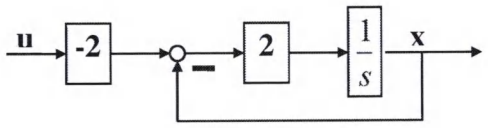
Mark Scored:

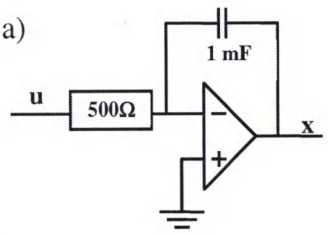
KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2019

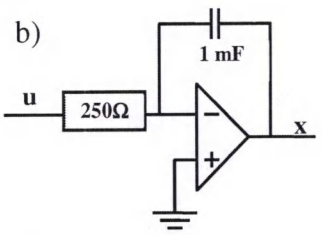
Level : B. E.
Year : IV
Course : COEG 401
Semester: I
Exam Roll No. :
Time: 30 mins.
F. M. : 20
Registration No.:
Date FEB 25 2019

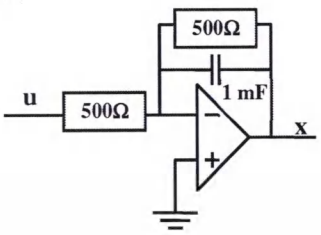
SECTION "A"
[20 Q.× 1= 20 marks]

1) The Op-Amp circuit for block diagram below is



a)


b)


c)


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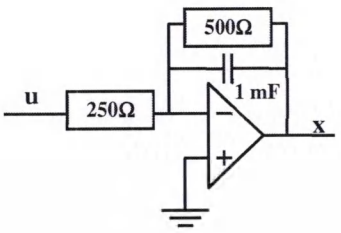


2) Consider the following statement for an underdamped second-order system.
i. Peak overshoot in step input response reduces as damping is increased from 0.2 to 0.6
ii. Resonance peak in frequency response reduces as damping is increased from 0.2 to 0.6
a) None of the above statements are true.
b) Statement (i) is true but statement (ii) is false.
c) Statement (i) is false but statement (ii) is true.
d) Both the statements are true.

3) The steady state error due to step input can be eliminated from proportional control system with type-0 plant by _____.
i. introducing differential mode in the controller.
ii. introducing integral mode in the controller.
a) None of the above statements are true.
b) Statement (i) is true but statement (ii) is false.
c) Statement (ii) is true but statement (i) is false.
d) Both the statements are true.

4) Consider the following statements: _____.

i. If an open loop system is unstable, applying feedback will always improve its stability.
ii. If an open loop system is subject to parameters variations, applying feedback will always improve robustness.

a) None of the above statements are true.
b) Statement (i) is true but statement (ii) is false.
c) Statement (i) is false but statement (ii) is true.
d) Both the statements are true.

5) In a digital control scheme, selection of large sampling interval _____.

a) improves the steady state performance
b) deteriorates the steady state performance
c) has no effect on steady state performance
d) influences steady state performance that depends on plant parameters

6) A system with large rise time can be made faster by _____.

a) shifting the pole far from imaginary axis
b) shifting the pole close to imaginary axis
c) adding a zero
d) none of the above

7) The main characteristics of lag compensator is/are,

a) it is a low pass filter
b) zero is larger than pole
c) it is a first order system with a zero and a pole
d) all the above

8) The initial slope of the Bode plot for a system with repeated poles at origin is _____.

a) 20 dB/decade b) 40 dB/decade c) -20 dB/decade d) -40 dB/decade

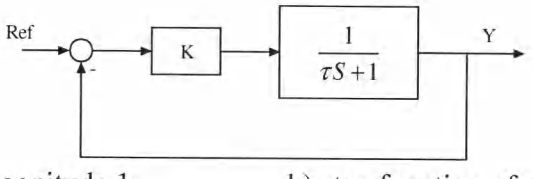
9) The compensator scheme that is highly sensitive to noise is _____.

a) PD b) PI c) both PD and PI d) neither PD of PI

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

a) controllable and observable b) controllable but not observable
c) not controllable but observable d) neither controllable nor observable

