MIE 1128: Materials for Clean Energy Technologies
Syllabus – Fall 2024

Course meets Fridays 12-2 pm, BA 1200

Course Instructor: Prof. Olivera Kesler, kesler@mie.utoronto.ca. Extra help time after every class or online by arrangement at mutually convenient times.

Course TA: Sumaiya Farzana, s.farzana@mail.utoronto.ca

E-mail communication: please use MIE 1128 as the start of the subject line of any emails sent regarding the course content.

Course Topics, and proportions for the 13-week semester:

1. (~0.5 weeks) Brief overview of environmental issues and clean energy technologies.

2. (~ 1 week) Solar cell materials. Trade-offs between cost and efficiency. Design strategies.

3. (~ 1 week) Fuel cell materials. Overview of different fuel cell types and major materials requirements for each.

4. (~ 1 week) Solid oxide fuel cell materials. Materials requirements for fuel cell stack components, including challenges posed by high-temperature operating environments. Current materials used for anode, electrolyte, cathode, interconnects, and candidate replacement materials. Lower-temperature operation attempts and added materials requirements. Anode materials for oxidation of multiple fuels.

5. (~ 1 week) Gas turbine materials. Use of high temperature steels, nickel alloys. The gas environment: the need for protective coatings: MCrAlY and thermal barrier coatings (TBC's) based on yttria-stabilized zirconia. Processing methods: thermal spraying and related microstructures.

6. (~ 5 weeks) Conductivity in ceramics and semiconductors. Ionic, electronic, and mixed conductivity. Implications for solar cells, fuel cells, oxide layer growth in gas turbines, oxygen separation membranes for gas turbines, gas sensors.

7. (~ 1 week) Materials for other forms of energy conversion. Wind turbines. Geothermal, hydro, tidal, and wave power. Materials implications of operating environments and design constraints.

8. (~ 3 weeks) Seminar presentations.

Evaluation: 80 % assignments
20 % final seminar presentation on a materials issue (s) related to a clean energy technology

Text: Ceramic Materials Science and Engineering by Carter and Norton (available for free from U of T library in electronic format to download). The chapter on Defects will be covered. Other earlier chapters are recommended for solidification of materials science background. Powerpoint format lecture notes will also be posted on the course website. Notes written on the chalkboard are only available in class.