

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering



Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: DMX4409 Sensors
Academic Year	: 2020/21
Date	: 04 th January 2022
Time	: 14:00-17:00hrs
Duration	: 3 hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Four (4)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test (CBT).
6. Answers should be in clear handwriting.
7. Do not use Red colour pen.

Question 01

- a) List any four criteria used for selection of a transducer for industrial application. [5 marks]
- b) Explain need of signal conditioning in process industry. [5 marks]
- c) Describe in brief use of tactile sensors in process industry. [5 marks]
- d) Describe the procedure to measure pressure using diaphragm with strain gauge. [5 marks]

Question 02

- a) A capacitive type level sensor is used to measure the level of water (conducting) in a tank. With a neat labeled diagram, describe the construction of this sensor. Also, state the reason for the change in capacitance with the change in the level of water. [5 marks]
- b) Compare RTD and thermistor based on Temperature coefficient, Linearity, Temperature range and cost. [5 marks]
- c) Describe the working of RVDT with a neat sketch. [5 marks]
- d) Explain the principle of working of Hall effect sensor. [5 marks]

Question 03

The quality control system in a steel rolling mill uses a proximity sensor to measure the thickness of rolled steel (steel gage) at every two feet along the sheet, and the mill controller adjustments are made based on the last twenty measurements. Specifically, the controller is adjusted unless the probability that the mean thickness lies within 1 percent of the sample mean, exceeds 0.99. A typical set of twenty measurements in millimeters is given in Table Q3.

- a) State the critical parameter(s) to be measured for the thickness of steel gauge. [5 marks]
- b) Determine the standard deviation for the measurement. [10 marks]
- c) Check whether adjustments would be made in the gauge controller based on these measurements. [5 marks]

5.10	5.05	4.94	4.98	5.10	5.12	5.07	4.96	4.99	4.95
4.99	4.97	5.00	5.08	5.10	5.11	4.99	4.96	4.90	4.10

Table Q3

Question 04

- a) Define sensitivity? Why are sensitivity and linearity in potentiometers conflicting performance parameters? [5 marks]
- b) State five desirable characteristics of a transducer. [5 marks]
- c) Name the type of transducer in which:
- i. Measurand is temperature and output variable is voltage. [2 marks]
 - ii. Measurand is force and output variable is resistance change. [2 marks]
 - iii. Measurand is pressure and output variable is displacement. [2 marks]
- d) Compare the following:
- i. Accuracy and precision. [2 marks]
 - ii. Static and dynamic performance characteristics. [2 marks]

Question 05

- a) "Air cored inductive transducers are suitable for use at higher frequencies". Describe. [5 marks]
- b) "For measuring the magnitude as well as the direction of displacement using LVDT, it is used in conjunction with a phase-sensitive demodulator followed by a low-pass filter". Describe. [5 marks]
- c) A displacement of ± 12.5 mm results in a secondary voltage of 5V in an LVDT. If the then secondary voltage is 3.2V, determine the absolute value of the corresponding displacement. [10 marks]

Question 06

A wall tile manufacturer has decided to improve the quality of their 6" and 8" production line by installing an automatic system to inspect the quality of each tile on the conveyor before they are packaged. The quality parameters that need monitoring are each tile's length, width, and weight. The conveyor may carry either 6" or 8" tiles in batches at the rate of one tile every second. The tolerance allowed for either length is 2.0mm and for the weight is 25g (variation in weight indicates defects in density and thicknesses of tile, also same tolerance is applicable

to both types of tiles). If a tile fails any of these tolerances, it has to be ejected from the conveyor belt by means of some actuators before it reaches the packaging station.

- a) Identify suitable sensors, actuators, controllers, and other vital components for the above design. Elaborate on the significant characteristics of the selected components in the component selection stage. [10 marks]
- b) Discuss any drawbacks of your design and propose ways of enhancing its performance. [10 marks]

Question 07

- a) Distinguish the difference between NPN transistor output and the PNP transistor output of the sensor. [5 marks]
- b) Explain the mutual interference that occurs with Proximity Sensors. [5 marks]
- c) Describe the noises that influence the Proximity Sensor. [5 marks]
- d) What happens if Proximity Sensors are used in high temperatures? [5 marks]

Question 08

- a) Describe the features of hall effect sensors. [5 marks]
- b) Explain the working of absolute and incremental encoders. [5 marks]
- c) Explain the role of sensors in flexible manufacturing systems. [5 marks]
- d) Explain the principle of color sensing and vision. [5 marks]

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