

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER– VI (New) EXAMINATION – WINTER 2019****Subject Code: 2160407****Date: 09/12/2019****Subject Name: Instrumentation and Control for Bioengineering****Time: 02:30 PM TO 05:00 PM****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1**
- (a) Derive Laplace transform of Ramp Function. **03**
- (b) Give mathematical equation for Initial Value Theorem and Final Value Theorem. **04**
- (c) Derive the transfer function for Mercury in glass thermometer clearly indicating the assumption made. What is the significance of time constant? **07**

- Q.2**
- (a) Define and explain the Time constant. **03**
- (b) Compare the two tank non-interacting and two tank interacting processes. Also write their transfer functions. **04**
- (c) Find the inverse of the following functions. **07**
- a)  $f(s) = \frac{1}{s(\tau_1 s + 1)(\tau_2 s + 1)}$
- b)  $x(s) = \frac{1}{s(s^2 - 2s + 5)}$

**OR**

- (c) Solve the following differential equation by Laplace Transform. **07**

$$\frac{d^3 x}{dt^3} + 2 \frac{d^2 x}{dt^2} - \frac{dx}{dt} - 2x = 4 + e^{2t}$$

$$x(0) = 1, x'(0) = 0, x''(0) = 1$$

- Q.3**
- (a) A control system has time constants of 1.5 minute and 2 minute and a P – controller. Obtain the response of the closed loop for a unit step change in the set point, and controller gain that gives a damping ratio of 0.5. **03**
- (b) Explain the various terms used to describe an under damped second order response. **04**
- (c) Discuss the transfer function for P, PI and PID controller and its merits and demerits. **07**

**OR**

- Q.3**
- (a) A proportional controller is used to control temperature within the range of 70°C to 100°C. The controller is adjusted so that the output pressure goes from 3 Psi to 15 Psi as the measured temperature goes from 72° to 75°C, with the set point held constant. Find the gain and proportional band. **03**
- (b) Explain advantages and disadvantages of higher gain  $K_c$ . **04**
- (c) A thermometer with time constant 7 sec showing a steady temperature of 30°C is suddenly immersed in heated oil bath at 150°C. Find **07**
- a) Time required for temperature reading of 100°C.
- b) Time required for the 80 % response

- Q.4**
- (a) What are parts of a measuring instrument? **03**
- (b) Explain dynamic and Static characteristics of an instrument. **04**
- (c) Discuss pressure spring thermometer. **07**

**OR**

- Q.4**
- (a) Describe various viscosity measurement methods? **03**

- (b) Explain the working of any one type of pyrometer. **04**  
(c) Write a note on Bellows differential pressure element with neat sketch. **07**

- Q.5** (a) What is a second order process? Write its transfer function. **03**  
(b) Plot Bode diagram for First order control system. **04**  
(c) What is thermal well? Why is it used? How thermal well affect the dynamic response of the thermometer? **07**

**OR**

- Q.5** (a) Define Amplitude ratio and Phase angle. **03**  
(b) List different flow meters used in industry. Explain working of Venturimeter. **04**  
(c) Draw a schematic diagram for displacement float liquid level gage and describe in details. **07**

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