

KATHMANDU UNIVERSITY  
End Semester Examination  
February/March, 2018

Score: \_\_\_\_\_

Level : B.E.

Year : IV

Course : COEG 401

Semester: I

Exam Roll No: \_\_\_\_\_

Time: 30 mins.

F.M. : 20

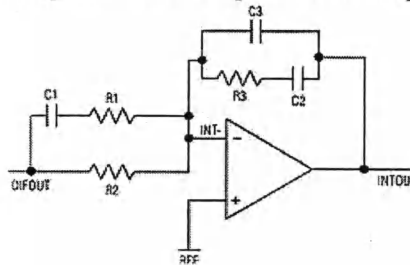
Registration No.: \_\_\_\_\_

Date **MAR 08 2018**

SECTION "A"

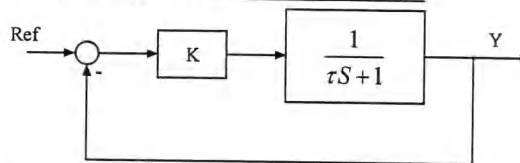
[20 Q.×1=20 marks]

- 1) Which compensator is implemented in operational amplifier circuit below?

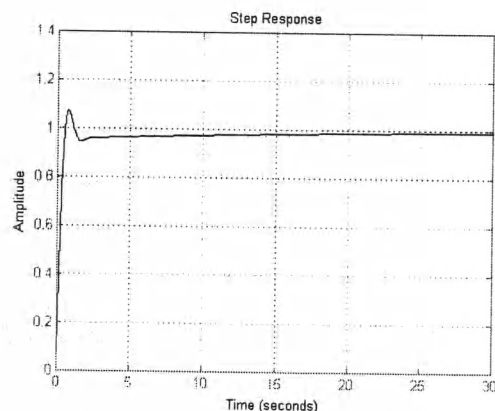


- a) P                                      b) PI                                      c) PID                                      d) Phase lag
- 2) If the unit step response of a second order system is very sluggish, factors that may be responsible for large value of rise time may be \_\_\_\_\_.
- large value of gain margin and phase margin.
  - system poles lie in imaginary axis.
- 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.
- 3) For a negative feedback control system, using proportional controller will \_\_\_\_\_.
- improve disturbance signal rejection.
  - improve steady state tracking accuracy.
- 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) Which of the following is true for derivative control?
- Reduces steady state error.
  - Suppresses noise.
  - Results in large controller output for abrupt change in reference.
  - Increases settling time.
- 5) A phase lag compensator may be realized using op-amp circuit of \_\_\_\_\_.
- proportional plus integral action
  - proportional plus gain-limiter integral action
  - proportional plus derivative action
  - proportional plus bandwidth-limiter derivative action

- 6) Op-Amp is used as inverting amplifier to serve as P controller in a negative feedback control system. Decreasing input resistor of the amplifier will \_\_\_\_\_.
- reduce the gain crossover frequency
  - cause the system to respond more slowly
  - increase the gain crossover frequency
  - increase the phase crossover frequency
- 7) The transfer function of a system is  $C(s) = \frac{(s+100)}{s^2(s+10)}$ . The phase shift at  $\omega=50$  and  $\omega=200$  will be respectively \_\_\_\_\_.
- $-90^\circ$  and  $-180^\circ$
  - $-180^\circ$  and  $-180^\circ$
  - $-270^\circ$  and  $90^\circ$
  - none
- 8) A type-1 system can be changed to type-2 system by cascading \_\_\_\_\_.
- PD
  - PI
  - either PD or PI
  - none
- 9) Observable form of state space realization of a minimal transfer function is \_\_\_\_\_.
- controllable and observable
  - controllable but not observable
  - not controllable but observable
  - neither controllable nor observable
- 10) 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 \_\_\_\_\_.

