MAE 423
Heat Transfer

Problem Set 6

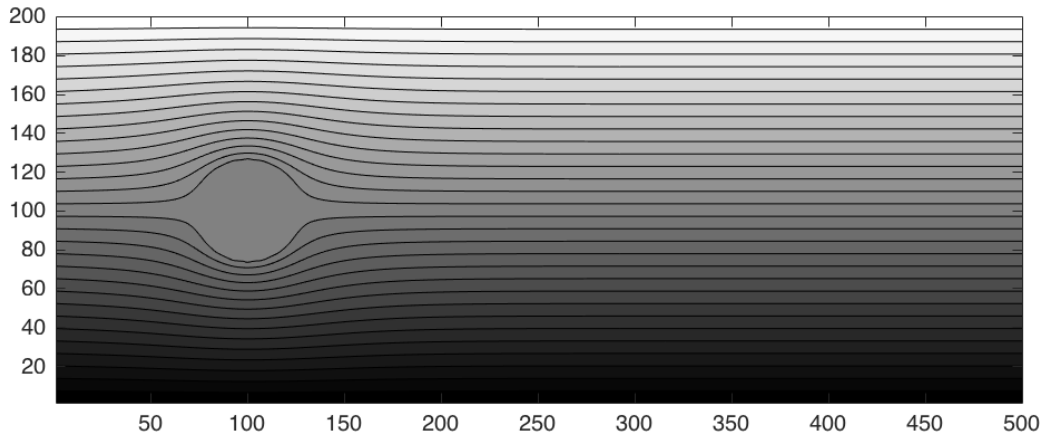
Date: Mon, 25 Nov '19
Due: Fri, 6 Dec '19 Please turn in either in class or in the boxes outside my office, D302 EQ by 'midnight'

The two numbered problems refer to the problems in Holman, 10th ed., end of Chapter 8.

Important: Please read and follow the guidelines for problem set preparation as outlined in the introduction to the course (posted on BB in Course Materials). As a reminder: be sure to draw any relevant sketches, list any assumptions and/or simplifications, show all analyses, and be very sure to check dimensions/units of your final answer, along with ascertaining that the sign and rough order-of-magnitude of the answer appears reasonable (and if it doesn't, please comment accordingly).

There are four (4) problems in this problem set.

1. At a first step in part 1 of your final project, you will need to establish an initial flow around the circular cylinder. Use the array suggested for the final project (500 x 200 grid points), and place the center of the cylinder (50 grid points in diameter) 100 grid points downstream from the inflow boundary. Use the same boundary conditions as in the project: uniform inflow, straight streamlines for the upper and lower lids. Also use a uniform velocity for the outflow. Solve the potential flow equation: $\nabla^2\psi = 0$ for the bulk flow, and use a convergence criteria of no more than a 1% change for all ψ. Plot the streamlines as shown in the example below (grey level mapping of ψ is optional).



2. 8-1

3. 8- 5

4. On a clear night the effective radiation temperature of the sky may be taken as -70°C. Assuming that there is no wind and the convection heat-transfer coefficient from the air to the dew that has collected on the grass is 28 W/(m^2·K), estimate the minimum temperature that the air must have to prevent formation of frost. Neglect evaporation of the dew, and assume that the grass is insulated from the ground insofar as conduction is concerned. Take the emissivity as unity for water.