KATHMANDU UNIVERSITY
End Semester Examination [C]
June, 2018

Marks Scored:

Level : B.E.
Year : IV

Course : COEG 401
Semester: I

Exam. Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date JUN 18 2018

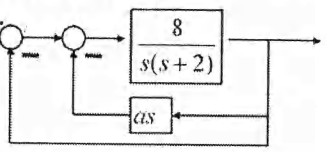
SECTION "A"
[20 Q. × 1 =20 marks]

1. Which of the following is deficiency of proportional controller?
   a) It has limitation to change the steady
   b) It scales up the error signal by the same amount throughout the response.
   c) Very large value of proportional constant can lead to instability
   d) All of the above

2. With feedback the, the transient response of the system as compared to without feedback.
   a) decays slowly
   b) rise at fast rate
   c) rise at slow rate
   d) no effect on transient performance

3. A large time constant corresponds to _____.
   a) sluggish system
   b) faster system
   c) overdamped system
   d) underdamped system

4. In the unity feedback system shown in the figure, the value of the derivative feedback constant a, which will give $\zeta = 0.9$, is _____
   a) 0.386
   b) 0.457
   c) 0.562
   d) 0.238



5. Frequency ranges of Bode magnitude and phase are described by _____.
   a) the lowest and highest important frequencies of dominant factors of the open-loop transfer function.
   b) the lowest and highest important frequencies of all the factors of the open-loop transfer function.
   c) resonant frequencies of the second order factors.
   d) non of the above.

6. Given the system, $\dot{x}(t) = -2\sin(x(t)) + 4u(t)$, for the working point $x_w = \frac{\pi}{2}$,
   a) $u_w = 0$
   b) $u_w = 0.5$
   c) $u_w = 1$
   d) $u_w = 2$

7. Which of the following information about stability can be obtained from Bode plot.
   a) the value of open loop gain at which the system will become marginally stable.
   b) how far the system is from becoming marginally stable.
   c) number of closed-loop poles in the right plane for a specified open-loop gain.
   d) both (a) and (b)

8. Which system would give best performance in terms of control engineering?
   a) With poles in the left half of s-plane and close to the imaginary axis.
   b) With poles in the left half of s-plane and far from the imaginary axis.
   c) With poles in the right half of s-plane and close to the imaginary axis.
   d) With poles in the right half of s-plane and far from the imaginary axis.

9. Which of the following is true for derivative control?
   a) decrease overshoot and increase steady state error
   b) decrease both overshot and settling time.
   c) increase both overshoot and settling time.
   d) increase overshoot and decrease settling time.

10. PLC when kept in run mode _____.
   a) do not access internal memory
   b) can interact with i/o module
   c) debugging mode is active
   d) uses additional computational time

Fill in the blanks.

11. Rank of the matrix, $\begin{bmatrix} 1 & 0 \\ -5 & 1 \end{bmatrix}$, is _____.

12. For a MIMO system with 2 inputs and 4 outputs, size of its transfer function matrix is _____.

13. Gain crossover frequency of a system $\frac{10}{s+1}$ is _____.

14. For a system to be stable gain crossover frequency should be _____ _____ phase crossover frequency.

15. GM of system with open loop transfer function $G(s)=\frac{1}{s+5}$, is _____ dB.

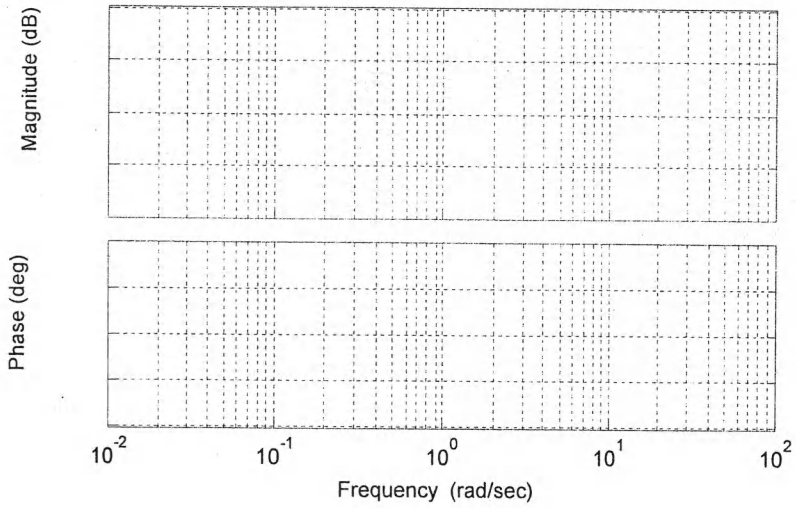
16. MATLAB command for calculating the pole of a state space model is _____.

17. Parallel realization is a method of obtaining _____ of transfer function.

18. If velocity error of a system is infinite, then the type of the system is _____.

19. Tracking speed of a control system can be analyzed by observing _____.

20. Draw the bode diagram of $G(s) = \dfrac{1}{s(s+5)}$



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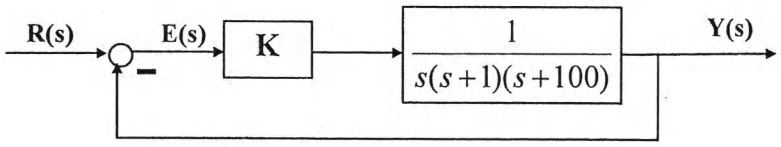
SECTION "B"

Attempt *ANY FIVE* questions. Semilog graph papers will be provided.

