

Dr. Dean Livelybrooks  
Dept. of Physics; Univ. of Oregon  
Winter 2017

**Physics 162 – Physics of Solar and Renewable Energies**  
**SYLLABUS**

<b>INSTRUCTOR</b>	<b>Dr. Dean Livelybrooks</b> Office: 225 Willamette Hall, Email: <a href="mailto:dlivebyb@uoregon.edu">dlivebyb@uoregon.edu</a>
<b>CLASS TIMES</b>	TuTh 14:00-15:50 (2:00-3:50 pm), Willamette 110 <i>Attendance is not required, but is <b>very</b> strongly recommended.</i>
<b>TEACHING ASSISTANTS</b>	Graduate student teaching fellow (GTF): <ul style="list-style-type: none"><li>• Spencer Alexander: <a href="mailto:spencerjhalexander@gmail.com">spencerjhalexander@gmail.com</a></li></ul> Science Literacy Program (SLP) Fellows: <ul style="list-style-type: none"><li>• Graduate: Blake Parris: <a href="mailto:parris@uoregon.edu">parris@uoregon.edu</a></li><li>• Undergraduate: Ilia Duckler: <a href="mailto:iduckler@uoregon.edu">iduckler@uoregon.edu</a></li></ul>
<b>OFFICE HOURS</b>	<b>Make use of office hours!</b> Even if you don't have specific questions about homework, feel free to drop by and chat about course topics. <ul style="list-style-type: none"><li>• Dr. Livelybrooks ('Dr. D.'), Weds. (09:00) and Thurs. 09:30, Willamette 225.</li><li>• Blake Parris, Graduate SLP Fellow, Weds 14:00, Willamette 40.</li><li>• Ilia Duckler, Undergrad. SLP Fellow, TBA, TBA</li><li>• Spencer Alexander: Thursday, 17:00 (5pm), B010 (Physics) Science Library</li></ul> Note: <i>office hour times may change</i> , both by request (if particular times are bad for many students) and due to scheduling conflicts of the instructors (e.g. travel). <i>You're strongly encouraged to come to office hours, either with specific course-related questions, or just to chat about physics, science, and other general topics.</i>
<b>EMAIL</b>	<b>Email:</b> You can certainly ask questions of me and the teaching assistants by email. I usually respond within 48 hours. Although I encourage emails between students, the instructor, SLP Fellows and the TA to encourage learning, I (personally) rarely respond to emails that begin "Hey..." or are otherwise poorly constructed.
<b>TEXTBOOK</b>	<ul style="list-style-type: none"><li>• There is no required textbook for the course. The lectures plus supplemental readings supplied via Canvas will be sufficient.</li><li>• <i>Energy, Environment, and Climate</i> by Richard Wolfson is recommended – it's a very good, recent book on these topics. I've placed a copy on reserve at the</li></ul>

Science Library.

We'll also use parts of *Sustainable Energy – Without the Hot Air* by David MacKay, a remarkable book that quantifies a lot of energy-related issues. The book is available **free** online, at <http://www.withouthotair.com/>.

## TOPICS AND AIMS

Modern civilization uses vast amounts of energy in forms that are unsustainable and environmentally damaging. What are our alternatives? Can they meet our needs?

We'll explore, briefly, conventional energy sources and their environmental impacts. We will look at alternative forms of energy—solar, wind, wave, geothermal, biomass, etc.— and their challenges, including their general intermittency and the problem of energy storage. We will also look at energy conservation as a 'source' of alternate energy. We will do this *quantitatively*, investigating the physics behind various energy sources, storage schemes, and conservation efforts. Why? It's easy to have good intentions about energy and the environment, but without quantitative analysis, good intentions alone are insufficient for guiding important decisions and can often do real harm.

*Who are you?* By enrolling in this course, I'm assuming it's likely that you care about energy issues. By being university students, I'm assuming that you'll be the decision-makers of the future – businesspeople, policy makers, or at least voters – who will be faced with complex choices having to do with energy and society.

