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NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2006

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Transformers and Induction Machines

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

Note: ***Answer any FIVE full questions.***

1 a. Explain with phasor diagram how the flux in the transformer core remains fairly constant from no-load to full load assuming lagging power factor. **(06 Marks)**

b. Draw the complete phasor diagram for a transformer when the load p.f is lagging. (Take secondary terminal voltage V_2 as vertical reference) **(04 Marks)**

c. What happens when the primary of a power transformer is connected to DC supply of the same voltage rating? **(04 Marks)**

d. A single phase transformer has percentage regulation of 4 and 4.4 for lagging power factors of 0.8 and 0.6 respectively. The F.L copper loss is equal to iron loss. Calculate i) the lagging P.f at which F.L regulation is maximum ii) The F.L efficiency at unity P.f. **(06 Marks)**

2 a. Draw the approximate equivalent circuit of a transformer referred to the primary side and indicate how it differs from the exact equivalent circuit. **(05 Marks)**

b. What are the different losses occurring in a transformer on load? How can these losses be determined experimentally? **(07 Marks)**

c. A '$\Delta - \Delta$' bank consisting of three single phase 20 KVA, 2300 / 230V transformers supplies a load of 40 KVA. If one transformer is removed, find for the resulting V-V connection .

i) KVA load carried by each transformer

ii) Total KVA rating of the V-V bank.

iii) Ratio of the V-V bank to '$\Delta - \Delta$' bank transformer ratings. **(08 Marks)**

3 a. Explain with necessary diagrams how two. 3 – phase transformers can be used to convert a 3 phase supply to a 2 phase one. If the load is balanced on one side, show that it will be balanced on the other side. **(10 Marks)**

b. Two – 100 kw transformers each has a maximum efficiency of 98% but in one the maximum efficiency occurs at F.L while in the other it occurs at half load. Each transformer is on F.L. for 4 hrs, on half load for 6 hrs and one-tenth load for 14 hrs per day. Determine the all day efficiency of each transformer. **(10 Marks)**

4 a. Discuss the necessary conditions for the parallel operation of 2 transformers. **(05 Marks)**

b. Consider a 4 KVA, 200 / 400 V single phase transformer supplying full – load current at 0.8 lagging p.f. The OC / SC test results are as follows .

OC test : 200 V , 0.8 A, 70 w

SC test : 20 V , 10 A, 60 w (HV side)

Calculate i) efficiency and secondary voltage.

ii) the load at u.p.f corresponding to maximum efficiency. **(08 Marks)**

c. Two 2200 / 110 V transformers are operated in parallel to share a load of 120 KVA at 0.8 p.f lagging. Transformers are rated as below.

A : 100 KVA : 0.8 % Resistance and 10 % Reactance.

B : 60 KVA : 1 % Resistance and 5 % Reactance.

Find load carried by each transformer. **(07 Marks)**

Contd...2

5 a. Explain with the help of neat sketches the differences between the 3 phase slip ring induction motor and the 3-phase squirrel cage I.M. **(06 Marks)**

b. Derive the expression for developed torque in a 3 phase I.M and find the condition for maximum torque. **(06 Marks)**

c. Calculate the torque exerted by an 8 pole 50 Hz, 3 phase I.M operating with a 4 percent slip which develops a maximum torque of 150 kgm at a speed of 660 rpm. The resistance per phase of the rotor is 0.5 Ω . **(08 Marks)**

6 a. Draw and explain the phasor diagram and equivalent circuit of a 3 phase I.M. **(08 Marks)**

b. A 20 hp, 400 V, 50 Hz. 3 phase star connected I.M. has the following test data.
No – load test : 400 V, 9A, Cos ϕ = 0.2.
Blocked rotor : 200 V, 50 A, Cos ϕ = 0.4.
Draw a circle diagram and determine i) line current ii) P.f. iii) Slip and iv) efficiency at F.L. **(12 Marks)**

