



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2009/2010**

**SUBJECT NAME** : ELECTRICAL MACHINES AND DRIVE  
**SUBJECT CODE** : DEK 3143  
**COURSE** : 3 DEE/DET/DEX  
**DATE** : NOV 2009  
**DURATION** : 2 1/2 HOURS  
**INSTRUCTION** : ANSWER ANY FOUR (4) QUESTION  
OUT OF FIVE (5) QUESTION

THE QUESTION PAPER CONSIST OF FOUR (4) PAGES

- Q1** (a) Briefly explain short-circuit tests to measure parameters of the transformer. (5 marks)

- (b) 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 of the transformer  
 (ii) Find the efficiency of the transformer at 115 V of 0.85 lagging power factor

(20 marks)

- Q2** (a) A compound DC motor rated at 240 V, 50 Hz, 1800 rpm has armature resistance,  $0.2 \Omega$ , series field resistance,  $0.6 \Omega$  and shunt field resistance,  $120 \Omega$ . The rotational losses are 150 W. The full load line current is 40 A.

- (i) Find the back emf,  $E_c$   
 (ii) Find the developed mechanical power,  $P_{mech}$   
 (iii) Find the output power,  $P_{out}$   
 (iv) Find the output torque,  $\tau_{out}$   
 (v) Find the efficiency of the motor,  $\eta$   
 (vi) Draw the power flow diagram for this type of motor

(19 marks)

- (b) List and sketch the equivalent circuit for three (3) types of self excitation in DC machine.

(6 marks)

- Q3** (a) The 8 poles, wound-rotor induction motor is excited by a 3-phase, 50 Hz source. Calculate the frequency of the rotor current under the following conditions:
- at stand still
  - motor turning at 300 rpm in the same direction as the revolving field
  - motor turning at 400 rpm in the opposite direction to the revolving field
- (6 marks)

- (b) A 3-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:

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

If the total friction and windage losses are 200 W,

- Draw the equivalent circuit with all the parameters
- Find the input power,  $P_{in}$
- Find the air gap power,  $P_{ag}$
- Find the mechanical power,  $P_{mech}$
- Find the torque induced by the motor,  $\tau_{ind}$
- Find the efficiency of the motor,  $\eta$

(19 marks)

- Q4** (a) Sketch the phasor diagram of the synchronous motor with various type of power factor.
- unity power factor
  - lagging power factor
  - leading power factor
- (6 marks)

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

- Find the speed rotation of the magnetic field in rpm
- Find the internal generated voltage at no load condition
- Determine the voltage regulation if the generator is connected to full load current at 0.85 power factor lagging

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- (iv) Calculate the efficiency of the generator,  $\eta$  and draw the phasor diagram

(19 marks)

- Q5** (a) Explain the operation and sketch the symbol of the following devices.

- (i) Power Diode
- (ii) Insulated Gate Bipolar Transistor, IGBT
- (iii) Silicon-Controlled Rectifier, SCR

(9 marks)

- (b) Explain the three operation modes of an induction machine as stated below:

- (i) Motoring
- (ii) Generating
- (iii) Plugging

(6 marks)

- (c) Induction motor is widely used in the industries. Give six (6) advantages of this type of motor.

(6 marks)

- (d) Autotransformer is one of the methods to start a synchronous motor. Briefly explain by showing the schematic diagram to illustrate its operation.

(4 marks)