(Pages : 2) **B – 2890**

Reg. No. : .....

Name : .....

Second Semester M.Tech. Degree Examination, December 2016

(2013 Scheme)

Branch : Electrical Engineering

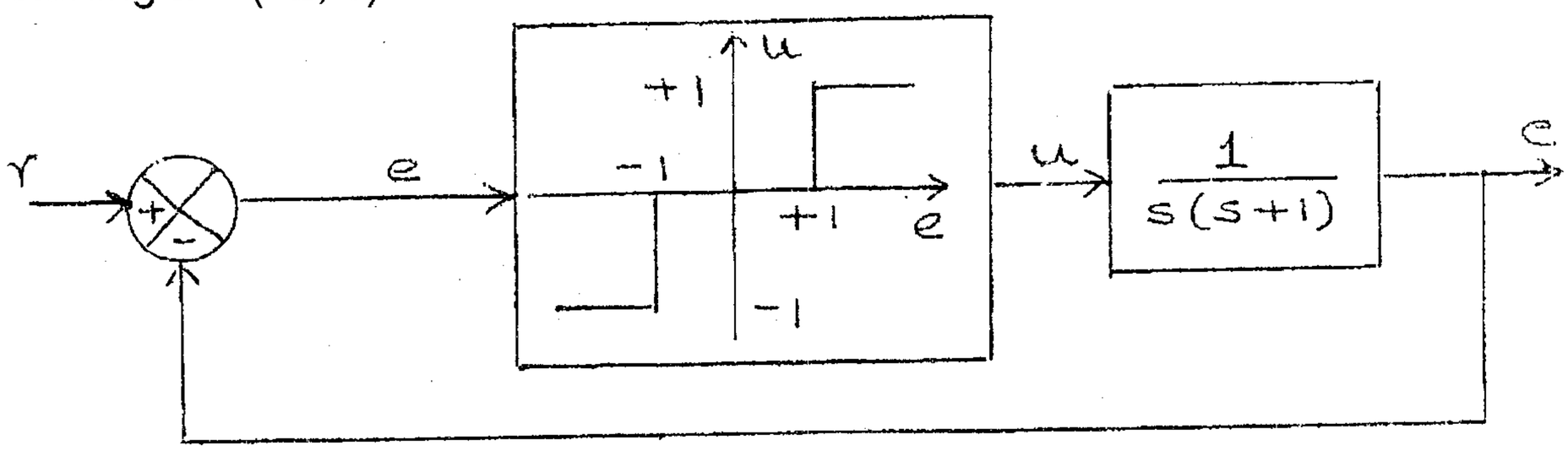
ECC 2002 : NON LINEAR CONTROL SYSTEMS

Time : 3 Hours Max. Marks : 60

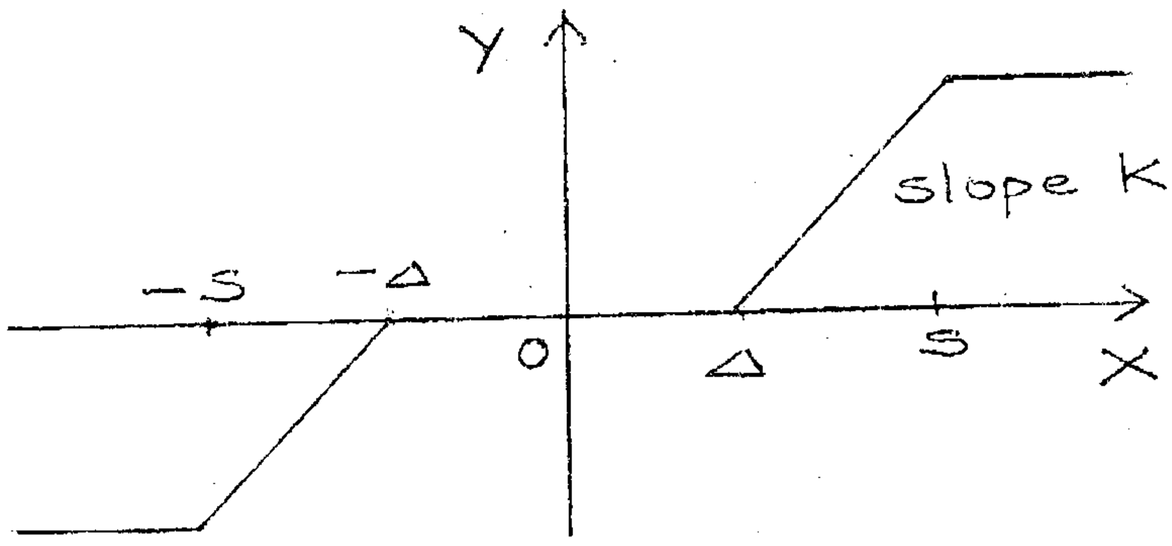
***Instruction** : Answer **any two** questions from **each** Module.*

