# 1 Introduction

# 2 Solver

This section details all the pieces of the solver. The scheme is designed to solve the full 2-D Navier-Stokes equations using a finite volume method using local time-stepping. The equations to be solved are

$$\begin{aligned} \frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x_i}\rho u_i &= 0, \\ \frac{\partial \rho u_i}{\partial t} + \frac{\partial}{\partial x_j}\left(\rho u_i u_j + P\delta_{ij} - \tau_{ij}\right) &= 0, \\ \frac{\partial \rho E}{\partial t} + \frac{\partial}{\partial x_i}\left(\rho u_i H + Q_i - \tau_{ij}u_j\right) &= 0, \end{aligned} \tag{1}$$

where $\tau_{ij}$ is the viscous stress tensor, $\rho E = \frac{P}{\gamma - 1} + \frac{1}{2}\rho(u^2 + v^2)$ is the internal energy, and $\rho H = \rho E + P$ is the internal enthalpy.

## 2.1 Euler Fluxes

## 2.2 Viscous Fluxes

## 2.3 Time Stepping

## 2.4 Boundary Conditions

# 3 Test Case: Oblique Shock

Convergence and contour plots

# 4 Flat Plate Boundary Layer

Convergence and contour plots

# 5 Transonic Symmetric Airfoil

Convergence and contour plots

# 6 Conclusion