



UNIVERSITI KUALA LUMPUR
MALAYSIAN SPANISH INSTITUTE

FINAL EXAMINATION
JULY 2023 SEMESTER

COURSE CODE	: SRD 25103
COURSE NAME	: CONTROL SYSTEMS
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	: DIPLOMA OF ELECTRONIC ENGINEERING TECHNOLOGY (INDUSTRIAL AUTOMATION AND CONTROL)
DATE	: 27 SEPTEMBER 2023
TIME	: 9.00 AM – 12.00 PM
DURATION	: 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please **CAREFULLY** read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of **TWO (2)** sections; Section A and Section B.
4. Answer **ALL** questions in Section A. For Section B, answer **FOUR (4)** questions only.
5. Please write on answer booklet provided.
6. Answer all questions in English **ONLY**.
7. Laplace Transform table has been appended for your reference.

THERE ARE 7 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.



SECTION A (20 MARKS)**INSTRUCTION (Answer ALL Questions)**

Please use the answer booklet provided.

1. A control system working under unknown random actions is called
 - A. Computer control system
 - B. Digital data system
 - C. Stochastic control system
 - D. Adaptive control system

2. Any externally introduced signal affecting the controlled output is called a
 - A. Feedback
 - B. Stimulus
 - C. Signal
 - D. Gain control

3. Which of the following should be done to make an unstable system stable?
 - A. The gain of the system should be decreased
 - B. The gain of the system should be increased
 - C. The number of poles to the loop transfer function should be increased
 - D. The number of zeros to the loop transfer function should be increased

4. The steady state accuracy increases by.
 - A. Integrator
 - B. Differentiator
 - C. Phase lead compensator
 - D. Phase lag compensator

5. As a result of introduction of negative feedback which of the following will not decrease?
- A. Band width
 - B. Overall gain
 - C. Distortion
 - D. Instability
6. Regenerative feedback implies feedback with
- A. Oscillations
 - B. Step input
 - C. Negative sign
 - D. Positive sign
7. The output of a feedback control system must be a function of
- A. Reference and output
 - B. Reference and input
 - C. Input and feedback signal
 - D. Output and feedback signal
8. Zero initial condition for a system means
- A. Input reference signal is zero
 - B. Zero stored energy
 - C. No initial movement of moving parts
 - D. System is at rest and no energy is stored in any of its components
9. The transient response, with feedback system,
- A. Rises slowly
 - B. Rises quickly
 - C. Decays slowly
 - D. Decays quickly

10. In a stable control system backlash can cause which of the following?
- A. Underdamping
 - B. Overdamping
 - C. Poor stability at reduced values of open loop gain
 - D. Low-level oscillations

SECTION B (80 MARKS)

INSTRUCTION (Answer FOUR Questions only)

Please use the answer booklet provided.

Question 1

- (a) A car is moving at a constant speed of 50 km/h, give the most important device for the feedback element for the driver? (5 marks)
- (b) An automatic toaster is a _____ loop control system. (5 marks)
- (c) Sketch the transient response? (10 marks)