11) In the closed loop system shown in figure below, it is desired that the output Y changes by unit step with zero error at steady state. This can achieve this by providing reference signal equal to _____.



a) step function of magnitude 1 b) step function of magnitude (1+K)/K
c) step function of magnitude K(1+K) d) none

12) A unity gain negative feedback system has system transfer function of $\frac{1}{s^2+2s+4}$. The step response of the system with unit proportional gain is shown is figure (11.a) below. What should be done to obtain step response as shown in figure (11.b)

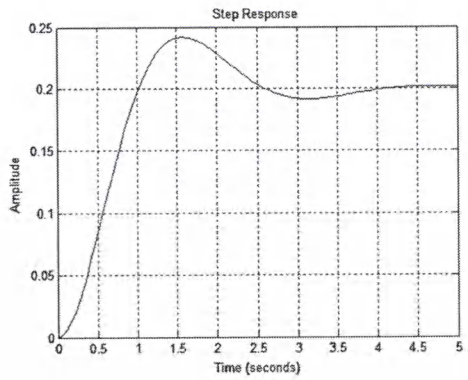


Figure 11.a

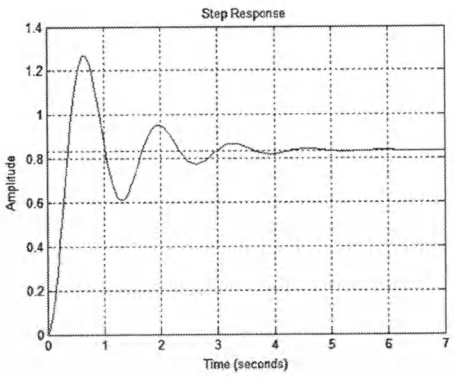


Figure 11.b

a) Increase Kp
b) Decrease Kp
c) Increase K_d and decrease Kp
d) Decrease K_d and decrease Kp

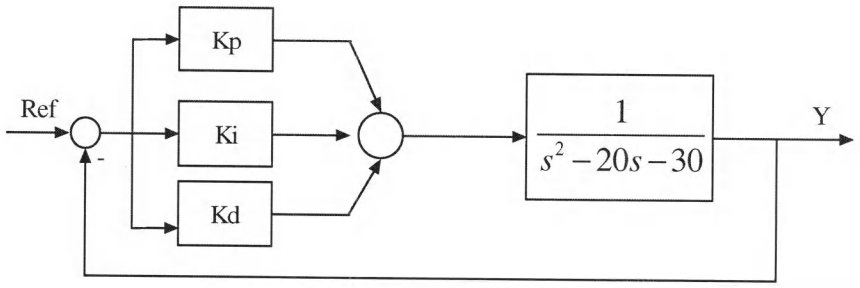
13) Disturbance in a negative feedback closed loop control system _____.
a) is useful since it helps in improving the system performance.
b) is not always useful and it depends on the location and type of dynamic system with respect to the disturbance
c) always deteriorated the system performance
d) is not critical for feed forward system

14) The phase provided by the Phase Lag Compensator with transfer function at gain crossover frequency of the system should be
a) -3 degree b) -6 degree c) -12 degree d) none

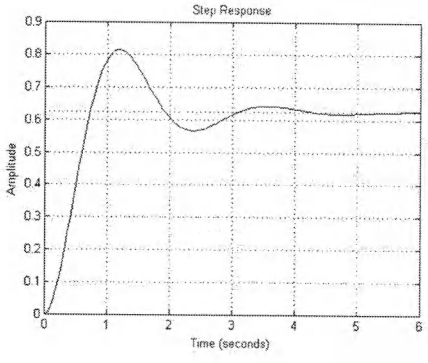
15) Open loop transfer function of a unity feedback system is $G(s)=\frac{K}{s(s+5)}$. The gain K that will result in phase margin of 50° approximately is _____.
a) 15 b) 20 c) 25 d) 30

16) Bode plot characteristic which is the best indicator of the close-loop step response rise time is _____.
a) phase margin
b) gain margin
c) phase crossover frequency
d) gain crossover frequency

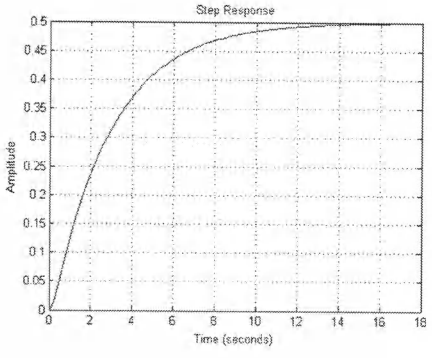
17) For a negative feedback control system shown in figure below, the value of proportional gain is 2 , derivative constant is 5 and integral constant is 4. The step response of the system is _____.



