Reg. No.

# INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

## IV SEMESTER B.S. (Engg) DEGREE EXAMINATION –MAY 2016

**SUBJECT: DYNAMICS OF SYSTEMS (ME 244)**

**(OLD SCHEME)**

**$20^{TH}$ MAY, 2016**

**Time: 3 Hours** **Max. Marks: 100**

- ✓ **Answer ANY FIVE Questions.**
- ✓ **Missing data may be suitably assumed.**
- ✓ **Semi – log & Graph sheets will be provided.**

1(A) Determine the transfer function [Y(s)/F(s)] of the following mechanical system shown in Figure 1(A). 10

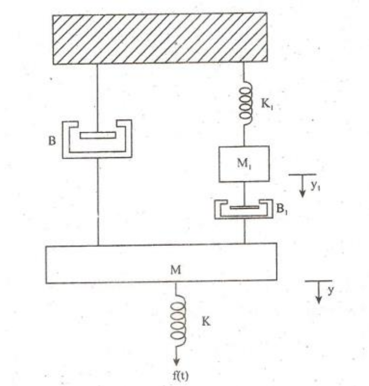


Figure 1(A).

1(B) For the mechanical translational system shown in Figure 1(B), Draw analogous electrical network based on force voltage analogy and also write down analogous electrical equations. 10

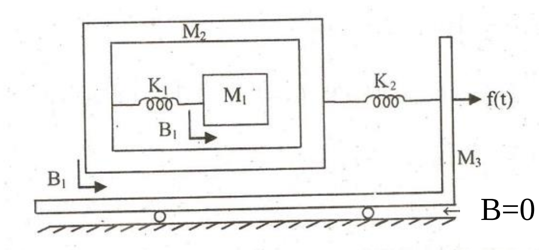


Figure 1(B)

2(A) For a closed loop second order system 10

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

derive expression for step response when the system is critically damped case and also draw the response

2(B) Obtain the state model for the following transfer function using phase variables. 08

$$\frac{y(s)}{u(s)} = \frac{s^2 + 3s + 4}{s^3 + 2s^2 + 3s + 2}$$

3(A) For the mechanical translational system shown in Figure 3(A), 12

i) Draw equivalent mechanical network and with free body diagrams write down the differential equations describing the system.

ii) Draw analogous electrical network based on force current analogy.

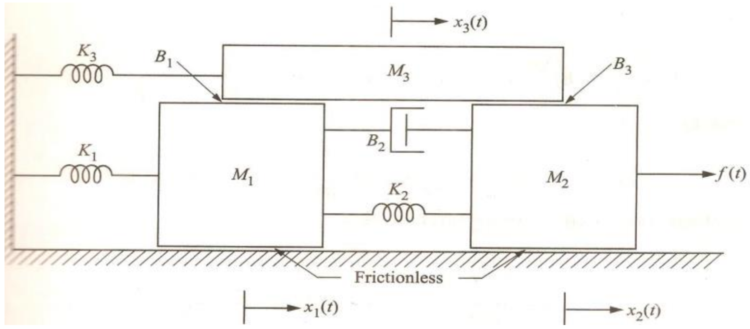


Figure 3(A)

3(B) Consider a unity feedback control system with forward transfer function 10

$$G(s) = \frac{K}{s(s+10)}$$

Determine the gain K, so that the system will have damping ratio of 0.5. For this value of K determine the peak overshoot, settling time, and peak time for a unit step input.

4(A) For a closed loop second order system 10

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

Derive expression for (i) Band width (ii) resonant peak

4(B) The open loop transfer function of a system with unity feedback is 10

$$G(s) = \frac{10(s+1)}{s^2(5s+6)}$$

Determine the steady state error for an input of $1+4t+3t^2$.

5(A) Sketch the Bode plot for open loop transfer function of a unity feedback control system is given by 14

$$G(s) = \frac{10}{s(0.1s+1)(1+0.5s)}$$

Find the gain margin and phase margin.

5(B) Using Routh stability criteria determine stability of the system whose characteristic equation is given by $s^5+2s^4+3s^3+6s^2+5s+3=0$. 06

6(A) List the advantages of Proportional, Integral and Derivative controllers. With neat diagrams explain P+I controller. 08

6(B) Consider a negative feedback system characterized by 12

$$G(s) = \frac{K(s+6)}{s(s+2)(s+1)}$$

Sketch the root locus plot for all values of K ranging from 0 to ∞.

7(A) A unity feedback system is given by 12

$$G(s)H(s) = \frac{K}{s(s^2+s+4)}$$

Sketch the Nyquist plot and calculate the range of 'K' for which the system is stable.

7(B) Evaluate state controllability and observability of the system with 08

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

8(A) Consider a continuous time system described as $\dot{\boldsymbol{x}} = \begin{bmatrix} \mathbf{2} & -\mathbf{1} \\ -\mathbf{1} & \mathbf{1} \end{bmatrix} \boldsymbol{x} + \begin{bmatrix} \mathbf{4} \\ \mathbf{3} \end{bmatrix} \boldsymbol{u}$; y= $[\mathbf{1} \quad \mathbf{1}]\boldsymbol{x} + \mathbf{7}\boldsymbol{u}$ 14

Design state feedback control law which places the closed loop poles at -0.5 ± j0.5 and verify the result by Ackermann's formula.

8(B) Obtain the closed loop transfer function [C(s)/R(s)] of the system whose block diagram is shown in Figure 8(B). 06

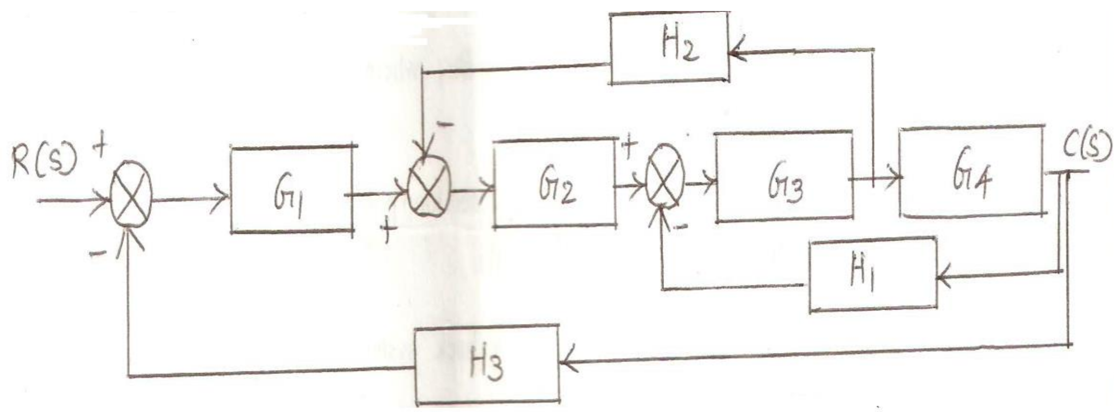


Figure 8(B)