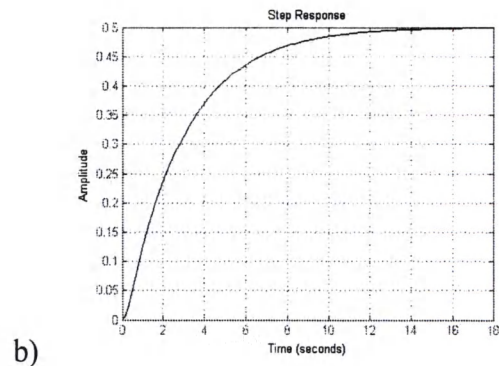
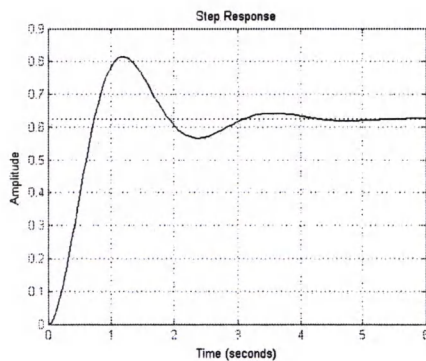
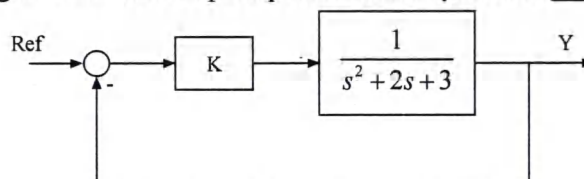


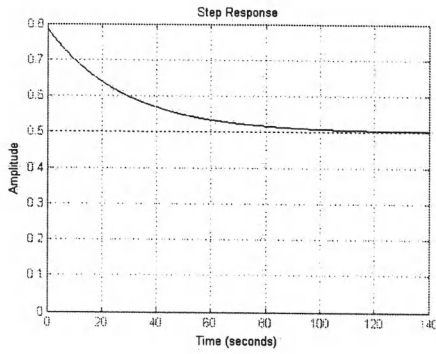
- step function of magnitude 1
  - step function of magnitude  $(1+K)/K$
  - step function of magnitude  $K(1+K)$
  - none
- 11) A unity gain negative feedback system has system transfer function of  $\frac{1}{s^2 + 3s + 1}$ . The system is compensated by PID controller with  $K_p=17$ ,  $K_d=2$  and  $K_i=1$  with unit step response as shown in figure. What should be done to eliminate overshoot and zero steady state error for unit step input?



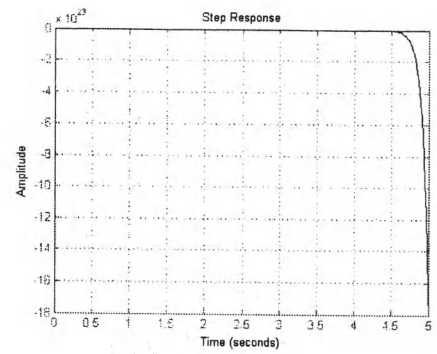
- Increase  $K_d$  and decrease  $K_i$
- Increase  $K_d$  and increase  $K_i$
- Decrease  $K_d$  and increase  $K_i$
- Decrease  $K_d$  and decrease  $K_i$

- 12) Disturbance in a negative feedback closed loop control system \_\_\_\_\_.
- is useful since it helps in improving the system performance.
  - is not always useful and it depends on the location and type of dynamic system with respect to the disturbance
  - always deteriorated the system performance
  - is not critical for feed forward system.
- 13) Which of the following statements are true for sampling time of digital closed loop control system?
- It defines the time between successive pulses and hence cannot represent frequency information beyond the limitation of sampling theorem
  - It defines the speed of the system.
  - It defines the processing capability of the system
  - All the above
- 14) The system given by  $\dot{x} = \begin{bmatrix} 1 & 5 \\ 2 & 1 \end{bmatrix}x + \begin{bmatrix} 1 \\ 2 \end{bmatrix}u$  and  $y = [1 \ 0]x$  is \_\_\_\_\_.
- controllable and observable
  - controllable but not observable
  - not controllable but observable
  - neither controllable nor observable
- 15) A negative feedback cascaded system has 2 inputs and 3 outputs. If all the inputs and outputs are considered, the size of transfer function matrix is \_\_\_\_\_.
- [2x2]
  - [2x3]
  - [3x3]
  - [3x2]
- 16) Which of the following is not the primary component of PLC system?
- Memory
  - Microprocessor
  - Signal conditioning unit
  - Output module
- 17) For a negative feedback control system shown in figure below, the value of proportional gain is 5. The step response of the system is \_\_\_\_\_.