We'll examine a variety of topics:

1. Present energy usage and sources
2. Energy: What is it?
3. Fossil Fuels and their environmental impacts, including climate change (Brief\*)
4. Wind, wave, and geothermal energy sources
5. Solar energy
6. Energy storage
7. Energy conservation
8. Biomass
9. (if time allows) Geoengineering and other tactics for dealing with climate change

\* Fossil fuels and Climate Change are discussed at length in **Physics 161** (Physics of Energy and the Environment). Physics 161 **is not** a prerequisite for 162.

*Other goals:* We will develop our abilities to think critically and quantitatively about scientific issues. Science, contrary to what you may have experienced in the past, is not about "learning facts" but rather about learning how to investigate and draw logical conclusions. We'll practice this!

## LEARNING OUTCOMES

Students completing the course will have enhanced their abilities to:

- Understand how physical principles influence energy use.
- Assess and interpret graphs and quantitative data.
- Understand the process by which science generates knowledge.

<b>CANVAS</b>	We will be using Canvas in this course to distribute course materials, and also for online assignments. URL: <a href="https://canvas.uoregon.edu/">https://canvas.uoregon.edu/</a>
<b>HOMEWORK</b>	<p>There will be homework assignments approximately every week. Feel free to discuss the questions with others, but of course, <i>the work you submit should be your own</i>. Assignments will mainly be submitted online, via Canvas. Solutions to all the problem sets will be posted – <b>study</b> these. <u>No late homework will be accepted.</u> Some assignments will involve finding and analyzing data. You should be able to navigate the internet and make simple graphs (e.g. with Excel).</p> <p><i>Homework grading:</i></p> <p>(1) Each student’s lowest score will be dropped from the overall total.</p> <p>(2) We will not comment in detail on your homework when grading it. It is especially important to study the problem set solutions.</p> <p>(3) <u>Feel free to discuss homeworks during office hours</u> (with instructor, SLP Fellows, TA).</p>
<b>QUIZZES</b>	There will be about 5 short quizzes. (They won’t be surprises; you’ll get advance notice of at least one class.) We’ll use these to assess understanding of key points as we progress without the heavy weight of a “real” exam. Each student’s lowest quiz score will be dropped from the overall total. There won’t be any make-up quizzes; if you miss one, this will be the quiz dropped from your overall grade calculation.
<b>POP. SCIENCE ARTICLES</b>	I’ll assign various “popular” science articles and ask you to analyze and comment on them. These assignments will be described further as the term progresses.
<b>CLICKERS</b>	<p>We’ll use “clickers,” personal response systems that allow real-time polling and assessment in class. There is a participation grade associated with the clickers, described further in the grading section. Each student needs one clicker, which looks like this:</p>  <p>Clickers can be purchased at the bookstore. Borrowing a clicker from someone <i>not</i> enrolled in this course <u>will</u> work fine as long as you always use this clicker in class, and no one else is using it in class.</p> <p><b>Clicker registration:</b> We’ll do this through Canvas – details TBA; <b>don’t</b> use <a href="http://iclicker.com">iclicker.com</a>!</p> <p><b>Overall score.</b> Clicker points cannot be made up. However, I realize that absences are unavoidable, and so I will rescale the clicker scores so that 90%</p>

