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BIEL-020

B.Tech. – VIEP – ELECTRONICS AND COMMUNICATION ENGINEERING (BTECVI)

01000

Term-End Examination

December, 2014

BIEL-020 : CONTROL ENGINEERING

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any* ***seven*** *questions. All questions carry equal marks. Use of scientific calculator is permissible. Use of graph paper and semi-log sheet is allowed.*

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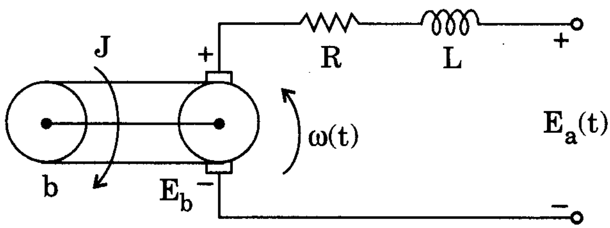
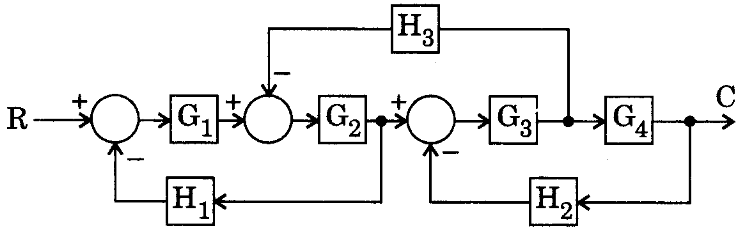
1. Write the equation and block diagram of an armature controlled DC motor (separately excited) whose field current is held constant. Derive the transfer function taking the speed $\omega(s)$ as output and applied armature voltage $E_a(s)$ as input with the given parameters.

(L = Armature Inductance, R = Armature Resistance, K_t = Torque Constant, b = Damping Constant, Load-Torque T_L = 0, J = Moment of Inertia of Armature and Load referred to rotor shaft. (All quantities are in SI units) *10*

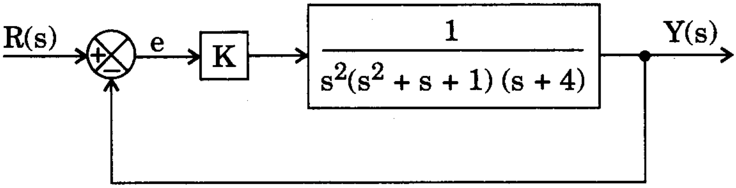


2. Find the transfer function $\frac{C(s)}{R(s)}$ for the block diagram using Mason's Gain formula. *10*



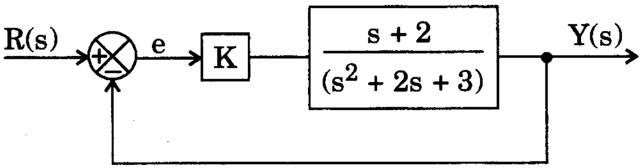
3. A unity feedback system has open loop transfer function $G(s) = \frac{10}{s(s+2)(s+5)}$. Find the steady-state error for unit-step, unit-ramp and unit-parabolic input. *10*

4. Consider the system given below :



Using Routh's stability criteria determine the range of 'K' for which the closed loop system is stable. *10*

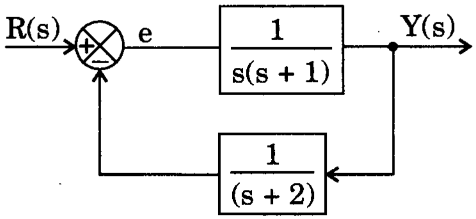
5. Consider the system given below :



(a) Sketch the root locus in the graph-paper as 'K' varies from 0 to ∞, showing all relevant steps and points.

(b) From the root locus find the value of 'K' for which system has a damping coefficient 0·707. *10*

6. Consider the following system :



(a) Draw a suitable Nyquist contour (with mathematical equation for each part).

(b) Sketch Nyquist plot in plain-paper showing all necessary calculations.

(c) From the Nyquist plot determine the stability of the closed loop system. *4+4+2*

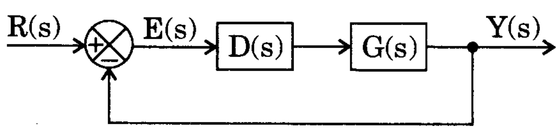
7. Consider the open loop transfer function $G(s) = \dfrac{200}{(s+2)(s+4)(s+5)}$.

(a) Draw the asymptotic Bode plot of G(s) in the semi-log paper (mark all corner-frequency and slope).

(b) From the asymptotic Bode plot sketch the actual plot approximately.

(c) In the plot, indicate Gain crossover and Phase crossover frequency and approximately calculate the Gain-margin and Phase margin. *4+2+4*

8. An uncompensated system is given as below, where $G(s) = \dfrac{1}{s^2}$;



Using Root-Locus analysis design a PD controller D(s) such that settling time $t_s \leq 4$ seconds (taking 2% tolerance) and maximum peak overshoot $M_p \leq 16{\cdot}30\%$. *10*

9. A system is given by the following differential equations :

$$\frac{d^3x}{dt^3} + 2\frac{d^2x}{dt^2} + 3\frac{dx}{dt} + 5x = u_1 + 2u_2$$

$$y_1 = 4\frac{dx}{dt} + 3u_1;$$

$$y_2 = 3\frac{d^2x}{dt^2} + 2u_2;$$

$$y_3 = x + u_2$$

Obtain a state space representation of the system. *10*

10. Write short notes on any ***two*** of the following : *2×5=10*

(a) PID Controller

(b) Lead and Lag Compensator

(c) Neural Network based control