7 a. Why starter is necessary to start an I.M? Explain in detail auto-transformer method of starting a cage I.M. **(10 Marks)**

b. An 18650w, 4 pole, 50 Hz, 3 phase I.M. has friction and windage losses of 2.5 percent of the output. The F.L slip is 4 %. Compute for F.L i) the rotor copper loss
ii) the rotor input iii) the shaft torque. **(10 Marks)**

8 Explain any Four of the following :

a. Double revolving field theory of 1 phase I.M.
b. Induction generator.
c. Welding Transformers.
d. Methods of cooling in Transformer.
e. Auto transformer. **(20 Marks)**

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NEW SCHEME

Sixth Semester B.E. Degree Examination, Dec. 06 / Jan. 07
Electrical and Electronics Engineering
Transformer and Induction Machine

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

Note : ***1. Answer any FIVE full questions.***

1 a. Develop an equivalent circuit of a single phase transformer and show that the parameters of the primary and secondary winding may be combined to give a simplified equivalent circuit referred to primary side. **(10 Marks)**

b. In a 25 kVA; 2000/200 V transformer the iron and copper losses are 350 and 400 W respectively. Calculate the efficiency on u.p.f at i) F.L ii) ½ load iii) determine the load for maximum efficiency and the iron and copper losses in this case. **(10 Marks)**

2 a. Describe in detail Sumpner's test for determining the efficiency of a transformer. What are the limitations of this test? **(10 Marks)**

b. Two transformers A and B are connected in parallel to a load of $(2 + j\ 1.5)\ \Omega$. Their impedances in secondary terms are $Z_A = (0.15 + j\ 0.5)\ \Omega$ and $Z_B = (0.1 + j\ 0.6)\ \Omega$. Their no load terminal voltages are $E_A = 207\ \angle 0^0$ V and $E_B = 205\ \angle 0^0$ V. Find the power output and power factor of each transformer. **(10 Marks)**

3 a. Derive an expression for saving of copper when an auto transformer is used and hence discuss its applications. **(10 Marks)**

b. The primary and secondary voltages of an auto transformer are 230 V and 75 V respectively. Calculate the currents in the different parts of the winding when load current is 200 A. Also calculate the saving of copper. **(05 Marks)**

c. A 3 phase step down transformer is connected to 6600 V mains and takes 10 A. Calculate the secondary line voltage, line current and output for the following connections :
   i) Delta/Delta
   ii) Star/Star
   iii) Delta/Star
   iv) Star/Delta. **(05 Marks)**

4 Write short notes on :
   a. Welding transformer
   b. Constant current transformer
   c. Parallel operation of 1 Ph transformer
   d. All day efficiency of a transformer. **(20 Marks)**

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5 a. Show that a rotating magnetic field can be produced by the use of 3 phase currents equal magnitude and explain how this principle of rotating field is applied to the ca of an induction motor.

b. Draw the no load and short circuit diagram for a 20 HP, 400V, 50 Hz, 3 phase st connected induction motor, from the following data (fine values)

No load test	:	400 V	9 A	$\cos\Phi = 0.2$
Short circuit test	:	200 V	50 A	$\cos\Phi = 0.4$

From the diagrams find i) the line current and P.F at F.L
ii) the maximum horse power. **(10 Mark**

6 a. State the various losses that occur in an induction motor. Explain how they vary wi frequency, voltage and load. **(07 Mark**

b. With the help of a phasor diagram, describe the performance of an induction motor a a generator. **(08 Mark**

c. The rotor of a 4 pole, 50 Hz slip ring IM has a resistance of 0.25 Ω per phase an runs at 1440 rpm at full load. Calculate the external resistance per phase which mu be added to lower the speed at 1200 rpm, the torque being the same as before. **(05 Mark**

7 a. Explain the principle of operation of a 1 Ph IM using double revolving field theor **(10 Mark**

b. A 250 W, 230 V, 50 Hz, 1 Ph capacitor start IM has the following constants for th main and auxiliary windings. Main winding $Z_m = (4.5 + j\ 3.7)\ \Omega$, auxiliary windin $Z_a = (9.5 + j3.5)\ \Omega$. Determine the value of the capacitor that will place the main an auxiliary winding currents in quadrature at staring. **(10 Mark**