	counts as 100%; i.e. you can miss 10% of the clicker
<b>GRADING</b>	<p>The various grade components and their weights for the final grade are:</p> <ul style="list-style-type: none"> <li>• <i>Homework Assignments: 20%</i></li> <li>• <i>Quizzes: 20%</i></li> <li>• <i>Popular Science Article Assignments: 12%</i></li> <li>• <i>Clicker (participation): 8%</i></li> <li>• <i>Midterm Exam (probably February 9): 20%</i></li> <li>• <i>Final Exam (12:30pm Wednesday, March 22): 20%</i></li> </ul> <p><b>Overall Grade:</b> A=88-100%; B=76-87.9%; C=64-75.9%; D=52-63.9%; F&lt;52%.</p> <p><b>Absences.</b> Students with a serious and well-documented reason for missing an exam should contact Dr. Livelybrooks to discuss accommodations.</p>
<b>LAPTOPS IN CLASS</b>	
<p><u>The use of laptop computers in class is not allowed.</u> Why? Several studies, plus past experience, show that students using laptops in class spend a great deal of time on non-class-related activities (surfing the web, playing games, ...) and that these distractions negatively impact both learning and grades. This alone isn't a reason to ban laptops – you're responsible for your own performance in class. <i>In addition</i>, however, studies have shown that non-class-related laptop use distracts and impacts the learning of <i>other students nearby</i>. (E.g. Fried, C. B. <i>Computers &amp; Education</i> <b>50</b>, 906-914 (2008).) Plus, <i>students</i> have complained to me about the environment created by their classmates' laptop use.</p> <p>Taking notes by hand, by the way, is more effective in cementing concepts in your mind. (Note, by the way, that lecture slides are posted online, so you don't have to frantically transcribe everything anyway.)</p> <p><b>In summary, laptops are not allowed in class.</b> The only exceptions will be for people with documented medical needs; please see me if this is the case.</p>	
<b>HOW TO DO WELL IN THE COURSE</b>	<ul style="list-style-type: none"> <li>• Attend class.</li> <li>• Do the homework, and study the solutions.</li> <li>• Work on understanding all the concepts and example questions discussed in the lectures and the homework. "Understanding" does <i>not</i> mean "it sounds like it makes sense to me," but more deeply, "I could explain this concept to one of my classmates."</li> <li>• Come to my or the SLP Fellows/GTFs' office hours with questions!</li> <li>• <i>Another suggestion: <b>Sleep!</b> Numerous studies show that sleeping helps both memory and understanding.</i></li> </ul>
<b>STUDENTS WITH DISABILITIES</b>	If aspects of the instruction or design of this course result in barriers to your inclusion, please notify me as soon as possible. You are also welcome to contact Disability Services in 164 Oregon Hall, 346-1155.

Dr. Dean Livelybrooks, University of Oregon  
**Calendar: Physics 162, Winter 2017**

DATE	AGENDA
<b>Week 1: January 10, 12</b>	
Tu 10 <sup>th</sup>	<p><i>Class 1:</i> Very short intro to present energy usage and making sense of graphs. Estimation; Power and Energy. Course Syllabus.</p> <p><i>Reading:</i> none</p> <p><i>Assignments:</i> Homework #1, due Tuesday 17<sup>th</sup>; Math Diagnostic <b>first attempt due Thursday 12<sup>th</sup>.</b></p>
Th 12 <sup>th</sup>	<p><i>Class 2:</i> More on Power and Energy. Math review; “office hours”</p> <p><i>Reading:</i> Chapter 1 of “Make it stick”, or Blog post about this.</p> <p><b>Assignment Due: First try to pass Math Diagnostic quiz (on-line, before class).</b></p> <p><i>Assignment:</i> Homework #2, due Thursday, 19-January.</p>
<b>Week 2: January 17, 19</b>	
Tu 17 <sup>th</sup>	<p><i>Class 3:</i> Fossil Fuels, climate (Brief version of Phys. 161 discussion). Different forms of energy</p> <p><b>Assignment Due: Homework #1.</b></p> <p><b>Quiz 1</b></p>
Th 19 <sup>th</sup>	<p><i>Class 4:</i> Conservation of energy. Forms of Energy. Hydroelectric power</p> <p><b>Assignment Due: Homework #2.</b></p> <p><i>Assignments:</i> Homework #3, due next Thursday (26-January); Popular Science Article Assignment 1, due Thursday, 2-February.</p>
<b>Week 3: January 24, 26</b>	
Tu 24 <sup>th</sup>	<p><i>Class 5:</i> Hydroelectric power (including specific and overall U.S. abundance estimate). Intro to electromagnetic induction, generators. Hydroelectric issues.</p>
Th 26 <sup>th</sup>	<p><i>Class 6:</i> More on electromagnetism, induction, generators. The electrical distribution grid.</p> <p><b>Assignment Due: Homework #3.</b></p> <p><i>Assignment:</i> Homework #4, due next Thursday (2-February).</p> <p><b>Quiz 2</b></p>
<b>Week 4: January 31, February 2</b>	
Tu 31 <sup>st</sup>	<p><i>Class 7:</i> Wind power (scaling, then more exact).</p>
Th 2 <sup>nd</sup>	<p><i>Class 8:</i> Wind power: efficiency, spacing, overall abundance; other issues.</p> <p><b>Assignment Due: Homework #4.</b></p> <p><b>Assignment Due: Popular Science Article Assignment 1</b></p>
<b>Week 5: February 7, 9</b>	
Tu 7 <sup>th</sup>	<p><i>Class 9:</i> Solar power; insolation. Exam review and a bit about tides.</p>

