Instructions for the Superposition Demo Program

Introduction

The Superposition Demonstration program is an application that shows how flows can be built up by piecing together elementary solutions of the Laplace equation. Here, the solutions include a horizontal freestream, sources, sinks, horizontal doublets, and circulations. The user selects one of the demonstrations and is presented with a graphical depiction of the flow. While all demonstrations include default values for the singularities and the freestream velocity, the user may change the default values. The output also includes a results window that includes information about the flow.

Using the Program

Clicking on the program icon results in the main window appearing as shown in Figure 1. There are 4 demonstrations to choose from. The resulting flow field from

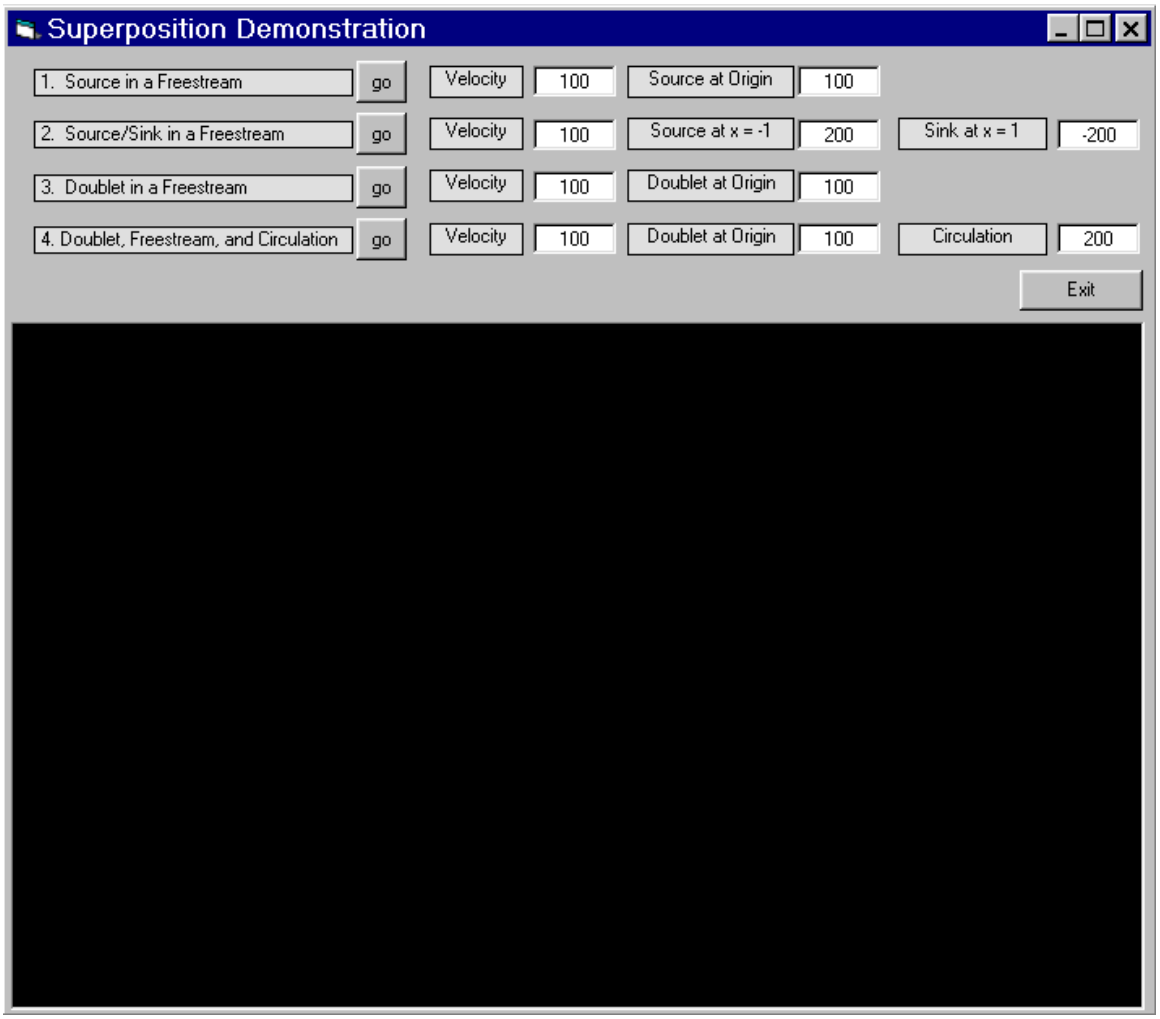

Figure 1. Main window of the Superposition Demonstration Program.

superposing the elementary solutions with strengths as indicated is then shown in the main graphic window. A solution window opens for each demonstration giving the streamline equation, location of stagnation points, and other interesting features of the flow. Each demonstration is described next.

