

22531

12223

3 Hours / 70 Marks

Seat No.

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- Instructions* – (1) All Questions are *Compulsory*.
- (2) Answer each next main Question on a new page.
- (3) Illustrate your answers with neat sketches wherever necessary.
- (4) Figures to the right indicate full marks.
- (5) Assume suitable data, if necessary.
- (6) Use of Non-programmable Electronic Pocket Calculator is permissible.
- (7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

- 1. Attempt any FIVE of the following:** **10**
- a) Define control system and give any two practical examples.
- b) Define
- i) Transient response
- ii) Steady state response
- c) State the classification of control actions.
- d) Draw the symbols of NO and NC contacts used in PLC.
- e) List Timer and counter instruction of PLC.
- f) Define
- i) Poles
- ii) Transfer function
- g) Draw the ladder logic diagram
- i) NAND Gate
- ii) EX-OR Gate

P.T.O.

2. Attempt any THREE of the following:

12

- a) For the given transfer function

$$\text{T.F.} = \frac{10 (S + 3)}{(S + 2) (S + 1) (S + 4)} \text{ Find}$$

- i) Pole's
 - ii) Zero's
 - iii) Characteristics equation
 - iv) Plot Pole's and Zero's in S-plane.
- b) State the need of PLC in automation.
- c) Draw the ladder logic diagram
- i) Half Adder
 - ii) Half Subtractor
- d) Explain scanning cycle of PLC.

3. Attempt any THREE of the following:

12

- a) Derive the transfer function of following circuit.
Refer Fig. No. 1.

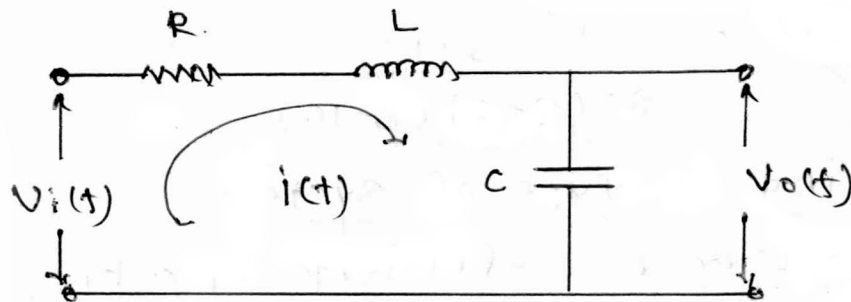


Fig. No. 1.

- b) Describe ON-OFF control action with equation and response curve.
- c) Sketch the block diagram of PLC.
- d) Explain the Sourcing and Sinking concept in D.C. Input module.

4. Attempt any THREE of the following: 12

- Explain Proportional Integral (PI) controller with O/P response curve.
- Distinguish between fixed and modular PLC. (any four points)
- Sketch the block diagram of process control system and explain the function of each block.
- Draw block diagram of AC discrete input module of PLC.
- Explain memory organization of PLC.

5. Attempt any TWO of the following: 12

- a) For the given differential equation

$$\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 8y(t) = 8x(t)$$

where $y(t)$ is O/P and $x(t)$ is I/P

Find, All Time Response Specification.

(ξ , T_r , T_p , T_d , T_s , $\%M_p$)

- b) Find out transfer function by using block diagram reduction technique. Refer Fig. No. 2.

$$TF = \frac{C(S)}{R(S)} = ?$$

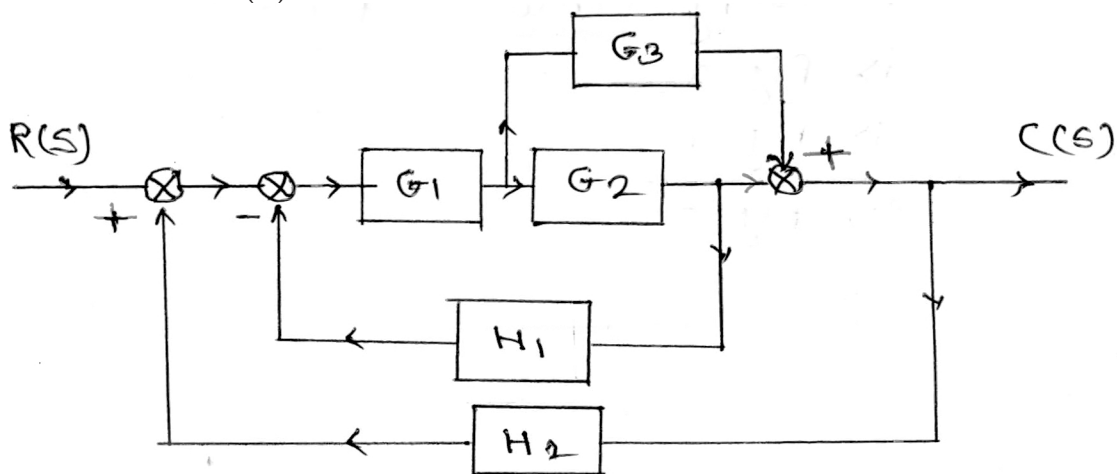


Fig. No. 2.

- c) Calculate range of K for the given unity feedback system to be stable with $G(S)$.

$$G(S) = \frac{K}{S(S + 2)(S + 4)(S + 8)}$$

6. Attempt any TWO of the following:

12

a) Define transfer function and derive the derivation of transfer function of closed loop control system.

b) A unity feedback system has

$$G(S) = \frac{10(S + 1)}{S^2(S + 2)(S + 10)}$$

Find.

i) Type of system

ii) Error coefficients k_p , k_v , k_a .

iii) Steady state error e_{ss} , for input $r(t) = 1 + 4t + \frac{t^2}{2}$.

c) Draw the ladder diagram for the following circuits.

Refer Fig. No. 3, 4 and 5.

i)

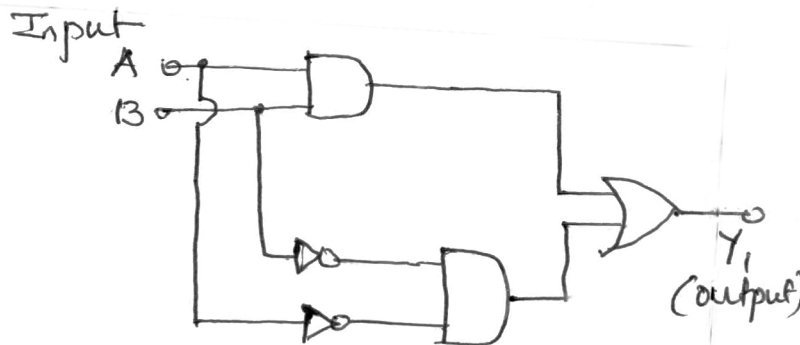


Fig. No. 3.

ii)

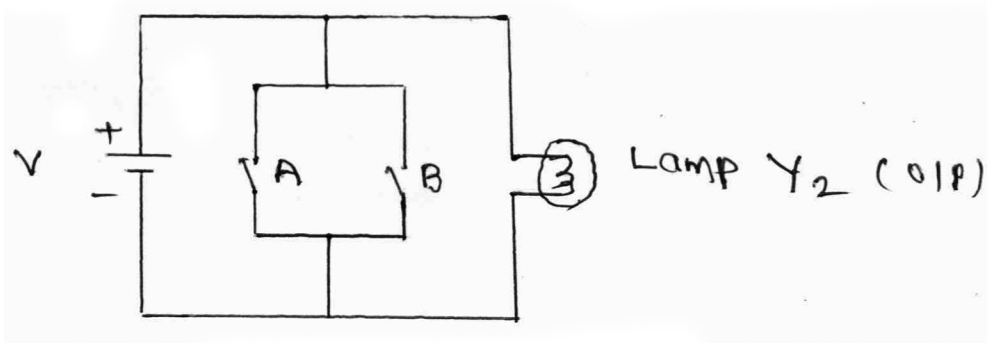


Fig. No. 4.

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[5]

Marks

iii)

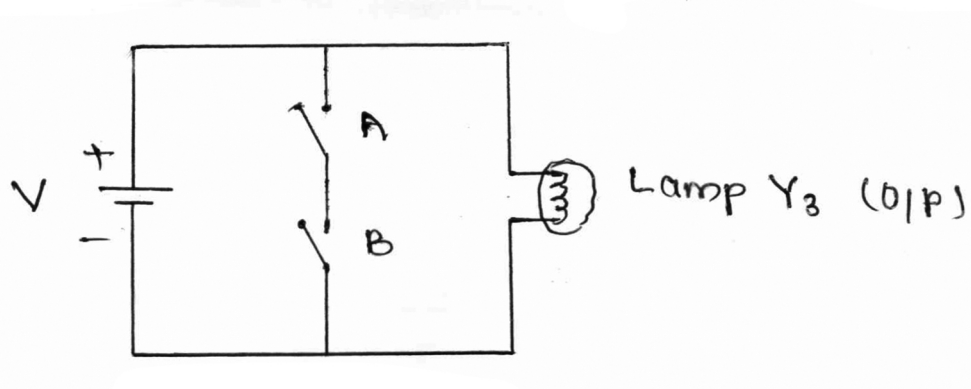


Fig. No. 5.

