KATHMANDU UNIVERSITY
End Semester Examination
December 2024 /January 2025

Marks Scored:

Level : B.E.
Year : IV
Course : COEG 401
Semester : I
Exam Roll No. :
Time: 30 mins.
F. M. : 10

Registration No.:
Date : 2025-Jan-05

SECTION "A"
[20Q. × 0.5 = 10 marks]

Choose the most appropriate answer and **encircle**.

1. Check the controllability and observability of the system described by the following state space.

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

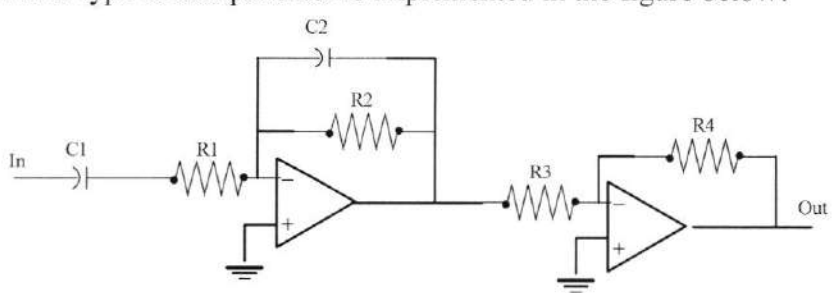
a. Controllable and observable
b. Controllable but not observable
c. Not controllable but observable
d. Neither controllable nor observable

2. Which of the following is NOT an effect of increasing the derivative gain in a PID controller?
a. Reduced overshoot
b. Fast rise time
c. Increased noise sensitivity
d. Increased damping ratio

3. The controllability matrix of a system is defined as _____.
a. The matrix formed by the system's state and direct transition matrix
b. The matrix formed by the system's state and output matrix.
c. The matrix formed by the system's state and input matrix.
d. The matrix formed by the system's state matrix

4. For which of the following error type integral control is most suited?
a. Large error for long duration of time.
b. Large error occurring rapidly for small duration of time
c. Small errors occurring rapidly for a small duration of time.
d. Small error for long duration of time.

5. Which type of compensator is implemented in the figure below?



a. P
b. PI
c. PD
d. PID

6. For a non-liner system described by $y = x^2 + 3x + 5$, for the working point $x_w = 2$, The linear equation of the system is _____.

a. $y = 5x + 1$ b. $y = 5x - 1$ c. $y = 7x + 1$ d. $y = 7x - 1$

7. In Ziegler–Nichols PID tuning with continuous cyclic method, if the value of critical gain is 6 and critical period is 24. The value of derivative time constant and integral time constant for a PID controller are _____.

a. 2 and 2 b. 2 and 3 c. 3 and 2 d. 3 and 3

8. In a feed forward control system, the disturbance _____.

a. is useful since it helps to mitigate errors
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

9. Determine the validity of the following statements.

i. If an open loop system is unstable, adding integral control will stabilize the system.
ii. If the system has large steady state error, increasing derivative gain will mitigate the problem.

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 statements are true.

10. Which of the following task in the cycle of process scan of PLC, largest time is allocated?

a. Input scan b. Output scan
c. Program scan d. Programming and monitoring

11. What does the term "context switch" refer to in real time operating systems?

a. Performing mode switching and executing functional code.
b. Switching between threads or tasks by saving and restoring their states
c. Transferring control from user mode to kernel mode
d. Restarting the operating system after a crash

12. Decide whether each of the following answers is true (T) or false (F). Dead lock condition in an operating system _____.

i. is caused if a resource can be accessed only by a single process at a time.
ii. is caused if tasks have different priority in an operating system.