Demonstration 1. Superposition of a source in a uniform freestream

The first demonstration, a source at the origin in a uniform freestream is shown in Figure 2. Default values for the velocity and source strength are 100 and 100. The units do not really matter as it is the relative magnitudes of these values that determine the size and position of the stagnation streamline. The user is encouraged to change the default values to see how increasing

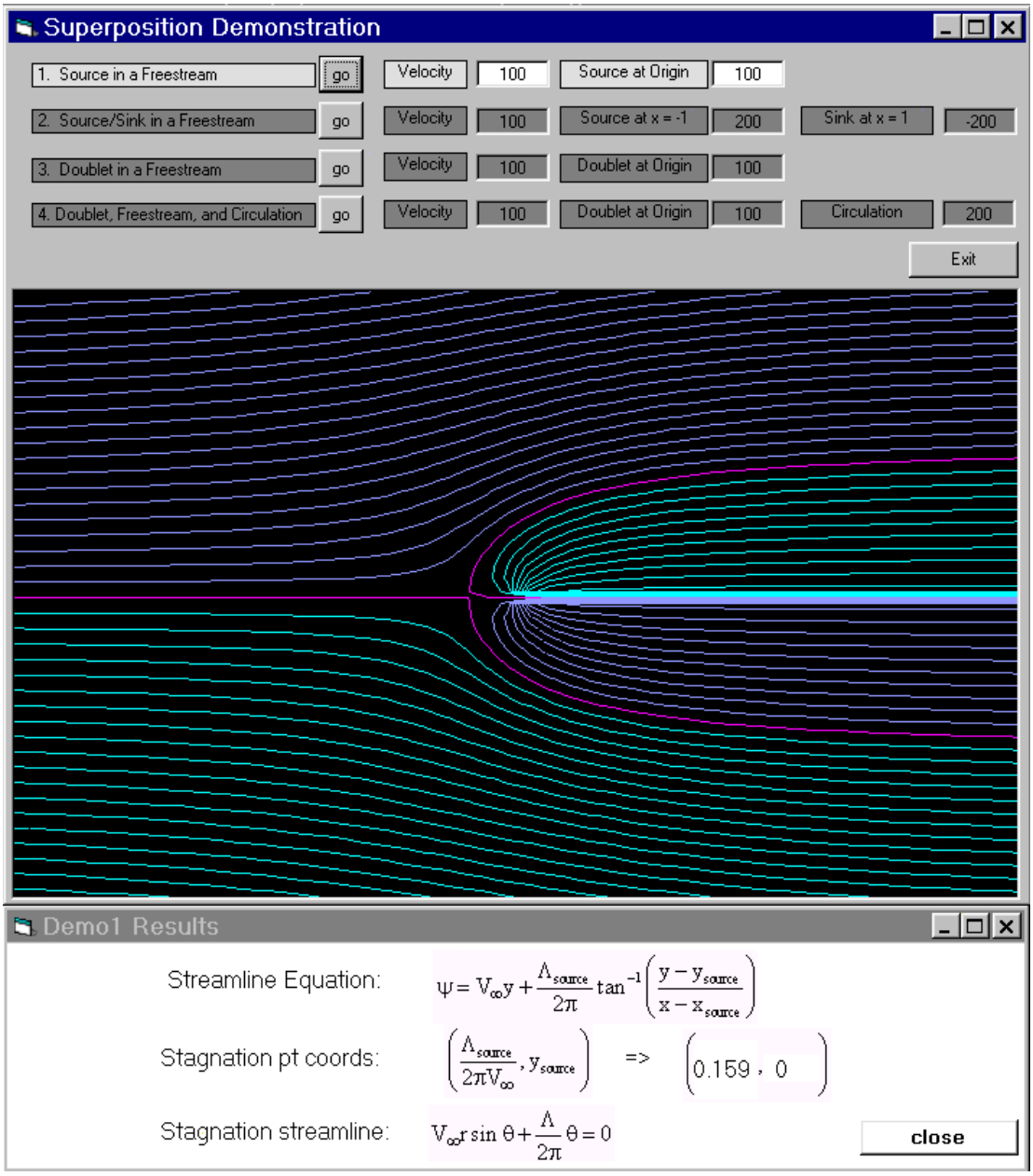

Figure 2. Demo 1 – Source in a uniform freestream.

the source strength relative to the velocity increases the flow deflection and moves the stagnation point further upstream.

