

APR 03 2017

KATHMANDU UNIVERSITY
End Semester Examination
March/April 2017

Marks Scored:

Level : B.E.

Year : IV

Course : COEG 401

Semester: I

Exam. Roll No. :

Time : 30 mins.

F.M. : 20

Registration No.:

Date :

SECTION "A"

[20 Q. × 1 = 20 marks]

- 1) A compensator is in the form $C(s) = K_c \left(\frac{1 + \alpha \tau s}{1 + \alpha \tau} \right)$; $\alpha > 1, K_c > 0$ & $\tau > 0$. The compensator may be realized by op-amp circuit for _____.
- Proportional plus integral action
 - Proportional plus gain-limiter integral action
 - Proportional plus derivative action
 - Proportional plus bandwidth-limiter derivative action
- 2) If a first order unit negative feedback system is controlled by a proportional controller, increment in proportional gain will _____.
- increase the time constant and decrease the steady state error to step input.
 - decrease the time constant and decrease the steady state error to step input.
 - decrease the time constant and increase the steady state error to step input.
 - increase the time constant and increase the steady state error to step input.
- 3) The steady state error due to step command can be eliminated from proportional controller with type-0 plant by _____.
- i. intentionally misadjusting reference input
 - ii. introducing integral mode in the controller
- None of the above statements are true
 - Statement (i) is true but statement (ii) is false
 - Statement (ii) is true but statement (i) is false
 - Both the statements are true
- 4) If there is constant error in the output signal, derivative control will _____.
- reduce the error to zero
 - reduce the error but not necessarily to zero
 - have no effect on the error
 - increases the error
- 5) Consider a unity-feedback system with open loop transfer function $C(s) = \frac{K}{s(1+s)}$. Increase in gain K will cause _____.
- the gain crossover frequency to reduce
 - the gain crossover frequency to increase
 - the system to respond more slowly
 - none

6) The transfer function of a system is $C(s) = \frac{10(1+0.2s)}{(1+0.5s)}$. The phase shift at $\omega=0$ and $\omega=\infty$ will be respectively _____.

- 90 and 0 degree -180 and 180 degree
 -90 and 90 degree none

7) A type-1 system can be changed to type-2 feedback system by the cascading _____.

- PD PI either PD or PI neither PD or PI

8) Controllable form of state space realization of a minimal transfer function is _____.

- controllable and observable controllable but not observable
 not controllable but observable not controllable and not observable

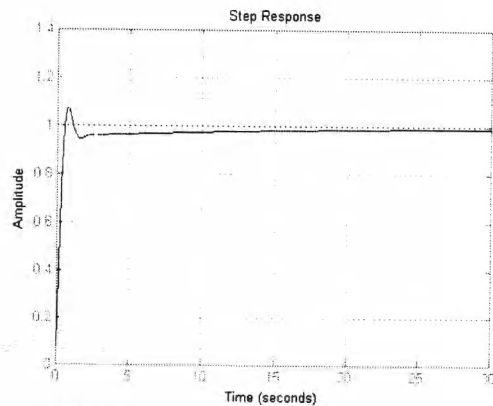
9) The compensator $G(s) = \frac{20}{s+0.01}$ is a _____.

- PI-controller PD-controller
 Phase-lead compensator Phase-lag compensator

10) A unity gain negative feedback system has system transfer function

of $\frac{1}{s^2 + 3s + 1}$. The system is

compensated by PID controller with $K_p=17$, $K_d=2$ and $K_i=1$ with unit step response as shown in figure. What should be done to eliminate overshoot and zero steady state error for unit step input?



- Increase K_d and decrease K_i Decrease K_d and increase K_i
 Increase K_d and increase K_i Decrease K_d and decrease K_i

11) A system has continuous state space matrices A , B , C and D . The discretized matrices \tilde{A} , \tilde{B} , \tilde{C} and \tilde{D} using Forward Euler method for sampling time T are _____ respectively.

