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MANIPAL INSTITUTE OF TECHNOLOGY

III SEMESTER B.TECH. (MECHATRONICS ENGINEERING) END SEMESTER EXAMINATIONS, NOV 2019

SUBJECT: SENSORS AND INSTRUMENTATION [MTE 2155]

(28/11/2019)

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

✤ Answer ALL the questions.

(A constituent institution of MAHE, Manipal)

- Data not provided may be suitably assumed
- ✤ Graph sheets will be provided
- 1A. Explain the operation of the most appropriate transducers:
 - i) To measure the flow-rate of the fluid
 - ii) To measure the rpm of the turbine

For the following application:

A chemical industry manufacturing brine solution (electrically conductive solution) produces a huge quantity of waste water which should be treated before being disposed or recycled. The brine solution is passed through a turbine that rotates at a rate that is proportional to the rate of flow of the solution. Turbine also has toothed rotor to measure the speed. (Figure: 2M, explanation: 3M)

1B. Identify the type of characteristic analysis shown in Fig.Q2. Explain any two **03 CO1** characteristics of such type of analysis.



1C. Draw ladder logic to implement the below given Boolean expression:02

[MTE 2155]

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CO2

CO3

05

$$D = \left(\overline{\overline{A}B + \overline{C}}\right)(A + C)$$

Construct a ladder logic diagram that will implement the following function: 05 **CO2** 2A $X = \ln [10 + A(B\cos^{-1}(4C+5))^{2}]$ If the result is greater than 100, then an output light 'P' will be turned ON. A, B and C are inputs. **2B** Explain the construction and working principle of a suitable flow-meter for a 03 **CO3** ten-storey residential apartment, where water is to be pumped from the ground floor to the top floor. It is required to measure the flow-rate per hour for economical assessment. (Construction: 1.5 M, Working: 1.5M) 2C Compare Gravity control system and Spring control system in electromechanical 02 **CO1** devices. (Any four points) 3A (a) Explain the construction and operation of the pressure sensor used as part of 05 **CO3** Tyre pressure monitoring systems in automotive industry. These miniaturized pressure sensors are integrated into the tyres of the vehicles, either internally or externally to measure and monitor the pressure of tyres. And accordingly the driver gets the warning signal to avoid sudden tyre failure. (Construction: 1.5M, operation: 1.5M) (b)Explain the working principle of resistive strain gauge and how it can be part of Wheatstone bridge for measurement of applied force. (2M) **3B** Identify one OSI layer of networking for each of the below given services in 03 **CO4** industrial process automation: a) Sending E-mail b) Secured data transmission c) Error detection in the data **3C** Explain the working principle of the transducer with the help of a diagram, for 02 **CO3** the scenario where a group of students built a small remote controlled (RC) car and planned to measure the vibrations on the RC car. Due to torque constraints they could not afford for an additional power supply on the board. **4**A Explain the construction and working of a suitable encoder so that there is no 05 **CO3** loss of data in a small scale industry where power cuts are very often. Justify the selection of the encoder. (Construction: 2M, Working: 2M, Justification: 1M) **4B** Calculate the following for the given data: 03 **CO1** $R1 = 47 \ \Omega \pm 2\%$ and $R2 = 82 \ \Omega \pm 5\%$ a. The magnitude of error in each resistor b. The limiting error in ohms and in percent when the resistors are connected in series. c. The limiting error in ohms and in percent when the resistors are connected in parallel.

- 4C Discuss how rotational speed of ceiling fan can be measured using a non-contact 02 CO3 type measurement technique using light. (Working principle: 1M, Operation: 1M)
- 5A Explain the working principle of a suitable non-contact type temperature sensor 05 CO3 with an appropriate diagram, in the production of steel in a heating furnace. This temperature sensor must be used for the measurement of molten steel temperature (2000 °C) without affecting the process control metallurgical quality. Also, mention any four desirable properties of the materials which are looked into for the manufacturing of temperature sensors. (Figure: 1.5M, explanation: 1.5M, properties: 2M)
- 5B Draw ladder logic for the process in a production factory where a system
 o3 CO2
 produces certain number of yellow-colored and green-colored products. The system is limited to produce 348 products/day (including both the colors). The production unit is shut down once the desired count is reached. An LED is turned ON till the total number is 348 or less.
- 5C Describe the role of the following levels of networks in industrial process 02 CO4 automation:

a) Field levelb) Input-Output levelc) Process control leveld) Enterprise level