8 Write short notes on

a. Explain crawling and cogging.
b. What are the limitations and applications of shaded pole IM?
c. Deep bar rotor IM.
d. Star-Delta starter for 3 Ph IM. **(20 Marks**

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NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2007
Electrical and Electronics Engineering
Transformers and Induction Machine

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

Note : *Answer any FIVE full questions.*

1 a. Explain with the help of phaser diagrams the operatrions of single phase transformer on load at i) Unity power factor ii) lagging power factor iii) Leading power factor. **(06 Marks)**

b. State and prove the condition under which a transformer operates at maximum efficiency. **(04 Marks)**

c. A 10 kVA, 500/250V, 50 Hz single phase transformer had its maximum efficiency of 94%, when delivering 90% of its rated output at unity power factor. Estimate full load copper losses and iron losses of transformer, also find efficiency when delivering its full load output at 0.8 pf lag. **(10 Marks)**

2 a. Explain the tests to be carried on a single phase transformer and develop the equivalent circuit and show how the parameters of the primary and secondary winding may be combined to give a simplified equivalent circuit referred to primary side. **(10 Marks)**

b. Obtain the equivalent circuit of a 200/400 V, 50Hz 1 phase transformer from the test data.

O.C. Test :	200V, 0.7A, 70W	LV side readings
S.C. Test :	15v, 10A, 85W	HV side readings

Calculate the secondary voltage when delivering 5 kW load at 0.8 pf lagging, the primary voltage being 200V. **(10 Marks)**

3 a. Define "All day efficiency" of a transformer. Explain its importance in distribution transformers. How does it differ from commercial or ordinary efficiency? **(05 Marks)**

b. Write a brief note on different methods of cooling of transformers. **(05 Marks)**

c. There are two 100 kW transformers. Each has a maximum efficiency of 98% but in one of the transformer maximum efficiency occurs at full load while, in the other it occurs at half load. Each transformer is on full load for 4 hours, on half load for 6 hours and one tenth load for 14 hours per day. Determine the "All day efficiency" of each transformer. **(10 Marks)**

4 a. Derive an expression for the copper savings in a autotransformer as compared with two winding transformer. **(04 Marks)**

b. Explain with the help of connection diagram and phasors, how a 2 phase supply can be obtained from a 3 phase supply. **(08 Marks)**

Contd... 2

c. Two electric furnaces are supplied with 1 phase current at 80V from a 3 phase, 11000 V system by means of two single phase SCOTT connected transformers with similar secondary windings, when the load on one furnace is 500 kW and on the other 800 kW, what current will flow in each of the 3 lines i) at Upf and ii) 0.8 pf (lag). **(08 Marks)**

5 a. Explain with suitable sketches the construction of squirrel cage and slipring induction motor. State the merits and demerits of each type. **(08 Marks)**

b. Prove that rotor copper losses are proportional to slip for constant rotor input. **(04 Marks)**

c. The useful full load torque of 3 phase, 6 pole, 50Hz induction motor is 162.84 Nm. The rotor is observed to make 90 cycles per minute. Calculate i) Motor O/P ii) Cu losses in rotor iii) motor i/p iv) efficiency, if mechanical torque lost in windage and friction is 20.36 Nm and stator losses are 830 W. **(08 Marks)**

6 a. Discuss the procedure for no-load test and blocked rotor test on a 3 phase induction motor. How are the parameters of equivalent circuit are determined from test results? **(10 Marks)**

b. A 415V, 29.84 kW, 50Hz, delta connected motor gave the following test data.
No – load test : 415V, 21A, 1250W
Blocked rotor test : 100V, 45A, 2730W.
Construct the circle diagram and determine i) Line current and power factor for rated output ii) the maximum torque. Assume stator and Rotor copper losses are equal at stand still. **(10 Marks)**

