KATHMANDU UNIVERSITY
End Semester Examination
July/August, 2024

Marks Scored:

Level : B.E.
Year : III
Course : EPEG 302
Semester : I

Exam Roll No. :
Time: 30 mins.
F. M. : 10

Registration No.:
Date 23 JUL 2024

SECTION "A"
[20 Q. × 0.5 = 10 marks]

Choose and encircle in the most appropriate option from each set of choices

1. A 3 - Φ, 12 pole, 600 V, 50 Hz star connected IM has rotor resistance and stand still resistance of 0.03 Ω and 0.5 Ω respectively. The speed of maximum torque will be _____ rpm
   a. 240 b. 450 c. 470 d. 540

2. The principal of starting 3-Φ induction motor is similar to_____
   a. Capacitor runs induction motor
   b. Synchronous motor
   c. The reactive power increases
   d. The transformer with secondary short circuited.

3. A 230 V, 50 Hz, 4 pole single phase induction motor is rotating in the clockwise (forward) direction at a speed of 1425 rpm. If the rotor resistance at standstill is 7.8 Ω. Then the effective rotor resistance in the backward branch of the equivalent circuit will be _____ Ohm
   a. 4 b. 2 c. 6 d. 8

4. For a 3 phase induction motor with slip 's', if E_2, R_2 and X_2 represents rotor induced emf, rotor resistance and rotor reactance respectively, then the rotor current per phase is given as _____
   a. $\frac{sE_2}{\sqrt{(R_2)^2+X_2{}^2}}$ b. $\frac{E_2}{\sqrt{(R_2)^2+sX_2{}^2}}$ c. $\frac{E_2}{\sqrt{(sR_2)^2+X_2{}^2}}$ d. $\frac{E_2}{\sqrt{(R_2/s)^2+X_2{}^2}}$

5. For a three phase induction motor, the maximum torque, also called pull out torque is always_____
   a. Dependent of rotor resistance b. Independent of resistance
   c. Equal to rotor resistance d. Equal to 1

6. I. An induction can never operate at leading power factor.
   II. Speed of the induction motor can be made more than synchronous speed and still it will work as motor.
   a. I is true, II is false b. I is true, II is true
   c. I is false, II is true d. I is false, II is also false

7. In Yd11 vector grouping_____
   a. high-voltage star winding lags low-voltage delta winding by 30^0
   b. high-voltage star winding leads low-voltage delta winding by 30^0
   c. high-voltage star winding lags low-voltage delta winding by 90^0
   d. high-voltage star winding leads low-voltage delta winding by 90^0

8. For designing a 5 kVA, 1-Φ, 50 Hz, 415/240 V transformer with K = 0.75 and B_m = 1.6 Tesla, the cross sectional area of the core must be _____ mm^2

a. 470 b. 47000 c. 4700 d. 47

9. Of the following statements concerning parallel operation of transformers, the one which is not correct is

a. Transformers must have equal voltage ratings
b. Transformers must have same ratio of transformation
c. Transformers must be operated at the same frequency
d. Transformers must have equal kVA ratings

10. Scott connections are used for _____

a. single phase to three phase transformation
b. three phase to single phase transformation
c. three phase to two phase transformation
d. three phase to three phase transformation

11. Two single phase 100 kVA transformers, each having same leakage impedances are connected in parallel. When a load of 150 kVA at 0.8 pf lagging is applied

a. both transformers will operate at power factor more than 0.8 lagging.
b. both transformers will operate at power factor less than 0-8 lagging.
c. one of transformers will operate at pf more than 0.8 lagging and other will operate at pf less than 0.8 lagging.
d. both transformers will operate at identical power factors

12. If all other requirements for parallel operation of transformers are fulfilled, which one of the following pairs of three-phase transformers, with the given VECTOR GROUPS, can be operated in parallel?

a. Yd 1 and Yy O. b. Yd 1 and Dy11.
c. Dd 6 and Dy 1. d. Dd 0 and Dy 11

13. A single phase transformer of 2200/220V having rated l.v. current of 150 A has to undergo open circuit test on h.v side. The instruments used are voltmeter of 200V and ammeter of 1A. Then the results _____

a. will be wrong b. will be accurate
c. of ammeter will burn d. none of the mentioned

14. Two alternators A and B are operating in parallel. If the excitation of A is increased, then

a. The reactive power of A is increased while that of B is decreased.
b. The reactive power of A is decreased while that of B is increased.
c. The reactive power of A is decreased.
d. The reactive power of A is increased while that of B is unchanged.

15. The following statement/s is/are incorrect for a synchronous motor

I. It has starting torque.
II. It speed varies from no load to full load.
III. It can operate at lagging, leading and zero power factors.

a. I, II and III. b. Only II. c. Only III. d. I and II.

16. Two similar synchronous generators are working in parallel to supply a common load demand with identical excitations and steam supplies to their prime movers. Now, if the steam supply to the prime mover of one of the generators is decreased compared to the other, with field excitation kept unchanged, then
   a. its active power component will remain the same but the reactive power contribution will increase.
   b. its active power will decrease while the reactive power of both will remain same.
   c. both active and reactive components of power will increase.
   d. its active power contribution will increase but reactive power contributions of both will remain unchanged.

17. If the excitation of an alternator connected to an infinite bus-bar is changed, keeping the power input to its prime mover unchanged, its _____ will change.
   a. kW output b. power-factor c. kVA output d. kVAR output

18. A stationary alternator should not be connected to the live bus-bar because
   a. it is likely to operate as a synchronous motor.
   b. it will get short circuited.
   c. it will reduce bus-bar voltage.
   d. all of the above.