22531

21222

3 Hours / 70 Marks

Seat No.

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15 minutes extra for each hour

- Instructions* –
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 - (6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. **Attempt any FIVE of the following:** **10**
- a) Give the specification for the PLC based on the following:
 - i) Type of PLC
 - ii) No. of inputs and outputs
 - b) Define:
 - i) Time response
 - ii) Steady state response
 - c) Derive transfer function of the given electrical circuit. (fig. 1)

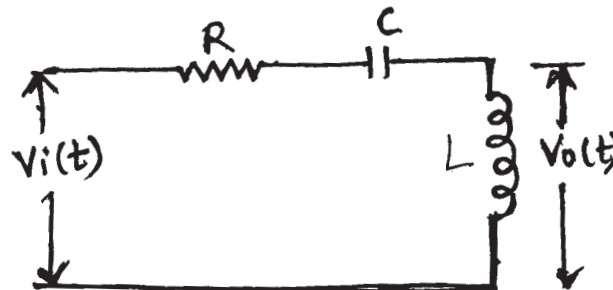
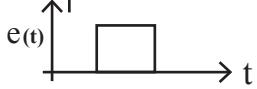


Fig. No. 1

P.T.O.

- d) Draw the block diagram of PLC.
- e) Draw the response of first order control system and show the effect of time constant in it.
- f) Compare open loop system and closed loop system on the basis of following points.
- i) Feedback path
 - ii) Complexity
 - iii) Cost
 - iv) Accuracy
- g) Draw the output of derivative controller mode if the error signal is
- 

2. Attempt any THREE of the following: 12

- a) Write any four rules of block diagram reduction technique.
- b) Define following terms related to control action:
 - i) Controller
 - ii) Error signal
 - iii) Offset
 - iv) Proportional Band
- c) Describe the wiring details of AC i/p module of PLC.
- d) Write any four input and output devices which can be interface with PLCs.

3. Attempt any THREE of the following: 12

- a) For a given T.F = $\frac{K (s + 7)}{s (s + 2) (s + 5) (s^2 + 7s + 12)}$ find
- i) Poles
 - ii) Zero
 - iii) Characteristics equation
 - iv) Order of the system

- b) Explain the procedure of PLC installation.
- c) Define the following terms related to PLC:
 - i) Scanning cycle
 - ii) Scanning
 - iii) Scan time
 - iv) Speed of Execution
- d) Incorporation of PI action may lead to instability in the closed loop performance - justify.

4. Attempt any THREE of the following: 12

- a) 'Modular PLCs are preferable in automation industry' - Justify.
- b) Describe PI control action with respect to output equation transfer function. State two advantages.
- c) Define marginally stable system. Draw the location of poles and response of such a system.
- d) Differentiate between Linear and Nonlinear control systems.
- e) Give the functional description for following timer instructions.
 - i) On delay
 - ii) Off delay
 - iii) Retentive
 - iv) Reset

5. Attempt any TWO of the following: 12

- a) A unity feedback system with open loop transfer function

$$G(s) = \frac{10 (s + 2) (s + 3)}{s (s + 1) (s + 4) (s + 7)}$$
 Find out
 - i) Types of system & K_p , K_v , K_a .
 - ii) Steady state error for $U/P = 3+t+t^2$
- b) Compare Relay logic control and Programmable logic control. (min. 6 points)

- c) Draw ladder diagram for 3 motor operation for following condition.
- Start push button, start motor M1.
 - When motor M1 is ON after 8 minutes M2 is ON and M1 is OFF.
 - When M2 is ON, after 15 minutes M3 is ON and M2 is OFF. and when stop push button is pressed M3 is OFF.

6. Attempt any THREE of the following:

12

- Draw the ladder diagram to verify
 - 'AND' Gate logic
 - 'NOR' Gate logic.
 - 'OR' Gate logic.
- Derive the transfer function of fig 2 using block diagram simplification method.

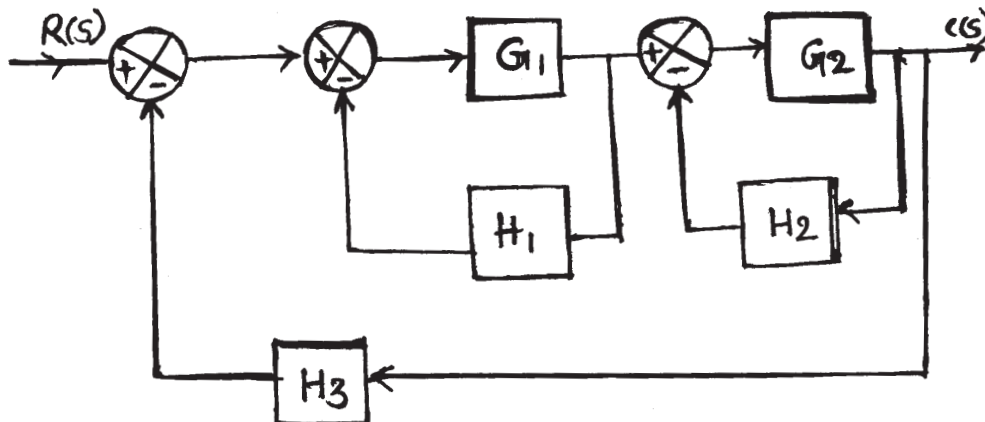


Fig. No. 2

- Write any three advantages and disadvantages of Routh's criterion. Also describe different cases to find stability of a system.

22531

11920

3 Hours / 70 Marks

Seat No.

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- Instructions* –
- (1) All Questions are *Compulsory*.
 - (2) Answer each next main Question on a new page.
 - (3) Illustrate your answers with neat sketches wherever necessary.
 - (4) Figures to the right indicate full marks.
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 - (7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

- 1. Attempt any FIVE of the following: **10****
- a) List any four names of PLC programming languages.
 - b) Define transient response and steady state response for any system.
 - c) Calculate the order of following system.
$$G(S) = \frac{(S + 2)(S + 5)}{S(S + 3)(S + 4)}$$
 - d) List two inputs and two output devices of PLC.
 - e) Sketch and label the time response for second order system.
 - f) Draw the general block diagram of closed loop control system.
 - g) Draw electronic PI controller using Op-amp.

P.T.O.

- 2. Attempt any THREE of the following: 12**
- a) State any four block diagram reduction rules with neat diagram.
 - b) Draw neat block diagram of process control system.
 - c) Describe Discrete AC output modules of PLC with the help of neat diagram.
 - d) Illustrate the steps for PLC Installation.
- 3. Attempt any THREE of the following: 12**
- a) Discuss the special cases of Routh's Criterion.
 - b) Draw the PLC ladder diagram for 2 input OR logic gate.
 - c) Draw labeled block diagram of PLC.
 - d) Elaborate ON - OFF controller with suitable example. State significance of neutral zone.
- 4. Attempt any THREE of the following: 12**
- a) Classify Fixed and Modular PLC.
 - b) Describe PID controller with neat diagram, output equation and response.
 - c) Define the following terms related to second order system.
 - (i) Damping
 - (ii) Damping Ratio
 - (iii) Undamped Natural Frequency.
 - (iv) Damped Frequency.
 - d) Describe Linearity Property and Change of Scale Property of Laplace Transform.
 - e) Describe Relay instruction for PLC.

5. Attempt any TWO of the following:

12

- a) For a unity feedback control system

$$G(S) = \frac{100(S + 2)}{S^2}$$

Calculate all the Error constants.