Question 2

- (a) Figure 2 shows the response of a control system. Name A, B and C

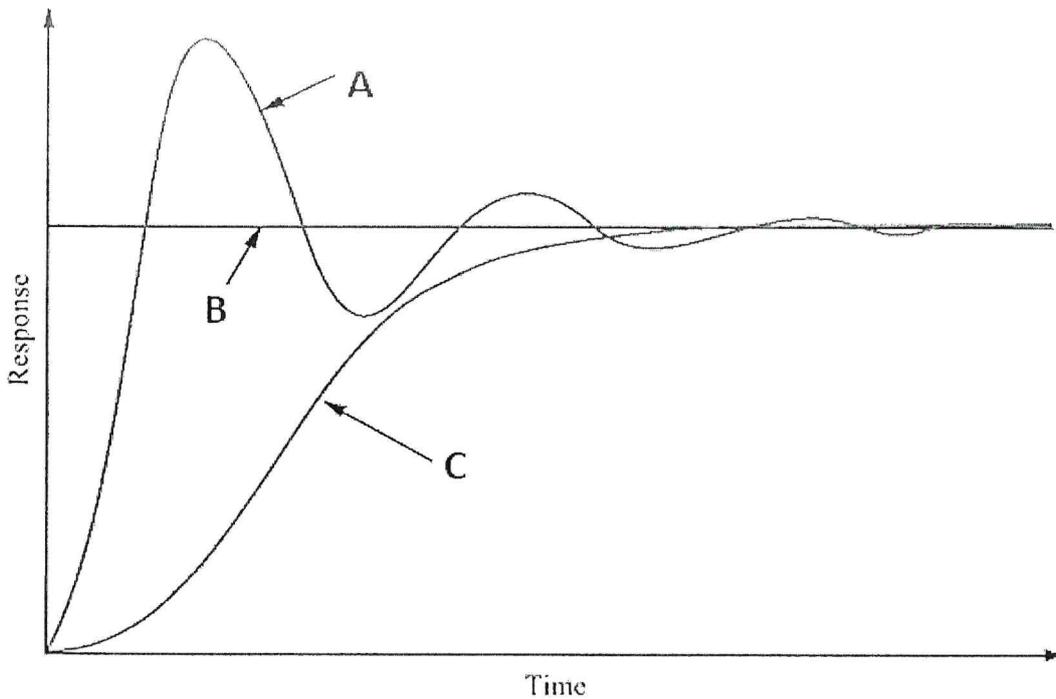


Figure 1: Response Characteristics of A Control System

- (b) What is damping ratio? (15 marks)
- (5 marks)

Question 3

Compute the Laplace transform of the given function:

- (a) $e^{-2t} \cos(3t) + 5e^{-2t} \sin(3t)$ (5 marks)
- (b) $10 + 5t + t^2 - 4t^3$ (5 marks)
- (c) $(t^2 + 4t + 2)e^{3t}$ (5 marks)
- (d) $6e^{5t} \cos(2t) - e^{7t}$ (5 marks)

Question 4

- (a) Figure 2 shows the block diagram for input – output relationship. Prove the equation below.

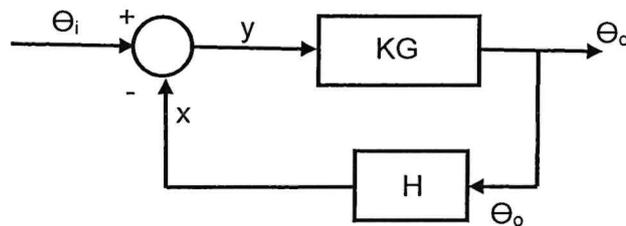


Figure 2: Input – out relationship

$$\frac{\theta_o}{\theta_i} = \frac{KG}{1 + KGH}$$

(10 marks)

- (b) Consider the response to a unit step input of a system represent by the equation below. Find the second order system step input, $\bar{\theta}_o$.

$$\frac{d^2\theta}{dt^2} + 2\frac{d\theta}{dt} + 10\theta_o = 10\theta_i$$

(assume initial conditions are zero)

(10 marks)

Question 5

A system has the following open loop transfer function:

$$KGH(j\omega) = \frac{1}{j\omega(1 + j\omega 0.5)(1 + j\omega 2.0)}$$

Taking into account $\omega = 0.5, 0.6, 0.7, 0.8, 0.9, 1.0 \text{ rad/s}$.

