Avai 193
Fall 2016
Laboratory Greensheet

Lab Report 1

Title: Instrumentation Test Technique Research

Process: Break into groups of 4 people. These groups will be the same for all of the experiments performed during the semester.

Objective: Research the assigned instrumentation test technique procedure for your group. Options include the following:

- Laser Vapor Screen
- Laser Sheet
- Liquid Crystals
- Oil flow
- Particle Image Velocimetry
- Planar Laser Induced Florescence
- Pressure Sensitive Paint
- Schlieren Photography and Videography
- Shadowgraph
- Skin Friction Interferometry
- Sublimation
- Temperature Sensitive Paint
- Tufts

Requirements: Include a description of the technique, its history, its application and its capabilities and limitations. Prepare and submit a written report. Present your results to the class in the form of a PowerPoint presentation.

Pick a topic and let me know the title of your paper. Do not duplicate another group's topic.

Presentation and Written Report Due Date: Section1 (Tues. Section), September 6, 2016; Section 2 (Thurs. Section): September 1, 2016

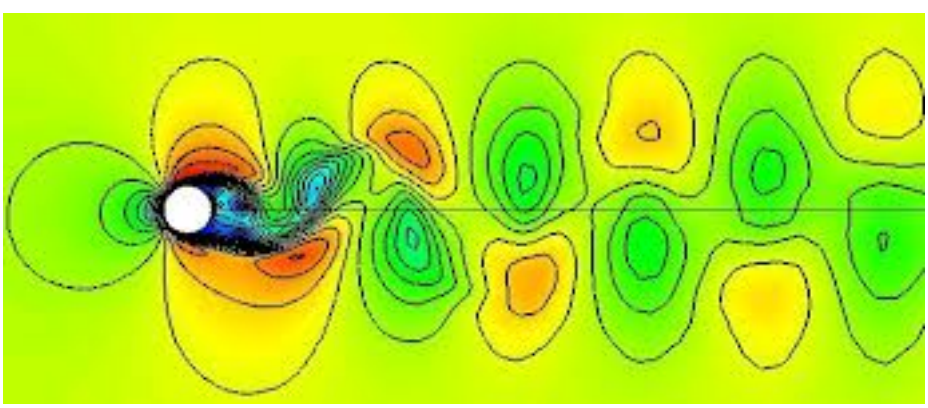
Lab Report 2

Title: Two-Dimensional Cylinder - Experimental and Theoretical Study

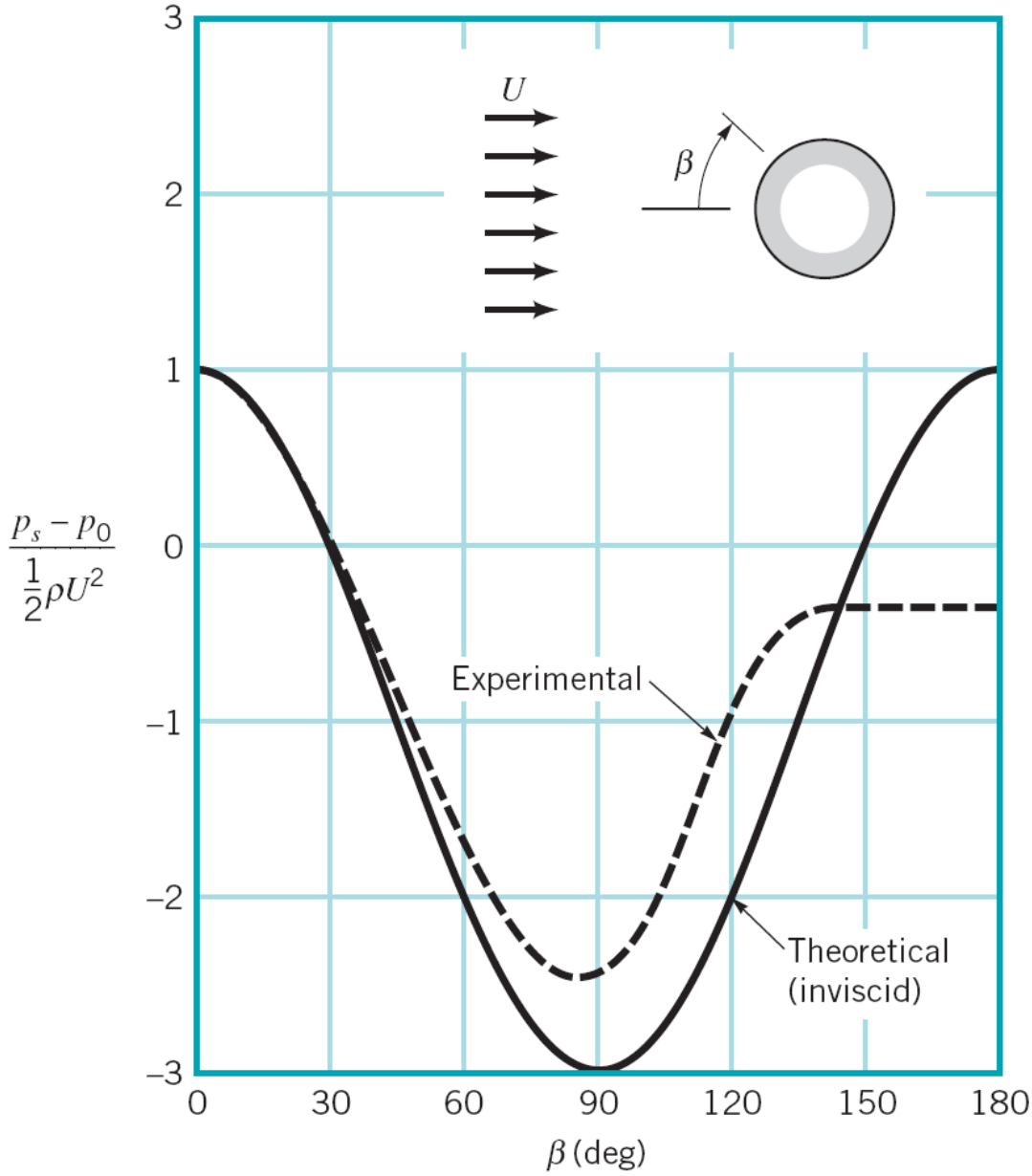
Objective: Determine the experimental surface pressure and velocity distribution for a two-dimensional cylinder and compare the pressure distribution with the inviscid theoretical results. Operate the tunnel at its fastest speed, i.e. Reynolds number. Compare your experimental results with those on the next page and those obtained by another experimental researcher found on the internet.

