poles are connected in series such that mmf's are additive and they are called Phase windings of SRM.

9. What are the difference between SRM and Stepper motor?

1. In SRM is designed for continuous rotation. SRM requires a rotor position sensor.
2. In Stepper motor is designed to rotate in step by step rotation.

It does not require rotor position sensor.

10. What is hysteresis current control?

This type of current controller maintains a more or less constant current throughout the conduction period in each phase. This controller is called hysteresis type controller.

11. Define Chopping mode of operation of SRM.

In this mode, also called low speed mode, each phase winding gets excited for a period which is sufficiently long.

12. Define Single pulse mode of operation of SRM.

In single pulse mode, also called high speed mode, the current rise is within limits during the small time interval of each phase excitation.

13. State the principle of operation of switched reluctance motor.

The SRM develops an electromagnetic torque due to variable reluctance principle. When air gap is minimum, the reluctance will be minimum. Hence inductance will be maximum, so the rate of change of inductance is zero.

When the reluctance varies, there will be a change in inductance so when a Particular stator winding of SRM is excited, the rotor pole comes in alignment with that stator pole and thus the rotor rotates.

14. What is the need for shaft position sensor for SRM?

- ✓ For commutation the turning on and turning off of various semiconductor devices in the switching circuitry is influenced by the signals obtained from the rotor position sensor.
- ✓ For speed control of the motor, it is necessary to use the rotor position sensor.

15. Clearly specify the function of controller circuit in SRM.

The controller gets the signal from the rotor position sensor, reference speed signal and the signal from the output of power semiconductor circuit and then suitably turns on and off the concerned phase windings of SRM.

16. What are the advantages of C – dump circuit?

1. The circuit uses lower number of switching devices.
2. The presence of diodes in the circuit ensures faster demagnetization of phases.

17. What are the different modes of operation of SRM?

1. Low speed operation mode
2. High speed operation mode.

18. What is meant by effectiveness in SRM?

In SRM, the energy stored in the magnetic field is not necessarily dissipated. With the appropriate converter circuit, it can be recovered to the supply at the end period of rising inductance. Hence the term effectiveness is used instead of efficiency.

19. State the need for non-linear analysis of switched reluctance motor.

Machine with linear magnetic characteristics means that it ahs constant magnetic permeability and no magnetic saturation. In practice, the SRM which follows variable reluctance principle operates with its magnetic material in saturation. As saturation tends to increase the size of the variable reluctance machines for a given output, the non- linear analysis is required.

20. What are the two types of current control technique?

1. Hysteresis type current regulator.
2. Voltage- PWM type current regulator or duty cycle control.

21. What is meant by dwell in SRM?

In SRM the term dwell means conduction period.

22. Why SRM does not have the reliable starting rate of the stepper motor?

Because of the large step angle and lower torque/inertia ratio, the SRM does not have the reliable starting rate of the stepper motor.

23. Differentiate SRM and SyRM.

S.No	***SRM***	***SyRM.***
1.	In order to have self starting Capability and bidirectional control, the rotor of a SRM has lesser poles than the stator.	The motor has the same number of poles on stator and rotor.
2.	The stator of SRM has salient poles with concentrated coils like a d.c motor.	The stator of SRM is cylindrical type with distributed winding.
3.	In SRM, both stator and rotor have salient poles.	The stator has a smooth bore except fro slotting.
4.	Excitation is a sequence of current pulses applied to each phase in turn	Excitation is a set of poly phase Balanced sine wave currents.

UNIT IV–PERMANENT MAGNET BRUSHLESS DC MOTORS

1. What are the advantages of brushless dc motor drives?

- ✓ Regenerative braking is possible.
- ✓ Speed can be easily controllable.
- ✓ It is possible to have very high speeds.
- ✓ There is no field winding so that field copper loss is neglected.

