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BIEL-020

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

Term-End Examination

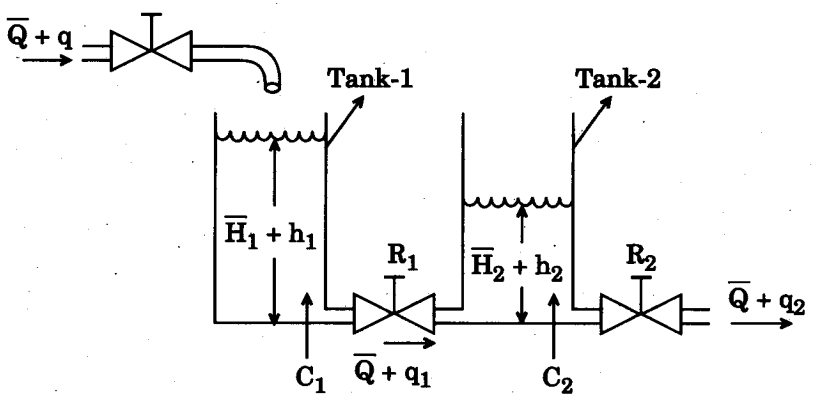
December, 2015

BIEL-020 : CONTROL ENGINEERING

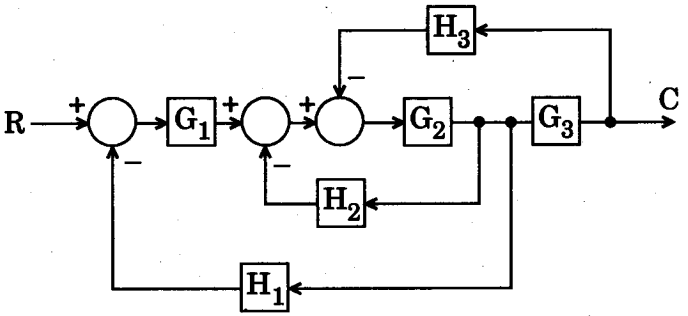
Time : 3 hours *Maximum Marks : 70*

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. Consider the coupled tank system as shown below. Find the transfer function of the system taking 'q' as input and 'h_2' as output. (All notations are having their usual meaning) *10*



2. Find the transfer function $\frac{C(s)}{R(s)}$ for the block diagram, using block reduction technique. *10*



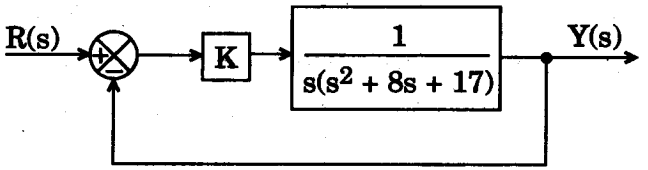
3. Define Rise Time, Settling Time and Maximum Peak Overshoot for a standard 2^{nd} order underdamped system and indicate them in the step response of a system. Also derive their mathematical expression in terms of system parameters. (Use standard notation) *10*

4. Using R-H 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 :

$$s^7 + 4s^6 + 10s^5 + 14s^4 + 10s^3 + 14s^2 + 9s + 10 = 0.$$

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

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

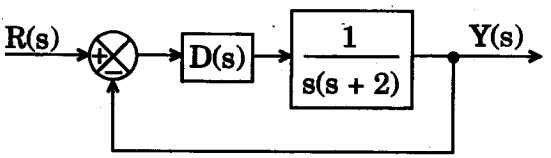


Calculate the value of 'K' approximately (mathematically or graphically) for which the close-loop system response gives 16·3% overshoot.

8+2

6. Sketch the bode plot of the open-loop transfer function $G(s) = \frac{1}{s(s+1)(s+2)}$ in a semi-log paper and show the gain margin, phase margin, gain crossover frequency and phase crossover frequency. *10*

7. Consider the following system :



Using the root locus method, design a suitable lag-lead compensator so that the following specifications are met : *10*

$M_p \leq 16{\cdot}3\%$; $t_s \leq 2$ sec (taking 2% tolerance) and $K_v = 30$.

8. (a) Phase margin is correlated to which time domain specification and how ? 4

(b) An experiment is carried out on an open-loop stable minimum phase LTI system and the following steady state inputs and outputs are noted :

Input	Output
3 sin (1·41t)	1·5 sin (1·41t – 180°)
3 sin (0·9t)	2 sin (0·9t – 150°)
3 sin (0·45t)	3 sin (0·45t – 120°)
3 sin (0·25t)	3·5 sin (0·25t – 90°)

(i) Calculate the phase crossover frequency, gain crossover frequency, gain margin and phase margin of the system.

(ii) If the system is made close-loop with unity feedback, will the close-loop system be stable ? Justify the answer. 6

9. (a) Define state variables and state space. 2

(b) What are the advantages of state space analysis over transfer function analysis ? 2

(c) Define controllability and observability. 2

(d) Determine the controllability and observability of the following system : 4

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

10. Write short notes on any ***two*** of the following : *5+5*

(a) M-Circle and N-Circle

(b) PID Control

(c) Fuzzy Logic Based Control