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BIEL-020

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

00416

Term-End Examination

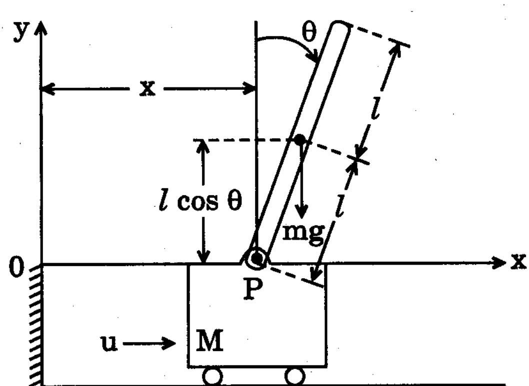
June, 2016

BIEL-020 : CONTROL ENGINEERING

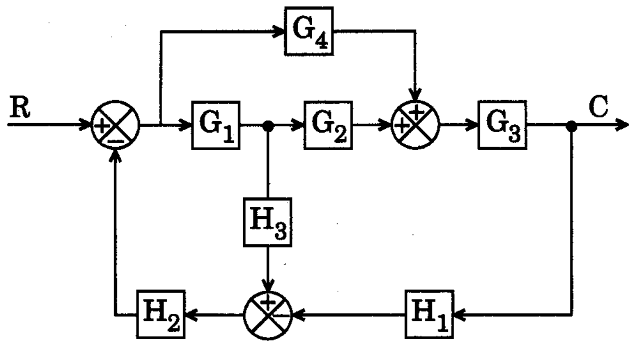
Time : 3 hours *Maximum Marks : 70*

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.*

1. An inverted pendulum is mounted on the motor driven cart. It is unstable and may fall. Here we assume it falls only along the plane of the paper. The control force u(t) is applied to the cart. Obtain a mathematical model of the system taking θ(t) as the output and u(t) as the input. (All notations have their usual meaning) *10*



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



3. (a) A unity feedback system has open-loop transfer function $G(s) = \frac{1}{s(s+1)(s+2)}$.

Find the static error coefficients and dynamic error coefficients. *6*

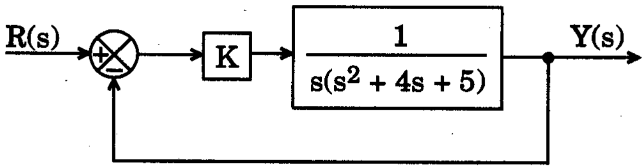
(b) How does steady state error of a system depend on the type of the system ? *4*

4. Using Routh-Hurwitz stability criterion, determine the number of poles in the left half, right half and on the imaginary axis of s-plane for a system whose characteristic equation is

$$s^7 + 5s^6 + 11s^5 + 15s^4 + 19s^3 + 15s^2 + 9s + 5 = 0.$$

Also comment on the stability of the system. *10*

5. For the given system, sketch the root locus in a graph paper as 'K' varies from 0 to ∞, showing all relevant steps and calculations. *10*



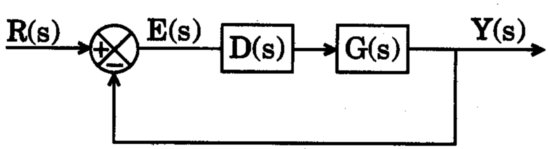
6. Consider a unity feedback system having open-loop transfer function (OLTF) $\dfrac{1}{s^2(s+1)}$:

   (a) Sketch a suitable Nyquist path (contour) with a mathematical description. *3*

   (b) Sketch a Nyquist plot on a plain paper showing relevant calculations. *5*

   (c) From the Nyquist plot, determine the stability of the system. *2*

7. Consider the system given below, where $G(s) = \dfrac{1}{(s+1)(s+5)}$:



Using root locus analysis, design a PI controller D(s) such that : *10*

   (a) Damping ratio of Dominant Poles (ξ) = 0·45

   (b) Undamped Natural Frequency (ω_n) = 3·5 rad/sec

   (c) Steady state error (e_{ss}) = 0.

8. Consider a unity feedback system with open-loop transfer function (OLTF) $G(s) = \dfrac{4}{s(s+2)}$:

The system is desired to have the following specifications :

$$\text{Phase Margin} \geq 50^\circ \text{ and } K_v = 20 \text{ sec}^{-1}.$$

Using the Bode plot method, design a lead compensator D(s) such that the above requirements are met. *10*

9. (a) Write the dimension of the A, B, C, D matrices of a state space model of a 3-input 4-output 5^{th} order system. *2*

(b) Write a state space model of a SISO 2^{nd} order system such that it is : *3*

(i) Both controllable and observable

(ii) Controllable but not observable

(iii) Observable but not controllable

(c) Calculate the state transition matrix for the following system : *5*

$$\dot{X} = \begin{bmatrix} 0 & -3 \\ 1 & -4 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u; \quad y = [1 \quad -1]\, X$$

10. (a) Realize a lag compensator using op-amp, resistances and capacitances. *3*

(b) Discuss briefly about Neural based control. *4*

(c) Discuss the effect of pole-zero-cancellation in a transfer function. *3*