

(3 Hours)

[Total Marks: 80]

N.B: (1) Question No.1 is **compulsory**.(2) Answer any **three** questions from Question Nos. 2 to 6.

(3) Assume suitable data if necessary.

- 1 Answer any FOUR of the following questions:-
- (a) Explain crystallization curve. 5
 - (b) Explain the need of multi effect evaporators. 5
 - (c) Discuss control parameters in gas turbine. 5
 - (d) What do you mean by runaway reaction? 5
 - (e) Explain hazard triangle. 5
- 2 (a) Draw surge characteristics. Explain any one method of surge control for centrifugal compressor. 10
- (b) Explain the construction and working of 1:1 shell and tube heat exchanger. 10
- 3 (a) Draw and explain process flow diagram of refinery industry. 10
- (b) Discuss feedback and cascade control scheme of evaporator. 10
- 4 (a) What is start up heater? Discuss its process and safety control. 10
- (b) Explain atmospheric tray control scheme with safety interlocks. 10
- 5 (a) Explain the process of Penicillin-G production along with its control parameters. 10
- (b) Discuss pressure control scheme and overhead product composition of distillation column. 10
- 6 Write short note- 20
- (a) Shrinking and swelling effect in boiler
 - (b) Hazard reduction techniques.

Duration: 03 Hours.

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Instructions to the candidates if any:-

- N. B.** (1) Question No. 1 is **compulsory**.
 (2) Answer any **Three** out of remaining questions.
 (3) Assumptions made should be **clearly** stated.

Q. 1 Solve

- Explain structure of Cell
- What is blood circulation? Explain its types
- What is Hounsfield Number in CT?
- Compare direct and indirect blood pressure measurement

20

Q. 2) a) What is Heart Sound? Explain electrical and mechanical activities of Heart

10

b) Explain human respiratory system and parameters to be measured

10

Q. 3) a) Explain EEG measurement with 10-20 Electrode placement system

10

b) Explain direct blood pressure measurement

10

Q.4) a) Explain hemodialyser machine and precautions to be taken

10

b) Explain rate responsive pacemaker

10

Q. 5) a) Explain working of CT machine with suitable block diagram

10

b) Compare X ray, CT and ultra sound imaging

10

Q.6) a) Explain working principle of MRI machine

10

b) Explain physiological effects of electric current

10

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Duration: 3 Hours

Max. Marks 80

N.B.

1. **Q.1** is compulsory. Attempt **any three** from the remaining questions.
2. All questions carry equal marks.
3. Figures in the Right margin indicate full marks.
3. Assume suitable data if necessary

Q.1 Attempt **any four**

20

- a. Determine the sign-definiteness of following matrices

$$(i) F = \begin{bmatrix} 3 & 2 \\ 1 & 1 \end{bmatrix}, \quad (ii) G = \begin{bmatrix} -1 & -2 \\ -3 & -2 \end{bmatrix}$$

- b. Define the singular point in phase-plane. Compute the singular points for the following system.

$$\dot{x} = x^3 - 3x^2 + 2x$$

- c. Define relative degree for the system $\dot{z} = f(z) + g(z)u$ at $y = h(z)$.
 d. Linearize the following system at point $z_o = [-1 \ 1 \ 1]^T$ with the nominal input is to be held constant at $u_0 = 1$.

$$\begin{aligned} \dot{z}_1 &= 0.5z_2^2 - 0.5 \\ \dot{z}_2 &= 0.5z_3^2 - 0.5 \\ \dot{z}_3 &= -3z_1 - z_2^2 - z_3^2 + u \end{aligned}$$

- e. Obtain the classical control 'c' from the IMC controller 'q' using block diagram reduction rules.
 f. Explain the linear and nonlinear components of the friction.

Q.2 A. Write the steps to construct the Lyapunov function using variable gradient method. **10**

B. Obtain the describing function for saturation nonlinearity. **10**

- Q.3 A.** Determine the stability of the system, **10**

$$\begin{aligned}\dot{x}_1 &= -2x_1 \\ \dot{x}_2 &= -3x_2\end{aligned}$$

using Lyapunov's equation.

- B.** Linearize the following system using feedback control **10**

$$\begin{aligned}\dot{x}_1 &= -x_1 - x_2^2 + (\sin x_1 + \cos x_1)u \\ \dot{x}_2 &= x_1 \\ y &= x_2\end{aligned}$$

Where y is output and u is input.

- Q.4 A.** What is limit cycle? Explain it with Vander Pol's equation. **10**

- B.** What is jump resonance in frequency response? Explain it with an example. **10**

- Q.5 A.** Construct the phase trajectory for the system $\ddot{x} + \dot{x} + 2x = 0$ using delta method. **10**

Consider an initial condition $x(0) = 1, \dot{x}(0) = 1$.

- B.** Design the optimal control for the system **10**

$$\dot{x} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

that minimizes the performance index

$$J = \frac{1}{2} \int_0^{\infty} \left\{ x^T \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} x + u^2 \right\} dt$$

- Q.6 A.** Design the IMC controller for the system model **10**

$$\tilde{G}_p = \frac{e^{-3s}(-0.5s + 1)}{25s + 1}$$

to track the step input. Use simple factorization for design.

- B.** Obtain the IMC based PI controller for the model **10**

$$\tilde{G}_p = \frac{5}{10s + 1}$$

(3 Hours)

[Total Marks: 80]

- N.B: (1) Question No. 1 is compulsory.
(2) Attempt any **Three** questions from remaining.
(3) Figures to the right indicate full marks.

