

KATHMANDU UNIVERSITY  
End Semester Examination [C]  
December, 2024

Marks Scored:

Level : B.E.

Year : III

Exam Roll No. :

Time: 30 mins.

Registration No.:

Course : EPEG 302

Semester : I

F. M. : 10

Date : 18 DEC 2024

SECTION "A"

[20 Q. × 0.5 = 10 marks]

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

- The chemical used in breather of transformer should have the quality of
  - Ionizing air.
  - Cleansing the transformer oil.
  - Absorbing moisture.
  - Cooling the transformer oil.
- The material used for construction of transformer core is usually
  - Iron.
  - Copper.
  - Aluminium.
  - Silicon steel.
- The number of bushings in a transformer can be reduced if
  - Tappings are provided at the phase ends.
  - Tappings are provided at high voltage side.
  - Tappings are provided at low voltage side.
  - Tappings are provided at middle of transformer.
- Two transformers having different percentage impedance are intended to be operated in parallel. The consequence is
  - Transformers cannot be connected in parallel at all.
  - Transformers will be overheated.
  - Power factors of both the transformers will be same.
  - Parallel operation will still be possible, but both transformers will work at different power factors.
- Power transformers are generally designed to have maximum efficiency around
  - No load.
  - Half load.
  - Near full load.
  - 10% over load.
- The complete equivalent circuit diagram of a three phase induction motor can be obtained through
  - Blocked rotor test alone.
  - Running light and blocked rotor and stator resistance tests.
  - Running light and blocked rotor tests.
  - Running light test alone.
- The relation between maximum torque and full load torque when referred to induction motor is
  - $T_f/T_{max} = 2a/(a^2+s^2)$ .
  - $T_f/T_{max} = 2/(a^2+s^2)$ .
  - $T_f/T_{max} = 2as/(a^2+s^2)$ .
  - $T_f/T_{max} = a/(a^2+s^2)$ .where,  $s$ =slip and  $a$ = resistance to reactance ratio.
- A double squirrel cage induction motor has outer cage of higher resistance metal bars primarily for the purpose of increasing its
  - Speed regulation.
  - Starting torque.
  - Efficiency.
  - Starting current.

9. In a circle diagram of an induction motor, point of maximum point lies on the tangent drawn parallel to  
 a. Output line.      b. Torque line.      c. Vertical axis.      d. Horizontal axis.
10. A squirrel cage induction motor runs at constant speed only so long as  
 a. Torque developed by it remains constant.  
 b. Its supply voltage remains constant.  
 c. Its torque exactly equals the mechanical load.  
 d. Stator flux remains constant.
11. When applied rated voltage per phase is reduced by one half, the starting torque of an induction motor becomes \_\_\_\_\_ of the starting torque with full voltage.  
 a. 1/2.      b. 1/4.      c.  $1/\sqrt{2}$ .      d.  $\sqrt{3}/2$ .
12. A double squirrel cage induction motor  
 a. Two rotors moving in opposite direction.  
 b. Two parallel windings in rotor.  
 c. Two parallel windings in stator.  
 d. Two series winding in rotor.
13. The crawling of an induction motor is caused by  
 a. High loads.      b. Low voltage supply.  
 c. Improper design of machine.      d. Harmonics developed in motor.
14. The principle of operation of a three phase induction motor closely resembles to that of  
 a. Synchronous motor.  
 b. D.C series motor.  
 c. Transformer with short circuited secondary.  
 d. Transformer with open circuited secondary.
15. The synchronous motors are not self-starting because  
 a. Direction of rotation is not fixed.  
 b. The direction of instantaneous torque reverses after half cycle.  
 c. Starters cannot be used in these machines.  
 d. Starting winding is not provided in these machines.
16. A synchronous motor can be used a synchronous capacitor when it is  
 a. Under loaded.      b. Over loaded.      c. Under excited.      d. Overexcited.
17. Two water turbine driven identical alternators are running in proper synchronism and carry equal loads. If excitation of one alternator is increased without changing its input water turbine supply  
 a. It will keep supplying same load.  
 b. kVAR supplied by it would decrease.  
 c. Its power factor will increase.  
 d. kVA supplied by it would decrease.
18. The armature reaction of an alternator influences  
 a. Operating speed.      b. Waveform.      c. Windage loss.      d. E.m.f per phase.

19. A negative regulation can be expected in case of
- Lagging power factor load.
  - Leading power factor load.
  - Unity power factor load.
  - High speed alternators.
20. If two alternators are running in proper synchronism and the voltage of machine is suddenly increased
- The machines will stop.
  - The machines will burn out.
  - Synchronizing torque will be produced to restore further synchronism.
  - None of the above.



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Level : B.E.  
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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. 13.0 kV, 55-MVA, 0.95 power-factor-lagging, 50-Hz, and four-pole Y-connected synchronous generator has a synchronous reactance of 2.5 Ohm and an armature resistance of 0.2 Ohm. At 50 Hz, its friction and windage losses are 1 MW, and its core losses are 1.5 MW. The field circuit has a dc voltage of 125 V, and the maximum field current is 10 A. The current of the field circuit is adjustable over the range from 0 to 10 A. The OCC of this generator is shown in Figure 1.

