Wrexham Glyndŵr University

MODULE SPECIFICATION

Module Title:	**Advanced Thermo-fluid and Turbomachinery**	**Level**:	6	**Credit Value**:	20

Module code:	ENG616	**Is this a new module?** NO	**Code of module being replaced**:	

Cost Centre:	GAME	**JACS3 code**:	H141

Trimester(s) in which to be offered:	1, 2	**With effect from:**	September 17

School:	Applied Science, Computing & Engineering	**Module Leader:**	Dr X Huang

Scheduled learning and teaching hours	60 hrs
Guided independent study	140 hrs
Placement	0 hrs
Module duration (total hours)	200 hrs

Programme(s) in which to be offered	Core	Option
BEng (Hons) Aeronautical & Mechanical Engineering	☐	✓

Pre-requisites
None

Office use only

Initial approval February 2017

APSC approval of modification Version 1

Have any derogations received Academic Board approval? Yes ✓ No ☐

Module Aims
1. To further develop the concepts and applications introduced in the Level 5 Thermo-fluid and Propulsion module. 2. To develop the applications of π theorem in fluid mechanics and heat transfer. 3. To further develop the applications of the second law of thermodynamics to more advanced thermodynamic power cycles in turbomachinery using different working fluids. 4. To further develop the concepts of fluid flow, classification of flows, differential analysis of fluid flow 5. To develop the investigation of heat transfer and heat exchangers.

Intended Learning Outcomes		
Key skills for employability KS1 Written, oral and media communication skills KS2 Leadership, team working and networking skills KS3 Opportunity, creativity and problem solving skills KS4 Information technology skills and digital literacy KS5 Information management skills KS6 Research skills KS7 Intercultural and sustainability skills KS8 Career management skills KS9 Learning to learn (managing personal and professional development, self-management) KS10 Numeracy		
At the end of this module, students will be able to		Key Skills
1	Analyse thermodynamically irreversible processes and apply the analysis on more advanced thermodynamic cycles.	KS3
2	Apply fundamental principles on power cycle development to increase cycle thermal efficiency.	KS3
		KS6
3	Apply π theorem on analysis of heat transfer and fluid flow	KS3
		KS6
4	Apply principles of differential analysis on the inviscid flow, potential flow and real flow.	KS3
		KS6
5	Solve problems involving heat transfer, flow in pipelines, design of heat exchangers.	KS3

Derogations
A derogation from regulations has been approved for this programme which means that whilst the pass mark is 40% overall, each element of assessment (where there is more than one assessment) requires a minimum mark of 30%.

Assessment:

The learning outcomes will be assessed by means of a 3-hour written examination. It is an unseen time-constrained examination with a fixed number of questions, typically five, where students are required to answer only four.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)	Duration (if exam)	Word count (or equivalent if appropriate)
1	1, 2, 3, 4, 5	Examination	100	3 hours	

Learning and Teaching Strategies:

This module will be delivered by a set of structured lectures and will also contain laboratory demonstrations. Tutorials will be utilised to support lectures. The students will also be encouraged to undertake self-readings of essential and recommended books.

Syllabus outline:

Thermodynamics:

First and Second laws of thermodynamics in close and open systems. Reversible and irreversible processes, the property entropy as a consequence of the second law. Further property diagrams, entropy changes in various processes. Working fluids. *T-s* and *p-v* diagrams for gases and vapours. Power generation and power cycles. Use of steam table Components in power plants: compressors, turbines, valves and boiler and condenser. Use of isentropic efficiency to estimate work transfer to and from the devices listed.

Turbomachinery in Power Generation:

Analysis on power generation cycles. Brayton cycle and gas turbine. Use of property table. Rankine cycle and steam turbine. Power cycle development to increase cycle thermal efficiency. Criteria for maximum thermal efficiency in various cycles. Modifications necessary to achieve improvements in efficiency and work ratio. Expressions giving the work output and thermal efficiency of various cycles. Use of intercooling, reheat, regeneration, heat exchangers in gas and steam turbine cycles. Actual and ideal cycles.

The Flow of Real Fluids:

Fluid in motion: continuity equation, Bernoulli equation. Real fluid flow. Equations for the steady viscous flow of fluid in pipes. Volume flow rate and the loss of head for a steady viscous flow of fluid in pipes. Maximum velocity and mean velocity of the steady viscous flow. Turbulent flow in pipes and representation of the velocity distribution, the relationship between 'friction factor' and Reynolds number, the effect of pipe roughness on the friction factor. Use of Moody chart.

Concepts of fluid flow, Classification of flows, Differential analysis of fluid flow, Motion and deformation of fluid element. Stream Function. Velocity potential. The properties of potential flow. Rotational and irrotational flow. Circulation. Vorticity. Continuity equation and N-S equation.

Dimensional analysis:

Dimensional reasoning and fundamental and derived units and dimensions. Relationships by dimensional analysis. Group method of dimensional analysis (Buckingham's π theorem). Use of dimensionless groups in investigative work. The use of model studies for various applications in heat transfer and fluid flow.

Fundamentals of Heat Transfer:

Mechanisms of heat transfer: heat conduction, heat convection and heat radiation. Steady state conductive heat transfer. Heat transfer through a single thickness of material and walls. One dimensional heat transfer through several thicknesses of different materials. Composite walls. Conduction through a flat plate, cylindrical wall and spherical wall. Convective heat transfer, forced and natural convection. Heat transfer coefficient. Overall heat transfer coefficient. Thermal resistance. Thermal radiation, absorptivity, reflectivity and transmissivity in relation to radiation.

Heat Exchangers:

Types of heat exchanger. Parallel flow heat exchangers and design calculations. Counter flow heat exchangers and design calculations. Log mean temperature difference. Fouling.

Bibliography:

Essential reading

Cengel, Y.A. and Boles, M (2014) Thermodynamics: An Engineering Approach (8th edition), McGraw-Hill.

Douglas, J. F. and Gasiorek, J (2011) Mechanics of Fluids (6th edition), Prentice Hall.

Bergman, T. L (2011) Fundamentals of Heat and Mass Transfer (7th edition), Wiley

Other indicative reading

Rogers, G.F.C and Mayhew, Y. R (1999) Thermodynamic and Transport Properties of Fluids, Blackwell.

Joel, R (2008) Basic Engineering Thermodynamics, Longman.