Demonstration 2. Superposition of a source and sink in a uniform freestream

The second demonstration, shown in Figure 3, places a source and a sink in a uniform freestream. The source, at x = -1, is one the upstream side and the sink, at x = 1, is one the downstream side. Since the strengths of the source and sink are the same, a symmetric solution is produced. The user may change the magnitudes of the source and sink as well as the

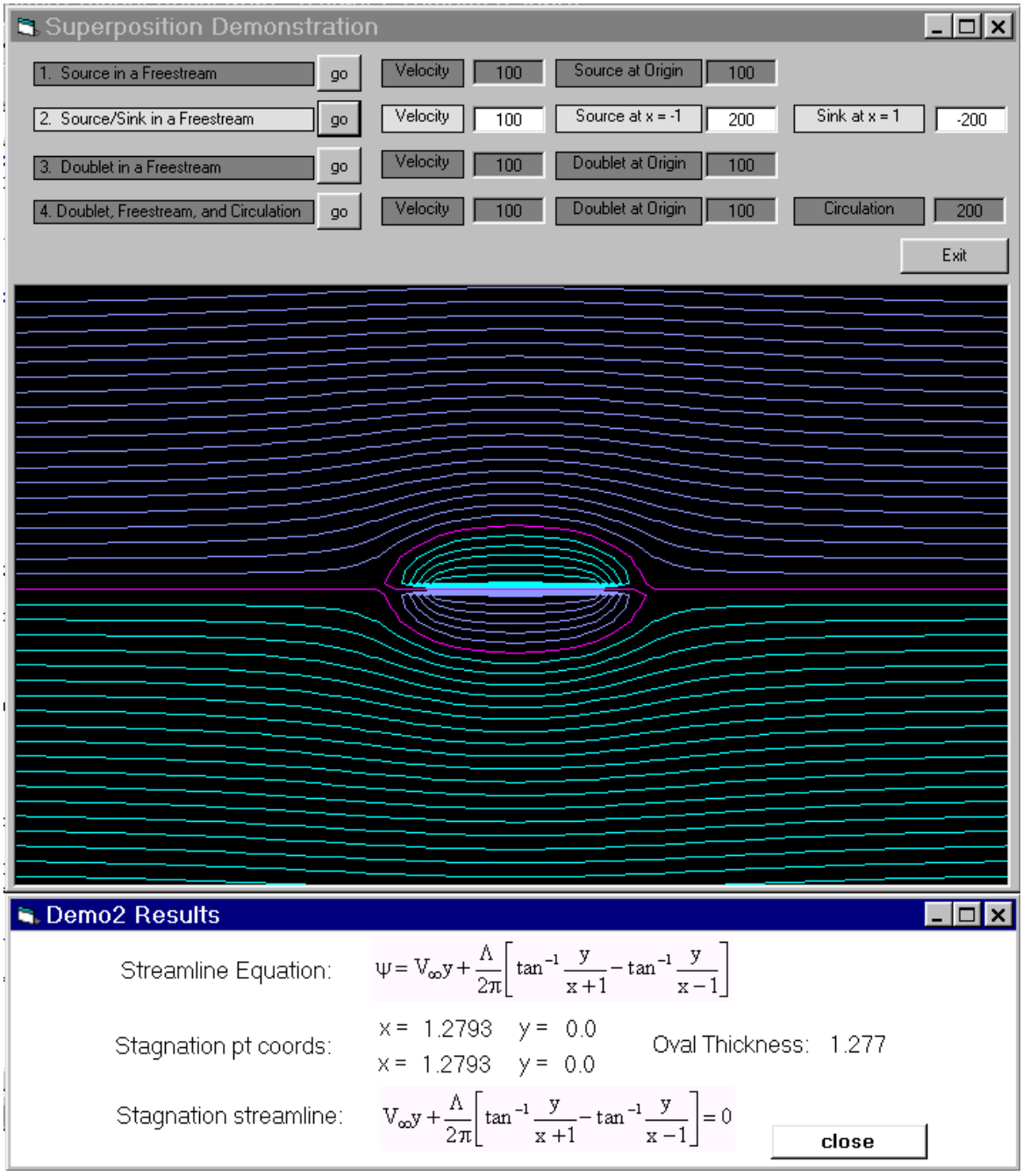

Figure 3. Demo 2 – Source and sink in a uniform freestream.

freestream velocity. The results window shows the equation of the streamlines, the location of the two stagnation points, the thickness of the oval if the magnitudes of the source and sink are the same, and the equation of the stagnation streamline. The user will find that there will be a closed body of some kind regardless of the difference between the magnitude of the source and sink strengths.

