Department of Electrical Engineering
Assignment
Date: 25/06/2020

Course Details

Course Title: AC Machines **Module:** B-Tech
Instructor: **Rashid aleem sir** 50
Total Marks:

Student Details

Name: **AZHAD NIAZ** **Student ID:** **15493**

Q1	In which motors the rotor does not receive power by conduction?Explain the advantages and disadvantages in detail of that motor?	Marks (5)
Q2	A slip-ring induction motor runs at 290 r.p.m at full load,when connected to 50Hz supply?Determine the no of poles and slip?	(5)
Q3	The power input to the rotor of 440V,50Hz ,6 pole ,3 phase induction motor is 80KW.The rotor electromotive force is observed to make 100 complete alteration per minute.Calculate the slip,the rotor speed and rotor copper losses per phase?	(5)
Q4	Explain in detail the basic principle of alternators and also discusss its construction?	(5)
Q5	A 3-phase,16-pole alternator has a star connected winding with 144 slots and 10 conductor per slots.The flux per pole is 0.03 weber,sinusoidally distributed and the speed is 375 r.p.m.Find the frequency rpm and the phase and line e.m.f.Assume full pitched coil?	(5)
Q6	Write a note on three phase transformer connections?	(5)
Q7	A 500KVA,3 phase,50 Hz transformer has a voltage ratio of 33/11-KV and is delta/star connected.The resistances per phase are :high voltage of 35 ohm low voltage 0.876 ohm and the iron loss is 3050 W.Calculate the value of	(10)

	efficiency at full load and one –half of full load respectively at unity power factor and at 0.8 pf.	
Q8	Answer the following short questions? Q1)What Is The General System Requirements Of Alternator? Q2)Will The Alternators Have Rotating Armature System Or Stationary Armature System? Q3)What Are The Advantages Of Stationary Armature And Rotating Field System? Q4)What Are The Advantages Of Three Phase Motor Over Single Phase Motor? Q5)What Is Meant By Turbo Alternators?	(10)

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Q1: In which motors the rotor does not receive power by conduction?Explain the advantages and disadvantages in detail of that motor?

ANS:

In AC motors, the rotor does not receive electrical power but conduction by induction in the same way as the secondary of 2-winding transformer receives its power from the primary winding.
That is why such motors are known as rotating transformer. When you give three phase supply to the three phase stator winding then it is called as three phase induction motor.

The effect of applying load on the speed, slip, stator current, power factor, efficiency and torque are discussed below:

EFFECT ON STATOR CURRENT:

Current drawn by the stator is determined by two factors. One component is the magnetizing current required to maintain the rotating field. The second component produces a field which is equal and opposites to that formed by the rotor currents. The rotor current increases with loads, the stator current will also therefore increases with load. Power factor of an induction motor on no load is very low because of the high value of magnetizing current. With load the power factor increases because the power component of the current is increased

ADVANTAGES AND DISADVANTAGES:

The advantages and disadvantages of ac machine are as follow:

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ADVANTAGES	**Disadvantages**
It cost high	Its speed cannot varied without sacrifice some effiecency
It start from rest and need no extra starting motor and has not be synchronized	Its starting torque is somewhat inferior to that of dc shunt motor
lower power demand on start and minimal maintenance.	AC will produce eddy currents due to the production of a back emf. - Because motors are generators that operate in reverse, they produce an emf just like generators do
Ac motors are brushless and develop a higher torque	A single phase induction motor, unlike a 3 phase induction motor, does not have a self starting torque.
The speed and the power developed can be varied with the aid of a controller.	During light load conditions, the power factor of the motor drops to a very low value. ...
They can operate at higher voltages hence reducing the size of wire.	Speed control of an induction motor is very difficult to attain.

Q2: A slip-ring induction motor runs at 290 r.p.m at full load, when connected to 50Hz supply? Determine the no of poles and slip?

