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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016**

COURSE NAME : ELECTRICAL MACHINES
COURSE CODE : BEF24103
PROGRAMME : BEV
EXAMINATION DATE : JUNE / JULY 2016
DURATION : 3 HOURS
INSTRUCTION : ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

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- Q1 (a)** List **four (4)** general principles of operation of electrical machines. (4 marks)
- (b) Explain briefly **three (3)** types of AC machine. (3 marks)
- (c) A Y-connected, 2-pole generator has a peak flux density of 0.2 T, mechanical shaft rotation of 3600 rpm, stator diameter of 0.5 m, coil length of 0.3 m and 15 number of turns per coil. Identify the flux generated, the maximum voltage, the rms phase voltage and the terminal voltage. (4 marks)
- (d) The dimensions of a ferromagnetic core with a depth of 7 cm and relative permeability of 1500 are shown in **Figure Q1(c)**. The air gaps on the left and right sides of the core are 0.07 cm and 0.05 cm, respectively. Due to fringing effect, the effective areas of both air gaps are increased 5% larger than their physical size. The number of turns of coil wrapped around the center leg of the core and the current injected to the coil are 400 turns and 1 A, respectively.
- (i) Calculate all reluctances. (8 marks)
- (ii) Predict the flux in each leg of the core. (4 marks)
- (iii) Determine the magnetic flux density in both air gaps. (2 marks)
- Q2 (a)** Summarize **four (4)** general power losses in AC electrical machines. (4 marks)
- (b) Identify **three (3)** methods of speed control of induction motor. (6 marks)
- (c) A three-phase, 440 V, 50 Hz, 6 pole, Δ -connected induction motor has the following parameter referred to the stator. The rotor is running at 1740 rpm and the rotational loss is 1700 W.
- $$R_1 = 0.1 \Omega \quad X_1 = 0.7 \Omega \quad X_m = 35 \Omega \quad R_2 = 0.3 \Omega \quad X_2 = 0.7 \Omega$$
- (i) Construct the equivalent circuit of the induction motor. (2 marks)

- (ii) Analyse the synchronous speed, the slip, the total impedance, the stator current and the power factor. (6 marks)
- (iii) Predict the input power, the stator copper loss, the air gap power, the converted power and the output power. (5 marks)
- (iv) Estimate the induced torque and the load torque. (2 marks)

- Q3** (a) (i) Define **two (2)** common approaches to supply DC power source to the field circuit on the rotor of a synchronous generator. (2 marks)
- (ii) Outline **five (5)** steps or procedures to determine induced voltage parameter E_A of a synchronous generator (5 marks)
- (iii) State **four (4)** types of power losses in the synchronous generator (2 marks)
- (b) A motor-generator set consists of a 4-poles synchronous motor driving a synchronous generator. The motor is supplied by three-phase electrical line with voltage and frequency of 415 V and 50 Hz, respectively. Evaluate the number of poles for the generator, if the synchronous generator is designed to produce three-phase output with frequency of 400 Hz. (3 marks)
- (c) A 50 kVA, 415 V, Δ -connected three-phase synchronous generator is tested with a rated field current of 7 A. The testing data are given as;
- $$V_{T,OC} = 415V \quad I_{L,SC} = 200A \quad V_{DC} = 12V \quad I_{DC} = 36A$$
- (i) Determine the armature resistance and the synchronous reactance per-phase. (4 marks)
- (ii) Estimate the internal generated voltage, E_A if the power factor of the generator at rated operation is 0.866 lagging. (4 marks)
- (d) A 415 V, 50 Hz, six-pole and Y-connected synchronous motor operated at maximum operation, draws 80 A from the line supply at 0.9 pf leading and 85% efficiency. Analyse the maximum output torque of this motor. (5 marks)

- Q4** (a) Summarize **two (2)** methods to control the speed of compounded DC motor. (2 marks)
- (b) A 7.5 hp, 120 V series DC motor is supplied by a full-load line current of 56 A and the full speed is 1000 rpm. The armature resistance and field resistance are given as 0.4Ω and 0.3Ω , respectively. Assume the total losses are constant 400 W.
- (i) Sketch and label the appropriate equivalent circuit of the motor. (2 marks)
- (ii) Examine the efficiency of the motor at full-load operation. (3 marks)
- (iii) Estimate the speed of the motor if it operates at 50% from armature current, assuming the ratio flux at this condition over full line current is 0.85. (7 marks)
- (c) A 120 V shunt DC motor is supplied by a full-load line current of 55A. The armature resistance and field resistance are given as 0.4Ω and 0.3Ω , respectively. In order to control the motor, a variable resistor with range of 0 to 400Ω (R_{adj}) is connected in series with the field resistor. The rated speed of the motor is 1200rpm.
- (i) Sketch and label the appropriate equivalent circuit of the shunt DC motor. (2 marks)
- (ii) Determine the motor speed at no-load condition if the variable resistor is adjusted to 200Ω where in this condition the internal generated voltage E_{Ao} at rated speed is 150V. (3 marks)
- (iii) Estimate the speed of the motor at full-load operation and also the speed regulation of the motor by assuming no armature reaction and the variable resistor is adjusted to 200Ω . (6 marks)

– END OF QUESTIONS –

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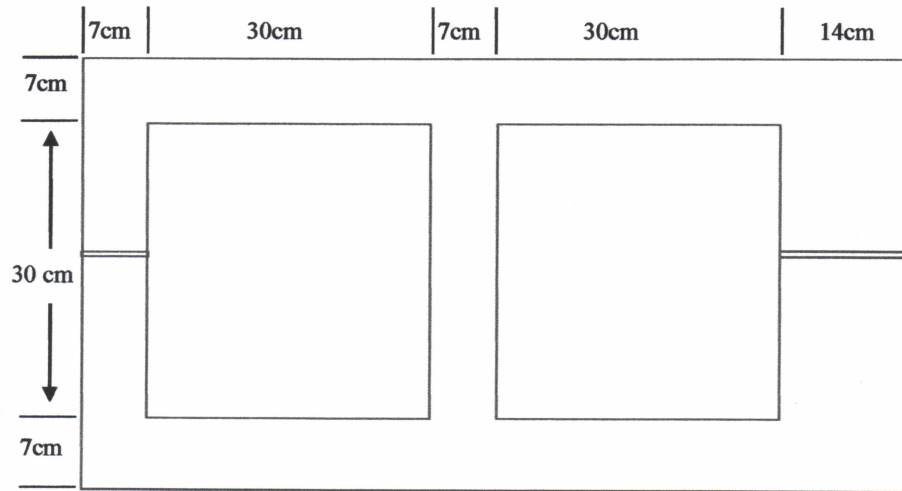


FIGURE Q1(c)