Question 1

a) "Two parameters of system control in manufacturing process influence kind of automatic control required : (1) Time and (2) Precision.". Classify the following control problems based on the two stated parameters:
    - Car speed controller.
    - Temperature controller in air conditioning unit.
    - Washing machine sequential controller.

b) Convert the following binary numbers to; Octal and Hexadecimal:
    i)   010111010
    ii)   101011101

c) What are the main differences between continuous and discrete control systems.

d) Develop *logic network*, *Relay Ladder Logic (RLL)* and *truth table* for the following Boolean equation: $f = A.(B + \overline{C}) + \overline{B}.D$?

Question 2

a) What is the main difference between the proximity (Nearby) and contact type logic sensors?

b) State type of the proximate detectors used to detect glass bottle on filling line?

c) What are main differences between electrometrical and solid state relays, what are the advantages and drawbacks (disadvantages)

Question 3

a) Draw *Logic Network*, *RLL* and *Pneumatic Network* for *R/S* flip-flop memory, having two push buttons switches/valves; *Start* and *Stop*?

b) Explain the meaning of using sustain and non-sustain control signals with pneumatic double acting cylinder as mechanical actuator.

c) Develop the *RLL* for the following pneumatic machine sequence using non-sustain control signals for all double acting cylinders:

$$Start, A^{+}, A^{-}, A^{+}, \begin{pmatrix} B^{+}, Delay\,10s,\, B^{-} \\ C^{+} \end{pmatrix}, C^{-}, 10s\,delay, A^{-}$$

d) What is the reason of using manual control cycle in machine controller ? Suggest the suitable switches required and modify the *RLL* in (c) to include manual cycle?

Question 4

Given the following machine control sequence:

$$Start, A^{+}, (repaet\,3\,times; (B^{+}, C^{+}, 20s\,delay, C^{-}, B^{-})), A^{-}.$$

(a) Re-arrange the machine sequence using on-delay and/or off-delay functions.
(b) Develop RLL for the given machine sequence assuming non-sustain outputs for all cylinders?.
(c) Modify the RLL for the given machine sequence assuming sustain control output signal for cylinder A <u>only</u>?

Analog output

Question 5

Given the following machine sequence; $Start, B^+, C^+, (2.5V\ DA), B^-, C^-$.

Develop the RLL for non-sustain output signals. Given analog conversion equations:
$D = 200 * A$, and
$A = 0.005 * D$
Where D: Digital value and A: Analog voltage.
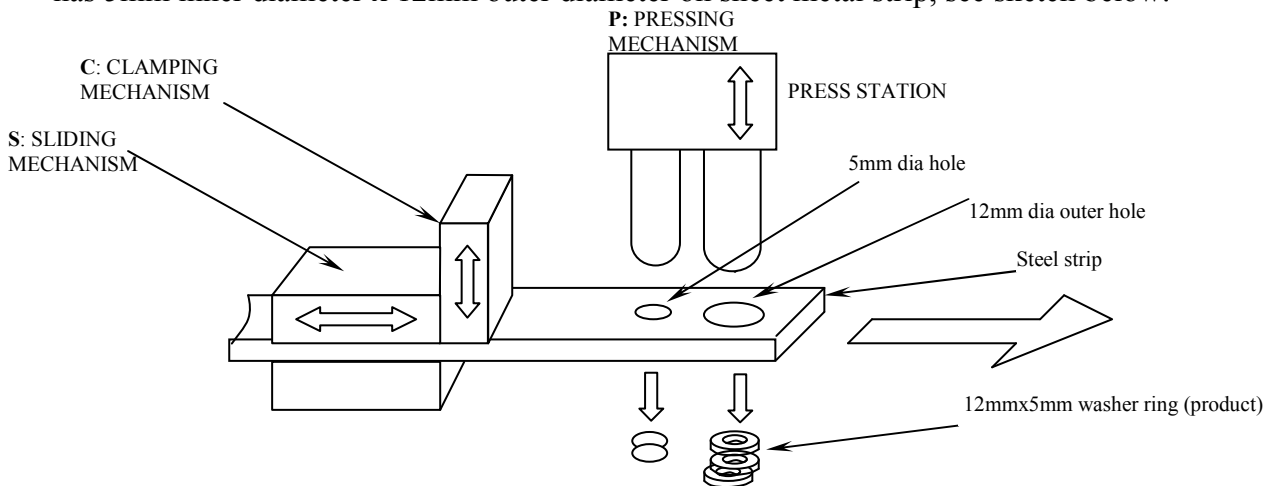Analog output register address YW004.
Analog output *RLL* instruction :

$$Input ——\Big(Digital\ Value\ \textbf{MOV}\ DA\_Address \Big)—— Output$$

Question 6

One pressing station is used to carry out two forming (Blanking) processes to produce a ring washer has 5mm inner diameter x 12mm outer diameter on sheet metal strip, see sketch below:

P: PRESSING MECHANISM

C: CLAMPING MECHANISM

S: SLIDING MECHANISM

PRESS STATION

5mm dia hole

12mm dia outer hole

Steel strip

12mmx5mm washer ring (product)

Four mechanismes are used in machine structure (see fig. above) and powered using penumatic double acting cylinders having 5/3 double solenoid with two spring return valve. The machine operation sequence is as follows:

1. Start
2. Clamping the steel strip using clamping mechanism (C).
3. Forward feeding of steel strip using sliding mechanism (S).
4. Pressing stations (P) (forward movement of press)
5. Back movement of press (P).
6. Unclamping steel strip using clamping mechanism.
7. Backward of the sliding mechanism (S).
8. Goto step 2 or end (step 8) depend on a selector switch set by the machine user (while do loop)
9. End