- b) Describe Operating cycle of PLC with neat diagram.
 c) Develop a ladder diagram for 4:1 Multiplexer

6. Attempt any TWO of the following:

12

- a) Illustrate PLC Timer in detail.
 b) Apply the block diagram reduction rules to obtain Transfer Function $C(S) / R(S)$ of the following block diagram.
 (Refer Figure No. 1)

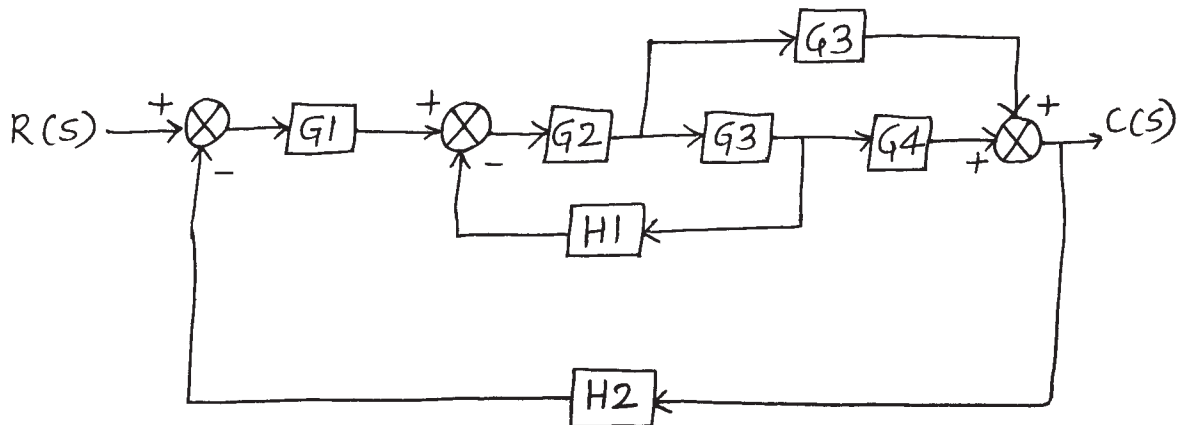


Figure No. 1

- c) Describe four standard test inputs with their mathematical expression and Graphical Representation.

Scheme – I

Sample Question Paper

Program Name : Electronics Engineering Programme Group
Program Code : DE/EJ/ET/EN/EX/EQ
Semester : Fifth
Course Title : Control Systems and PLC
Marks : 70

22531

Time: 3 Hrs.

Instructions:

- (1) All questions are compulsory.
- (2) Illustrate your answers with neat sketches wherever necessary.
- (3) Figures to the right indicate full marks.
- (4) Assume suitable data if necessary.
- (5) Preferably, write the answers in sequential order.

Q.1) Attempt any FIVE of the following: -

10 Marks

- (a) Draw electrical symbol used to represent NO pushbutton, NC pushbutton.
- (b) Define: Stable system and marginally stable system.
- (c) Give two practical examples of: i) Open loop system ii) Closed loop system.
- (d) Define following terms with respect to PLC
 - i. Scan time
 - ii. Speed of execution
- (e) Find order of system for the unity feedback system with

$$C(s) = \frac{16}{s(s+8)}$$

- (f) Compare Linear and non-linear system on the basis of additive property and homogeneous property.
- (g) Find the output of derivative controller mode if error is zero.

Q.2) Attempt any THREE of the following: -

12 Marks

- (a) Give any four rules for block diagram reduction technique.
- (b) Illustrate Proportional- Derivative control(PD) action with output Equation and nature of output response
- (c) Draw and describe the block diagram of AC discrete output module of PLC.
- (d) Name any four input and output devices which can be interfaced with PLC.

Q.3) Attempt any THREE of the following.

12 Marks

(a) Transfer function of a second order system is given by

$$\frac{C(s)}{R(s)} = \frac{64}{s^2 + 5s + 64}$$

Find

- i. Natural frequency of oscillation
 - ii. Damping Ratio
 - iii. Peak Time
 - iv. Settling Time
- (b) State four points of information associated with a counter instruction of PLC.
- (c) Draw block diagram of PLC and give the function of isolator used in it.
- (d) Plot a graph of proportional-Integral (PI) controller mode output as a function of time for the given error in figure-1. $K_P=5$, $K_I=1.0 \text{ S}^{-1}$ and $P_I(0) = 20\%$.

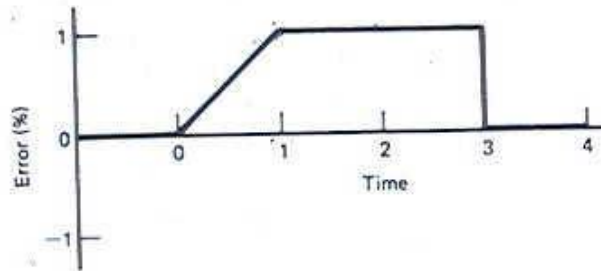


Figure-1

Q.4) Attempt any THREE of the following.

12 Marks

- (a) Justify 'Modular PLCs are preferable in automation industry.
- (b) Draw and describe Proportional band in Proportional controller mode.
- (c) List the different types of standard test input signals to test the control system. Also give their Laplace transform with sketch.
- (d) Derive transfer function for the system given in figure-2:

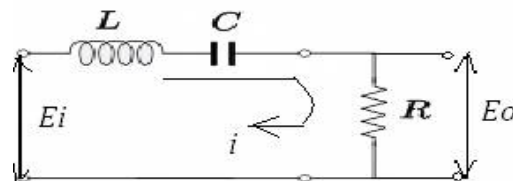


Figure-2

- (e) Describe sinking and sourcing concept in DC input modules of PLC

Q.5) Attempt any TWO of the following.

12 Marks

(a) For unity feedback system with

$$G(s) = \frac{5(s+1)}{s^2(s+3)(s+10)}$$

Find type of system, static error coefficient and steady state Error when input to the

system is $r(t) = 1 + 3t + \frac{t^2}{2}$

(b) With respect to PLC

- i. State the importance of PLC in automation
- ii. Describe memory organization of PLC.

(c) Draw ladder diagram for 3 motor operation for following conditions

- i. Start push button starts motors M1 and
- ii. after 10 seconds motor M2 starts and
- iii. after 10 seconds motor M3 starts

Q.6) Attempt any TWO of the following.

12 Marks

(a) Draw the ladder diagram to verify : AND gate , NAND Gate and NOR Gate logic

(b) Obtain transfer function for the system given in figure -3,using block diagram reduction technique

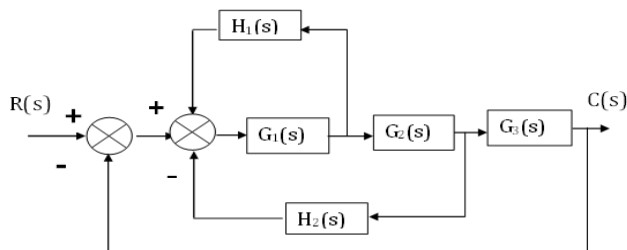


Figure-3

(c) State the Routh's criterion and describe two special cases of Rouths criterion with example

Scheme – I

Sample Test Paper - I

Program Name : Electronics Engineering Programme Group
Program Code : DE/EJ/ET/EN/EX/EQ
Semester : Fifth
Course Title : Control Systems and PLC
Marks : 20

22531

Time: 1 Hour.

Instructions:

- (1) All questions are compulsory.
- (2) Illustrate your answers with neat sketches wherever necessary.
- (3) Figures to the right indicate full marks.
- (4) Assume suitable data if necessary.
- (5) Preferably, write the answers in sequential order.

Q.1 Attempt any FOUR.

08 Marks

- (a) Define following terms with respect to controller –
 - i. Offset error
 - ii) Proportional band.
- (b) For time response of second order system state formula for:
 - i. Rise time
 - ii) Settling time
- (c) Compare Open Loop and Closed Loop Control system based on Transfer function and Stability.
- (d) Give the values of damping ratio for critically damped system and over damped system.
- (e) Draw the block diagram of DC Servo System.

Q.2 Attempt any THREE.

12 Marks

- (a) Define transfer function. Derive an expression for transfer function of simple closed loop system.
- (b) For a unity feedback system having open loop transfer function

$$G(s) = \frac{K(s+2)}{s(s^3 + 7s^2 + 12s)}$$

Determine:

- i) Type of system
- ii) Error constant K_p, K_v and K_a
- (c) Find the range of values of K so that system with following characteristic equation will be stable: $s^4 + 5s^3 + 5s^2 + 4s + k = 0$
- (d) Describe Neutral zone in ON-OFF controller mode.

Scheme – I

Sample Test Paper - II

Program Name : Electronics Engineering Programme Group
Program Code : DE/EJ/ET/EN/EX/EQ
Semester : Fifth
Course Title : Control Systems and PLC
Marks : 20

22531

Time: 1 Hour.

Instructions:

- (1) All questions are compulsory.
- (2) Illustrate your answers with neat sketches wherever necessary.
- (3) Figures to the right indicate full marks.
- (4) Assume suitable data if necessary.
- (5) Preferably, write the answers in sequential order.

Q.1 Attempt any FOUR.

08 Marks

- (a) List out functions of PLC output module.
- (b) List two types of PLC programming devices
- (c) Explain the terms normally open and normally closed contact.
- (d) Draw PLC Scan Cycle.
- (e) List any four compare instructions of PLC.

Q.2 Attempt any THREE.

12 Marks

- (a) State stepwise procedure of PLC installation.
- (b) Draw the ladder diagram to verify:
 - i) OR gate ii) NOR Gate logic.
- (c) Draw the block diagram of AC discrete input module of PLC.
- (d) Illustrate Proportional-Integral (PI) control action with output Equation and nature of output response

11819

3 Hours / 100 Marks

Seat No.

