EE305

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Third Semester B.E. Degree Examination, January/February 2005

Electrical & Electronics Engineering

(Old Scheme)

# Transformers and Induction Machines

Time: 3 hrs.] [Max.Marks : 100

**Note:** *Answer any FIVE full questions.*
*All questions carry equal marks.*

**1.** (a) Define voltage regulation as applied to a transformer. Explain its significance from the point of view of electrical power consumer. Derive on expression for the regulation of transformer under lagging power factor load condition. (10 Marks)

(b) A $1000kW$ single phase transformer has an efficiency of 95% at both full load and half load when working at unity power factor. Determine the efficiency at 60% of the full load. (10 Marks)

**2.** (a) Deduce the exact equivalent circuit of a single phase transformer and describe the necessary tests to determine the constants of the equivalent circuit. (10 Marks)

(b) A 50 Hz single phase transformer has a turn ratio of 6. The resistances are $0.90\Omega$ and $0.03\Omega$ and the reactances $5\Omega$ and $0.13\Omega$ on high voltage and low voltage windings respectively. Find i) voltage to be applied to h.v. side to obtain a full load current of $200A$ in the low voltage winding on short circuit ii) Power factor on short circuit. (10 Marks)

**3.** (a) Define all day efficiency of a transformer. Explain its importance in distribution transformers. How does it differ from ordinary efficiency? (5 Marks)

(b) Write a brief note on different methods of cooling of transformers. (6 Marks)

(c) Explain with the help of connection and phasor diagram the scott connection for 3 phase to 2 phase conversion. Show the 3 -phase side is balanced, if 2 - phase side is balanced. (9 Marks)

**4.** (a) Explain the need for the parallel operation of transformers. What are the conditions to be fulfilled for satisfactory parallel operation of transformers? With a neat circuit and phasor diagram, derive an expression for the load shared by the transformers connected in parallel having equal voltage ratios. (10 Marks)

(b) A 500 KVA transformer with 1.5% resistive and 5% reactive drop is connected in parallel with 1000 KVA transformer with 1% resistive and 4% reactive drop. The secondary voltage of each transformer is 400V on load. Determine how they share a load of 500 KVA at a power factor of 0.8 lagging. Find the p.f at which the transformers work. (10 Marks)

**5.** (a) Explain with suitable sketches the construction of squirrel cage and slip ring induction motor. State the merits and demerits of each type. (8 Marks)

(b) Prove that the rotor copper losses are proportional to slip for a constant rotor input. (4 Marks)

Contd.... 2

(c) A 4 pole 3 phase $50Hz$ induction motor supplies a useful torque of 159 Nm. Calculate at 4% slip i) the rotor input ii) motor input iii) motor efficiency if the friction and windage losses amount to 500watts and stator losses are 1000 watts. (8 Marks)

6. (a) Explain how the performance of 3 phase induction motor is predetermined using the circle diagram by conducting the necessary tests. (10 Marks)

(b) Explain the necessity of a starter for a 3 phase induction motor. Name the different methods of starting a squirrel cage induction motor. Explain auto transformer method of starting of 3 phase squirrel cage induction motor with a suitable diagram. (10 Marks)

7. (a) Name the different methods of speed control available for 3 phase induction motor. Explain Kramer system of speed control with a suitable diagram. (7 Marks)

(b) Draw the equivalent circuit of a double cage rotor Induction motor and sketch the torque slip curve. (5 Marks)

(c) A 3 phase induction motor having a 6 pole star connected stator winding runs on 240V, 50 Hz supply. The rotor resistance and standstill reactance are. $0.12\Omega$ and. $0.85\Omega$/ phase. The ratio of stator to rotor turns is 1.8. Full load slip is 4%. Calculate the developed torque at full load, maximum torque and speed at maximum torque. (8 Marks)

8. (a) Explain the principle of operation of a single phase induction motor using double revolving field theory. Explain why it is not self starting. List the different starting methods. (10 Marks)

(b) With a neat diagram describe the principle of operation of a capacitor start induction motor and name its important application. Explain how you would determine the value of capacitance required. (10 Marks)

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(Pages : 2) **EE—305**

THIRD SEMESTER B.E. (ELECTRICAL AND ELECTRONICS) DEGREE EXAMINATION, AUGUST/SEPTEMBER 2000

# TRANSFORMERS AND INDUCTION MACHINES

Time : Three Hours Maximum : 100 Marks

*Answer any* **five** *questions.*
*All questions carry equal marks.*
*Assume suitable values for any missing data.*

