UNIVERSITY OF TEXAS ARLINGTON | OFFICE OF SUSTAINABILITY

Faculty Advisory Network on Sustainability
Integrating Sustainability in Curriculum Template

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Department/College: Materials Science & Engineering / College of Engineering

Semester/Year: Fall 2022

Course Name: MSE 4355 / 5355 Materials for Energy

Description

The course aims to introduce concepts and design of advanced materials for sustainable energy generation and storage systems. It will cover polymer electrolyte materials, metallic nanoparticles, semiconductors, and nano-fabrication in clean energy conversion, energy storage, fuel cells, photovoltaic cells, and other emerging energy harvesting and storage.

In a brief paragraph, describe the changes to the course you have revised.

Students will be introduced directly to the UN SDG's and specifically the goals that will be supported by this course. Students will be asked to describe how different materials and methods used in the energy supply chain support those goals. After searching and locating relevant research articles related to each topic, students will complete a literature review over each section. Each student will then use their literature review to create a presentation for the class that must focus on one of the SDG's. Each presentation (covering each energy sector) should address one of the four Sustainable Development Goals given as relevant to the course. They are SDG's 7, 11, 12, and 13. Students must focus at least one presentation on each of these four SDG's. In addition, student reflections will include responding to questions about what they learned about sustainability, materials, and energy. A course project will require students to consider all aspects of the energy supply chain and use the information learned in the course to create a multi-faceted solution that addresses more than one energy sector by using at least one of the Sustainable Development Goals.

Required Texts

Materials and Nanomaterials for Energy, K.L. Wallis, Ph.D., 2022, in development. This textbook will be provided as a free to students Open Educational Resource. It is currently being written and will be piloted for the class in Fall 2022. Following the pilot period, this resource will be published as an open educational resource (OER), meaning faculty and students everyone will be able to download and use the book for free.

Other course material will be research publications that can be accessed through the subscriptions of the UTA library. Some publications may be accessed through Open Access journals, which are also available at no cost to the student.

Learning Outcomes aligned with sustainability

Students will understand the importance of materials science and engineering to each of the following energy sectors and topics:

- Energy sources – photovoltaics, wind, hydro, biomass, fossil fuels, nuclear
- Energy change – gas turbines, fuel cells, hydrogen generation, electrical motors
- Energy distribution – power transmission, smart grids, heat transfer
- Energy storage – electrical, chemical, thermal
- Energy usage – insulation, A/C, lightweight construction, lighting

These learning outcomes are aligned *explicitly* with sustainability. Upon completion of the course, students should be able to:

- Identify materials used in each of the following energy sectors: energy sources, energy change, energy distribution, energystorage, and energy usage.
- Recognize the current state and future needs of each sector in terms of the implications for SDG's 7, 11, 12, and 13.
- Evaluate material solutions by considering the entire life-cycle from production to recyclability and end-of-life possibilities
- Reflect on and provide a thorough description of learned knowledge regarding materials, sustainability, and the energy supply chain
- Synthesize information about all energy sectors and create a logical and reasonable solution to issues found in at least two sectors using one or more of the Sustainable Development Goals.

These learning outcomes are aligned *implicitly* with sustainability. Upon completion of the course, students should be able to:

- Apply knowledge of materials science to identify which physical, chemical, optical, and other material properties contribute to specific needs in the energy industry
- Analyze peer-reviewed literature in each relevant energy category and summarize the important material properties and technologies
- Demonstrate knowledge about the significance of current research in the field of materials science and engineering as it relates to energy

Sustainability Course Competencies:

National Academies of Sciences, Engineering, and Medicine. 2020. *Strengthening Sustainability Programs and Curricula at the Undergraduate and Graduate Levels.* Washington, DC: The National Academies Press. https://doi.org/10.17226/25821.

According to this report, the following competencies should be goals for sustainability courses and programs. These will be incorporated into the course through class discussions and personal reflection questions.

Systems thinking competence: the ability to collectively analyze complex systems across different domains and across different scales, thereby considering cascading effects, inertia, feedback loops, and other systemic features.

Anticipatory competence: the ability to collectively analyze, evaluate, and craft rich "pictures" of the future related to sustainability issues and sustainability problem-solving frameworks. Decision science in the face of uncertainty is a key competency. These skills are tailored to address key issues of sustainability, including unintended harmful consequences and intergenerational equity.

• *Normative competence*: the ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets. This involves applying ethical principles to available alternatives and embracing the value that sustainability is an inclusive goal involving

individual, societal, and environmental well-being. It also recognizes that values guide behavior, which must be incorporated into developing effective sustainability strategies.

• *Strategic competence*: the ability to collectively design and implement interventions, transitions, and transformative governance strategies toward sustainability. Students need to understand theory of change approaches that focus on implementing solutions that have a high potential to scale up, as well as community-led design.

• *Interpersonal competence*: the ability to motivate, engage, and facilitate collaborative and participatory sustainable research and problem-solving. This critical competence includes the need for conflict management, leadership, teamwork, and inclusiveness.

Alignment with the UN Sustainable Development Goals

Please describe which SDGs align with the course teachings- https://sdgs.un.org/goals

Goals **SDG #4 Quality Education** – Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, and **SDG #5 Gender Equality** – Achieve gender equality and empower all women and girls – will be supported by the classroom environment and the pedagogy used in teaching the class.

Goals **SDG #7 Affordable and Clean Energy** – Ensure access to affordable, reliable, sustainable and modern energy for all, **SDG #11 Sustainable Cities and Communities** – Make cities and human settlements inclusive, safe, resilient and sustainable, **SDG #12 Responsible Consumption and Production** – Ensure sustainable consumption and production patterns, and **SDG #13 Climate Action** – Take urgent action to combat climate change and its impacts. These four SDG's are directly relevant to the material covered in the course and will be emphasized in assignments of presentations, reflections, and a course project.

Additional Information and Resources

MSE 4355-5355 Materials for Energy Syllabus Fall 2022 – Attached