- $I+TA$, TB , C and D TA , $I+TB$, C and D
 TA , TB , C and D TA , TB , TC and TD

12) Which of the following process of PLC has longest time allocation?

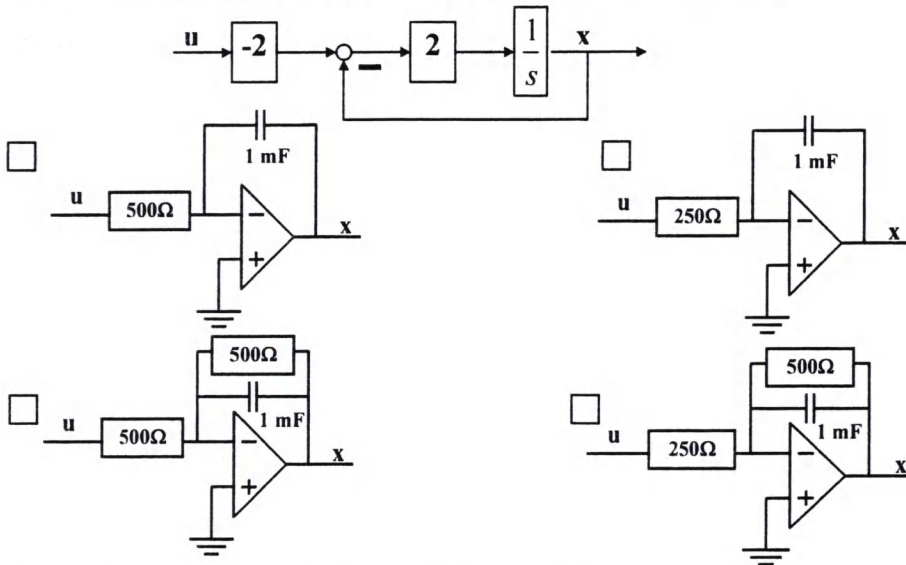
- Input scan Output scan Program scan Terminal scan

13) Which of the following is deficiency of proportional controller?

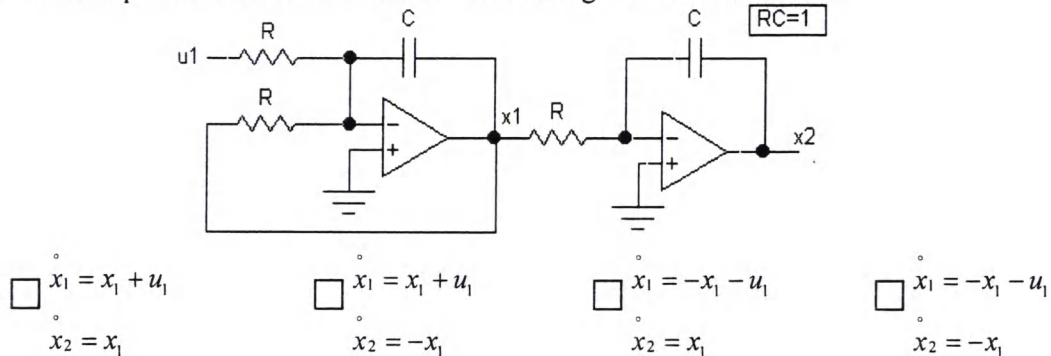
- It has limitation to change the steady state error
 It scales up the error signal by the same amount throughout the response.
 Very large value of proportional constant can lead to instability
 all of the above

- 14) A lag compensation network normally consists of _____ elements.
 R & L L & C R & C R, L & C
- 15) Sequential controller is applied for _____.
 conditional logic sequential logic
 relay logic all of the above

16) The op-amp circuit for the given basic block diagram is:



17) State equations of the circuit shown in the figure below are:



18) Transfer function of following system is _____.

$$\dot{\underline{x}} = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \underline{x} + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} u \quad y = [0 \quad 0 \quad 0.5] \underline{x}$$