19. The magnetization curve in the induction generator working in isolation has similar characteristic as _____
   a. dc shunt generator b. dc cumulative field generator
   c. synchronous generator d. all of the mentioned

20. In a synchronous motor the nature of armature reaction is
   a. Demagnetizing.
   b. Cross-magnetizing.
   c. Partly demagnetizing and partly cross magnetizing.
   d. Partly magnetizing and partly cross-magnetizing.

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28 JUL 2024

Course : EPEG 302
Semester : I
F. M. : 40

SECTION "B"
[5 Q. × 8 = 40 marks]

Attempt ANY FIVE questions. Assume any suitable data if required.

1.

a. A 100 MVA 230/115 kV Δ-Y three phase transformer has a per unit resistance of 0.012 pu and a per unit reactance of 0.06 pu. The excitation branch elements are R_C =100 pu and X_M= 20 pu. [1+1+1.5+1.5=5]
   i. If this transformer supplies a load of 80 MVA at 0.8 PF lagging, draw the phasor diagram of one phase of the transformer.
   ii. Determine the voltage regulation of the transformer bank under these conditions.
   iii. Sketch the equivalent circuit referred to the low voltage side of the one phase of transformer. Calculate all the transformer impedances referred to the low voltage side.
   iv. Determine the losses in the transformer and the efficiency of the transformer under the condition of part (ii).

b. Explain the working principle of a Scott connection transformer. Obtain a phasor diagram for the T-T connected transformer with unity power factor loads on transformer secondary sides. [3]

2.

a. Describe with a phasor and connection diagram, the parallel operation of two three phase transformer bank connected in Y-Y, and having 0 degree and 180 degree phase shift respectively. [3]

b. A three phase transformer bank is to handle 500 kVA and have a 34.5/11 kV voltage ratio. Find the high voltage rating, low voltage, turns ratio and apparent power of each individual transformer in the bank as shown in table 1 if the transformer bank is connected in: [2]
   i. Y-Δ
   ii. Δ-Δ

Table 1. Table for question 2 (b)

Connections	Primary Voltage	Secondary voltage	Apparent power	Turns ratio
Y-Δ				
Δ-Δ				

c. Explain different types of cooling methods implemented for oil immersed transformers. [3]

P.T.O.

3.

a. A 208 Volts four pole 60 Hz, Y connected wound rotor induction motor is rated at 30 hp. Is equivalent circuit components are: [4]
R_1=0.100 Ω; R_2=0.070 Ω; X_M= 10.0 Ω; X_1=0.210 Ω; X_2=0.210 Ω; P_{mech} = 500W; P_{core}= 400W; P_{misc}=150W

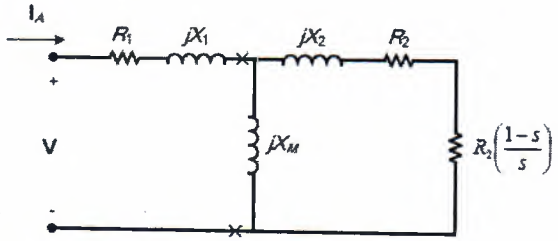

Figure 1. Equivalent circuit for question 3 (a)

For a slip of 0.55, find

i. The line current.
ii. The stator copper loss.
iii. The air gap power.
iv. The power converted from electrical to mechanical.
v. The induced torque.
vi. The load torque.
vii. The overall machine efficiency
viii. The motor speed in r.p.m

b. Derive the conditions for value of maximum torque under starting and running condition for a slip ring induction motor. [4]

4.

a. Plot the torques and slip/speed characteristic curve of a three phase induction motor and explain the motoring, generating and plugging mode of operation. [3]
b. Explain the relationship between effect of unity and lagging power factor on the developed torque in a three phase induction motor. [3]
c. Explain the blocked rotor test and no load test of a three phase squirrel cage induction motor. [2]

5.

a. Explain the "V-curve" for an alternator and illustrate with the phasor diagram for an alternator that operates at lagging power factor when it is overexcited. [3]
b. Two synchronous generators named 'Gen-I', and 'Gen-II' are to be operated in parallel mode. Gen-I is operated at first, therefore, setting the system voltage and frequency. Consider two cases with constant power output of both generators and change in the generator II excitation: [3]
   i. Gen-II is connected at a voltage below the voltage of Gen-I.
   ii. Gen-II is connected at voltage slightly above voltage of Gen-I.
   Describe the conditions with the voltage (V) versus reactive power (Q_G) diagram for the parallel operation of both synchronous generators for the above cases.
c. Explain the starting mechanism for a three synchronous motor. [2]

6.

a. A 200 MVA, 12 kV, 0.85 PF lagging, 50 Hz, 20 pole Y connected water turbine generator has a per unit synchronous reactance of 0.9 and a per unit armature resistance of 0.1. This generator is operating in parallel with a large power system (infinite bus). [4]

[Assume: V= 1.0<0 pu and I=1.0<power factor angle pu at rated condition]

i. What is the speed of rotation of the generator's shaft? What is the magnitude of the internal generated voltage at rated conditions? What is the torque angle of the generator at rated conditions?

ii. Calculate the values of generator's synchronous reactance and armature resistance in Ohms.

iii. If the field current is held constant and armature resistance is neglected, what is the maximum possible output of the generator?

iv. At the absolute maximum power possible, how much reactive power will this generator be supplying or consuming? Sketch the phasor diagram with consideration for unchanged field current.

b. Explain the affect of armature reaction with the help of a phasor diagram in an alternator for leading power factor loads. [4]