Name: ID. No.:

BITS, PILANI – DUBAI

International Academic City, Dubai

B.E. (Hons.) EIE

Year III – Semester I 2007 – 2008

SURPRISE QUIZ III

Course: INSTR UC371 [Electromechanical Energy Conversion]

Date: November 26, 2007 Time: 10 Minutes M.M. = 10 (2.5 %)

NOTE: Choose the most appropriate one. **[10 × 1 = 10]**

i. **Lap winding is suitable for ..... current, ... voltage DC generators.**
   (i) High, low
   (ii) Low, high
   (iii) Low, low
   (iv) High, high

ii. **The sole purpose of a commutator in a DC generator is to**
   (i) Increase output voltage
   (ii) Reduce sparking at brushes
   (iii) Provide smoother output
   (iv) Convert the induced AC into DC

iii. **During the generating mode of a DC machine:**
   (i) I_a is in the direction of E_a and T (torque of electromagnetic origin) is opposite to the direction of rotation of armature.
   (ii) I_a flows in opposition to E_a and T (torque of electromagnetic origin) is opposite to the direction of rotation of armature.
   (iii) I_a is in the direction of E_a and T (torque of electromagnetic origin) is also in the direction of rotation of armature.
   (iv) I_a flows in opposition to E_a and T (torque of electromagnetic origin) is in the direction of rotation of armature.

iv. **In the circle diagram for induction motor, the diameter of the circle represents**
   (i) Slip
   (ii) Rotor current
   (iii) Running torque
   (iv) Line voltage

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SURPRISE QUIZ

Course: INSTR UC371 [Electromechanical Energy Conversion]

Date: 29 October 2007 Time: 10 Minutes M.M. = 10 (2.5 %)

NOTE: Choose the most appropriate one. [10 × 1 = 10]

i. A 4-pole, 12-slot lap-wound DC armature has two coil-sides/slot. Assuming single turn coils and progressive winding, the back pitch would be

(i) 5
(ii) 7
(iii) 3
(iv) 6

ii. Which loss is not common between transformer and rotating machine?

(i) Copper loss
(ii) Eddy current loss
(iii) Windage loss
(iv) Hysteresis loss

iii. The saving in Cu achieved by converting a 2-winding transformer into an autotransformer is determined by

(i) Voltage transformation ratio
(ii) Load on the secondary
(iii) Magnetic quality of core material
(iv) Size of the transformer core.

ix. A 200 kVA transformer has an iron loss of 1kW and full-load Cu loss of 2kW. Its load kVA corresponding to maximum efficiency is …… kVA.

(i) 100
(ii) 141.4
(iii) 50
(iv) 200

x. A transformer has negative voltage regulation when its load power factor is

(i) Zero
(ii) Unity
(iii) Leading
(iv) Lagging

BONUS QUESTION: (05)

A Scott-connected transformer set supplies two single-phase furnaces A and B each at 120 V from a 3-phase 6600 V system. If the furnace connected to teaser transformer takes 300 kW at unity power factor and the other one connected to main transformer takes 495 kW at 0.8 power factor lagging, determine the line currents taken from the 3-phase mains. Neglect losses.

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Year III - Semester I 2007 - 2008

SURPRISE QUIZ

Course: INSTR UC371 [Electromechanical Energy Conversion]

Date: 17 October 2007 Time: 10 Minutes M.M. = 10 (2.5 %)

NOTE: Choose the most appropriate one. [10 × 1 = 10]

i. **A shell-type transformer has**
   (i) High eddy current losses
   (ii) Reduced magnetic leakage
   (iii) Negligible hysteresis losses
   (iv) None of the above

ii. **The no-load current drawn by transformer is usually what percent of the full-load current?**
   (i) 0.2 to 0.5 per cent
   (ii) 2 to 5 per cent
   (iii) 12 to 15 per cent
   (iv) 20 to 30 per cent

iii. **The purpose of providing an iron core in a transformer is to**
   (i) Provide support to windings
   (ii) Reduce hysteresis loss
   (iii) Decrease the reluctance of the magnetic path
   (iv) Reduce eddy current losses

iv. **An air-core transformer, as compared to iron-core transformer, has**
   (i) Less magnetic core loss
   (ii) More magnetic core loss
   (iii) No magnetic core loss
   (iv) less ohmic loss

