



Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/B.Tech(CHE)/OLD/SEM-6/CHE-603/2013**

**2013**

**INSTRUMENTATION AND PROCESS CONTROL**

Time Allotted : 3 Hours

Full Marks : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words  
as far as practicable.*

**GROUP – A**

**( Multiple Choice Type Questions )**

1. Choose the correct alternatives for any *ten* of the following :

$$10 \times 1 = 10$$

- i) What is the Laplace transform of  $\sin t$  ?

- a)  $\frac{1}{s^2 + 1}$                       b)  $\frac{s}{s^2 + 1}$   
c)  $\frac{1}{s^2 - 1}$                       d)  $\frac{s}{s^2 - 1}$ .

- ii) Response of a system to a sinusoidal input is called

- a) Impulse response              b) Unit step response  
c) Frequency response              d) None of these.



- iii) Time constant is
- The time taken by the controlled variable to reach 63.2% of its full change
  - Same as transportation lag
  - Same as dead time
  - The time required by the measured variable to reach 63.2% to its ultimate change.
- iv) Degree to which an instrument indicates the changes in measured variable without dynamic error is called
- Speed of response
  - Reproducibility of instrument
  - Fidelity
  - its static characteristics.
- v) Which of the following relates the absorption and evolution of heat at the  $j$  junctions of a thermocouple to the current flow in the circuit ?
- Seebeck effect
  - Peltier effect
  - Joule heating effect
  - Thomson effect.
- vi) Pirani gauge is used to measure
- Measurement of very high pressure
  - Measurement of very high vacuum
  - Liquid level under pressure
  - Liquid level at atmospheric pressure.



- vii) Hot wire anemometer is used for the measurement of
- a) Flow rate of fluid
  - b) Very high temperature
  - c) Thermal conductivity of gases
  - d) None of these.
- viii) Thermistor is a
- a) Semiconductor whose resistance decreases with temperature rise
  - b) Metal whose resistance increases linearly with temperature rise
  - c) Metal whose resistance does not vary with temperature
  - d) Device for measuring nuclear radiation.
- ix) The frequency at which maximum amplitude ratio is attained is called
- a) Corner frequency      b) Resonant frequency
  - c) Cross over frequency      d) Natural frequency.
- x) On-Off control is a special case of ..... Control.
- a) Proportional (P)
  - b) Proportional Integral (PI)
  - c) Proportional Derivative (PD)
  - d) Proportional Integral Derivative (PID).



- xi) Which of the following controllers has got the smallest maximum deviation ?
- a) Proportional (P)
  - b) Proportional Integral (PI)
  - c) Proportional Derivative (PD)
  - d) Proportional Integral Derivative (PID).
- xii) Which stability method uses open loop transfer function for stability analysis ?
- a) Bode
  - b) Root locus
  - c) Nyquist
  - d) All of these.

### GROUP – B

#### ( Short Answer Type Questions )

Answer any *three* of the following.  $3 \times 5 = 15$

2. What is dynamic measurement ? What is dead zone of an instrument ? Elaborate the statement “precise measurement may not necessarily be accurate or vice versa.  $1 + 1 + 3$
3. What are RTDs and thermocouples ?
4. What is the steady state output of a process  $\left( G_p(s) = \frac{2s}{s^2 + 3s + 2} \right)$  for a step input of magnitude 5 ?



5. The characteristic equation of a system is given by,

$$s^4 + 3s^3 + 5s^2 + 4s + 2 = 0$$

Determine the stability of the system by Routh Harwitz method.

6. Write the difference between closed and open loop systems.  
Why the derivative controller cannot be used independently ?

3 + 2

### GROUP – C

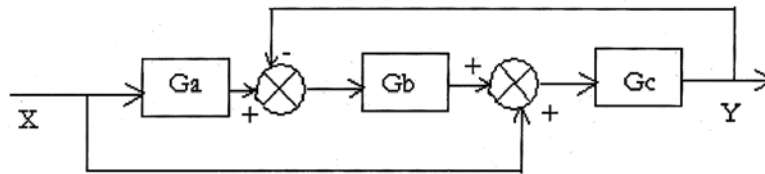
#### ( Long Answer Type Questions )

Answer any *three* of the following.  $3 \times 15 = 45$

7. a) Describe the construction and operation of a pirani gauge. 5
- b) Discuss the principle of operation of any one composition measurement device. 4
- c) With a schematic diagram explain construction and operation of a total radiation pyrometer. 6
8. a) Unit impulse response of a system is given by  $y(t) = (t/\tau^2)e^{-t/\tau}$  where the terms have their usual meaning. Obtain the expression for unit step response of this system. 5



- b) Liquid flows into a tank at the rate of  $q \text{ m}^3/\text{s}$ . The tank has three vertical walls and one sloping outwards at an angle  $\beta$  to the vertical. The base of the tank is a square with sides of length  $x \text{ m}$  and the average operating level of liquid in the tank is  $h_s \text{ m}$ . If the relationship between liquid level and flow out of the tank at any instant is linear, develop a formula for determining the time constant of the system. 10
9. a) A step change of magnitude 10 is introduced into a system having the transfer function  $\frac{Y(s)}{X(s)} = \frac{10}{s^2 + s + 0.16}$ . Determine Per cent Overshoot, Rise time, Maximum value of  $Y(t)$ , Period of oscillation. 10
- b) Discuss the utility of phase and gain margin in stability analysis. What is proportional band of a controller ? 5
10. a) Determine the transfer function  $Y(s)/X(s)$  for the block diagram as shown below. Express the results in terms of  $G_a$ ,  $G_b$  and  $G_c$ .



5

- b) Consider the feed back control system for which the open loop transfer function is given by  $G(s) = \frac{K}{s(s+2)(s+1)}$ . Showing all the steps clearly, sketch the root locus diagram for the system. 10



11. a) The overall transfer function of a system is given by

$$Gp(s) = \frac{2.5.e^{-0.1s}}{3s + 1}$$

Find the PID controller settings using Ziegler Nichols rules. 8

- b) Explain cascade control and feed forward control. 7

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