G 374 (Pages : 3) Reg. No.................................

Name.....................................

B.TECH. DEGREE EXAMINATION, MAY 2014

Sixth Semester

Branch : Electrical and Electronics Engineering

EE 010 603—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 :

   $G(s)H(s) = \dfrac{K}{s(s+5)(s+10)}$. 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 : $G(s) = \dfrac{s+3}{s^2 + 2s + 7}$.

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 $G(s) = \dfrac{80}{s(s+2)(s+20)}$. Determine the gain margin and phase margin. Comment on the stability of the system.

Or

12. (a) For the system with transfer function $GH(s) = \dfrac{10}{s(s+1)(s+2)}$. Find the steady-state error when it is subjected to the input $r(t) = 1 + 2t + \dfrac{3t^2}{2}$.

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

Or

14. Sketch the polar plot for the system with $G(s) = \dfrac{10}{s(s+1)(s+2)}$ 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 $G(s) = \dfrac{K}{s(s+2)(s+30)}$. Design a lead compensator to meet the following specifications :

(i) Phase margin $\geq 35°$.

(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 :

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

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

(i) State transition matrix ; and

(ii) Time response for unit step input.

Or

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

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

Take sampling period T = 0.01 sec.

(5 × 12 = 60 marks)