GGS CMT, Kharar

Question Bank

Electrical Machine-2
Subject code – BTEE-402-18
4th Semester
Electrical Engineering

1. Why a 3-phase synchronous motor will always run at synchronous speed?

Because of the magnetic coupling between the stator poles and rotor poles the motor runs exactly at synchronous speed.

2. What are the two classification synchronous machines?

The classification synchronous machines are:

i. Cylindrical rotor type
ii. Salient pole rotor type

3. What are the essential features of synchronous machine?

i. The rotor speed is synchronous with stator rotating field.
ii. Varying its field current can easily vary the speed.
iii. It is used for constant speed operation.

4. Mention the methods of starting of 3-phase synchronous motor.

a. A D.C motor coupled to the synchronous motor shaft.
b. A small induction motor coupled to its shaft. (Pony method)
c. Using damper windings –started as a squirrel cage induction motor.

5. What are the principal advantages of rotating field system type of construction of synchronous machines?

- Form Stationary connection between external circuit and system of conditions enable the machine to handle large amount of volt-ampere as high as 500 MVA.
- The relatively small amount of power required for field system can be easily supplied to the rotating field system via slip rings and brushes.
- More space is available in the stator part of the machine for providing more insulation to the system of conductors.
- Insulation to stationary system of conductors is not subjected to mechanical stresses due to centrifugal action.
-

6. Write down the equation for frequency of emf induced in an alternator.

$F = PN / 120$ Hertz

Where P = No. Of poles

N = Speed in rpm.

7. What are the advantages of salient pole type of construction used for synchronous machines?

- They allow better ventilation.
- The pole faces are so shaped radial air gap length increases from the pole center to the pole tips so that flux distribution in the air gap is sinusoidal in shape which will help to generate sinusoidal emf.
- Due the variable reluctance, the machine develops additional reluctance power, which

is independent of excitation.

8. Why do cylindrical rotor alternators operate with steam turbines?

Steam turbines are found to operate at fairly good efficiency only at high speeds. The high-speed operation of rotor tends to increase mechanical losses, so the rotors should have smooth external surface. Hence smooth cylindrical type rotors with less diameter and large axial length are used for synchronous generators driven by steam turbines with either 2 or 4 poles.

9. Which type of synchronous generators are used in Hydroelectric plants and why?

As the speed of operation is low, for hydro turbines used in hydroelectric plants, salient pole type synchronous generators are used. These allow better ventilation and also have other advantages over smooth cylindrical type rotor.

10. What is the relation between electrical degree and mechanical degree?

Electrical degree θ_e and mechanical degree are related to one another by the number of poles P, the electrical machine has, as given by the following equation.

$\theta_e = (P/2)\ \theta_m$

11.

12. What is the meaning of electrical degree?

Electrical degree is used to account the angle between two points in rotating electrical machines. Since all electrical machines operate with the help of magnetic fields, the electrical degree is accounted with reference to the polarity of magnetic fields. 180 electrical degrees is accounted as the angle between adjacent North and South poles

13. Why short-pitch winding is preferred over full pitch winding?

Advantages: -

- Waveform of the emf can be approximately made to a sine wave and distorting harmonics can be reduced or totally eliminated.
- Conductor material, copper is saved in the back and front-end connections due to less coil span.
- Fractional slot winding with fractional number of slots/phase can be used which in turn reduces the tooth ripples.
- Mechanical strength of the coil is increased.

14. Write down the formula for distribution factor.

$$K_d = \frac{\sin(m\beta/2)}{m\sin(\beta/2)}$$

m - number of slots/pole/phase

β - angle between adjacent slots in electrical degree n - order of harmonics.

15. Define winding factor.

The winding factor K_w is defined as the ratio of phasor addition of emf induced in all the coils belonging to each phase winding of their arithmetic addition.

16. Why are alternators rated in kVA and not in kW?

The continuous power rating of any machine is generally defined as the power the machine or apparatus can deliver for a continuous period so that the losses incurred in the machine gives rise to a steady temperature rise not exceeding the limit prescribed by the
insulation class.

