# UTHM
### Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

# FINAL EXAMINATION
## SEMESTER II
## SESSION 2014/2015

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| COURSE NAME | : | ELECTRICAL MACHINES & DRIVES |
| COURSE CODE | : | DAE 32303 |
| PROGRAMME | : | 2 DAE |
| EXAMINATION DATE | : | JUNE 2015 / JULY 2015 |
| DURATION | : | 2 ½  HOURS |
| INSTRUCTION | : | ANSWER **FOUR (4)** QUESTIONS ONLY |

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

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**Q1**   a)   With the aid of an appropriate diagram, briefly describe the generation of Direct Current ( DC ) Signal in DC machines.

( 3 marks )

b)   Name **three ( 3 )** types of DC motors and draw their schematic diagrams.

( 3 marks )

c)   A compound DC motor rated at 440 V, 10 HP, 2000 rpm has armature resistance 0.21 $\Omega$, series field resistance 0.5 $\Omega$ and shunt field resistance 150 $\Omega$. The rotational losses are 220 W. The full load line current is 45 A.

(i)   Compute the developed mechanical power.

( 5 marks )

(ii)   Indicate the output power.

( 2 marks )

(iii)   Identify the load torque.

( 2 marks )

(iv)   Find the efficiency of the motor.

( 4 marks )

d)   A DC series generator delivers 150 kW at 11 kV to a load. The armature resistance is 25 $\Omega$ and the field resistance is 60 $\Omega$.

(i)   Calculate the generated emf, $E_g$

( 3 marks )

(ii)   Identify the input power if the stray and friction losses are 350 W.

( 3 marks )

**Q2**   The purpose of open circuit test and short circuit test is to determine the shunt and series branch parameter of a practical transformer.

(a)   Briefly explain with the aid of an appropriate circuit configuration, the open circuit test procedures.

( 3 marks )

(b)   Briefly describe with the aid of an appropriate circuit configuration, the short circuit test procedures.

( 3 marks )

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(c)  Short-circuit and open-circuit tests were performed on a 150kVA transformer, 50 Hz, rated at 220V/2400V, and the results are listed as follows:

$V_{sc}$ = 44 V $\qquad\qquad$ $V_{oc}$ = 220 V
$I_{sc}$ = 43.57 A $\qquad\qquad$ $I_{oc}$ = 8 A
$P_{sc}$ = 480 W $\qquad\qquad$ $P_{oc}$ = 60 W

Construct the equivalent circuit with the necessary parameters of the transformer referred to the low voltage side.

( 14 marks )

(d)  An ideal-transformer having 100 turns on the primary and 2250 turns on the secondary is connected to a 220 V, 50 Hz source. The load across the secondary draws a current of 3 A at a power factor of 0.78 lagging.

(i)  Calculate the effective value of the primary current.

( 2 marks )

(ii)  Indicate the primary current if the secondary current is 100 mA.

( 1 marks )

(iii)  Estimate the peak flux linked by the secondary winding.

( 2 marks )

**Q3**  (a)  State **two (2)** advantages and **two (2)** disadvantages of an Induction machines.

( 4 marks )

(b)  You have been requested to analyze the data for an induction motor in order to determine its performance. The following data are given to you at 440 V , 50 Hz , 6 poles, Y connected, rated at 100 hp, the equivalent parameter for the motor are which referred to the stator are given below;

$R_s$ = 0.084 $\Omega$/phase $\qquad\qquad$ $X_s$ = 0.20 $\Omega$/phase
$R_R$ = 0.066 $\Omega$/phase $\qquad\qquad$ $X_R$ = 0.165 $\Omega$/phasee
$R_C$ = $\infty$ $\qquad\qquad$ $X_m$ = 6.9 $\Omega$/phase

Losses in the motor are identified as follows:
Windage & friction losses = 1.5 kW
Stray losses $\qquad$ = 120 W
Core losses $\qquad$ =100 W

Using approximate and actual equivalent circuit with a slip of 0.05, determine the following;

(i)    Sketch a complete equivalent circuit.

( 2 marks )

(ii)   Calculate the line current.

( 4 marks )

(iii)  Estimate the stator copper loss.

( 2 marks )

(iv)   Indicate the air gap power.

( 3 marks )

(v)    Identify the developed power.

( 3 marks )

(vi)   Solve the induced torque

( 3 marks )

(vii)  Calculate the load torque

( 2 marks )

(viii) Identify the efficiency of the motor.

( 2 marks )

Q4    (a)    A 3-phase Y-connected synchronous generator supplies a load of 15 MW at power factor 0.85 lagging and the terminal voltage is 11 kV. The armature resistance is 0.2 ohm/phase and synchronous reactance of 0.76 ohm/phase.

(i)    Calculate the armature current

( 2 marks )

(ii)   Indicate the internal generated voltage

( 2 marks )

(iii)  Estimate the voltage regulation.

( 1 marks )

(iv)   Draw the phasor diagram.

( 2 marks )

b)    A 2400 V, 60 kW, 50 Hz, 6 poles, delta-connected synchronous motor has a synchronous reactance of 4 $\Omega$/phase and armature resistance of 2 $\Omega$/phase. At full load, the efficiency is 92 %. Find the following requirements for this machine when it is operating at full load at rated power factor of 0.85 lagging.

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(i)    Sketch the phasor diagram to represent back emf,

( 2 marks )

(ii)    Calculate the supply voltage , $E_A$

( 3 marks )

(iii)    Indicate the armature current.

( 3 marks )

(iv)    Indicate the voltage regulation.

( 2 marks )

(v)    Estimate the input power

( 2 marks )

(vi)    Solve the developed mechanical power

( 4 marks )

(vii)    Sketch the power flow diagram

( 2 marks )

Q5    (a)    Briefly describe the following aspect of a Stepper motor.

(i)    The physical construction of the motor

( 4 marks )

(ii)    The performance of the motor

( 4 marks )

(iii)    The characteristics of the motor

( 4 marks )

(b)    State the **three ( 3 )** main types of Stepper motor

( 3 marks )

(c)    Describe in details any **one ( 1 )** of the following motors by considering its design and its operating fundamentals.

(i)    Universal motor
(ii)    Servo motor
(iii)    Reluctance motor

(10 marks )

**Q6** (a)    What is the main difference between DC motor and DC generator.

( 2 marks )

(b)    State **three (3)** advantages of DC motors

( 3 marks )

(c)    Illustrate the **two (2)** types of DC motor equivalent circuits.

( 3 marks )

(d)    Illustrate the **two (2)** types of DC generator equivalent circuits.

( 3 marks )

(e)    A separately excited dc motor turns at 1500 r/min when the armature is connected to a 240 V source. Calculate the armature voltage required so that the motor runs at :

(i)   2500 r/min

( 2 marks )

(ii)  200 r/min

( 2 marks )

(f )   A three phase, Y connected synchronous generator is rated 120 kVA, 2.0 kV, 50 Hz, 0.85 pf lagging. Its synchronous inductance is 2.5 mH and effective resistance is 2.5 $\Omega$.

(i)    Solve the voltage regulation at this frequency.

( 5 marks )

(ii)   Solve the rated voltage and apparent power if the supply frequency is going to be twice.

( 5 marks )

- END OF QUESTION -