As a final project for the course, you will work as a group to analyze the supersonic flow over a diamond-wedge airfoil as a function of angle of attack (see Figure below). The airfoil has a chord length of 1 m and a maximum thickness of 10 cm. The free stream flow properties are $M_\infty=3$, $p_\infty=1$ atm and $T=270$ K. We wish to examine the flow for a range of angles of attack $\alpha$ between 0 and 30° in increments of 5°.

1. **THEORETICAL ANALYSIS.** Using shock-expansion theory, you are to determine for each angle
   - oblique shock and expansion wave angle(s); assume the weak shock solutions in all subsequent calculations
   - pressure distribution on the upper wing surface
   - pressure distribution on the lower wing surface
   - temperature distribution on the upper wing surface
   - temperature distribution on the lower wing surface
   - lift per unit span
   - drag per unit span
   - lift/drag ratio

2. **NUMERICAL SIMULATION.** In parallel with the theoretical analysis, you are to develop an inviscid CFD model of this problem with FLUENT and obtain the corresponding results as above. Note that the angle of attack is easily accomplished within a single mesh by simply using a velocity inlet condition by specifying vector components. There are some practical matters you may wish to consider in developing this code:
   - What is the necessary extent of your domain?
   - You will need to mesh heavily in the regions where the shock is expected; you may want to use theory to predict where these shocks will occur to guide you
   - Appropriate solver settings and boundary conditions for supersonic compressible flow
   - Consult the FLUENT documentation for guidance

3. **REPORT AND PRESENTATION.** Working as a group, prepare a short report documenting your solutions as well as a Powerpoint presentation. In the oral presentation, each person will be required to participate equally. Because this is an extended project, teamwork is important here and may be more productive rather than simply dividing up responsibilities and working independently.
Schematic diagram for the supersonic flow over the diamond airfoil.

M=3
P=1 atm
T=270 K