Question Paper

Exam Date & Time: 14-Jan-2021 (02:00 PM - 05:00 PM)

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

FOURTH SEMESTER B.TECH ELECTRONICS AND INSTRUMENTATION END SEMESTER EXAMINATIONS, JAN 2021

LINEAR CONTROL THEORY [ICE 2253]

Marks: 50 **Duration: 180 mins.**

Part A

Answer all the questions.

Instructions to Candidates: Missing data may be suitably assumed

1) A) Obtain the transfer function $\frac{X_o(s)}{X_i(s)}$ of the mechanical system shown in figure 1(a). Also obtain the transfer function $\frac{E_o(s)}{E_i(s)}$ of the electrical system shown in figure 1(b). Show that these transfer functions of the two systems are of identical form and thus they are analogous systems. (5)

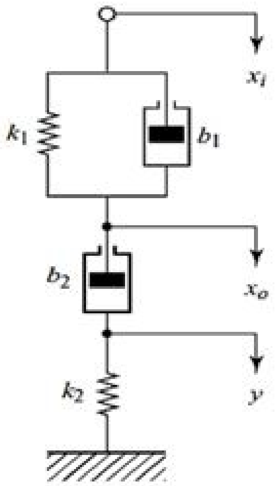

Figure 1(a)

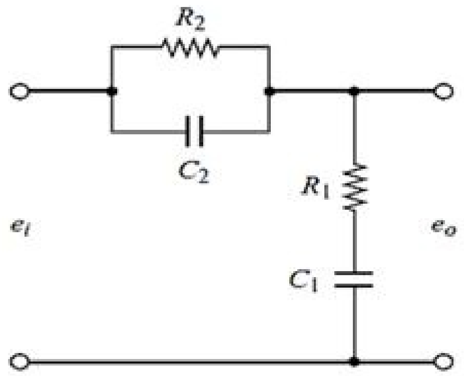

Figure 1(b)

B) Distinguish between open loop and closed loop system. What are the characteristics of negative feedback? (3)

C) What pole locations characterize (i) the under damped system (ii) over damped system (iii) critically damped system (iv) undamped system. (2)

2) A) Using Mason's rule find the transfer function, $T(s) = \frac{C(s)}{R(s)}$, for the system described by signal flow graph as shown in figure 2. (5)

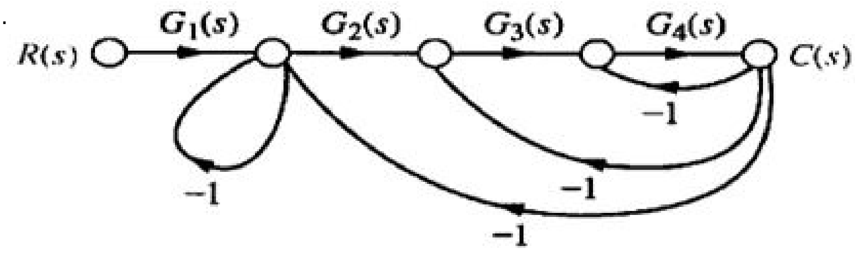

Figure 2

B) Consider a unity feedback system with a closed loop transfer function $\frac{C(s)}{R(s)} = \frac{Ks+b}{s^2+as+b}$. (3)

Determine the open loop transfer function G(S). Also obtain the steady state error for the system with unit ramp input.

C) Define corner frequency. What are the advantages of Bode plot? (2)

3) A) For the system shown in figure 3, (i) Find Kp, Kv, and Ka (ii) Find the steady state error for an input of $50u(t)$, $50tu(t)$,and $50t^2u(t)$ (iii) State the system type. (5)

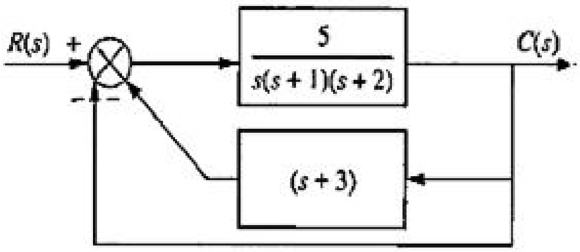

Figure 3

B) What is Nyquist stability criterion? For the loop transfer function $G(s)\,H(s) = \frac{K}{s(s+2)(s+10)}$, based on the following statements comment on the closed loop stability of the system (Case I and Case II), justify the answer. What is the range of K for the stability? (5)

Case I: When K is less than 240, the contour crosses real axis at a point between 0 and -1. On travelling through Nyquist plot in clockwise direction it is found that the point -1+j0 is not encircled.

Case II: When K is greater than 240, the contour crosses real axis at a point between -1 and $-\infty$.

On travelling through Nyquist plot in clockwise direction it is found that the point -1+j0 is encircled two times.

4) A) Construct the Routh array and determine the stability of the system represented by the characteristic equation, $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. Also determine the number of roots lying on right half s - plane, left half s - plane and on imaginary axis. (5)

B) Sketch the root locus for the unity feedback system whose open loop transfer function is G(s) H(s) = $\frac{K(s+1.5)}{s(s+1)(s+5)}$ (5)

5) A) A unity feedback system has an open loop transfer function, G(s) = $\frac{K}{s(1+2s)}$. Design a suitable lag compensator so that phase margin is 40^0 and steady state error for ramp input is $\leq$ 0.2 (7)

B) What is meant by compensation in control systems? Write the transfer function of lead compensator and draw its pole - zero plot. (3)

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