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Question Paper Code : 20748

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2022.

Fourth Semester

Instrumentation and Control Engineering

IC 8451 — CONTROL SYSTEMS

(Common to Electrical and Electronics Engineering/
Electronics and Instrumentation Engineering)

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Identify the Force-Voltage analogy of the given mechanical elements
   (a) Mass (M),
   (b) Damping Constant (B)
   (c) Spring Constant (K)
   (d) Velocity (v)
2. An automobile driver uses a control system to maintain the speed of the car at a prescribed level. Sketch the block diagram to illustrate the feedback system.
3. The block diagram of a control system is shown in figure. 1. Determine the system type number and error of the system for unit ramp input signal.

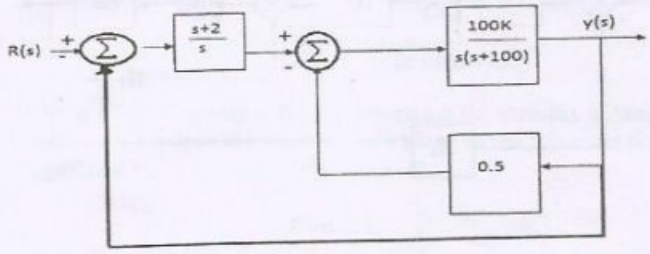

Figure 1

4. What do you mean by time constant of the system?

5. A typical frequency response curve of a feedback control system has been shown in Figure. 2 .State what is X and Y.

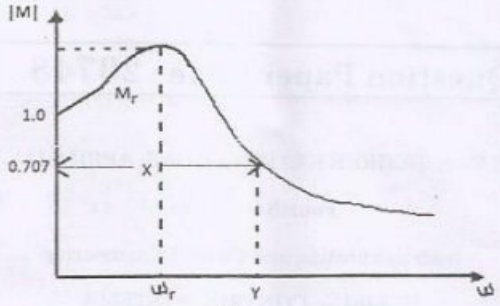

Figure. 2

6. The damping ratio and natural frequency of oscillations of a second order system is 0.8 and 5 rad/sec respectively. Calculate the resonant peak and resonant frequency?

7. The characteristic polynomial of third order system is $: s^3 + s^2 + 2s + 24 = 0$. Check the stability using Routh-Hurwitz criterion.

8. What is the necessary condition that the characteristic equation of a feedback system satisfies the BIBO stability?

9. Is the state model of the system should be unique?

10. What are the advantages of state variable technique?

PART B — (5 × 13 = 65 marks)

11. (a) Find the transfer function $C(s)/R_1(s)$ and $C(s)/R_2(s)$ in figure. 3 and assume that the one input is present in each case.

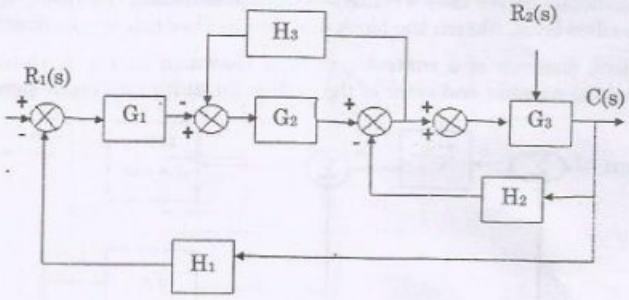

Figure 3

Or

(b) A bridged network is often used as filter network control system as shown in Figure 4. Determine the transfer function of the system.

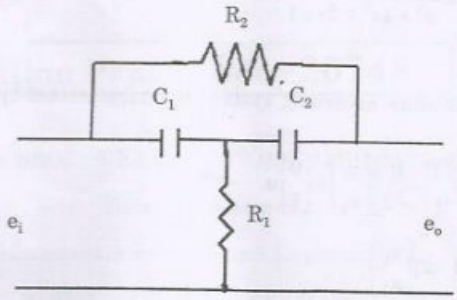

Figure. 4

12. (a) Derive the expression for peak overshoot and peak time of the second order system for a unit step input.

Or

(b) Consider the following system:

$$G(s)=\frac{K(s+1)}{(s+1)(s+5)}$$

Determine the error for each of the three signal types.

13. (a) The oblique wing aircraft has a wing that pivots the wing in the front. The wing is in normal position for low speeds and can move to a skewed position for improved suspension flight. The aircraft control system has $G(s)H(s)=\frac{100}{s(0.1s+1)(0.001s+1)}$. Sketch the bode diagram and ascertain the stability. Also find the frequency when magnitude is 0 dB and phase angle is – 180°.

Or

(b) Obtain the polar plot for $G(s)H(s)=\frac{1}{(s+1)(2s+1)}$.

14. (a) Using Routh-Hurwitz criterion, determine the stability of the system and number of roots in the right half of s plane in the following characteristic equations : $s^5+s^4+2s^3+2s^2+3s+5=0$.

Or

(b) How do you select the compensators for designing the control system? Illustrate the effects of lag and lead compensators.

15. (a) Estimate the state model of the system whose transfer function is given as $G(s)=\dfrac{10}{s^3+4s^2+2s+1}$.

Or

(b) A linear time invariant system is characterized-by the state variable model.

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-1 & 0\\ 0 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u$$

$$Y(t)=\begin{bmatrix}1 & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

Evaluate the controllability and observability of the system.

PART C — (1 × 15 = 15 marks)

16. (a) A computer uses a printer as a fast output device. It is desirable to maintain accurate position control which is moving on the paper rapidly. Consider a system with unity feedback and transfer function for the motor and amplifier is $G(s)=\dfrac{k}{s(s+1)}$. Design a lead compensator so that the given system to meet the following design specifications:

$K_v=10\ s^{-1}$, PM = 30°

Or

(b) To improve the dynamic performance of the system shown in figure. 5, a PI controller is added as shown. Determine the value of Proportional constant and Integral constant such that the resulting system will have a damping ratio of and natural frequency of 4 rad/sec.

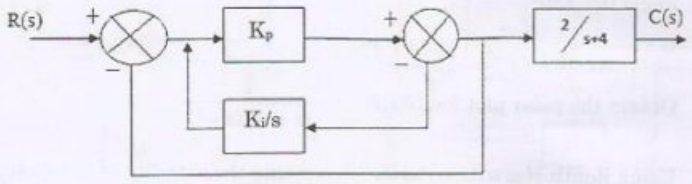

Figure. 5