



UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

FIRST SEMESTER EXAMINATIONS, NOV./ DEC. 2018

COURSE NO: EL 373

COURSE NAME: CONTROL SYSTEMS

CLASS: EL III

TIME: 3 HOURS

Name: _____ Index Number: _____

PART A

Answer all questions briefly.

20 Marks

1. State five (5) standard test signals used in control systems.
2. State three (3) disadvantages of an open loop control system.
3. Is time-controlled traffic light an open or closed loop control system. Justify your answer.
4. Draw the graph of two (2) non-linearity in control systems and explain how anyone works.
5. State and explain three (3) requirements of a good control system.
6. Tabulate three (3) differences between linear and nonlinear control systems.
7. Define the following terms:
 - i. Servomechanism.
 - ii. Jump resonance.
 - iii. Steady state error.
 - iv. Damping.

PART B

Answer all questions.

40 Marks.

8. The impulse response of a system is $\sqrt{3}e^{-t/2} \sin \frac{\sqrt{3}t}{2}$. Determine the transfer function of the system.
9. Determine and plot the poles and zeros of the transfer function below and hence comment on the stability of the system.

$$G(s) = \frac{10(s+5)(s-1)(s+2.5)^2}{(s-1)(s+2)(s-4)(s+3)^3}$$

10. Using the canonical form of a closed loop feedback system prove that the steady state error is given by

$$e_{ss} = \lim_{s \rightarrow 0} s \frac{R(s)}{G(s)H(s)}$$

11. The open loop transfer function of a servo system with unity feedback is

$$G(s) = \frac{40}{s(1+0.5s)}$$

Determine the following:

- i. Position error constant (K_p)
- ii. Velocity error constant (K_v)
- iii. Acceleration error constant (K_a)
- iv. Steady state error if the input = $r(t) = 1 + 5t + 10t^2$

12. Draw and label the response for under-damped second order system and define the following terms:

- i. Rise time
- ii. Peak time
- iii. Peak overshoot
- iv. Settling time.

13. For the first order system shown in Figure 1 determine the output response $C(t)$ if the system is excited by a unit ramp input.

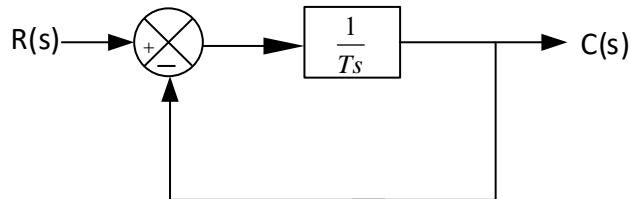


Figure 1

PART C

Answer any **three** questions from this section.

40 Marks.

14. Construct the Routh array and determine the stability of the system whose closed loop

$$\text{transfer function } T(s) = \frac{50}{s^5 + 2s^4 + 24s^3 + 48s^2 - 25s - 50}$$

15. For the control system shown in Figure 2, determine:

- i. The values of k_1 and k_2 so that maximum peak overshoot (m_p) is 6% and peak time (T_p) is 1.5 seconds.
- ii. The rise time and the settling time assuming a steady state error of 2%.

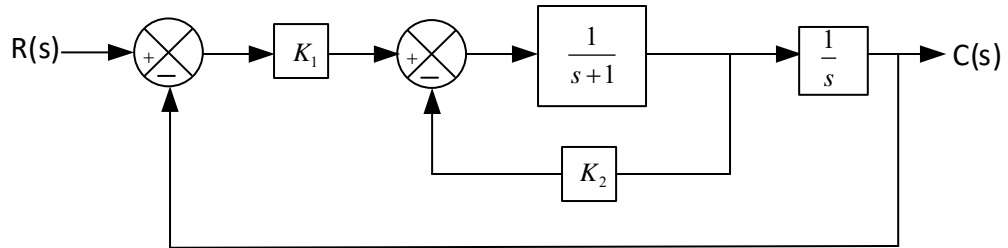


Figure 2

16. Convert the block diagram in Figure 3 to a signal flow graph and use the Mansion's gain rule to determine the transfer function $C(s)/R(s)$.

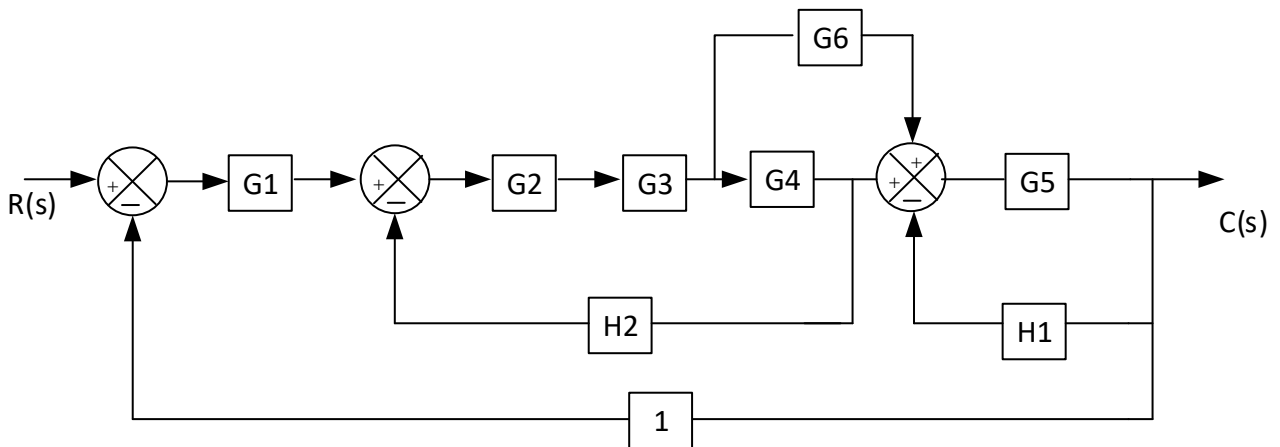


Figure 3

17. Develop a model for the armature-controlled DC motor shown in Figure 4 with the armature voltage $e_a(t)$ as input and load speed $\theta(t)$ as output. Hence obtain the transfer function of the system.

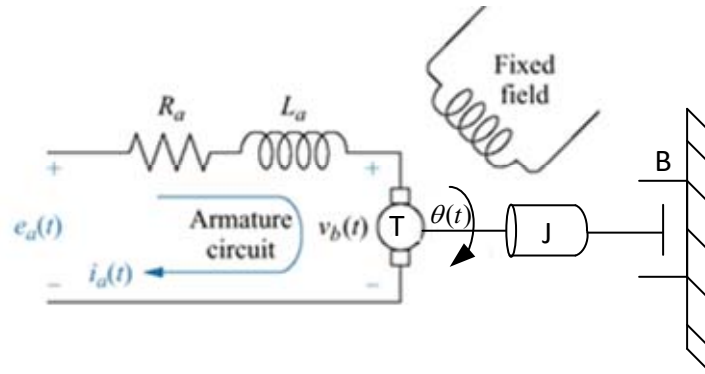


Figure 4

18. Draw the root locus of the system below and obtain the value of k when the damping ratio (ζ) is 0.4. Comment on the stability of the system.

$$G(s)H(s) = \frac{k}{s(s+2)(s+4)}$$

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