BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF ENGINEERING AND PHYSICS

Bachelor of Science Honours Degree in Electronic Engineering

EEM2103 (1) Electrical Machines and Measurements

Duration: 3 hours **Total marks: 100**

Instructions

1. This question paper consists of 5 printed pages
2. This examination paper consists of 7 Questions
3. Each question carries 20 marks
4. Answer any Five (5) questions
5. Start each question on a new page
6. Read all questions carefully

NB: DO NOT TURN OVER THE QUESTION PAPER OR COMMENCE WRITING UNTIL INSTRUCTED TO DO SO.

Question 1

a) With the aid of a diagram, describe the principle of operation of a simple d.c. motor. [7]

b) Give a brief description of the stepper motor elements. [6]

c) List any five possible functions of the signal-conditioning stage. [5]

d) Distinguish between passive and active transducer. [2]

Question 2

a) Highlight any four advantages and one disadvantage of auto transformers. [5]

b) Define the following terms: [6]

(i) Transducer
(ii) Sensor
(iii) Actuator

c) Describe the principle of operation of a three-phase induction motor. [3]

d) Draw a full labelled block diagram of the instrumentation system. [3]

e) Explain the working principle of an electrical resistance thermometer. [3]

Question 3

a) (i) Highlight the purpose served by the servo motor. [2]

(ii) Hence, state components that constitute the servo motor. [3]

b) In general, describe the principle of operation of a DC servomotor. [6]

c) Describe the principle of operation of the different types of stepper motors. [9]

Question 4

a) With the aid of a diagram/s, explain how the Linear Variable Differential Transformer (LVDT) is used to measure displacement. [5]

b) (i) Briefly describe armature reaction, highlighting its effects on generator output voltage and speed of the electric motor. [3]

(ii) Highlight how the effects of armature reaction are overcome. [1]

c) A 415V, 3-phase, 4 wire, star-connected system supplies three resistive loads as shown in Figure 4c below. Determine:

i) the current in each line [3]
ii) the current in the neutral conductor. [3]

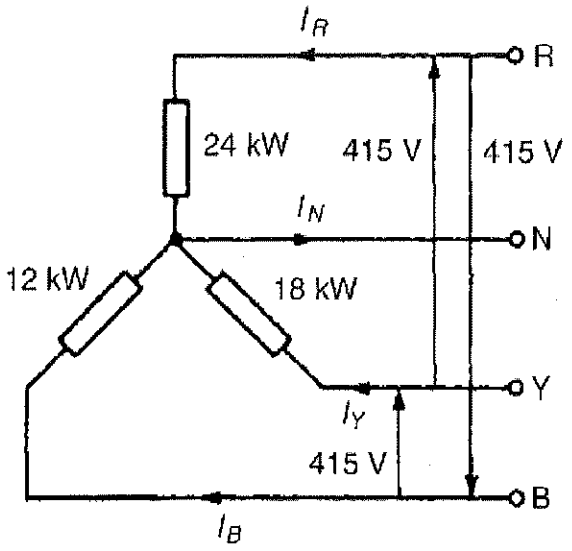

Figure 4c

d) With the aid of formula, highlight the parameter that determine the Force on a current-carrying conductor. [3]

e) Calculate the mutual inductance between two coils when a current changing at 200A/s in one coil induces an e.m.f of 1.5V in the other. [2]

Question 5

a) Describe two sources of losses in transformers on load. [7]

b) With the aid of a tree diagram, highlight the different types of errors in a measurement system. [5]

c) Highlight any four advantages of electronic comparators. [4]

d) Describe the following terms as used in measuring instruments. [4]

(i) Backlash
(ii) repeatability
(iii) hysteresis
(iv) magnification

Question 6

a) List and explain four advantages of auto transformers over double-wound transformers. [4]

b) A 415V, 3-phase a.c motor has a power output of 12.75kW and operates at a power factor of 0.77 lagging and with an efficiency of 85%. If the motor is delta-connected, determine:

i) the power input [2]
ii) the line current [2]
iii) the phase current [2]

c) State four Properties of laser. [4]

d) Briefly describe the classifications of the DC generators. [4]

e) Determine the terminal voltage of a generator which develops an e.m.f. of 200 V and has an armature current of 30 A on load. Assume the armature resistance is 0.30 Ω. [2]

Question 7

a) A transformer takes a current of 0.8A when its primary is connected to a 240 Volt, 50 Hz supply, the secondary being on open circuit. If the power absorbed is 72 watts, determine:

i) the iron loss current [2]
ii) the power factor on no-load [1]
iii) the magnetizing current. [2]

b) State three factors to be considered in the selection of instruments. [3]

c) Describe the stages involved in the processes behind the working principle of the LASER. [12]