DMI COLLEGE OF ENGINEERING

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DEPARTMENT OF ELECRTICAL AND ELECTRONICS ENGINEERING

EE3009 – SPECIAL ELECTRICAL MACHINES

UNIT – 1 STEPPER MOTOR

1. What is stepper motor?

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.

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.

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

8. Define detent torque

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.

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.

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

17. What is multi stack VR motor

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.

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 response

Unit – II

SWITCHED RELUCTANCE MOTORS (SRM)

Part – A

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 shold be capable of carrying magnetizing currents

4. Why rotor position sensor is essential for the operation of switchedreluctance 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?

- 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?

- 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/dθ)

10. What is phase winding?

Ststor 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 winding‟‟‟‟ of SRM.

11. Write the characteristics of SRM.

- 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

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 optoisolators, these isolators use short optical transmission paths to transfer a signal from one part of a circuit to another.

19. Define the power circuitry of SRM.

- The most common approach to the powering of a switched reluctance motor is to use an asymmetric bridge converter.
- 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.

20. What are the current control schemes?

- Hysteresis type current regulator
- PWM type current regulator

UNIT III - PERMANENT MAGNETS AND BRUSHLESS DC MOTORS

1. what are the advantages of brushless dc motors drives?

- ✓ 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?

Its arrangement is located in the rotor
No of commutators segments are very high

4. Define electronic commutators?

- ✓ 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

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8. why is the PMBLDC motor called electronically commulated motor?

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?

- ✓ 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 is meant by self control?

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

19. 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

20. 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

UNIT - IV

PERMANENT MAGNET SYNCRONOUS MOTOR

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?

- ✓ 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?

- ✓ 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,steelrolling.

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,aircrafttest 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?

- ✓ 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 inverterfed synchronous motor drive?

- ✓ High efficiency
- ✓ Four auadrant operation with regeneration braking is possible

14.what are the merits of PMSM?

- ✓ 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?

- ✓ Flux density distribution in the air gap is sinusoidal
- ✓ Armature winding consists of full pitched,concentrated similarly located coilsof equal number of turns

17.Why PMSM operating in self controlled mode 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 function similar to a dc machine

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 sideconverter 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?

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

Xs=Xt+Xa

UNIT – V STUDY OF OTHER SPECIAL MACHINES

PART – A

1.Define an AC series motor and explain its principle of operation.

An AC series motor is a type of electric motor that uses alternating current (AC) to operate. It is characterized by its high starting torque and variable speed. The principle of operation is based on the interaction of two magnetic fields: the field produced by the stator windings and the field produced by the rotor windings.

2.List the advantages and disadvantages of AC series motors.

Advantages: high starting torque, variable speed, simple construction, low cost.

Disadvantages: high speed at no-load, poor speed regulation, brushes require regular maintenance.

3.Explain why AC series motors are not suitable for applications where constant speed is required

AC series motors are not suitable for applications where constant speed is required because their speed varies with the load. When the load is increased, the speed of the motor decreases

4.State the factors that affect the speed of an AC series motor.

The factors that affect the speed of an AC series motor are: applied voltage, load torque, field resistance, and armature resistance.

5.What are the various parts in AC series motor.

The main parts of an AC series motor are: stator, rotor, armature, field windings, brushes, and commutator.

6. What is hysteresis motor?

A hysteresis motor is a single-phase synchronous motor whose operating principle is based on the effect of magnetic hysteresis. According magnetic hysteresis, the magnetic flux density in a ferromagnetic material lags behind the magnetising force.

7. Comment on the area of the hysteresis loop for the magnetic material used in hysteresis motor.

The rotor of a hysteresis motor is made of a magnetic material like **chrome steel or alnico** for high retentivity that has high hysteresis loss property. Example of this type of materials is chrome, cobalt steel or alnico or alloy. Hysteresis loss becomes high due to a large area of the hysteresis loop.

8. Advantages of Hysteresis motor

Hysteresis motors have **uniform torque from standstill to synchronous speed**. A hysteresis motor can synchronise any load which it can accelerate, no matter how great the inertia of the load. A hysteresis motor is inherently quiet and produces smooth rotation of the load.

9. Explain how a hysteresis motor works.

The hysteresis motor has a rotating rotor made of a ferromagnetic material and a stationary stator with a rotating magnetic field. The hysteresis effect causes the rotor to follow the rotating magnetic field, producing torque.

10. What are the applications of hysteresis motors?

Hysteresis motors are used in applications where constant speed and low noise are required, such as recorders, clocks, and fans.

11. How can the speed of a hysteresis motor be controlled?

The speed of a hysteresis motor is controlled by the frequency of the rotating magnetic field. The frequency of the rotating magnetic field can be controlled by using a frequency converter.

12. What is the difference between a hysteresis motor and a synchronous motor?

A hysteresis motor is a type of synchronous motor, but it does not require a separate field excitation.

13. What are the factors that affect the starting torque of a hysteresis motor?

The factors that affect the starting torque of a hysteresis motor are the rotor material, the rotor volume, and the frequency of the rotating magnetic field.

14. How can the efficiency of a hysteresis motor be improved?

The efficiency of a hysteresis motor can be improved by using a high-quality rotor material, reducing the air gap between the rotor and the stator, and using a high-frequency rotating magnetic field.

15. What are the limitations of hysteresis motor?

The limitations of hysteresis motors are low starting torque, high cost, and limited power output.

16. What are some of the emerging applications of hysteresis motor?

Emerging applications of hysteresis motors include robotics, microelectromechanical systems (MEMS), and renewable energy systems.

17. Explain how a linear motor works.

A linear motor has a moving part (primary) and a stationary part (secondary). The primary is energized by a current, which creates a magnetic field. The secondary is made of a ferromagnetic material, which is attracted to the magnetic field of the primary. As the current in the primary is changed, the magnetic field moves, causing the secondary to move along with it.

18. What are the advantages and disadvantages of linear motors?

Advantages: high speed, high acceleration, high precision, direct drive, no backlash. Disadvantages: high cost, complex construction, limited force.

19. What are the applications of linear motors?

Linear motors are used in a wide variety of applications, including: Machine tools, Robotics, Packaging , Semiconductor manufacturing, medical devices, transportation.

20. How can the speed of a linear motor be controlled?

The speed of a linear motor can be controlled by the frequency and amplitude of the current applied to the primary.