1)

i) In the closed loop negative feedback control system defined in figure below,



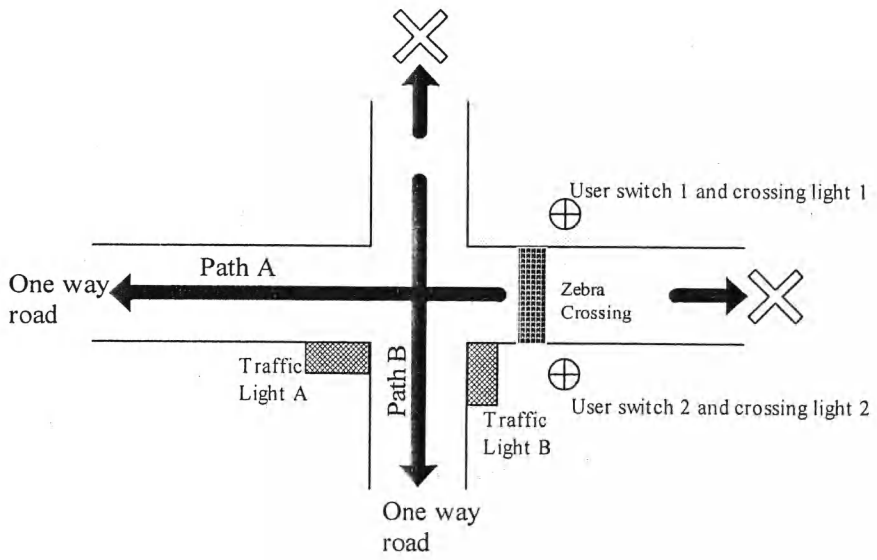
Using frequency domain analysis, evaluate the value of K to meet flowing specifications. [9]

- Velocity error $\leq 5\%$
- Phase margin $\geq 40^{o}$
- Gain margin ≥ 12 dB
- Gain crossover frequency as large as possible.

ii) Write down MATLAB command to evaluate transfer fiction from state space representation of a system. [2]

2)

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:

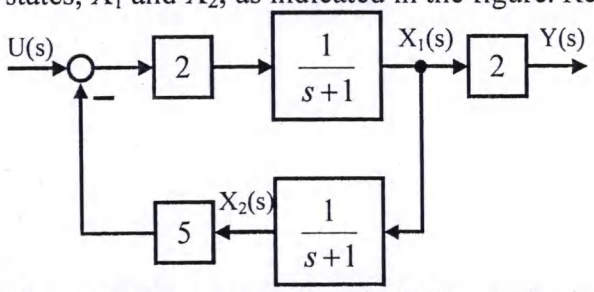
- Both traffic light A and B should alternately light green and red for 30 second each.
- When traffic light A is green crossing light 1 and 2 should light red.
- When traffic light B is green crossing light 1 and 2 should light green.
- If traffic light A is green and either of user switch 1 or 2 is 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 Grafcet diagram and ladder diagram to implement above control objective. [9]

ii) Draw and explain the block diagram of a PLC system. [2]

3)

i. Find the state space representation of the system given in the figure below considering the states, X_1 and X_2, as indicated in the figure. Realize the state space using Op-Amps. [5]



ii. Show that the system given in Q4i) can also be represented by the following state space. [3]

$$A=\begin{bmatrix}-2 & -11\\ 1 & 0\end{bmatrix}\ B=\begin{bmatrix}1\\0\end{bmatrix}\ C=\begin{bmatrix}4 & 4\end{bmatrix} \text{ and } D=[0]$$

iii. Realize the state space given in Q3ii) using Op-Amps. [3]

4)

i) Discretize the following system using forward Euler and ZOH. [6]

$$A=\begin{bmatrix}0 & -2\\ 7 & 1.3\end{bmatrix}B=\begin{bmatrix}3\\3\end{bmatrix}C=\begin{bmatrix}8 & -6\end{bmatrix}D=[0]$$

ii) Given the following system: $\dot{x}=4x^2+7u$ and $y=5x$. [3]

a) Find the linearized equation for the system.
b) Assume that we want $x_w = 1$. Find u_w for this working point.
c) Find the linearized system for the working point from b).

iii) Briefly explanin about the general process of linerazing state spact equations. [2]

5)

i) Obtain the state space representation of the system using both cascade and parallel realization. [6]

$$G(s)=\frac{1}{(s+5)^2(s+2)}$$

ii) The open loop transfer function of unit feedback system is $G(s) = \frac{2K}{s(1+sT)}$.

a) By what factor the amplifier gain K should be multiplied so that the damping ratio is increased from 0.2 to 0.6 [2]

b) By what factor the time constant T should be multiplied so that the damping ratio is reduced from 0.9 to 0.2 [3]

6) Write notes on. *(*Attempt *ANY FOUR)*

a) Controllable and observable form of non-minimal transfer function. [2.75]

b) Op-amp circuit for P, PD, PID controllers [2.75]

c) Frequency domain analysis for stability [2.75]

d) Process cycle of PLC [2.75]

e) Realization of non-minimal transfer function [2.75]

f) Linearization of non linear state space [2.75]

COEG-401 - Table

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