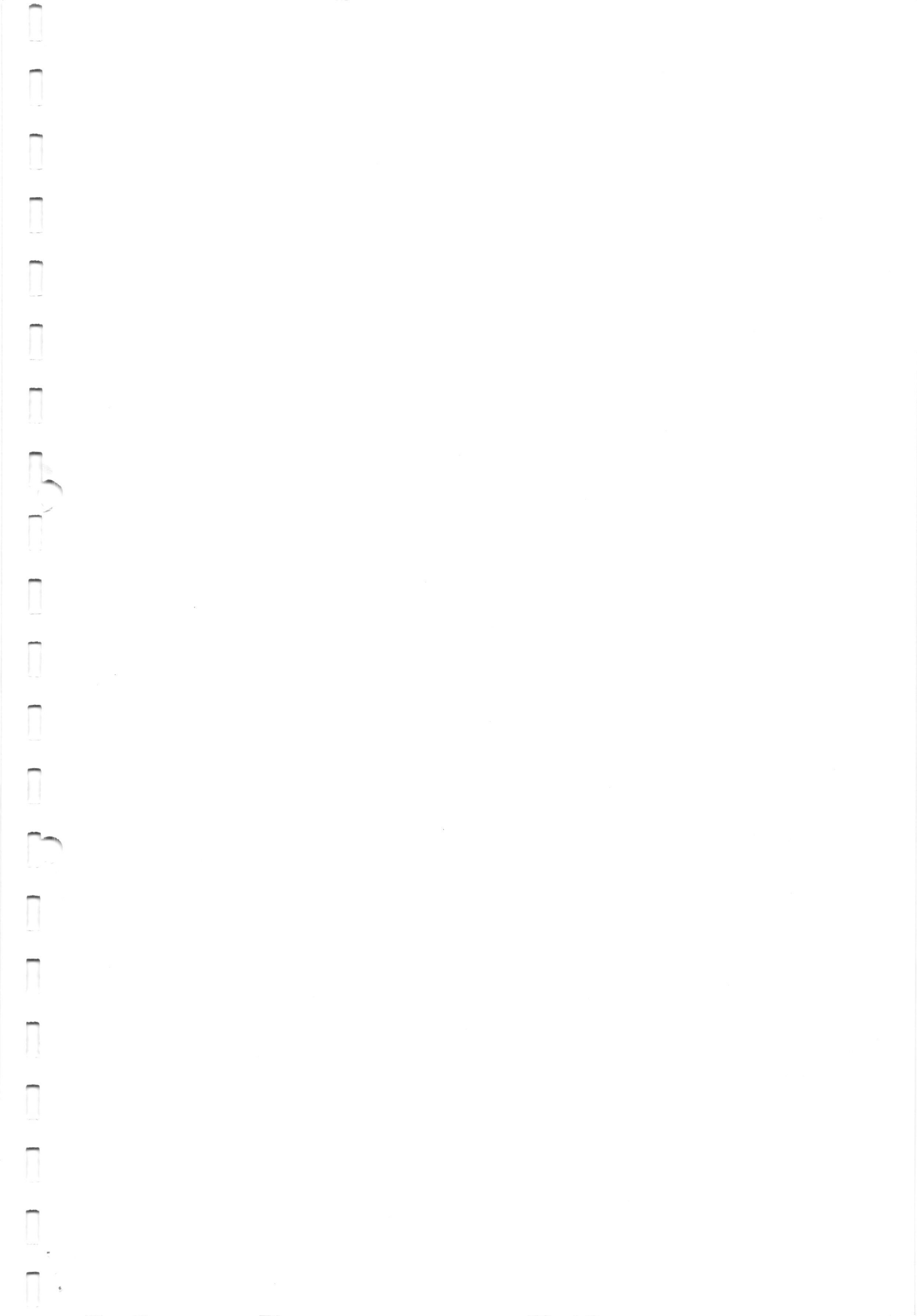
- $1/s^3$ $-1/s^3$ $2/s^3$ $-2/s^3$

19) Zero state response of a system results only from the _____.

