Course unit title:	Turbomachinery		
Course unit code:	ME402		
Type of course unit:	Elective		
Level of course unit:	Bachelor (1st Cycle)		
Year of study:	4		
Semester when the unit is delivered:	8(Spring)		
Number of ECTS credits allocated :	6		
Name of lecturer(s):	Dr. Charalambos Chasos		
Learning outcomes of the course unit:	1. Explain the differences between the different types of turbomachines (axial, radial, mixed flow) and describe their applications and performance. 2. Analyze compressible and incompressible fluid/rotor energy transfer using Euler turbine and Euler pump equations. 3. Read and interpret performance curves for pumps, fans, compressor and turbines. 4. Use dynamic similarity laws to predict turbomachine performance from scale model performance data. 5. Analyse the performance of turbomachines, and design turbomachines, with dimensional analysis, velocity triangles and steady flow energy equation for axial and centrifugal rotors and rotor/stator stages		
Mode of delivery:	Face-to-face		
Prerequisites:	ME202, ME200	Co-requisites:	None
Recommended optional program components:	None		
Course contents:	**Types of turbomachines:** Axial, radial and mixed flow turbomachines. Types of pumps, fans, compressors and turbines (impulse and reaction). Applications of turbomachines. Performance considerations of turbomachines. **Theoretical analysis of turbomachines:** Compressible and incompressible flow governing equations, continuity equation and steady flow energy equation with control volume approach and tangential momentum considerations (Euler pump and Euler turbine equations) with meridional flow approach through turbomachines. Two-dimensional cascades, fluid dynamics effect of a blade row and parameters, cases of frictionless flow and real cascades with fluid friction. **Dimensional analysis:** Global dimensionless performance parameters for turbomachines. Overall hydraulic efficiency of pumps and turbines, effects of turbomachine features on efficiency and reduction of variables with dimensional analysis. Characteristic curves of pumps and fans, dimensionless characteristic curves and turbomachine selection. Dynamic similarity laws for turbomachines and design of turbomachine using scale models. Performance and efficiency curves (“Cordier” diagrams). **Performance analysis of axial compressors and turbines:** Dimensional analysis for a single stage turbine and a single stage compressor with local dimensionless performance parameters (flow and work coefficients), stage velocity triangle and steady flow energy equation. Total-to-total efficiency of single stages, stage reaction, effects of variables on efficiency and reduction of variables with dimensional analysis. Axial stages (rotors and rotor/stator) velocity triangles, 50% reaction stage and arbitrary reaction stage, and dimensionless velocity triangles relationships. Design aspects, selection of stages, lift and drag coefficients and diffusion factors, selection of pitch/chord ratio. Optimum axial turbine and axial compressor stages and performance curves (“Smith” diagrams). **Performance analysis of mixed flow and radial turbomachines:** Local dimensionless performance parameters for mixed-flow pumps and fans. Steady		

	flow energy equation, specific work input in mixed-flow pumps and fans, stagnation enthalpy relative to a rotor and rothalpy. Total-to-total efficiency and reduction of variables with dimensional analysis. Velocity triangles for a mixed-flow fan, and dimensionless velocity triangles relationships. Aspects of design and analysis of mixed-flow cascades with geometrical techniques. Considerations of relative eddy and slip flow in radial and mixed-flow cascades.
Recommended and/or required reading:	Thermodynamics cycles and principles of fluid mechanics
Textbooks:	1. R. I. Lewis, ***Turbomachinery Performance Analysis***, John Wiley & Sons Inc., 1996 2. D. G. Wilson & T. Korakianitis, ***The Design of High-Efficiency Turbomachinery and Gas Turbines***, Prentice Hall, 1998 3. S. L. Dixon, ***Fluid Mechanics and Thermodynamics of Turbomachinery***, Butterworth-Heinemann, 1998 4. Donald F. Young, Theodore H. Okiishi, Bruce Roy Munson, ***Fundamentals of Fluid Mechanics***, John Wiley & Sons, 4th edition, 2002 5. Hans Josef Rath (Editor), C. Egbers, ***Advances in Fluid Mechanics and Turbomachinery***, Springer Verlag, 1998 6. John Denton, ***Developments in Turbomachinery Design***, Mechanical Engineering Pubns Ltd, 1999 7. Nicholas C. Baines and David Japikse, ***Introduction to Turbomachinery***, Concepts ETI, 1997
Planned learning activities and teaching methods:	The course is delivered to the students by means of lectures, conducted with the help of computer presentations. Lecture notes and presentations are available through the web for students to use in combination with the textbooks.
Assessment methods and criteria:	• Assignment 20% • Test 20% • Final Exam 60%
Language of instruction:	English
Work placement(s):	No