University of Sargodha
College of Engineering and Technology
Department of Electrical Engineering

Linear Control System (EE-321)

Semester / Session : 6^{th} / Fall-2018

Mid-Term Exam: Spring - 2020

Date: 21 / 04 / 2020

Teacher: Dr. Imran Khan

- Time allowed 90 minutes.
- Attempt all questions.
- Solved paper must be returned within 2 hours to imran.khan@uos.edu.pk.

Name: **Reg#:**

Signature:

Given the closed loop system (see Figure 1)

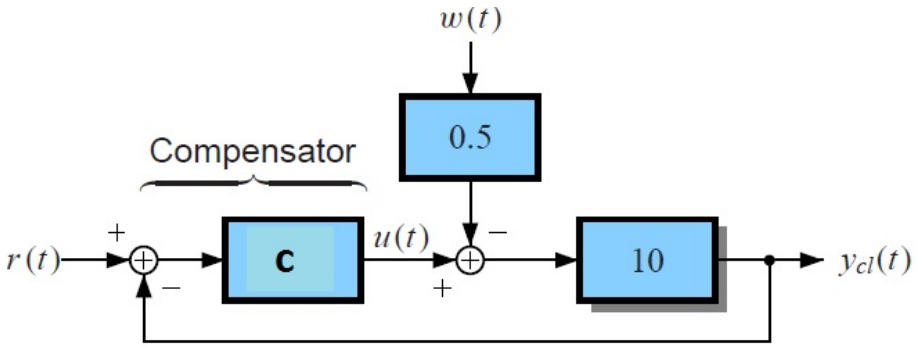

Figure 1: Closed Loop Control Configuration

if $w(t) = 5$ and $r(t) = 50$, then answer question 1 to 3

1. $u(t)$ =?
   a. $10(r(t) - y_{cl}(t))$

b. $c(r(t) - 0.5w(t))$

c. $c(r(t) - y_{cl}(t))$

d. $10(0.5w(t) - y_{cl}(t))$

2. $y_{cl}(t) =?$

   a. $\frac{10Cr(t)-5w(t)}{1+10w(t)}$

   b. $\frac{10Cr(t)-5w(t)}{1+10C}$

   c. $\frac{10Cr(t)-5w(t)}{1+10u(t)}$

   d. $\frac{10Cw(t)-5r(t)}{1+10C}$

3. $C =?$, such that the percentage error of tracking $r(t)$ is exactly 2% Hint: $e(t) = r(t) - y_{cl}(t)$.

   a. 100.5

   b. 205.5

   c. 374.5

   d. 425.5

4. Closed loop system is more_____than the open loop system.

   a. Stable

   b. Robust

   c. Faster

   d. Cheaper

   You are a control engineer and Toyota Motors has given you a project that their new Toyota Yaris 2021 must have a button, which activates a control system. When this button is pressed, all the functions of the car e.g. throttle, gear etc, are adjusted in such a way that a reference speed is maintained by observing the speedometer, regardless of the road condition (slopes etc). Answer question 5 to 8

5. Which control scheme will you use?

   a. Open-loop

   b. Manual Control

   c. Closed-loop

   d. Not clear

6. What is the actuator in this system?

   a. Gear

b. Speedometer

c. Brakes

d. Throttle

7. What is the output of the system?

   a. Gear

   b. Throttle angle

   c. Speed

   d. Button

8. Identify the disturbance in this system?

   a. Brakes

   b. Button

   c. Reference speed

   d. Slopes

9. Mathematical models of physical systems are important because

   i. physical systems are of no use.

   ii. they help understanding system behavior.

   iii. they simplify physical systems.

   iv. of cost reduction in controller synthesis.

   which of the above is true?

   a. ii and iv

   b. i and ii

   c. iii and iv

   d. i and iii

10. What will be the order of mathematical model representing a mechanical system which consists of 2-masses, 3-dampers and 2-springs

    a. 2

    b. 4

    c. 6

    d. 8

11. If the value of damping coefficient in translational mechanical system is zero, then it will introduce_____in the system

a. Stability

b. Instability

c. Speed

d. Marginal stability

12. If there are 1-capacitor, 1-inductor and 2-resistors in an electrical network, the order of the system will be_____

    a. 2

    b. 4

    c. 3

    d. 5

13. Final value theorem is applicable to_____systems.

    a. Stable

    b. Unstable

    c. Marginally stable

    d. Both a and c

14. The dynamics of an LTI system are completely characterized by

    i. Impulse response

    ii. Step response

    Choose one of the following?

    a. i only

    b. ii only

    c. Both i and ii

    d. Non of the above

15. The Laplace transform of_____of a system is its transfer function.

    a. Exponential

    b. Step Response

    c. Output

    d. Impulse Response

16. Consider a resistor shown in Figure 2 where $v(t)$ is the voltage drop across the resistor, $i(t)$ is the current through the resister and R is the resistance. The mathematical model of this circuit is $v(t) = i(t)R$. Is this model dynamic?

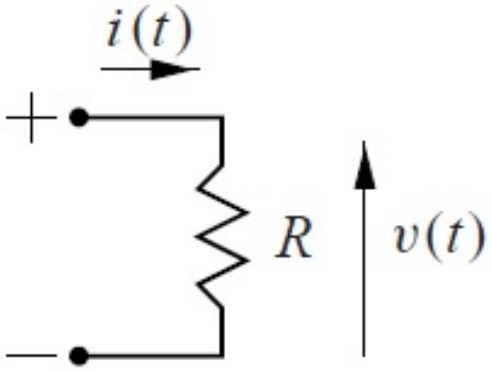

Figure 2: Resistor Schematic

a. Yes

b. No

c. Not cleared

d. Simultaneously static and dynamic

Based on Mass-Spring-damper system in Figure 3, answer question 17 and 18.

