I/L/TX

Reg. No:

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: BMEE308L - Control Systems
Class NBR(s): 3866 / 3867 / 3868 / 3869 /3870
Time: Three Hours

Slot: F1
Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instruction: Use of Bode plot is allowed.

PART – A (5 X 12 = 60 Marks)
Answer ALL Questions

1. With a suitable example of a mechatronics system, elaborate the steps involved in the mechatronics system design process and name three approaches to the mathematical modelling of control systems.

2. Using electro-mechanical modelling, derive the transfer function of a direct current motor and explain the Proportional-Integral-Derivative error control strategy for speed control applications.

3. Apply block diagram reduction technique for the feedback control system given in Fig.1. Assuming zero disturbance, find the transfer function and determine the value of K using Routh-Hurwitz's stability criterion.

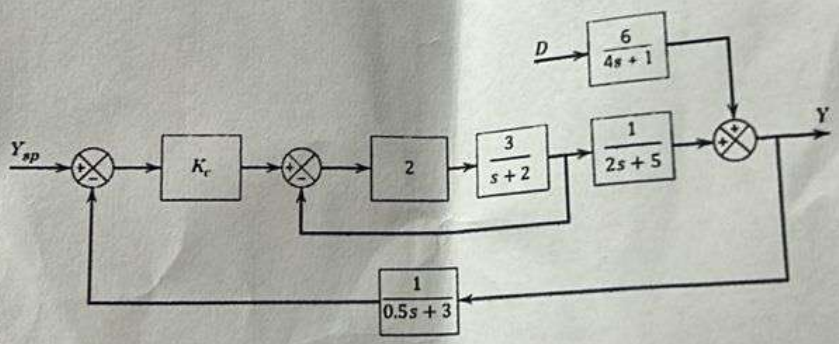

Fig.1 Feedback control system

4. Draw the Bode plot for the following open loop transfer function:

$G(s) = 10 / s\,(1+0.2s)\,(1+0.3s)\,(1+s)$

Obtain the gain cross over, phase cross over frequencies.

5. Explain the state-space modelling of a mechanical system with Spring-Mass-Damper.

PART – B (2 X 20 = 40 Marks)

Answer ALL Questions

6. A general second order system is given by the following block diagram for the unit step input as shown in fig. 2

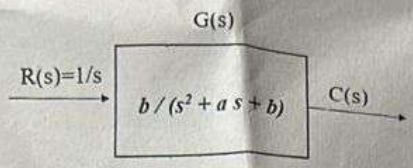

Fig. 2 Second order system

(a) Assuming b=9 and different values of a=0, a=2, a=6, a=9, calculate the pole locations and label it in pole-zero plot.

(b) Derive the expressions for the transient responses of the second order system for the different pole locations identified in (a).

7.a) Design a proportional control system for a typical closed loop control system with different elements as given below in fig. 3

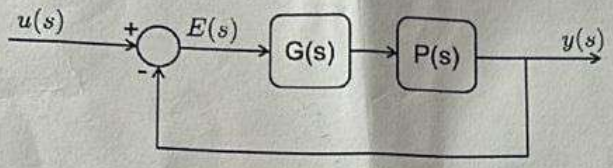

Fig. 3 Proportional control system

The plant is described by a first order transfer function is

$P(s) = 1 / (5s+2)$

i. Assuming that G(s) is a proportional controller and unity feedback, derive the closed loop transfer function of the system.

ii. Draw the transient response characteristics of the system with unit step input.

iii. Apply the final value theorem to calculate the steady state output to unit step input.

iv. Calculate the value of gain Kp for time constant of 0.5. Determine the steady state error for the value of Kp for unit step input.

OR

7.b) A unity feedback open loop transfer function of second order system is given by $G(s) = 1 / s(s+2)$.

(i) Find the rise time, peak time, setting time, percentage overshoot.

(ii) Evaluate the static error constants for the step, ramp and parabolic inputs.

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