2. **What are the disadvantages of brushless dc motor drives?**
   - ✓ Motor field cannot be controlled.
   - ✓ It requires a rotor position sensor.
   - ✓ It requires a Power semiconductor switching circuit.
   - ✓ Power rating is restricted because of the maximum available size of Permanent magnets.
3. **List the various PM materials.**
   - ✓ Alnico
   - ✓ Rare earth magnet.
   - ✓ Ceramic magnet.
   - ✓ NdFeB magnet.
4. **Mention the some applications of PMBL DC motor.**
   - ✓ Power alternators.
   - ✓ Automotive applications.
   - ✓ Computer and robotics applications.
   - ✓ Textile and glass industries.

5. **Why the PMBL DC motor is called electronically commutated motor?**
   The phase windings of PMBL DC motor is energized by using power semiconductor switching circuits. Here, the power semiconductor switching circuits act as a commutator.

6. **What are the classifications of BLPM dc motor?**
   - ✓ BLPM square wave motor
   - ✓ BLPM sine wave motor.

7. **What are the two types of BLPM SQW DC motor?**
   - ✓ 1800 pole arc BLPM square wave motor.
   - ✓ 1200 pole arc BLPM square wave motor.

8. **Name the position sensors that are used for PMBL DC motor.**
   - ✓ Optical position sensor.
   - ✓ Hall Effect position sensor.

9. **What are the materials used for making Hall IC pallet.**
   - ✓ Indium- antimony Gallium- arsenide.
10. **What are the relative merits of the brushless dc motor drives?**
    - ✓ Regenerative braking is possible.
    - ✓ Speed can be easily controllable.
    - ✓ It is possible to have very high speeds.
    - ✓ There is no field winding so that field copper loss is neglected.
11. **What is hall sensor?**
    A sensor is operated with half effect principle. It is called hall sensor. It is used to sense the rotor position of the BLPM DC motor.
12. **What are the types of PM DC motor?**
    - ✓ PMBL square wave motor.
    - ✓ PMBL sine wave motor.

13. What is optical sensor?

A sensor is operated with photo transistor. It is the optical sensor. It is mainly used to sense the rotor position of the BLPM DC motor.

14. What is PM DC commutator motor?

A dc motor consists of PM in the stator and armature winding, commutator in the rotor. This motor is called PM DC commutator motor.

15. **Compare PMBLDC motor and SRM**.

S.No	***PMBLDC motor***	***SRM***
1.	Rotor is a permanent magnet	No permanent magnet in the rotor
2.	High cost	Cost is less compared with PMBLDC Motor.
3.	More efficient	Less efficient

16. Name the two comparators used in the power controllers of PMBLDC motor.

- ✓ Speed Comparator.
- ✓ Current comparator.

17. What is permanent magnet DC commutator motor?

A dc motor consists of permanent magnet in the stator and armature winding, commutator in the rotor. This motor is called permanent magnet DC commutator motor.

18. What are the differences between mechanical and electronic commutators?

S.No	***Mechanical commutator***	***Electronic commutator***
1.	Commutator is made up of commutator segments and mica insulation. Brushes are made up of carbon or graphite.	Power electronic switching devices are used in the commutator.
2.	Commutator arrangement is located in the rotor.	Commutator arrangement is located in the stator.
3.	Number of commutator segments are very high	Number of switching devices is limited to 6
4.	Sparking takes place.	There is no sparking
5.	Sliding contact between commutator and brushes	No sliding contacts.

19. Compare conventional dc motor and PMBLDC motor.

S.No	***Features***	***Conventional DC motor***	***PMBL DC motor***
1.	Mechanical Structure	Field magnets on the stator	Field magnets on the rotor
2.	Maintenance	Maintenance is high	Low Maintenance
3.	Commutation method	Mechanical contact between brushes and	Electronic switching using power semiconductor devices

		commutator	i.e MOSFETS, Transistors.
4.	Detecting method	Automatically detected by brushes	Rotor position can be Detected by using sensor. i.e Hall sensor, optical encoder.

