ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2009

CONTROL SYSTEM - II

SEMESTER - 6

Time : 3 Hours] [Full Marks : 70

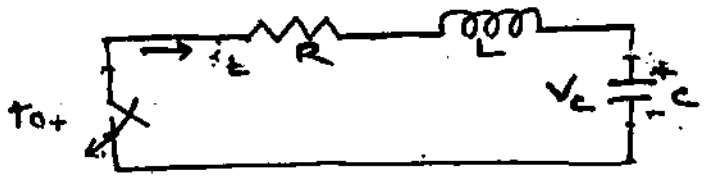
Graph sheet is provided on page 31.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) How many state variables are associated with the circuit ?



a) 0 b) 1

c) 2 d) 3.

ii) Describing function analysis is based on

a) harmonic linearization

b) system linearisation

c) degree of non-linearity

d) input-output. ratio based on 2nd harmonic.

iii) The state equation of a linear system is given by

$\dot{X} = AX + BV$ where $A = \begin{bmatrix} 0 & 2 \\ -2 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

The state transition matrix of the system is

a) $\begin{bmatrix} e^{2t} & 0 \\ 0 & e^{2t} \end{bmatrix}$ b) $\begin{bmatrix} e^{-2t} & 0 \\ 0 & e^{-2t} \end{bmatrix}$

c) $\begin{bmatrix} \sin 2t & \cos 2t \\ -\cos 2t & \sin 2t \end{bmatrix}$ d) $\begin{bmatrix} \cos 2t & \sin 2t \\ -\sin 2t & \cos 2t \end{bmatrix}$

iv) Lyapunov function is

a) energy function b) work function

c) state function d) output function.

v) Phase plane analysis is generally restricted to

a) second order system b) third order system

c) first order system d) any order system.

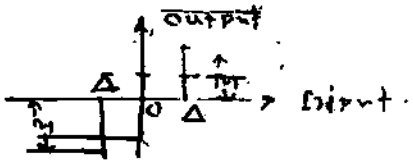
vi) If the quadratic form of a matrix is

$10\,x_1^2 + 4x_2^2 + x_3^2 + 2\,x_1x_2 - 2x_2\,x_3 - 4x_1\,x_3$, then the matrix A is

a) positive definite b) positive semidefinite

c) negative definite d) negative semidefinite.

vii) The input-output characteristics of the control system shown in the figure. The non-linearity is known as