1. Answer the following: - [20]
 - a) Explain the different types of plants and controls with examples.
 - b) Draw a ladder diagram for a Two – Motor system having following conditions: -
 - i) Starting push button starts Motor-1.
 - ii) After 10 seconds, Motor-2 is ON.
 - iii) Stopping the switch stops Motor -1 and 2.
 - c) List any three SCADA vendors with their system.
 - d) Explain the duties and tasks of level 4 in hierarchical computer control.
2. a) Design a PLC based automation system for Oven with the following sequence of operation: - [10]
 - i) Heater will be ON, when the power switch is activated and door is closed and temperature is below the limit.
 - ii) The fan will be ON when the temperature is above the limit and door is closed.
 - iii) The light will be ON, if the light switch is ON or whenever the door is open.Draw the GUI and I/O wiring diagrams. Also show memory calculations.
b) Explain sinking and sourcing output modules of PLC with neat diagram. [10]
3. a) Explain with block neat diagram, Centralized control system architecture. [10]
b) Explain the functions and task of supervisory computer in DCS. [10]
4. a) Explain how SCADA is used for a geographically large area with diagram. [10]
b) Explain with neat diagram, a system that allows an MTU to store data in central data store. [10]
5. a) What are the safety standards? Explain IEC 61508 seven-part standard in detail. [10]
b) What is an Alarm, categories of Alarm, objectives of good Alarm and factor to be considered in the design of Alarm? [10]
6. Write note on: - (**Any Two**) [20]
 - a) ERP and typical modules of ERP.
 - b) Advanced PLC instructions.
 - c) Evolution of DCS.

Duration 3Hrs**Total Marks: 80****Note:****Question no. 1 is compulsory.****Solve any three out of remaining five questions.**

Q.1) Write short notes on any four. [20]

1. WPAN
2. FHSS
3. iMode
4. Ultra wide band
5. Redundancy in gateway.

Q.2) Solve the following. [20]

- a) What is frequency reuse principle? Explain cellular telephony with neat block diagram.
- b) Explain with neat block diagram OQPSK.

Q.3) Answer the following. [20]

- a) Explain principal of DS-SS with neat block diagram.
- b) Explain Zigbee with architecture and show its different network topology.

Q.4) Solve the following. [20]

- a) Explain WAP Architecture in detail.
- b) Explain how Wireless HART adaptor works? How it is powered and its types of connection.

Q.5) Answer the following. [20]

- a) Explain Wireless HART Security.
- b) Elaborate principal of CDMA with neat block diagram.

Q.6) Answer the following. [20]

- a) Error performance in fading channel.
- b) Wireless Foundation Fieldbus.
- c) Multipath propagation.
- d) Introduction to 3G and 4G.

(3 Hours)

(Total Marks : 80)

Please check whether you have got the right question paper.

- N.B. :**
- 1) Question no. 1 is compulsory.
 - 2) Solve **any three** questions from remaining **five questions**.
 - 3) Assume suitable data if any required.

1. Solve any four (20)
- a) Distinguish between global, local and dynamic thresholding
 - b) Explain run length decoding
 - c) What are the differences between lossy and lossless compression
 - d) Explain slint transform
 - e) Explain Median filter

2. a) Explain the fundamental steps in Image processing (10)
 b) Perform Histogram Equalization on gray level distribution shown in the table. What happen if the Histogram equalization is equalized twice

Gray level	0	1	2	3	4	5	6	7
No. of pixel	513	1300	950	350	100	435	100	148

3. a) Explain following terms with example (10)
- i) Image Negative
 - ii) Gray level slicing
 - iii) Bit plane slicing
 - iv) Log transformation
- b) Generate Huffman code for a given Image source. Calculate entropy of the same and average length of the code generated. Also calculate compression ratio achieved compared to standard binary encoding.

Level	0	1	2	3	4	5	6	7
Probability	0.1	0.09	0.02	0.01	0.5	0.2	0.03	0.05

4. a) Explain the Morphological operation. (10)
- i) Opening
 - ii) Closing
 - iii) Thinning
 - iv) Thickening
- b) What is Hadamurd Transform calculate the Hadamard transform of the following (10)
 Image.

2	1	3	1
4	2	2	2
1	3	2	3
4	2	2	1

5. a) Explain the terms with diagram (10)
- (i) Neighbours of pixel
 - (ii) Connectivity
 - (iii) Adjacency
 - (iv) Path
- b) Explain the properties of 2-D DFT (10)
6. Write a short notes on (20)
- 1. Euclidian Distance, D4, D8, DM Distance
 - 2. Hit and Miss transform
 - 3. Homomarpic filtering
 - 4. Hough Transform for line detection
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(3 Hours)

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N.B. 1. Question No.01 is compulsory

2. Attempt any **Three** questions from remaining **Five** questions
3. Assume suitable data wherever required

1. Answer the following **20**
 - a. Explain in detail the need of safety instrumented system.
 - b. What do you understand by operation phase of safety life cycle? Explain.
 - c. Compare process control system and safety control system.
 - d. What is consequence analysis? What are the factors to be considered for good impact consequence analysis?
2. a. Explain SIL determination using ALARP method. **10**
 - b. What is complimentary event, mutually exclusive event and non mutually exclusive event? Explain. **10**
3. a. Draw and explain the safety life cycle of IEC-61511. **10**
 - b. What is a protection layer? Explain in detail. **10**
4. a. Explain in detail fault propagation modelling for likelihood analysis. **10**
 - b. Write short note on safety instrumented function. **10**
5. a. What is risk matrix? Explain in detail. **10**
 - b. Explain the following terms with respect to consequence analysis:- **10**
 - i. Hazards
 - ii. Initiating events
 - iii. Intermediate events
 - iv. Incident
 - v. Incident outcome
6. a. Compare SIS technology based on relay system and solid state device system. **10**
 - b. Explain in detail the SIL determination using risk graph method. **10**