Apart from the constant loss the variable loss incurred in alternators is the copper loss, occurring in the 3-phase winding, which depends on I^2R, the square of the current delivered by the generator. is directly related to apparent power delivered by the generator,Thus the alternators have only their apparent power in VA/kVA/MVA as their power rating.

17. What are the causes of changes in voltage of alternators when loaded?

- Voltage variation due to the resistance of the winding R.
- Voltage variation due to the leakage reactance of the winding X_1.
- Voltage variation due to the armature reaction.

18. What is meant by armature reaction in alternators?

The interaction between flux set up by the current carrying armature conductors and the main field flux is defined as the armature reaction.

19. What do you mean by synchronous reactance?

It is the sum of the leakage reactance X_1 and armature reactance X_a

$$X_s = X_1 + X_a$$

20. What is effective resistant [R_{eff}]?

The apparent increase in resistance of the conductor when an alternating current is flowing through it is known as effective resistance.

21. What is synchronous impedance?

The complex addition of resistance R and synchronous reactance jX_s is synchronous impedance Z_s.

$$Z_s = (R+jX_s) = Z_s \angle \theta$$

Where $\theta = \tan^{-1}(X_s/R)$

$$|Z_s| = \sqrt{(R^2+jX_s^2)}$$

22. What is meant by load angle of an alternator?

The phase angle introduced between the induced emf phasor E and terminal voltage phasor V during the load condition of an alternator is called load angle. The load angle increases with increase in load. It is positive during generator operation and negative during motor operation.

23. Define the term voltage regulation of alternator.

It is defined as the change in terminal voltage from no load-to-load condition expressed as a function or terminal voltage at load condition, the speed and excitation conditions remaining same.

% Regulation = (E-V)/V x 100

24. What is the necessity for predetermination of voltage regulation?

Most of the alternators are manufactured with large power rating and large voltage ratings. Conduction load test is not possible for such alternators. Hence other indirect methods of testing are used and the performance can be predetermined at any desired load currents and power factors.

25. Why is the synchronous impedance method of estimating voltage regulation is considered as pessimistic method?

Compared to other methods, the value of voltage regulation obtained by this method is always higher than the actual value and therefore is called pessimistic method.

26. Why is the MMF method of estimating the voltage regulation is considered as the optimization method?

Compared to EMF method, MMF method involves more number of complex calculation steps. Further the OCC is referred twice and SCC is referred once while predetermining the voltage regulation for each load condition. Reference of OCC takes core saturation effect. As this method requires more effort, the final result is very close to the actual value. Hence this method is called the optimistic method.

1. **What does hunting of synchronous motor mean?**

When the load applied to the synchronous motor is suddenly increased or decreased, the rotor oscillates about its synchronous position with respect to the stator field. This action is called hunting.

2. **What could be the reasons if a 3-phase synchronous motor fails to start?**

It is usually due to the following reasons

a. Voltage may be too low.

b. Too much starting load.

c. Open circuit in one phase or short circuit.

d. Field excitation may be excessive

3. What is synchronous condenser?

An over-excited synchronous motor under no load ,used for the improvement of power factor is called as synchronous condenser because, like a capacitor it takes a leading current.

4. Write the applications of synchronous motor.

a. Used for power factor improvement in sub-stations and in industries.

b. Used in industries for power applications.

c. Used for constant speed drives such as motor-generator set, pumps and compressors.

5. What is an inverted 'V' curve?

For a constant load, if the power factor is plotted against various values of field exciting current, the curve formed is inverted V Shape and called as inverted 'V' curve.

6. A synchronous motor starts as usual but fails to develop its full torque. What could it be due to?

a. Exciter voltage may be too low.

b. Field spool may be reversed.

7. What are the two types of 3-phase induction motor?

a. Squirrel cage induction motor.
b. Slip ring induction motor.

8. Write the two extra features of slip ring induction motors.

a. Rotor is having 3-phase winding.
b. Extra resistance can be added in the rotor circuit by connecting through the help of three slip rings for improving the power factor, increasing Starting Torque, limiting the starting current.

