Problem 1.

Use a DE to model the motion of a parachutist in the following problem: A parachutist whose mass is $m(kg)$ drops from a helicopter hovering $h(m)$ above the ground and falls toward the earth under the influence of gravity. Assume the gravitational force is constant. Assume also that the force due to air resistance is proportional to the velocity of the parachutist, with the proportionality constant $b_1(N \cdot s/m)$ when the parachute is closed and with constant $b_2 = 7b_1$ when the parachute is open. If the parachute opens exactly $T(\text{min})$ after the parachutist leaves the helicopter, after how many seconds will he hit the ground?

- Give detailed methematical explanation of your problem
- Find data to choose your constants
- Graph your solution.

Problem 2 (a) The vector function $\overrightarrow{E} = (E_x, E_y, E_z)$ where

$$E_x = 6xy, \qquad E_y = 3x^2 - 3y^2, \qquad E_z = 0,$$

represents possible electrostatic field. Calculate the line integral of $\overrightarrow{E}$ from the point $(0,0,0)$ to the point $(x_1, y_1, 0)$ along the path which runs straight from $(0,0,0)$ to the point $(x_1, 0, 0)$ and then to $(x_1, y_1, 0)$. Do a similar calculation for the path which runs along the two other sides of the rectangle, via the point $(0, y_1, 0)$. If you get the same answer, $\overrightarrow{E}$ indeed represents the electrostatic field. Find the equation describing surfaces of constant potential of this field.

(b) Find all solutions to a differential equation

$$6xy\,\mathrm{d}x + \left(3x^2 - 3y^2\right)\,\mathrm{d}y = 0.$$

(c) Compare your solutions in parts (a) and (b). What is common and what is different in two solutions? Explain your answer.