BONUS QUESTION: (05)

A 100-VA 120/12-V transformer is to be connected so as to form a step-up autotransformer (Figure 2). A primary voltage of 120 V is applied to the transformer.

i. What is the secondary voltage of the transformer?

ii. What is its maximum voltampere rating in this mode of operation?

iii. Calculate the rating advantage of this autotransformer connection over the transformer's rating in conventional 120/12-V operation.

BITS, PILANI - DUBAI

International Academic City, Dubai

III Year (EIE) 2007 - 2008, Semester - I
COMPREHENSIVE EXAMINATION (Closed Book)

Course Title: Electromechanical Energy Conversion (INSTR UC371)

Date: December 27, 2007 **Time:** 3 Hours **M.M. = 60 (30 %)**

NOTE:
(i) Answer all questions. Assume missing data, if any and make a note about it.
(ii) Graph sheets are not provided. Graphs to be drawn on the answer sheets only.
(iii) Answer all parts of a question in continuation.
(iv) Do not leave any blank page(s) in between the answers.

QUESTION 1 CHOOSE THE MOST APPROPRIATE ONE. **(10 × 1 = 10)**

i. **Sumpner's test on two identical transformers yields information about**
(i) Core loss only
(ii) Full-load copper loss only
(iii) Both core loss and full-load copper loss
(iv) It yields no information on losses.

ii. **A 2 kVA transformer has iron loss of 150 W and full load copper loss of 250 W. The maximum efficiency of the transformer would occur when the total loss is**
(i) 500 W
(ii) 400 W
(iii) 300 W
(iv) 275 W

iii. **What is the arrangement of windings in a core type single phase transformer?**
(i) Half LV inside and half HV outside on each core limb.
(ii) LV on one core limb and HV on the other
(iii) Sandwiched LV and HV discs on each core limb
(iv) Half HV inside and half LV outside on each core limb.

iv. **Equalizer rings are required in a lap wound DC machine**
(i) To improve commutation
(ii) To filter out harmonics
(iii) To prevent the flow of circulating currents through brushes
(iv) To reduce armature reaction

v. **Synchronous reactance is**
(i) The difference of armature leakage reactance and reactance equivalent of armature reaction.
(ii) The same as armature leakage reactance.
(iii) The reactance equivalent of armature reaction.
(iv) The sum of armature leakage reactance and reactance equivalent of armature reaction.

vi. **Inter-poles help commutation in a DC machine by**
- (i) Canceling the armature reaction mmf
- (ii) Aiding the main poles
- (iii) By causing statically induced emf in the coils undergoing commutation
- (iv) By causing dynamically induced emf in the coils undergoing commutation

vii. **A single-phase stator winding when excited with AC voltage produces**
- (i) A single rotating field rotating at synchronous speed.
- (ii) Two rotating fields rotating at synchronous speed in opposite directions.
- (iii) Two rotating fields rotating in the same direction but at different speeds.
- (iv) Two rotating fields rotating in opposite directions but with different speeds.

viii. **Under no-load condition, power drawn by the prime mover of an alternator goes to**
- (i) Produce induced emf in armature winding
- (ii) Meeting no-load losses
- (iii) Produce power in the armature
- (iv) Meet Cu losses both in armature and rotor windings

ix. **For a synchronous machine on infinite bus active power can be varied by**
- (i) Changing field excitation
- (ii) Changing of prime mover speed
- (iii) Both (i) and (ii) above
- (iv) None of the above

x. **If main field current of a salient-pole synchronous motor fed from an infinite bus and running at no-load is reduced to zero, it would**
- (i) Come to a stop
- (ii) Continue running at synchronous speed
- (iii) Run at sub-synchronous speed
- (iv) Run at super-synchronous speed

Question2 **(5 + 5 = 10)**

(a) Two 110 V, single-phase furnaces take loads of 500 kW (connected to teaser transformer) and 800 kW (connected to main transformer) respectively at a power factor of 0.71 lagging and are supplied from 6600 V, 3-phase mains through a Scott-connected transformer combination. Calculate the currents in the 3-phase line, neglecting transformer losses. Draw the phasor diagram.