Requirements: The two-dimensional model has only a single pressure port that should be connected to the manometer board. The static pressure port on the bottom of the tunnel should also be connected to the manometer board. The cylinder can be rotated in the wind tunnel and the angle of rotation should be noted using the attached scale. The cylinder should be rotated through 180^0 with measurements taken every 10^0. Take data at the fastest speed the tunnel will operate. Determine the Reynolds number at which the tunnel is operating. Use Bernoulli's equation and the hydrostatic equation to determine the surface speed and pressure on the cylinder by creating an Excel spreadsheet. Plot the surface pressure coefficient and speed versus cylinder angle β on two different charts. Compare the experimental and theoretical pressure distributions with the results on the next page. Do some research to obtain experimental and theoretical results performed by other researchers and compare your results with theirs. Prepare a formal report and present your results to the rest of the class.

Presentation and Written Report Due Date: Section1 (Tues. Section), September 20, 2016; Section 2 (Thurs. Section): September 15, 2016



Experimental and theoretical pressure coefficient distribution for flow over a circular cylinder as a function of the azimuthal angle β.



Lab Report 3

Title: Symmetric Airfoil Aerodynamics - Experimental and Computational Study

Objective: Determine the surface pressure distribution and lift coefficient for the NACA 0012 airfoil experimentally and computationally. Operate the wind tunnel at its maximum velocity. Each group should take data at the following assigned angles of attack:

Group 1: -4^0, $\mathbf{4^0}$, 10^0, 18^0
Group 2: -2^0, 6^0, $\mathbf{12^0}$**,** 20^0
Group 3: $\mathbf{0^0}$, $\mathbf{8^0}$, 14^0, 16^0
Group 4: 2^0, $\mathbf{8^0}$, 16^0, 22^0
Group 5: $\mathbf{4^0}$, 10^0, $\mathbf{12^0}$, 20^0

Bold face angles of attack indicate that computational data for comparison is supplied.

