Reg.No.									

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

IV SEMESTER B.S. DEGREE EXAMINATION – APRIL / MAY 2017

SUBJECT: DYNAMICS OF SYSTEMS (ME 244)

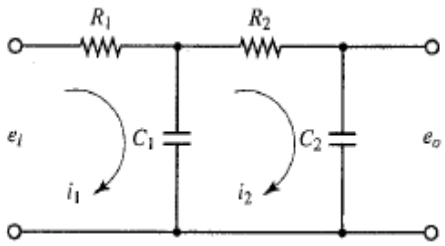
(BRANCH: MECHANICAL ENGINEERING)

Thursday, 27 April 2017

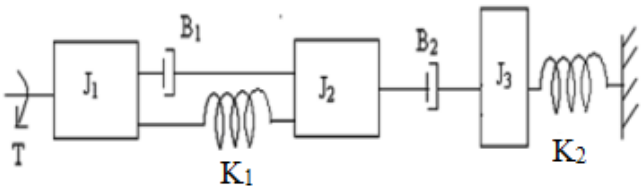
Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE full Questions.**
- ✓ **Missing data, if any, may be suitably assumed**
- ✓ **Semi-log and graph sheets will be provided**

1A Define transfer function of a control system. Derive the transfer function $\frac{E_{0(S)}}{E_{i(S)}}$ of the electrical system shown in fig.



1B For the mechanical rotational system shown in fig.



i. Draw the free body diagrams and write down the differential equations describing the system.

ii. Draw analogous electrical network using torque voltage and torque current analogy. Write down the analogous electrical equations for torque voltage analogy. **8+12**

2A The open loop transfer function of a certain unity feedback control system is given as :

$$G(s) = \frac{K}{s(s+4)(s+80)}$$

It is desired to have phase margin as at least 33° and the velocity error constant to be greater than or equal to 30. Design a phase lag compensator.

2B Describe in brief the characteristics of the following controllers with the respective mathematical representation :

a) Derivative control b) Integral control **16+4**

3A 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.

3B Sketch the root locus of the system whose open loop transfer function is given as :

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

8+12

4A Obtain the state space model for the following transfer function using phase variables.

$$\frac{y(s)}{u(s)} = \frac{s^2+7s+2}{s^3+9s^2+26s+24}$$

4B Sketch the Nyquist plot for an open loop transfer function of a system which is defined as :

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

8+12

5A What is steady state error of a system? Derive the expression for steady state error.

5B Write the general format of loop transfer function of a control system.
Consider a unity feedback system with a closed loop transfer function

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

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

5C A system is given by a differntial equation, $\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 8y = 8x$ where y = output and x = input. Find the rise time, peak time, maximum overshoot and settling time if it is subjected to a step input.

4+8+8

6A Sketch the polar plot for an open loop transfer function of a unity feedback system given by

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

Also determine the gain margin and phase margin.

6B 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.

$$s^7 + 9s^6 + 24s^5 + 24s^4 + 24s^3 + 24s^2 + 23s + 15 = 0$$

12+8

7A Sketch the test input signal used in time domain analysis which resembles a constant acceleration and write the mathematical expression for the same. Derive the expression for the response of an over damped second order system for a unit step input and draw its response.

7B With the help of neat diagram, derive the transfer function of armature controlled DC servo motor.

10+10

8A Sketch the Bode plot for the following transfer function. Calculate the gain cross-over and phase cross over frequency for the same :

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

8B Evaluate the controllability and observability of the system with

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

12+8