Instruction: (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.

1. Attempt any FIVE of the following: [10]
   (a) Draw electrical symbol used to represent NO pushbutton, NC pushbutton.
   (b) Find order of system for the unity feedback system with
       \[ C(s) = \frac{16}{s(s+8)} \]
   (c) Write any four applications and four advantages of Servo system.
   (d) Define the following term:
       (i) Time Response
       (ii) Transient Response
       (iii) Steady State Response
       (iv) Steady State error
   (e) List the various factors which governs the selection of PLC for particular use.
       (minimum eight points)
   (f) Compare Linear and non-linear system on the basis of additive property and
       homogeneous property.

2. Attempt any THREE of the following: [12]
   (a) Give any four rules for block diagram reduction technique.
   (b) Draw and describe the block diagram of AC discrete output module of PLC.
   (c) (i) For a given Transfer function
       \[ T.F. = \frac{K(S+7)}{S(S+2)(S+5)(S^2+7S+12)} \]
       find (1) Pole  (2) Zero  (3) Characteristics equation  (4) Pole Zero plot
   (ii) (1) Find the Transfer function of a given differential equation.
       \[ \frac{dy}{dt^2} + 4 \frac{dy}{dt} + 8y(t) = 8x(t) \]
   (2) Define: (a) Logical Instructions  (b) Data Handling Instructions
   (d) Draw the basic block diagram of PLC and write the function of each block.

3. Attempt any THREE of the following: [12]
   (a) Draw block diagram of PLC and give the function of isolator used in it.
   (b) Plot a graph of proportional-Integral (PI) controller mode output as a function of
       time for the given error in figure-1. \( K_P = 5 \), \( K_I = 1.0 \ S^{-1} \) and \( P_i(0) = 20\% \).
   (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

4. Attempt any THREE of the following: [12]
   (a) Draw and describe Proportional band in Proportional controller mode.
   (b) Derive transfer function for the system given in figure

```
L            C
|              |
|              |
Ei            Ri
i
|              |
|              |
Eo
```

(c) Compare Relay logic control and Programmable logic control. (minimum eight points)
(d) Describe sinking and sourcing concept in DC input modules of PLC

5. Attempt any TWO of the following: [12]
   (a) With respect to PLC
      (i) State the importance of PLC in automation
      (ii) Describe memory organization of PLC.
   (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.

6. Attempt any TWO of the following: [12]
   (a) Describe ON-OFF control action with equation and response curve.
   (b) Derive the Transfer Function of following circuit:

```
R
C
V_i(t)
i(t)
V_o(t)
```

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

```
R(s)
+        +
G_1(s)    G_2(s)
 -        -
H_2(s)
```

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