7 a. Describe the constructional features of a double cage inductor motor and explain its operation. Draw the equivalent circuit of motor and speed torque characteristics. **(10 Marks)**

b. Explain why single phase induction motor is not self starting. Describe any one method of starting of a single phase induction motor. **(05 Marks)**

c. A 250 watts, 230 volts, 50Hz, capacitor start motor has the following constants for the main winding $Z_m = (4.5 + j\ 3.7)$ ohm and auxiliary winding $Z_a = (9.5 + j\ 3.5)$ ohm. Determine the values of starting capacitor to achieve a phase difference of 90^0 between the currents of two winding at starting. **(05 Marks)**

8 a. State the different methods of speed control of 3 phase induction motor and discuss in detail any two methods. **(10 Marks)**

b. Write short notes on :
i) Voltage build up in an induction generator.
ii) Parallel operation of single phase transformers. **(10 Marks)**

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Sixth Semester B.E. Degree Examination, Dec. 07 / Jan. 08
Transformer and Induction Machine

hrs. Max. Marks:100

Note : ***Answer any FIVE full questions.***

Derive an EMF equation for a single phase transformer. Draw and explain vector diagram of transformer loaded with resistive, inductive and capacitive loads separately. **(10 Marks)**

Derive an equation for the output current corresponding to maximum efficiency of the transformer. **(04 Marks)**

A 50 KVA 4400/200V transformer has $R_1 = 3.45\Omega$, $R_2 = 0.009\Omega$, $X_1 = 5.2\Omega$, $X_2 = 0.015\Omega$ calculate the :

i) Equivalent impedance referred to Primary.
ii) Equivalent impedance referred to Secondary.
iii) Total copper loss. **(06 Marks)**

Explain in details OC and SC test (with circuit diagram) for determination of efficiency and regulation of single phase transformer. **(10 Marks)**

The following readings are obtained for a 6 KVA 240/400V 50Hz single phase transformer

O.C. Test : Primary Voltage - 240V,
Primary Current – 0. 8A,
Power consumed - 80W.

S.C. Test on HV side
Voltage - 20V, Current - 15A, Power drawn – 80W.

Find the full load efficiency at 0.8 power factor and unity power factor and also calculate the regulation at 0.8 pf lagging and leading loads. Give your observation on the results. **(10 Marks)**

What are different types of transformers? Explain their applications. **(10 Marks)**

Prove that an autotransformer will result in saving of copper in place of 2 winding transformer. **(06 Marks)**

Discuss the uses and disadvantages of autotransformer. **(04 Marks)**

Explain with diagram the method of conversion of 3 phase supply to 2 phase. Show that load is balanced on both sides. **(10 Marks)**

What is All day efficiency?

Find the All day efficiency of distribution transformer having maximum efficiency of 98% at 15 KVA at u pf of and loaded as follows:

12Hours – 2 kW at 0.5 pf lag.
6 Hours – 12 kW at 0.8 pf lag.
6 Hours – No load. **(10 Marks)**

What are different types of induction Motors? Explain their uses. **(10 Marks)**

A 400V, 3phase 50 Hz, star connected induction motor has a stator impedance of $(0.06+j0.2)\Omega$ and an equivalent rotor impedance of $(0.06+j0.022)\Omega$. Find the maximum gross power and the slip at which it occurs (neglect exciting current). **(06 Marks)**

Why starter is required for starting an induction motor. **(04 Marks)**

6 a. Explain the steps in detail for construction of circle diagram of a 3 phase induction motor from the data obtained from OC and SC test. **(10 Marks)**

b. Draw the circle diagram from no-load and short circuit test of a three phase 14.92 kW, 400V, 6 pole induction motor from the following test results with line values.
No-load – 400V, 10A, 0.2 pf.
S.C – 100V, 25A, 0.4 pf.
Rotor copper loss at stand still is half of total copper loss. From the diagram, find
i) Line current, slip, efficiency and power factor at full load. ii) The maximum Torque. **(10 Marks)**

7 a. Explain the principle of operation of single phase induction motor using double revolving field theory. **(10 Marks)**

b. Explain different types of starting methods for squirrel cage and phase wound induction motor. **(10 Marks)**

8 Write short notes on any four :

a. Induction Generator.
b. Welding Transformer.
c. Dot Convention.
d. Methods of Cooling in Transformer.
e. Losses in Induction Motor. **(20 Marks)**