- internal disturbance external input feedback driving input

20) For a minimal system, size of _____ matrix should be equal to order of system.

- output input state direct transfer



KATHMANDU UNIVERSITY
End Semester Examination
March/April 2017

APR 03 2017

Level : B.E.
Year : IV
Time : 2 hrs. 30 mins.

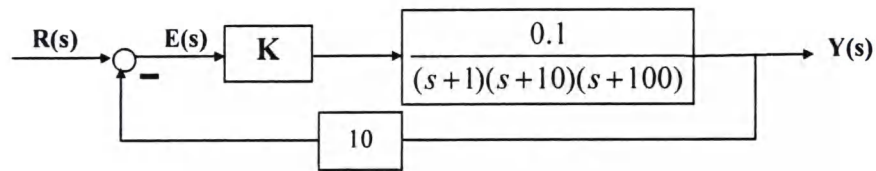
Course : COEG 401
Semester : I
F.M. : 55

SECTION "B"

Attempt ANY FIVE questions. Semilog graph papers will be provided

1)

i) Block diagram of a closed loop control system is shown in figure below,



Design compensator for the system to meet the following specifications [9]

- Position error $\leq 10\%$
- Phase margin $\geq 60^\circ$
- Gain margin ≥ 10 dB
- Gain crossover frequency as large as possible.

ii) Briefly describe process scan of PLC and how this scan process is affected by setting PLC in terminal mode and run mode. [2]

2)

i) Write down generalized matrix for realization of state space representation of non linear system. Realize the following non linear system to state space form. [2+4]

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} x_1^2 \sin(u_1) + 8x_2 \\ x_1 x_2 + \cos(u_1) + 1 \end{bmatrix} \rightarrow \begin{matrix} f_1 \\ f_2 \end{matrix} \quad y_1 = -x_1^2 + x_2 \rightarrow g_1$$

ii) Discretize the following system using forward Euler and ZOH. [5]

$$A = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \quad B = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \quad C = [1 \quad 0] \quad D = [0]$$

3)

i) Obtain the state space representation of the system using both cascade and parallel realization. [5]

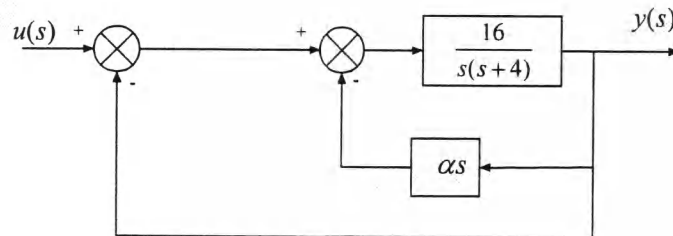
$$G(s) = \frac{(s+1)}{s(s+10)(s+100)}$$

iii) Realize the state space of the system obtained in (i) by operational amplifier. [6]

- 4)
- Using an appropriate example of a non-minimal system, Justify the statement, "Observable form of non-minimal system is observable but not controllable". [5]
 - Draw operational amplifier circuit for P, PI, PID and phase lag compensator. [3]
 - Write down MATLAB program to obtain transfer function from state space representation of a MIMO system. [3]

5)