20. Define magnetic remanence.

It is defined as the magnetic flux density which persists in the magnetic materials even though the magnetizing forces are completely removed.

21. Define coercivity forces.

It is defined as the demagnetizing force which is necessary to neutralize completely the magnetism in an electromagnet after the value of magnetizing force becomes zero.

The above demagnetizing force is obtained by an increasing negative field strength, which is called as coercive field.

22. What are position sensors?

The position sensors detect the position of the rotating magnets and send logic codes to a commutation decoder which, after processing this code, activates the firing circuits of semiconductor switches feeding power to the stator winding of the drive motor. The reliable position sensing techniques do not involve contact between stationary and moving parts.

23. What are the materials used for making hall IC pallet?

1. Indium- antimony
2. Gallium – arsenide.

24. Write down the emf equation of P.M brush less D.C motor.

E ph = 2 Bg r l Tph ωm volts.

Where, Bg = The flux density in air gap (Wb/m2)

r = Radius of the air gap (m)

l = Length of the armature (m)

ωm = Angular velocity in mech. rad / sec.

Tph = Number of turns per phase.

25. Write down the torque equation of P.M brush less D.C motor.

T = 4 Bg r l Tph I N-m

Where, Bg = The flux density in air gap (Wb/m2)

r = Radius of the air gap (m)

l = Length of the armature (m)

ωm = Angular velocity in mech. rad / sec.

I = the current flowing through the motor.

26. When does the demagnetization occur in BLPM DC motor?

During the normal operation of motor, when the torque and back emf are constant, if the field flux level becomes low, then demagnetization occurs.

27. What are the ways by which demagnetization can be limited in permanent magnet?

There are several ways to limit the demagnetization. One way is to keep the current below the maximum value and another way is y use of pole shoes to a permanent magnet to collect the flux and then transfer it to the air gap.

28. Define the energy product and maximum energy product of a permanent magnet.

The absolute values of the product of the flux density and the field intensity at each points along the demagnetization curve is called energy product. The maximum value of the energy product is called maximum energy product and this quantity is one of the strengths of the permanent magnet.

29. State the advantages of brushless configuration.

- ✓ Brush maintenance is no longer required.
- ✓ Sparking associated with brushes is eliminated.
- ✓ The absence of commutator and brush gear reduces the motor length.
- ✓ The brushless permanent magnet motors will have better efficiency and greater output power.

30. State the principle of operation of PM brushless DC motor.

When d.c supply is given to the motor, the armature winding draws a current. This current sets up an mmf which is perpendicular to the main mmf set up by the permanent magnet field. Hence a force is experienced by the armature conductors according to Fleming's left hand rule. As it is in the stator, a reactive force develops a torque in the rotor. If this developed torque is more than the load torque and frictional torque, the motor starts rotating.

31. Compare conventional dc motor and PMBLDC motor.

S.No	***PMBLDC motor***	***Conventional d.c motor***
1.	The Rotor has permanent magnets	Field magnets are located in the stator.
2.	Low maintenance	Maintenance requirement is high because of the presence of commutator and Brushes.
3.	The motor can be designed for higher voltages subjected to the constraint caused by the power Semiconductor switching circuits.	Standardized design procedures are Available.

UNIT V –PERMANENT MAGNET SYNCHRONOUS MOTORS

1. What are the features of PM synchronous motor?

- ✓ Robust, compact and less weight.
- ✓ No field current or rotator 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.

2. **What are the advantages of load commutation?**
    - ✓ It does not require commutation circuits.
    - ✓ Frequency of operation can be higher.
    - ✓ It can be operate power levels beyond the capability of forced commutation.
3. **What are the applications of PMSM?**
    - ✓ Used as a direct drive traction motor.
    - ✓ Used as high speed and high power drives for compression, blowers, conveyors, fans, pumps, conveyors, steel rolling mills, main line traction, aircraft test facilities.
    - ✓ Fiber spinning mills.