(b) A 20 kVA, 2000/200 V, single-phase transformer has the following parameters:

HV winding	$r_1 = 3 \quad \Omega$	$x_1 = 5.3 \quad \Omega$
LV winding	$r_2 = 0.05 \quad \Omega$	$x_2 = 0.05 \quad \Omega$

Find the voltage regulation at (i) 0.8 pf lagging, (ii) unity pf, and (iii) 0.707 pf leading

Also calculate the secondary terminal voltage when delivering full-load current at these power factors with the primary voltage held fixed at 2 kV.

Question3 **(5 + 5 = 10)**

(a) Draw the circuit diagram for conducting Hopkinson's Test performed on DC machines and obtain the expression for efficiencies of the two machines.

(b) The Hopkinson's test on two DC machines gave the following results for full-load: Line voltage 250 V; line current, excluding field current, 50 A; motor armature current 38 A; field currents 5 A and 4.2 A. Calculate the efficiency of each machine. Armature resistance of each machine = 0.02 Ω.

Question4 **(5 + 5 = 10)**

(a) What do you infer by 'Power Across Air-gap' in case of an Induction Motor? Obtain the expressions for (i) Electromagnetic Torque Developed, and (ii) Mechanical Power Output, of an Induction Motor in terms of 'Power Across Air-gap'.

(b) A 400 V, 3-phase, 50 Hz, 4-pole, star-connected induction-motor takes a line current of 10 A with 0.86 pf lagging. Its total stator losses are 5 % of the input. Rotor copper losses are 4% of the input to the rotor, and mechanical losses are 3% of the input of the rotor. Calculate (i) slip and rotor speed, (ii) torque developed in the rotor, and (iii) shaft-torque.

Question5 **(5 + 5 = 10)**

(a) (i) Upon what factors does the power angle of a synchronous generator depend? Explain with a phasor diagram.

(ii) Explain the meaning and significance of SCR (Short Circuit Ratio), in the context of a synchronous machine.

(b) The open and short circuit tests data on a 3-phase, 1 MVA, 3.6 kV, star connected synchronous generator is given below:

I_f (A)	60	70	80	90	100	110
V_{oc} (line) (V)	2560	3000	3360	3600	3800	3960
I_{sc} (A)	180					

Find

(i) The unsaturated synchronous reactance.

(ii) The adjusted synchronous reactance.

(iii) The short circuit ratio

Question6 (10)

A 220 V, 50 Hz, 4-pole, single-phase induction motor has the following circuit model parameters:

$r_{1m} = 3.6 \quad \Omega$ $\qquad$ $(x_{1m} + x_2) = 15.6 \quad \Omega$

$r_2 = 6.8 \quad \Omega$ $\qquad$ $x = 96 \quad \Omega$

The rotational losses of the motor are estimated to be 75 W. At a motor speed of 940 rpm, determine the line current, the power factor, the shaft power, and the efficiency.

BITS, PILANI - DUBAI
International Academic City, Dubai

III Year (EIE) 2007 - 2008, Semester - I
TEST - II (Open Book)

Course Title: Electromechanical Energy Conversion (INSTR UC371)

Date: November 18, 2007 Time: 50 Minutes M.M. = 25 (≈12.5 %)

NOTE:
(i) Answer all the questions.
(ii) Graph sheets are not provided. Graphs to be drawn on the answer sheets only.
(iii) Answer all parts of a question in continuation.
(iv) Do not leave any blank page(s) in between the answers.
(v) Use of text book & handwritten class notes (not in Xeroxed form) is permitted to answer this question paper.

