**Division of Engineering and Mathematics**
**School of Science, Technology, Engineering, and Mathematics**
**University of Washington Bothell**

# B ME 481 A Citizen Engineer (5 cr)

## Winter 2020

Time and Location: MW 8:45 - 10:45 AM, UW1 041

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Office Hours: MW 1:15 - 2:15 PM, F 10:00 - 11:30 AM and by appointment

Canvas Homepage: https://canvas.uw.edu/courses/1368475

## Course Description

*"[A] new epistemology of engineering practice and education is needed, one that is based on the idea of reflective and adaptive practice, systems thinking, engagement, and a holistic approach to global problems. This new form of engineering education and practice must be designed to cover a wide range of technical and nontechnical issues to train global citizen engineers and whole persons, capable of operating in a multicultural world, not just narrow-minded technical experts."*
--Bernard Amadei, Engineering for Sustainable Development, p. 103

*"Mechanical engineering will be challenged to develop new technologies and techniques that support economic growth and promote sustainability."*
--ASME, 2028 Vision for Mechanical Engineers

Citizen Engineer explores the relationship between engineering and society with a focus on roles and responsibilities of engineers in sustainable development. The course draws on economics, ethics, culture, and politics for insight into the interactions between engineering and larger global contexts. It explores what it means to be an engineer who is also an active, ethical participant in local, national, and global communities—a "citizen" engineer.

As builders of infrastructure and agents of technological change, engineers play a critical role in economic development: **we create the built environment**, **and supply the products most people associate with a good life**. Yet, while these products often raise living standards, making and using them may also impose significant costs on society and the environment that may not be taken fully into account in the design process. Pollution, depletion of natural resources, loss of jobs, and widening of social inequalities as a result of unequal access to new technologies, and loss of privacy are examples of such costs. More tragic are occasions when greed, professional negligence, or incompetence result in the release of dangerous products, industrial accidents, and disasters that harm people, property, and environment. Although risk

can never be eliminated, an uncompromising commitment to ethical behavior, coupled with a sensitivity to the social and political contexts, can certainly reduce it, while maximizing the benefit engineers bring to society.

*This year's theme is energy transition, focusing on the electricity system.*

By now you all are well versed in the physics of energy. You've studied energy conversion in thermal, electrical, and mechanical systems, and some of you may even be applying energy science in your capstone design projects. The goal of this course is to broaden your knowledge of energy and to situate it within larger social, economic, and political processes. We push beyond the science and engineering to ask:

- What happens to energy once engineering has transformed it into a useful service? What factors drive the engineering of energy systems, determine where investments are made, and regulate its production and end use?
- How are imperatives of climate change, economic growth, and social justice shaping the energy system and pushing it in new directions?
- What does "sustainable energy" mean in the larger context of sustainable development?
- How are engineers stepping up to the challenge of energy transition? What are we in the engineering community doing to ensure that our designs and innovations are being deployed for just and ethical ends? What should we be doing?

We approach these questions from four directions.

1. Philosophy: We will apply various philosophical approaches to develop insights into difficult and often controversial terms such as "justice," "good," "fair," "ethical," and "sustainable."

2. Energy science: We examine renewable energy and storage technologies in terms of how they work and their effects on the energy system.

3. Political economy: We learn about the business and economics of energy, the operation of electricity markets, and the role of policy and regulation in energy transition.

4. Professional practice: We explore professional licensure in engineering, engineering ethics, and role professional engineers can play in sustainable development.

The course is designed to meet graduation requirements for diversity (D), writing (W), and individuals and society (I&S) credits. Accordingly, it includes substantial amounts of writing, as well as reading and assignments more typical of liberal arts than of engineering courses. By its design, the course should push you outside your comfort zone and into a mode of critical thinking that cuts across technical and nontechnical fields. You will be challenged to think, speak, and write with clarity, logic, and persuasiveness. I hope that you will leave the course with strengthened resolve to be an ethical engineer and engaged citizen. Such is the hallmark of the "citizen engineer."

**Community-Based Learning and Research (CBLR)**

Citizen Engineer is a Community-Based Learning and Research (CBLR) course. CBLR is a collaboration between universities and organizations in the larger community for the mutually beneficial exchange of knowledge and resources. Through participation in CBLR projects and reflection on the results, students gain a deeper understanding of the course content and a

heightened sense of civic responsibility. Other benefits include experience managing real-world projects and working with clients, building professional networks, and acquisition of new knowledge outside one's own discipline.