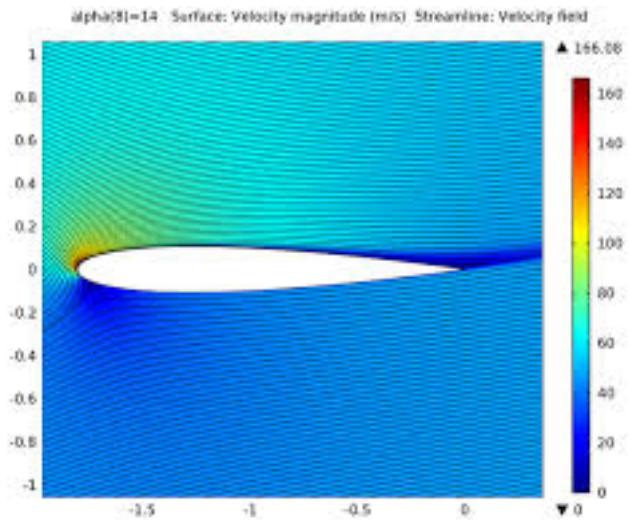
Compare the computational and experimental results. Compare your results with those obtained by another experimental researcher.

Requirements: The geometry of the airfoil and the location of the pressure probes will be provided. Get the free-stream total conditions from the "Terrapod Handheld Weather Station," i.e., barometric pressure and temperature. Determine the static pressure at each orifice using the manometer board, Bernoulli's equation and the hydrostatic equation by creating an Excel spreadsheet. Calculate the pressure coefficient and surface velocity at each orifice from the pressure data. Plot the pressure coefficient and velocity distribution on the upper and lower surfaces as a function of percentage of chord for each angle of attack. Use the K&E Planimeter to determine the lift coefficient for each angle of attack. Determine the lift generated on the airfoil at each angle of attack.

Obtain numerical results either from a published technical report obtained on the internet or by using Mathematica Player and the program "PotentialFlowOverANACAFourDigitAirfoil.nbp." Determine the equivalent pressure coefficient distribution and lift coefficient for the same cases obtained experimentally in the lab. Compare the potential flow results with the experimental data you obtained. The computer program can be found on the internet.

Prepare a formal report and present your results to the rest of the class.

Presentation and Written Report Due Date: Section1 (Tues. Section), October 4, 2016; Section 2 (Thurs. Section): September 29, 2016


alpha(8)=14 Surface: Velocity magnitude (m/s) Streamline: Velocity field
▲ 166.08
▼ 0
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.5
-1
-0.5
0
160
140
120
100
80
60
40
20
0

Lab Report 4

Title: Boundary Layer on a Flat Plate

Objective: Determine the boundary layer velocity profiles at five axial stations along a flat plate with the wind tunnel operating at its maximum velocity. Compare those results with another researcher's. Compute the local shear stress at each of those stations. Integrate that data to determine the skin friction drag on the top surface of the flat plate. Compare that drag with the theoretical value obtained using the formulas presented in class for a flat plate undergoing laminar, transitional and turbulent flow.

Requirements: Utilize the height of the probes of the boundary layer rake on the flat plate provided by the instructor for your calculations. Select five stream-wise locations on the flat plate near the end of the plate at which the boundary layer rake will be positioned for the experiment. Mount the flat plate in the wind tunnel and connect it to the manometer board noting which probe of the rake is connected to which manometer tube. Get the free-stream total conditions from the "Terrapod Handheld Weather Station," i.e., barometric pressure and temperature.

Note the tunnel-off manometer board reading and tunnel on static pressure manometer board reading.