c)



d)

18) Transfer function of following state space representation of the system is \_\_\_\_\_.

$$A = \begin{bmatrix} 0 & 1 \\ 0 & 2 \end{bmatrix} B = \begin{bmatrix} 1 \\ 0 \end{bmatrix} C = [1 \quad 1] D = [0]$$

a)  $\frac{s-1}{s^2-2}$

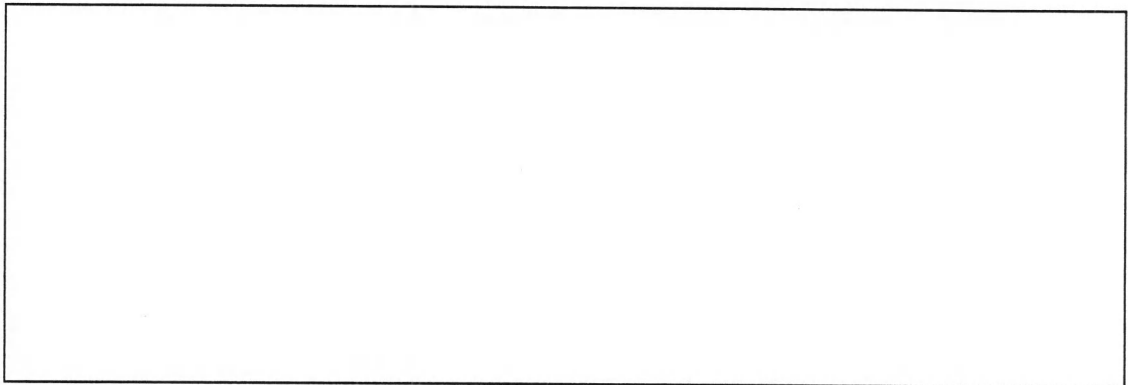
b)  $\frac{s-2}{s^2-2s}$

c)  $\frac{1}{s^2-2}$

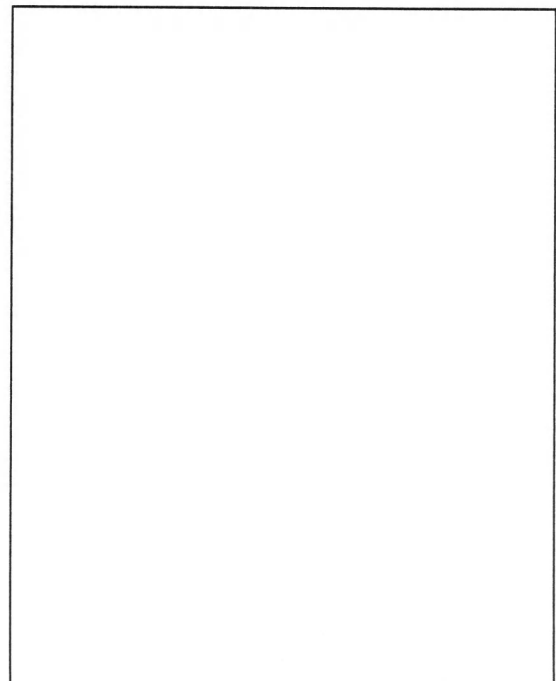
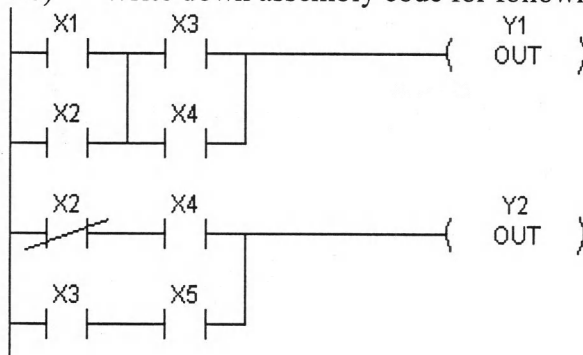
d)  $\frac{2}{s^2-2s}$

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

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



20) Write down assembly code for following ladder logic.



