Reg. No. | | | | | | | | | | |

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

IV SEMESTER B.S. DEGREE EXAMINATION – OCT. / NOV. 2017

SUBJECT: DYNAMICS OF SYSTEMS (ME 244)

(BRANCH: MECH)

Friday, 03 November 2017

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

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

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

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

1(B) With neat sketches, derive the transfer function of armature controlled DC Servo motor. 08

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 overdamped case and also draw its response

2(B) For the mechanical translational system shown in Figure 2(B),

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

II. Draw analogous electrical network using force current analogy. Also write down the analogous electrical equations. 10

3(A) Write the differential equation for the electrical system shown in Figure 3(A), also obtain its analogous mechanical system equations using force voltage analogy. 10

3(B) The open loop transfer function of a system with unity feedback is $G(s) = \frac{60}{s^2+7s+10}$ 10

Determine the steady state error for an input of $6+5t+3t^2$.

4(A) A second order system is represented by the transfer function, 10

$$\frac{Q(s)}{u(s)} = \frac{1}{Js^2+Fs+K}$$

A step input of 10 N-m is applied to the system and test results are

I. Maximum overshoot is 6%.
II. Time at peak overshoot is 1sec.
III. The steady state value of the output is 0.5 radians.

Determine the values of J, F, K.

4(B) Using Routh stability criteria determine stability of the following two systems:

I. The system loop transfer function has poles at S = 0, S = -1, S = -3 and zero at S = -6, gain K of forward path is 10.

II. Type one system with an error constant of 10 sec^{-1} and poles at S = -3 and S = -6. 10

5(A) Evaluate state controllability and observability of the system with

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, \quad C = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix}.$$ 08

5(B) Sketch the root locus for the system having 12

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

Also determine 'K' for damping ratio of 0.5 from the root locus.

6(A) A unity feedback system is given by 08

$$G(s) = \frac{K}{s(s+2)(s+10)}.$$

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

6(B) Consider the linear system described by the transfer function 12

$$\frac{y(s)}{u(s)} = \frac{10}{s(s+1)(s+2)}$$

Design a state feedback controller so that the poles are placed at -2, -1±i.

7(A) With neat sketches, explain Proportional plus integral controller and proportional plus derivative controllers. 08

7(B) Sketch the bode plot for the transfer function 12

$$G(s) = \frac{10}{s(1+0.4s)(1+0.1s)}$$

Determine the gain margin and phase margin.

8(A) For a second order system 10

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

Derive expressions for (i) resonant peak (ii) Resonanat frequency.

8(B) The characteristic equation of a unity feedback control system is given by 10

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

Determine the location of roots on s plane and hence comment the stability of the system

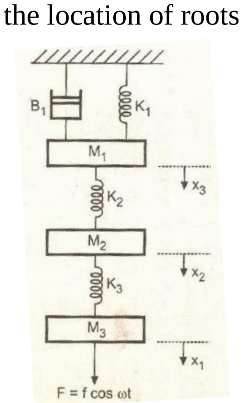

Figure 2(B)

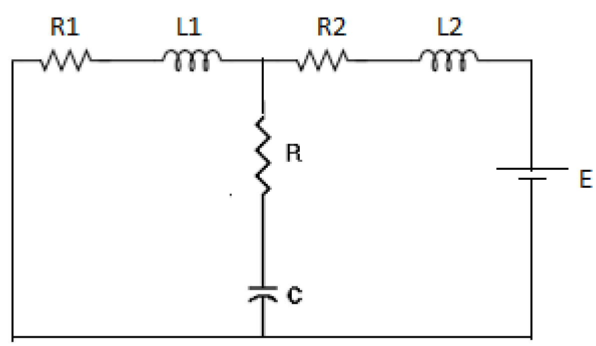

Figure 3(A)