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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013**

COURSE NAME : ELECTRICAL MACHINES AND DRIVES
COURSE CODE : DAE 32303
PROGRAMME : 3 DAE
EXAMINATION DATE : MARCH 2013
DURATION : 2 1/2 HOURS
INSTRUCTION : ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

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Q1 (a) Draw and label completely the equivalent circuit of self excitation machine:

- (i) DC series machine.
- (ii) DC shunt machine.

(6 marks)

(b) A compound DC motor rated at 240 V, 50 Hz, 1800 rpm has armature resistance, 0.2Ω , series field resistance, 0.6Ω and shunt field resistance, 120Ω . The rotational losses are 150 W. The full load line current is 40 A.

- (i) Draw the complete equivalent circuit,
- (ii) Find the back emf, E_c
- (iii) Find the developed mechanical power, P_{mech}
- (iv) Find the output power, P_{out}
- (v) Find the output torque, τ_{out}
- (vi) Find the efficiency of the motor, η
- (vii) Draw the power flow diagram for this type of motor

(19 marks)

Q2 A 1000 VA 120/240 V transformer has been tested to determine its equivalent circuit. The results of the tests are shown below.

Open circuit test

$V_{oc} = 240 \text{ V}$

$I_{oc} = 0.5 \text{ A}$

$P_{oc} = 40 \text{ W}$

Short circuit test

$V_{sc} = 15 \text{ V}$

$I_{sc} = 6.0 \text{ A}$

$P_{sc} = 25 \text{ W}$

- (i) Find the equivalent circuit of the transformer referred to the high voltage side and low voltage side of the transformer.
- (ii) Find the efficiency of the transformer at 115 V of 0.85 lagging power factor.

(25 marks)

- Q3 (a)** Induction motor is a common type of AC machine. Identify three (3) weaknesses of the machines.

(6 marks)

- (b)** A three-phase, 415 V, Y-connected, 50 Hz, 4 poles, induction motor having 1440 rpm full load speed. The machine has the following impedances in ohms per phase referred to the stator circuit:

$$\begin{array}{ll} R_1 = 0.4 \, \Omega & X_1 = 4.0 \, \Omega \\ R_2 = 1.0 \, \Omega & X_2 = 6.0 \, \Omega \\ X_m = 80.0 \, \Omega & \end{array}$$

If the total friction and windage losses are 200 W,

- (i) Draw the equivalent circuit with all the parameters value.
- (ii) Find the input power, P_{in}
- (iii) Find the air gap power, P_{ag}
- (iv) Find the mechanical power, P_{mech}
- (v) Find the torque induced by the motor, τ_{ind}
- (vi) Find the efficiency of the motor, η

(19 marks)

- Q4 (a)** Sketch the phasor diagram of the synchronous motor with various type of power factor.

- (i) leading power factor.
- (ii) lagging power factor.

(6 marks)

- (b)** A three-phase, 415 V, 50 Hz, 4 poles, star-connected synchronous generator has synchronous inductance, $L = 1.28 \text{ mH /phase}$ and armature resistance is $0.01 \, \Omega/\text{phase}$. At full load condition, the machine supplies 1000 A at 0.85 lagging power factor. The friction and windage losses are 20 kW and the core losses are 10 kW. Calculate:

- (i) The speed rotation of the magnetic field in rpm.
- (ii) The internal generated voltage at no load condition.
- (iii) The voltage regulation if the generator is connected to full load current at 0.85 power factor lagging.
- (iv) The efficiency of the generator, η and draw the phasor diagram.

(19 marks)

- Q5** (a) Draw and label completely the basic circuit of capacitor start-induction run motor.
(5 marks)
- (b) (i) State the maximum speed of an electric motor.
(ii) Give a reason for your answer in Q5 (b)(i).
(5 marks)
- (c) An induction motor runs at 2880 rpm when connected to the 240 V, 50 Hz main supply. Determine:-
(i) synchronous speed, N_s
(ii) number of poles, p
(iii) percentage of slip, %S
(5 marks)
- (d) Give three (3) comparisons between capacitor start-induction run motor and shaded-pole motor.
(5 marks)
- (e) Give five (5) examples of applications of capacitor start-induction run motor in commercial or industrial sectors.
(3 marks)
- (f) State the relationship between output power, efficiency and losses of an induction motor.
(2 marks)
- Q6** (a) State the function of power electronic circuit.
(2 marks)
- (b) Draw and label completely the block diagram of power electronic system.
(5 marks)
- (c) State the function of the following:-
(i) DC / DC converters (chopper)
(ii) AC / DC converters (rectifier)
(iii) AC / AC converters (AC voltage controller)

(iv) DC / AC converters (inverter)

(8 marks)

(d) Briefly describe the speed control for induction motor using supply frequency control method.

(5 marks)

(e) Briefly explain an armature resistance control method for the DC motor speed control

(5 marks)

- END OF QUESTION -