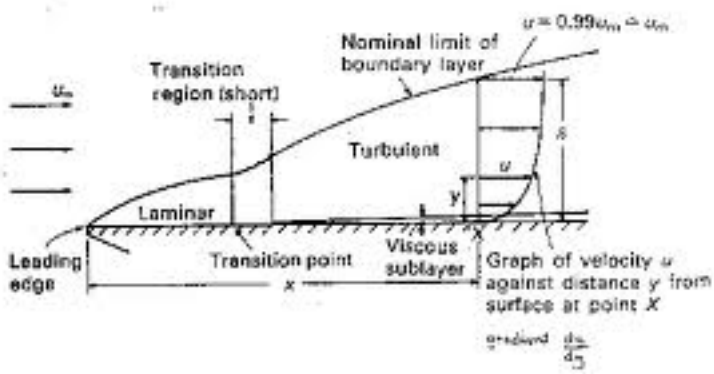
Take the readings on the manometer board for each probe of the rake at each stream-wise location. Reduce that data to determine the velocity distribution throughout the boundary layer at each stream-wise location. Calculate the velocity gradient at the wall using that data and the subsequent shear stress. Using the average shear stress, estimate the skin-friction drag on the flat plate. Compare that result with the theoretical value based on formulas presented in class for both a laminar/turbulent and turbulent flow conditions.

Prepare a formal report and present your results to the rest of the class.

Presentation and Written Report Due Date: Section1 (Tues. Section), October 18, 2016; Section 2 (Thurs. Section): October 13, 2016

BOUNDARY LAYER ON FLAT PLATE

(y scale greatly enlarged)



Lab Report 5

Title: Asymmetric Airfoil Aerodynamics - Experimental and Computational Study

Objective: Determine the surface pressure distribution and lift coefficient for the NACA 4412 airfoil experimentally and computationally. Operate the wind tunnel at its maximum velocity. Each group should take data at the following assigned angles of attack:

Group 1: -4^0, $\mathbf{4^0}$, 10^0, 18^0
Group 2: -2^0, $\mathbf{4^0}$, 12^0, 20^0
Group 3: $\mathbf{0^0}$, $\mathbf{8^0}$, 14^0, 16^0
Group 4: 2^0, $\mathbf{8^0}$, 16^0, 22^0
Group 5: $\mathbf{4^0}$, 10^0, 12^0, 20^0

Bold face angles of attack indicate that computational data for comparison is supplied.

Compare the computational and experimental results. Compare your results with those obtained by another experimental researcher.

Requirements: The geometry of the airfoil and the location of the pressure probes will be provided. Get the free-stream total conditions from the "Terrapod Handheld Weather Station," i.e., barometric pressure and temperature. Determine the static pressure at each orifice using the manometer board, Bernoulli's equation and the hydrostatic equation by creating an Excel spreadsheet. Calculate the pressure coefficient and surface velocity at each orifice. Plot the pressure coefficient and velocity distribution on the upper and lower surfaces as a function of percentage of chord for each angle of attack. Use the K&E Planimeter to determine the lift coefficient for each angle of attack. Determine the lift generated on the airfoil at each angle of attack.

Obtain numerical results either from a technical report or by using Mathematica Player and the program "PotentialFlowOverANACAFourDigitAirfoil.nbp." Determine the equivalent pressure coefficient distribution and lift coefficient for the same cases obtained experimentally in the lab. Compare the potential flow results with the experimental data you obtained. The computer program can be found on the internet.

Prepare a formal report and present your results to the rest of the class.

Presentation and Written Report Due Date: Section1 (Tues. Section), November 1, 2016; Section 2 (Thurs. Section): October 27, 2016

Lab Report 6

Title: Aerodynamic Effects of Airfoil Icing

Objective: Determine the surface pressure distribution and lift coefficient for the NACA 4412 airfoil experimentally and computationally with a layer of simulated ice along the leading edge. Operate the wind tunnel at its maximum velocity. Each group should take data at the following assigned angles of attack:

Group 1: -4^0, 4^0, 10^0, 18^0
Group 2: -2^0, 4^0, 12^0, 20^0
Group 3: 0^0, 8^0, 14^0, 16^0
Group 4: 2^0, 8^0, 16^0, 22^0
Group 5: 4^0, 10^0, 12^0, 20^0

Compare the computational and experimental results. Compare your results with those obtained by your group without the simulated icing.