Five key elements make up the core of CBLR:
1) Engagement with the community beyond the university around a matter of mutual interest.[1]
2) Academic content that grounds and informs the collaboration.
3) Reciprocity in the form of mutual trust and shared effort between students and partners.
4) Mutual learning by both students and partners.
5) Reflection on the work accomplished, implications, and extent to which it contributed to the attainment of course learning outcomes.

Our partner this year is The Energy Authority (TEA). TEA is a nonprofit corporation with offices in Jacksonville, Florida and Bellevue, Washington.[2] Its owners are public power utilities. It provides public utilities with access to advanced resources and technology systems so they can respond competitively in the changing energy markets. Through partnership with TEA, utilities benefit from an experienced organization that is singularly focused on deriving the maximum value of their assets from the market. TEA offers portfolio management, Regional Transmission Organization (RTO) market management, natural gas management, bilateral energy trading, power supply management, and advisory services to their clients.

Representing the partner in our collaboration are Mr. Scott Gleason and Mr. Kevin Galke. Mr. Gleason directs TEA's energy trading operations for the western US. Mr. Galke manages portfolio analytics. Both are based in TEA's Bellevue office. Supporting our project is the UWB Office of Community-Based Learning and Research and its Director, Kara Adams.[3]

## Learning Outcomes

At the end of this course, students will be able to:

1. Identify and compare different ways of thinking about ethics, justice, and sustainability.
2. Apply perspectives from engineering and ethics to the analysis of public policy related to energy and the environment.
3. Describe the organization and operation of the energy system.
4. Describe how electricity markets operate.
5. Explain how intermittent sources of electric power work, and identify challenges and opportunities in their integration into the electricity system.
6. Execute a community-based learning and research (CBLR) project to deliver a solution that meets the partner's requirements.

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[1] Marybeth Lima and William C. Oakes, *Service-Learning: Engineering in Your Community, Second Edition* (Oxford University Press, 2014), pp. 3-4.

[2] http://www3.teainc.org

[3] https://www.uwb.edu/cblr

## ABET Learning Outcomes

The learning outcomes for this course map to ABET outcomes (3), (4), (5), and (7):

(3) An ability to communicate effectively with a range of audiences.
(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## Course Materials

Textbooks:
Travis Bradford, *The Energy System: Technology, Economics, Markets, and Policy* (The MIT Press, 2018).
Michael J. Sandel, *Justice: What's the Right Thing to Do?* (New York: Farrar, Straus and Giroux, 2009).

Other readings will be posted in Canvas as needed.

## Assignments

1. **Classwork and Discussion (20%)**
   A class like this needs active, informed participation. Expect on any day to receive a worksheet with exercises and activities to do individually or in groups. Some may require a short oral report to the class after the assignment has been completed; others may require you to write out an answer in paragraph form. Some may be given out ahead of time so that you have more time to prepare. Exercises may be based on the readings, items in the news, your capstone projects, or lecturer. Classwork will collected at the end of each class. Bring all assigned reading to each class meeting.

2. **Canvas Quizzes (20%)**
   Five online quizzes will be spread out across the term. Quizzes are open book and consist mostly of multiple choice questions based on the reading, though you should not be surprised to see an occasional short answer, fill-in-blank, or essay (one paragraph) question mixed in. Each quiz will be activated in Canvas around one week before it is due. Quizzes are due by 11:59 pm on the date they appear on the syllabus.

3. **Ethics and Policy Essay (20%), 1000 - 1500 words in length**
   This essay applies ethical and political economy arguments to advocate for or against Senate Bill 5489 ("Environmental Justice Bill") under consideration in the current Washington State legislative session.[4] This bill is of interest to the Washington Society of Professional Engineers, of which I am past President and current Executive Committee Member, because

[4] https://app.leg.wa.gov/billsummary?BillNumber=5489&Year=2019&Initiative=False

of its potential impact on the engineering community in our state. I am, at this time, neutral on the bill, so I am open to being persuaded to take a side. Your job: advise me which position I should take. Since your essay is a policy recommendation directed at me, feel free to address me directly in the text.

Your essay should draw from the various approaches to ethics and justice we study in the course. Also, use your engineering judgment, and consider economic and societal implications. Your essay should include one counter argument, followed by a refutation that shows the greater persuasiveness and reasonableness of the position you are advocating. Your sources include the text of the bill itself, hearings and documents related to the bill, advocacy and commentary by organizations for and against the bill, news articles, and our course texts. In particular, I ask that you think hard about the meaning of "environmental justice," both in the abstract and in the specific context of the proposed legislation. Key questions include the extent to which the goal of furthering environmental justice warrants political action at the state level and the the form such actions should take.