- (a) Write expression for gain and phase angle. (5 marks)
- (b) Calculate gain and phase angle for a given value of ω . (5 marks)
- (c) Plot a Nyquist diagram and determine the system stability condition. (10 marks)

Question 6

A system has the following open loop transfer function:

$$KGH(j\omega) = \frac{5}{j\omega(1 + j\omega 20)(1 + j\omega 4)}$$

- (a) Determine the low frequency slope. (5 marks)
- (b) Identify the break frequency and change of slope. (5 marks)
- (c) Sketch an asymptotic gain curve for a system. (10 marks)

APPENDIX

Table of Laplace Transforms

$f(t) = L^{-1}\{F(s)\}$	$F(s) = L\{f(t)\}$	$f(t) = L^{-1}\{F(s)\}$	$F(s) = L\{f(t)\}$
1. 1	$\frac{1}{s}$	2. e^{at}	$\frac{1}{s-a}$
3. $t^n, n=1,2,3,\dots$	$\frac{n!}{s^{n+1}}$	4. $t^p, p > -1$	$\frac{\Gamma(p+1)}{s^{p+1}}$
5. \sqrt{t}	$\frac{\sqrt{\pi}}{2s^{3/2}}$	6. $t^{n-1/2}, n=1,2,3,\dots$	$\frac{1 \cdot 3 \cdot 5 \dots (2n-1)\sqrt{\pi}}{2^n s^{n+1/2}}$
7. $\sin(at)$	$\frac{a}{s^2+a^2}$	8. $\cos(at)$	$\frac{s}{s^2+a^2}$
9. $t \sin(at)$	$\frac{2as}{(s^2+a^2)^2}$	10. $t \cos(at)$	$\frac{s^2-a^2}{(s^2+a^2)^2}$
11. $\sin(at) - at \cos(at)$	$\frac{2a^3}{(s^2+a^2)^2}$	12. $\sin(at) + at \cos(at)$	$\frac{2as^2}{(s^2+a^2)^2}$
13. $\cos(at) - at \sin(at)$	$\frac{s(s^2-a^2)}{(s^2+a^2)^2}$	14. $\cos(at) + at \sin(at)$	$\frac{s(s^2+3a^2)}{(s^2+a^2)^2}$
15. $\sin(at+b)$	$\frac{s \sin(b) + a \cos(b)}{s^2+a^2}$	16. $\cos(at+b)$	$\frac{s \cos(b) - a \sin(b)}{s^2+a^2}$
17. $\sinh(at)$	$\frac{a}{s^2-a^2}$	18. $\cosh(at)$	$\frac{s}{s^2-a^2}$
19. $e^{at} \sin(bt)$	$\frac{b}{(s-a)^2+b^2}$	20. $e^{at} \cos(bt)$	$\frac{s-a}{(s-a)^2+b^2}$
21. $e^{at} \sinh(bt)$	$\frac{b}{(s-a)^2-b^2}$	22. $e^{at} \cosh(bt)$	$\frac{s-a}{(s-a)^2-b^2}$
23. $t^n e^{at}, n=1,2,3,\dots$	$\frac{n!}{(s-a)^{n+1}}$	24. $f(ct)$	$\frac{1}{c} F\left(\frac{s}{c}\right)$
25. $u_c(t) = u(t-c)$ <u>Heaviside Function</u>	$\frac{e^{-cs}}{s}$	26. $\delta(t-c)$ <u>Dirac Delta Function</u>	e^{-cs}
27. $u_c(t) f(t-c)$	$e^{-cs} F(s)$	28. $u_c(t) g(t)$	$e^{-cs} L\{g(t+c)\}$
29. $e^{ct} f(t)$	$F(s-c)$	30. $t^n f(t), n=1,2,3,\dots$	$(-1)^n F^{(n)}(s)$
31. $\frac{1}{t} f(t)$	$\int_s^\infty F(u) du$	32. $\int_0^t f(v) dv$	$\frac{F(s)}{s}$
33. $\int_0^t f(t-\tau) g(\tau) d\tau$	$F(s)G(s)$	34. $f(t+T) = f(t)$	$\frac{\int_0^T e^{-st} f(t) dt}{1-e^{-sT}}$
35. $f'(t)$	$sF(s) - f(0)$	36. $f''(t)$	$s^2F(s) - sf(0) - f'(0)$
37. $f^{(n)}(t)$	$s^n F(s) - s^{n-1} f(0) - s^{n-2} f'(0) - \dots - sf^{(n-2)}(0) - f^{(n-1)}(0)$		