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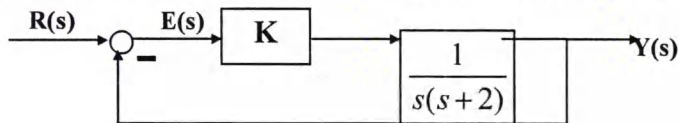
Course : COEG 401  
Semester: I  
F.M. : 55

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,



Using Bode plot, evaluate value of proportional gain and design phase lag compensator for the system to meet the following specifications [9]

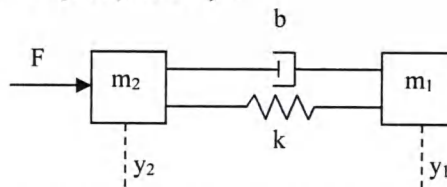
- Velocity error  $\leq 10\%$
- Phase margin  $\geq 60^\circ$
- Gain margin  $\geq 12$  dB
- Gain crossover frequency as large as possible.

- ii) Derive the expression for evaluating transfer function from state space representation of a system. [2]

2)

- i) Derive the state space representation and draw the block diagram of single input multiple output system shown in figure below. Write down MATLAB program to obtain transfer function from state space representation. [6+2]

Input  $u = F$  and Output  $y_1$  and  $y_2$



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

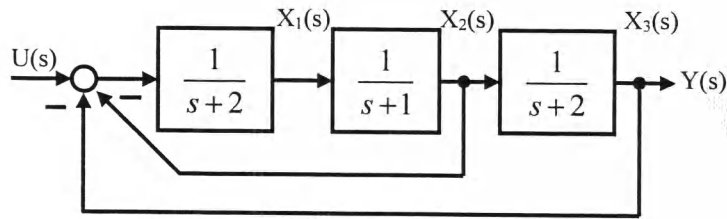
$$A = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} B = \begin{bmatrix} 1 \\ 1 \end{bmatrix} C = [1 \quad 0] D = [0]$$

3)

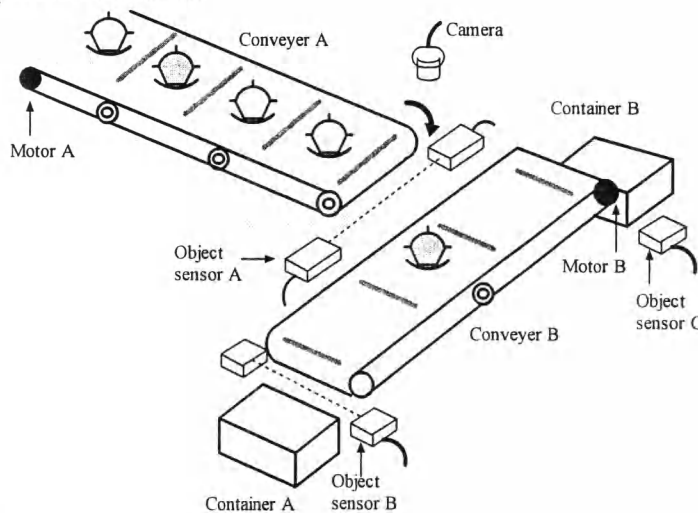
- i) Obtain the state space representation of the system using both cascade and parallel realization. [6]

$$G(s) = \frac{10}{(s+1)^2(s+2)}$$

- ii) 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]



- 4)
- Explain with an appropriate example and necessary graph, how derivative control can aid to improve transient performance of underdamped system". [5]
  - With an appropriate block diagram, explain the working of digital control system. Explain the significance of sampling time and method of discretization of state space representation of a system. [3]
  - Write down MATLAB program to obtain transfer function from state space representation of a MIMO system. [3]
- 5)
- Consider a practical system and justify the statement, "Non minimal system is never controllable because it has unnecessary state". [4]
  - Given the following system:  $\dot{x} = \begin{bmatrix} x_1(4x_2 + 5u) \\ 3x_1 + x_2^2 \end{bmatrix}$  and  $y = x_1 + u$ , find the linearized model of the system for  $u_w = 2$  [4]
  - Write short notes on frequency domain analysis for stability. [3]
- 6)
- Objective of the below system is to separate gray object from white object and place them in separate container. [7]



#### Control Algorithm:

- Step1: Move Conveyor A until an object is sensed by object sensor A.
- Step2: Activate camera and take input from camera
- Step3: Move conveyor B to left if object is white and move it to right if object is gray.
- Step1: Stop conveyor B if object is sensed by object sensor B or object sensor C and return to step 1.