Demonstration 3. Superposition of a doublet in a uniform freestream

The third demonstration shows how a doublet in a freestream results in the flow identical to that of a circular cylinder in a freestream. The user may vary the velocity or the doublet

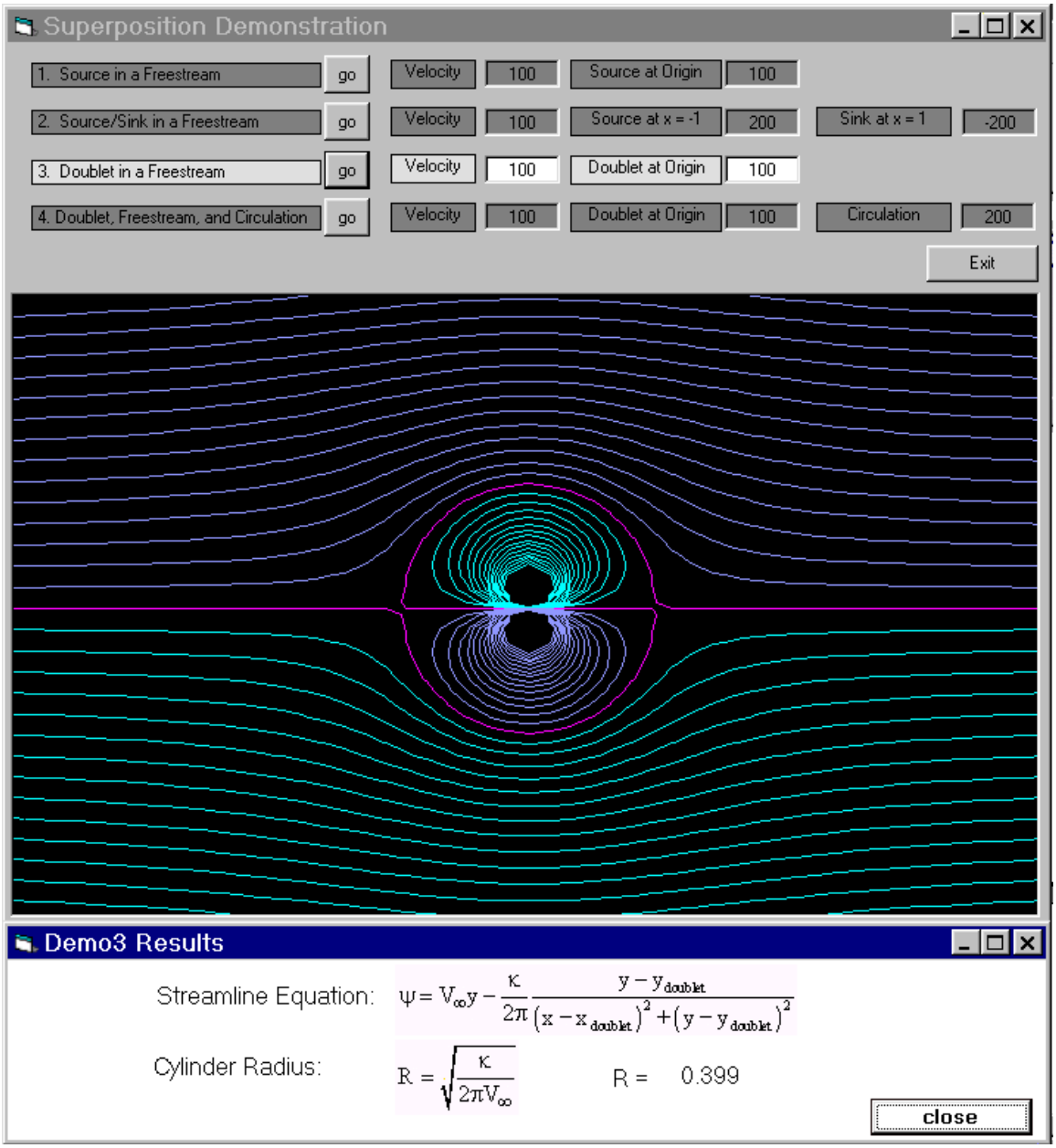

Figure 4. Demo 3 – Doublet at origin in a freestream.

strength and observe the change of cylinder diameter.

