KATHMANDU UNIVERSITY
End Semester Examination [C]
June/July 2024

04 JUL 2024

Level : B.E.
Year : III
Time : 2 hrs. 30mins.

01 JUL 2024

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

SECTION "B"
[4 Q × 10 = 40 marks]

Attempt *ANY FOUR* questions. *Assume any suitable data if required.*

1.

a. A 250 kVA, 440 V, 50 Hz, Y-connected synchronous generator with a rated field current of 5.5 A was tested and the following data were obtained:
Open circuit voltage, $V_{T,OC}$ = 540 V at the rated field current, I_F.
Short circuit current, $I_{L,SC}$ = 300 A at the rated field current, I_F.
When a DC voltage of 10 V was applied to two of the terminals, a current of 25 A was measured. Find the generator's armature resistance and the approximate synchronous reactance at rated condition. [4]

b. The exciting current of a 1-phase, 10 kVA, 2200/220 V, 60 Hz transformer is 0.25 A when measured on the high-voltage side. Its equivalent impedance is 10.4+j31.3 Ω when referred to the HV side. Taking the transformer rating as base,
i. Determine the base values of voltages, currents, and impedances for both high-voltage and low-voltage sides.
ii. Express the exciting current in per-unit form for both high voltage and low voltage sides.
iii. Obtain the equivalent circuit in per-unit form.
iv. Find the full load copper loss in per unit form.
Determine the per-unit voltage regulation (using the per-unit equivalent circuit from part (c) when the transformer delivers 75% full load at 0.6 lagging power factor. [4]

2.

a. Three physically identical synchronous generators are operating in parallel. They are all rated for a full load of 4 MW at 0.85 PF lagging. The no-load frequency of generator A is 61 Hz, and its speed droop is 3.4 percent. The no-load frequency of generator B is 61.5 Hz, and its speed droop is 3 percent. The no-load frequency of generator C is 60.5 Hz, and its speed droop is 2.6 percent. If a total load consisting of 7 MW is being supplied by this power system, what will the system frequency be and how will the power be shared among the three generators? [1.5+1.5=3]

b. Explain with a phasor diagram the effect of change in field current on a synchronous motor operating on a lagging power factor. [3]

c. A 480-V, 60 Hz, 400-hp 0.8-PF-leading eight-pole delta connected synchronous motor has a synchronous reactance of 0.6 ohm and negligible armature resistance. Ignore its friction, windage, and core losses for the purposes of this problem. Assume that back e.m.f , E_A is directly proportional to the field current I_F (in other words, assume that the motor operates in the linear part of the magnetization curve), and that e.m.f, E_A = 480 V when field current, I_F = 4 A. If this motor is initially supplying 400 hp at 0.8 PF lagging, what are the magnitudes and angles of E_A and armature current, I_A? [2]

P.T.O.

3.

a. The following results were obtained on a 3-phase, 75 kW, 3.3 kV, 6-pole, 50 Hz squirrel cage induction motor. [3]

No Load (NL) test: Rated frequency @ 50 Hz
V_o = 3.3 kV (line)

Blocked Rotor (BR) test: Frequency @ 15 Hz
V_{BR} = 400 V (line), I_{BR} = 27 A, P_{BR} = 15000 W

DC test on stator resistance/phase = 3.75 Ω

i. Determine the parameters of the circuit model (exact version)
ii. Calculate the maximum torque and the slip at which it occurs
iii. For a slip of 4%, calculate the stator current, its p.f. and motor efficiency.

b. Derive the expression of torque in a three phase induction motor

" $T_d = [3 \times E_{RO}^2 / 2\pi N_s] * [s \times R_R / R_R^2 + s^2 X_R^2]$ "

and, explain the relationship between effect of unity and lagging power factor on the developed in a three phase induction motor. [3+2=5]

4.

a. What are the major differences between shell type transformer and core type transformer? Discuss about on-load and off-load tap changing transformer. [4]

b. The following data are obtained for two transformers A and B connected in parallel to a load of (2+j1.5) Ω.

