

## Course Outline

1. COURSE INFORMATION			
Session Offered	Fall 2023		
Course Name	Renewable Generation		
Course Code	ENR TECH 4RG3		
Date(s) and Time(s) of lectures	Saturdays, 1:00pm – 4:00pm		
Program Name	Power and Energy Engineering Technology		
Calendar Description	Design, installation and commissioning of Solar and Wind powered systems. The environmental and economic impacts of such technologies. Federal and provincial rules, regulations, and legislation.		
Instructor(s)	Laith Al-Musawi	E-Mail: <a href="mailto:almusal@mcmaster.ca">almusal@mcmaster.ca</a> Office Hours & Location: Online by appointment	
2. COURSE SPECIFICS			
Course Description			
Instruction Type	<b>Code</b>	<b>Type</b>	<b>Hours per term</b>
	C	Classroom instruction	39
	L	Laboratory, workshop or fieldwork	
	T	Tutorial	
	DE	Distance education	
	<b>Total Hours</b>		39
Resources	<b>ISBN</b>	<b>Textbook Title &amp; Edition</b>	<b>Author &amp; Publisher</b>
	9780470015001	Wind Energy Explained Theory, Design and Application, 2 <sup>nd</sup> Edition	J. F. Manwell, J.G. McGowan, A.L. Rogers, John Wiley & Sons Ltd
	9780199545339	Renewable Energy – Power for a Sustainable Future, 3 <sup>rd</sup> Edition	Edited by Godfrey Boyle, Oxford
	9780415633581	Renewable Energy Resources, 4 <sup>th</sup> Edition	John Twidell, Routledge
	<b>Other Supplies</b>		<b>Source</b>
RETScreen Matlab/Simulink		<a href="http://www.natural-resources.canada.ca">www.natural-resources.canada.ca</a> <a href="https://www.mathworks.com/products/simulink.html">https://www.mathworks.com/products/simulink.html</a>	
Prerequisite(s)	ENRTECH 3EP3, ENGTECH 3TD3 and ENGTECH 4TF3.		
Corequisite(s)			
Antirequisite(s)			
Course Specific Policies			
Departmental Policies	Students must maintain a GPA of 3.5/12 to continue in the program.  In order to achieve the required learning objectives, on average, B.Tech. students can expect to do at least 3 hours of “out-of-class” work for every		

	<p>scheduled hour in class. “Out-of-class” work includes reading, research, assignments and preparation for tests and examinations.</p> <p>Where group work is indicated in the course outline, such collaborative work is mandatory.</p> <p>The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during the class time, unless the instructor makes an explicit exception.</p> <p>Announcements made in class or placed on Avenue are considered to have been communicated to all students including those individuals that are not in class.</p> <p>Instructor has the right to submit work to software to identify plagiarism.</p>	
<b>3. SUB TOPIC(S)</b>		
Week 1 (Sept 9 <sup>th</sup> )	<p><b>Course Introduction</b></p> <ul style="list-style-type: none"> <li>Renewable Energy in Ontario and Canada: Wind, Solar, Hydro, and energy storage.</li> </ul> <p><b>Wind Turbine Design – Aerodynamics of Wind</b></p> <ul style="list-style-type: none"> <li>Wind Energy as Kinetic Energy</li> </ul>	
Week 2 (Sept 16 <sup>th</sup> )	<p><b>Wind Turbine Design – Aerodynamics of Wind Cont.</b></p> <ul style="list-style-type: none"> <li>Betz’ Limit</li> <li>Coefficient of Performance</li> <li>Wind Turbine Tip Speed Ratio</li> <li>Aerodynamic Force on Turbine Blades</li> <li>Mechanical Power from Wind Turbines</li> </ul>	Ch. 3 – Book 1
Week 3 (Sept 23 <sup>rd</sup> )	<p><b>Wind Turbine Generator</b></p> <ul style="list-style-type: none"> <li>Type 1: Induction Generator</li> <li>Type 2: Wound Rotor Induction Generator with Variable Rotor Resistance</li> <li>Type 3: Doubly-Fed Induction Generator</li> <li>Type 4: Induction Generator with Full Converter</li> </ul>	Ch. 5 – Book 1
Week 4 (Sept 30 <sup>th</sup> )	<i>* No class (National Day for Truth and Reconciliation) *</i>	
Week 5 (Oct 7 <sup>th</sup> )	<p><b>Wind Farm Design and Construction</b></p> <ul style="list-style-type: none"> <li>Wind Farm Components</li> <li>Grid Connection Assessment</li> </ul>	Ch. 5, 8 Book 1
Week 6 (Oct 14 <sup>th</sup> )	<p><b>Wind Characteristics and Resources</b></p> <ul style="list-style-type: none"> <li>Meteorological Towers</li> <li>Statistical Analysis of Wind Data</li> <li>Estimation of Prospective Areas – Wind Resource Maps</li> <li>Estimating Energy Output</li> </ul>	Ch. 2 – Book 1
Week 7 (Oct 21 <sup>st</sup> )	<i>*Midterm Recess*</i>	
Week 8 (Oct 28 <sup>th</sup> )	<b>Midterm Exam</b>	

