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BT–6 / M12

CONTROL SYSTEM ENGINEERING

Paper–ECE–302–E

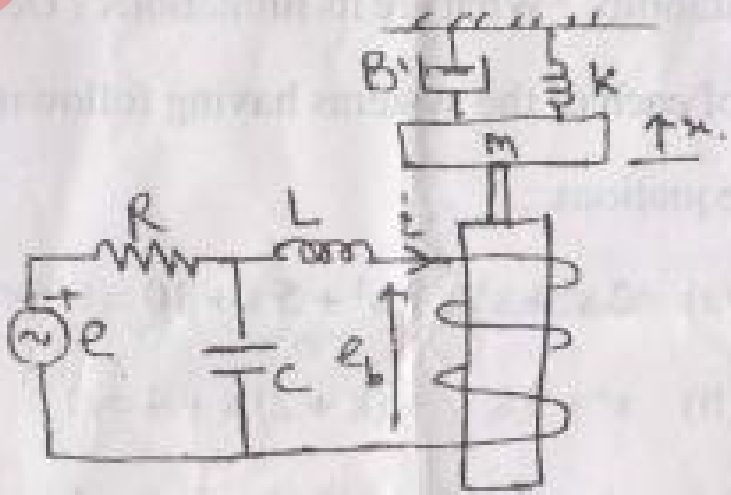
Time allowed : 3 hours] *[Maximum marks : 100*

Note : *Answer any five questions selecting at least one question from each section.*

Section–I

1. (a) Compare and contrast open loop and closed loop control systems. 8

(b) Derive transfer functionX (s) / E(s) for the electromechanical system of Fig. 1 Assume that the coil has back e.m.f. $e_b = k_i \dot{x}$, and coil current i produces a force $F = K_i$ i on the mass M.



12

Fig. 1

2. (a) What is feedback ? Explain advantages and disadvantages of negative feedback. 8

(b) Determine the closed loop transfer function of the following system (Fig. 2.)

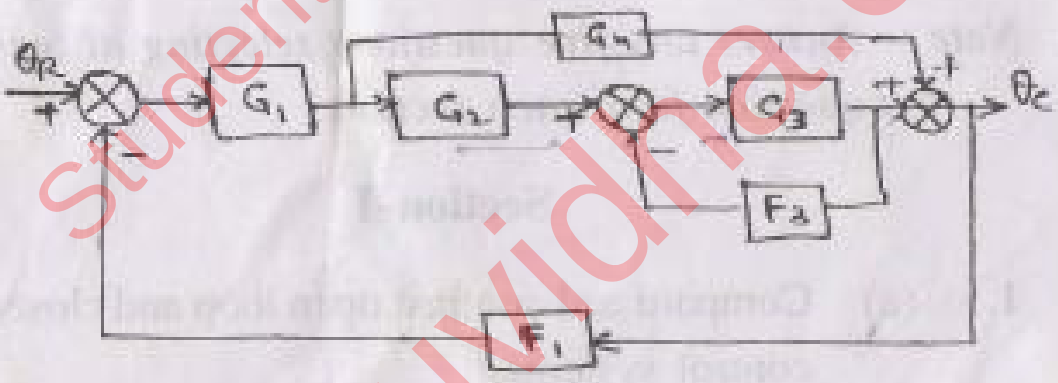


Fig. 2 12

Section–II

3. What is Routh-Hurwitz criterion for determining stability ? What are its limitations ? Determine stability of each of the systems having following characteristic equations :

(a) $2s^4 + s^3 + 3s^2 + 5s + 10 = 0$

(b) $s^3 + 3ks^2 + (k+2)s + 4 = 0$

(c) $s^6 + s^5 + 2s^4 + 3s^3 + 7s^2 + 4s + 4 = 0$ 4×5

4. Sketch the root locus for a negative feedback control system with the following specifications :

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

Hence determine K for stable system. 20

Section–III

5. (a) State and explain Nyquist criterion of stability. 5

(b) Define gain margin, phase margin, gain cross-over frequency, phase cross over frequency and relative stability. 5

(c) Open loop transfer function of a unity feed back system is

$$G(s) = \frac{2}{s(1+0.1s)(1+0.2s)}$$

Determine the quantities defined in port (b) for this system using Nyquist plot. 10

6. Plot the Bode diagram for the unity feedback systems with following transfer functions :

(a) $\dfrac{200}{jw(jw+5)(jw+10)}$

(b) $\dfrac{10(s+2)}{s(s+3)(s+5)(s+10)}$

Determine gain margin and phase margin in each case and comment on stability. 20

Section–IV

7. Why compensation of control systems may be needed ? What are the methods of compensation ? Discuss any two techniques and bring out clearly the situations in which one would be preferred over the other technique. 20

8. (a) Explain the concepts of 'state', 'controllability' and 'observability'. 8

(b) Obtain the static models equivalent to following systems

(i) $\dfrac{C(s)}{R(s)} = \dfrac{10(s+4)}{s(s+1)(s+3)}$

(ii) $\dfrac{d^3y}{dt^3} + 6\dfrac{d^2y}{dt^2} + 11\dfrac{dy}{dt} + 2y = 6u(t)$ 12

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