Transformer A:
Impedance in secondary, Z_A = (0.15+j0.5) Ω
Induced e.m.f., E_A = 207 V

Transformer B:
Impedance in secondary, Z_B = (0.1+j0.6) Ω
Induced emf., E_B = 205 V

Find the power output and power factor of each transformer [4]

5.

a. Explain the ONAN, ONAF, OFAF, OFWF methods of cooling for oil immersed transformers. [4]

b. With appropriate connections and phasor diagrams, explain Yd11, Dy1, Dy11, Yy0 and Dd0 vector grouping of three phase transformer. [4]

6.

a. Discuss various starting methods of three phase induction motor. With the help of torque-speed characteristics, explain the operations of an induction machine in plugging, motoring and regenerative modes. [4]

b. Write short notes on [4]
i. Construction of Synchronous Generator
ii. Working Principle of Induction Generator

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Time: 30 mins.
F. M. : 10

Registration No.:
Date : 04 JUL 2024

SECTION "A"
[20Q. × 0.5 = 10 marks]

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

1. **Figure 1** represents _____ type construction of the transformer.

   a. closed core
   b. shell
   c. both closed core and shell
   d. flux

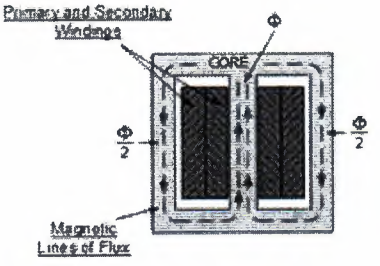

Figure 1

2. The exciting current was found to be 3 A when measured on the LV side of a 20-kVA, 2000/200- V transformer. The exciting current in pu on the LV as well as HV side is ___
   a. 0.03 b. 0.3 c. 0.003 d. 0.0003

3. 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

4. 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

5. The path of a magnetic flux in a transformer should have _____
   a. high resistance b. high reluctance c. low resistance d. low reluctance

6. If the excitation of the synchronous generator fails, it acts as a/an
   a. Synchronous motor.
   b. Synchronous generator itself and has no effect.
   c. Induction motor.
   d. Induction generator.

7. 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 increased 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 will increase.
   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.

8. When two alternators are operating in parallel, if the power input to one of the alternators is cut off, the alternator will
   a. continue to run as a synchronous motor rotating in the same direction.
   b. continue to run as a synchronous motor rotating in opposite direction.
   c. stop running.
   d. get damaged due to burning of stator and rotor windings.

9. 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

10. A reluctance motor is equivalent to _____
   a. salient pole motor with field current
   b. cylindrical pole motor with field current
   c. salient pole motor without field current
   d. cylindrical pole motor without field current

11. A 500 V, 55 kVA single phase alternator has an effective resistance of 0.5 Ω. An excitation current of 10 A produces 200 A armature current on short circuit and an emf of 450 V on per circuit. The synchronous reactance will be _____
   a. 2.193 Ω b. 22.567 Ω c. 4.785 Ω d. 14.896 Ω

12. The For cylindrical rotor motor, the pull out torque occurs at _____
   a. $\delta = 0^0$ b. $\delta = 45^0$ c. $\delta = 90^0$ d. $\delta = 180^0$

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

14. Blocked rotor test of an induction motor corresponds, in case of a transformer, to
   a. full load. b. half-full load.
   c. no load. d. short-circuit operation.

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15. 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. $\frac{E_2}{\sqrt{(R_2/s)^2+X_2{}^2}}$

16. The starting torque of a single phase induction motor is _____
a. uniform b. high c. low d. zero

17. When load is placed in three phase induction motor, its slip _____
a. increases b. decreases c. does not change d. equals to zero

18. The principal of starting 3-Φ induction motor is similar to _____
a. capacitor run induction motor
b. synchronous motor
c. repulsion motor type starting
d. transformer with short circuited secondary

19. If the rotor power output of 3 phase induction motor is 12 kW, the rotor copper losses at slip of 5 % will be _____
a. 600 W b. 625 W c. 650 W d. 700 W

20. For a three phase induction motor, the maximum torque (also called pull out torque) and slip at maximum torque are _____
a. independent and dependent of rotor resistance respectively
b. dependent and independent of rotor resistance respectively
c. both independent of rotor resistance
d. both dependent of rotor resistance