#### B.TECH/CHE/6<sup>TH</sup> SEM/CHEN 3201(BACKLOG)/2021

## PROCESS DYNAMICS, INSTRUMENTATION AND CONTROL (CHEN 3201)

**Time Allotted : 3 hrs** 

Full Marks: 70

 $10 \times 1 = 10$ 

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and <u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

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

### Group – A (Multiple Choice Type Questions)

- 1. Choose the correct alternative for the following:
  - (i) Mc Leod gauges are usable upto a pressure of
     (a) 10<sup>-3</sup> Torr
     (b) 10<sup>-4</sup> Torr
     (c) 1 Torr
     (d) 10<sup>-6</sup> Torr
  - (ii) For measuring the temperature of a red hot furnace, which is the most suitable instrument?
    - (a) Platinum resistance thermometer(c) Optical pyrometer
      - r (b) Thermocouple
      - (d) Bimetallic thermometer
  - (iii) Rapidity with which the instrument responds to the change in input is termed as

     (a) fidelity
     (b) speed of response
     (c) sensitivity
     (d) accuracy
  - (iv) In case of step response of a second order system two complex conjugate roots are obtained
     (a) critically damped
     (b) underdamped
     (c) overdamped
     (d) pseudo
  - (v) Pneumatic valve exhibits

     (a) first-order dynamics
     (b) inherently second order dynamics
     (c) multicapacity system in series
     (d) none of these
  - (vi) Routh test
    - (a) cannot determine as to how many roots of the characteristics equation have positive real roots
    - (b) cannot be used to test the stability of a control system containing transportation lag
    - (c) criterion is not applicable to systems with polynomial characteristic equation
    - (d) criterion provides information about the actual location of roots.

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(vii)	Which of the following controllers has maximum offset?				
	(a)PI	(b)P	(c) PD	(d) PID	
(viii)	Bode diagram are generated from output response of the system subjected which of the following input?				
	(a) Impulse	(b) ramp	(c) sinusoidal	(d) step	
(ix)	Phase lag of the frequency response of a second order system to a sinus forcing function is				
	(a) 30°	(b)90°	(c) 180°	(d) 120°	
(x)	The second order system with the transfer function $4/(s^2+2s+1)$ has a damping ratio of				
	(a) 2.0	(b) 0.5	(c) 1.0	(d) 4.0	

#### Group – B

- 2. (a) Explain the working principle of resistance temperature detector. State its advantage and disadvantages.
  - (b) Mention and discuss the static characteristics of an instrument.
  - (c) Discuss the working principle of pirani gauge.

(3+2) + 3 + 4 = 12

- 3. (a) A thermometer having a time constant of 0.1 min placed in a temperature bath, and after the thermometer comes to equilibrium with the bath, the temperature of the bath is increased linearly with time at a rate of 2<sup>0</sup>/min. Find the response as a function of time. Find the dynamic error after 1 min.
  - (b) Discuss the working principle of one flow meter.
  - (c) Mention the desirable properties of a thermocouple. Give one example.

(5+2) + 3 + 2 = 12

## Group – C

- 4. (a) Consider the reaction  $A \rightarrow B$  is occurring at a rate  $r = kC_o$  in a continuous stirred tank reactor where  $C_o$  is the concentration of A in reactor. If  $C_i$  be the concentration of A in feed stream, F, the constant feed rate, V, the volume of mixture in reactor, derive the transfer function relating  $C_o$  to  $C_i$ , assuming constant density and constant V.
  - (b) Show that a pneumatic valve exhibits an inherent second-order dynamics.
  - (c) In case of response of a 2<sup>nd</sup> order system, discuss the following terms:
    - (i) percent overshoot
    - (ii) period of oscillation.

6 + 4 + 2 = 12

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- 5. (a) What do you understand by SISO and MIMO system?
  - (b) Obtain the expression of response following a step input to a 2<sup>nd</sup> order over damped system.
  - (c) A stream of solution containing dissolved salt flows at a constant volumetric flow rate q into stirred a tank of constant holdup volume V. The concentration of salt in the entering stream x varies with time. Determine the transfer function relating the outlet concentration y to the inlet concentration x.
  - (d) Obtain the expression of amplitude ratio and phase lag of the frequency response from a 2<sup>nd</sup> order system.

2 + 5 + 3 + 2 = 12

# Group – D

- 6. (a) Deduce the characteristic expression for the feedback control system. Define servo and regulatory problem for a feedback control system.
  - (b) Describe the characteristics of ON-OFF and Single speed floating controllers.

(5+5)+2=12

- 7. (a) Shows that the liquid level of a tank with constant discharge at the outlet will be controlled effectively using P-controller.
  - (b) Derive the dynamic response of a second order system for critically dampened system

8 + 4 = 12

#### **Group – E**

8. Consider the feedback control system for which the open loop transfer function is given by. Showing all the steps clearly, sketch the root locus diagram for the system.  $G(s) = \frac{K(s+1)}{(s+2)(s+3)}.$ 

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- 9. (a) Write the advantages and disadvantages of Bode stability and Nyquist stability analyses.
  - (b) What is cross-over frequency? Discuss the Bode stability plot for the two process connected in series with the transfer function of  $G_1(s) = 1/(2s+1)$  and  $G_2(s) = 6/(5s+1)$ , respectively.

4 + 8 = 12

Department & Section	Submission Link
СНЕ	https://classroom.google.com/c/Mjk2ODgzMjM3Mjgx/a/MzY0NTU4MzE4ODE2/details