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Question Paper Code : 10296

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012.

Fourth Semester

Electronics and Communication Engineering

EC 2255/147405/EC 46/EE 1256 A/10144 EC 406/080290023 — CONTROL SYSTEMS

(Regulation 2008)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What are the advantages of the closed loop control system?

2. What are the properties of signal flow graphs?

3. List the advantages of generalized error coefficients.

4. Why derivative controller is not used in control system?

5. Draw the polar plot of $G(s)=\frac{1}{(1+sT)}$.

6. State the uses of Nicholas chart.

7. What is root locus?

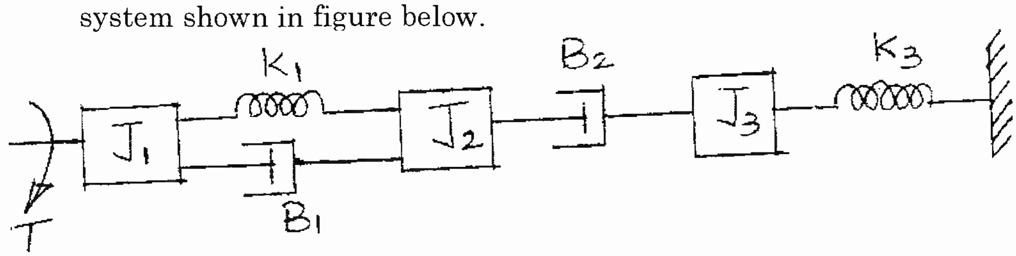
8. State Nyquist stability criterion.

9. How the modal matrix is determined?

10. What is meant by quantization?

PART B — (5 × 16 = 80 marks)

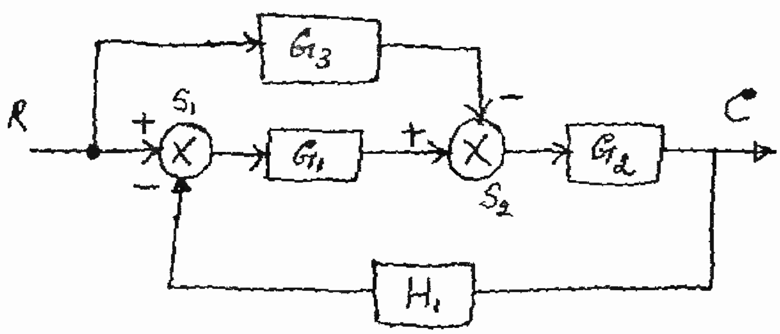
11. (a) Write the differential equations governing the mechanical rotational system shown in figure below.



Draw the torque-voltage and torque-current electrical analogous circuits and verify by writing mesh and node equations. (16)

Or

(b) (i) Using block diagram reduction technique, find the closed-loop transfer function C/R of the system whose block diagram is shown below. (8)



(ii) Construct the signal flow graph for the following set of simultaneous equations.

$$X_2 = A_{21}X_1 + A_{23}X_3$$
$$X_3 = A_{31}X_1 + A_{32}X_2 + A_{33}X_3$$
$$X_4 = A_{42}X_2 + A_{43}X_3$$

and obtain the overall transfer function using Mason's gain formula. (8)

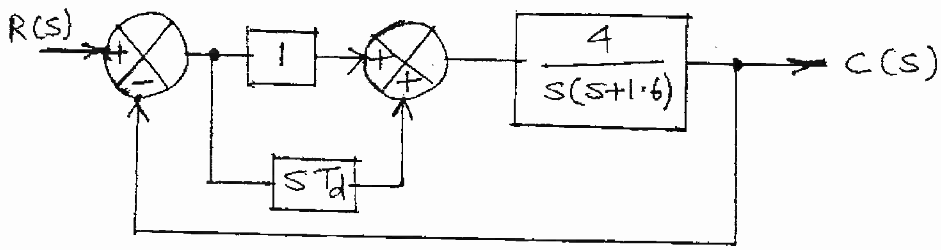
12. (a) (i) The open loop transfer function of a unity feedback control system is given by $G(s)=\dfrac{K}{s(sT+1)}$ where K and T are positive constants. By what factor should the amplifier gain be reduced so that the peak over-shoot of unit step response of the system is reduced from 75% to 25%. (8)

