

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

SECOND YEAR EXAMINATION FOR THE AWARD OF DEGREE
OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC
ENGINEERING

EENG 241: ELECTRICAL MACHINES I

STREAMS: BSC (EENG)

TIME: 2 HOURS

DAY/DATE: MONDAY 06/04/2020

8.30 A.M. – 10.30 A.M.

INSTRUCTIONS:

- Answer question ONE and any other TWO questions
- Do not write on the question paper

QUESTION ONE

- (a) Name and state the use of instrument transformers [2 marks]
- (b) Explain the three characteristics of a DC Generator [3 marks]
- (c) Why is transformer rating in kVA and not in KW [3 marks]
- (d) Explain why in a power plant power is usually supplied from several generators of small ratings connected in parallel instead of from one large generator. [3 marks]
- (e) What is an electromechanical energy conversion system? [1 mark]
- (f) State and derive the condition for maximum power in a DC motor [3 marks]
- (g) A 250 V shunt motor takes a total current of 20 A. The shunt field and armature resistance are 200 Ohms and 0.3 Ohms respectively. Determine:
- (i) The value of back emf [3 marks]
- (ii) Gross mechanical power in the armature [2 marks]
- (h) A 2000/200 V, 20 kVA transformer has 66 turns in the secondary. Calculate:
- (i) The primary turns [2 marks]
- (ii) Primary and secondary full-load currents. Neglect the losses. [2 marks]

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- (i) Name two advantages of autotransformers? [2 marks]
- (j) A 3-phase, 50 Hz transformer has a delta-connected primary and star connected secondary, the line voltages being 33000 V and 300 V respectively. The secondary has a star-connected balanced load at 0.85 power factor lagging. The line current on the primary side is 7A. Determine the current in each coil of the primary and in each secondary line. What is the output of the transformer in kW? [4 marks]

SECTION B – ANSWER ANY TWO QUESTIONS

QUESTION TWO (20 MARKS)

- (a) List three types of self-excited generators [3 marks]
- (b) The figure below shows an electromechanical system along with dimensions. The magnetic core is made of cast iron whose B-H characteristics is shown in the graph diagram. The coil has 350 turns and coil resistance of 8 ohms. For a fixed air gap of length $g=10\text{mm}$, a DC source is connected to the coil to produce a flux density of 1.2 Tesla in the air gap.
- (i) Find the voltage of the DC source [4 marks]
- (ii) Find the stored field energy [5 marks]

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- (c) Briefly explain the application of autotransformers [4 marks]
- (d) A 12-pole, lap-wound armature rotated at 400 r.p.m is required to generate 300 V. the useful flux is 0.8 Wb. If the armature has 120 slots, calculate the number of conductors per slot. [4 marks]

QUESTION THREE (20 MARKS)

- (a) What is the fundamental principle involved in electromechanical energy conversion? [2 marks]
- (b) What is the disadvantage of using an electric field as a medium for electromechanical energy conversion? [1 mark]
- (c) With the help of a diagram, explain the condition of maximum efficiency of a DC generator. [4 marks]
- (d) A shunt generator supplies 100A at a terminal voltage of 220 volts. The armature and shunt field resistances are 0.15 Ohms and 60 Ohms respectively. The iron and frictional losses are 2400 W. Find;
- (i) The e.m.f generated [3 marks]
 - (ii) Copper losses [2 marks]
 - (iii) Commercial efficiency [3 marks]
- (e) What is the theory of an ideal transformer [3 marks]
- (f) Why is the resistance of the field winding of a dc shunt generator kept below critical field resistance? [2 marks]

QUESTION FOUR (20 MARKS)

- (a) Briefly explain the operation principle of a DC motor [2 marks]
- (b) A 60 KW, 400V DC shunt generator has armature and field resistances of 0.04 and 250 Ohms respectively. Calculate the total power developed by the armature when it delivers full load output [4 marks]
- (c) State the losses in a DC motor [3 marks]
- (d) Explain working principle of a transformer [4 marks]
- (e) Briefly explain two types of transformer tests [4 marks]
- (f) What are the three advantages of transformer tests? [3 marks]