

CBCS SCHEME

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18MT731

Seventh Semester B.E. Degree Examination, Feb./Mar. 2022 Automation in Process Control

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Explain the block diagram of a process control system with relevant example. (10 Marks)
- b. Suppose a force of 400N must be applied to open a valve. Find the diaphragm area if a control gauge pressure of 70 kPa must provide this force. (05 Marks)
- c. Explain the following Control System Evaluation parameters.
(i) Stability (ii) Steady State regulation. (05 Marks)

OR

- 2 a. Briefly explain Final Control Operation with a block diagram. (10 Marks)
- b. What is an Electrical Actuator? Explain how solenoid converts electrical energy to mechanical energy with relevant diagrams. (10 Marks)

Module-2

- 3 a. Explain process characteristics of process control in detail. (10 Marks)
- b. A controller outputs a 4 to 20 mA signal to control motor speed from 140 to 600rpm with a linear dependence. Calculate (i) Current corresponding to 310 rpm.
(ii) The value of (i) expressed as the percent of control output. (10 Marks)

OR

- 4 a. Explain in detail about Control System parameters. (10 Marks)
- b. Analyse the following case study and plot a graph of water temperature versus time. The temperature of water in a tank is controlled by a two position controller. When the heater is off, the temperature drops at 2K per minute. When the heater is ON the temperature rises at 4K per minute. The set point is 323K and the neutral zone is $\pm 4\%$ of the set point. There is a 0.5 min lag at both the on and off switch points. Find the period of oscillation and plot the water temperature versus time. (10 Marks)

Module-3

- 5 a. Define the nature of discrete state process control system with a block diagram representation. (08 Marks)
- b. Explain how a discrete state process can be described in terms of the objectives and hardware of the process with examples. (12 Marks)

OR

- 6 a. Explain single variable and compound variable characteristics of a control. (05 Marks)

- b. A process requires adjustments of setpoint to increase production. A particular sequence must be followed to provide the increase. SP_1 , SP_2 and SP_3 are the setpoint, P and P_{CR} are the pressure and a critical pressure respectively and T and T_{CR} are the temperature and critical temperature respectively. Develop a flowchart that increase the setpoints as follows:
1. Increase SP_1 by 1%.
 2. Wait 10s, test for pressure compared to critical.
 3. If the pressure is less than critical then
 - a. Decrease SP_2 by $\frac{1}{2}\%$
 - b. Increase SP_3 by $\frac{3}{4}\%$
 - c. Wait for $T < T_{CR}$.
 - d. Increase SP_2 by 1%
 - e. Go to step 2
 4. If the pressure is above critical
 - a. Decrease SP_1 by $\frac{1}{2}\%$
 - b. Decrease SP_2 by $\frac{1}{4}\%$
 - c. Go to step 2. (08 Marks)
- c. Explain the following Process Loop tuning methods:
- (i) Open loop transient response method (07 Marks)
 - (ii) Ziegler – Nichols method. (07 Marks)

Module-4

- 7 a. What is Analog Controller? Explain the general features of Analog controller system. (07 Marks)
- b. Explain the error detector using a ground-based current and a differential amplifier of an electronic controller. (06 Marks)
- c. Level measurement in a sump tank is provided by a transducer scaled as 0.2 V/m. A pump is to be turned on by application of +5V, when the sump level exceeds 2.0m. The pump is to be turned back off when the sump level drops to 1.5m. Develop a two position controller with neutral zone made from OPAMP and a comparator. (07 Marks)

OR

- 8 a. Explain the need of composite control mode and explain Proportion-Integral control mode of analog electronic controllers using OPAMP. (10 Marks)
- b. Design a process control system that regulates light level by outputting a 0-10V signal to a lighting system that provides 30-180 lux. The sensor has transfer function of $-120\Omega/\text{lux}$ with a $10\text{ k}\Omega$ resistance at 100 lux. The setpoint is to be 75 lux and proportional control with a 75% proportional band has been selected. Draw the designed circuit using OPAMP. (10 Marks)

Module-5

- 9 a. What is V-F converter? Explain wide sweep multivibrator VFC, with relevant diagrams. (10 Marks)
- b. Explain Weighted Resistor DAC with an example of 4 bit binary weighted DAC. (10 Marks)

OR

- 10 a. What is FVC? Explain with relevant diagrams and equations. (10 Marks)
- b. Explain 12 bit, $6\ \mu\text{s}$ successive approximation DAC, with neat diagram. (10 Marks)

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