

FINAL
Examination Paper

(COVER PAGE)

Session : August 2018

Programme : Diploma In Mechanical Engineering (DMEN)

Course : EEE2115 : Electrical Power and Machines

Date of Examination : December 10,2018 (Monday)

Time : 11:00 am – 1:00 pm Reading Time : Nil

Duration : 2 Hours

Special Instructions :

This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Materials permitted :

Calculator

Material provided :

Nil

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Moderator : Dr Jeya Gopi Raman

This paper consists of 6 printed pages, including the cover page.

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
 EEE2115: ELECTRICAL POWER AND MACHINES
 FINAL EXAMINATIONS: AUGUST 2018 SESSION

Instructions: This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Question 1

- (a) Data obtained from short-circuit and open-circuit tests of a 75 kVA, 4600/230 V, 50 Hz transformer are:

Open-circuit Test	Short-circuit Test
(Low-voltage side Data)	(High-voltage side Data)
$V_{OC} = 230 \text{ V}$	$V_{SC} = 160.8 \text{ V}$
$I_{OC} = 13.04 \text{ A}$	$I_{SC} = 16.3 \text{ A}$
$P_{OC} = 521 \text{ W}$	$P_{SC} = 1200 \text{ W}$

Solve for the core-loss resistance ($R_{fe,LS}$) from open-circuit test data.

(2 marks)

- (i) Solve for the magnetizing reactance ($X_{M,LS}$) from open-circuit test data.

(6 marks)

- (ii) Determine the transformer windings resistance ($R_{eq,HS}$) from short-circuit test data.

(2 marks)

- (iii) Determine the transformer windings reactance ($X_{eq,HS}$) from short-circuit data.

(3 marks)

- (b) Determine the voltage regulation of the transformer operating at rated load and 0.75 power factor lagging. Sketch appropriate schematic diagram.

(12 marks)

Question 2

- (a) Figure 2 (a) shows two resistors connected to a 6 V battery.

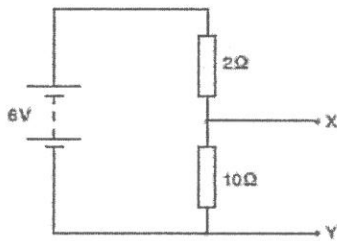


Figure 2 (a)

- (i) What name do we use to describe this way of connecting resistors? (2 marks)
- (ii) Calculate the combined resistance of the two resistors. (2 marks)
- (iii) Calculate the current in the circuit. (2 marks)
- (iv) Use your answer in (a)(ii) to calculate the potential difference across the 10Ω resistor. (2 marks)
- (v) State the potential difference between terminals X and Y. (2 marks)
- (b) A series AC circuit contains the following components: $R = 150\Omega$, $L = 250\text{ mH}$, $C = 2.00\mu\text{F}$ and a source with $\Delta V_{\text{max}} = 210\text{ V}$ operating at 50.0 Hz . Calculate:
- (i) inductive reactance (2 marks)
- (ii) capacitive reactance (3 marks)
- (iii) Circuit impedance (4 marks)
- (iv) maximum current (3 marks)
- (v) phase angle between current and source voltage. (3 marks)

Question 3

- (a) A shunt generator delivers 195 A at a terminal potential of 250 V. The armature resistance and the shunt field resistance are 0.02Ω and 50Ω respectively. The iron and friction losses equal 950 W. Find:
- (i) the emf generated and sketch appropriate schematic diagram. (6 marks)
 - (ii) the total copper losses. (4 marks)
 - (iii) the output of the prime mover. (2 marks)
 - (iv) the electrical and mechanical efficiency. (5 marks)
- (b) When a DC generator is being driven at 1,200 rpm, the generated emf is 125 V. What will be the generated emf if
- (i) the field flux is decreased by 10% with the speed remaining unchanged. (4 marks)
 - (ii) the speed is reduced to 1,100 rpm, the field flux remaining unchanged. (4 marks)

Question 4

- (a) A DC shunt motor has input voltage 200 V, $R_a = 0.116 \Omega$ and $R_{shunt} = 75 \Omega$. It is found that the motor draws a line current of 165.16 A with a shaft speed of 500 rpm. Sketch a schematic diagram to calculate the output mechanical power. (10 marks)
- (b) A 240V DC separately excited shunt motor has an armature resistance of 0.68Ω and draws a full current of 24 A at a speed of 100rpm. Sketch a schematic diagram. Calculate:
- (i) the emf E_a (4 marks)
 - (ii) the output power developed (2 marks)
 - (iii) the torque developed (2 marks)
 - (iv) If the pole flux is reduced by 20%, calculate the new speed. (3 marks)
- (c) Derive an expression for frequency of the generated voltage (induced emf) in the armature of a generator. (4 marks)

Question 5

- (a) A 3-phase, 4000 V, 60 Hz, 500 hp, 4-pole induction motor is operating at rated condition. The breakdown of losses as follow:

Stator Copper Loss	12.4 kW
Rotor Conductor Loss	19.9 kW
Core Loss	11.1 kW
Stray Power	10.2 kW
Fiction and Windage Losses	18.2 kW

- (i) Sketch the power flow diagram with its values. (2 marks)
- (ii) Shaft speed (4 marks)
- (iii) Shaft torque (4 marks)
- (iv) Developed torque (2 marks)
- (v) Input power to stator (2 marks)
- (vi) Overall efficiency (2 marks)
- (b) A large 3-phase, 4,000V, 60 Hz, 10-pole, squirrel-cage induction motor draws a current of 385 A and a total active power of 2,344 kW when operating at full load. The corresponding speed is accurately measured and is found to be 709.2 rpm. The WYE- connected stator has resistance per phase of the stator winding is 0.05 Ω . The total core loss is 23.4 kW and the windage & friction losses are 12 kW. Determine:
- (i) power factor of the load (2 marks)
- (ii) active power input to the rotor (4 marks)
- (iii) rotor conductor loss (3 marks)

Question 6

- (a) A 20 kW, 3-phase, Y-connected, 50 Hz, 400 V, 4-pole synchronous motor is operating at rated condition. It operates with a power angle of 50° and an efficiency of 95 %. The motor has a synchronous reactance of 3Ω per phase. Determine:
- (i) the active input power, P_{in} (2 marks)
 - (ii) the excitation voltage, E_f (4 marks)
 - (iii) the armature current, I_a (5 marks)
 - (iv) What is the effect of increasing the field excitation on the performance of a synchronous motor? (2 marks)
- (b) A 20-pole synchronous generator running at 300 r/min supplies to a 6-pole induction motor that is loaded to run at a slip of 5%. Find the speed at which the induction motor runs and the frequency of the currents induced in its rotor. (12 marks)

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