Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER V • EXAMINATION – WINTER - 2012

Subject code: 150504 **Date: 16-01-2013**

Subject Name: Instrumentation and Process Control

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)** Solve the following differential equation by Laplace transform. **07**

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

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

(b) 1) Define and explain the following terms **03**

i) Time constant
ii) Damping parameter
iii) stability of the process

2) Write short notes on the following **04**

i) Feedback and feed forward control system
ii) Classification of process variables

Q.2 **(a)** Define and Explain the following terms **07**

1) Accuracy 2) Static error 3) Drift 4) Reproducibility 5) Span of an instrument 6) Dead zone 7) Sensitivity of instrument

(b) Derive the transfer function of mercury thermometer. Determine the response equation of mercury thermometer for impulse forcing function. **07**

OR

(b) Two interacting tanks are operating at a steady state flow rate of $4\times10^{-3} m^3/\min$. At time t= 0, the inlet flow rate to the 1st tank is suddenly increased to $14 \times10^{-3} m^3/\min$. **07**

Data:

$A_1 = A_2 = 0.04 m^2$ $R_1 = 100 min/m^2$ $R_2 = 150 min/m^2$

Find the height in the level of each tank as a result of this disturbance.

Q.3 **(a)** The transfer function of the second order control system is given as, **07**

$$G(s) = \frac{5}{2S^2 - 1.63S + 5}$$

A step change of magnitude 5 is given in the input variable. Determine,

1) Overshoot 2) Rise time 3) Period of oscillation
4) Maximum value of response

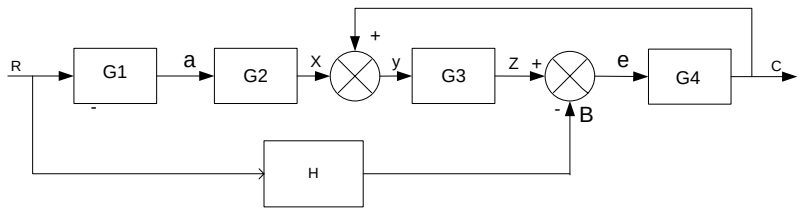
(b) Define second order system. Derive the transfer function of U-Tube Manometer in which pressure P is acting in one limb and other limb is open to **07**

the atmosphere.

OR

Q.3 **(a)** A proportional derivative controller having the gain Kc and the derivative time is 4 is used to controller two first order non-interacting systems having time constant τ_1=1 and τ_2=0.5. If the gain of the process is 0.5. Sketch the Root locus diagram for the control system. The transfer function of the measuring element is 1/S. **07**

(b) 1) Determine the overall transfer function C(s)/R(s) for the system shown in the following figure. **04**



2) Derive the offset for first order system controlled by proportional controller and unit step change is given to set point. **03**

Q.4 **(a)** Starting with the principal and working, explain the construction of Bimetallic thermometer with neat sketch. **07**

(b) Define Amplitude ratio and Phase angle. Plot Bode diagram for First order control system. **07**

OR

Q.4 **(a)** With the help of neat sketch, describe pneumatic balance pressure thermometer. Also discuss disadvantages of it. **07**

Q.4 **(b)** Write a note on Bellows differential pressure element with neat sketch. **07**

Q.5 **(a)** Determine the stability of the system having the open loop transfer function given as, **07**

$$G(s) = \frac{Kc}{s(s+1)(s+2)}$$

Use Routh criterion. Determine the value of gain of the controller for which the system just causes instability.

(b) Describe variable area meter with neat figure. Also explain the methodology for determination of flow rate with equation. **07**

OR

Q.5 **(a)** Explain the liquidometer for level measurement of liquid. State its limitations. **07**

(b) Draw a schematic diagram for displacement float liquid level gage and describe in details. **07**

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