a) on-off non-linearity with dead zone

b) on-off non-linearity

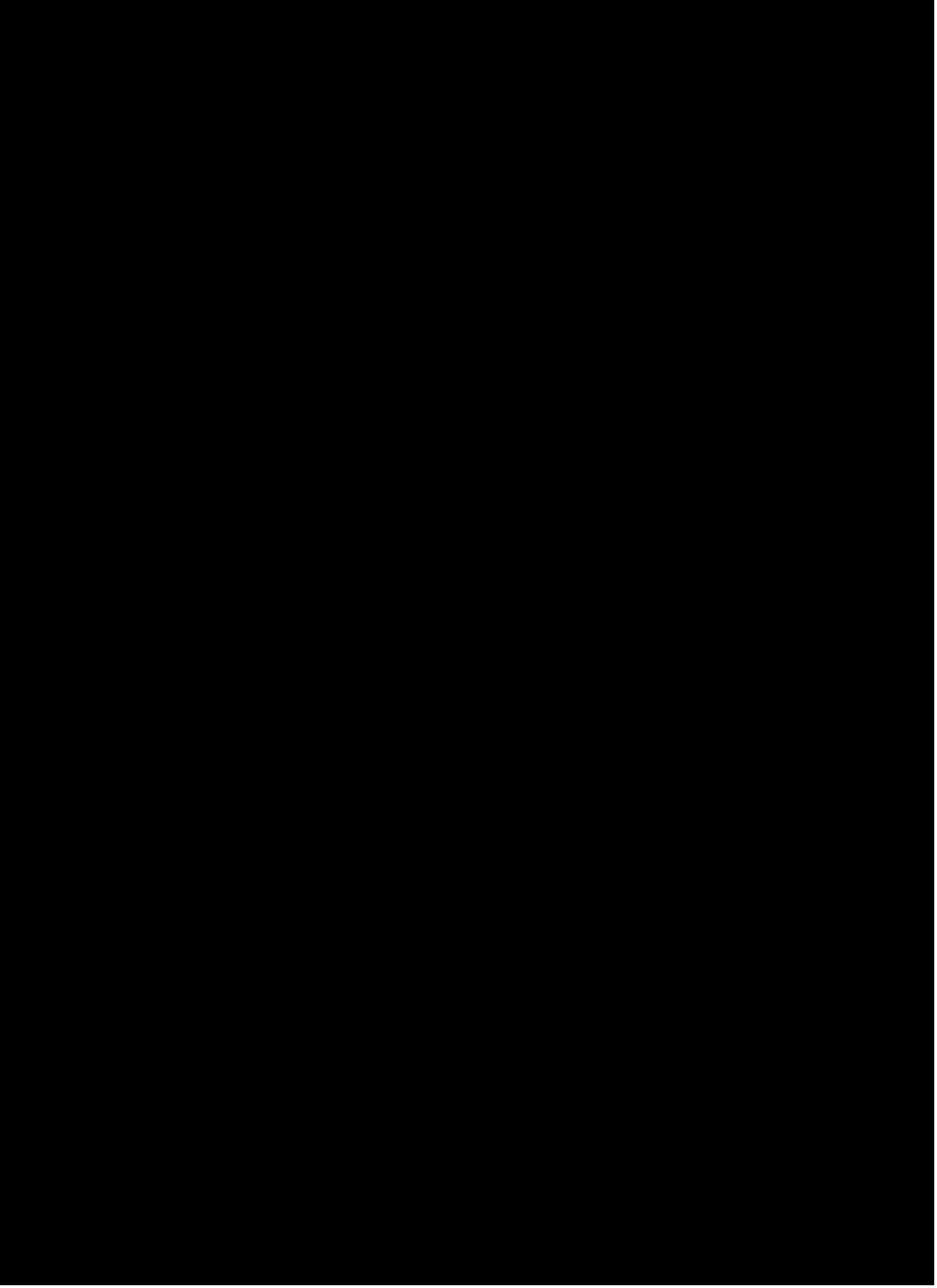
c) dead zone with saturation

d) on-off non-linearity with hysteresis.

viii) $Z[\,x(t)\,]$ is given by

a) $\sum_{k=0}^{\infty} x(kT)\,Z^{k}$ b) $\sum_{k=1}^{\infty} x(kT)\,Z^{-k}$

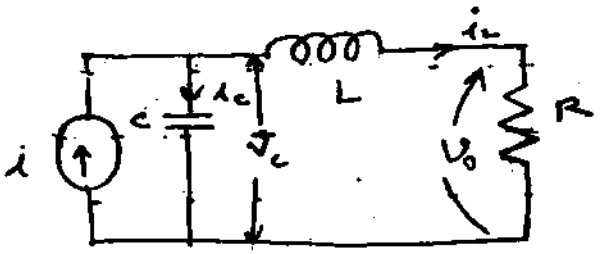
c) $\sum_{k=0}^{\infty} x(kT)\,Z^{-k}$ d) $\sum_{+\infty}^{-\infty} x(T)\,e^{-k}$.



GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. a) Consider the network shown in figure. Obtain the state variable formulation.



b) Are choice of state variables unique ? 4 + 1

3. Solve the following difference equation using Z - transform method

$x(k+2) + 5x(k+1) + 6x(k) = 0,$

Given $x(0) = 0, x(1) = 1.$

4. Consider the system given by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 3 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

check for state controllability.

