

Seat No.: \_\_\_\_\_

Enrolment No. \_\_\_\_\_

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**BE SEM-VI Examination-Nov/Dec-2011**

**Subject code: 160404**

**Date: 28/11/2011**

**Subject Name: Instrumentation and Process Control**

**Time: 10.30 am -1.00 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)**

1) Solve the following function for x(t) **04**

$$\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + 2x = 2$$

$$x(0) = x'(0) = 0$$

**03**

2) Invert the following function by Laplace Transform.

$$x(s) = \frac{1}{s(s^2 - 2s + 5)}$$

**(b)** Define second order system. A manometer 60 cm long and 6.3 mm inside diameter glass tube is half filled with water. The manometer is subjected to a pressure differential of 3500 N/m<sup>2</sup>. Determine the following: **07**

- 1) Time constant
- 2) Damping coefficient.

Indicate, if the manometer is suitable. Suggest design of the manometer considering the initial transient state. Take viscosity of water=1 mN-s/m<sup>2</sup> and the density of water =1000 kg/m<sup>3</sup>.

**Q.2 (a)** Derive and explain the several features of step response of first order system. **07**

**(b)** Define Interacting and Non-interacting system. Derive the transfer function for non-interacting multi capacity control system in series. **07**

**OR**

**(b)** The overall transfer function of the control system is given as, **07**

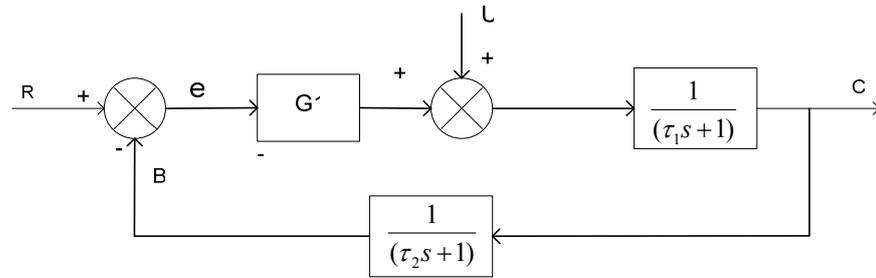
$$G(s) = \frac{16}{1.5s^2 - 2.4s + 6}$$

A step change of magnitude 6 is introduced into the system. Determine,

1) Overshoot    2) Period of oscillation    3) Natural period of oscillation

4) Rise time    5) Ultimate value of response    6) Maximum value of response

- Q.3 (a)** Obtain the transfer function  $C(s)/R(s)$  for the block diagram shown in the figure. **07**



- (b)** Define Servo problem and Regulator problem. A PD controller is used to control first order system with first order measuring element. Determine the expression for the offset for servo mechanism control system. **07**

**OR**

- Q.3 (a)** What are static characteristic of an instrument? Define  
1) Accuracy 2) Reproducibility 3) Sensitivity **07**

- (b)** Describe the principle, construction and working of thermocouple used for temperature measurement. **07**

- Q.4 (a)** A proportional controller having gain  $K_c$  is used to control two non-interacting liquid level tanks having time constant  $\tau_1=1$  and  $\tau_2=0.5$ . For the unit feedback control system. Determine the stability of the system using Routh criterion. **07**

- (b)** Describe the construction and working of the optical pyrometer with neat figure. **07**

**OR**

- Q.4 (a)** The open loop transfer function of a control system is given as, **07**

$$G(s) = \frac{Kc(0.5s + 1)}{s(s + 1)(s + 0.5)}$$

Sketch the root locus diagram of the control system. Indicate open loop poles and zeros, breakaway point, asymptotic lines, the direction in which the locia travel.

- (b)** Describe the principle, construction and working of electromagnetic flow meter. What are its advantages and limitations? **07**

- Q.5 (a)** Define amplitude ratio and phase angle. Plot the Bode diagram for the first order control system. **07**

- (b)** What are the different types of the manometer? Explain in detail the enlarged lag manometer with the help of neat figure. **07**

**OR**

- Q.5 (a)** Derive the response equation for the under damped second order control system for step forcing function. **07**

- (b)** Describe the principle, construction and working of rotameter. **07**