sem VII / Inst/ Rev/ A.Cs/ Dec.09

SP-6605

Con. 5613-09.

(3 Hours) [Total Marks : 100

N.B.:(1) Question No. **1** is **compulsory**.
(2) Attempt any **four** questions from remaining **six** questions.
(3) Assume **suitable** data if **needed**.

1. Attempt any **four** of the following :— 20

(a) A scalar non linear system is described by the differential equation—

$$\dot{x}(t) = f(x(t)), \quad x \in R$$

where non linear function satisfies :

$f(0) = 0$
$f(x) < 0 \; ; \; x > 0$
$f(x) > 0 \; ; \; x , < 0.$

Show that $x = 0$ is globally asymptotically stable equilibrium point.

(b) Consider scalar differential equation—

$$\dot{x}(t) = 1 + x^2(t) \; ; \; x)0) = 0$$

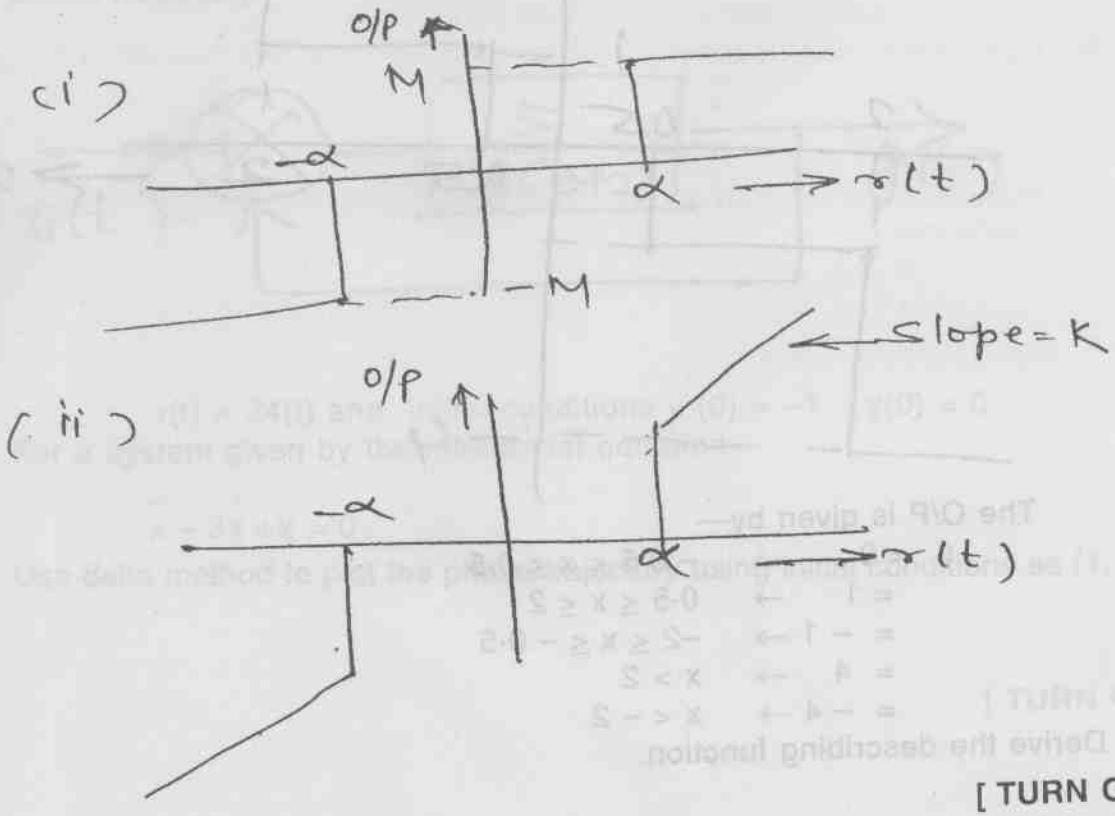
Show that $x(t) = \tan(t)$ is a solution what happens as $t \to \pi/2$.

(c) Explain jump response for soft spring with characteristics.

(d) On what factors Robustness of the system depends.

(e) Discuss gradient update law.

(f) For sinusoidal input and given non-linearity draw the possible output.