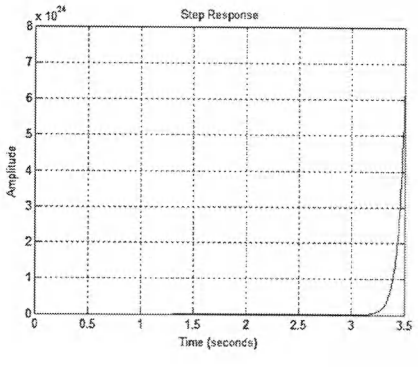
a)



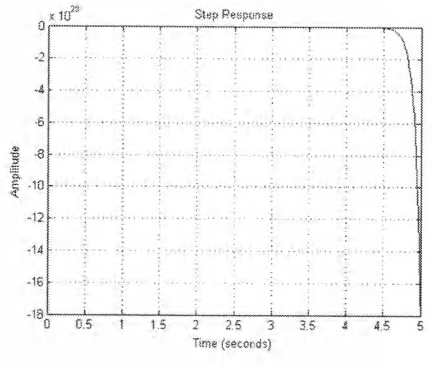
b)



c)



d)



18) 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.

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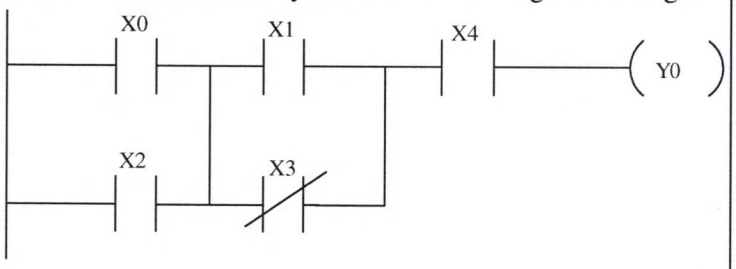
19) Draw the Ladder diagram equivalent of following combination logic.

$$Y_1 = \left(\left(\overline{X_1 + X_2}\right) + Y_1\right) + X_3 + X_4$$

20) Write down assembly code for following ladder logic.



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Level	: B.E.	Course	: COEG 401
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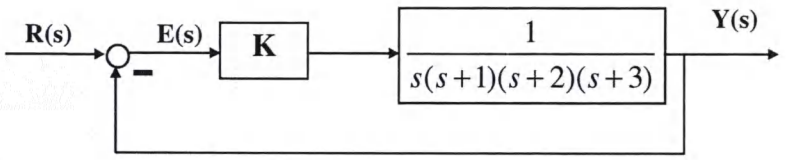
Time	: 2 hrs. 30 mins.	F.M.	: 55

SECTION "B"

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

1)

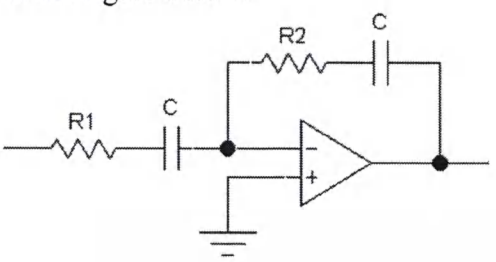
i) Block diagram of a closed loop control system is shown in figure below,



Using Bode plot, evaluate value of proportional gain and design phase lag compensator for the system to meet the following specifications [7]