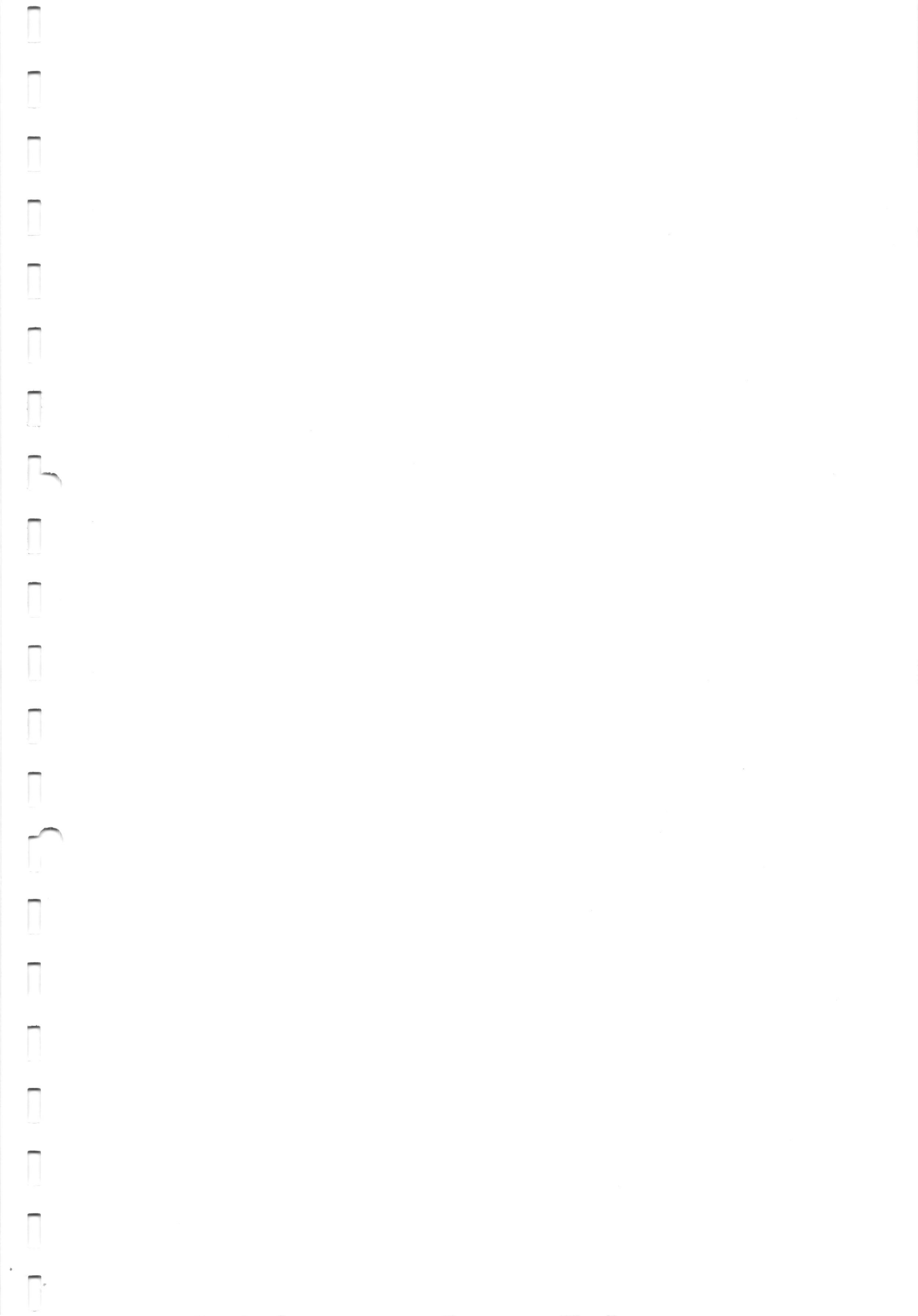
Construct Grafcet diagram and ladder diagram to implement above control algorithm.

[Note: Output from camera = 1 if object is gray and 0 if object is white.