Th 9 <sup>th</sup>	<p><b>Midterm Exam</b></p> <p><i>Assignment:</i> Popular Science Article Assignment 2 due Thursday, 23-February</p>
<b>Week 6: February 14, 16</b>	
Tu 14 <sup>th</sup>	<i>Class 10:</i> Solar power and semiconductors.
Th 16 <sup>th</sup>	<p><i>Class 11:</i> Photovoltaics.</p> <p><i>Assignment:</i> Homework #5, due Thursday, 23-February</p> <p><b>Quiz 3.</b></p>
<b>Week 7: February 21, 23</b>	
Tu 21 <sup>st</sup>	<i>Class 12:</i> Photovoltaics, incl. photons, efficiency, worksheet
Th 23 <sup>rd</sup>	<p><i>Class 13:</i> Photovoltaics: multi-junction devices. Solar power: cost and other issues</p> <p><b>Assignments Due: Popular Science Article Assignment 2; Homework #5.</b></p> <p><i>Assignment:</i> Homework #6, 2-March; Popular Science Article Assignment 3 due Thursday, 9-March</p>
<b>Week 8: February 28, March 2</b>	
Tu 28 <sup>th</sup>	<i>Class 14:</i> Batteries and Energy Storage
Th 2 <sup>nd</sup>	<p><i>Class 15:</i> Solar energy: Passive solar heating; active solar heating; solar thermal power. Thermal energy (brief).</p> <p><b>Assignment Due: Homework #6.</b></p> <p><i>Assignment:</i> Homework #7, due Thursday 9-March</p> <p><b>Quiz 4</b></p>
<b>Week 9: March 7, 9</b>	
Tu 7 <sup>th</sup>	<i>Lecture 16:</i> Heat engines; Carnot efficiency. Geothermal.
Th 9 <sup>th</sup>	<p><i>Lecture 17:</i> Finish geothermal. Biofuels. Food.</p> <p><b>Assignments Due: Popular Science Article Assignment 3, Homework #7</b></p> <p><i>Assignment:</i> Homework #8.</p>
<b>Week 10: March 14, 16</b>	
Tu 14 <sup>th</sup>	<p><i>Lecture 18:</i> Biofuels. Nuclear, Fuel Cells. Hydrogen. Outlook and Overview.</p> <p><b>Quiz 5</b></p>
Th 16 <sup>th</sup>	<p><i>Lecture 19:</i> Review (question time)</p> <p><b>Assignment Due: Homework #8.</b></p>
<b>Final Exam Week, Weds March 22, 12:30-14:20</b>	
We 22 <sup>nd</sup>	FINAL EXAM