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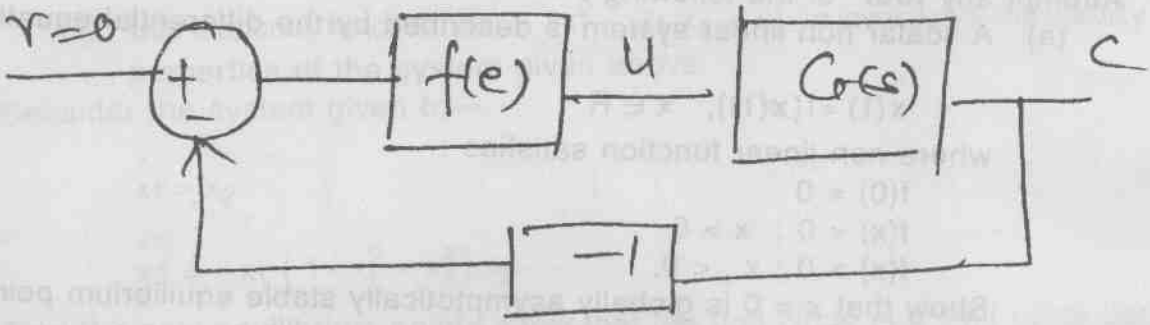
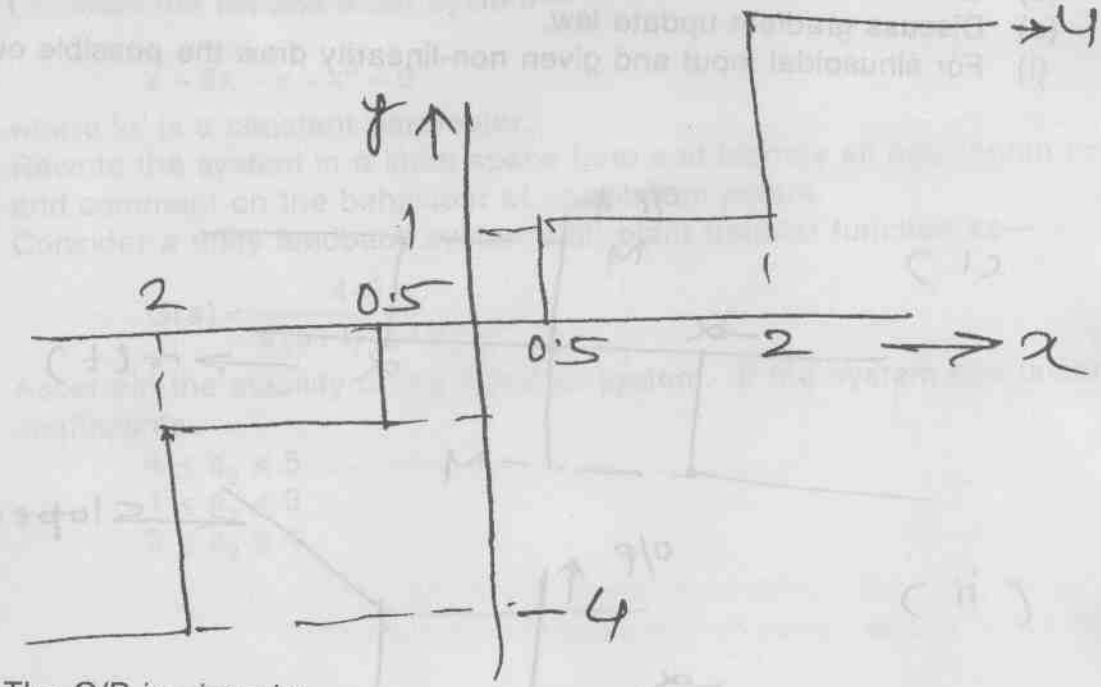
2. (a) Consider the feedback loop in **figure** the linear system $G(s) = \frac{1}{(s+1)^4}$ is connected to a static nonlinearity $u(t) = f(e(t))$ where $f(0)$ has describing function. **10**

$$N(X, jw) = X + 3X^2 \angle 0^\circ$$



What is the amplitude and frequency of the limit cycle ? Comment on stability of limit cycle.