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- Instructions :**
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 - (4) Assume suitable data, if necessary.
 - (5) Preferably, write the answers in sequential order.

Marks

1. (A) Attempt any THREE :

12

- (a) Draw the block diagram of DC servo system.
- (b) Classify the different modes of process control actions.
- (c) Name any four I/P and O/P devices each used with PLC.
- (d) Draw the block diagram of process control system.

(B) Attempt any ONE :

6

- (a) Draw block diagram of AC output module. Draw its wiring diagram.
- (b) Derive the transfer function of the following block diagram in Fig. 1 :

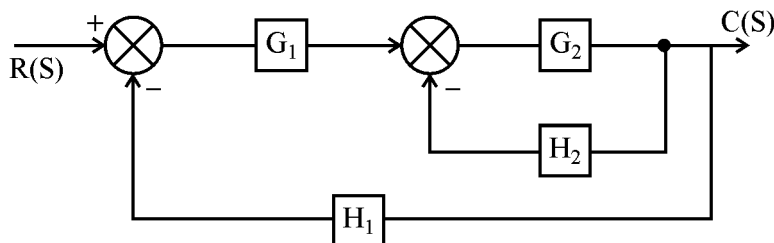


Fig. 1

2. Attempt any TWO :

16

- (a) For a unity feedback system, the TF is given by $\frac{C(s)}{R(s)} = \frac{25}{s^2 + 6s + 25}$.

Find (i) rise time (ii) peak time (iii) peak overshoot (iv) settling time.

- (b) An unity feedback system has $G(S)$,

$$G(S) = \frac{10(S+1)}{S^2(S+2)(S+10)}$$

Find,

- (i) Type of system
 (ii) Error coefficient k_p , k_v & k_a .
 (iii) Steady state error for I/P,

$$r(t) = 1 + 4t + t^2/2.$$

- (c) Draw block diagram of PLC. Write function of each block.

3. Attempt any FOUR :

16

- (a) Derive the transfer function of given network. Refer Fig. 2.

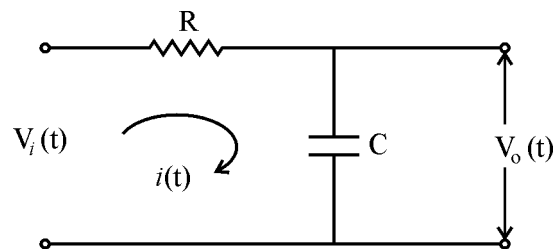


Fig. 2

- (b) Describe the role of PLC in automation.
 (c) Define transfer function. Derive the expression of T.F. of closed loop system.
 (d) For system, characteristic equation is $s^4 + 22s^3 + 10s^2 + s + k = 0$. Find K.
 (e) Define the term scanning cycle, speed of execution in PLC.

4. (A) Attempt any THREE : 12

- (a) Explain with diagram sinking and sourcing concept in DC input modules.
- (b) Define pole and zero. Give its S-plane representation.
- (c) Compare proportional and integral controller on the basis of equation, advantages, response to error and application.
- (d) Write any four logical instructions in PLC.

(B) Attempt any ONE : 6

- (a) Draw block diagram of AC input module.
- (b) Describe PID control action w.r.t. equation and response to error.

5. Attempt any TWO : 16

- (a) List and explain the timer instructions of PLC.
- (b) Consider the system with characteristic equation

$$s^4 + 6s^3 + 26s^2 + 56s + 80 = 0.$$

Determine stability of the system using Routh's criteria.

- (c) A unity feedback system has

$$G(S) = \frac{40(s+2)}{s(s+1)(s+4)}$$

Determine all error coefficients.

6. Attempt any FOUR :**16**

- (a) Draw the ladder diagram for
 - (i) AND gate
 - (ii) NAND gate
 - (b) State Routh's stability criteria.
 - (c) List any two rules of block diagram reduction technique.
 - (d) Explain on-off controllers with neat diagram.
 - (e) Compare open loop and closed loop system.
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17536

21718

3 Hours / 100 Marks

Seat No.

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Marks

1. (A) Attempt any THREE : 12
- (a) Compare open loop and closed loop control system based on block diagram, transfer function, examples and stability.
 - (b) Describe role of PLC in automation.
 - (c) Draw labelled block diagram of Process Control System. Give classification of control actions.
 - (d) List standard test input signals. Give their laplace representation.
- (B) Attempt any ONE : 6
- (a) Draw block diagram of AC input module of PLC. Describe function of each block.

- (b) Derive the transfer function of block diagram using block diagram reduction rules.

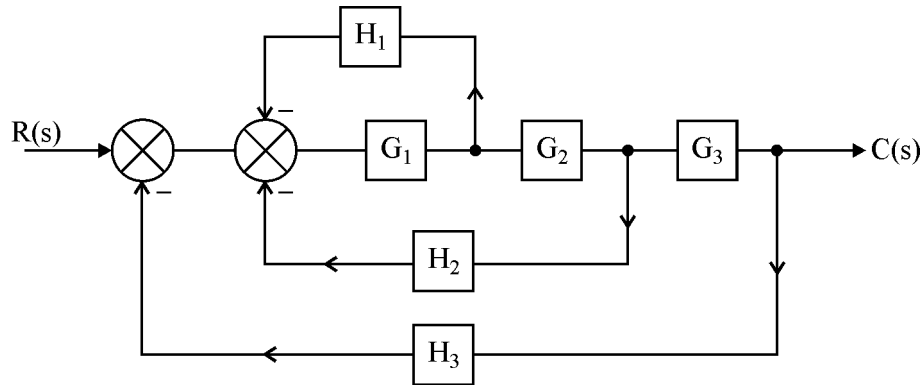


Fig. No. – 1

2. Attempt any TWO :

16

- (a) Determine the range of values of K for system to be stable whose characteristic equation is

$$s^4 + 22s^3 + 10s^2 + s + K = 0$$

- (b) For a system having closed loop transfer function $\frac{C(s)}{R(s)} = \frac{18}{s^2 + 4s + 18}$

Determine :

- (i) W_d – damped frequency of oscillations.
 - (ii) Peak time
 - (iii) % Peak overshoot
 - (iv) Settling time
- (c) Draw ladder diagram for following logical equations :
- (i) $Y = \bar{A}\bar{B} + AB$
 - (ii) $Y = (\bar{A} + \bar{B})(A + B)$

3. Attempt any FOUR :

16

- (a) Compare fixed and modular PLC. (any 4 points)
- (b) Draw response of 2nd order system for step input for given values of zeta (ζ)
 - (i) $\zeta = 0$ (ii) $\zeta = 0.5$ (iii) $\zeta = 1$ (iv) $\zeta = 5$
- (c) Define transfer function. Obtain transfer function of RC network.
- (d) Draw and explain memory organization in PLC.
- (e) Define ‘ON-OFF’ controller. Describe it’s working principle using one example.

4. (A) Attempt any THREE :

12

- (a) Draw labelled block diagram of PLC. List any two output devices.
- (b) Draw ON-Delay instruction format of PLC. Give significance of EN and DN bits.
- (c) Draw electronic circuit diagram for PD controller. Describe why derivative controller not used alone.
- (d) Define Servo-System. Draw block diagram of DC Servo-System.

(B) Attempt any ONE :

6

- (a) For system whose open loop transfer function is

$$G(s)H(s) = \frac{100}{s^2(1 + 0.5s)(s + 2)}$$

Determine :

- (i) Type of system
- (ii) Error constants K_p , K_v , K_a
- (iii) Steady state error for unit parabolic input.
- (b) Draw ladder diagram to blink LED continuously for 60 times. LED should be ON for one second and OFF for one second.

5. Attempt any FOUR :

16

- (a) Obtain stability of system whose characteristic equation is

$$s^5 + s^4 + 3s^3 + 9s^2 + 16s + 10 = 0$$

use Routh's criterion.

- (b) Describe with neat diagram concept of sinking and sourcing in discrete input module.
- (c) Define following terms :
 - (i) Poles
 - (ii) Zero's
 - (iii) Order of system
 - (iv) Characteristic equation
- (d) State Routh's stability criterion. Explain with example.
- (e) State and explain any four block diagram reduction rules.
- (f) List data handling instructions of PLC. Describe any one in details.

6. Attempt any FOUR :

16

- (a) Define following terms related to PLC (i) Scanning cycle (ii) Speed of execution.
 - (b) Compare Proportional and Integral control action on basis of (i) Response to error (ii) Output equation (iii) applications (iv) limitations.
 - (c) Derive unit step response of 1st order system.
 - (d) List comparison instruction of PLC. Describe any two with diagram.
 - (e) Define : (i) Relative Stability (ii) Marginally Stable System.
 - (f) Draw block diagram of power supply used in PLC. Describe function of each block.
-

11718

3 Hours / 100 Marks

Seat No.

