SPC 407
Sheet 4
Compressible Flow – Oblique Shock wave

1. It is claimed that an oblique shock can be analyzed like a normal shock provided that the normal component of velocity (normal to the shock surface) is used in the analysis. Do you agree with this claim?
2. How do oblique shocks occur? How do oblique shocks differ from normal shocks?
3. For an oblique shock to occur, does the upstream flow have to be supersonic? Does the flow downstream of an oblique shock have to be subsonic?
4. Can the Mach number of a fluid be greater than 1 after a normal shock wave? Explain.
5. Consider supersonic airflow approaching the nose of a two-dimensional wedge and experiencing an oblique shock. Under what conditions does an oblique shock detach from the nose of the wedge and form a bow wave? What is the numerical value of the shock angle of the detached shock at the nose?
6. Consider supersonic flow impinging on the rounded nose of an aircraft. Is the oblique shock that forms in front of the nose an attached or a detached shock? Explain.
7. Consider supersonic airflow approaching the nose of a two-dimensional wedge at a Mach number of 5. Using the Fig., determine the minimum shock angle and the maximum deflection angle a straight oblique shock can have.
8. Air at 12 psia, 30 °F, and a Mach number of 2.0 is forced to turn upward by a ramp that makes an 8° angle off the flow direction. As a result, a weak oblique shock forms. Determine the wave angle, Mach number, pressure, and temperature after the shock.
9. Air r flowing at 8 psia, 480 °R, and Ma_1 = 2.0 is forced to undergo a compression turn of 15°. Determine the Mach number, pressure, and temperature of air after the compression.

10. Air flowing at 60 kPa, 240 K, and a Mach number of 3.4 impinges on a two-dimensional wedge of half-angle 8°. Determine the two possible oblique shock angles, β_{weak} and β_{strong}, that could be formed by this wedge. For each case, calculate the pressure, temperature, and Mach number downstream of the oblique shock.
11. Calculate the maximum surface pressure (in newtons per square meter) that can be achieved on the forward face of a wedge flying at Mach 3 at standard sea level conditions ($p_1 = 1.01 \times 10^5$ N/m^2) with an attached shock wave.