4. **What are the features of closed loop speed control of load commutated inverter fed synchronous motor drive?**
    - ✓ Higher efficiency.
    - ✓ Four quadrant operations with regeneration braking is possible.
    - ✓ Higher power ratings and run at high speeds (6000 rpm).

5. **What are the merits of PMSM?**
    - ✓ It runs at constant speed.
    - ✓ No field winding, no field loss, better efficiency.
    - ✓ No sliding contacts. O it requires less maintenance.

6. **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.

7. **What are the assumptions made in derivation of emf equation for PMSM?**
    - ✓ Flux density distribution in the air gap is sinusoidal.
    - ✓ Rotor rotates with a uniform angular velocity.
    - ✓ Armature winding consists of full pitched, concentrated similarly located coils of equal number of turns.

8. **Why PMSM operating in self controlled lode is known commutatorless dc motor.**

    Load side controller performs some what similar function as commutator in a dc machine. The load side converter and synchronous motor combination functions 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 all speeds. Consequently, the drive consisting of load side converter and synchronous motor is known as "commutator less dc motor".

9. **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 operation of load side converter is very low compared to source frequency. Such an operation can be realized. The operation of inverter is termed as pulsed mode.

10. 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.

11. What is meant by self control?

As the rotor speed changes the armature supply frequency is also a change proportionally so that the armature field always moves at the same speed as the motor. The armature and rotor field move in synchronism for all operating points. Here accurate tracking of speed by frequency is realized with the help of rotor position sensor.

12. Differentiate the SyRM and PMSM.

S.No	***SyRM***	***PMSM***
1.	Rotor has no permanent magnet	Rotor has permanent magnet
2.	Less cost	High cost
3.	Low efficiency	High efficiency

13. How are PMBLDC motor and PMSM different?

PMBLDC Motor

- ✓ Rectangular distribution of magnetic flux in the air gap.
- ✓ Rectangular current waveforms.
- ✓ Concentrated stator winding.

PMSM

- ✓ Sinusoidal or quasi –sinusoidal distribution of magnetic flux in the air gap.
- ✓ Sinusoidal or quasi-sinusoidal current waveforms.
- ✓ Quasi-sinusoidal distribution of stator conductors.

14. State the two classifications of PMSM and the types in each.

- ✓ Sinusoidal PMSM.
- ✓ Trapezoidal PMSM.

15. What is meant by slot less motor?

The stator teeth are removed and resulting space is partially filled with addition copper.

16. Differentiate between self control and vector control of PMSM.

S.No	***Self control***	***Vector control***
1.	Dynamic performance is poor	Better performance
2.	Control circuit is simple	Control circuit is complex

17. What is brushless a.c motor?

The sinusoidal current fed motor, which has distributed winding on the stator inducing sinusoidal voltage, is known as brushless a.c motor. It is used in high power drives. The brushless a.c motor is also known as PMSM.

18. What are the types of PMSM?

1. General classification.
    1. Surface mounted motor.
    2. Interior motor.

The surface mounted motor is further classified as,

1. Projected type.
2. Insert type.

2. Based on rotor classification.
    1. Peripheral
    2. Interior.
    3. Claw-pole
    4. Transverse.

19. When does a PM synchronous motor operate as a SyRM?

If the cage winding is induced in the rotor and the magnets are left out or Demagnetized, a PM SyRM operates as a SyRM.

20. State the power controllers for PMSM.

- ✓ PWM inverter using power MOSFETS with microprocessor control.
- ✓ PWM inverter using BJT's with microprocessor control (up to 100 KW).

21. Write the advantages of optical sensors.

Quite suitable for sinusoidal type motor as it is a high resolution sensor. The signal from the photodiode rises and falls quite abruptly and the sensor outputs are switched high or low so the switching points are well defined.

