

INDUSTRIAL AUTOMATION
(AEIE 3223)

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) In terms of human participation in the processes performed by the manufacturing systems, the basic categories can be distinguished as
 - (a) manual work systems
 - (b) worker-machine systems
 - (c) automated systems
 - (d) all of the mentioned.
 - (ii) Product design variations can be achieved from
 - (a) fixed automation systems
 - (b) flexible automation systems
 - (c) programmed automation systems
 - (d) both (b) and (c).
 - (iii) The top level of the automation pyramid is known as
 - (a) Manufacturing Execution Systems (MES)
 - (b) Enterprise Resource Planning (ERP)
 - (c) Supervisory level
 - (d) Control level.
 - (iv) Process model developed using the principles of chemistry, physics, and biology is known as
 - (a) empirical approach
 - (b) theoretical approach
 - (c) semi-empirical approach
 - (d) any of the above.
 - (v) The process with transfer function $G(s) = \frac{K}{s}$ is an example of a
 - (a) linear lag system
 - (b) purely capacitive system
 - (c) exponential transfer lag system
 - (d) first-order lag system.
 - (vi) For modelling of a stirred tank heater system principle of _____ conservation need to be considered.
 - (a) total mass
 - (b) momentum
 - (c) total energy
 - (d) both (a) and (c)

- (vii) To realize FF control, response speed of disturbance path must be
 (a) slower than that of control path (b) faster than that of control path
 (c) equal to that of control path (d) independent that of control path.
- (viii) The transfer function of a 4 second transportation lag element is
 (a) $\frac{1}{(s+4)}$ (b) e^{4s} (c) e^{-4s} (d) $e^{-s/4}$
- (ix) Switching of the communication packets among different network segments by defining the suitable path is the function of
 (a) Repeater (b) Router (c) Bridge (d) Gateway.
- (x) The full-duplex mode of communication is used in
 (a) Radio (b) Walkie-Talkies (c) Keyboard (d) Telephone.

Group - B

2. (a) What is manufacturing system? Describe the categories of manufacturing systems in terms of human participation in the processes.
 [(CO1)(Understand/LOCQ)]
 (b) Discuss the relative strength of machines over the humans in automation.
 [(CO1)(Analyse/IOCQ)]
 (c) What do you mean by fixed automation system? [(CO1)(Remember/LOCQ)]
6 + 4 + 2 = 12
3. (a) State the advantages of automation in manufacturing process.
 [(CO6)(Remember/LOCQ)]
 (b) The blending process shown in Fig. 1. If the nominal value of x_1 is $x_{1,0}$, what nominal flow rate w_2 is required to produce the desired outlet concentration of x_0 ? Draw the control scheme.
 [(CO2)(Evaluate/HOCQ)]

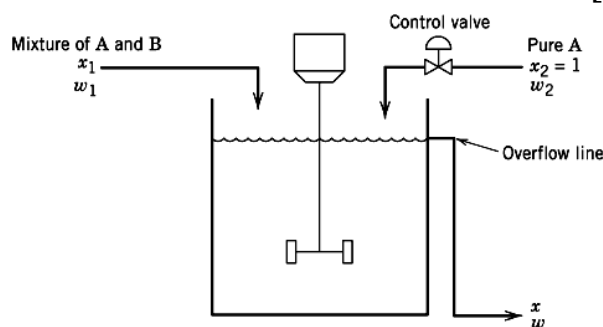


Fig. 1

- (c) What do you mean by theoretical modelling and where it is applicable?
 [(CO2)(Understand/LOCQ)]
4 + 6 + 2 = 12

Group - C

4. (a) Derive the transfer function for a level tank fitted with an inlet flow line and a linear resistance at the outlet. How can the response time be improved?
 [(CO3)(Apply/IOCQ)]

- (b) Compute the time response for the above system when input is increase by a step of A . [[C03](Analyse/IOCQ)]
- (c) Show that two non-interacting level tank system is inherently over damped or critically damped system. [[C03](Create/HOCQ)]
- 5 + 3 + 4 = 12**

5. (a) Consider a process having two manipulated variables and two controlled variables and assume interaction exist among variables. Draw different possible control loop configurations. Considering any one control loop configuration, analyse how a controlled variable be affected by variation of manipulated variables. [[C05](Apply, Analyse/IOCQ)]
- (b) For an unknown process the output response corresponds to the step input is found as in the Fig. 2. Estimate the model of the process and the parameters following empirical modelling technique. [[C03](Create/HOCQ)]

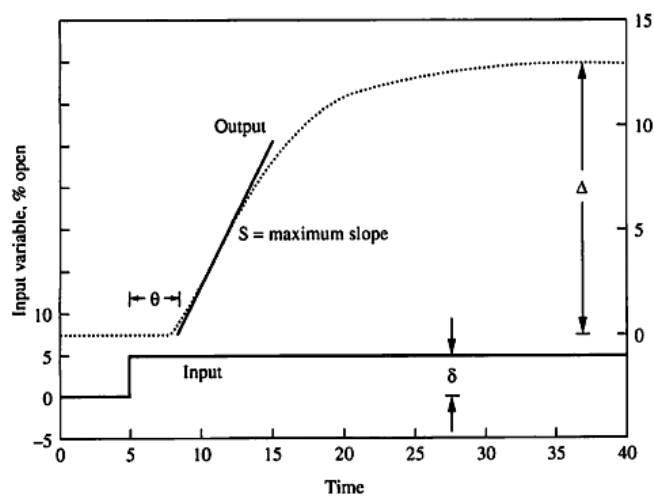


Fig. 2

(4 + 3) + 5 = 12

Group - D

6. (a) Draw the block diagram of a feedforward feedback control scheme. State when did some one consider feedforward control scheme and how did feedback control eliminates the disadvantages of feedforward controller? [[C04](Remember/LOCQ)](Analyse/IOCQ)]
- (b) In a mixing process two streams A and B are mixed to produce a product C. If B is the independent stream then suggest a control scheme that can maintain the product quality of C and describe the same with suitable block diagram. [[C04](Create/HOCQ)]
- (3 + 4) + 5 = 12**
7. (a) Why adaptive control is invited in process control system? Analyse gain schedule adaptive control strategy with necessary block diagram. [[C05](Apply, Analyse/IOCQ)]
- (b) Discuss internal model control strategy with suitable block diagram. [[C05](Analyse/IOCQ)]
- (5 + 2) + 5 = 12**

Group - E

8. (a) Draw and describe the 5-level architecture of distributed control system.
[(C06)(Understand/LOCQ)]
(b) Describe ring topology of DCS architecture with suitable schematic diagram.
[(C06)(Remember/LOCQ)]
8 + 4 = 12
9. (a) How is master-slave mechanism differs from carrier sense multiple access with collision detection mechanism used for media access control?
[(C06)(Analyse/IOCQ)]
(b) Explain with suitable diagram the importance of trend display of DCS.
[(C06)(Understand/LOCQ)]
6 + 6 = 12
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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.46	42.71	20.83

Course Outcome (CO):

After the completion of the course students will be able to

1. Learn and familiarize with the automation technologies which typically exist in industry.
2. Explain the concept of process modelling, process dynamics and process instrumentation.
3. Understand and develop the transfer function, state space models, time series models and empirical models from process data.
4. Explain feedback and feedforward control schemes and learn the controller design.
5. Understand advanced control strategies- internal model control, cascade control, model predictive control and batch process control.
6. Acquire knowledge about the distributed control system and its function.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question