

Group - E

8. (a) How do you define stable and unstable responses of process? What is the difference between open-loop unstable and closed-loop unstable?
- (b) Write the merits and demerits of Routh-Hurwitz stability criteria for control system. Derive the stability condition using Routh-Hurwitz criterion for the following characteristic polynomial equation,
- $$s^3 + 2s^2 + (2 + k_c)s + \frac{k_c}{\tau_I} = 0.$$

(2 + 1) + (3 + 6) = 12

9. (a) Write the difference between Bode plot and Nyquist plot. Write the significance of gain margin.
- (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.

(2 + 2 + 2) + (2 + 4) = 12**PROCESS DYNAMICS, INSTRUMENTATION AND CONTROL
(CHEN 3201)****Time Allotted : 3 hrs****Full Marks : 70*****Figures out of the right margin indicate full marks.******Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one 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: **10 × 1 = 10**
- (i) Mercury- in-glass thermometer is an example of
 (a) zero order system (b) first order system
 (c) second order system (d) none of these.
- (ii) _____ is the largest range of values of a measured variable to which the instrument does not respond.
 (a) Drift (b) Sensitivity
 (c) Dead zone (d) Fidelity.
- (iii) Following a step change to a under damped second order system, the rise time will with increase in damping factor
 (a) increase (b) decrease
 (c) not change (d) oscillate.
- (iv) For measuring the temperature of a high temperature furnace, the most suitable instrument is
 (a) platinum resistance thermometer (b) thermocouple
 (c) bimetallic thermometer (d) optical pyrometer.
- (v) Decay ratio is equal to
 (a) overshoot (b) (overshoot)²
 (c) (overshoot)^{0.5} (d) none of these.
- (vi) A negative gain margin expressed in decibels means a/an----- system
 (a) stable (b) unstable
 (c) critically damped (d) none of these.

- (vii) Which of the systems having following transfer functions is stable?
 (a) $1/(s^2+2)$ (b) $1/(s^2-2s+3)$
 (c) $1/(s^2+2s+2)$ (d) $\text{Exp}(-20s)/(s^2+2s-1)$.
- (viii) A proportional controller with a gain of K_c is used to control a first order process. The offset will increase, if
 (a) K_c is reduced
 (b) K_c is increased
 (c) integral control action is introduced
 (d) none of these.
- (ix) 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.
- (x) At very large values of radian frequency, phase lag of the frequency response of a second order system to a sinusoidal forcing function approaches to
 (a) 30° (b) 90°
 (c) 180° (d) 120° .

Group - B

2. (a) Explain the working principle of resistance temperature detector. Also state its advantages and disadvantages.
 (b) A mercury-in-glass thermometer having a time constant of 0.12 min. and equilibrated with ambient temperature of 25°C has suddenly been placed in a constant temperature bath maintained at 75°C . Find the error if the reading is taken after 2 min.
 (c) What do you understand by 'pressure transducer'? What do you understand by 'piezoelectricity'?
- 5 + 4 + (2 + 1) = 12**
3. (a) State the difference in working principle between thermocouple and thermistor. Give example of each type.
 (b) Mention the pressure range that can be measured by U tube manometer, Bourdon tube, bellows and diaphragm.

- (c) Discuss the working principle of Bourdon tube.

6 + 2 + 4 = 12**Group - C**

4. (a) A pure capacitive system can be named as a pure integrator-justify.
 (b) Two interacting liquid-level tanks are connected in series. The time constants are 1.0 min and 0.7 min., respectively. The cross-sectional area of first and second tanks are 1 m^2 and 0.8 m^2 , respectively. The resistance in the second tank is $1 \text{ m}^3/\text{min}$. Obtain the dynamic response of the level in tank 2 if the inlet flowrate to tank 1 is increased by $0.05 \text{ m}^3/\text{min}$, at time $t = 0$.
- 5 + 7 = 12**
5. (a) Give an example of critically damped system.
 (b) For a tank of cross-sectional area 100 cm^2 and inlet flowrate q_i (in cm^3/s), the outlet flow rate, q_o (in cm^3/s) is related to the liquid height, h (in cm) as $q_o = 2\sqrt{h}$. Obtain the transfer function of the process around the steady-state point, $q_{is} = 16 \text{ cm}^3/\text{s}$ and $h_s = 35 \text{ cm}$.
 (c) Obtain the expression of frequency response from a first order system. How does the amplitude ratio and phase lag of frequency response differ between first order and second order system?

1 + 4 + (5 + 2) = 12**Group - D**

6. (a) Deduce the expression of an offset for the servo and regulatory problem for a first order process using proportional control action.
 (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) With a block diagram, explain working of cascade process control system. What is wild stream?

8 + (3 + 1) = 12