The essay should be word-processed, in 14-point font. Double-space everything. Number the pages at the bottom right, except for the first page. Include your name at the top of the first page of the essay. Include list of references at the end. Cite sources using IEEE citation forma, which can be found here: https://ieee-dataport.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf

Bring four copies of a draft of the complete paper—it shouldn't be the first, rough draft, but neither should it be the final version!—to class on **Wednesday, February 12**. On that day, we will have a peer writing session, facilitated either by me or a consultant from the Writing Center. You will work in small groups; each student will read and critique the draft of each of the other students, following the instructions and coaching given by the facilitator. Using the feedback from your peer group, you will revise the essay. Attach the original version (the one your peer group edited), showing the markups you made in response to the feedback. Submit your essay in class, in hard copy, on **Wednesday, February 19**. In addition, upload the final draft, minus the edited version, to Canvas no later than 11:59 pm the same day. Be aware that the essays will be processed through the VeriCite plagiarism detection system on Canvas.

4. **Community Based Learning Project (20%)**
Among the services The Energy Authority (TEA) provides to public power utilities that are its clients is support in composing Integrated Resource Plans (IRPs). An IRP is a roadmap utilities use to plan how they will meet future electric power needs in their service regions. IRPs look at current and projected future demand for electricity; match that demand with their current generation, transmission, and distribution assets; and show how they will develop their resources to meet any gaps while also complying with applicable laws and regulations. According to one source, "Essentially, an IRP states: '*We have these resources and this problem. This is how we will use the first to solve the second.*"[5]

As states mandate cleaner energy with less greenhouse gas emissions, and customers generate more of their own power in-house or within their own communities (distributed generation), planning for the future has become much more challenging for utilities, especially

[5] https://energyacuity.com/blog/what-is-an-integrated-resource-plan-why-is-it-important/

ones that are small or publicly owned. Enter companies like TEA, which helps public utilities with these plans.

TEA wants your help with two such IRPs. One is for a public utility in California, the other for one in Washington State. Your task: In teams of ~4 students, help TEA with background research and a short report on one of the following:

- Local air pollution minimization for disadvantaged communities in California: Describe and provide quantitative evidence to support how electric power load serving entities (LSEs) in a California public utility district will meet renewable portfolio standard (RPS) and greenhouse gas (GHG) emission obligations from 2018 to 2030.

- Meeting requirements of Section 8 of the 2019 Clean Energy Act in Washington State (SB 5116): The 2019 Clean Energy Act[6] requires that utilities in the state achieve new clean energy standards through programs that a) deliver long-term and short-term public health benefits while reducing costs and risks; b) equitably distribute energy benefits and reduction of burdens to vulnerable populations; c) enhance energy security and resiliency; and d) avoid negative environmental impacts to vulnerable communities. Propose a set or recommendations for how public utilities in WA should implement these new regulations.

Your final deliverable is a report, ~5-8 pages in length (one per group), single-spaced summarizing findings in the format specified by TEA, which is your client for project. Details on content, organization, and schedule will be worked out between each team and the client, assisted by UWB's Office of Community-Based Learning and Research. The final report will be submitted to the client and to me on **March 11**. TEA will introduce the projects at our first class meeting. Reports will be assessed on the degree to which they satisfy the client's requirements—which, in the end, is how our work as engineers is judged in the real world!

5. **Reflection Essay, ~1000 words in length (20%)**
Each student submits this essay on Canvas no later than **11:59 pm March 18**. In it you should reflect on what you learned in the course, and how you have come to understand the meaning of "citizen engineer" and "professional engineer" in the context of energy transition, sustainable development, and the common good. Devote at least a paragraph to the CBLR project's contribution to your learning.

## Policies and Campus Resources

Grading: All assignments are scored on the 100-point scale. Canvas will convert the score from the 100-point scale ($x$) to the 4-point scale ($y$) by the following rule:

If $x > 95$, then $y = 4.0$

If $62 \le x \le 95$, then $y = x/10 - 5.5$ If $x < 62$, then $y = 0$

More information on the UW grading system can be found here:
http://www.washington.edu/students/gencat/front/Grading_Sys.html

Late and missed assignments: Classwork not submitted by the end of the class in which it is assigned receive a grade of zero. The lowest grade will be dropped. All other assignments will

[6] https://app.leg.wa.gov/billsummary?BillNumber=5116&Initiative=false&Year=2019

receive a deduction of 10% for each day late unless I can be persuaded to excuse the lateness; after three days, the grade becomes a zero.

