

The Open University of Sri Lanka
Faculty of Engineering Technology



Study Programme : Bachelor of Technology (Engineering)
Name of the Examination : Final Examination
Course Code and Title : MEX4271 – Sensors and actuators
Academic Year : 2014/15
Date : 04th August 2015
Time : 0930hr-1230hr
Duration : 3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper has **eight** questions.
3. Answer **five** questions only.

Question 01

- (a) Explain the difference between static and dynamic characteristics of a sensor/transducer. [4 marks]
- (b) Write two dynamic characteristics and explain briefly. [4 marks]
- (c) Explain the following terms briefly
- i. Hysteresis error
 - ii. Resolution
- [4 marks]
- (d) Explain the significance of the following information given in the specification of a strain gauge transducer:
- Range : 70 to 1000 kPa
Full range output : 40 mV
Non linearity & hysteresis : $\pm 0.5\%$ full range output.
Thermal zero shift : 0.030% full range output/ $^{\circ}\text{C}$

[8 marks]

Question 02

- (a) Name three sensors which are used for displacement measurement. [3 marks]
- (b) Write two signal conditioning operations. Briefly explain one signal conditioning operation. [4 marks]
- (c) Schematic diagram of a measuring device shown in Figure Q2
- Identify the components x, y and z of this device. [3 marks]
 - Describe the operation of the device, explaining the function of each component and identifying the nature of the measurand and the output of the device. [4 marks]
 - List the advantages and disadvantages of this device. [4 marks]
 - Describe a possible application of this device. [2 marks]

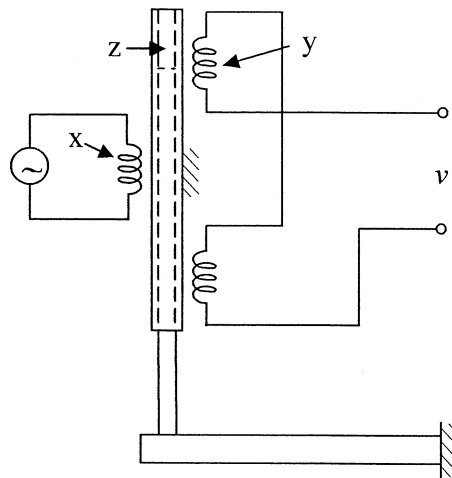


Figure Q2

Question 03

Assume you are a member of a domestic washing machine designing project.

- (a) Suggest suitable method to determine the mass of the laundry in a washing machine. [5 marks]
- (b) If you need to measure the water level of the washing machine, propose a method for it. [5 marks]
- (c) Suggest a sensor to determine the amount of dirt in the laundry. Explain how it works. [5 marks]
- (d) Design a system involving a microprocessor to integrate the above three measurements. [5 marks]

Question 04

- (a) Discuss advantages and disadvantages of fiber optic sensors. [5 marks]
- (b) A Platinum resistance thermometer has a resistance of 25Ω at 0°C and the temperature coefficient of resistance of platinum α is $0.0038/^\circ\text{C}$. When measuring the temperature of a process, resistance value of 50Ω is obtained. What is the corresponding temperature of the process? [5 marks]
- (c) A bad characteristic of strain gauges is that of resistance change with changes in temperature. Describe how to eliminate error due to temperature changes when use strain gauges in applications such as load cells? [5 marks]
- (d) Gauge factor of a strain gauge is 2.0 and resistance equal to 120Ω . Calculate the resistance change of the strain gauge, if it is subject to a strain of 0.003? [5 marks]

Question 05

- (a) Calculate the rotational speed of a stepper motor with step angle 1.8° , if stepping rate is 100 steps/sec. [3 marks]
- (b) What are the common types of stepper motors? Briefly explain each types. [9 marks]
- (c) What are the advantages of a solid-state switch over an electromechanical switch? [4 marks]
- (d) When selecting a control relay for an application, what are the typical terms need to be considered? [4 marks]

Question 06

- (a) Explain the following components of pneumatic system briefly.
i. Compressor ii. Reservoir iii. Air service unit [6 marks]
- (b) Draw the symbols of following pneumatic components
i. 3/2 way push button valve with spring return
ii. 2/2 way roller lever valve with spring return
iii. 4/2 way double solenoid electro-pneumatic valve [6 marks]

- (c) As part of a drilling operation, the work piece requires to be held in a vice. The vice is to be operated pneumatically by a double acting cylinder. To allow the operator time to position the work piece, the vice should close slowly.