9. Can we add extra resistance in series with squirrel cage rotor? State the reason?

We cannot add extra resistance in series with the rotor because all the copper bars of the rotor are short circuited in both the sides by copper end rings to have a closed circuit.

10. Why an induction motor is called rotating transformer?

The rotor receives electrical power in exactly the same way as the secondary of a two winding transformer receiving its power from primary. That is why an induction motor can be called as a rotating transformer i.e., in which primary winding is stationary but the secondary is free to rotate.

11. Why an induction motor will never run at its synchronous speed?

If it runs at synchronous speed then there would be no related speed between the two, hence no rotor emf, no rotor current so no rotor torques to maintain rotation. That is why the rotor runs at its synchronous speed.

12. Define SCR?

Short circuit ratio (SCR) is defined as the ratio of field current required to produce rated voltage on open-circuit to field current required to produce rated armature current with the terminals shorted, while the machine runs at synchronous speed.

13. Why is open circuit charactertics called magnetic charactertic?

The OCC is called magnetic charactertic because it gives the variation of space component of flux in air gap and mmf / pole of magnetic circuit.

14. What are the losses determined from SCC?

i. Copper loss
ii. Mechanical loss

15. What are stray load losses?

Stray load loss is the sum of load core loss and loss due to the additional conductor resistance offered to the ac.

16. What is synchronizing?

The operation of connecting an alternator in parallel with another alternator or with common bus bars is known as synchronizing.

17. What is a synchroscope?

Synchroscope is an instrument, which shows the phase relationship of emf of the incoming alternator. It also indicates whether the incoming alternator is running slow or fast.

18. What is direct axis?

The mmf wave is height when it is aligned with the field pole axis called the direct axis or d axis.

19. What is quadrature axis?

The permeance offered to a mmf wave is lower when it is oriented 90^o

To the field pole axis called the quadrature axis or q axis.

20. What are the two curves required for POTIER method?

i. No load curve.
ii. Full load zero power factor curve called wattless load charactertic.

21. What are the three methods of determining voltage regulation?

i. Synchronous impedance method or EMF method.
ii. The ampere-turn or MMF method.
iii. Zero power factor or potier method.

22. When does a synchronous motor get over excited?

If the field excitation of the motor is increased, the field flux will become strong and E_b will increase. As a result E_b will exceed V and the motor will be called an over excited motor.

23. Define pullout torque?

The pullout torque is the torque, beyond which the synchronous link between field poles and resultant flux wave is severed and the machine falls out-of-slip.

24. What is the main advantage of POTIER method?

The voltage regulation calculated by potier's method is quite accurate.

25. What is meant by the subtransient period?

The initial period of decay of the short circuit current is called the subtransient, in which the current decay is governed mainly by the damper winding constant.

26. What is fractional pitch winding?

When a winding is made with coil span less than full pitch, the winding is called as fractional pitch winding.

THREE PHASE INDUCTION MOTOR

1. **What are types of 3- phase induction motor?**
   - i. Squirrel cage induction motor
   - ii. Slip ring induction motor

2. **Why the rotor slots of a 3-phase induction motor are skewed?**

The rotor slots of a three -phase induction motor are skewed

- i. to make the motor run quietly by reducing the magnetic hum
- ii. to reduce the locking tendency of the rotor

3. **Why the induction motor is called asynchronous motor?**

Since the induction motor runs always at a speed lesser than synchronous speed, it is called asynchronous motor.

4. **What are slip rings?**

The slip rings are made of copper alloys and are fixed around the shaft insulating it. Through these slip rings and brushes the rotor winding can be connected to external circuits.

5. **State the difference between slip ring rotor and cage rotor of an induction motor?**

Slip ring rotor has 3-phase windings. Three ends of which are stared and the other three ends are brought up and connected to 3 slip rings mounted in the shaft. Extra resistance can be added in the rotor circuit. Squirrel cage rotor has short-circuited copper bars. Extra resistance can't be added as slip ring rotor.

