Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER II
## SESSION 2017/2018

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|---|---|---|
| COURSE NAME | : | ELECTRICAL MACHINES AND DRIVES |
| COURSE CODE | : | DAE 32303 / DAR 21803 |
| PROGRAMME | : | DAE / DAR |
| EXAMINATION DATE | : | JUNE / JULY 2018 |
| DURATION | : | 2 HOURS 30 MINUTES |
| INSTRUCTION | : | ANSWER **FOUR (4)** QUESTIONS ONLY |



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

**Q1** (a) Briefly explain the working principle of alternating current ( AC ) signal generation on DC machine by using an appropriate diagram.

(3 marks)

(b) (i) Name **three ( 3 )** types of DC generators.

(3 marks)

(ii) **Draw** the schematic diagram of each DC generator type stated in **Q1(b)(i)**. **Label** each diagram completely.

(3 marks)

(c ) A 120 V series motor has 0.3 Ω field resistance. On full load, the line current is 17.0 A. The output power is 1600 W and the rotational loss is 160 W. Find the value of the armature resistance.

(3 marks)

(d) A compound DC motor rated at 415 V, 7 HP, 2010 rpm has an armature resistance of 0.20 Ω, series field resistance of 0.4 Ω and shunt field resistance of 150 Ω. The rotational losses are 210 W. The full load line current is 45 A.

(i) Find the developed mechanical power

(ii) Find the output power

(iii) Find the load torque

(iv) Find the efficiency of the motor

(v) Draw the power flow diagram for this type of motor with complete labelling of all the power values.

(13 marks)

**Q2** (a) Briefly explain the following:

(i) Open-circuit test procedures of the transformer
(ii) Short-circuit test procedures of the transformer

(5 marks)

(b) A step-up transformer is rated 140 kVA, 415 / 1000 V and has the following equivalent circuit parameter:

| | | |
|---|---|---|
| $R_p - 10\Omega$ | $R_s = 50\Omega$ | $R_m = 5000\ \Omega$ |
| $X_p = 20\Omega$ | $X_s = 80\Omega$ | $X_m = 1200\Omega$ |

(i) Draw with complete labelling the equivalent winding impedance referred to high voltage side.

(ii) Draw with complete labelling the equivalent winding impedance referred to low voltage side

(10 marks)

(c) Short-circuit test and open-circuit test were performed on a 100 kVA transformer, rated 277 V / 7200 V, and the results are listed below.

| | |
|---|---|
| $V_{sc} = 400$ V | $V_{oc} = 277$ V |
| $I_{sc} = 15.1$ A | $I_{oc} = 14.88$ A |
| $P_{sc} = 1200$ W | $P_{oc} = 1000$ W |

(i) Construct the equivalent circuit with the necessary parameters of the transformer referred to the low voltage (LV) side.

(7 marks)

(ii) Construct the equivalent circuit with the necessary parameters of the transformer referred to the high voltage (HV) side.

(3 marks)

**Q3** (a) By referring to the per phase equivalent circuit of a three phase induction motor state down the equation of :

(i) The gross output power of the induction motor
(ii) The output torque of the motor

(8 marks)

(b) A 4 poles, 50 Hz, star connected 3-phase induction motor having a rating of 50 kW and 415 V has a slip of 5% at 0.85 lagging power factor. If the full load efficiency is 85%, calculate :

(i) The input power
(ii) The line current and the phase current
(iii) The speed of the rotor (in rpm)
(iv) The frequency of the rotor
(v) The torque developed by the motor (assuming negligible friction and windage losses )

(17 marks)

**Q4** (a) The excitation voltage of a synchronous generator is 1219.7 V (line to neutral) when the armature current is $8\angle -20^0$ A. If the synchronous reactance is 10 Ω and the torque angle is $3.5^0$. Find:-

(i) The voltage across the synchronous reactance.
(ii) The terminal voltage of the generator.
(iii) The power factor of the generator.
(iv) Draw the phasor diagram.

(13 marks)

(b) A 3-phase star connected synchronous generator supplies a load of 8 MW at 0.7 leading power factor and at a terminal voltage of 6.6 kV. The armature resistance is 0.15 Ω /phase and synchronous reactance of 0.5 Ω/phase. Calculate :-

(i) The armature current
(ii) The internal generated voltage
(iii) The voltage regulation

(12 marks)

**Q5** (a) Draw and label completely the basic circuit of the universal / series motor.

(2 marks)

(b) Briefly explain the principle of operation of the universal motor.

(5 marks)

(c) Give **four (4)** advantages of the universal motor.

(4 marks)

(d) Determine the following for the single phase induction motor with the rotor speed ( $N_r$ ) of 594 rpm and using power supply of 220V, 50 Hz.

(i) synchronous speed, $N_S$
(ii) number of poles, p
(iii) percentage of slip, % S.

(6 marks)

(e) (i) State the maximum synchronous speed of the single phase motor with the power supply of 240 V, 50 Hz.

(ii) Give a reason to prove your answer in **Q5 (e) (ii)**.

(5 marks)

(f) State the relationship between slip, S and rotor speed, $N_r$.

(3 marks)

**Q6** (a) Draw the following symbols:-

(i) Triac
(ii) IGBT

(4 marks)

(b) Name **two (2)** components used for fully controlled of power switches.

(2 marks)

(c) Give **two (2)** examples of applications for each of the following:-

(i) UJT
(ii) Diac



(4 marks)

**Q6**

(d) State **three (3)** functions of the DC / DC converters (chopper).

(3 marks)

(e) Briefly explain the speed control of the DC motor drives using the armature voltage control method.

(5 marks)

(f) Briefly explain the speed control of the AC motor drives using the stator voltage control method.

(7 marks)

- **END OF QUESTION -**