(ii) A certain unity negative feedback control system has the following forward path transfer function $G(s) = \frac{K(s+2)}{s(s+5)(4s+1)}$. The input applied is $r(t) = 1 + 3t$. Find the minimum value of K so that the steady state error is less than 1. (8)

Or

(b) (i) Discuss the effect of derivative control on the performance of a second order system. (8)

(ii) Figure shows PD controller used for a system.



Determine the value of T_d so that system will be critically damped. Calculate its settling time. (8)

13. (a) (i) For the following transfer function,

$$G(s) = \frac{K(s+3)}{s(s+1)(s+2)}$$

sketch the Bode magnitude plot by showing slope contributions from each pole and zero. (8)

(ii) For an unity feedback system with closed loop transfer function $\frac{G(s)}{1+G(s)}$ derive the equations for the locus of constant M circles and constant N circles. (8)

Or

(b) (i) Write the procedure to obtain Nichol's chart from Constant M circles. (8)

(ii) Write a MATLAB program to examine stability using Bode plot for the given transfer function $G(s) = \frac{20_e^{-0.2s}}{s(s+2)(s+8)}$. Explain the code (statements) as to what the variables and numbers mean and also what action is caused by each statement. State also how you will interpret the result. (8)

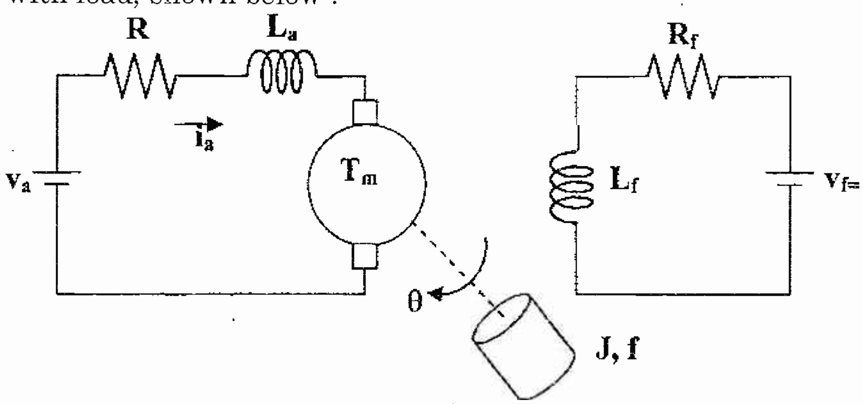
14. (a) (i) Construct Routh array and determine the stability of the system whose characteristic equation is $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. (6)

(ii) Sketch the root locus of the system whose open loop transfer function is $G(s) = \frac{K}{s(s+2)(s+4)}$. Find the value of K so that the damping ratio of the closed loop system is 0.5. (10)

Or

(b) Draw the Nyquist plot for the system whose open loop transfer function is $G(s)H(s) = \frac{K}{s(s+2)(s+10)}$. Determine the range of K for which the closed loop system is stable. (16)

15. (a) Obtain the state space representation of armature controlled D.C. motor with load, shown below :



Choose the armature current i_a, the angular displacement of shaft θ, and the speed $\frac{d\theta}{dt}$ as state variables and θ as output variables. (16)

Or

(b) (i) The state model matrices of a system are given below :

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix}$$

Evaluate the observability of the system using Gilbert's test. (10)

(ii) Find the controllability of the system described by the following equation :

$$\dot{X} = \begin{bmatrix} -1 & -1 \\ 2 & -1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U(t).$$ (6)