(b) Consider the logarithmic quantizer with two levels. **10**



The O/P is given by—

$y = 0 \rightarrow -0.5 \leq x \leq 0.5$

$= 1 \rightarrow 0.5 \leq x \leq 2$

$= -1 \rightarrow -2 \leq x \leq -0.5$

$= 4 \rightarrow x > 2$

$= -4 \rightarrow x < -2$

Derive the describing function.

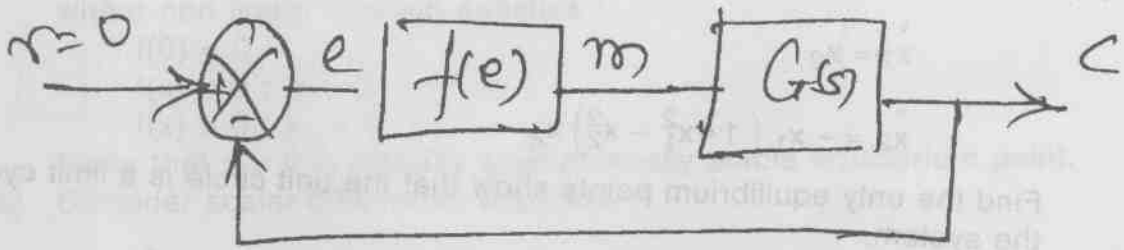
3. (a) Consider the nonlinear system described by the equations— **10**

$$\dot{x}_1 = -3x_1 + x_2$$

$$\dot{x}_2 = x_1 - x_2 - x_2^3$$

Using Krasovskii's Method construct a Liapunov's function for the given system.

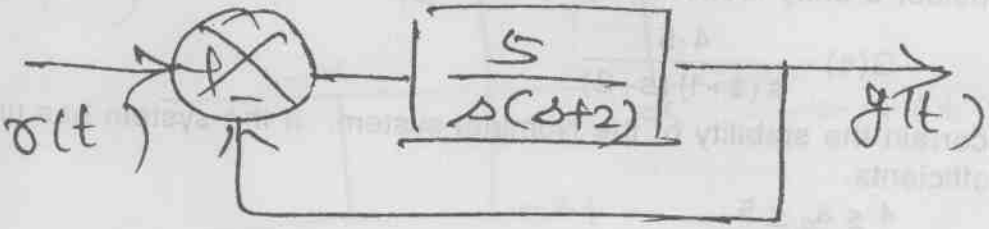
(b) For the control system shown in **figure**, use variable gradient method to investigate stability of the system. **10**



$$f(e) = e^3$$

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

4. (a) For the block diagram shown in **figure**, use method of isocline to draw the phase trajectory. **10**



r(t) = 24(t) and initial conditions y (0) = −1 ; y(0) = 0

(b) For a system given by the differential equation— **10**

$$\ddot{x} + 3\dot{x} + x = 0$$

Use delta method to plot the phase trajectory using initial conditions as (1, 0).

5. (a) Consider the system : 10

$$\dot{x}_1 = -x_1$$

$$\dot{x}_2 = -2x_1 - x_2$$

(i) Is the system asymptotically stable ?

(ii) Use Liapunov function $V(x) = 3x_1^2 - 2x_1x_2 + x_2^2$ to investigate the stabilty properties of the system given above.

(b) Consider the system given by— 10

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = -x_1\left(1 - x_1^2 - x_2^2\right)x_2$$

Find the only equilibrium points show that the unit circle is a limit cycle for the system.

6. (a) Discuss different Adaptive control schemes. 10
(b) Explain methods for improving Robustness of the system. 10

7. (a) Consider the second order system— 10

$$\ddot{x} + 2\dot{x} - x + x^3 = 0$$

where 'α' is a constant parameter.
Rewrite the system in a state space form and identify all equilibrium points and comment on the behaviour of equilibrium points.

(b) Consider a unity feedback system with plant transfer function as— 10

$$G(s) = \frac{4 \cdot 5}{s\,(s+1)\,(s+2)}$$

Ascertain the stability of the Nominal system. If the system has uncertain coefficients.

$$4 \le a_0 \le 5$$
$$1 \le a_1 \le 3$$
$$2 \le a_2 \le 4.$$