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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. | **Semester: VI**
Branch: Mechanical Engineering | **Duration: 3 hrs.**
Course Code: 20ME6DCCOE/16ME6DCCOE | **Max Marks: 100**
Course: Control Engineering | **Date: 13.09.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) Along with suitable examples, define the following terms: (i) Reference input, (ii) Controlled variable, (iii) Plant, (iv) Manipulated variable and (v) Disturbance. **10**

b) Determine the transfer function $G(s) = \frac{V_L(s)}{V(s)}$, for the circuit given in the Fig. 1(b). **10**

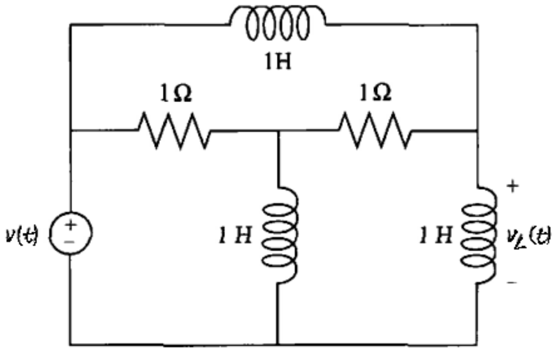

Fig. 1(b)

OR

2 a) Obtain transfer function between angular displacement of the motor, $\theta_m(s)$, and the armature emf, $E_m(s)$ for an armature controlled DC motor. **10**

b) Develop state-space representation for the mechanical system shown in Fig. 2(b). Consider $x_2(t)$ as the output. **10**

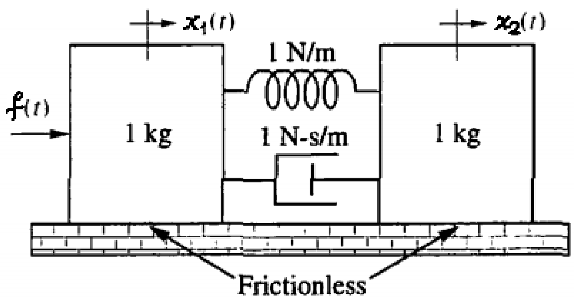

Fig. 2(b)

UNIT - II

3 a) For a first-order system without any zero, do the following: (i) derive unit-step response, (ii) define transient response specifications and (iii) derive expressions for rise time & settling time. **10**

b) Fig. 3(b-i) shows a mechanical vibratory system. When 2 N of force (step input) is applied to the system, the mass oscillates as shown in Fig. 3(b-ii). Determine m, b and k of the system from this response curve. The displacement x is measured from the equilibrium position. **10**

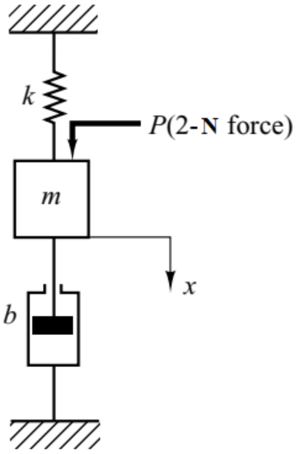

Fig. 3(b-i)

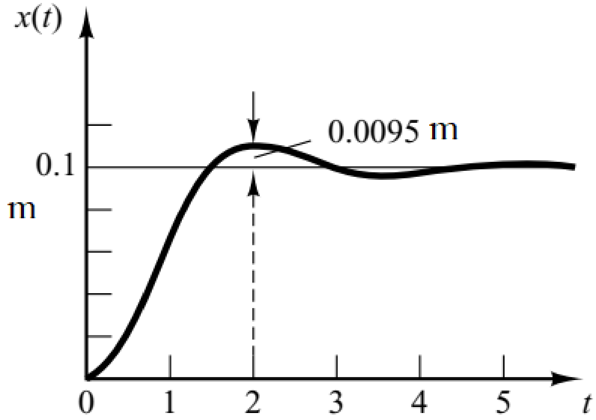

Fig. 3(b-ii)

OR

4 a) Determine the number of right-half-plane poles in the closed-loop transfer function: $T(s) = \frac{10}{s^5+7s^4+6s^3+42s^2+8s+56}$ **10**

b) Forward transfer function of a negative-unity feedback system is given by: **10**

$$G(s) = \frac{K}{s(s+a)}$$

Determine the following: (i) K and *a* to yield $K_v = 1000$ and a 20% overshoot.
(ii) K and *a* to yield a 1% error in the steady state and a 10% overshoot.

UNIT - III

5 For the system shown in the Fig. 5 below, draw the root locus graph. Determine the range of K within which the system is stable. Also, determine and indicate on the graph the following details: (i) the breakaway point on the real-axis, (ii) the exact point and gain where the locus crosses the jω-axis and (iii) the exact point and gain where the locus crosses the 0.45 damping ratio line. **20**

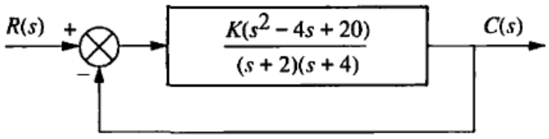

Fig. 5

UNIT - IV

6 A unity feedback control system has $G(s) = \frac{80}{s(s+2)(s+20)}$. Draw the Bode plot for this system. Also, determine ω_{gc}, ω_{pc}, G.M and P.M. Comment on the stability of the system. **20**

UNIT - V

7 a) The open loop transfer function of a unity feedback system is given by $G(s) = \frac{1}{s(s+1)(2s+1)}$. Sketch the polar plot and determine the gain and phase margins of the system. **10**

b) Using Nyquist criterion, determine whether the closed loop system having the following open loop transfer function is stable or not? **10**

$$G(s)H(s) = \frac{1 + 4s}{s^2(1 + s)(1 + 2s)}$$

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