Engine and Auxiliary Systems

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Introduction

Turbulence is a highly unstable, stochastic process which cannot be analyzed by deterministic tools and instead, one relies on statistical methods. The statistical tools used for RANS simulation are rather simple and involve the decomposition of the instantaneous velocity and temperature field into mean and fluctuating quantities, known as Reynolds decomposition:

\[ \tilde{u} = U + u \]  
\[ \tilde{p} = P + p \]  
\[ \tilde{\theta} = \Theta + \theta \]

The Reynolds averaged continuity, Navier Stokes, and energy equations are obtained by substituting (1), (2) and (3) in to continuity, momentum and energy equations and time averaging the equations. The resultant form of the averaged equations is given as:

**Continuity:**

\[ \frac{\partial U_i}{\partial x_i} = 0 \]  

**Momentum:**

\[ \frac{\partial U_i}{\partial t} + U_j \frac{\partial U_i}{\partial x_j} = \frac{1}{\rho} \frac{\partial P}{\partial x_j} + \nu \frac{\partial^2 U_i}{\partial x_j \partial x_j} - \frac{\partial}{\partial x_j} (u_i \overline{u_j}) \]  

**Energy:**

\[ \frac{\partial \Theta}{\partial t} + U_j \frac{\partial \Theta}{\partial x_j} = \alpha \frac{\partial^2 \Theta}{\partial x_j \partial x_j} - \frac{\partial}{\partial x_j} (\overline{u_i \theta_i}) \]