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- Instructions :**
- (1) All Questions are *compulsory*.
 - (2) Answer each next main Question on a new page.
 - (3) Illustrate your answers with neat sketches wherever necessary.
 - (4) Figures to the right indicate full marks.
 - (5) Assume suitable data, if necessary.
 - (6) Use of Non-programmable Electronic Pocket Calculator is permissible.
 - (7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE :

20

- (a) Write any four applications and four Advantages of Servo System.
- (b) Derive the transfer function of Fig. (1-b) using block diagram simplification method.

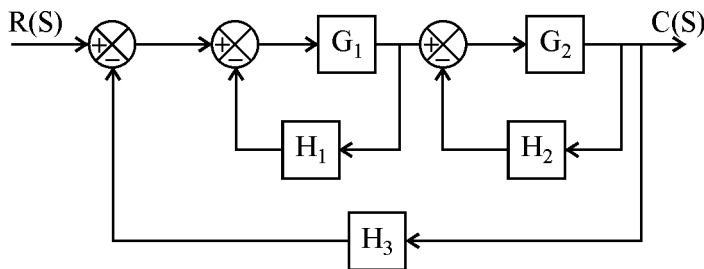


Fig. (1-b)

[1 of 8]

P.T.O.

- (c) Define the following term :
- (i) Time Response
 - (ii) Transient Response
 - (iii) Steady State Response
 - (iv) Steady State error
- (d) List the various factors which governs the selection of PLC for particular use.
(minimum eight points)
- (e) Draw and explain memory organization of PLC.
- (f) Explain the sourcing and sinking concept in DC Input module.
- (g) Define the following term :
- (i) Neutral Zone
 - (ii) Control Action

2. Attempt any TWO :

16

- (a) (i) For a given Transfer function

$$\frac{\text{T.F.} = K(S + 7)}{S(S + 2)(S + 5)(S^2 + 7S + 12)}$$

find (i) Pole (ii) Zero (iii) Characteristics equation (iv) Pole Zero plot

- (ii) (1) Find the Transfer function of a given differential equation. **2**

$$\frac{d^2y}{dt^2} + 4 \frac{dy}{dt} + 8y(t) = 8x(t)$$

- (2) Define : (a) Logical Instructions **1**

(b) Data Handling Instructions. **1**

- (b) (i) A system has $G(S) \cdot H(S) = \frac{K}{S(S+2)(S+4)(S+8)}$ where K is positive

Find (1) Characteristics equation

(2) Rang of K value for stability.

- (ii) Draw electronic PID controller and explain operation of its each stage.

Give two advantages and two disadvantages of Electronic Controller.

- (c) Draw the basic block diagram of PLC and write the function of each block.

3. Attempt any FOUR :

16

- (a) Compare open loop system and closed loop system on the basis of following point :

- (i) Feedback path
- (ii) Complexity of design
- (iii) Cost and maintenance
- (iv) Accuracy and bandwidth

- (b) Define the following term related to PLC :

- (i) Scanning Cycle
- (ii) Scanning
- (iii) Scan Time
- (iv) Speed of Execution

P.T.O.

- (c) Derive an expression for unit step response $C(t)$ of first order system. Also draw Response Curve.
- (d) Define following term related to control action :
- (i) Controller
 - (ii) Error Signal
 - (iii) OFF Set
 - (iv) Proportional Band
- (e) Give the functional descriptions for following Timer Instructions :
- (i) ON Relay
 - (ii) OFF Relay
 - (iii) Retentive
 - (iv) Reset
- (f) What is the importance of stability ? Define absolute & relative stability.

4. Attempt any TWO :

16

- (a) A unity feedback system with open loop transfer function.

$$G(S) = \frac{10(S+2)(S+3)}{S(S+1)(S+4)(S+7)}$$

Find out (i) Types of system and K_p , K_v , K_q .

- (ii) Steady state error for input = $3 + t + t^2$

- (b) Compare Relay logic control and Programmable logic control. (minimum eight points)
- (c) Draw ladder diagram for 3 motor operation for following condition :
- (i) Start push button, start motor M_1 .
 - (ii) When motor M_1 is ON after 8 minute M_2 is ON and M_1 is OFF.
 - (iii) When M_2 is ON after 15 minute M_3 is on and M_2 is OFF.
 - (iv) When stop push button is pressed M_3 is OFF.

5. Attempt any FOUR :

16

- (a) Compare proportional and Integrated controller on the basis of following point :
- (i) Equation
 - (ii) Advantages
 - (iii) Response to Error
 - (iv) Application
- (b) Define transfer function and derive the expression of transfer function of closed loop system with positive feedback.
- (c) Write any four rules of block diagram simplification.

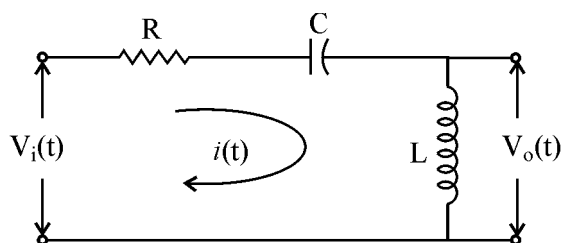
P.T.O.

- (d) Define and write the formula of following :
- (i) Delay time (t_d)
 - (ii) Settling time (t_s)
 - (iii) Peak time (t_p)
 - (iv) Peak over shoot (M_p)
- (e) Write any four advantages and disadvantages of Routh's criterion.
- (f) Draw the block diagram of AC Discrete Input module of PLC.

6. Attempt any FOUR :

16

- (a) Give the functional descriptions for AND, OR, EX-OR and NOT instructions.
- (b) Describe ON-OFF control action with equation and response curve.
- (c) Derive the Transfer Function of following circuit :



- (d) What are the Different Standard Test Signal ? Draw them and give their Laplace representation.

- (e) Define the following term :
- (i) Stable System
 - (ii) Unstable System
 - (iii) Relatively Stable System
 - (iv) Critically Stable System
- (f) Draw the ladder diagram to verify
- (i) AND Gate logic
 - (ii) NOR Gate logic
-

16172

3 Hours / 100 Marks

Seat No.

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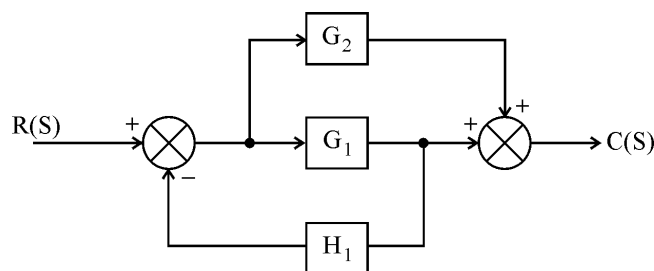
- Instructions :**
- (1) All Questions are *compulsory*.
 - (2) Illustrate your answers with neat sketches wherever necessary.
 - (3) Figures to the right indicate full marks.
 - (4) Assume suitable data, if necessary.
 - (5) Use of Non-programmable Electronic Pocket Calculator is permissible.
 - (6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks1. (A) Attempt any **THREE** of the following :**12**

- (a) Define stability. Sketch the root locations in S-plane for stable & unstable system.
- (b) Give the classification of PLC. Explain modular PLC in brief.
- (c) Define servo system. Draw the block diagram of DC servo system.
- (d) Draw electronic PID controller and state its equation.

(B) Attempt any **ONE** of the following :**6**

- (a) Using block diagram reduction technique, obtain T.F. of the block diagram.



- (b) State with respect to PLC :
 - (i) Scanning Cycle &
 - (ii) Speed of execution

2. Attempt any TWO of the following :

16

- (a) Find K_p , K_v , K_a & steady state error for a system with open loop transfer function as

$$G(S)H(S) = \frac{10(S+2)(S+3)}{S(S+1)(S+4)(S+5)}$$

Where input $r(t) = 3 + t + \frac{t^2}{2}$

- (b) A unity feedback system has

$$G(S) = \frac{16}{S(S+5)}$$

If a step input is given, calculate (i) rise time, (ii) peak time, (iii) maximum overshoot, (iv) settling time.

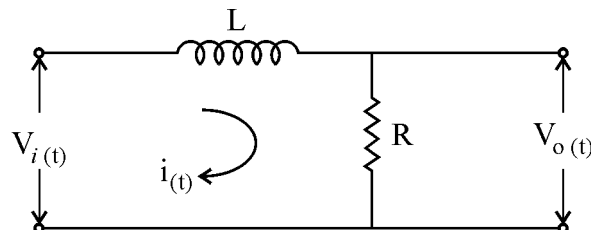
- (c) Draw ladder diagram for ON & OFF of lamps for following conditions :

- (i) START push button switch ON Green & Red lamp &
 (ii) STOP push button switch OFF Green lamp first & after 20 seconds Red lamp.

