PRIFYSGOL glyndŵr UNIVERSITY

MODULE SPECIFICATION FORM

Module Title:	**Propulsion (Aircraft)**	Level:	**5**	Cedit Value:	**10**

Module code: (if known) **ENG50K**	Cost Centre: **GAAE**	JACS2 code: **H450**

Semester(s) in which to be offered: **2**	With effect from: **July 2015**

Office use only: To be completed by AQSU:	Date approved: July 2015 Date revised: Version No: 1

Existing/New: **New**	Title of module being replaced (if any): N/A

Originating Academic area: **Engineering and Applied Physics**	Module Leader: **X Huang**

Module duration (total hours)	100	**Status:** core/option/elective (identify programme where appropriate):	**Free-standing 10-credit component comprising second half of ENG538 (Thermo-fluids and Propulsion).**
Scheduled learning and teaching hours	36		
Independent study hours	64		
Placement hours	0		

Percentage taught by Subjects other than originating Subject (please name other Subjects):	**0%**

Programme(s) in which to be offered: **Enginering European Programme** (Non Award Bearing)	Pre-requisites per programme (between levels):	**None**

Module Aims:

To develop principles and applications of fluid momentum as applied to aircraft propulsion units, the design and operation of real gas turbine and jet engine cycles and their component parts, gas turbine engine intakes and nozzles, propulsion units and analysis of gas turbine engines.

Expected Learning Outcomes

Knowledge and Understanding:

At the completion of this module, the student should be able to:

1. Derive relationships for the thrust, power and propulsive efficiency of an aircraft, and thus explain the reasons for using bypass engines;
2. Apply the principle of centrifugal and axial flow in compressors and turbines, and determine their characteristics, hence analyse the design and operation of multi-stage compressors/turbines and determine their performance characteristics; Analyse intake and nozzle performance; *(KS 1, 3)*
3. Analyse of component characteristics and investigate the off-design performance of engines.

Key skills for employability

1. Written, oral and media communication skills,
2. Leadership, team working and networking skills
3. Opportunity, creativity and problem solving skills
4. Information technology skills and digital literacy
5. Information management skills
6. Research skills
7. Intercultural and sustainability skills
8. Career management skills
9. Learning to learn (managing personal and professional development, self management)
10. Numeracy

Assessment: *Please indicate the type(s) of assessment (eg examination, oral, coursework, project) and the weighting of each (%).*

Assessment is by means of an examination covering all outcomes. It is an unseen time-constrained exam. (This corresponds to Assessment 2 of ENG538.)

Assessment number (use as appropriate)	Learning Outcomes met	Type of assessment	Weighting	Duration (if exam)	Word count (if coursework)
Assessment One:	1, 2, 3	Examination	100%	2 hr	

Learning and Teaching Strategies:

This module will be presented to students through a series of lecture materials including videos, demonstrations and structured technical visits to suitable establishments (e.g.: RAF, Cosford). Laboratory investigations and tutorials will be used to support lectures and to provide an opportunity for students to work on problems with individual attention if needed.

Syllabus outline:

Propulsive Efficiency and Propellers: Newton's laws of motion, momentum equation and Froude's momentum theory; thrust and power developed by aircraft propulsion systems, propulsive efficiency of an aircraft, reasons for using by-pass engines; variation of propulsive efficiency with speed for propeller, jet, turbo-prop, and by-pass engine propulsion; propeller geometry and propeller coefficients, blade element and vortex theory; development of propeller characteristics, propeller matching and propulsion by propeller; fan propulsion, ducted fans, multi-spool engines.

Gas turbine and jet engine cycles: practical cycles, closed and open cycles; shaft power cycles, jet engine, prop-engine cycles.

Centrifugal and axial flow compressors: centrifugal compressors, work done and pressure rise; compressor characteristics and applications; axial flow compressors, stage performance, velocity diagrams, cascade theory, blade design; multistage compressors.

Axial flow gas turbines: introductory theory, blade design and vortex theory, estimation of stage performance, velocity diagrams; turbine cascades and three dimensional flow in turbines, design and operation of multistage turbines; overall turbine performance characteristics, blade cooling and its effects.

Gas turbine engine intakes and nozzles: intake performance, subsonic intake analysis; jet pipe design and operation; nozzle performance characteristics and off-design operation of nozzles.

The overall operation of gas turbine propulsion units: analysis and matching of components; off-design (engine performance) operation of single shaft gas turbines and jet engines.

Bibliography:

Essential Reading:

Saravanamutto, H.I.H. et al. (2009) *Gas turbine theory*. 6th Edn., Harlow: Pearson Education.

Rogers, G.F.C. & Mayhew, Y.R. (1994) *Thermodynamic & Transport Properties of Fluids*. 5th Edn., Oxford: Blackwell.

Recommended reading:

Farokhi, S. (2008) *Aircraft Propulsion*, John Wiley & Sons.

Cumpsty, N.A. (2003) *Jet propulsion*: *A Simple Guide to the Aerodynamic and Thermodynamic Design and Performance of Jet Engines*, Cambridge: Cambridge University Press.

Goldsmith, E & Seddon, J. (1993) *Practical intake aerodynamic design*, Oxford: Blackwell Scientific Publications.