Requirements: The geometry of the airfoil and the location of the pressure probes will be provided. Get the free-stream total conditions from the Handheld Weather Station in the laboratory, i.e., barometric pressure and temperature. Determine the static pressure at each orifice using the manometer board, Bernoulli's equation and the hydrostatic equation by creating an Excel spreadsheet. Calculate the pressure coefficient at each orifice from the pressure data. Plot the pressure coefficient on the upper and lower surfaces as a function of percentage of chord for the airfoil with and without the simulated ice. Use the K&E Planimeter to determine the lift coefficient for each angle of attack. Determine the lift generated on the airfoil at each angle of attack. Compare these results with those you obtained for the airfoil without the simulated ice.

Prepare a formal report and present your results to the rest of the class.

Presentation and Written Report Due Date: Section1 (Tues. Section), November 15, 2016; Section 2 (Thurs. Section): November 10, 2016

Lab Report 7A

Title: Aerodynamic Effects of Stall Strips

Objective: Experimentally determine the surface pressure distribution and lift coefficient for the NACA 4412 airfoil with a stall strip installed along the leading edge of the airfoil. Operate the wind tunnel at its maximum velocity. Each group should take data at the following assigned angles of attack:

Group 2: -2^0, 2^0, 6^0, 10^0, 14^0, 18^0, 22^0
Group 4: -3^0, 1^0, 5^0, 9^0, 13^0, 17^0, 21^0

Compare your results with those obtained by your group for the 4412 airfoil without the stall strip.

Requirements: Mount the provided stall strip along the leading edge of the airfoil such that they straddle the pressure probes on the top surface using rubber cement. The geometry of the airfoil and the location of the pressure probes will be provided. Determine the location of the pressure orifices on the airfoil as a percentage of the chord. Get the free-stream total conditions from the Handheld Weather Station in the laboratory, i.e., barometric pressure and temperature. Determine the static pressure at each orifice using the manometer board, Bernoulli's equation and the hydrostatic equation by creating an Excel spreadsheet. Calculate the pressure coefficient at each orifice from the pressure data. Plot the pressure coefficient on the upper and lower surfaces as a function of percentage of chord for the airfoil with and without the stall strip. Use the K&E Planimeter to determine the lift coefficient for each angle of attack. Determine the lift generated on the airfoil at each angle of attack. Compare these results with those you obtained for the airfoil without the stall strip.

Prepare a formal report and present your results to the rest of the class.

Presentation and Written Report Due Date: Section1 (Tues. Section), November 29, 2016; Section 2 (Thurs. Section): December 1, 2016

Lab Report 7B

Title: Aerodynamic Effects of Vortex Generators

Objective: Experimentally determine the surface pressure distribution and lift coefficient for the NACA 0012 airfoil with a series of vortex generators installed along the leading edge of the airfoil. Operate the wind tunnel at its maximum velocity. Each group should take data at the following assigned angles of attack:

Group 3: -2^0, 2^0, 6^0, 10^0, 14^0, 18^0, 22^0
Group 5: -3^0, 1^0, 5^0, 9^0, 13^0, 17^0, 21^0

Compare your results with those obtained by your group for the NACA 0012 airfoil without the vortex generators.

Requirements: Mount the provided vortex generators above the leading edge of the airfoil such that they straddle the pressure probes on the top surface. The geometry of the airfoil and the location of the pressure probes will be provided. Determine the location of the pressure orifices on the airfoil as a percentage of the chord. Get the free-stream total conditions from the Handheld Weather Station in the laboratory, i.e., barometric pressure and temperature. Determine the static pressure at each orifice using the manometer board, Bernoulli's equation and the hydrostatic equation by creating an Excel spreadsheet. Calculate the pressure coefficient at each orifice from the pressure data. Plot the pressure coefficient on the upper and lower surfaces as a function of percentage of chord for the airfoil with and without the vortex generators. Use the K&E Planimeter to determine the lift coefficient for each angle of attack. Determine the lift generated on the airfoil at each angle of attack. Compare these results with those you obtained for the airfoil without the stall strip.

Prepare a formal report and present your results to the rest of the class.

Presentation and Written Report Due Date: Section1 (Tues. Section), November 29, 2016; Section 2 (Thurs. Section): December 1, 2016