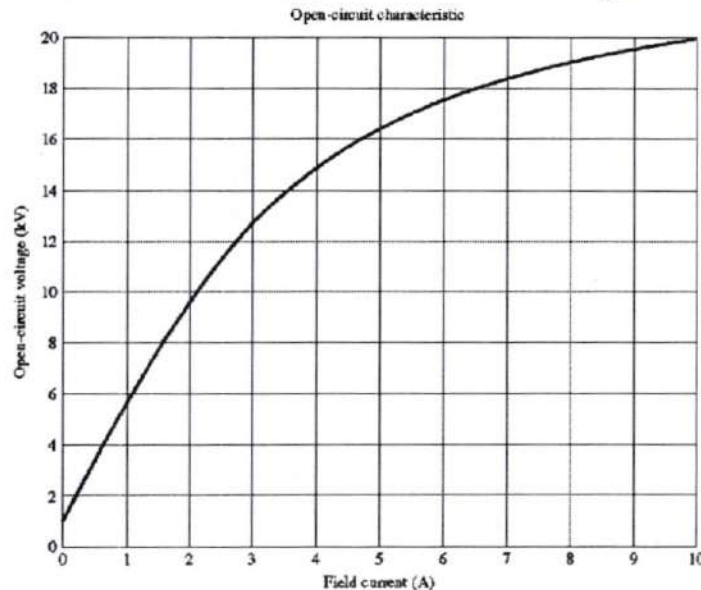


Figure 1. OCC curve for question 1 (a)

- i. How much field current is required to make the terminal voltage,  $V_T$  (or line voltage) equal to 13.0 kV when the generator is running at no load? What is the internal generated voltage  $E_A$  of this machine at rated conditions? What is the phase voltage  $V_P$  of this generator at rated conditions?
  - ii. How much field current is required to make the terminal voltage  $V_T$  equal to 13.0 kV when the generator is running at rated conditions?
  - iii. Suppose that this generator is running at rated conditions, and then the load is removed without changing the field current. What would the terminal voltage of the generator be?
  - iv. How much steady-state power and torque must the generator's prime mover be capable of supplying to handle the rated conditions?
- [4]
- b. Explain with a suitable diagram, the operating principle of a synchronous motor.

[4]

P.T.O.

2.

- a. Two three transformers are connected in parallel. The load 1200 kVA at 0.95 p.f. is to be shared by them. Determine how the load will be shared when transformer 1 has percentage resistance and percentage reactance 1.5% and 4.2% respectively and the transformer 2 has percentage resistance and percentage reactance 1.8% and 4.6% respectively. [4]
- b. Two synchronous generators named 'Gen-A', and 'Gen-B' are to be operated in parallel mode. Gen-B is operated at first, therefore, setting the system frequency. Consider two cases with constant excitation:
- Gen-A is connected at a frequency below the frequency of Gen-B.
  - Gen-A is connected at frequency slightly above frequency of Gen-B.
- Describe the conditions with the frequency ( $f$ ) versus real power ( $P_G$ ) diagram or house diagram for the parallel operation of both synchronous generators in the above cases. [4]

3.

- a. Plot the torques-slip characteristic curve of a three phase induction motor and explain the motoring, generating and plugging mode of operation. [4]
- b. A 208-V four-pole 60-Hz Y-connected wound-rotor induction motor is rated at 30 hp. Its equivalent circuit components are

$$R_1 = 0.100 \text{ Ohm} \quad R_2 = 0.070 \text{ Ohm} \quad X_M = 10.0 \text{ Ohm}$$

$$X_1 = 0.210 \text{ Ohm} \quad X_2 = 0.210 \text{ Ohm}$$

$$P_{\text{mechanical}} = 500 \text{ W} \quad P_{\text{core}} = 400 \text{ W}$$

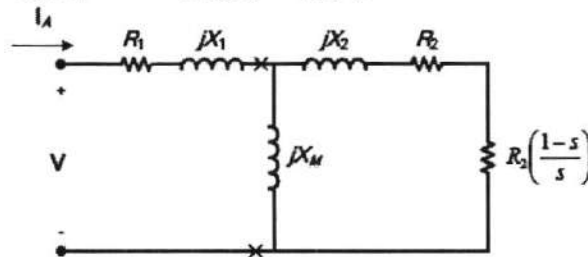


Figure 2. Equivalent circuit for 3 (c)

For a slip of 0.05, find

- The line current,  $I_L$ , stator copper losses,  $P_{SCL}$ , air-gap power,  $P_{AG}$ , power converted from electrical to mechanical form,  $P_{conv}$
- The induced torque  $T_{ind}$ , load torque  $T_{load}$
- The overall machine efficiency, and motor speed in revolutions per minute. [2+1+1=4]

4.

- a. Explain the working principle of a Scott connection transformer. Obtain a phasor diagram for the T-T connected transformer with 0.85 lagging power factor loads on transformer secondary sides. [2+2=4]
- b. Describe with a phasor and connection diagram, the parallel operation of two three phase transformers having +30 degree and -30 degree phase shift respectively. [4]

5.

- a. A three phase step down transformer takes 15A when connected to 4400V mains. The turn ratio per phase is 10. Neglecting losses, find the secondary line voltage, line current and output if the transformer windings are connected
- Star/delta connected.
  - Delta/star connected.

[4]

- b. Explain the effect of armature reaction on a synchronous generator for leading power factor loads, lagging power factor loads and unity power factor loads.

[4]

6.

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

[4]

- b. A 440V, 4 poles, 1490 rpm, 35 kW, 3 phase induction motor is to be used as an asynchronous generator. The rated current of the motor is 42A and the full load power factor is 0.87. Calculate,

- Capacitance required per phase if capacitors are connected in delta.
- Speed of the driving engine for generating a frequency of 50 Hz.

[1.5+1.5=4]