: Motor B moves clockwise and anti-clockwise if (0,1) and (1,0) is given respectively. The motor stops if (0,0) is given to the circuit]

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

- 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 [2]



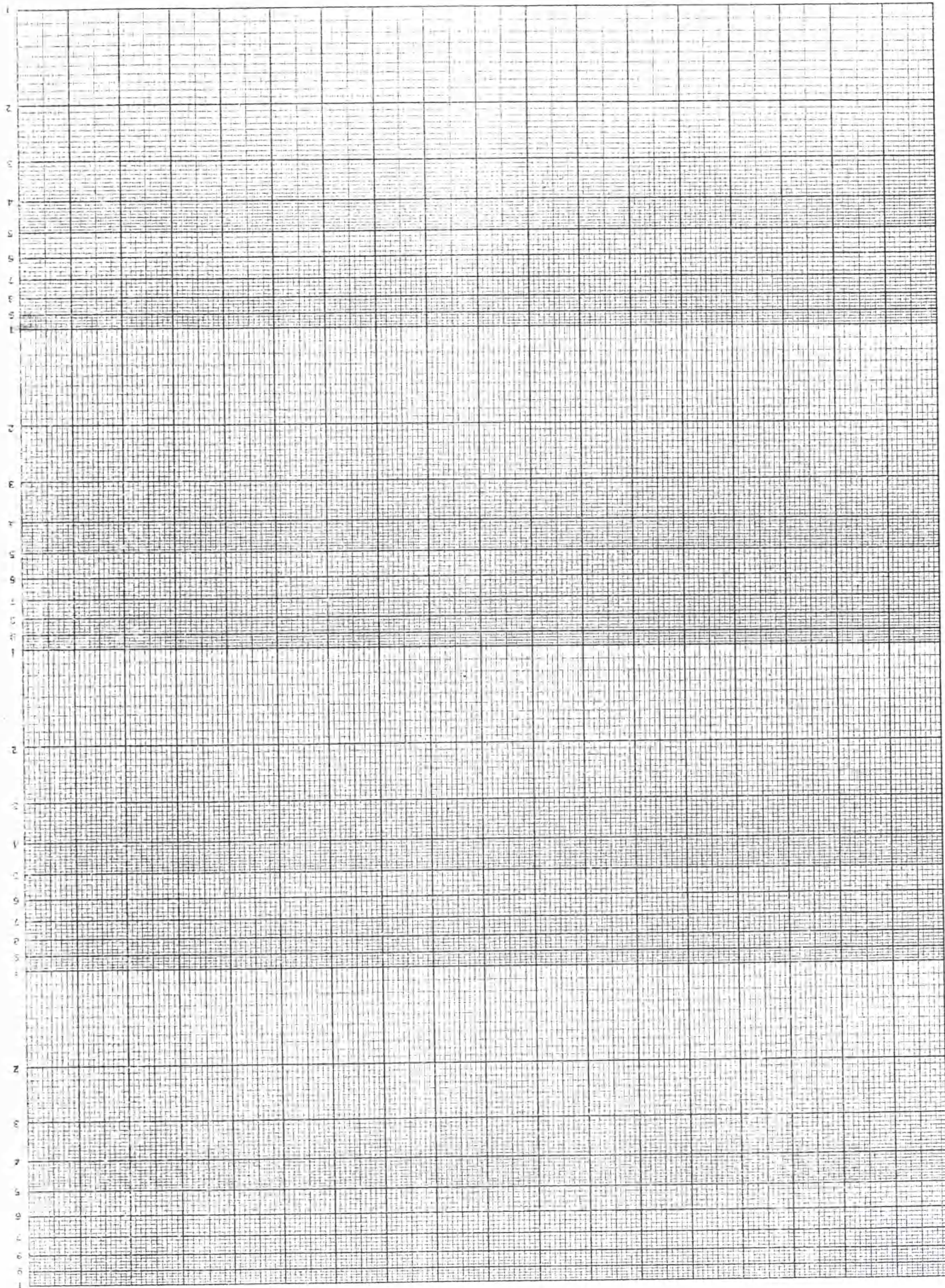


Joseph D. O'Neil, Prof. 5544

CEEG-401

Table

Log 4 Cycles of min. 1/2 and 1 cm



MAR 08 2018