3. Attempt any FOUR of the following :

16

- (a) Derive the transfer function of given network.



- (b) List any four input & four output devices used with PLC.
 (c) Explain the significance of Laplace transform in control system.
 (d) For a system with the characteristic equation :

$$S^4 + 6S^3 + 21S^2 + 36S + 20 = 0$$

Find the stability of the system with Routh's stability criterion.

- (e) Describe in brief memory organization of PLC.

4. (A) Attempt any THREE of the following : 12

- (a) State the principle of ON-OFF control action. Write its standard equation & define neutral zone.
- (b) Draw the typical wiring details & four specifications of AC output module of PLC.
- (c) Explain the need of PLC in automation.
- (d) What are the different standard test inputs ? Draw them & give their Laplace representation.

(B) Attempt any ONE of the following : 6

- (a) Draw the block diagram of discrete input module & explain each block.
- (b) Draw the labelled block diagram of process control system & explain each block.

5. Attempt any TWO of the following : 16

- (a) List & explain the timer instructions of PLC. Draw the Ladder diagram to verify
 - (i) OR gate &
 - (ii) NOR gate logic
- (b) Define the terms : (i) Poles, (ii) Zeros, (iii) Order of system & (iv) Characteristic equation. Also for a given transfer function.

$$\frac{C(S)}{R(S)} = \frac{10(S + 8)}{S(S + 4)(S^2 + 5S + 6)}$$

Find, (i) Poles (ii) Zeros & (iii) Plot them on S-Plane.

- (c) A unity feedback system has

$$G(S)H(S) = \frac{K}{S(S + 2)(S + 4)(S + 8)}$$

Where 'K' is positive. Determine range of values of K for the system to be stable.

6. Attempt any FOUR of the following :**16**

- (a) Why 'D' control action is not used alone ? Justify.
 - (b) Define :
 - (i) Linear & Non-linear system.
 - (ii) Time varying & Time in-varying system.
 - (c) List two instructions each of the following :
 - (i) Relay instructions.
 - (ii) Data handling instructions.
 - (iii) Logical instructions.
 - (iv) Comparison instructions.
 - (d) Draw electronic PD-controller. State its equation. Explain PD controller in brief.
 - (e) Draw neat sketch of unit step response of a second order system with neat labeling.
-



17536

16117

3 Hours / 100 Marks

Seat No.

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- Instructions :**
- (1) All questions are **compulsory**.
 - (2) Answer **each** next main question on a **new** page.
 - (3) Illustrate your answers with neat sketches **wherever** necessary.
 - (4) Figures to the **right** indicate **full** marks.
 - (5) Assume suitable data, if **necessary**.
 - (6) Mobile Phone, Pager and any other Electronic Communication devices are **not** permissible in Examination Hall.

Marks

1. A) Attempt **any three** :

12

- Draw the block diagram of DC servo system.
- State the need of PLC in automation.
- Define stability and with diagram of root location in s-plane define stable and unstable systems.
- Draw the block diagram of process control system.

B) Attempt **any one** :

6

- Explain:
 - Benefits of PLC in automation (3 points)
 - Scanning cycle.
- Derive the transfer function of the system as shown in figure 1, using block diagram reduction techniques.

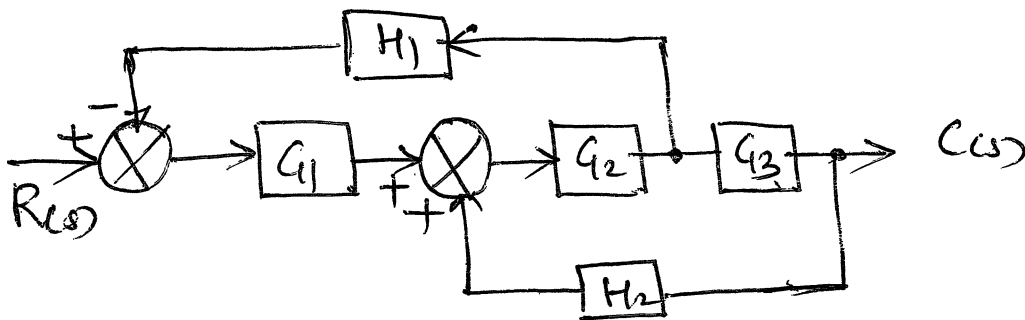


Figure 1

P.T.O.



2. Attempt any two :

16

- a) A second order system is given

$$\frac{C(s)}{R(s)} = \frac{6}{s^2 + 5s + 6}$$

Determine :

- a) Rise time
 b) Peak time
 c) Settling time
 d) Peak overshoot.
- b) For a given transfer function

$$\frac{C(s)}{R(s)} = \frac{s(s+2)}{(s^2+2s+2)(s^2+7s+12)}$$

Find :

- i) Poles
 ii) Zeros
 iii) Pole-zero plot
 iv) Characteristic equation.
- c) Draw ladder diagram for 2 motor operation for following condition
 i) Start push button starts motor M_1 after 10 seconds and motor M_2 after 20 seconds.
 ii) When stop push button is pressed it stops M_2 and after 15 seconds M_1 .

3. Attempt any four :

16

- a) Define transfer function. Derive an expression for transfer function of closed loop system.
 b) Draw the block diagram of PLC and explain its C.P.U. block.
 c) State with diagram any four block diagram reduction rules.
 d) By means of Routh's criteria determine the stability of the system $s^4 + 2s^3 + 8s^2 + 4s + 3 = 0$.
 e) Explain the function and organization of memory in PLC.

4. A) Attempt any three :

12

- a) Write the O/P equations and draw the response of PI and PD controller.
 b) Explain with diagram concept of sinking and sourcing in discrete input module.
 c) Differentiate between fixed and modular PLC (4 points).
 d) List different standard test inputs. Draw them and give their laplace transform equations.

B) Attempt any one :

6

- a) Explain with diagram and waveform of down-counter instructions in PLC.
 b) List types of control actions. Give its output equation and corresponding laplace transforms.

**5. Attempt any two :****16**

- a) Draw the block diagram of analog input module. Explain each block. List its 4 specification.
- b) Derive steady state error and error constants equations for Type-0 and Type-1 systems.
- c) Using Routh's criteria, determine the range of K values for system to be stable

$$G(s)H(s) = \frac{K}{s(s+2)(s+4)(s+5)}$$

6. Attempt any four of the following :**16**

- a) Explain w.r.t. proportional action
 - i) offset
 - ii) proportional band.
 - b) State any two advantage and disadvantages of Routh array.
 - c) Describe the wiring details of Discrete output module.
 - d) Draw electronic PD controller. State its equation and give its two disadvantage.
 - e) State with diagram the effect of damping on the response of second order system.
-

17536

14115

3 Hours / 100 Marks

Seat No.

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- Instructions* –
- (1) All Questions are *Compulsory*.
 - (2) Answer each next main Question on a new page.
 - (3) Illustrate your answers with neat sketches wherever necessary.
 - (4) Figures to the right indicate full marks.
 - (5) Assume suitable data, if necessary.
 - (6) Use of Non-programmable Electronic Pocket Calculator is permissible.
 - (7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. a) Attempt any **THREE** of the following : **12**
- (i) Define stable and unstable system; critically stable and conditionally stable system.
 - (ii) Name any four input and output devices each used with PLC.
 - (iii) Compare open loop and closed loop system based on block diagram, transfer function, examples and stability.
 - (iv) Classify different modes of process control action.

P.T.O.

b) Attempt any ONE of the following :

6

- (i) Describe in brief memory organization of PLC.
- (ii) Derive the transfer function of the following block diagram. Refer Fig. No. 1.

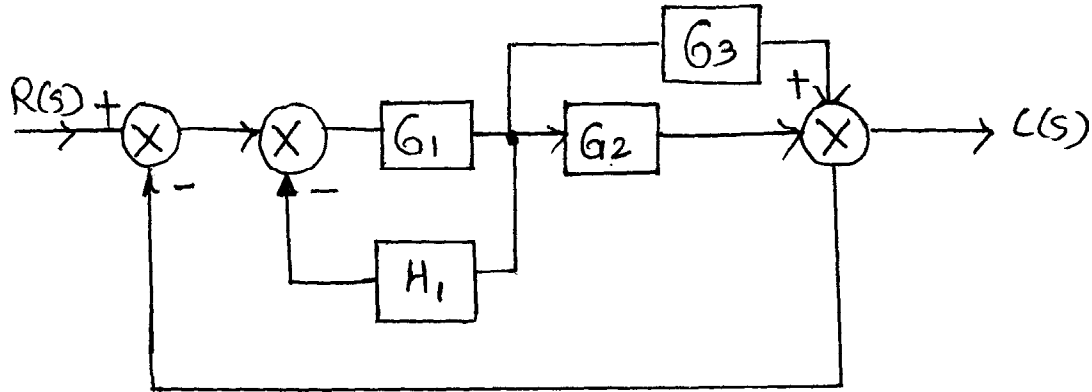


Fig. No. 1

2. Attempt any TWO of the following :

16

- a) T.F. of a second order system is given by $\frac{C(s)}{R(s)} = \frac{2s}{s^2 + 6s + 2s}$.
Find out T_r , T_p , T_s and % M_p for unit step input.

