Reg. No. :

Question Paper Code : X10604

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020 AND APRIL/MAY 2021

Fourth Semester

Electrical and Electronics Engineering

IC 8451 – CONTROL SYSTEMS

(Electronics and Instrumentation Engineering/Instrumentation and Control Engineering)

(Regulations 2017)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Define transfer function.

2. What are the memory elements in mechanical translation and electrical system ?

3. Derive the impulse response of first order system.

4. An open loop transfer function of unity feedback system is given as $G(s)=\frac{10}{(s+1)}$. What is its steady state error for unit step input ?

5. Define gain margin and phase margin.

6. Find the type and order of the system $G(s)=\frac{10}{s^2(s+1)(s+2)}$.

7. Define Nyquist stability criterion.

8. Compare lag compensator with lead compensator.

9. What are the advantages of state space analysis ?

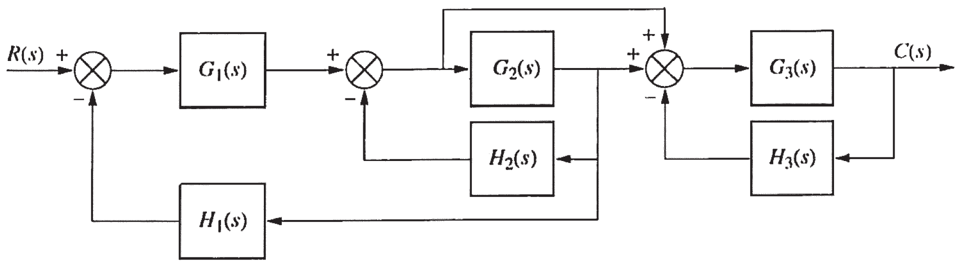
10. Write the state model of a linear time invariant system.

PART – B **(5×13=65 Marks)**

11. a) Derive the transfer function of armature controlled DC motor with essential block diagrams.

(OR)

b) Determine the transfer function of the given system using block diagram reduction technique.



12. a) i) A closed loop control system is represented by the differential equation $\frac{d^2C}{dt^2} + 4\frac{dc}{dt} = 16e$ where $e = r - c$ is the error signal. Determine the undamped natural frequency, damping ratio and percentage maximum overshoot for a unit step input. **(8)**

ii) A unity feedback system is characterized by the open loop transfer function $G(s) = \frac{1}{s(0.5s+1)(0.2s+1)}$. Determine the steady state errors for unit-step, unit-ramp and unit-acceleration input. **(5)**

(OR)

b) Construct the root locus of the open loop transfer function

$$G(s)H(s) = \frac{K}{s(s+2)(s^2+2s+5)}.$$

13. a) Sketch the Bode plot for the given transfer function. Determine Gain cross-over frequency phase cross-over frequency, gain margin and phase margin

$$G(s)H(s) = \frac{2000}{s(s+2)(s+100)}.$$

(OR)

b) Sketch the Polar plot for a unity feedback system with open loop transfer function $G(s) = \frac{1}{s(1+s)^2}$. Also find the frequency at which $|G(j\omega) = 1|$ and the corresponding phase angle.

14. a) A unity feedback control system is characterized by the open loop transfer function $G(s) = \frac{K(s+13)}{s(s+3)(s+7)}$. Using Routh criterion, calculate the range of values of K for the system to be stable. Also determine the value of K the system become marginally stable and calculate the frequency of oscillation if any.

(OR)

b) Draw the Nyquist plot and assess the stability of the closed loop system whose open loop transfer function is $G(s)H(s) = \frac{(s+4)}{(s+1)(s-1)}$.

15. a) i) Obtain the state model for the system described by the transfer function

$$T(s) = \frac{Y(s)}{U(s)} = \frac{1}{s^3 + 6s^2 + 10s + 5}.$$ **(8)**

ii) Obtain state transition matrix for the state model whose A matrix is given by $A = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$. **(5)**

(OR)

b) Determine the state controllability and observability of the system

$$\dot{x}(t) = Ax(t) + Bu(t) \quad Y(t) = Cx(t) \quad A = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & -1 \end{bmatrix} \; B = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} \; C = \begin{bmatrix} 1 & 0 & 1 \end{bmatrix}.$$

PART – C **(1×15=15 Marks)**

16. a) Compensate the system with the open loop transfer function $G_f(s) = \frac{K}{s(s+1)(s+5)}$ to meet the following specifications

i) Damping ratio $\zeta = 0.3$

ii) Settling time $t_s = 12s$

Velocity error constant $K_v \geq 8\ s^{-1}$.

(OR)

b) An unity feedback servo mechanism whose $G(s) = \frac{K_v}{s(1+ST)}$ is designed to keep a radar antenna pointed at a flying aeroplane. If the aeroplane is flying with a velocity of 600 km/h, at a range of 2 km and the maximum tracking error is to within 0.1°, determine the required velocity error coefficient K_v.