SOLUTION:

Since N is 290 rpm. N_s

Has to be somewhere near it say 300 rpm

If N_s is assumed as 300 rpm then\

$$300 = \frac{120 \times 50}{P}$$

∴ P=20

$$\therefore \quad \text{Slip} = \frac{300-20}{300} = 3.33\%$$

Ans…

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Q3:

The power input to the rotor of 440V,50Hz ,6 pole ,3 phase induction motor is 80KW.The rotor electromotive force is observed to make 100 complete alteration per minute. Calculate the slip, the rotor speed and rotor copper losses per phase?

SOLUTION:

100 alternations minutes = $\frac{100}{60}$ cycles/sec

1.6667Hz = sf

Hence, the slip $s = \frac{1.6667}{50}$ = 0.3333p.u or 3.333%

(ii) rotor speed N = (1-0.3333)1000

Since $N_2 = \frac{120 \ . \ 50}{6}$ =1000rpm, N=966.67rpm

(iii) Rotor copper losses phase = $\frac{1}{3}$. (S. rotor input)

Total rotor power input = 80KW

Rotor power input per phase = 80/3KW

Rotor copper losses per phase

$$\frac{0.333 \ . \ 80}{3} \text{KW} = 0.8888\text{KW}$$

Ans,,

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Q4: Explain in detail the basic principle of alternators and also discusss its construction?

ANS:

Types of Alternator

Alternators or synchronous generators can be classified in many ways depending upon their application and design. According to application these machines are classified as-

1. Automotive type - used in modern automobile.
2. Diesel electric locomotive type - used in diesel electric multiple units.
3. Marine type - used in marine.
4. Brush less type - used in electrical power generation plant as main source of power.
5. Radio alternators - used for low brand radio frequency transmission

Construction and working principle of Alternator:

Main parts of the alternator consist of stator and rotor. But, the unlike other machines, in most of the alternators, field exciters are rotating and the armature coil is stationary.

Stator:

In DC machine stator of an alternator is not meant to serve path for magnetic flux. Instead, the stator is used for holding armature winding. The stator core is made up of lamination of steel alloys or magnetic iron, to minimize the eddy current losses.

Rotor:

There are two types of rotor used in an alternator:
(i) Salient and (ii) cylindrical type

Salient pole type: Salient pole type rotor is used in low and medium speed alternators. Construction of AC generator of salient pole type rotor is shown in the figure above. This type of rotor consists of large number of projected poles (called salient poles), bolted on a magnetic wheel. These poles are also laminated to minimize the eddy current losses. Alternators featuring this type of rotor are large in diameters and short in axial length.

Cylindrical type: Cylindrical type rotors are used in high speed alternators, especially in turbo alternators. This type of rotor consists of a smooth and solid steel cylinder having slots along its outer periphery. Field windings are placed in these slots.

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Working principle:

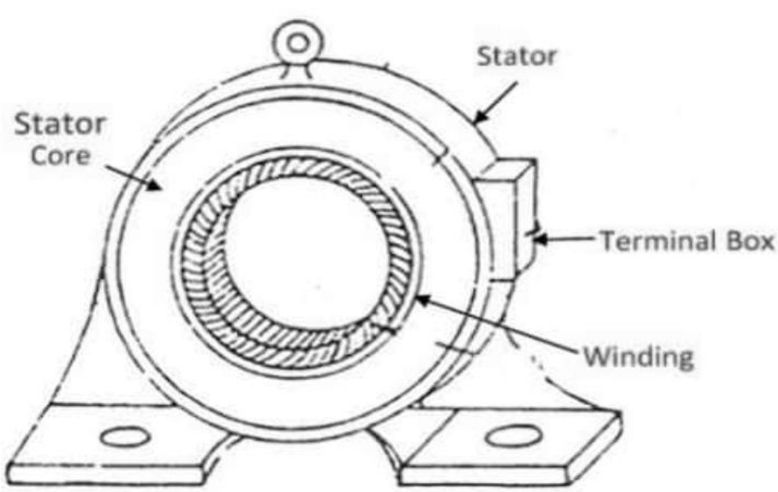
The working principle of alternator is very simple. It is just like basic principle of DC generator. It also depends upon Faraday's law of electromagnetic induction which says the current is induced in the conductor inside a magnetic field when there is a relative motion between that conductor and the magnetic field.