- b) A unity feedback system has $G(S) = \frac{10(s+1)}{s^2(s+2)(s+10)}$.

Find out : -

- (i) Type of system.
 - (ii) Static error coefficient K_p , K_v , K_a
 - (iii) Steady state error for input $r(t) = 1 + 4t + t^2/2$
- c) Draw ladder diagram for 2 motor operation for following conditions -
- (i) start push button starts motors M_1 and M_2 and
 - (ii) Stop push button stops motor M_1 first and after 10 seconds motor M_2 .

3. Attempt any **FOUR** of the following : 16

a) Derive the transfer function of given network. Refer Fig. No. 2.

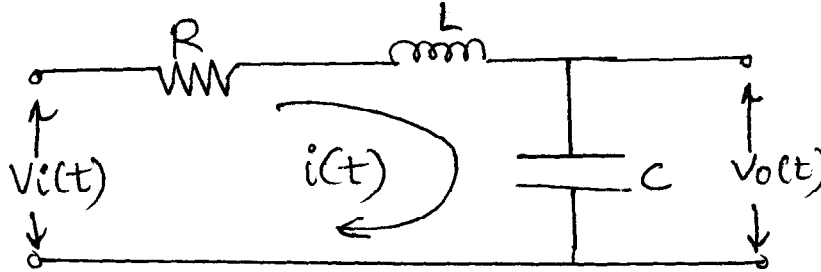


Fig. No. 2

- b) Draw block diagram of PLC and explain each blocks in brief.
 c) Define transfer function. Derive the expression of T.F. of closed loop system.
 d) For system, characteristic equation is $s^4 + 22s^3 + 10s^2 + s + k = 0$. Find k.
 e) Describe the term redundancy in PLC.

4. a) Attempt any **THREE** of the following : 12

- (i) Compare proportional and integral controller on the basis of equation, advantages, response to error and application.
 (ii) Draw the block diagram and AC input module of PLC.
 (iii) Describe the role of PLC in automation.
 (iv) Derive relation of steady state error in terms of open loop transfer function $G(S).H(s)$. Find e_{ss} for step input.

b) Attempt any **ONE** of the following : 6

- (i) Describe the wiring details of AC-output module of PLC.
 (ii) Draw the labelled block diagram and process control system and explain. Define w.r.t. controller –
 (1) Offset error
 (2) Proportional band.

5. Attempt any TWO of the following : **16**

- a) (i) Describe sinking and sourcing concept in DC input modules of PLC.
- (ii) Draw the block diagram of AC discrete input module of PLC.
- b) (i) Draw the effect of damping on the response of second order system.
- (ii) Define the time response specifications delay time T_d , rise time T_r , settling time T_s and peak overshoot M_p .
- c) By means of Routh's criteria, determine stability of system represented as

$$s^4 + 2s^3 + 8s^2 + 4s + 3 = 0$$

6. Attempt any FOUR of the following : **16**

- a) Describe ON-OFF control action. State its any one advantage and disadvantage of each.
 - b) State Routh's stability criteria and discuss different cases to find stability of a system.
 - c) Explain the TON instruction of PLC.
 - d) Draw electronic PID controller. State its equation and give its two advantages.
 - e) Define servo system. Draw its standard block diagram and explain.
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17536

21415

3 Hours/100 Marks

Seat No.

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- Instructions:**
- (1) Illustrate your answers with **neat sketches wherever necessary.**
 - (2) Figures to the **right** indicate **full** marks.
 - (3) Assume **suitable data**, if necessary.
 - (4) **Use of Non-programmable Electronic Pocket Calculator is permissible.**
 - (5) **Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.**

MARKS

1. A) Attempt **any three** :

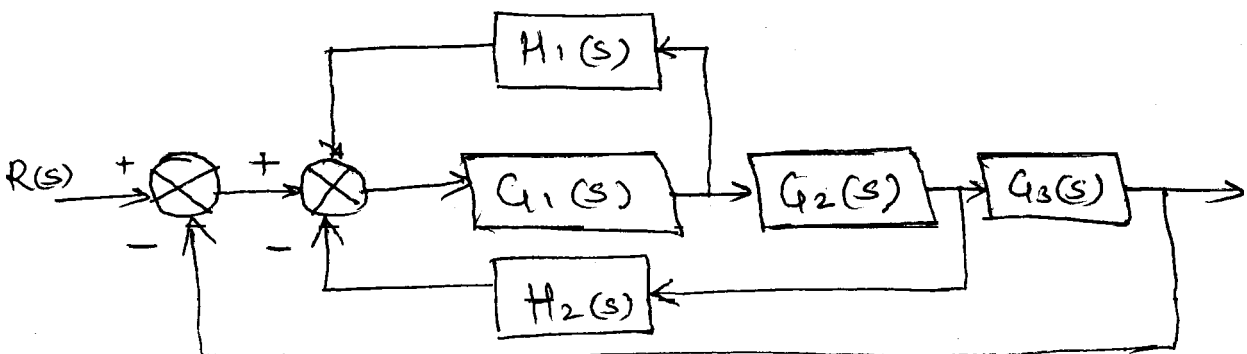
12

- a) Define stability and locate stable and unstable system poles on s-plane.
- b) List various input/output modules of PLC .
- c) Differentiate between open loop and close loop system.
- d) Compare between PI and PD controllers (any four points).

B) Attempt **any one** :

6

- a) Explain the need and benefits of PLC in automation.
- b) Derive the transfer function of the following block diagram :



P.T.O.



2. Attempt **any two** :

16

a) For a unity feedback system, the open loop T.F. $G(s) = \frac{25}{s(s+6)}$. Find out :

- i) Rise time
- ii) Peak time
- iii) Max-overshoot
- iv) Settling time.

b) For unity feedback system having $G(s) = \frac{5(s+1)}{s^2(s+3)(s+10)}$ determine type of system, error coefficient and the steady state error for I/P

$$r(t) = 1 + 3t + \frac{t^2}{2}.$$

c) Draw ladder diagram for 3 motor operation for following condition :

- 1) Start push button, start motor M_1 .
- 2) When motor M_1 is ON after 5 min M_2 is ON and M_1 is OFF ?
- 3) When M_2 is ON after 10 min M_3 is ON and M_2 is OFF ?
- 4) When stop push button is pressed M_3 is OFF ?

3. Attempt **any four** :

16

- a) Derive the transfer function of RLC network.
- b) Define scan cycle. Explain its significance in PLC.
- c) Differentiate between AC and DC servo system (four points).



MARKS

d) Find out the range of K for the given system to be stable with

$$G(s)H(s) = \frac{K}{s(s+4)(s^2+2s+2)}$$

e) Define the term scanning cycle, speed of execution in PLC.

4. A) Attempt **any three** :

12

- a) Explain why derivative action is not used alone. State its one advantage and disadvantage.
- b) Explain memory function and organization of ROM and RAM in PLC.
- c) Explain with diagram sinking and sourcing concept in DC I/P modules.
- d) Define pole and zero. Give its s-plane representation.

B) Attempt **any one** :

6

- a) Describe the wiring details of AC output modules of PLC.
- b) Describe PID control action w.r.t. equation and response to error. State one advantage and one disadvantage of it.

5. Attempt **any two** :

16

- a) List and explain the timer instructions of PLC.
- b) Explain with laplace representation standard test inputs. State its need and significance.
- c) Consider the system with characteristic equation $s^5 + 2s^4 + 3s^3 + 6s^2 + 2s + 1 = 0$. Determine stability of the system using Routh's criteria.



6. Attempt **any four** :

16

- a) Draw and explain the block diagram of process control system.
 - b) State Rouths stability criteria. Describe different cases to find stability of a system.
 - c) Draw the ladder diagram for to verify :
 - 1) AND gate
 - 2) NAND Gate logic.
 - d) List type of control action. Give one advantage and disadvantage.
 - e) List any two rules of block diagram reduction technique.
-



17536

15116

3 Hours / 100 Marks

Seat No.

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- Instructions :**
- (1) All questions are compulsory.
 - (2) Illustrate your answers with **neat** sketches **wherever** necessary.
 - (3) Figures to the **right** indicate **full** marks.
 - (4) Assume suitable data, if **necessary**.
 - (5) Mobile Phone, Pager and any other Electronic Communication devices are **not** permissible in Examination Hall.

