THE OPEN UNIVERSITY OF SRI LANKA
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING
DIPLOMA IN TECHNOLOGY

# ECX4238 - ELECTRICAL MACHINES

FINAL EXAMINATION –2009/2010

**Date: 01st April 2010** **Time: 1400 - 1700 hrs**

This paper contains seven questions and answer any **five (5)**. All questions carry equal marks.

**Question 1**

(a) A power transformer name plate indicates following.

| | |
|---|---|
| kVA : 160 | |
| vector group :31DY11 | Rating-Continuous |
| Cooling :ONAN | Impedance Voltage 4.43% |
| Insulation Level :HV 75 kV | Primary : 33000V, Secondary :415V |
| Excitation current: 0.73 % | Rated current: secondary: 222.59 A, primary 2.8 A |

Explain what is meant by each of the above detail.

(b) What is meant by Core type and shell type transformers?

(c)What are the methods used to dissipate heat generated in a power transformer.

(d)Explain the duty cycle of an electrical machine

**Question 2**

a) Briefly explain loses of a DC motor

b) A 240 V shunt motor takes a current of 3.5 A on no-load. The armature circuit resistance is 0.4 Ohm and the shunt field winding resistance is 160 Ohm. When the motor operates at full load at 2400 rpm it takes 24A.

Determine

i. It's efficiency at full load
ii. Torque developed
iii. The no load speed
iv. Percent speed regulation

**Question 3**

a) With the help of suitable sketches explain briefly the speed characteristics and torque characteristics of DC motors. What types of DC motors are suitable for nearly constant speed application?

b) A DC shunt generator having a combine armature and field resistance of 0.5 Ohm is running at 1200 rpm and delivering 6 kW, at a terminal voltage of 230 volts. If the speed is raised to 1500 rpm find the new current and terminal voltage when the load is adjusted to 8 kW. Assume the magnetizing characteristic is linear within the operating range.

**Question 4**

a) Briefly explain no- load test and locked rotor test for determination of motor parameters.

b) A 400V, 50 Hz, 4 pole Y connected 3 phase Induction motor rated at 1440 rpm has stator resistance between any two terminals of 3.0 Ohm. The No load and locked rotor test yield following results:

| **No Load test:** | **Locked rotor test :** |
|---|---|
| Power input = 800 W | Power input 60 W |
| Line current =2 A | Line current 2.5 A |
| Line voltage = 400 V | Line voltage 32 V |

Friction and windage loses measured on a separate test resulted 20 W.

Assuming stator and rotor reactance are equal, find :

i. stator resistance
ii. rotor resistance
iii. Rotor copper loss resistance
iv. Magnetizing reactance
v. stator and rotor reactance

**Question 5**

a) Draw and explain equivalent circuit of an Induction Motor.

b) A 3 phase Y connected 400 V 25 hp 50 Hz 4 pole Induction Motor has following constants. Stator Resistance = 0.5 Ohm, Rotor resistance = 0.2 Ohm, Stator reactance = 0.6 Ohm, Rotor reactance = 0.3 Ohm, Magnetizing reactance = 14.75 Ohm, Friction and windage losses 265W.

At slip of 2%, and when the motor is running at rated voltage and frequency, calculate,

i. The speed
ii. Stator current
iii. Power factor
iv. Output torque
v. Output power
vi. Efficiency

**Question 6**

a. What is meant by Round Rotor and a salient pole synchronous machine and what are their uses?

b. A 12 kVA 415V, 1500 rpm 50 Hz Y connected generator has a field winding resistance of 50 Ohm. The armature winding impedance is 0.5 + j 10.0 Ohm per phase. When the generator operates at its full load and 0.8 lag, the field current is 7 A. The rotational loss is 550 W. Determine

i. Voltage regulation
ii. The efficiency of the generator
iii. Torque applied by the prime mover

**Question 7**

a. Show that the power angle,

$$Sin\delta = \frac{P_d X_s}{3E_a V_a}$$

b. A 400 V, Y connected Synchronous motor has synchronous reactance of 10 Ohm per phase. It's armature resistance may be neglected. When the motor runs at a speed of 1800 rpm it consumes 9 kW and the excitation voltage is 560 V. determine

i. power factor
ii. power angle and
iii. torque developed by the motor.