(3 Hours) **[Total Marks: 80]**

N.B. :
1) **Question No.1 is compulsory**
2) **Answer any three questions from remaining question.**
3) **Draw suitable diagrams wherever required.**

1. Answer any **four** of the following questions: - **20**
    (a) Discuss the control parameter in gas turbine.
    (b) Explain the drying rate curve.
    (c) Explain capacity and economy with respect to evaporator.
    (d) Explain the need of safety interlock associated with boiler.
    (e) List primary and secondary products of refinery unit.

2. (a) Explain instrumentation and control used in atmospheric tray dryer. **10**
    (b) Explain with neat sketch milk pasteurization process and its control. **10**

3. (a) Explain the need and operation of selective control scheme for two effect evaporator. **10**
    (b) List out the raw materials required for Penicillin-G production. Draw process flow
       diagram and explain production process for Penicillin-G. **10**

4. (a) Explain column pressure control scheme for distillation column. **10**
    (b) Explain construction and operation of circulation magma crystallizer. **10**

5. (a) Explain hazardous area classification as per IEC & NEC standard. **10**
    (b) Draw and explain process flow of refinery industry. **10**

6. Write short note on- **20**
    (a) Bypass control scheme in Heat Exchanger
    (b) Startup heater
    (c) Process of crystallization
    (d) Instrumentation used in Iron and steel industry

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Duration: 03 Hours.   **Total marks: 80**

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   **20**

a) Explain Nervous system

b) Explain propagation of Action Potential

c) Explain origin of ECG, EMG and EEG.

d) Explain Larmor frequency with its equations.

Q. 2) a) Explain types of bio potential electrode   **10**

b) Explain rate responsive pacemaker with block diagram   **10**

Q. 3) a) Explain EMG measurement with block diagram   **10**

b) Explain ultrasonic blood flow measurement   **10**

Q.4) a) Explain working principle of MRI   **10**

b) Explain modes of ultrasound imaging   **10**

Q. 5) a) Explain working of heart lung machine   **10**

b) Explain working of artificial kidney and precautions to be taken   **10**

Q.6) a) What is cardiac output? Explain its measurement   **10**

b) Explain physiological effects of electric current?   **10**

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Duration: 3 Hours **Total Marks: 80**

Note:

1. **Question one is compulsory.**
2. **Solve any three from remaining and assume suitable data**

Q1.	**Solve any four**	**20**
a.	Explain types of stability in details.	
b.	Draw sinusoidal response of saturation with dead zone nonlinearity and write the response equation.	
c.	Demonstrate types of physical nonlinearity with its example	
d.	What is mean by optimal control problem formulation? What are the requirements?	
e.	Differentiate linear and nonlinear system in details	

Q2.a. Derive the describing function for relay with dead-zone nonlinearity   10

Q2. b Give definition of 1,2, and ∞ norm and   **10**

Compute 2-norm of following,

$$A = \begin{bmatrix} 0.8 & 0 \\ 0 & 1.7 \end{bmatrix} \quad B = \begin{bmatrix} 1 & 0 \\ 0 & 5 \end{bmatrix}$$

Q3.a Design IMC- PI controller for plant model in order to achieve the response with time constant of 1.5 Sec.   **10**
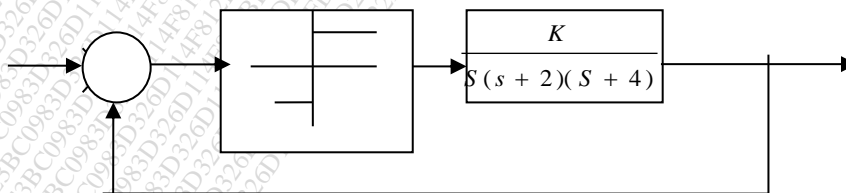
$$G(s) = \frac{(-s+1)}{(2s+1)}$$

Q3.b. Design the optimal controller via Riccati equation for the system   **10**

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ 2 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

to minimize the performance index

$$J = \int_0^\infty (x_1^2 + x_2^2 + u^2) dt$$

Q4.a. Investigate Stability using Describing function of following system which has unity relay signal as a nonlinearity.

$$\frac{K}{S(s+2)(S+4)}$$

10

Q4.b. Comment on stability using Lyapnov for the nonlinear systems given below , **10**

1.
$$\dot{x}_1 = -x_1 + x_2 + x_1^3 + x_1 x_1^2$$
$$\dot{x}_2 = -x_1 - x_2 + x_1^2 x_2 + x_2^3$$

2.
$$\dot{x}_1 = -x_1 - x_1(x_1^2 + x_2^2)$$
$$\dot{x}_2 = -x_1 - x_2(x_1^2 + x_2^2)$$

Q5.a. Design the Lyapunov function using Krasovskii's method for the following system. **10**

$$\dot{x}_1 = x_2, \dot{x}_2 = x_1 - x_2^2$$

Q5.b. Using different equilibrium point comment of singular point and draw trajectories **10**

$$\dot{x}_1 = -x_1^3 + x_2$$
$$\dot{x}_2 = x_1 - x_2^3$$

Q6a. Explain limit cycle in detail **06**

Q6b. How to comment on stability using singular point explain in details **08**

Q6c. Explain direct method of Lyapunov stability, design the Lyapunov function for the following system **06**

$$\dot{x} = Ax$$

where A is Hurwitz

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(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) What do you understand by automation and explain the benefits of automation?
   b) What are advantages of PLC over the relay logic systems? Illustrate with relevant examples.
   c) With neat block schematic, explain the functions of MTU.
   d) What are the functions Controller Module in DCS?

2. a) What is IEC standard PLC languages?
   Write a PLC Program using ladder logic for a process describe below according to following sequence: - [10]
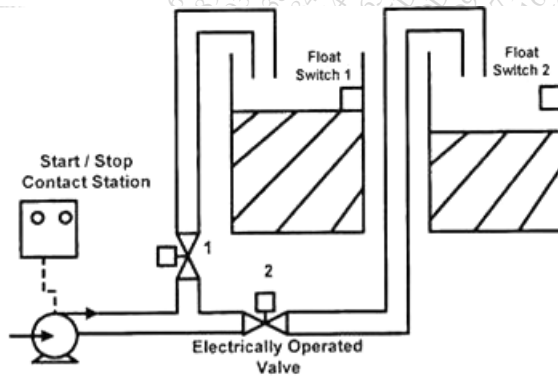
   i) The pump is operating manually by a push-button "Start".
   ii) Start PB is pressed to start operation & V1 is open to fill the tank A.
   iii) When the first tank becomes full, the circuit should automatically start to fill the second tank by closing the first valve, and opening the second valve V2.
   iv) When the second tank is full, the pump disconnects automatically and a "sign lamp" is turned on to show that second tank is full.
   v) A stop button is pressed to stop operation.
   b) With neat circuit diagram, explain AC input module connected to PLC. [10]

3. a) Explain Evolution of DCS with neat sketch. [10]
   b) Explain the functions and task of supervisory computer in DCS. [10]

4. a) With neat sketch, explain how RTU communicate with field and MTU in SCADA. [10]
   b) Define scan interval of SCADA and explain the factors affecting it with examples. [10]

5. a) What is ERP? What are the benefits of integrating MES with ERP? [10]
   b) Explain the basic SIS layout with neat block diagram. [10]

6. a) What is the need of Alarm Management System?
   Name the standards related to AMS. Elaborate Alarm lifecycle model. [10]
   b) Compare PLC, DCS and SCADA systems. [10]

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