Marks

1. A) Attempt **any three** :

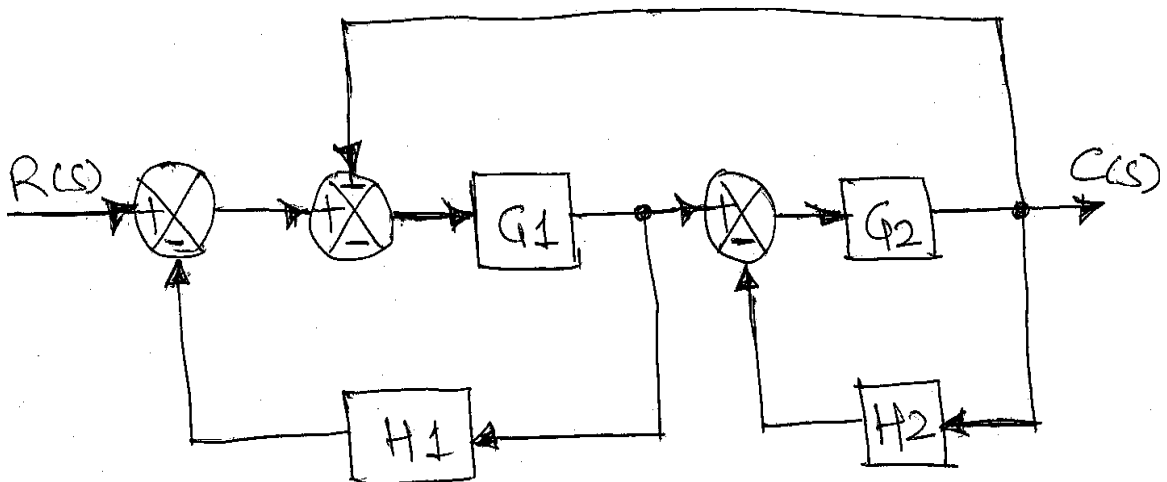
12

- i) Compare open loop and close loop control system.
- ii) Define the terms :
 - a) Poles
 - b) Zeros
 - c) Order of system
 - d) Characteristic equation
- iii) State the advantages of PLC.
- iv) Draw block diagram of process control system. State functions of its block.

B) Attempt **any one** :

6

- i) Draw block diagram of PLC. Describe working of different parts of PLC.
- ii) Derive transfer function of block diagram shown in fig. using block diagram reduction rules.



P.T.O.

2. Attempt **any two** :

a) A system is given by differential equation $\frac{d^2y}{dx} + 4 \cdot \frac{dy}{dx} + 8 \cdot y = 8 \cdot x$. Where y is output and x is input. Determine time domain specification.

- | | |
|--------------------|---------------------|
| i) Rise time | ii) Peak time |
| iii) Settling time | iv) Peak overshoot. |

b) For unity feedback system having open loop transfer function $G(S) = \frac{K(S+2)}{S(S^3+7S^2+12S)}$

Find :

- | | |
|--|----------------------------|
| i) Type of system | ii) All error coefficients |
| iii) Steady state error for input $r(t) = R/2 \cdot t^2$. | |
- c) Draw the ladder diagram for two motor system with following condition :
- | | |
|--------------------------------|------------------------------------|
| i) Start switch starts motor 1 | ii) 10 second later motor 2 starts |
| iii) Stop switch stops motor 1 | iv) 15 second later motor 2 stops |

3. Attempt **any four** :

16

- a) Derive transfer function of RC Network.
- b) Describe the proportional control action w.r.t. eqn and response. State significance of proportional band.
- c) Draw block diagram of servo system. State function of its component.
- d) Define the terms :
- | | |
|-----------------------------|---------------------------------|
| i) Stable system | ii) Unstable system |
| iii) Critical stable system | iv) Conditionally stable system |
- e) Draw block diagram of DC input module of PLC. Describe its working.

4. A) Attempt **any three** :

12

- | | |
|---|----------|
| i) State Routh's stability criteria. State its advantages. | |
| ii) Draw block diagram of PLC power supply. State functions of its component. | |
| iii) Explain ON/OFF delay timer instruction with diagram. | |
| iv) Develop ladder diagram for logical operation. | |
| a) OR | b) EX-OR |

B) Attempt **any one** :

6

- | |
|--|
| i) Describe the wiring details of AC output module of PLC with diagram. |
| ii) Explain PD control action w.r.t. equation and response. State their advantages and drawback. |

**5. Attempt any two :****16**

- a) Consider sixth order system with characteristic equation $S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$. Determine stability of system using Routh's criterion.
- b) State output time response relationship of second order system for step input. Give meaning of different terms in it. Show the effect of damping on time response with waveforms.
- c) Describe the concept of sinking and sourcing in DC input module. Differentiate between fixed PLC and modular PLC.

6. Attempt any four :**16**

- a) Describe PI control action. State their advantages.
 - b) List different input and output devices used in PLC.
 - c) Differentiate between linear time invariant and linear time varying system.
 - d) Draw block diagram of AC output module of PLC. Describe its working.
 - e) The transfer function of system is $\frac{C(S)}{R(S)} = \frac{K(S+6)}{S(S+2)(S+5)(S^2+7S+12)}$. Determine poles, zeros and pole-zero plot of system.
-



17536

15162

3 Hours / 100 Marks

Seat No.

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- Instructions :**
- (1) All questions are **compulsory**.
 - (2) Illustrate your answers with neat sketches **wherever** necessary.
 - (3) Figures to the **right** indicate **full** marks.
 - (4) Assume suitable data, if **necessary**.
 - (5) Use of Non-programmable Electronic Pocket Calculator is **permissible**.
 - (6) Mobile Phone, Pager and any other Electronic Communication devices are **not** permissible in Examination Hall.

Marks

1. A) Attempt **any three**: **12**
- a) Consider a system with characteristic equation $S^5 + 2S^4 + 2S^3 + 4S^2 + 11S + 10 = 0$. Determine stability using Routh's criteria.
 - b) List any four advantages of PLC.
 - c) Compare open loop and closed loop control system (four points).
 - d) Draw block diagram of process control system. Explain the function of each block.
- B) Attempt **any one**: **6**
- a) Explain the memory organization of PLC.
 - b) Draw the block diagram of DC servo system. Explain the function of each block.
2. Attempt **any two**: **16**
- a) For the unity Feedback system having open loop transfer function.
$$G(S) = \frac{K(S+2)}{S(S^3 + 7S^2 + 12S)}$$
Determine :
 - i) Type of system
 - ii) Error constant K_p , K_v and K_a
 - iii) Steady state error for unit parabolic input.
 - b) Draw the time response of second order system. Explain the effect of damping on the response of second order system.
 - c) Draw ladder diagram to verify following logic gates truth table :
 - a) NAND gate
 - b) EXOR gate
 - c) NOR gate
 - d) AND gate

P.T.O.


3. Attempt any four :

- a) Compare linear and non-linear system (four points).
- b) Explain the functions of output module of PLC.
- c) What is Laplace transform ? Explain the significance of Laplace transform in control system.
- d) Define :
 - i) Stability
 - ii) Relative stability.
- e) Define scan time of PLC. Explain the significance of scan time.

4. A) Attempt any three :
12

- a) Explain the offset in proportional controller. Draw the response of proportional controller.
- b) List any four specifications of AC input module.
- c) Explain in detail the role of CPU in PLC.
- d) Write the Laplace transform for the following input signal.
 - i) step
 - ii) ramp
 - iii) parabolic
 - iv) impulse

B) Attempt any one :
6

- a) List the timer instructions of PLC. Explain any one of them in detail.
- b) Compare PI, PD and PID controller (four points).

5. Attempt any two :
16

- a) Draw the ladder diagram for 2 motor operation :
 - i) When start button is pushed motor M1 and M2 start
 - ii) After 10 sec. motor M1 stops
 - iii) Motor M2 stops 15 sec. after motor M1 has stopped
 - iv) Both M1 and M2 will stop when stop push button is pressed.
- b) For a unity feedback system, the open loop TF $G(S) = \frac{25}{S(S+6)}$. Determine
 - i) Rise time
 - ii) Peak time
 - iii) Maximum overshoot
 - iv) Settling time
- c)
 - i) Define critically stable and conditionally stable system.
 - ii) For the characteristic equation $S^4 + 20KS^3 + 5S^2 + (10 + K)S + 15 = 0$. Determine the value of K for stable system.

6. Attempt any four :
16

- a) Explain in brief ON-OFF control action.
 - b) State Routh's criteria. Describe different cases to find stability of system (any two).
 - c) With the help of neat diagram explain the concept of sourcing and sinking DC input module of PLC.
 - d) Explain the derivate control action with equation and response curve. Why derivate action cannot be used alone ?
 - e) State and explain any two rules of block diagram reduction.
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