a. (i)T (ii)T b. (i)T (ii)F c. (i)F (ii)T d. (i)F (ii)F

13. Decide whether each of the following answers is true (T) or false (F). Integral windup can be eliminated by _____.

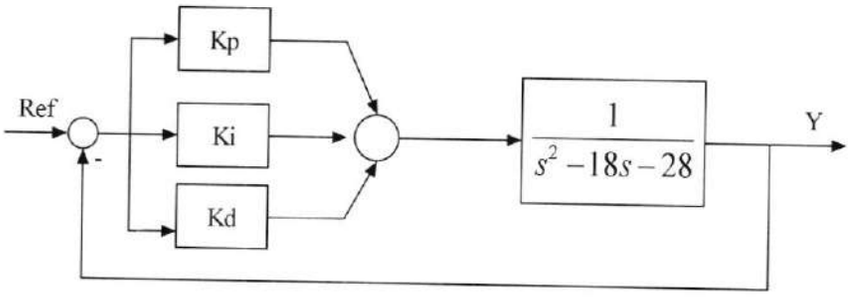
i. using integral control for large errors only.
ii. limiting control signal by adjusting integral part.

a. (i)T (ii)T b. (i)T (ii)F c. (i)F (ii)T d.(i)F (ii)F

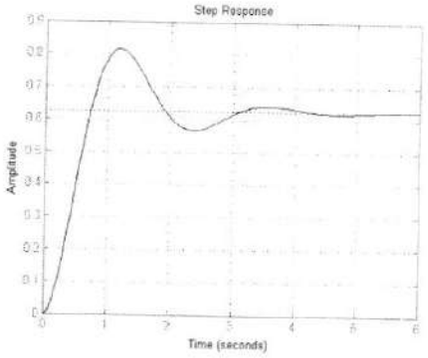
14. In case of more than one task waiting for semaphore task selection may be done by_____.

a. first in, first out. b. priority order. c. non-deterministic d. all

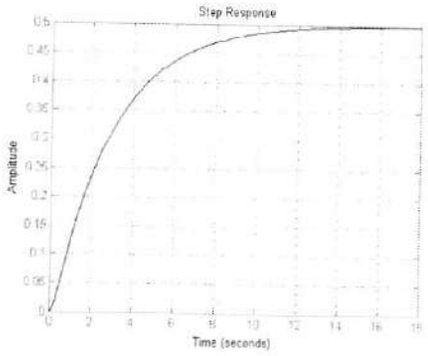
15. For a negative feedback control system shown in the figure below, which of the following is the most relevant response curve of the system to a step input?



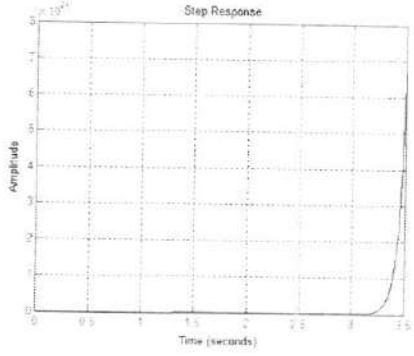
a.



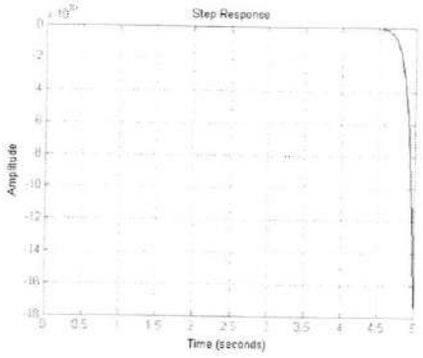
b.



c.



d.



16. The condition of several boards trying to be bus master at the same time, creating a conflicting situation, is called _____.

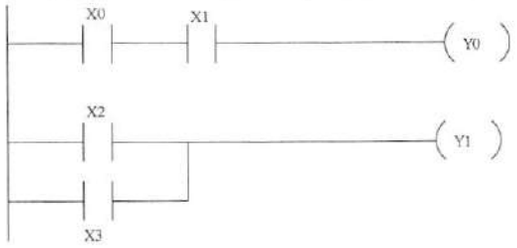
a. bus arbitration b. bus contention c. block transfer d. none

17. In real time control system _____.

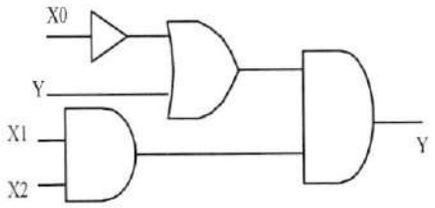
a. system never reaches deadlock condition.
b. task priority is either fixed or determined by the operating system.
c. multi-tasking is not possible
d. only event-based interrupts are used.