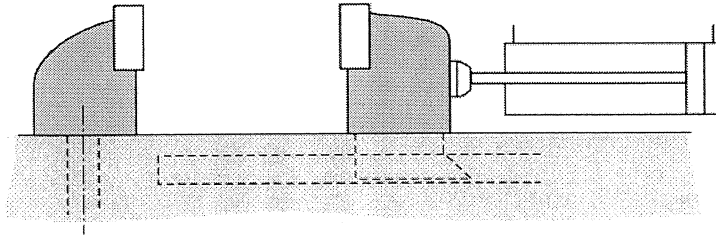


Figure Q6

Design a pneumatic system that will perform this task. (Draw pneumatic system using standard symbols and name each component of the system clearly) [8 marks]

Question 07

- (a) A machine is operating as a motor at a speed of 800 rpm with $I_A = 25$ A and $I_F = 2.5$ A. Magnetization curve of the machine is shown in Figure Q7-a. The field resistance is $R_F = 40\Omega$. Find the voltage V_F applied to the field circuit, the developed torque, and the developed power. [8 marks]

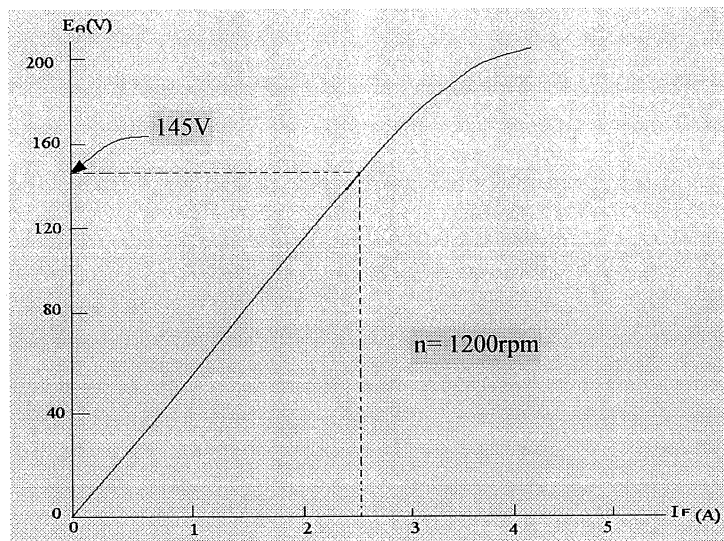


Figure Q7- a

- (b) The plot of torque vs. speed for the series dc motor shown in Figure Q7-b. A series-connected dc motor runs at $n_{m1} = 800$ rpm while driving a load that demands a torque of 10Nm. Neglect the resistances, rotational loss, and saturation effects. Find the angular speed and the power output. Then, find the new speed and output power if the load torque increases to 20Nm. [12 marks]

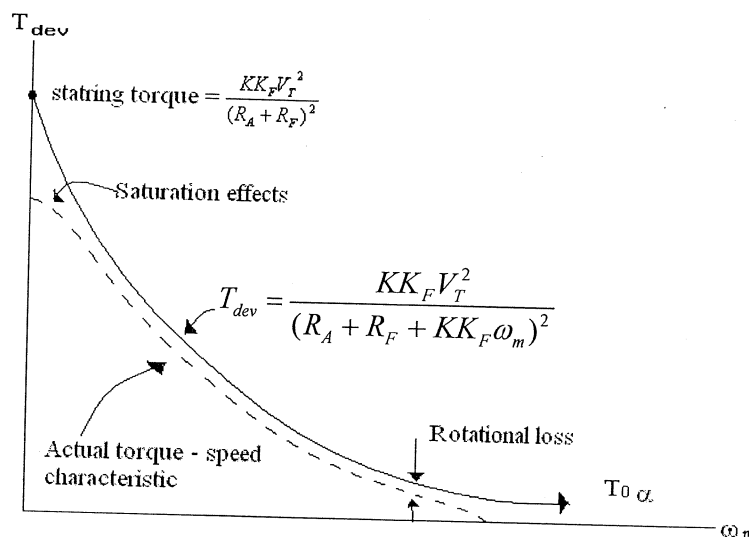


Figure Q7- b

Question 08

- (a) A 5 hp, four pole 60Hz three-phase induction motor runs at 1750 rpm under full-load conditions.
- Determine the slip and the frequency of the rotor currents at full load. [4 marks]
 - Estimate the speed if the load torque drops in half. [4 marks]
- (b) An induction motor (230Vrms, 60-Hz three phase Y-connected) draws 25A at a power factor of 80% lagging. The total stator copper loss is 350W, the total rotor copper loss is 120W and the rotational loss is 450W for all three phases. Determine
- Input power [3 marks]
 - Developed power [3 marks]
 - Output power [3 marks]
 - Efficiency [3 marks]

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