Question1 **(6)**

Two transformers A and B are connected in parallel to a load of (2 + j1.5) ohms. Their impedances in secondary terms are $Z_A = (0.15 + j0.5)\ \Omega$ and $Z_B = (0.1 + j0.6)\ \Omega$. Their no-load terminal voltages are $E_A = 207\ \angle 0^0\ volt$ and $E_B = 205\ \angle 0^0\ volt$. Find the power output and power factor of each transformer.

Question2 **(6)**

Draw the lap-winding diagram in the developed form for a 4-pole, 24-slot armature with one coil-side/slot. Assume single-turn coils and progressive winding. Indicate the number and position of brushes on the commutator. What is the number of parallel paths?

Question3

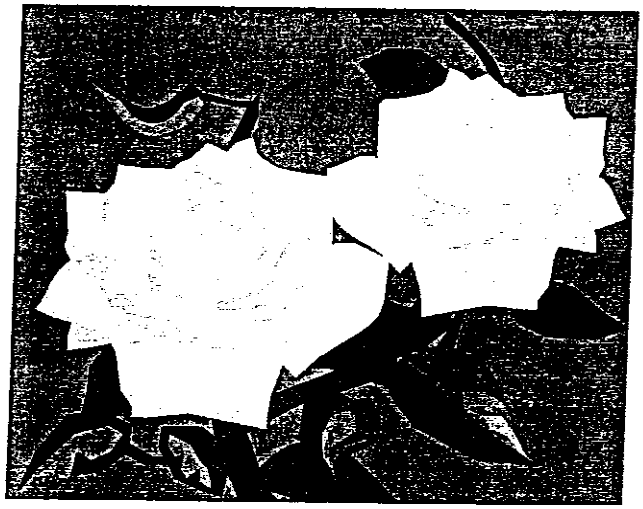
(6)

A 20 kW, 500 V shunt motor has an efficiency of 90% at full load. The armature copper loss is 40% of the full-load loss. The field resistance is 250 Ω. Calculate the resistance values of a 4-section starter suitable for this motor, if starting current $\leq 2I_{fl}$.

Question4

(7)

A 480 V, 20 kW shunt motor took 2.5 A when running light. For an armature resistance to be 0.6 Ω, field resistance of 800 Ω and brush drop of 2 V, find the full-load efficiency.



BITS, PILANI – DUBAI
International Academic City, Dubai

III Year (EIE) 2007 – 2008, Semester – I
TEST – I (Closed Book)

Course Title: Electromechanical Energy Conversional (INSTR UC371)

Date: September 30, 2007 **Time:** 50 Minutes **M.M.** = 25 (≈12.5 %)

NOTE: (i) Answer all the questions.
(ii) All questions to be answered in the answer sheet only.
(iii) Answer all the parts of a question in continuation.
(iv) Do not leave any blank page(s) in between the answers.

Question1 **(10)**

A 10 kVA, 2500/250 V, single phase transformer gave the following test results

Open-Circuit Test (on low-voltage side) : 250 V, 0.8 A, 50 W

Short-Circuit Test (on high-voltage side) : 60 V, 3 A, 45 W

(i) Calculate the efficiency of half of full-load at 0.8 p.f.

(ii) Calculate the load kVA at which maximum efficiency occurs and also the maximum efficiency at 0.8 p.f.

(iii) Compute the voltage regulation at 0.8 p.f. leading.

Question2 **(10)**

A 15-kVA, 2000-V/200-V, transformer has an iron loss of 250 W and full-load copper loss of 350 W. During one day (24 hours) the transformer has the following load cycle: 9 h on $\frac{1}{4}$ full-load at 0.6 power factor, 7 h on full-load at 0.8 power factor; 6 h on $\frac{3}{4}$ full-load at unity power factor; and 2 h on no-load. Find the all-day efficiency of the transformer.

Question3

(5)

How, one can determine the steady temperature rise in a single-phase transformer (as if the transformer was fully loaded continuously) without actually loading it. Draw a circuit diagram to conduct this test and explain its principle.