*Total number of printed pages:***7** **D/4th/DIE404**

2021

CONTROL SYSTEMS

Full Marks: 60

Time: Two hours

The figures in the margin indicate full marks for the questions.

A. Multiple Choice Questions 1 x 20=20

1. 1. The steady-state error of a feedback control system with an acceleration input becomes finite in a
   a. type 0 system
   b. type 1 system
   c. type 2 system
   d. type 3 system
2. In force voltage analogy system, displacement is equivalent to
   a. Current
   b. Flux
   c. Charge
   d. Inductance
3. Control systems are normally designed with damping factor
   a. Undamped
   b. Overdamped
   c. critically-damped
   d. Underdamped
4. The type number of a transfer function denotes
   a. The number of poles at origin
   b. The number of zeros at origin
   c. The number of finite poles
   d. The number of poles at infinity

5. What is the Laplace transformation of a unit ramp function?

   a. $\frac{1}{s^2}$

   b. s^2

   c. $\frac{1}{s}$

   d. None of these

6. If the characteristics equation of a system is $s^2+4s+10=0$, the system is

   a. Underdamped

   b. critically-damped

   c. Overdamped

   d. Undamped

7. The input to a controller is

   a. Sensed signal

   b. Desired variable value

   c. Error signal

   d. Servo signal

8. A unity feedback system with open loop transfer function $G(s)=\frac{4}{s(s+p)}$ is critically damped. The value of the parameter p is

   a. 4

   b. 3

   c. 2

   d. 1

9. If the type of the system is increased

   a. Stabilization becomes more difficult

   b. Stabilization becomes more easy

   c. There is no effect on stability

   d. None of these

10. If the open loop transfer function is $G(s)=\frac{(1+s)}{s(1+0.5s)}$, the corner frequencies are

a. 0 and 1

b. 0 and 2

c. 0 and -1

d. 1 and 2

11. If the open loop transfer function with unity feedback has a phase angle of -150^0 at the gain crossover frequency. The phase margin of the system is

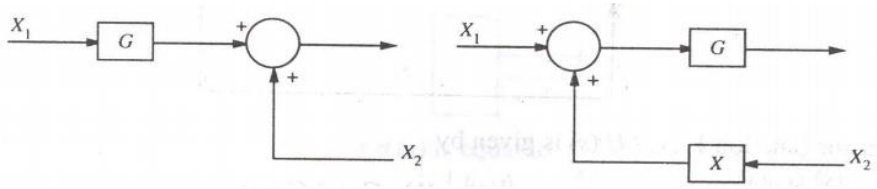
a. -150^0

b. 210^0

c. 30^0

d. None of these

12. The figure gives two equivalent block diagram. The value of the block 'X' is given by



a. G(s)

b. 1/G(s)

c. 1

d. None of these

13. The terms in the first column of Routh array of a characteristics equation are 5, 2,-4, 6, 3. The number of roots of the characteristics equation on the right half of S plane is equal to

