

B.TECH. DEGREE EXAMINATION, MAY 2014**Sixth Semester**

Branch : Electrical and Electronics Engineering

EE 010603—CONTROL SYSTEMS (EE)

(New Scheme—2010 Admission onwards)

[Regular/Improvement/Supplementary]



Time : Three Hours

Maximum : 100 Marks

*Graph Sheets may be supplied.***Part A***Answer all questions.**Each question carries 3 marks.*

1. Define static error and static error coefficients.
2. What are the advantages of Nyquist plot ?
3. Draw Bode plot of a lead compensator.
4. Explain the diagonalization technique.
5. Write the relationship between transfer function and state space model of a discrete system.

(5 × 3 = 15 marks)

Part B*Answer all questions.**Each question carries 5 marks.*

6. Determine the error constants K_p , K_v ; and K_a for the system having transfer function :

$$G(s)H(s) = \frac{K}{s(s+5)(s+10)}$$

Also find the steady-state error for an input $r(t) = 5t + 5$.

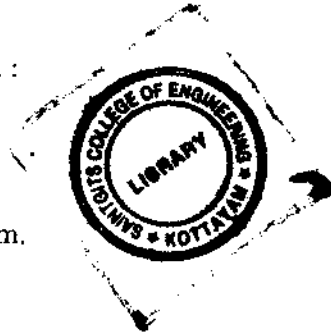
7. Give the properties of minimum phase and non-minimum phase systems.
8. Draw circuit of a phase lag compensator using RC network and derive its transfer function.
9. Represent the following system in phase variable form : $G(s) = \frac{s+3}{s^2+2s+7}$.

Turn over

10. A dynamic system is represented by a state model :

$$\dot{X} = \begin{bmatrix} 0 & 2 \\ -3 & -5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u. \text{ Given } X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$$

Determine the state transition matrix of the system.



(5 × 5 = 25 marks)

Part C

*Answer all questions.
Each question carries 12 marks.*

11. Draw the Bode plot for unit feedback system with $G(s) = \frac{80}{s(s+2)(s+20)}$. Determine the gain margin and phase margin. Comment on the stability of the system.

Or

12. (a) For the system with transfer function $GH(s) = \frac{10}{s(s+1)(s+2)}$. Find the steady-state error

when it is subjected to the input $r(t) = 1 + 2t + \frac{3t^2}{2}$.

(7 marks)

- (b) Explain how the transportation lag is incorporated in obtaining the frequency response plots?

(5 marks)

13. Sketch the Nyquist plot of unity feedback control system having the open loop transfer function

$$G(s) = \frac{(s+4)}{(1-s^2)}. \text{ Determine the stability of the system using Nyquist stability criterion.}$$

Or

14. Sketch the polar plot for the system with $G(s) = \frac{10}{s(s+1)(s+2)}$ and unity feedback. Find the phase margin and gain margin and comment on the stability.

15. The forward path transfer function of a unity negative feedback system is

$$G(s) = \frac{K}{s(s+2)(s+30)}. \text{ Design a lead compensator to meet the following specifications :}$$

- (i) Phase margin $\geq 35^\circ$.

- (ii) Steady-state error for unit ramp input ≤ 0.04 rad/sec.

Or

16. Describe the design procedure for the PID controller using frequency response method.

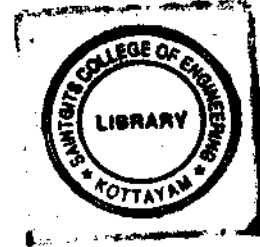
17. Obtain Jordan Canonical form realisation of the system $\frac{Y(z)}{R(z)} = \frac{z^3 + 8z^2 + 17z + 8}{(z+1)(z+2)(z+3)}$.

Or

18. Obtain the state model for the transfer function :

$$\frac{Y(s)}{U(s)} = \frac{10s + 1}{(s+1)(s+2)(s+4)} \text{ in}$$

- (i) phase variable form ; and
- (ii) canonical variable form.



Draw the simulation diagram in each case.

19. Consider the control system described by the state model :

$$\dot{X} = \begin{bmatrix} 1 & 4 \\ -2 & -5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \text{ and } y = [1 \ 0] x \text{ given } x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}. \text{ Determine}$$

- (i) State transition matrix ; and
- (ii) Time response for unit step input.

Or

20. Express the following continuous time equations in discrete form :

$$\dot{x} = \begin{bmatrix} 1 & 1 \\ -4 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u, \quad y = [0 \ 1] x.$$

Take sampling period $T = 0.01$ sec.

(5 × 12 = 60 marks)