Question Paper

Exam Date & Time: 05-Jun-2018 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
IV SEMESTER B.Sc. DEGREE MAKE UP- EXAMINATION - MAY / JUNE 2018
DATE: 5 JUNE 2018
TIME : 9.30 AM TO 12.30 PM
Dynamics Of Systems [ME 244]

Marks: 100 **Duration: 180 mins.**

Answer ANY FIVE full Questions.
Missing data, if any, may be suitably assumed

1) A) Obtain the state space model for the following transfer function using phase variables. (12)

$$\frac{Y(s)}{U(s)} = \frac{3s^3 - s^2 + 3s - 7}{s^4 - 2s^3 + 8s^2 - 11s + 4}$$

B) With the help of neat diagram, derive the transfer function of field controlled DC servo motor. (8)

2) A) Consider a system defined by $\dot{x} = Ax + Bu$, where, (16)

$$A = \begin{bmatrix} -2 & -4 & -1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \quad B = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

By using the state-feedback control **u** = -**Kx**, it is desired to have closed loop poles at -4, -8 and -10 respectively. Determine the state-feedback gain matrix K. Verify the result by using Ackerman's formula.

B) What is the need of a controller in control systems? Describe in brief the characteristics of PID controller with the mathematical representation. (4)

3) A) Sketch the Nyquist plot for an open loop transfer function of a system which is defined as : (12)

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

B) (8)

A servo system is given by a differntial equation, $\frac{d^2c}{dt^2} + 8\frac{dc}{dt} = 64e$ where c = displacement of the output shaft, r = displacement of the input shaft and $e = r-c$. Find the rise time, peak time, maximum overshoot and settling time if the system is subjected to a step input.

4) A) What is transient response and steady state response of a second order control system? Derive the expression for the response of an under damped second order system for a unit step input and draw its response. (10)

B) Define frequency domain specifications resonant peak, resonant frequency, bandwidth, gain margin and phase magrin. Derive the expression for resonant peak for a second order system (10)

5) A) Define Controllability and Observability. Evaluate both for the following parameters of the state space model: (10)

$$A = \begin{bmatrix} 0 & 1 & 3 \\ -6 & 8 & 1 \\ -2 & 7 & 6 \end{bmatrix} \quad B = \begin{bmatrix} 8 \\ 4 \\ 0 \end{bmatrix} \quad C = [0 \quad -2 \quad 1]$$

B) Determine the transfer function for the mechanical system shown in figure fig. 5(b) (10)

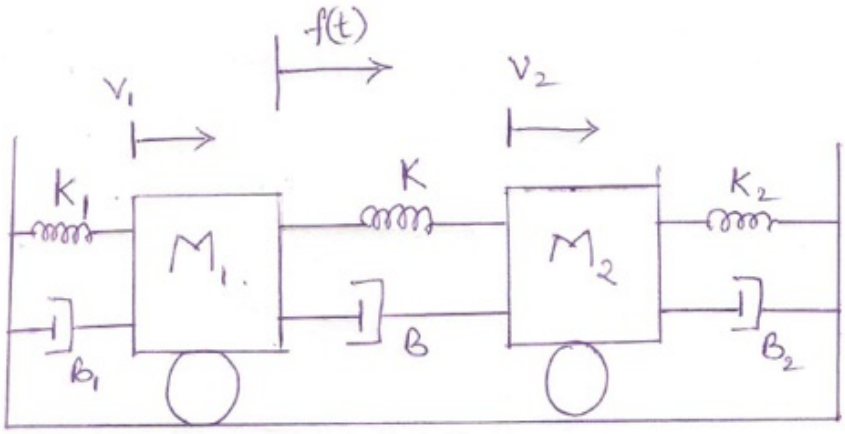

Fig 5 (b)

6) A) Sketch the root locus of the system whose open loop transfer function is given as: (12)

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

B) Discuss the different cases of location of the characteristic roots of a general second order transfer function on the s-plane. Comment on the impulse response and stability for each case. (8)

7) A) For the electrical system shown in fig. 7(a), (8)

i) Write down the differential equations describing the electrical system.

ii) Draw the equivalent mechanical analogous system and rotational analogous system.

iii) Write the differential equations for mechanical translational and rotational system.

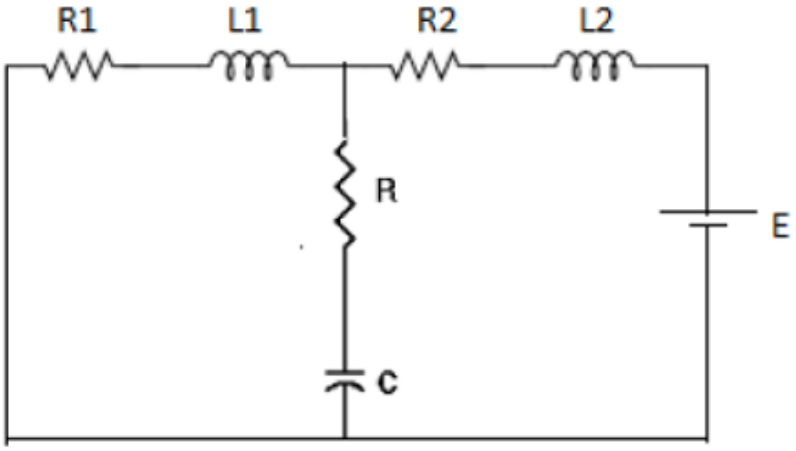

Fig 7(a)

B) Describe the difference between open loop and closed loop control system with one example. (4)

C) Define a stable and unstable system. For the characteristic equation given below, calculate the number of roots lying on the right hand side of the s-plane and comment on the stability of the system using the R-H stability criterion. (8)

$$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$$

8)

A) State any two disadvantages of the classical LTI approaches which could be overcome by state space approach. Obtain the transfer function for a system having state model: (6)

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} -2 & -3 \\ 4 & 2 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 3 \\ 5 \end{bmatrix} U \text{ and } Y = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} \text{ with } D = 0$$

B) Consider a unity feedback system with a closed loop transfer function (6)

$$M(s) = C(s) / R(s) = \frac{Ks+b}{s^2+as+b}$$

Determine open loop transfer function G(s). Show that the steady state error for a unit ramp input is given by **(a - K)/b**.

C) Determine the magnitude and phase using bode plot analysis for the open loop transfer function (8)

$$G(s) = \frac{20}{s(1+3s)(1+4s)}$$

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