6. **Write an expression for the slip of an induction motor.**

Percentage slip = $(N_s - N_r) / N_s * 100$.

7. **What is cogging of an induction motor?**

When the number of stator and rotor teeth's is equal o r integral multiple of rotor teeth ,they have a tendency to align themselves exactly to minimum reluctance position. Thus the rotor may refuse to accelerate. This phenomenon is known as cogging.

8. **Explain why the no load current of an induction motor is much higher than that of an equivalent transformer.**

In induction motor, due to the presence of the air gap, the magnetizing current that is required to set up the flux is much higher. The working component of the current has to meet the hysteresis loss, eddy current loss, friction and windage losses. Hence the no load current of induction motor is higher.

9. **State the effect of rotor resistance on starting torque?**

Starting torque increases with increase in value of rotor resistance.

10. **What are the advantages of cage motor?**

- Since the rotor has very low resistance, the copper loss is low and efficiency is high
- On the account of simple construction of rotor, it is mechanically robust.
- Initial cost is less.
- Maintenance cost is less.
- Simple stating arrangement

11. **Give the conditions for maximum torque for 3-phase induction motor?**

The rotor resistance and rotor reactance should be equal for developing maximum torque i.e. $R_2 = s X_2$ where s is the slip –under running conditions.

$R_2 = X2$ under starting conditions

12. **What is reason for inserting additional resistance in rotor circuit of a slip ring induction motor?**

Introduction of additional resistance in the rotor circuit will increase the starting torque as well as running torque. Also it limits the starting current, improves the power factor.

13. **List out the methods of speed control of cage type 3-phase induction motor?**

a) By changing supply frequency

b) By changing the number of poles

c) By operating two motors in cascade

14. **Mention different types of speed control of slip ring induction motor?**

a) By changing supply frequency
b) By changing the number of stator poles
c) By rotor rheostat control
d) By operating two motors in cascade

15. What are the advantages of 3-phase induction motor?

a) It was very simple and extremely rugged, almost unbreakable construction
b) Its cost is very low and it is very reliable
c) It has been suffiently high efficiency .No brushes are needed and hence frictional losses are reduced
d) It requires minimum of maintenance.

16. What does crawling of induction motor mean?

Squirrel cage type, sometimes exhibit a tendency to run stably at speeds as low as 1/7 the of their synchronous speed, because of the harmonics this phenomenon is known as crawling

17. State the application of an induction generator?

a) Used in windmill for generating electric power.
b) Used in regenerative breaking places like traction.

18. Name the two windings of a single-phase induction motor.

I. Running winding
ii. Starting
winding.

19. What are the various methods available for making a single-phase motor self-starting?

i. By splitting the single phase into 2 phases
ii. By providing shading coil in the poles.

20. What is the function of capacitor in a single-phase induction motor?

I. To make more phase difference between the starting and running winding. ii. To improve the power factor and to get more torque.

21. Give the names of three different types of single-phase motor.

i. Split phase motor
ii. Shaded pole motor.
iii.Single phase series motor.
iv. Repulsion motor.

22. What is the use of shading ring in a pole motor?

The shading coil causes the flux in the shaded portion to lag behind the flux in unshaded portion of pole. This gives in effect a rotation of flux across the pole face and under the influence of this moving flux a stating torque is developed.

23. State any four use of single-phase induction motor.

Fans, Wet grinders, Vacuum cleaners, small pumps, compressors,drills

24. Why is the efficiency of a 3-phase induction motor less than of a transformer?

In induction motor, there is a mechanical loss due to the rotation of the rotor. Hence the efficiency of an induction motor is less than that of the transformer.

25. What are the types of starters?

Stator rheostat, Autotransformer and Star to Delta switch Rotor resistance starter.

STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR

1. What are the types of starters?

Stator rheostat, Autotransformer Star to Delta starter and rotor resistance starter.

