Definitive Module Document (DMD)

Module Code:2AAD0019

Title of Module
Full Title: Aerothermodynamics & Design
Short Title: Aerothermo & Design

Version: 1

Credit Points: 30

Level / ECTS Level: 2

First Offered: 1/9/2004 00-00-00

6. Home Department:
AAD

7. Departments(s) contributing to teaching:

9. Module Aims:

* understand the laws, principles and methods of analysis in aerothermodynamic systems

* use appropriate methods of experimental investigation in aerothermodynamics

* understand the physics of boundary layers and compressible flows in order to evaluate the flow parameters and aerodynamic forces around a wing.

* recognise the role of design in the aerospace industry, particularly with respect to typical aerospace sub-assemblies, features and systems.

* understand the behaviour of ideal and real gases.

* understand the second law of thermodynamics, concept of entropy, principles of operation of heat engines and heat pumps.

* understand the behaviour of compressible flows in nozzles and diffusers under various flow speed conditions.

* understand the phenomenon of normal and oblique shock waves and expansion waves.

* be aware of the relevant airworthiness requirements and other aerospace data, their application and influence on design

10a. Learning Outcomes: Knowledge and Understanding:

* analyse aerodynamic forces encountered in aircraft flight

* understand the growth of boundary layer and viscous drag

* model the flow around the aircraft

* understand the factors affecting the design of aircraft

* deal with problems involving ideal and real gases

* understand the practical implications of the second law of thermodynamics and concept of entropy

* recognise the limitations of heat engines efficiency and heat pumps coefficient of performance

* demonstrate an ability to deal with compressible flow in a variety of aerospace applications

* resolve problems involving normal and oblique compression and expansion waves

* demonstrate an awareness of the implications of their designs on weight, cost and complexity

* show an understanding of the fundamental operation of a variety of aircraft and missile systems

10b. Learning Outcomes: Skills and Attributes:

* analyse and calculate the aerodynamic forces including viscous drag

* model the wing vortex system and calculate the lift and vortex drag

* produce the aerodynamic design criteria for wings fitted to different aircraft

* plan and test a model of an aircraft in a wind tunnel to obtain the performance characteristics

* calculate fundamental gas parameters in various engineering applications

* analyse and characterise the performance of heat pumps and heat engines

* test and determine the performance characteristics of a typical heat pump in a laboratory environment

* calculate compressible flow and design parameters of nozzles and diffusers under various flow speed conditions

* analyse problems involving flow compression and expansion

* follow basic aerospace engineering design practice

* select appropriate materials for designed components

* select and specify appropriate bought-out components and units

11. Module Content
11a Module Content:
Aerodynamics

Aerofoil and wing geometry. Lift generation. Aerodynamic forces and moments. Wing characteristics. Effect of aspect ratio. International atmosphere. Speed measurement, IAS, TAS, EAS.

Wing vortex system, downwash and vortex drag. Viscous boundary layers, transition and separation. Viscous drag.

High lift devices. Aerodynamic drag and its estimation. Condition for minimum drag.

Aerodynamic design criteria for wings used in different aircraft.

Wind tunnel testing. Simulation of Reynolds number and Mach number.

Thermodynamics

Perfect, semi perfect and real gases. Enthalpy and internal energy of gases.

The second law of thermodynamics and its applications. Principle of heat engines and heat pumps. Clasius and Kelvin-Planks statements of the second law. Normal and reversed Carnot cycles. Entropy and the principle of increased entropy. Introduction to compressible flows. Stagnation and static properties of flowing flows. The speed of sound and the flow Mach number. Compressible flows in variable cross sectional area ducts (nozzles and diffusers).

Introduction to Compression and expansion waves. Normal and oblique shock waves. Variation of flow parameters across the waves. Waves tables. Expansion waves and flow parameters. DesignDesign of typical aerospace engineering assemblies etc. for specific functions, based on common aerospace practice. Selection of standard aerospace components - weight, function, reliability and fitness for purpose.

Examples-

Design of mounting arrangements for a guided-weapon sub-assemblyHydraulic circuit layout and component design

11b. Further details on how the learning outcomes of the module will be achieved:
Aerodynamics

Measurement of speed. Determination of pressure distribution, lift and drag using results from wind tunnel tests. Modelling of wing vortex system to evaluate the aerodynamic forces. Determination of spanwise variation of incidence for a given wing loading . Calculation of viscous drag, determination of criteria for transition and separation.

Appreciation of changes in wing characteristics fitted with high lift devices.

Calculation of different components of aerodynamic drag. Determination of lift, drag, and speed corresponding to the condition of minimum drag.

Testing of a model aircraft in a wind tunnel to obtain its performance characteristics. Appreciation of problems associated with wind tunnel testing.

Review of factors considered in the aerodynamic design of wings used in different aircraft.

Thermodynamics

Determination of perfect and semi perfect gases properties.

Determination of Heat pumps and Heat engines coefficient of performances and efficiencies. Calculations of entropy changes in various gaseous systems. Appreciation of the use of a combination of heat engines and pumps for refrigeration and power production purposes. Calculation of the work output and rate of heat transfer in heat engines and pumps.Calculations of compressible flow parameters, including stagnation parameters, in various aerospace applications. Appreciation of the use of nozzles and diffusers in aerospace applications. Calculation of the flow parameters in variable cross sectional area ducts under variable flow speed conditions.

Calculations of the Mach Number, entropy change and other flow parameters across normal and oblique shock waves.

Calculation of the flow parameter across an expansion (Prandtl-Meyer) wave.

Design

A series of lectures covering the design of major aircraft structure and systems, including detailed descriptions of the function s of principal components.

A series of assignments covering a range of drawing skills and techniques in accordance with BS308.

Two major design tasks of escalating complexity, with appropriate guidance and support.

12. Language of Delivery:
English

13. Language of Assessment:
English

14. Assessment Details (Academic):
Coursework: 50

Exam: 50

Other: Typically, assessment will consist of-

One 3-hour end-of-course examination

2 phase tests

2 laboratory reports

two assessed drawings plus one design test

Assessment Notes:
Separate passes are required in both the coursework and examination elements of assessment

15. Locations(s):
UH HATFIELD

16. Pre and Co-Requisite:
Pre-Requisite

Co-Req

Prohibited

17. Subject Board of Examiner/s:

18. Comments

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