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:

   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:

   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.

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P.T.O.
2. Attempt any two:

a) A system is given by differential equation \( \frac{d^3 y}{dx^3} + 4 \frac{dy}{dx} + 8y = 8x \). 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 \( r(t) = R/2.t^2 \).

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:

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:

   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:

   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:
   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:
   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.