2. List out the methods of speed control of cage type 3-phase induction motor?

a) By changing supply frequency
b) By changing the number of poles
c) By operating two motors in cascade

3. Mention different types of speed control of slip ring induction motor?

e) By changing supply frequency
f) By changing the number of stator poles
g) By rotor rheostat control
h) By operating two motors in cascade

4. State the advantages of capacitor start run motor over capacitor start motor.

Running torque is more; Power factor during running is more.

5. What is Universal motor?

A Universal motor is defined as a motor, which may be operated either on direct current or single-phase ac supply.

6. State some application of universal motor.

Used for sewing machines, table fans, Vaccum cleaners, hair driers, blowers etc

7. Explain why single-phase induction motor is not self-starting one.

When the motor is fed from a single phase supply its stator winding produces an alternating or pulsating flux, which develops no torque which is explained in Double revolving field theory.

8. What type of motor is used for ceiling fan?

Capacitor start and capacitor run single-phase motor is used for ceiling fans.

9. What is the type of induction motor used in wet grinders?

Capacitor start capacitor run single-phase induction motor.

10. What kind of motor is used in mixie?

Single-phase ac series motor is used in mixie.

11. what is the application of shaded pole induction motor?

Because of its small starting torque, it is generally used for small fans, toys, instruments, hair driers, ventilators, electric clock etc.

12. In which direction does a shaded pole motor run?

The rotor starts rotation in the direction from unshaded part to the shaded part.

13. why single-phase induction motor has low power factor?

The current through the running winding lags behind the supply voltage by a very large angle. Therefore power factor is very low.

14. Diffrentiate between "capacitor start "and "capacitor start capacitor run "induction motor?

In capacitor start motor, capacitor is connected in series with the starting winding. But it will be disconnected fro m the supply, when the motor picks up its speed. But in capacitor start capacitor run motor the above starting winding and capacitor are not disconnected, but always connected in the supply .so it has high starting and running torque.

15. State the application of an induction generator?

- Used in windmill for generating electric power.
- Used in regenerative breaking places like traction.

16. What do you mean by residual EMF in a generator.

The EMF induced in the armature conductor only due to the residual flux in the field poles is known as residual EMF

17. State the effect of rotor resistance on starting torque?

Starting torque increases with increase in value of rotor resistance.

18. How can varying supply frequency control speed?

We know that

$$Ns = \frac{120f}{P}$$

From the equation it is clear that by varying frequency speed can be varied it is very rarely.

19. How is speed control achieved by changing the number of

stator poles?

Here change in stator poles is achieved by having two or more independent stator windings in the same slot. Each winding gives different number of poles and different speeds. At a time only one winding is used and other is closed

20. What are the main disadvantages of rotor rheostatic control?

- The speed can be decreased by increasing the rotor resistance, but increases I^2R loss and hence decreases efficiency.
- Speed depends on load also and so used for small periods only.

21. What are the methods of speed control preferred for large motors?

- Kramer system
- Scherbius system

22. What is an induction regulator?

An induction regulator is used to obtain the constant voltage at the feeder end. Varying the range between the magnetic axes of the primary and secondary windings controls the voltage; it may be a single phase. Rotor is moved usually by a maximum of 180 degree.

23. Define-Slip frequency.

The relation motion of the stator flux and the rotor conductors induces the voltage of frequency S_f called slip frequency.

24. Define- Asynchronous torque.

When stator and rotor fields are stationary with respect to each other, a steady torque is produced and rotation is maintained. Such a torque existing at any mechanical speed other than synchronous speed is called as an asynchronous torque.

25. What is the main use of squirrel cage winding in synchronous motor starting?

When a squirrel cage winding called the amortissuer or damper winding is inserted in the rotor pole faces, the rotor comes up to the synchronous speed by induction motor action with the field winding unexcited.

26. What is breakdown torque?

From the torque verses slip charactertics, we can infer that as the torque increases, slip increases upto a maximum torque developed is called a breakdown torque.

27. What is the function of rotary converter? Where it is used?

Rotary converter converts low slip ac power. It is used in Kramer system, which is for the speed control of three-phase induction motor.