18. Adaptive system with gain scheduling is implemented for system _____.
    a. with linear control requirement.
    b. which operates in various operating regions.
    c. whose response is very slow.
    d. whose sources of disturbances are known.

19. Write down the assembly code for the following ladder logic.



20. Draw the ladder diagram of the following combinational circuit.



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SECTION "B"
[5 Q. × 8 = 40 marks]

*Attempt **ANY FIVE** questions.*

1.

a. Draw block diagram and derive frequency domain expression for a practical PID controller. Also explain derivative time constant and integral time constant. [3]

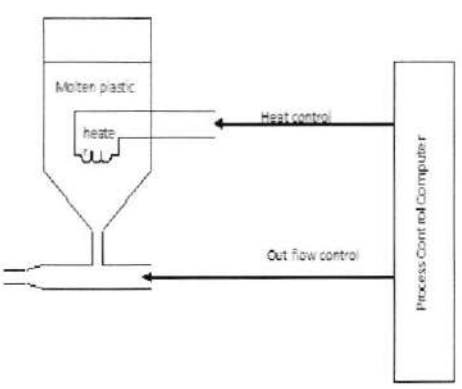
OR

Explain Ziegler–Nichols PID tuning method.

b. Explain with an appropriate example and necessary graph, how PID compensator can improve transient and steady state performance of a second order system. [5]

2.

a. For an industrial process shown in figure, control objective is to heat the plastic to a certain temperature and extrude molten plastic. The volume of the plastic extruded should be controllable.
Draw the complete block diagram of the system by selecting appropriate sensor, actuator and write down control algorithm to achieve control objective using both conventional and real time programming. [5]



b. Draw a block diagram of digital control system and explain how you can use multiplexers and demultiplexers in an event of multiple inputs and outputs. [3]

3.

a. Discretize the following system using Forward Euler and ZOH. [3]

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

b. What is a control loop in a digital control system? Write down the algorithm/program of a typical control loop with P controller. Also explain different methods used for synchronization of a control loop. [5]

P.T.O.

4.

a. Explain deadlock condition in an operating system. [4]

b. Explain how unprotected resources can cause race conditions. [4]

OR

Realize the following system using Op-Amp circuit

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

5.

a. Write about the cause and effect of integral windup. Also explain methods to eliminate it using appropriate algorithm/flowchart. [4]

b. Consider any industrial process and explain how distributed digital control architecture can be implemented in your example to carry out the process. [4]

OR

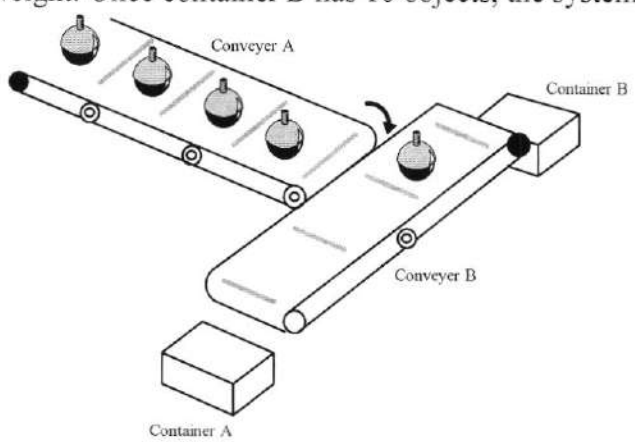
Obtain the observable form of state space realization of the following transfer function. Also check for controllability.

$$G(s)=\frac{S^3+4S-8}{S^3+2S^2+4S+8}$$

6.

a. A conveyor based industrial process is shown in the following figure.

The objective is to separate damaged products based on their weight. Conveyor A is used to transport objects to Conveyor B. Conveyor B moves left or right to separate and places the object in Container A if correct weight and in Container B if incorrect weight. Once container B has 10 objects, the system will stop.



- Select appropriate sensors and actuator.
- Draw Grafcet and Ladder diagram to achieve the above function. [6]

b. Distinguish between supervisory control system and direct digital control. [2]