Religious accommodations: Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy (https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/). Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form (https://registrar.washington.edu/students/religious-accommodations-request/).

Academic integrity: Engineering is a profession demanding a high level of personal honesty, integrity and responsibility. Therefore, it is essential that engineering students, in fulfillment of their academic requirements and in preparation to enter the engineering profession, adhere to the University of Washington's Student Code of Conduct (https://www.washington.edu/cssc/for-students/student-code-of-conduct/). Acts of academic misconduct may include but are not limited to

- Cheating, which includes working collaboratively and sharing answers on exams and other assignments, unless explicitly authorized to do so.
- Plagiarism, defined as representing the work of others as your own and not giving appropriate attribution to the author(s) whose work you are using in your research.

Concerns about these or other behaviors prohibited by the Student Conduct Code will be reported to the Student Conduct Office (https://www.uwb.edu/studentaffairs/studentconduct). Students who have engaged in academic misconduct on a particular assignment will receive a zero on the assignment, and the case will be referred to the Student Conduct Office for possible further action.

Disability resources: If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 425-352-5307 or uwbdrs@uw.edu. Reasonable accommodations are established through an interactive process between student, instructor, and DRS. For more information: https://www.uwb.edu/studentaffairs/drs

Office of Community-Based Learning and Research: Located in the Student Success Center, in UW1, first floor, uwbcblr@uw.edu.

For more a complete listing of STEM School Policies, see https://www.uwb.edu/getattachment/stem/about/stem-policies/Classroom-Policies-STEM-FC-1-12-17.pdf

Schedule for B ME 481 Winter 2020

| Date | Topic | Reading | Submission |
|---|---|---|---|
| 1/6 | Course introduction | | |
| 1/8 | Ethics - Doing the Right Thing<br>Energy - Thinking of Energy as a System | Sandel, Ch 1<br>Bradford, Ch 1 | |
| 1/13 | Ethics - Utilitarianism<br>Energy - Electric Industry in US Overview | Sandel, Ch 2<br>Bradford, Ch 4A-4C | |
| 1/15 | Ethics - Libertarianism and Markets<br>Energy - Electric Industry Markets and Regulation | Sandel, Chs 3-4<br>Bradford, Ch 4D-4F | Quiz 1 |
| 1/20 | Martin Luther King Day (no class) | | |
| 1/22 | Ethics - Kant and the Categorical Imperative<br>Energy - Economics of Elecricity | Sandel, Ch 5<br>Bradford, Ch 5 | |
| 1/27 | Ethics - Equality and Distribution<br>Energy - Fossil Fuel System | Sandel, Ch 6<br>Bradford, Ch 7 | Quiz 2 |
| 1/29 | Ethics - Affirmative Action for and Against<br>Energy - Hydro and Nuclear Power Systems | Sandell, Ch 7<br>Bradford, Ch 8 | |
| 2/3 | Ethics - Who Deserves What?<br>Energy - Renewables System - Wind | Sandel, Ch 8<br>Bradford, Ch 9A-9B | Quiz 3 |
| 2/5 | Ethics -Loyalty and Obligation<br>Energy - Renewables System - Solar | Sandel, Ch 9<br>Bradford, Ch 9C, 11A | |
| 2/10 | Ethics - Is there a “Common Good?”<br>Energy - Storage | Sandel, Ch 10<br>Bradford, Ch 10 | Quiz 4 |
| 2/12 | Peer Writing Workshop (bring 4 copies of essay!) | | |
| 2/17 | Presidents Day (no class) | | |
| 2/19 | Ethics in Engineering 1: Responsibilities<br>Ethics in Engineering 2:  Boeing 737 Max | Engineering Ethics 1*<br>Engineering Ethics 2* | Essay due |
| 2/24 | Ethics in Engineering 3: Codes of Ethics<br>Energy - Distributed Generation | Engineering Ethics 3*<br>Bradford Ch 11B-11D | |
| 2/26 | Energy - Future of the Electric Energy System | Bradford Ch 12 | Quiz 5 |
| 3/2 | Ethics in Engineering 4: AVs and AI | Engineering Ethics 4* | |
| 3/4 | Licensure and the Professional Engineer | What is a PE?* | |
| 3/9 | Open for Guest Speaker and Project Work | | |
| 3/11 | Open for Guest Speaker | | Project due |
| 3/16 | Order of the Engineer Induction (Optional) | | |

* Indicates readings that will be made available in Canvas.