



Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Bioprocess Control and Automation

Time: 3 hrs.

Max. Marks:100

Note: Answer FIVE full questions, selecting at least TWO questions from each part.

PART - A

- 1 a. Classify the temperature and pressure measuring instruments. With a neat sketch explain any two types of pressure measuring instruments with their advantages and disadvantages. (10 Marks)
- b. Briefly explain the methods of on-line and off-line estimation of biomass. (10 Marks)
- 2 a. Define and explain mathematically the following forcing functions and their Laplace transforms:
 - (i) Step input
 - (ii) Linear input.
 - (iii) Sinusoidal input.
 - (iv) Exponential input. (10 Marks)
- b. Define first order system. Derive an expression for the transfer function of mercury in glass thermometer. (10 Marks)
- 3 Define an interacting system connected in series. Derive the transfer function for a two tank interacting system in terms of liquid level in second tank and input flow rate to first tank. Write the response equations for two tank interacting system for step and impulse input to the system. (20 Marks)
- 4 a. Define the following terms with mathematical equations for an under damped system:
 - (i) Overshoot
 - (ii) Decay ratio.
 - (iii) Rise time.
 - (iv) Period of oscillation (10 Marks)
- b. Define a second order system. Derive the transfer function for a U-Tube Manometer. (10 Marks)

PART - B

- 5 a. Briefly explain the following:
 - (i) Actuators. (10 Marks)
 - (ii) Positioners. (10 Marks)
- b. Derive the transfer function for (PI) Proportional Integral Controller, Proportional-Derivative (PD) Controller and (PID) Proportional-Derivative-Integral Controllers. (10 Marks)
- 6 a. Briefly explain servo and regulator problem. Derive the general transfer function for servo and regulator mechanism control problem with a neat block diagram. (10 Marks)
- b. The major elements of a closed loop control system are having following transfer function,

$$G_p(s) = \frac{1.5}{(s+1)(2s+1)}, G_c(s) = K_c$$

Transfer function for rest of components in the loop are unity. All time constants are in minutes. Determine the transient response for a unit impulse input in set-point at a controller gain, K_c that gives critically damped system. (10 Marks)

- 7 a. Define stability. Explain the rules to be followed to determine the stability of the system by Routh Herwitz test. (10 Marks)
- b. Open loop transfer function of a chemical process is given by,
- $$G(s) = \frac{K}{(s+1)(50s^2 + 12s + 0.5)}$$
- Find out the range of K for which this system is stable. What will be the frequency of sustained oscillation? (10 Marks)
- 8 a. Explain the state estimation technique for various parameters of a bioreactor. (10 Marks)
- b. Discuss different methods of sterilization in a bioreactor and discuss their merits and demerits. (10 Marks)

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