Demonstration 4. Superposition of a doublet and circulation in a uniform freestream

This demo puts it all together to show how the lifting flow over a circular cylinder can be constructed. Of importance in this demo is the determination of the stagnation points as these will later be mapped to airfoil leading and trailing edges. The user may vary the circulation strength to change the diameter of the cylinder and the circulation to affect the location of the stagnation points. If the circulation exceeds $4\pi V_\infty R$, then the stagnation points are no longer on the cylinder surface.

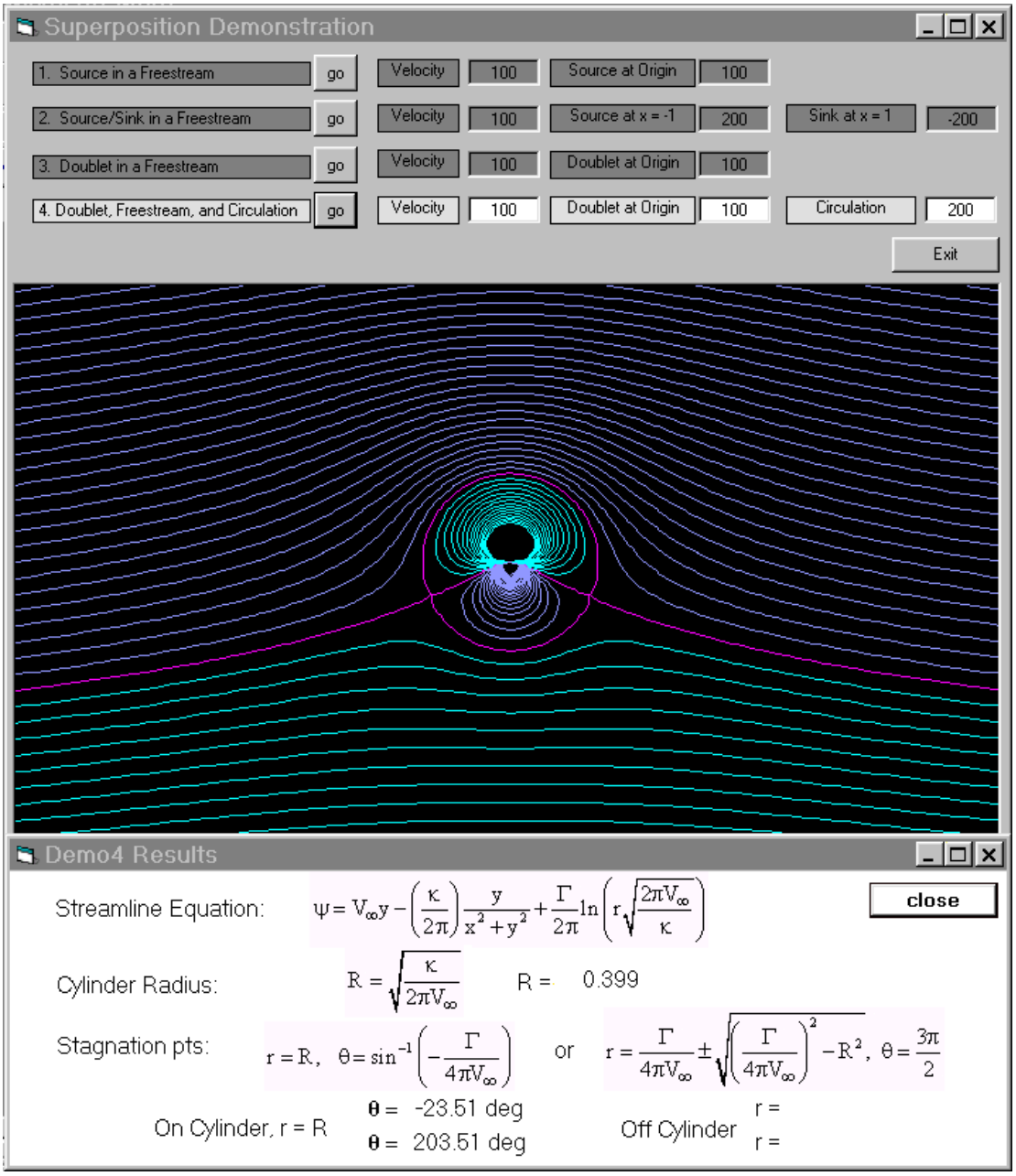

Figure 5. Demo 4 – Superposition of doublet and circulation in a uniform freestream.