

- (vii) Process history or past system response is not accounted for
- (a) P controller (b) PI controller
(c) PID controller (d) None of these.
- (viii) In general a closed loop transfer function becomes equal to the open loop transfer function when.
- (a) $K_c = 10$ (b) K_c is positive and increasing
(c) $K_c = 0$ (d) None of these.
- (ix) The frequency response of a first order system has a phase shift with lower and upper bounds given by
- (a) $-\infty, \pi/2$ (b) $-\pi/2, \pi/2$ (c) $-\pi/2, 0$ (d) $0, \pi/2$.
- (x) Bode diagram is a plot of
- (a) $\log(AR)$ vs $\log(f)$ and ϕ vs $\log(f)$
(b) $\log(AR)$ vs f and ϕ vs f
(c) AR vs $\log(f)$ and ϕ vs $\log(f)$
(d) none of these.

Group – B

2. (a) State the desirable properties of industrial thermocouple. Mention the different types of thermocouples used industrially.
(b) Discuss the working principle of a pyrometer.
(c) The power radiated from a hot piece of metal was measured by the radiation pyrometer and the temperature was determined as 820°C assuming a surface emissivity of 0.75. Later it was found that the accurate value of emissivity was 0.67. Find the error in the temperature distribution.

(2 + 2) + 4 + 4 = 12

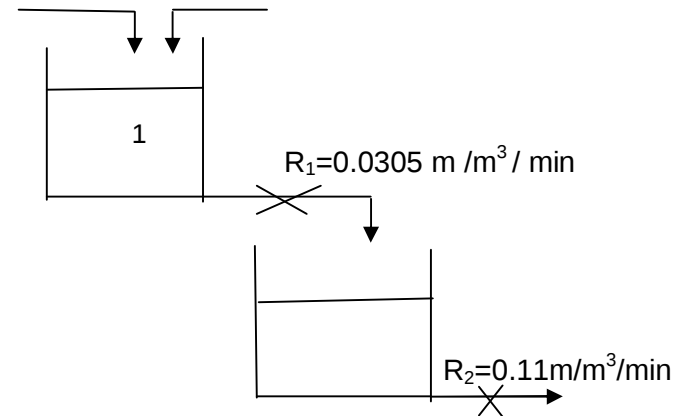
3. (a) Write down the desirable characteristics of a manometric liquid.
(b) Write down the working principle of a pirani gauge.
(c) Discuss the static and dynamic characteristics of instruments.

3 + 4 + 5 = 12

Group – C

4. (a) What do you understand by transportation lag? Derive the transfer function.

4. (b)



The two tank system shown in fig. above is operating at steady state. At time $t=0$, 1m^3 of water is quickly added to the first tank. Determine the maximum deviation in level from the steady state value in the second tank and the time at which the maximum occurs. The cross-sectional area of each tank is 1 m^2 .

3 + 9 = 12

5. (a) A mercury thermometer having a time constant of 0.12 min is placed in a constant temperature bath at 60°C and allowed to come to equilibrium with the bath. At time $t = 0$, the temperature of the bath begins to vary sinusoidally about its average temperature of 60°C with an amplitude of 4°C . If the frequency of oscillation is $10/\pi$ cycles/min,
- i) obtain the ultimate response of the thermometer reading as a function of time,
ii) find out the phase lag, in minute
- (b) A step change of magnitude 3 is introduced into the transfer function

$$\frac{Y(s)}{X(s)} = \frac{10}{[2s^2 + 0.3s + 0.5]}$$

Determine the overshoot and the frequency of oscillation.

- (c) Give an example of a pure capacitive system and obtain its transfer function. Why this system is called a pure integrator?

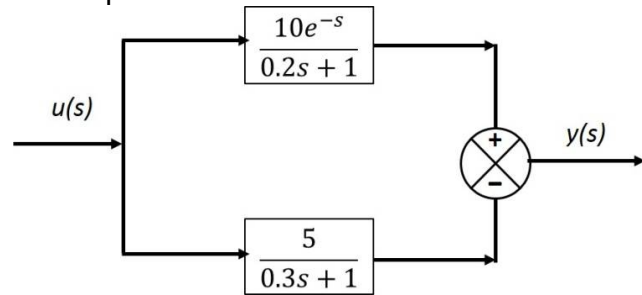
(4 + 1) + 4 + 3 = 12

Group – D

6. Describe the effect of proportional control on the response of a controlled first order process with step input to the set-point and disturbance, respectively. Show that the off-set for servo and regulatory control are equal to $\frac{1}{1+k_p k_c}$ and $\frac{-k_d}{1+k_p k_c}$, respectively. (Consider usual notation).

12

7. (a) The block diagram given below shows the process with the combination of two first order process, one with dead time and other without a dead time. Find the ultimate output response of the process with sinusoidal input at the set point.



- (b) What are the objectives of a control system?

10 + 2 = 12**Group – E**

8. (a) Draw the root locus diagram for the open loop transfer function

$$G(s) = \frac{k}{(s+1)(s+2)(s+3)}$$

- (b) Describe the controller tuning with 1/4 Decay ration criterion.

7 + 5 = 12

9. (a) Define stability of a control system. State and explain Routh - Herwitz criteria for stability.
- (b) Draw the Bode diagram for the two first order system connected in series having transfer functions

$$G_1(s) = \frac{1}{2s+1} \text{ and } G_2(s) = \frac{5}{6s+1}, \text{ respectively}$$

(2 + 5) + 5 = 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**
- The degree of closeness with which the output reproduces the time-varying input within a conversion factor in an instrument is called
(a) drift (b) sensitivity (c) fidelity (d) linearity.
 - Thermistors are made of
(a) ultra pure metal (b) metal oxides
(c) iron-copper alloys (d) nickel-chromium alloys.
 - Which of the following relates the absorption and evolution of heat at the junctions of a thermocouple to the current flow in the circuit?
(a) Thomson effect (b) Peltier effect
(c) Seeback effect (d) Joule heating effect.
 - McLeod gauge measures pressure.
(a) positive (b) sub-atmospheric
(c) very high (d) none of these.
 - Use of PI-control along with P-control facilitates
(a) elimination offset (b) reduction of offset
(c) reduction of stability time (d) none of these.
 - Number of poles in a system with transfer function $\frac{1}{s^2 + 2s + 1}$ is
(a) 2 (b) 5 (c) 3 (d) none of these.