- Velocity error $\leq 5\%$
- Phase margin $\geq 40^{o}$

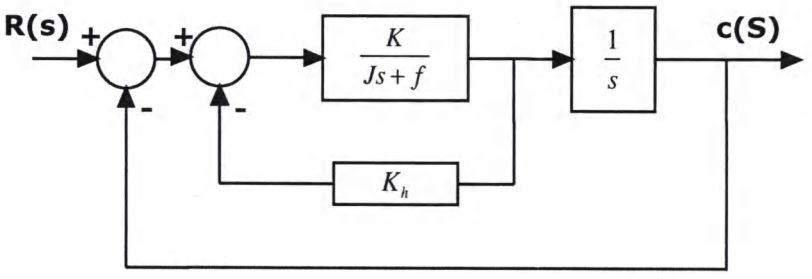
ii) For the circuit shown in the figure below:



a) Find the transfer function of the circuit [2]
b) What additions are required for using the circuit as a phase lag compensator? [2]

2)

i) For the system shown in figure below, determine the value of gain K and velocity feedback constant K_h, so the maximum overshoot in the unit-step response is 0.2 and the peak time is one second. With these values of K and K_h, obtain the rise time and settling time. Assume that J = 1Kg-m^2 and f=1N-m/rad/sec [6]



ii) Given the following system: $\dot{\underline{x}} = \begin{bmatrix} 3x_1(x_2+u) \\ 2x_1 + x_2^2 \end{bmatrix}$ and $y = 2x_1 + u$, find the linearized model of the system for $u_w = 2$ [5]

3)

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

a) By what factor the amplifier gain K should be multiplied so that the damping ratio is increased from 0.2 to 0.8 [3]

b) By what factor the time constant T should be multiplied so that the damping ratio is reduced from 0.9 to 0.3 [3]

ii) Discretize the following system using forward ZOH. [3]

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

iii) Write short notes on integral performance criterion. [2]

4)

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

$$G(s) = \frac{10(s+3)(s+4)}{(s+1)(s+2)(s+5)}$$

ii) Represent the state space obtained in (i) using Op-Amp circuit. [6]

5)

i) Explain with an appropriate example and necessary graph, how derivative control can aid to improve transient performance of second order underdamped system. [6]

ii) Justify the statement, "Controllable form of non-minimal transfer function is controllable but not observable." [5]

6)

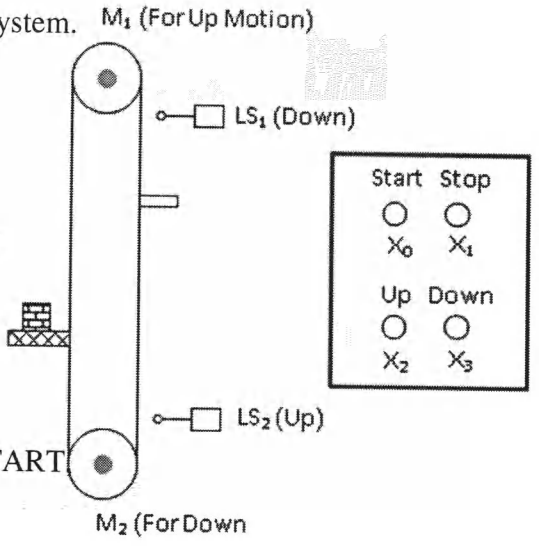
Shown in the figure is an Elevator System. Elevator is operated by two motors.

M1 for Up Movement
M2 for Down Movement

Two Limit Switches LS1 (for Down Limit) and LS2 (for Up Limit) are Normally Closed contacts.

Four Controls buttons is also provided.

STOP button is Normally Closed and START UP, DOWN buttons are Normally Open.



The required Sequence of Operation are given below

- When START button is pushed, the platform should be in the Down Position.
- When STOP button is pushed, the platform is halted at whatever position it occupies at that time.
- When UP or DOWN push buttons are pushed the platform should move accordingly. Note the platform should move when push button is pushed and halt when the button is released.

(a) Write Grafcet diagram for the elevator control. [2]
(b) Write ladder diagram for the given elevator control. [6]
(c) Write equivalent assembly code for your ladder diagram. [1]
(d) Consider motors M_1 and M_2 have over current relay OC_1 and OC_2. Integrate the contacts of over current relays in the ladder diagram. [2]

COEG-401

table