Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.Tech (EE)/SEM-1/MTC-102/2012-13

2012

ADVANCE CONTROL SYSTEMS

Time Allotted : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer any *five* questions.   5 × 14 = 70

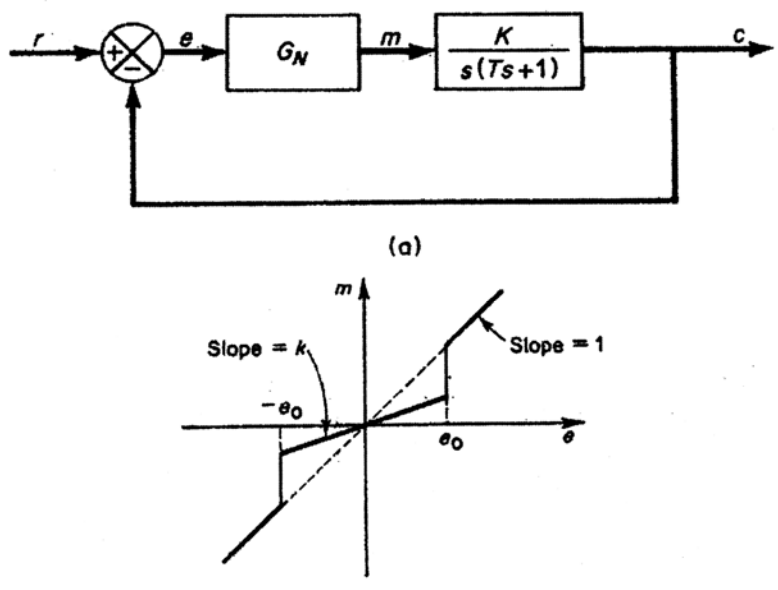
1 a) Find the equation of dynamic behaviour of the given RLC series circuit which is excited by a unit step voltage source $u(t)$, where $[x_1(t)\ x_2(t)]' = [v_c(t)\ i_L(t)]'$ ($V_c(t)$ is the voltage across the capacitor, $i_L(t)$ the current through the inductor) and initial conditions are $X'(0) = [x_1(0)\ x_2(0)]' = [v_c(0)\ i_L(0)]'$.

b) Prove that 'Choice of the state vector is not unique but the characteristic equation remains invariant under different forms of state variable representation'. Use the above RLC circuit.

c) Find the State Transition Matrix (STM) of the equation of question 1 (a) where R = 3 Ohm, L = 1 henry and C = ½ farad.

d) With the help of state transition matrix (STM) find the solution of current through the inductor, $i_L(t)$ and voltage across the capacitor, $V_c(t)$. 3 + 3 + 4 + 4

2. a) Consider the non-linear system shown in Fig. (a). The block denoted G_N is the non-linear gain element. The input-output characteristic curve of this element is shown in Fig (b). The gain of the element is unity or k, whenever the magnitude of the error signal e is greater than or less than e_o, respectively. When the system energized by (i) step and (ii) ramp source and $T = 1$, $K = 4$, $k = 0.0625$, $e_o = 0.2$, $R = 0.3$ and $V = 0.04$, find phase trajectories in phase plane.



b) Write a short note on Limit Cycle. (5 + 5) + 4

3. a) Describe the typical singular points of non-linear and a linearized system.

b) State the direct method Lyapunov and explain it with a proper example.

c) Define the stability of time-invariant and time-varying system using Lyapunov method.

d) Analyze the stability of the following system by Lyapunov Direct Method :

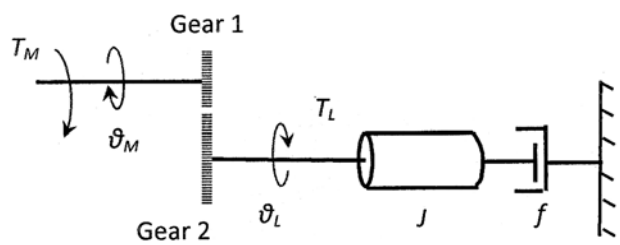
$$\dot{x}_1(t) = -x_1(t) - 2x_2(t)$$

$$\dot{x}_2(t) = x_1(t) - 4x_2(t)$$

3 + (2 + 2) + 4 + 3

4. a) Draw the block diagram of open loop and closed loop control systems and make a comparative study in between them.

b) Find out the TF of the following mechanical system (assume other conventional parameters) and obtain the electrical equivalent of it.



c) What do you mean by 'Equivalent system' ? Mention the advantages of using it.

4 + 6 + 4

5. a) How can we approximate a non-linear system to be a linear one ?

   b) Describe the operation of a DC servo motor based motion control system and obtain its closed loop transfer function.

   c) How does a tachometer feedback improve the stability of a motion control system ? 4 + 8 + 2

6. a) What is meant by continuous control and how does it differ from discrete-time control ?

   b) What is PID control ? Define its series and parallel form.

   c) 'Out of the various forms of PID controllers, PD form is a special class usually used in robotic applications.' Justify. 4 + 5 + 5

7. a) What is meant by controller tuning ? Mention some standard tuning rules.

   b) What are performance indices and sensitivity of a control system ?

   c) What is a compensator and how can you design a lead compensator for a second order system ? 4 + 4 + 6