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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION, APRIL/MAY 2018

Branch: ***ELECTRICAL & ELECTRONICS ENGINEERING***

Stream(s): ***Control Systems, Guidance & Navigation Control***

Course Code & Name: **01EE6104 & NONLINEAR CONTROL SYSTEMS**

Answer *any two full* questions from *each* part

Limit answers to the required points.

Max. Marks: 60 Duration: 3 hours

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PART A

1. a. State and explain Poincare Bendixon Criteria for the existence of limit cycles. (4)

   b. Whether the periodic orbits comply to the existence and uniqueness theorem. If so explain the theorem. (5)

2. a. Define equilibrium point. List the classification of equilibrium points. (4)

   b. For non-linear system having differential equation :

$$\ddot{y} - \left(0.1 - \frac{10}{3}\dot{y}^2\right)\dot{y} + y + y^2 = 0$$

   Find all the singularities. (5)

3. Give an account of how Lipschitz condition simplified existence and uniqueness theorem. (9)

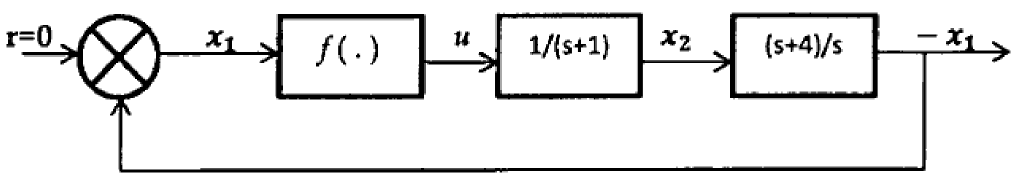
PART B

4. Construct a Lyapunov function for the following system using Variable Gradient Method:

$$\dot{x}_1 = -3x_2 - f(x_1)$$

$$\dot{x}_2 = -x_2 + f(x_1)$$

Non- linearity $f(x_1) = g(x_1).\, x_1$



(9)

5. a. State and explain Circle Criteria (4)

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b. Consider a non-linear system governed by the equation :

$$\dot{x}_1 = -x_1 + 2x_1^2 x_2$$

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

A candidate for Lyapunov function is $V = P_{11}x_1^2 + P_{22}x_2^2$; $P_{11} > 0$ and $P_{22} > 0$ which is a positive definite function. Check the stability for the system. Sketch the region of stability. (5)

6. a. Find the sector [0, k] for which the given transfer function is absolutely stable using Popov Criteria.

$$G(s) = \frac{1}{(s+2)(s+3)}$$ (6)

b. Write short notes on Kalman's Conjecture. (3)

PART C

7. Find out a control law for the system :

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

$$\dot{x}_2 = -x_1^2 + u$$

using feedback linearization control technique after suitable applying suitable transformation. (12)

8. a. Explain stabilization via linearization. (3)

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

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

$$\dot{x}_2 = \mu_c \sin u$$ (9)

9. a. Write notes on Integral control via linearization (6)

b. Write notes on Gain scheduling. (6)

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