Compressible Fluids I **AE 521 Fall 2022** **Instructor: P. Kreth**
Homework #4 **Due: 11/15/2022**

Note: *Show all necessary steps in determining your solution and list assumptions you have made (if any).* ***Grade:*** / 50

[10 pts] 1. We need to turn a supersonic flow by a total of 18°. The incoming Mach number is 2, and the upstream pressure and temperature are 100 kPa and 200 K, respectively. This turn can be accomplished through the following three options:

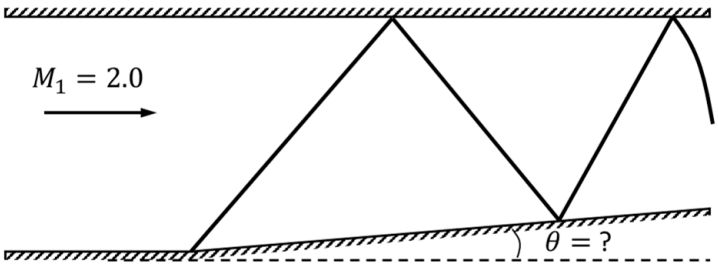
(a) One 18° turn

(b) Two 9° turns

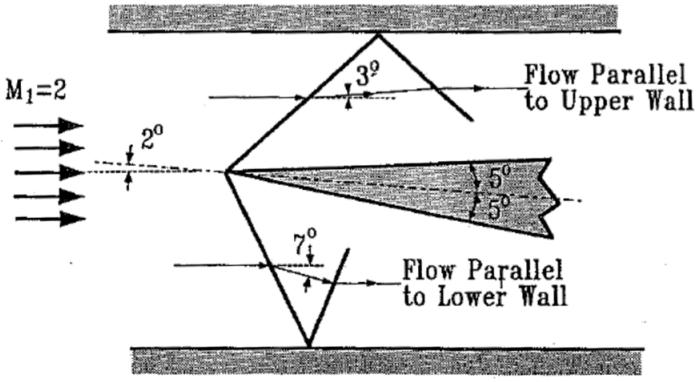
(c) Three 6° turns

Compare the final Mach number, stagnation pressure, static pressure, and static temperature using these three options. Which of these methods loses the least amount of total pressure?

[10 pts] 2. Air flows in a passage shown in the figure below. If the initial Mach number is 2.0, determine the maximum turning angle θ for which three regular reflections of the original shock are possible.

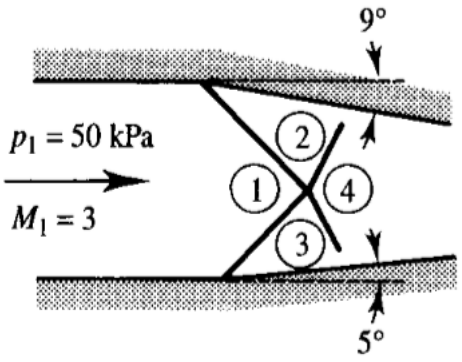


[10 pts] 3. A two-dimensional wedge with a total included angle of 10° is placed in a wind tunnel with parallel walls. If the incoming Mach number is 2, and if the axis of the wedge is inclined at an angle-of-attack of 2° to the incoming flow direction, find the Mach numbers upstream and downstream of the oblique shocks after they are reflected off the upper and lower walls of the tunnel. Sketch the flow pattern and determine the angles the waves make to the tunnel walls.



[10 pts] 4. Given the system of Oblique Shocks shown in the figure below, where the inlet pressure is 50 kPa and the Mach number is 3, find the pressure in region 4 downstream of the intersection of

the waves. *Hint: you should define two sub-regions within the larger region 4. Assume (guess) a flow direction here and compute the overall pressure ratios in both sub-regions. Iterate (guess again) until you reach convergence.*



[10 pts] 5. Consider two-dimensional flow over the double-wedge airfoil shown in the figure below. Find the Lift and Drag per unit span (per m) acting on the airfoil, and sketch the flow pattern. How does the pressure vary over the surface of the airfoil?