ELIZADE UNIVERSITY, ILARA-MOKIN,

ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SECOND SEMESTER EXAMINATION, 2017/2018 ACADEMIC SESSION

COURSE TITLE: ELECTROMECHANICAL DEVICES AND DESIGN

COURSE CODE: EEE 316

EXAMINATION DATE: 2nd AUGUST, 2018

COURSE LECTURER: Dr. Akinwumi A. AMUSAN

TIME ALLOWED: 2 HOURS

HOD's SIGNATURE

INSTRUCTIONS:

1. ANSWER ANY FOUR QUESTIONS

2. ANY INCIDENT OF MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM SHALL BE SEVERELY PUNISHED.

3. YOU ARE NOT ALLOWED TO BORROW CALCULATORS AND ANY OTHER WRITING MATERIALS DURING THE EXAMINATION.

4. ELECTRONIC DEVICES CAPABLE OF STORING AND RETRIEVING INFORMATION ARE PROHIBITED.

5. DO NOT TURN OVER YOUR EXAMINATION QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO

Question #1 (15 Marks)

(a) With the aid of appropriate block diagram and equations, describe an electromechanical energy conversion device using the field energy concept. (5 Marks)

(b) Give the various categories of electromechanical energy conversion devices with at least two examples of devices for each category (5 Marks)

(c) List 6 common constructional features / parts of all rotating electrical machines (3 Marks)

(d) What is the purpose of the armature windings and the field windings in rotating electrical machines? (2 Marks)

Question #2 [15 Marks]

(a) Describe the principle of operation of a transformer (4 Marks)

(b) Suppose a transformer is connected to a dc supply on the primary, what kind of output will be obtained on the secondary and why? (4 Marks)

(c) Enumerate the classification of transformers based on:
(i) Construction technique $(1\frac{1}{2}$ Marks)
(ii) Cooling method employed $(1\frac{1}{2}$ Marks)

(d) A 25 KVA transformer has 500 turns on the primary and 50 turns on the secondary winding. The primary is connected to a 3 KV, 50 Hz supply. Determine the:
(i) Full load primary (1 Mark)
(ii) Full load secondary current (1 Mark)
(iii) Secondary emf (1 Mark)
(iv) Maximum flux in the core. (1 Mark)
Neglect leakage drop and no load primary current.

Question #3 (15 Marks)

(a) Compare a synchronous motor with an induction motor based on motor speed, power factor, starting, excitation, cost, efficiency and simplicity. (6 Marks)

(b) State one application of synchronous motor (1 Mark)

(c) State the functions of commutator in dc machines (2 Marks)

(d) A 3-phase induction motor wound for 4 poles, is supplied with a 50 Hz frequency, determine the:
(i) Synchronous speed in rpm and rad/s, (2 Marks)
(ii) Rotor speed in rpm and rad/s, when the slip is 5%, (2 Marks)
(iii) Rotor frequency when the rotor runs at $\frac{3}{4}$ times the synchronous speed (2 Marks)

(a) Highlight the measured parameters and the purpose of transformer open circuit test and short circuit test   (3 Marks)

(b) A 20 KVA, 2200/220 V, 50Hz distribution transformer is tested for efficiency and regulation as follows:

OC test   220V   4A   150W - on lv side
SC test   84V   9A   360W - on hv side
Determine the:

(i) Core loss   ($\frac{1}{2}$ Mark)
(ii) No load working resistance   (1 Mark)
(iii) No load magnetizing reactance   (1 Mark)
(iv) Equivalent resistance referred to primary   (1 Mark)
(v) Equivalent resistance referred to secondary   (1 Mark)
(vi) Equivalent reactance referred to primary   (1 Mark)
(vii) Equivalent reactance referred to secondary   (1 Mark)
(viii) Draw the approximate equivalent circuit of the transformer referred to primary side ($1\frac{1}{2}$ Marks)
(ix) Regulation of the transformer at 0.8 pf lagging   (2 Marks)
(x) Output terminal voltage at full load current and 0.8 pf lagging   (1 Mark)
(xi) Efficiency of the transformer at full load 0.8 pf lagging   (1 Mark)

Question #5 (15 Marks)

(a)   (i) Why is transformer polarity test essential?   (2 Marks)
           (ii) Describe the transformer polarity test.   (4 Marks)

(b) A 20KVA, 440/220V single phase, 50 Hz transformer has iron loss of 324 W. The Cu loss is found to be 100W when delivering half full load current. Determine the:
(i) Efficiency when delivering full load current at 0.8 lagging pf   (2 Marks)
(ii) Percentage of the full load when the efficiency will be maximum   (1 Mark)
(iii) Corresponding maximum efficiency at 0.8 lagging pf   (2 Marks)

(c) State the types of iron losses in transformers.   (2 Marks)
How can these losses be minimized?   (2 Marks)

Question #6 (15 Marks)

(a) (i) Discuss some reasons for parallel operation of transformers   (4 Marks)
(ii) What are the requirements to be met before connecting two or more transformers in parallel?
                                                                                                                   (5 Marks)

(b) What are the applications of current and voltage transformers?   (2 Marks)

(c) The total iron loss in sample sheet steel weighing 13 kg is 20 W at 50 Hz and 35 W at 75 Hz both measured at the same peak flux density. Separate the iron loss at 75 Hz into hysteresis and eddy current loss.
                                                                                                                   (4 Marks)