1. (a) Derive the e.m.f. equation of the transformer. (5 marks)

   (b) Draw and explain the phasor diagrams of the given single phase transformer when leading, lagging p.f. loads are connected to the secondary. (5 marks)

   (c) A 50 Hz single-phase transformer has a turns ratio of 6. The resistances are 0.9 Ω and 0.03 Ω and reactances are 5.0 Ω, 0.13 Ω for high voltage and low voltage windings respectively. Find (i) the voltage to be applied to the high voltage side to obtain a full load current of 200 A in the low voltage winding on short circuit and (ii) power factor on short circuit. (10 marks)

2. (a) Derive the conditions for the maximum efficiency of a transformer. (5 marks)

   (b) Explain under what conditions the voltage drop across secondary will be zero when a load is connected to it ? (5 marks)

   (c) The efficiency at unity p.f. of a 6600/384 V, 200 kVA, single phase transformer is 98 % both on full load and half full load. The p.f. on no load is 0.2 and full load regulation at a lagging p.f. of 0.8 is 4 %. Draw the equivalent circuit referred to the L.V. side and insert all the values. (10 marks)

3. (a) Draw the approximate equivalent circuit of the given transformer and describe the required tests to determine the constants of the equivalent circuit. (10 marks)

   (b) A transformer has its maximum efficiency of .98 at 15 kVA, at unity p.f. During the day it is loaded as follows :—

   (i) 12 hours : 2 kW at 0.5 p.f.
   (ii) 6 hours : 12 kW at .8 p.f.
   (iii) 6 hours : 18 kW at .9 p.f.

   Find the all day efficiency. (10 marks)

4. (a) With necessary phasor diagrams describe any *two* of the following types of transformer connections :—

   (i) Star-delta. (ii) Delta-star.
   (iii) Delta-delta. (iv) Open delta. (12 marks)

   (b) A 3-phase step down transformer is connected to a 6600 volts mains and takes 10 A. Calculate the secondary line voltage, and line current for (i) Delta-star ; (ii) Delta-delta ; (iii) Star-delta connections. The ratio of turns/ph is 12. Neglect all losses. (8 marks)

**Turn over**

5. (a) Explain why an induction motor will not run at synchronous speed. (4 marks)

(b) What will be the speed of the rotor with respect to

(i) Stator structure

(ii) Stator m.m.f.

(iii) Rotor m.m.f.

(6 marks)

(c) A 3-phase induction motor with star connected rotor has an induced electromotive force of 60 V between slip rings at standstill on open circuit with normal voltage applied to the stator. The resistance and standstill leakage reactance of each rotor phase are 0.6 Ω and 4 Ω respectively. Calculate the current per phase in the rotor :

(i) when it is at standstill and connected to a resistance of 5 Ω and reactance of 2 Ω per phase and

(ii) when running with a slip of 4 % with its rotor terminals short circuited.

(10 marks)

6. (a) Draw and explain the torque slip characteristics of a 3-phase induction motor.

(5 marks)

(b) Derive an expression for the slip at which the maximum torque occurs and also an expression for maximum torque.

(5 marks)

(c) A 25 h.p., 6 pole, 50 Hz, 3-phase slip ring induction motor runs at 960 r.p.m. on full load with a rotor current per phase of 35 A. Allowing 250 watts for copper loss in the short circuiting gear and 1000 watts for mechanical losses, find the resistance/ph of the 3-phase rotor winding.

(10 marks)

7. (a) Show that the locus of the tip of the secondary current vector of a 3-phase induction motor is a circle.

(3 marks)

(b) A 30 h.p., 500 V, 50 Hz, 4 pole delta connected cage motor gave the following test data :—

| | | | |
|---|---|---|---|
| No load | : 500 V, | 8 A | 1.5 kW |
| Blocked rotor | : 150 V, | 50 A | 3.5 kW |

Draw the circle diagram and obtain the values of (i) line current, p.f., efficiency and slip under full load conditions. Assume stator and rotor resistances to be equal.

(17 marks)

8. (a) Describe any method of controlling the speed of a squirrel cage induction motor.

(5 marks)

(b) Explain why a single phase motor is not self starting. (2 marks)

(c) With neat diagram describe the principle of operation of a capacitor start induction motor.

(9 marks)

(d) Explain what happens when one line of a 3-phase induction motor gets open circuited (i) when it is running and (ii) when at standstill.

(4 marks)