The DC supply is given to the rotor winding through the slip rings and brushes arrangement. Having understood the very basic principle of alternator, let us now have an insight into its basic operational principal of a practical alternator.

During discussion of basic working of alternator, we have considered that the magnetic field is stationary and conductors (armature) are rotating. But generally in practical construction of alternator, armature conductors are stationary and field magnets rotate between them. The rotor of an alternator or a synchronous generator is mechanically coupled to the shaft or the turbine blades, which on being made to rotate at synchronous speed Ns under some mechanical force results in magnetic flux cutting of the stationary armature conductors housed on the stator.

As a direct consequence of this flux cutting an induced emf and current starts to flow through the armature conductors which first flow in one direction for the first half cycle and then in the other direction for the second half cycle for each winding with a definite time lag of 120° due to the space displaced arrangement of 120° between them. This particular phenomena result in 3φ power flow out of the alternator which is then transmitted to the distribution stations for domestic and industrial uses.

DIAGRAM:



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Q5: A 3-phase,16-pole alternator has a star connected winding with 144 slots and 10 conductor per slots.The flux per pole is 0.03 weber,sinusoidally distributed and the speed is 375 r.p.m.Find the frequency rpm and the phase and line e.m.f.Assume full pitched coil?

SOLUTION:

$$F= PN/120 = \frac{16\times375}{120} = 50Hz$$

Since K_e is not given would be taken as unity

$$n = \frac{144}{16} = 9;\ \beta = 180°/9 = 20°;\ m = \frac{144}{16\times3} = 3$$

$$K_d = \sin3\times\frac{(20°/2)}{3\sin(20°/2)} = 0.96$$

$$Z = 144\times10/3 = 480. T = \frac{480}{2} = 240/phase$$

$$E_{ph} = 4.44\times1\times0.96\times50\times0.03\times240 = 15.34V$$

Line voltage $E_L = \sqrt{3}\,E_{ph} = \sqrt{3}\times1534 = 2658V$

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Q6: Write a note on three phase transformer connections?

ANS:

Three Phase Transformer Connections:

Three phase transformer connections in three phase system, the three phases can be connected in either star or delta configuration. In case you are not familiar with those configurations, . In any of these configurations, there will be a phase difference of 120° between any two phases.

Windings of a three phase transformer can be connected in various configurations as

(i) star-star,
(ii) delta-delta
(iii) star-delta,
(iv) delta-star,
(v) open delta and
(vi) Scott connection. These configurations are explained below.

Star-star:

- Star-star connection is generally used for small, high-voltage transformers. Because of star connection, number of required turns/phase is reduced as phase voltage in star connection is 1/√3 times of line voltage only. Thus, the amount of insulation required is also reduced.
- The ratio of line voltages on the primary side and the secondary side is equal to the transformation ratio of the transformers.
- Line voltages on both sides are in phase with each other.
- This connection can be used only if the connected load is balanced.

Delta-delta:

- This connection is generally used for large, low-voltage transformers. Number of required phase/turns is relatively greater than that for star-star connection.
- The ratio of line voltages on the primary and the secondary side is equal to the transformation ratio of the transformers.
- This connection can be used even for unbalanced loading.
- Another advantage of this type of connection is that even if one transformer is disabled, system can continue to operate in open delta connection but with reduced available capacity.

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Star-delta OR wye-delta (Y-Δ)

- The primary winding is star star (Y) connected with grounded neutral and the secondary winding is delta connected.
- This connection is mainly used in step down transformer at the substation end of the transmission line.
- The ratio of secondary to primary line voltage is 1/√3 times the transformation ratio.
- There is 30° shift between the primary and secondary line voltages.

Delta-star OR delta-wye (Δ-Y)

- The primary winding is connected in delta and the secondary winding is connected in star with neutral grounded. Thus it can be used to provide 3-phase 4-wire service.
- This type of connection is mainly used in step-up transformer at the beginning of transmission line.
- The ratio of secodary to primary line voltage is √3 times the transformation ratio.
- There is 30° shift between the primary and secondary line voltages.