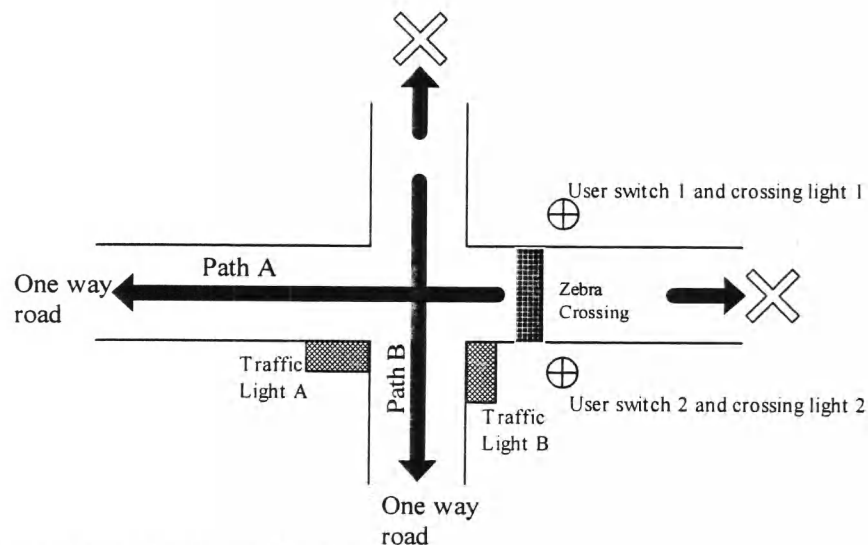
- The system below is a unity feedback control system with a minor rate feedback loop.
 - In the absence of rate feedback, determine the peak overshoot of the system to unit step input, and the steady state error resulting from unit ramp input. [2]
 Determine the rate feedback constant which will make the damping ratio 0.8.



- Write short notes on integral performance criteria. [3]

6)

i)



In the road layout shown in figure above:

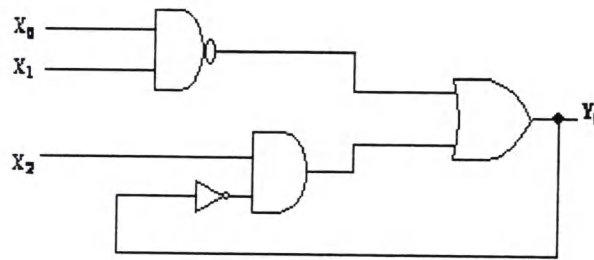
- Two one way road path A and path B cross each other and traffic can flow only through one path. (Traffic from path A cannot go to path B and vice versa)
- Traffic at path A and B are controlled by traffic light A and B respectively.
- Both traffic light A and B contains Red (stop) and Green (go) lights.
- There is zebra crossing in right side of path A and is equipped with user control switch and crossing light 1 and 2 with red and green light.

Control objective:

- Both traffic light A and B should alternately light green and red for 30 second each.
- When traffic light A is green crossing light 1 and 2 should light red.
- When traffic light B is green crossing light 1 and 2 should light green.
- If traffic light A is green and either of user switch 1 or 2 is pressed,
 - Traffic light A should light red
 - Traffic light B, crossing light 1 and 2 should light green for 20 seconds
 - After 20 seconds, traffic light A should light green for 30 seconds and usual process should continue.

Construct state chart, Grafcet diagram and ladder diagram to implement above control objective. [7]

b) Implement following digital circuit using ladder logic and write down machine code of ladder diagram using basic instruction set of PLC(With reference to DL240 of Direct Logic) [4]



Appendix

Controllability Matrix	$U=[B AB A^2B A^{n-1}B]$
Observability Matrix	$V=[C CA CA^2 CA^{n-1}]^T$

State Space to Transfer Function

$$G(s) = G(\infty) + \frac{b_3s^3 + b_2s^2 + b_1s + b_0}{s^4 + a_3s^3 + a_2s^2 + a_1s + a_0}$$

Controllable form

$$A = \begin{bmatrix} -a_3 & -a_2 & -a_1 & -a_0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \quad B = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$C = [b_3 \quad b_2 \quad b_1 \quad b_0] \quad D = [G(\infty)]$$

$$U^{-1} = \begin{bmatrix} 1 & a_3 & a_2 & a_1 \\ 0 & 1 & a_3 & a_2 \\ 0 & 0 & 1 & a_3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

