Reg. No. : ☐☐☐☐☐☐☐☐☐☐☐☐

Question Paper Code : 53679

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fourth Semester

Robotics and Automation Engineering

RO 6401 – AUTOMATIC CONTROL SYSTEMS

(Regulation 2013)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

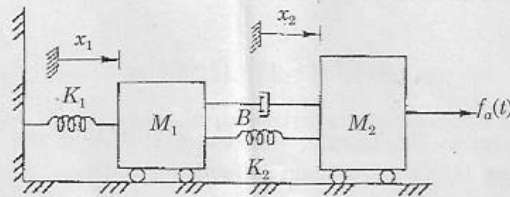1. Draw the free body diagram for the Mass M_2 in the mechanical system shown in Figure. 1.

Fig. 1

2. Obtain the transfer function of a tacho-generator from its basic principles.

3. The unit-step response of a system is given by $c(t) = 1 - e^{-10t}$ for $t \geq 0$. Find the transfer function of the system.

4. What is meant by time constant of a system?

5. The Polar plot of a system is shown in figure below. Find the gain margin and phase margin of the system.
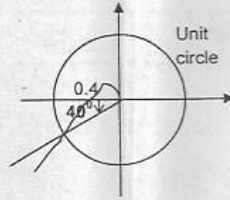

Fig. 5

6. Sketch the relation between frequency and phase of a second order under damped system for different damping ratios.

7. Differentiate absolute and relative stability of systems.

8. State the Nyquist stability criterion.

9. Determine the breakaway point of the root locus of a system whose open loop transfer function is : $G(s) = \dfrac{K}{s(s^2 + 5s + 6)}$.

10. Define state variable of a system.

PART B — (5 × 13 = 65 marks)

11. (a) Determine the transfer function $C(s)/R(s)$ of the system shown in Figure 11(a) by block diagram reduction method.
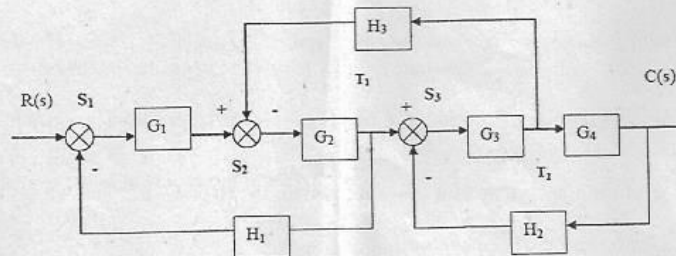

Fig. 11(a)

Or

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(b) Determine the transfer function $C(s)/R(s)$ for the system shown in Fig. 11(b).
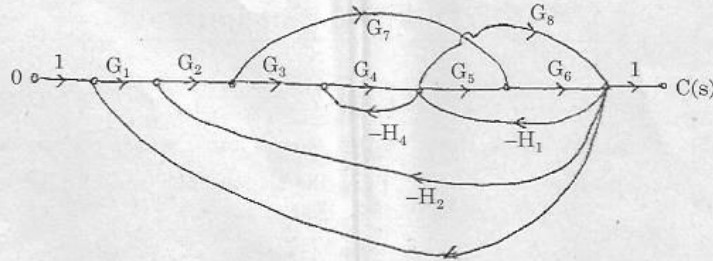

Fig. 11(b)

12. (a) (i) Obtain the unit-impulse response of a unity feedback control system whose open loop transfer function is $G(s) = \dfrac{2s+1}{s^2}$. (6)

(ii) Obtain the unit — step response of a unity feedback control system whose open — loop transfer function is $G(s) = \dfrac{1}{s(s+1)}$. Obtain also the rise time, peak time, maximum overshoot and settling time. (7)

Or

(b) The open loop transfer functions of three systems are given as $G(s) = \dfrac{2}{s(s+2)(s+4)}$. Also for the system given determine the steady state errors with step input $r(t) = u(t)$, ramp input $r(t) = t$ and acceleration input $r(t) = \dfrac{1}{2}t^2$.

13. (a) Sketch the polar plot of a system which has open loop transfer function $G(s) = \dfrac{20}{s(s+1)(s+2)}$.

Or

(b) Sketch the Bode plot for the transfer function $G(s) = \dfrac{1000}{(0.1s+1)(0.001s+1)}$.

Determine (i) Gain Margin (ii) Phase Margin.

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14. (a) Utilize the Routh table to determine the number of roots of the following polynomials in the right half of the s-plane. Comment about the stability of the system.

(i) $s^5 + 2s^4 + 3s^3 + 6s^2 + 10s + 15$

(ii) $s^5 + 6s^4 + 15s^3 + 30s^2 + 44s + 24$.

Or

(b) Consider a system with open loop transfer function as $G(s)H(s) = \dfrac{4s+1}{s^2(s+1)(2s+1)}$. Draw the Nyquist plot and also comment on stability.

15. (a) Sketch the root locus for the unity feedback system whose open loop transfer function is $G(s)H(s) = \dfrac{K}{s(s+3)(s+8)}$.

Or

(b) Derive a state space model for the system shown. The input is i_a and the output is e_2.
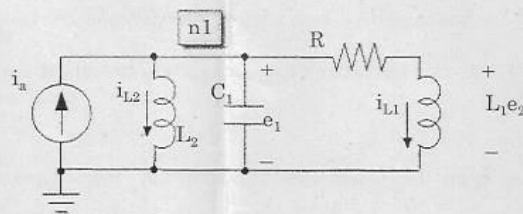

Fig. 15(b)

PART C — (1 × 15 = 15 marks)

16. (a) Describe the construction and working of variable reluctance and permanent magnet type of stepper motor.

Or

(b) What is a servo motor? Explain the construction, characteristics and control of AC servo motor.

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