MODULE – I

1. Construct an approximate phase trajectory for the following nonlinear system starting at A(–2, 0). **10**



2. a) Derive the describing function for nonlinearity with dead zone and saturation. **8**



b) Hence compare the effect of input on the describing functions for dead zone and saturation individually. **2**

3. a) How do you analyze the stability of a limit cycle associated with the nonlinear system, with the help of describing function ? **5**

b) Briefly explain the features of double input describing function. **5**

P.T.O.

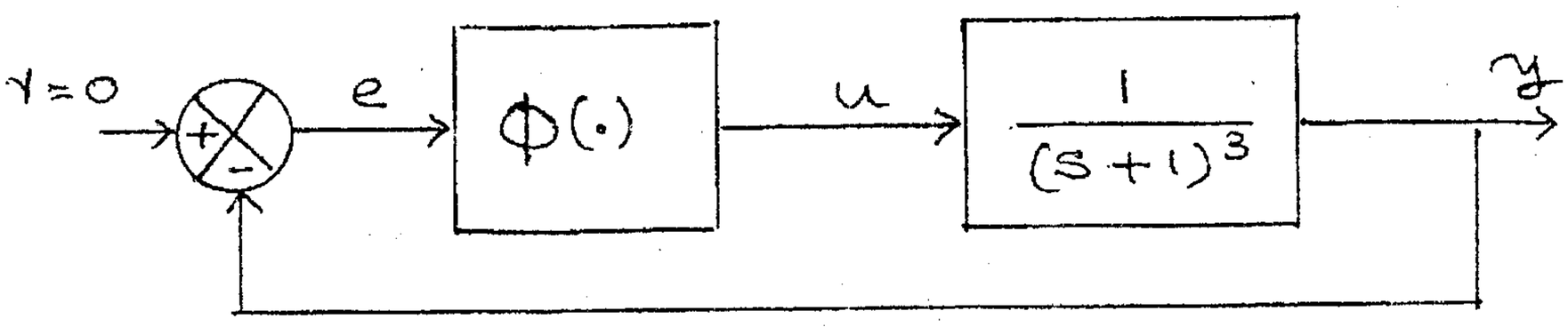
MODULE – II

4. Apply variable gradient method to determine a Lyapunov function for the following nonlinear system. Hence verify the stability of the system

$\dot{x}_1 = x_2$

$\dot{x}_2 = -x_1 - x_1^2 x_2$. **10**

5. Find the absolute stable sector for the following nonlinear system, by applying Popov's criterion. **10**



6. a) Explain the significance of energy functions as Lyapunov function for the stability analysis. **4**

   b) Explain the circle criterion as a generalization of Nyquist criterion for the stability analysis of nonlinear system. **6**

MODULE – III

7. Find feedback control and a change of variable that linearizes the following system

$\dot{x}_1 = -x_1 + x_2 - x_3$

$\dot{x}_2 = -x_1 x_3 - x_2 + u$

$\dot{x}_3 = -x_1 + u$. **10**

8. Consider the system

$\dot{x}_1 = -x_2 - 1.5x_1^2 - 0.5x_1^3$

$\dot{x}_2 = u$

Apply back stepping to design a state feedback control law to globally stabilize the origin. **10**

9. With a suitable example, explain the steps involved in the design of gain scheduled controller for tracking problem. **10**