ISEL
INSTITUTO SUPERIOR DE ENGENHARIA DE LISBOA

ISEL ADEM
Área Departamental de Engenharia Mecânica

Sheet course ()

Course	MSc IN MECHANICAL ENGINEERING		
Unit	Turbomachines	Mandatory	☐
		Optional	☒
Unit scientific area	Thermofluids and Energy	Category	E

Unit category: B - Basic; C - Core Engineering; E - Specialization; P - Complementary.

Year: 1st	Semester: 1st		ECTS:			
Contact time	Total: 45	T: 30	TP: 15	PL:	S:	OT:

T - Lectures; TP - Theory and practice; PL - Lab Work; S - Seminar; OT - Tutorial Guidance.

Unit Director	Title	Position
Paulo de Santamaria de S. T. Gouveia	Charter Engineer	Assistant Professor

Learning Objectives (knowledge, skills and competences to be developed by students)

(max. 1000 characters)

This course aims student's development of a well articulated and disciplined way of thinking for a good integration of all competences previously gained, mainly in Engineering sciences, applied in conceiving complex models for the characterization of COMPLETE thermodynamics machines (combining Heat and Work).

The course pretends conduct the student in establishing a functional model for the analysis of the several machine categories, studied during the course, adding new knowledge to previous student background, linking all this matters of the Mechanical Engineering (including technologies, materials, machines design, etc.) for the comprehension and design of turbo-machines.

The course intends to prepare the student with advanced knowledge on a central Mechanical Engineering subject with strategic future. New technologies and materials will lead to the general application of this type of engines, even in small and poor economies with the growing energy consumption restraints.

Syllabus

(max. 1000 characters)

Foundations on Applied Thermodynamics:

- Gas and vapour Cycles.

Nozzle Theory:

- Mach, critical properties. Design, friction. Expansion/shock waves.

Axial Turbines Fundamentals:

- Action turbine. Velocities, Efficiency, Friction and Reaction. Stages.

Turbo-machines Equations:

- Turbines and compressors. Configurations.

Multi-stages Machines:

- Stage efficiencies. Re-heating. Turbines/Compressors Efficiency.

Blades Cascade

- Forces. Velocities. Aerodynamics. Turbines/compressors Efficiencies.

2D- Axial Flow Turbines:

- Load, flow and reaction; velocities. Efficiencies: total and static.

2D- Axial Compressors.

- Velocities and Work. Load, flow and reaction. Analysis off design.

3D- Effects Impact

- Crossed flows. 3D equations.

Centrifugal Compressors

- Reaction. Inlet/outlet angles. Compression and Mach.

Radial Turbines

- Reaction. Inlet angle. Efficiency.

Turbo-Machines Characterization

- Non-dimensional analysis. Stall. Consumption. Variable geometry. Nozzle equivalent area.

Demonstration of consistency of the syllabus with the objectives of the course

(max. 1000 characters)

Although the course pretends to develop knowledge over a wide spectrum of different topics, the syllabus still meets the course objectives, namely in gaining:

i. Deep understanding and application of knowledge to practical problems of Fluid Mechanics.

ii. Further comprehension of applied thermodynamics, focused in physical phenomena.

iii. Sophisticated and thorough characterization of turbo-machines in different geometries.

iv. Complex analysis of internal Flows, its calculation and application to turbo-machines.

v. Integration of Dynamical aspects with Thermal issues within the turbo-machinery analysis.

vi. Integration of Mechanical Eng. know-how, promoting the interconnection of its knowledge areas.

The Laboratory experiences and Theoretical Work planned, as part of the evaluation, were designed specifically to achieve the objectives of the course, aiming to learn how to apply the knowledge gained in this and other courses and developing know-how on practical applications.

Teaching methodology (evaluation included)

(max. 1000 characters)

Develop the student critical capacity in establishing the relevant phenomena for the comprehension of complex thermodynamics equipments, preparing the student for turbo-machines operating principles analysis. The student shall search, select and process relevant data to develop new knowledge and skills, based not only on classes learning but also in preparing and improving the theoretic essay and for the Laboratory work reports:

- LAB- Two or three laboratory experiences reporting: Nozzle, Action turbine and Reactor (with a free turbine or generating impulse); depending on Laboratory availability.
- TRAB- Theoretical study and report: Basic turbine thermo-dynamical design and calculus.
- EF- Final written examination on class: minimum rating required is 8,0 (on a 20,0 scale).

NF- Final rating: weighted average of the partial grades = 0,2 x LAB + 0,3 x TRAB + 0,5 x EF

APPROVAL- Students shall be approved only if the Final Rating is greater or equal to 9,5 (20 scale).

Demonstration of consistency of teaching methods with the learning objectives of the course

(max. 3000 characters)

The teaching methodologies and assessment used are appropriate , taking into account the constraints on the resources of the School and the objectives pursued :

• The theoretical and practical classes are being taught in the classroom , using up sporadically the laboratory demonstrations possible .

• The content of the lessons is essentially theoretical , foreseeing lessons more practical (problems , estimating, project) to consolidate knowledge .

• After introducing the basic concepts , practical classes promote the structuring of thinking of applying theoretical knowledge in achieving practical solutions .

• The Laboratory Experiences and the theoretical Work were designed for students to gain team or multi - teams work in the development of complex calculation of Turbo-machines: problem analysis, survey of known information, research data and parameters necessary, structuring of the sequence of the calculations, characterization algorithms decisions, evaluation of results, development of final conclusions, suggestions for future improvement, etc.

The exam consists of an individual assessment of fundamental knowledge whose acquisition is considered mandatory to succeed in the course.

Main Bibliography

(max. 1000 characters)

MAIN

• Set of Texts and Notes selected by the Course Professor

• Gas Turbine Theory, 6ª Edição. Cohen, H., Rogers, F. & Saravanamutto, H.: Longman Group 2009

• Fluid Mechanics, Thermodynamics of Turbomachinery, 6ª Ed. S.L. Dixon: Butterworth-Heinemann, 2010.

OTHER

• Turbine Design. Fielding, L.: ASME Press, 2000.

• Turbomachinery- Design and Theory. R. S. Gorla and A. Khan: Marcel Dekker, 2003

• Turbomachinery: Basic Thery and Applications - 2nd edition. Earl Logan Jr.: Marcel Dekker, 1993

• Turbomachines. A Guide to Design, Selection and Theory. Balje, O.E.: John Willey & Sons. 1981

• Gás Turbine Engineering Handbook. Boyce, M. P.: 1982

• Elements of Gas Turbine Propulsion. J.D. Mattingly - AIAA Education Series, 2005

• The History of North American Small Gas Turbine Aircraft Engines – R.A. Leyes II & W. Fleming -

General Publication by AIAA, 1999

- Turbomáquinas Térmicas - Tomás S. Lencero, António M. Blanco, Francisco J. Aquilar – Editorial Síntesis, 2004