22. Write the disadvantages of optical sensors.

- ✓ It requires a clean environment.
- ✓ Provision of high resolution sensor adds the cost of the system

PART- B

UNIT- I

1. What are uncompensated and compensated single phase series commutator motor develop their performance equation and related phasor diagrams. (16)
2. Derive the expression for emf and torque equation of ac series motor. (16)
3. (a).Draw the phasor diagram of single phase series motor and also explain the characteristics of single phase ac series motor (8)

   (b).What modifications are necessary in a dc series motor ,so that it may work satisfactorily on ac? Explain its operations. (8)

4 .Explain the construction and principle of working of a universal motor and mention its applications. (16)

5. Describe the construction and working of repulsion motor .write its merits and demerits as compared to series motors. (16)
6. Explain different types of repulsion motor (16)
7. Draw the phasor diagram and explain the performance characteristics of repulsion motor (16)
8. (a).Draw and explain the equivalent circuit of ac series motor (8)
   (b).Discuss the various methods of speed control universal motors (8)
9. Describe the constructional features of a 3-phase ac series commutator motor. How is the speed control affected in such a motor? How does a 3-phase ac shunt commutator motor differ from a 3-phase ac series commutator motor in construction and operation? (16)
10. Explain the behavior of a commutator as a frequency changer (16)

UNIT- II

1. Explain the construction and various modes of excitation of VR stepper motor. (16)
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)
4. State and explain the static and dynamic characteristics of a stepper motor. (16)
5. Explain in detail about different types of power drive circuits for stepper motor. (16)
6. Explain the mechanism of torque production in VR stepper motor. (16)
7. Draw and explain the drive circuits for stepper motor. (16)

UNIT- III

1. Explain the construction and working principle of switched reluctance motor. (16)
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)
3. Draw a schematic diagram and explain the operation of a ‘C’ dump converter used for the control of SRM. (16)
4. (a).Derive the torque equation of SRM. (8)
   (b). write note on the power controllers used in switched reluctance motors (8)
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)
6. Describe the hysteresis type and PWM type current regulator for one phase of a SRM with relevant circuit diagrams (16)
7. With neat diagram, explain the microprocessor based control of switched reluctance motor (16)

UNIT- IV

1.Explain the construction and principles of operation of PMBL dc motor with neat diagram(16)

2. Describe the operation of power controllers for PMBLDC motor with neat diagram. (16)
3. Explain the construction and performance of a permanent magnet synchronous motor with neat diagram (16)
4. Derive the emf and torque equations permanent magnet synchronous motor (16)
5. (a). Explain the speed -torque characteristics of PMDC. (8)

(b). Explain with phasor diagram & measurement of Ld and Lq in PMSM. (8)

6. (a). Explain the speed- torque characteristics of PMSM. (8)
   (b). Explain the working of microprocessor based control in PMSM. (8)
7. Drive the expressions for the emf and torque of a PMBLDC motor. (16)
8. (a). Explain the vector control method for a PMSM with a block diagram and phasor diagram (8)
   (b). Explain the vector control method for a PMSM (8)
9. Explain the closed loop control scheme of a permanent magnet brushless DC motor drive with a suitable schematic diagram (16)
10. Draw the diagram of electronic Commutator. Explain the operation of electronic Commutator. (16)
11. (a).Explain with neat diagram and wave forms of the full wave inverter based PMBLDC motor (8)
    (b).Draw and explain the speed –torque characteristics of PMBLDC motor (8)

UNIT-V

1. Explain the principle of operation of a linear induction motor draw its characteristics. State its important applications (16)
2. Explain the principle of operation and constructional details of DC linear motor (16)
3. (a). Explain the different types of BLDC linear motors (8)
   (b). Explain the characteristics of DC linear motor (8)
4. Explain the different special types of DC linear motors (16)
5. Explain the principle of operation and constructional details of linear synchronous motor (16)
6. Explain the different types of linear synchronous motor and mention its applications. (16)