Reg. No.										

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

IV SEMESTER B.S. DEGREE EXAMINATION – MAY 2016

SUBJECT: DYNAMICS OF SYSTEMS (ME 244)

(NEW SCHEME)

20TH 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 [$Y_2(s)/F(s)$] of the following mechanical system shown in Figure 1(A). 10

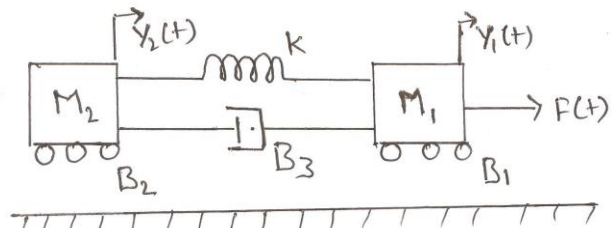

Figure 1(A).

1(B) Write the differential equation for the electrical system shown in Figure 1(B), also obtain its analogous mechanical system equations using force voltage analogy. 10

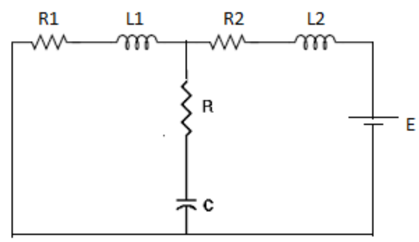

Figure 1(B)

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 of an underdamped case and also draw its response

2(B) Obtain a state space equation and output equation for the system defined by 10

$$\frac{Y(s)}{U(s)} = \frac{2s^3 + s^2 + s + 2}{s^3 + 4s^2 + 5s + 2}$$

3(A) For the system shown in Figure 3(A), find 10

i) K_p, K_v, K_a ii) steady state error for an input of $5t^2u(t)$ iii) state the system type number

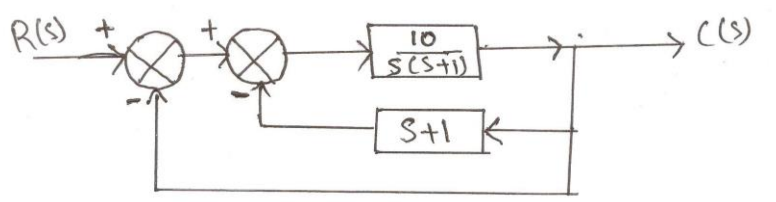

Figure 3(A)

3(B) A unity feedback control system with transfer function 10

$$G(s) = \frac{125}{s(s+10)}$$

Find the following

a) peak overshoot b) settling time c) steady state error for an input 5tu(t)

4(A) Write the mathematical representation of the following. Also specify characteristics of PI and PD controllers. 08

i) Proportional control ii) Integral control iii) Proportional Integral control iv) Proportional Derivative control v) Proportional Integral Derivative control

4(B) Sketch the root locus for the unity feedback system whose open loop transfer function 12

$$G(s)H(s) = \frac{K}{s(s+4)(s+6)}$$

What values of K the system is stable.

5(A) Sketch the Bode plot for open loop transfer function of a unity feedback control system is given by 10

$$G(s)H(s) = \frac{10}{s(0.5s+1)(0.01s+1)}$$

Also find gain crossover frequency and phase cross over frequency.

5(B) Using Routh stability criteria determine stability of the open loop system whose transfer function is given by 10

$$G(s) = \frac{K(s+4)(s+20)}{s^3(s+100)(s+500)}$$

Find the value of K that will cause sustained oscillations in the system. Also find the frequency of oscillations.

6(A) Define (i) Gain margin (ii) Phase margin (iii) Cut off frequency (iv) Bandwidth 06

6(B) Consider the system described by $\dot{x} = Ax + Bu$, where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}$; $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$. **Using** 14

feedback control law U=-Kx it is desired to have the closed loop poles at s= -1±j2 and s=-10. Find the state feedback matrix using Ackerman's formula.

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

$$G(s)H(s) = \frac{K(4s+1)}{s(s-1)}$$

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

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}, \qquad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, \qquad C = [1 \quad 0 \quad 1].$$

8(A) Consider a continuous time system described as $\dot{x} = \begin{bmatrix} 2 & -1 \\ -1 & 1 \end{bmatrix} x + \begin{bmatrix} 4 \\ 3 \end{bmatrix} u$; **y**=$[1 \quad 1]x + 7u$ 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) For a closed loop second order system 06

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

Derive expression for (i) Rise time (ii) Peak time