5. Compute the Z-transform of a sinusoidal function $x(t)$ where $x(t) = 0$ for $t < 0$

$= \sin \omega t$ for $t \geq 0.$

6. Consider the dynamics of the system represented by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

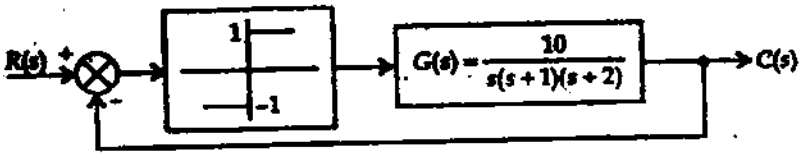
Formulate the Lyapunov function to test asymptotic stability of the system.

GROUP – C

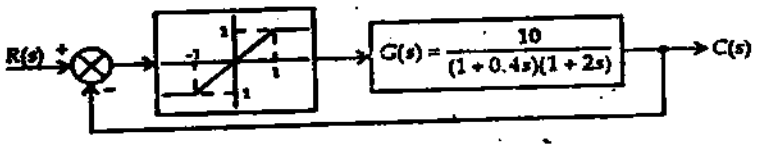
(Long Answer Type Questions)

Answer any *three* questions. 3 × 15 = 45

7. a) Determine the amplitude and frequency of the limit cycle of the non-linearity shown in the given figure.



b) Determine the stability of the system shown in the given figure.



10 + 5

8. A system is characterised by the following state equation

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} u, \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

a) Find the transfer function of the system.

b) Draw the block diagram of the above transfer function.

c) Compute the state transition matrix.

d) Obtain the solution to the state equation for a unit step input under zero initial condition. 4 + 3 + 4 + 4

9. a) Consider the following non-linear differential equation

$$\frac{d^2x}{dt^2} + x^2 + \left(\frac{dx}{dt}\right)^2 - 2x + \frac{dx}{dt} = 0.$$

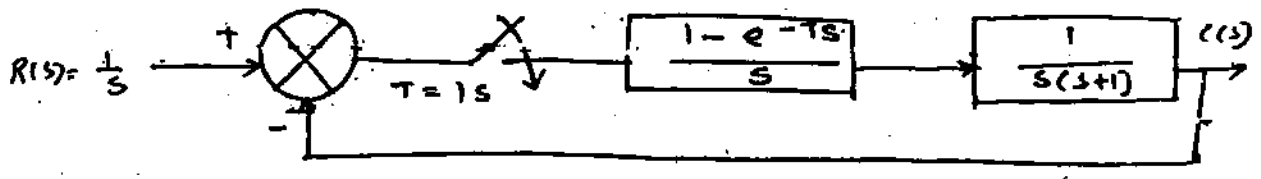
Determine the points of equilibrium.

b) Determine the type of singular point & draw the phase plane portrait for the van der Pole equation using graphical method.

$$\ddot{x} - (1 - x^2)\dot{x} + x = 0.$$

5 + 10

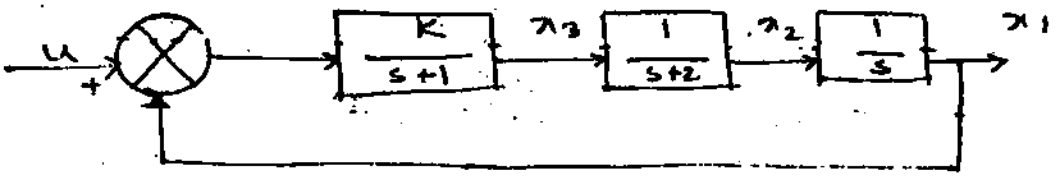
10. a) Find the time response of the system shown in figure



b) Write a note on Anti-aliasing filter. 10 + 5

11. a) What do you mean in the sense of Lyapunov, asymptotic stability, global stability & local stability ?

b) Determine the stability range for the gain k of the system shown in figure by Lyapunov's method.



5 + 10

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