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EE64

Sixth Semester B.E. Degree Examination, June/July 08
Transformer and Induction Machine

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. Draw the sketch of core type and shell type transformer. Draw 1 - ϕ as well as 3 - ϕ cores. What are the advantages of each over the other? **(08 Marks)**

b. What are the applications of transformer? **(04 Marks)**

c. The emf per turn of a 2200/220V, 50 Hz transformer is 12 V. Calculate i) The number of primary and secondary turns ii) The net cross – sectional area of core for a maximum flux density of 1.5T. **(08 Marks)**

2 a. What are the characteristics assumed for an ideal transformer? Draw the phasor diagram of an ideal transformer having load with leading power factor. **(06 Marks)**

b. What are the losses in a transformer? How each loss can be minimised? **(06 Marks)**

c. A 2300/230V, 500 KVA, 60 Hz distribution transformer has 1.8 kW of core loss and 8.2 kW of copper loss at rated load. The transformer is loaded in 24 hours as below.

No load				2 hours
20% of full load	at	0.7 p.f.	for	4 hours
40% of full load	at	0.8 p.f.	for	4 hours
80% of full load	at	0.9 p.f.	for	6 hours
Rated load	at	Unity p.f.	for	6 hours
125% full load	at	0.85 p.f.	for	2 hours

Assuming constant input voltage calculate all – day efficiency. **(08 Marks)**

3 a. What are the conditions to operate two transformers in parallel? **(06 Marks)**

b. Define voltage regulation of the transformer. Derive the equation of the same in terms of transformer parameters and load p.f. **(06 Marks)**

c. A 50 KVA, 2200/110V transformer when tested gave the following results:
OC test, with HV open : 400 W, 10 A, 110V
SC test, with LV short : 808W, 20.5A, 90V.
Compute all the parameters and draw the equivalent circuit as referred to HV side. **(08 Marks)**

4 a. Draw and discuss the connection diagrams of Y–Y, Δ - Δ and Y - Δ three phase transformers. **(06 Marks)**

b. Draw the circuit diagram and explain 3- phase to 2- phase conversion. **(06 Marks)**

c. An ideal 3- phase transformer connected delta/star delivers power to a balanced 3- phase load of 120 kVA at 0.8 p.f. The input line voltage is 11 kV and the phase – to – phase turns ratio $\frac{N_1}{N_2}$ is 10. Determine the line and phase voltages, line and phase currents on both the primary and the secondary sides. **(08 Marks)**

5 a. Explain the production of rotating magnetic field in the induction motor air gap. **(06 Marks)**

b. Explain the two types of induction motors based on rotor construction. What are their applications? **(06 Marks)**

c. A three phase induction motor stator has 6 poles. If the line frequency is 60 Hz calculate the rotor frequency at the instant of starting and at the full speed of 1140 rpm. **(08 Marks)**

6 a. Draw complete torque – slip characteristics of an induction machine: show starting torque, breakdown torque and rated torque. Mark the stable and unstable regions. **(06 Marks)**

b. Draw approximate circle diagram of an induction motor and mark all the important features. **(06 Marks)**

c. A 400 V, 6 pole, three phase, 50 Hz star connected induction motor gives following results:
BR test: 150V, 35 A, 4000 W; stator resistance, $R_1 = 0.55\Omega$/phase. When the motor is operating at a slip of 4% calculate gross mechanical power and torque. **(08 Marks)**

7 a. What is the need of starter for a three phase induction motor? List different types of starters. **(06 Marks)**

b. Draw the torque speed curves of an induction motor when its speed is controlled by
i) Voltage control
ii) rotor resistance control
iii) Voltage frequency (V/f) control.

c. A squirrel cage induction motor has a full load slip of 0.05. The motor starting current at rated voltage is six times its full load. Find the tapping on the auto – transformer starter, which should give full load torque at start. Also find the line current at starting. **(08 Marks)**

8 Briefly explain the following:

a. Cogging and crawling **(06 Marks)**

b. Induction generator **(06 Marks)**

c. Types of single phase induction motors and their applications **(08 Marks)**

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