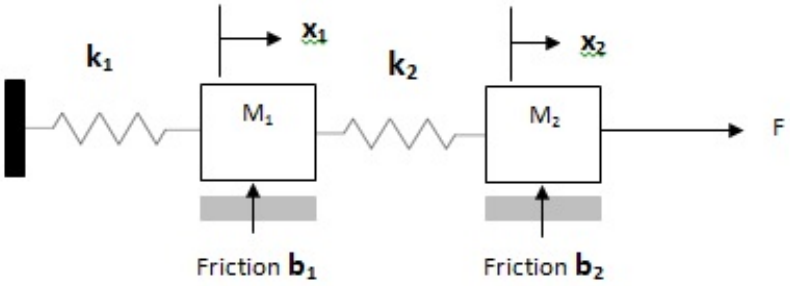

Figure 3: Mass Spring System

17. $M_1\ddot{x}_1 = ?$

a. $-b_1(\dot{x}_1 - \dot{x}_2) - k_1x_1 - k_2x_2$

b. $-b_1\dot{x}_1 - k_1x_1 - k_2(x_1 - x_2) + F$

c. $-b_1(\dot{x}_2 - \dot{x}_1) - k_1x_1 - k_2x_2$

d. $-b_1\dot{x}_1 - k_1x_1 - k_2(x_1 - x_2)$

18. $M_2\ddot{x}_2 = ?$

    a. $-b_2(\dot{x}_2 - \dot{x}_1) - k_1x_2 - k_2x_1$

    b. $-b_2\dot{x}_2 - k_2(x_2 - x_1) + F$

    c. $-b_2\dot{x}_2 - b_1\dot{x}_1 - k_2x_2 + F$

    d. $-b_2\dot{x}_2 - k_1x_1 - k_2(x_1 - x_2) + F$

19. The Laplace operator "$\mathcal{L}$" is a linear operator.

    a. True

    b. false

    c. Nonlinear

    d. Not a valid question

20. If there are two roots of the systems at the origin, then the system response will_____.

    a. Converge

    b. Diverge

    c. Oscillate with fixed amplitude and frequency

    d. Information is not sufficient to decide

21. The steady state error is the difference of_____ and _____.

    a. Input and output

    b. Output and states

    c. Output and reference

    d. Plant and controller

22. For a given system the convergence and divergence of response depends upon_____.

    a. Poles

    b. Zeros

    c. Both a and b

    d. Neither a nor b

23. Which is the most important characteristics of 1st order system that distinguishes it from a 2nd order systems.

    a. No overshoot

    b. Non-zero initial slope

    c. Both a and b

    d. Neither a nor b

Given the following equation

$$G(s) = \frac{400}{s^2 + 12s + 400} \tag{1}$$

then answer the questions 24 to 30

24. What is the value of w_n (rads/sec).

    a. 10

    b. 30

    c. 20

    d. 50

25. ζ =?

    a. 0.2

    b. 0.3

    c. 0.4

    d. 0

26. w_d =?

    a. 15.08

    b. 19.08

    c. 20.08

    d. 30.08

27. What is the maximum overshoot?

    a. 17.23%

    b. 27.23%

    c. 37.23%

    d. 47.23%

28. What is the settling time for 1% criterion?

    a. 0.676

    b. 0.767

    c. 0.565

    d. 0.656

29. What is the type of the system

a. Over damped

b. Under damped

c. Undamped

d. Critically damped

30. If systems damping is increased the overshoot will

a. Increase

b. Decrease

c. Remains same

d. Become zero

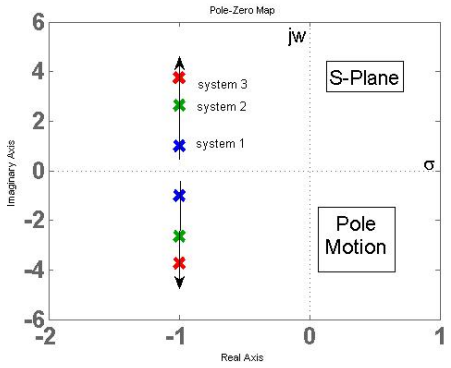

Figure 4: pz-map

Answer questions 31 and 32 from Figure 4

31. Which of the performance parameters will remain same for all systems

a. T_r

b. T_p

c. T_s

d. ζ

32. Which system will have higher overshoot

a. 1

b. 2

c. Same overshoot for all

d. 3

33. The output of an LTI system subjected to sinusoidal inputs has

    a. Same amplitude, different frequency
    b. Same frequency, different amplitude
    c. Same frequency, same amplitude and same phase
    d. Same frequency, scaled amplitude and shifted phase

34. Speed of response of a dynamical system is dependent upon

    a. Pole location
    b. Zero location
    c. Both pole and zero location

35. Consider the first order transfer function $H(s) = \frac{1}{s+8}$, choose one of the following

    a. Impulse response will decay
    b. Bounded inputs produce bounded outputs
    c. Step response in bounded
    d. All a, b and c