(vi) Which of the following is the input to a controller?
 (a) Servo signal    (b) Desired variable value
 (c) Error signal    (d) Sensed signal.

(vii) Fuzzy control can be used in
 (a) linear system    (b) nonlinear system
 (c) complex system    (d) all of these.

(viii) COA is a
 (a) fuzzification technique    (b) defuzzification technique
 (c) normalization technique    (d) denormalization technique.

(ix) Reset rate is the another term used for _____ time
 (a) integral    (b) derivative    (c) dead    (d) delay.

(x) If TF of a single tray in a Distillation column is $\frac{k}{(Ts+1)}$, then TF for 50 tray will be
 (a) $\frac{50k}{(Ts+1)}$    (b) $\frac{k}{(Ts+1)^{50}}$    (c) $\frac{k}{(50Ts+1)}$    (d) $\frac{k}{(Ts+50)}$ .

## Group – B

2.(a)  Explain the importance of process modelling and identification.

(b)  A jacketed heat exchanger heated by steam flow is shown in Fig. Develop a mathematical model of the system for the parameters given below:
Inlet fluid temperature and flow rate: $T_i$ and q.
Outlet temperature and flow rate: $T_o$ and q.
Steam (Jacket) temperature and Heat transfer area of walls: $T_s$ and F.
Heat transfer coefficient = $\alpha$, Specific heat capacity: $C_p$, Inside Volume of heat exchanger = V.



Input Reactant
Ti
Output
To
Steam
Ts
Condensed Steam

**Jacketed Stirred Reactor**
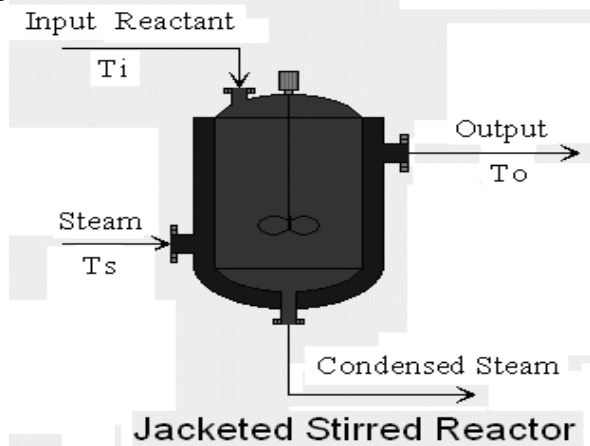
4 +8 = 12

3. (a)  Draw the process reaction curve for a typical second order over damped system for unit step input and indicate the different design parameters involved in it.

(b)  The study of the process reaction curve of an unidentified system with unit step input provides the following data:
First moment ($m_1$) = 3.5 minutes,
The tangent drawn along the straight line portion of the plot has a slope $M_i$ = 0.2 unit / minute, and it intersects final value c(t) = 1 (set-value) line at $t_m$ = 5.1 minute.
Approximate this unknown process by a second order plus dead time model (Given $\lambda$ vs. $\eta$ plot, where $\lambda = (t_m - m_1) M_i$ and $\eta = \tau_1 / \tau_2$ ).
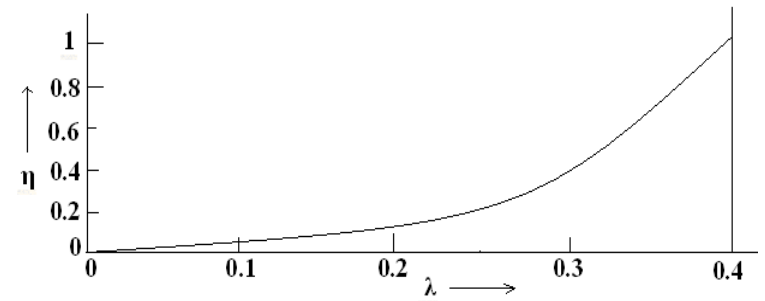


5 + 7 = 12

## Group – C

4. (a)  Develop the transition matrix ($\Phi$) for the given digraph with 8 subsystems.
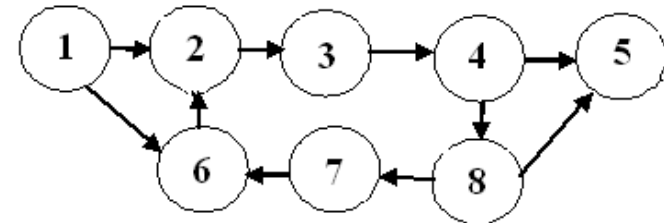


(b)  Construct interconnection matrix (H) from the transition matrix ($\Phi$) derived from the above diagraph.

6 + 6 = 12

## Group – D

5. (a) Show different steps of multi-level control system with block diagram and write the major advantages of the scheme.

(b) Why coordination problem is encountered in multilevel control? Develop a scheme for steady-state optimization of the overall system.

$$(4 + 2) + (2 + 4) = 12$$

### Group – D

6. (a) How adaptive control is different from conventional control?

(b) Present the MIT rule for a closed loop system.

(c) Illustrate Model Reference Adaptive System (MRAS) with block diagram for adjustment of a feed forward gain based on MIT rule.

$$2 + 4 + 6 = 12$$

7. (a) Develop a self-tuning adaptive scheme that can automatically tune the controller parameters for effective control.

(b) Design an open loop adaptive control scheme for zinc deposition in a Hot-dip galvanizing process.

$$6 + 6 = 12$$

### Group – E

8. (a) Give an outline diagram about temperature control of an oven.

(b) Design a scheme for metal rolling process to control and measure thickness and flatness of metal sheet.

$$4 + 8 = 12$$

9. (a) When a distillation column, as a separation unit, is not preferred?

(b) Derive the column dynamics of a Distillation Column consisting of 10 horizontal bubble cap tray.

(c) How temperature gradient and pressure difference influence the separation of products in a distillation column?

$$2 + 4 + 6 = 12$$

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### PROCESS CONTROL SYSTEM DESIGN
### (AEIE 5201)

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) The z-transform of $e^{-akT}$ is

(a) $\dfrac{z}{z-a}$    (b) $\dfrac{z}{z-k}$    (c) $\dfrac{z}{z-e^{-aT}}$    (d) $\dfrac{z}{z-ke^{-aT}}$ .

(ii) The z-transform of Laplace function $\dfrac{1}{s}$ is

(a) $\dfrac{z}{z-e^{-T}}$    (b) $\dfrac{Tz}{z-T}$    (c) $\dfrac{1}{z-1}$    (d) $\dfrac{z}{z-1}$ .

(iii) Transfer function of a system is used to calculate which of the following?
(a) The order of the system
(b) The time constant
(c) The output for any given input
(d) The steady state gain.

(iv) In electrical-pneumatic system analogy, the pressure is considered analogous to
(a) current
(b) voltage
(c) power
(d) air flow rate.

(v) The transfer function technique is considered as inadequate under which of the following conditions?
(a) Systems having complexities and non-linearities
(b) Systems having stability problems
(c) Systems having multiple input disturbances
(d) All of the above.