Open delta (V-V) connection

Two transformers are used and primary and secondary connections are made. Open delta connection can be used when one of the transformers in Δ-Δ bank is disabled and the service is to be continued until the faulty transformer is repaired or replaced. It can also be used for small three phase loads where installation of full three transformer bank is un-necessary. The total load carrying capacity of open delta connection is 57.7% than that would be for delta-delta connection

Scott (T-T) connection

Two transformers are used in this type of connection. One of the transformers has centre taps on both primary and secondary windings which is called as main transformer. The other transformer is called as teaser transformer. Scott connection can also be used for three phase to two phase conversion.

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Q7: A 500KVA,3 phase,50 Hz transformer has a voltage ratio of 33/11-KV and is delta/star connected.The resistances per phase are :high voltage of 35 ohm low voltage 0.876 ohm and the iron loss is 3050 W.Calculate the value of efficiency at full load and one –half of full load respectively at unity power factor and at 0.8 pf.

Solution:

Transformation ratio K = $\frac{11{,}000}{\sqrt{3}\times 33{,}000} = \frac{1}{3\sqrt{3}}$

Per phase R_{02} = 0.876+ $(\frac{1}{3\sqrt{3}})^2$ ×35=2.172Ω

Secondary phase current = $\frac{500{,}000}{\sqrt{3}\times 33{,}000} = \frac{500}{11\sqrt{3}}$ A

Full load condition

Full load total Cu loss = 3×$(\frac{11}{\sqrt{3}})^2$ ×2.172 =4,490 W; Iron loss= 3,050 W
Total full load losses

= 4,490+3,050 = 7,540 W; Output at unity p.f. =500 kW

F.L Efficiency = 500,000/507.540

= 0.9854 or 98.54% ; Output at 0.8 p.f. =400kW

Efficiency = 400,000/407.540

=0.982 or 98.2%

Half load condition

Output at unity p.f =250 kW

Cu losses = $(1/2)^2$ × 4,490
=1,222 W

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Total loss

=3,050+1,122=4,172 W

N= 250.000/254,172 = 0.9835 = 98.35%

Output at 0.8p.f = 200KW ∴ n=200,000/204,172 =98%

Q8: **Answer the following short questions?**

Q1) What Is the General System Requirements Of Alternator?

ANS:

For the generation of emf, there should be two basic systems.

(i) magnetic field system to produce the magnetic field

(ii) Armature system which houses the conductors on which the EMF is to be induced.

Q2) Will The Alternators Have Rotating Armature System Or Stationary Armature System?

ANS:

In Alternators there is always rotating field and stationary armature opposite to DC generator for following main reasons.

Generally in alternator mechanical prime mover torque is converted into electrical power by following faradays laws of EMI.

1. Armature winding as a stator can withstand large mechanical vibrations and centrifugal forces.
2. we can easily accommodate cooling ducts for armature to reduces Cu losses if and only if its stationary.
3. We can directly connect 3 phase loads to armature without requirements of any brushes if and only if armature is kept out as a stationary.

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Q3)What Are The Advantages Of Stationary Armature And Rotating Field System?

ANS;

Advantages of stationary armature-rotating field alternator

1) The current is drawn directly from fixed terminals on the stator without the use of brush contacts.

2) The insulation of stationary armature winding is easier.

3) The number of sliding contacts (slip rings) is reduced. Moreover, the sliding contacts are used for low-voltage DC Source

Q4)What Are The Advantages Of Three Phase Motor Over Single Phase Motor?

ANS:

1. Power delivered is constant. In single phase circuit the power delivered is pulsating and objectionable for many applications.
2. For a given frame size a polyphase machine gives a higher output than a single phase machine.
3. Parallel operation of three-phase generators is simpler than that of single phase generator.

Q5)What Is Meant By Turbo Alternators?

ANS:

Turbo-alternators are basically hydrogen cooled cylindrical rotor alternators used to generate electric power in generating stations.
They have only 2 poles and are run by a 3000 rpm turbine for 50 Hz machine and 3600 rpm for 60 Hz machine.