ANNEX 2 – COURSE DESCRIPTION

MEE500 Fundamentals of Energy Engineering

Course Title	Fundamentals of Energy Engineering
Course Code	MEE500
Course Type	Compulsory
Level	Masters (2nd Level)
Year / Semester	1st year / Fall Semester
Teacher's Name	Dr. George Karagiorgis, Dr. Katerina Meresi
ECTS	10 | Lectures / week: 3 | Laboratories/week: 0
Course Purpose	The course purpose is for the students to develop a sound understanding of the theory and operation of Energy Technology Systems. Students will gain the ability to evaluate various Energy Systems and investigate variables that influence performance etc. Upon completion of this course, the students will be able to develop skills on analysing Heat Exchangers, Gas Turbines, Steam Turbines, Renewables ICE etc.
Learning Outcomes	By the end of the course, students must be able to: 1. Describe the types and operation of energy technology systems in industrial and domestic applications, and select the most appropriate technology for specific energy requirements. 2. Describe renewable energy sources which can be used for power generation and list the technologies which utilise renewable energy sources 3. Use the principles of thermodynamics, combustion and emissions, heat transfer and fluid mechanics for the analysis of energy systems. 4. Use thermodynamic data, construct graphs of thermodynamic cycles and carry out energy balance of gas turbines, steam turbines, combined cycle plants and internal combustion engines and turbomachinery of various types. 5. Construct and explain performance graphs of gas turbines, steam turbines, combined cycle plants and internal combustion engines, turbomachinery and electric machines. 6. Describe methodologies for analysis and design of energy technology systems. Apply methodologies for analysis of energy technology systems. 7. Analyse the technologies involved in energy systems and specify the requirements for technology systems employed for energy applications
Prerequisites	Prior taught experience on energy engineering issues or instructor's approval | Corequisites: None
Course Content	**1. Introductory aspects for energy technology systems** - Principles of fluid mechanics, thermodynamics, combustion and emissions/pollution, and heat transfer. - Fuels (Heavy fuel oil, Natural Gas, Diesel and petrol) chemical composition and energy content. - Alternative sources of energy and applications. **2. Furnaces, Boilers and Steam Generators** - Fuel type utilisation, heat transfer characteristics and emissions produced. - Technical characteristics, design aspects, sizing and performance. - Types and applications of gas-fuelled, liquid-fuelled and solid-fuelled burners. - Industrial furnaces types for large process (cement), and reheating/refining systems. - Boilers and steam generators types, operation and performance. **3. Heat exchangers** - Heat exchangers types and applications. - Heat transfer phenomena and heat exchanger analysis. **4. Gas Turbines and Steam Turbines** - Gas turbine types, components and operation. - Basic processes in gas turbines (atmospheric air characteristics, compression, combustion and expansion).

	- Performance analysis of gas turbines, using simple analysis of an open-circuit gas turbine. Steam turbine types, components and operation. Basic processes in steam turbines (combustion, heat transfer, steam production, expansion and condensation). - Performance analysis of steam turbines, using simple analysis of superheat steam turbine power plant. - Combined-cycle power plants types, components and operation. - Basic processes in the combined-cycle power plants. - Performance analysis of a combined-cycle plant, using an open-circuit gas turbine, an interconnecting heat exchanger and a superheat steam turbine. 5. **Internal Combustion Engines** - Engine types, perfromance factors and expressions for indicated power, brake power, torque, specific fuel consumption etc. - Spark-ignition (Otto) Internal Combustion Engines (ICE): two-stroke, four-stroke, ideal air cycle, real cycle, induction system, fuel injection systems, gas flow, air/fuel mixture preparation, ignition, combustion, knock, emissions formation (HC, NOx, CO). - Compression Ignition (Diesel) ICE: two-stroke, four-stroke, ideal air cycle, real cycle, induction system, fuel injection systems, fuel injection, gas flow swirl/squish, air/fuel mixture preparation, ignition delay, phases of combustion, knock, emissions formation (smoke, NOx). - Modern ICE: gasoline direct injection (GDI), stratified charge engines, turbocharging and intercooling, homogeneous charge compression ignition engines (HCCI), common-rail high-pressure injection system, hybrid engines. 6. **Turbomachinery** - Performance curves and analysis of turbomachinery. - Design aspects of turbomachinery. - Fans and blowers types, operation and applications. - Compressors types, operation and applications. - Pumps types, operation and applications. 7. **Electric machines:** - Fundamental principles of electromagnetism. - Electromechanical power conversion, development of torque and voltage. - Generators, motors and loads. - Torque-speed characteristics, basic equations, characteristic curves, power flow, efficiency and losses in electric machines. - Motors and generators types and applications. 8. **Other aspects of energy technology systems:** - Energy storage systems types and applications (accumulators, capacitors, heat storage, flywheels). - Energy saving measures, thermal insulation, composite structures, thickness of insulation and calculations of heat transfer coefficients.
Teaching Methodology	The course is delivered to the students by means of lectures, conducted with the help of computer presentations. Possible visits at local power plants for demonstration of different types of gas turbines, steam turbines, combined-cycle power plants, internal combustion engines and electric machines. Lecture notes and presentations are available through the web for students to use in combination with the textbooks.
Bibliography	**Textbook:** Breeze, P. "***Power Generation Technologies***". Elsevier, 2005. **References** 1. F.P. Incropera and D.P. DeWitt. "***Fundamentals of Heat and Mass Transfer***". John Wiley & Sons, 5th Edition, 2002. 2. John B. Heywood. "***Internal Combustion Engine Fundamentals***". McGraw Hill Education, 1989. 3. Rolf Kehlhofer, Rolf Bachmann, Henrik Nielsen, "***Combined Cycle Gas & Steam Turbine Power Plants***". PennWell Corp. Publishers, 3rd edition, 2009. 4. H. I. H. Saravanamuttoo, G. F. C. Rogers, Henry Cohen. "***Gas Turbine Theory***". Prentice Hall, 5th edition, 2001.

	5. Moran, M. J. and Shapiro, H. W. "***Fundamentals of Engineering Thermodynamics***". 6th Edition, John Wiley and Sons. 2008. 6. Poullikkas, A. "***Introduction to power generation technologies***". Nova Science Publications. 2010. 7. R. I. Lewis. "***Turbomachinery Performance Analysis".*** John Wiley & Sons Inc., 1996 8. Stephen J. Chapman. "***Electric Machinery and Power System Fundamentals***". McGraw-Hill Education – Europe, 2001 9. Theodore Wildi. "***Electrical Machines, Drives and Power Systems***". Pearson Higher Education, 2005
Assessment	• Assignments 20% • Midterm Exams 20% • Final Exam 60%
Language	English