Universidad Europea de Madrid

Aerospace Engineering program

Aerodynamics and Aeroelasticity

Homework 3

Due February 8, 2017

**Problem 1**

Consider an infinitely thin flat plate of chord c at an angle of attack α in a supersonic flow. The pressures on the upper and lower surfaces are different but constant over each surface; i.e., Pu(s) = c1 and p1(s) = c2 , where c1 and c2 are constants and c2 > c 1. Ignoring the shear stress, calculate the location of the center of pressure.

**Problem 2**

Consider an airfoil at 12º angle of attack. The normal and axial force coefficients are 1.2 and 0.03, respectively. Calculate the lift and drag coefficients.

**Problem 3**

Consider a Lear jet flying at a velocity of 250m/s and altitude of 10km, where the density and temperature are 0.414 kg/m3 and 223K, respectively. Consider also a one-fifth scale model of the Lear jet being tested in a wind tunnel in the laboratory. The pressure in the test section of the wind tunnel is 1 atm. Calculate the necessary velocity, temperature, and density of the airflow in the wind-tunnel test section such that the lift and drag coefficients are the same for the wind-tunnel model and the actual airplane in flight. Note: The relation among pressure, density, and temperature is given by the equation of state.

**Problem 4**

Consider an infinitely thin flat plate with a 1m chord at an angle of attack of 10º in a supersonic flow. The pressure and shear stress distributions on the upper and lower surfaces are given by Pu = 4 x l04 (x - 1)2 + 5.4 x 104, and Pl = 2 x 104(x - 1)2 + 1.73 x 105, and shear stress Ʈu = 288x-0.2, and Ʈl = 73lx-0·2 respectively, where x is the distance from the leading edge in meters and p and Ʈ are in Newton per square meter. Calculate the normal and axial forces, the lift and drag, moments about the leading edge, and moments about the quarter chord, all per unit span. Also, calculate the location of the center of pressure.

**Problem 5**

Consider an airfoil in a wind tunnel (i.e., a wing that spans the entire test section).Prove that the lift per unit span can be obtained from the pressure distributions on the top and bottom walls of the wind tunnel (i .e., from the pressure distributions on the walls above and below the airfoil).