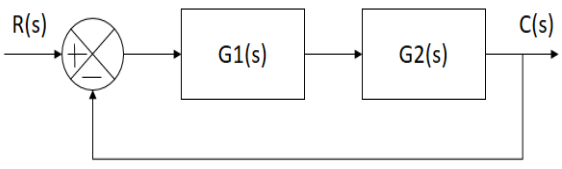
a. 2

b. 1

c. None

d. 3

14. The overall transfer function C(s)/R(s) of the following system is



a. $\dfrac{G_1(s)G_2(s)}{1-G_1(s)G_2(s)}$

b. $G_1(s)G_2(s)$

c. $\dfrac{1+G_1(s)G_2(s)}{G_1(s)G_2(s)}$

d. $\dfrac{G_1(s)G_2(s)}{1+G_1(s)G_2(s)}$

15. The Laplace transformation of $f(t)=K\sin\omega t$ is

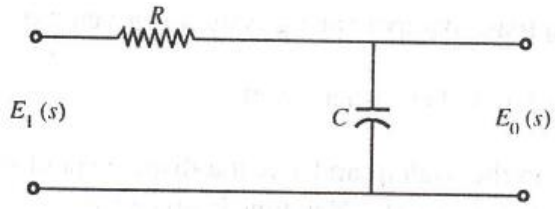
a. $\dfrac{K}{s^2-\omega^2}$

b. $\dfrac{K}{s+\omega}$

c. $\dfrac{K}{s^2+\omega^2}$

d. $\dfrac{K\omega}{s^2+\omega^2}$

16. The transfer function of the following network is



a. $\dfrac{1}{RCs+1}$

b. $\dfrac{1}{RCs}$

c. $\dfrac{RCs}{RCs+1}$

d. $RCs+1$

17. Centroid in root locus plot is

a. A point where all the root locus branches meet together

b. A point where all the asymptotic lines meet together with real axis

c. A point where two root locus branches cross each other

d. None of these

18. The loops in signal flow graph are called non-touching loop

a. If the loops not passes any common node

b. If the loops passes a common node

c. If the loops not passes any common branch

d. If the loops passes a common branch

19. In closed loop control system

a. Control action is independent of desired output

b. Control action is dependent of desired output

c. Control action is not a part of this

d. None of these

20 In a linear system

a. Output varies with input linearly

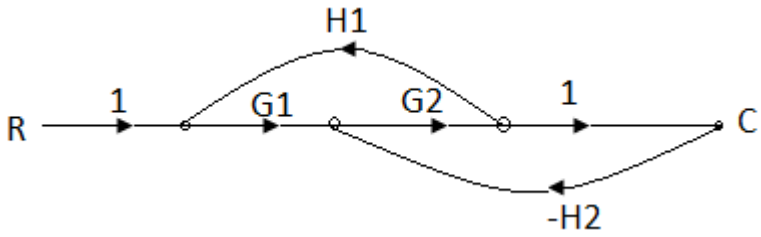
b. Output does not varies with input linearly

c. Output and input are not related

d. Output and input are independent to each other

B. Very Short Question 2*6=12

1. Find the overall transfer function for the SFG given bellow.

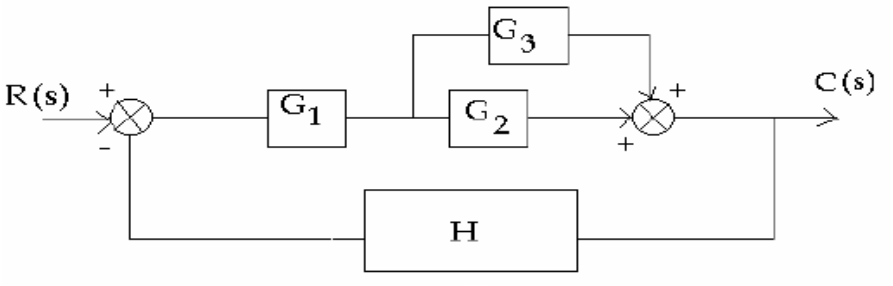


2. Determine the overshoot in the response of the system having the transfer function $\frac{16K}{s(s^2+2s+16)}$ for a unit-step input.

3. The open-loop transfer function of a unity feedback system is $G(s) = \frac{K}{s^2(s+5)}$.

Find out the value of K for the unstable system using Routh criterion.

4. Determine the overall transfer function of the following block diagram.



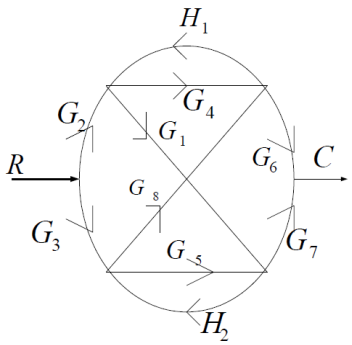
5. Find out the breakaway point in the root locus plot of the transfer function,

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

6. What is meant by transfer function? Give suitable example.

C Short Question 4*7=28

1. What is Mason's gain formula? Obtain the overall transfer function from the following signal flow graph.



2. A unit feedback system is characterised by an open loop transfer function, $G(s)=\frac{K}{s(s+10)}$. Determine the gain K, so that the system will have a damping ratio of 0.5. For this value of K determine the settling time, rise time, peak overshoot and time to reach the peak overshoot for a unit step input.
3. Sketch the bode plot for the open loop transfer function,

$$G(s)H(s)=\frac{2000}{s(s+2)(s+100)}\ .$$ Obtain gain and phase cross over frequency from the plot.

4. Find out the system stability for the polynomial using Routh criterion.

$$s^6+2s^5+8s^4+12s^3+20s^2+16s+16=0$$

5. Draw the root locus plot for the transfer function given by

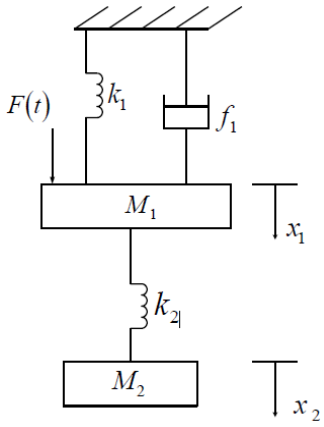
$$G(s)H(s)=\frac{K}{s(s+3)(s^2+2s+2)}\ .$$

6. Write short notes on Polar plot.

7. Write the differential equations governing the behaviour of the mechanical system shown in figure. Also obtain the analogous electrical circuits based on

   a. Force-current analogy

   b. Force-voltage analogy



****