Kleppner and Kolenkow (KK) Chapter 1: Problems 1.19 (10), 1.20 (10), Chapter 2: 2.2 (5), 2.3(5), 2.5(5)

P2.1 (Previously P1.2) Ant Trajectories (10 points, plus 5 extra credit points for the shortest correct solution to P1.2(c))

Three ants on the floor are initially at the vertices of an equilateral triangle, of length $d = 20$ cm on a side. Each ant moves towards it’s “counterclockwise” nearest neighbor at a constant speed $v_o = 1.0$ cm/sec. (Thus ant 1 chases ant 2 who chases ant 3 who chases ant 1.) Each ant adjusts its motion so it is always moving exactly towards its neighbor.

(a) Do the ants ever meet? If so how long does it take for them to meet.

(b) What is the total distance that each ant moves.

(c) Give an analytic expression for the path of each ant.

2.2 Piecewise-Continuous Pursuit (10 points)

A motorist is driving on an interstate highway at a uniform velocity $v_c = 80$ mph. A state trooper parked by the side of the road notices that the motorist is speeding and after a delay $\tau = 5.0$ sec begins his pursuit of the motorist. The police car has a maximum possible acceleration $a_{max} = 2.5$ m/sec$^2$ and it achieves a maximum speed of $v'_{max} = 90$ mph.

(a) How long does it take the police car to overtake the motorist.

(b) How far has the motorist travelled when he is overtaken.

(c) What is the maximum separation of the police car from the motorist in the resulting chase.