AEEE522 - Renewable Energy Sources and Sustainability

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<tr><td>Course Title</td><td colspan="5">Renewable Energy Sources and Sustainability</td></tr>
<tr><td>Course Code</td><td colspan="5">AEEE522</td></tr>
<tr><td>Course Type</td><td colspan="5">Elective</td></tr>
<tr><td>Level</td><td colspan="5">MSc (Level 2)</td></tr>
<tr><td>Year / Semester</td><td colspan="5">1 or 2</td></tr>
<tr><td>Teacher's Name</td><td colspan="5">Assoc. Prof. Antonis Papadakis</td></tr>
<tr><td>ECTS</td><td>8</td><td>Lectures / week</td><td>3</td><td>Laboratories/week</td><td>0</td></tr>
<tr><td>Course Purpose</td><td colspan="5">The aim of the course is to familiarize the students with the concepts and the principles of renewable energy sources and sustainability. Specifically, we discuss the most popular and widely used renewable technologies in Cyprus and worldwide that of solar cells, wind turbines, biomass, geothermal, fusion, fuel cells and wave energy.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="5">By the end of the course, students must be able to:
1. Explain the basic concepts behind fuel cells.
2. Define the principles of hydrogen production.
3. Explain wind power technology.
4. Describe biomass and biofuel processes.
5. Explain the principles and fundamentals of photovoltaic generation.
6. Examine the basic concepts of wave power generation.
7. Understand the basic concepts of geothermal energy.
8. Examine fusion power principles and devices.</td></tr>
<tr><td>Prerequisites</td><td colspan="2">None</td><td colspan="2">Corequisites</td><td>None</td></tr>
<tr><td>Course Content</td><td colspan="5">• Fuel Cells: Introduction to fuel cells, Electrochemical Cells, Fuel Cell Classification, Temperature of Operation, State of the Electrolyte, Type of Fuel, Chemical Nature of the Electrolyte, Fuel Cell Reactions, Alkaline Electrolytes, Acid Electrolytes, Molten Carbonate Electrolytes, Ceramic Electrolytes, Methanol Fuel Cells.
• Hydrogen Production: Chemical Production of Hydrogen, Historical, Modern Production: a) Partial Oxidation, b) Steam Reforming, c) Thermal Decomposition, d) Syngas, e) Shift Reaction, f) Methanation, g) Methanol, h) Sycrude, Hydrogen Purification, Desulfurization, CO_2 Removal, CO Removal and Hydrogen Extraction, Hydrogen Production Plants, Compact Fuel Processors, Electrolytic Hydrogen, Introduction to Electrolyzer Configurations: a)Liquid Electrolyte Electrolyzers, b) Solid Polymer Electrolyte Electrolyzers, c) Ceramic Electrolyte Electrolyzers, Efficiency of Electrolyzes, Concentration Differential Electrolyzers, Electrolytic Hydrogen Compressors
• Wind Power: Introduction to wind power, Turbine types and terms, Linear momentum and basic theory, Dynamic matching, Blade element</td></tr>
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	theory, Characteristics of the wind, Power extraction by a turbine, Electricity generation, Mechanical power, Social and environmental considerations. • **Biomass and Biofuels:** Introduction to Biomass and Biofuels, Biofuel classification, Biomass production for energy farming, Direct combustion for heat, Pyrolysis (destructive distillation), Further thermochemical processes, Alcoholic fermentation, Anaerobic digestion for biogas, Wastes and residues, Vegetable oils and biodiesel, Social and environmental aspects • **Photovoltaics Generation:** Introduction to Photovoltaic generation, The silicon p–n junction, Photon absorption at the junction, Solar radiation absorption, Maximising cell efficiency, Solar cell construction, Types and adaptations of photovoltaics, Photovoltaic circuit properties, Applications and systems, Social and environmental aspects. • **Wave Power:** Introduction to Wave power, Wave motion, Wave energy and power, Wave patterns, Devices. • **Fusion Energy:** ITER Experiment, Tokamaks, Magnetic Fusion Energy, Inertial Confinement Fusion Energy.
Teaching Methodology	Students are taught the course through lectures (3 hours per week) in classrooms or lectures theatres, by means of traditional tools or using computer demonstration. Auditory exercises, where examples regarding matter represented at the lectures, are solved and further, questions related to particular open-ended topic issues are compiled by the students and answered, during the lecture or assigned as homework. Topic notes are compiled by students, during the lecture which serve to cover the main issues under consideration and can also be downloaded from the e-learning platform or the lecturer’s webpage. Students are also advised to use the subject’s textbook or reference books for further reading and practice in solving related exercises. Tutorial problems are also submitted as homework and these are solved during lectures or privately during lecturer’s office hours. Teaching is based on lectures. The course delivery will be based on theoretical lecturing, assignments and exercises solved in class. Exercises will be handed to students and their solutions shall be analysed at lecture periods. Additional tutorial time at the end of each lecture will be provided to students. Students are expected to demonstrate the necessary effort to become confident with the different concepts and topics of the course.
Bibliography	**(a) <u>Textbooks:</u>** • Aldo V. da Rosa, ***Fundamentals of Renewable Energy Processes***, 3rd Edition, 2012, Elsevier Academic Press. • John Twidell, and Tony Weir, ***Renewable Energy Resources***, Taylor & Francis, 3rd Edition, 2015. **(b) <u>References:</u>** • Bent Sørensen, ***Renewable Energy: Physics, Engineering,***

	Environmental Impacts, Economics and Planning, 5th Edition, Elsevier, 2017. • Gilbert M. Masters, ***Renewable and Efficient Electric Power Systems***, 2nd Edition, John Wiley & Sons, 2013.
Assessment	The students are assessed via continuous assessment throughout the duration of the Semester, which forms the Coursework grade and the final written exam. The coursework and the final exam grades are weighted 40% and 60%, respectively, and compose the final grade of the course. Various approaches are used for the continuous assessment of the students, such as mid-term written exam and assignments. The assessment weight, date and time of each type of continuous assessment is being set at the beginning of the semester via the course outline. An indicative weighted continuous assessment of the course is shown below: • Assignments 30% • Mid-Term written exams 70% Students are prepared for final exam, by revision on the matter taught, problem solving and concept testing and are also trained to be able to deal with time constrains and revision timetable. The criteria considered for the assessment of each type of the continuous assessment and the final exam of the course are: (i) the comprehension of the fundamental concepts and theory of each topic, (ii) the application of the theory in solving related problems and (iii) the ability to apply the above knowledge in more complex design problems. The final assessment of the students is formative and summative and is assured to comply with the subject's expected learning outcomes and the quality of the course.
Language	**English**