ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

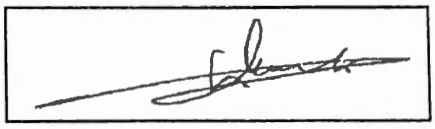
SEMESTER II EXAMINATION, 2016/2017 ACADEMIC SESSION

COURSE TITLE: ELECTROMECHANICAL DEVICES AND DESIGN – 2 UNITS

COURSE CODE: EEE 316

EXAMINATION DATE: 27th JULY 2017

COURSE LECTURER: Dr. D. O. Akinyele



HOD's SIGNATURE

TIME ALLOWED: 2 HRS

INSTRUCTIONS

1. ATTEMPT ANY **FOUR** QUESTIONS OF YOUR CHOICE
2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM
3. YOU ARE NOT ALLOWED TO BORROW CALCULATORS AND ANY OTHER WRITING MATERIALS

Question #1

(a) (i) With the aid of a diagram explain the subsystems of electromechanical devices. **(2.5 marks)**

(ii) What are piezoelectric devices, and how do they differ from other electromechanical devices? **(2.5 marks)**

(b) Describe the operational principle of a magnetic actuator and write the electrical equations for its linear and rotational motion. **(5 marks)**

(c) (i) What is quasi-static field theory? **(1 mark)**

(ii) How does the quasi-static field theory differ from the Maxwell's equations in the analysis of electromechanical devices? **(3 marks)**

(iii) What do you understand by the term "transducer"? Give one example. **(1 mark)**

Question #2

(a) What is the effect of armature reaction on DC generators and motors, and how can it be addressed in electrical machine design and operation? **(2 marks)**

(b) (i) With the aid of diagram, differentiate between long-shunt and short-shunt compound generators. **(2 marks)**

(ii) Mention the applications of series, shunt and compound-wound generators. **(3 marks)**

(c) A short-shunt compound generator supplies 80A at 200V. If the field resistance, $R_f = 40\Omega$, the series resistance, $R_{se} = 0.02\Omega$ and the armature resistance, $R_a = 0.04\Omega$, determine the e.m.f generated. **(8 marks)**

Question #3

(a) What is back e.m.f? **(2 marks)**

(b) A six-pole lap-wound motor is connected to a 250 V DC supply. The armature has 500 conductors and a resistance of 1Ω. The flux per pole is $200mWb$. Calculate the speed and the torque developed when the armature current is 40A. **(4.5 marks)**

(c) (i) Derive an expression for the efficiency of a DC motor. **(7.5 marks)**

(ii) What is the condition for maximum efficiency in a DC motor. **(1 mark)**

Question #4

(a) Explain the difference between a synchronous machine and an induction machine. **(5 marks)**

(b) What is a synchronous condenser? Mention its application in power system.

(2 marks)

(c) (i) What are the causes of low lagging power factor in electrical power system?

(3 marks)

(ii) An alternator is supplying a load of 300 kW at a p.f. of 0.6 lagging. If the power factor is raised to unity by another AC machine, evaluate the improvement in terms of power that can be supplied by the alternator for the same apparent power loading?

(4 marks)

(iii) Mention two applications of 3-phase induction motors? **(1 mark)**

Question #5

(a) What are eddy currents? State how their effect is reduced in transformers.

(4 marks)

(b) A single-phase transformer has 2400 turns on the primary and 600 turns on the secondary. Its no-load current is 4A at a power factor of 0.25 lagging. Assuming the volt drop in the windings is negligible; calculate the primary current and its power factor when the secondary current is 80Aat a power factor of 0.8 lagging. **(9 marks)**

(c) Draw the phasor diagram of the transformer arrangement in 5 (b). **(2 marks)**

Question #6

(a) Draw the phasor diagrams for an ideal transformer on no-load. **(4 marks)**

(b) Explain the advantages of parks transformation in a 3-phase balanced system.

(3 marks)

(c) The power and voltage ratings of three-phase system are 5,000kVA and 2,400 V respectively. It is desired to transform the three phase power to 2 phase power at 600V by Scott-connected transformers. Determine the voltage and current ratings of both primary and secondary of each transformer. The transformer no-load current is negligible. **(8 marks)**