Assignment 07

The assignment for Module 12 is due on 2019-10-16, 22:50 IST.

Unit 9 - Week 7: Aircraft engines and its Examples

Course outline

Week 0: Introduction

Week 1: Basic Thermodynamic and Propulsion Concepts

Week 2: Gas Turbine and Aircraft Engines

Week 3: Gas-Turbine Engines

Week 4: Aircraft Engine Systems

Exercises

Assignment 07

Due on 2019-10-16, 22:50 IST.

1. a) Show that the turbine inlet temperature is given by the equation:

\[ T_{in} = \frac{T_{atm} + \alpha}{\beta} \]

Where \( T_{in} \) is the turbine inlet temperature, \( T_{atm} \) is the ambient temperature, \( \alpha \) is the temperature rise across the compressor, and \( \beta \) is the temperature ratio across the turbine.

1. b) The air mass flow rate of the engine is given by the equation:

\[ m = \frac{P_{T_{in}}}{R_{G} T_{in}} \]

Where \( m \) is the mass flow rate, \( P_{T_{in}} \) is the total pressure at the turbine inlet, \( R_{G} \) is the gas constant, and \( T_{in} \) is the turbine inlet temperature.

1. c) The thrust of the engine is given by the equation:

\[ T = \frac{m v_{b} + \frac{1}{2} \rho A v_{b}^2}{\eta_t} \]

Where \( T \) is the thrust, \( m \) is the mass flow rate, \( v_{b} \) is the bulk velocity, \( \rho \) is the air density, \( A \) is the propulsive area, and \( \eta_t \) is the thrust efficiency.

1. d) The specific fuel consumption (SFC) of the engine is given by the equation:

\[ SFC = \frac{m}{\dot{W}_{in}} \]

Where \( SFC \) is the specific fuel consumption, \( m \) is the mass flow rate, and \( \dot{W}_{in} \) is the engine input work.

1. e) The overall efficiency of the engine is given by the equation:

\[ \eta_{overall} = \frac{\dot{W}_{out}}{\dot{Q}_{in}} \]

Where \( \eta_{overall} \) is the overall efficiency, \( \dot{W}_{out} \) is the engine output work, and \( \dot{Q}_{in} \) is the engine input heat.

1. f) The specific work output of the engine is given by the equation:

\[ \dot{W}_{out} = \frac{\dot{m} v_{b} + \frac{1}{2} \rho A v_{b}^2}{(1 - \eta_s)} \]

Where \( \dot{W}_{out} \) is the specific work output, \( \dot{m} \) is the mass flow rate, \( v_{b} \) is the bulk velocity, \( \rho \) is the air density, \( A \) is the propulsive area, and \( \eta_s \) is the specific work efficiency.

1. g) The net work output of the engine is given by the equation:

\[ \dot{W}_{net} = \dot{W}_{out} - \dot{W}_{in} \]

Where \( \dot{W}_{net} \) is the net work output, \( \dot{W}_{out} \) is the specific work output, and \( \dot{W}_{in} \) is the engine input work.

1. h) The overall efficiency of the engine is given by the equation:

\[ \eta_{overall} = \frac{\dot{W}_{net}}{\dot{Q}_{in}} \]

Where \( \eta_{overall} \) is the overall efficiency, \( \dot{W}_{net} \) is the net work output, and \( \dot{Q}_{in} \) is the engine input heat.

1. i) The specific fuel consumption (SFC) of the engine is given by the equation:

\[ SFC = \frac{\dot{m}}{\dot{W}_{net}} \]

Where \( SFC \) is the specific fuel consumption, \( \dot{m} \) is the mass flow rate, and \( \dot{W}_{net} \) is the net work output.

1. j) The effective specific work of the engine is given by the equation:

\[ \dot{W}_{eff} = \dot{W}_{out} \eta_{eff} \]

Where \( \dot{W}_{eff} \) is the effective specific work, \( \dot{W}_{out} \) is the specific work output, and \( \eta_{eff} \) is the effective efficiency.

1. k) The overall efficiency of the engine is given by the equation:

\[ \eta_{overall} = \frac{\dot{W}_{eff}}{\dot{Q}_{in}} \]

Where \( \eta_{overall} \) is the overall efficiency, \( \dot{W}_{eff} \) is the effective specific work, and \( \dot{Q}_{in} \) is the engine input heat.

1. l) The specific fuel consumption (SFC) of the engine is given by the equation:

\[ SFC = \frac{\dot{m}}{\dot{W}_{eff}} \]

Where \( SFC \) is the specific fuel consumption, \( \dot{m} \) is the mass flow rate, and \( \dot{W}_{eff} \) is the effective specific work.