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.

1. A) Attempt any three:
   a) Draw the block diagram of DC servo system.
   b) State the need of PLC in automation.
   c) Define stability and with diagram of root location in s-plane define stable and unstable systems.
   d) Draw the block diagram of process control system.

B) Attempt any one:
   a) Explain:
      i) Benefits of PLC in automation (3 points)
      ii) Scanning cycle.
   b) Derive the transfer function of the system as shown in figure 1, using block diagram reduction techniques.

[Diagram of system]

Figure 1

Marks

12

6

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

   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:

   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:

   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:

   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:
   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:
   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.