Week 9 (Nov 4 <sup>th</sup> )	<b>Hydro Turbines</b> <ul style="list-style-type: none"> <li>• Pelton Turbine</li> <li>• Francis Turbine</li> <li>• Kaplan Turbine</li> </ul>	Ch. 5 – Book 2
Week 10 (Nov 11 <sup>th</sup> )	<b>Hydroelectric Power – Fundamentals</b> <ul style="list-style-type: none"> <li>• Hydroelectric Resources in Ontario</li> <li>• Large, Small and Micro Hydropower Plants</li> <li>• Storage and Run-of-River Power Plants</li> <li>• Salient Pole Generator</li> </ul>	Ch. 5 – Book 2
Week 11 (Nov 18 <sup>th</sup> )	<b>Solar Power Technologies</b> <ul style="list-style-type: none"> <li>• Available Solar Radiation</li> <li>• Semiconductor Physics</li> <li>• Photovoltaic Systems</li> </ul>	Ch. 3 – Book 2
Week 12 (Nov 25 <sup>th</sup> )	<b>Solar Power – Part II</b> <ul style="list-style-type: none"> <li>• Solar Farm Design, Operation and Maintenance</li> <li>• Roof-top Solar Panels</li> <li>• Energy Storage</li> </ul>	Ch. 2 – Book 2
Week 13 (Dec 2 <sup>nd</sup> )	<b>Electrochemistry</b> <ul style="list-style-type: none"> <li>• Redox reactions</li> <li>• Galvanic Cells</li> <li>• Cell Potential</li> </ul> <b>Battery Energy Storage Systems (BESS)</b> <ul style="list-style-type: none"> <li>• Introduction to Energy Storage Systems</li> <li>• Characteristics of Battery Storage Systems</li> <li>• Second Life Batteries</li> </ul>	
<b>Classes end: Wednesday, December 6th, 2022</b>		
Final Examination Period: Friday, December 8 to Thursday, December 21 All examinations MUST be written during the scheduled examination period.		
Note that this structure represents a plan and is subject to adjustment term by term. The instructor and the University reserve the right to modify elements of the course during the term. The University may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes.		
<b>4. ASSESSMENT OF LEARNING</b>		<b>Weight</b>
Assignments		<b>20%</b>
Quizzes		<b>10%</b>
Midterm Test		<b>30%</b>
Final Examination (tests cumulative knowledge)		<b>40%</b>
<b>TOTAL</b>		<b>100%</b>
Percentage grades will be converted to letter grades and grade points per the University calendar.		
<b>5. LEARNING OUTCOMES</b>		
1. Identify the major components of wind power plants and their operating principles, including wind turbine aerodynamics and the four types of wind turbine generators		
2. Identify the major components of solar photovoltaic power plants and their operating principles		

3. Identify the major components of hydro power plants and their operating principles, including the different types of hydraulic turbines and the salient pole electrical generator
4. Analyse the operating characteristics of wind, solar, and hydro power plants using PSSE
5. Identify the role of energy storage in renewable energy integration
6. Understand grid operation with high penetration (>20%) of renewable energy
7. Understand Ontario's policies on renewable energy
<b>6. POLICIES</b>
<b>Anti-Discrimination</b>
The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible. <a href="http://www.mcmaster.ca/policy/General/HR/Discrimination_Harassment_Sexual_Harassment-Prevention&amp;Response.pdf">http://www.mcmaster.ca/policy/General/HR/Discrimination_Harassment_Sexual_Harassment-Prevention&amp;Response.pdf</a>
<b>Academic Integrity</b>
You are required to exhibit honestly and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.  Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.  It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, located at: <a href="http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicIntegrity.pdf">http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicIntegrity.pdf</a> .  The following illustrates only three forms of academic dishonesty: 1. Plagiarism. E.g. the submission of work that is not own or for which other credit has been obtained 2. Improper collaboration in group work 3. Copying or using unauthorized aids in tests and examinations.
<b>Requests for Relief for Missed Academic Term Work (Assignments, Mid-Terms, etc.)</b>
The McMaster Student Absence Form is an on-line self-reporting tool for Undergraduate Students to report absences for:  1) Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days: <ul style="list-style-type: none"><li>• Students may submit a maximum of one academic work missed request per term. It is the responsibility of the student to follow up with instructors immediately (within the 3 day period that is specified in the MSAF) regarding the nature of the accommodation. All work due in that time period however can be covered by one MSAF.</li><li>• MSAF cannot be used to meet religious obligation or celebration of an important religious holiday, for that has already been completed or attempted or to apply for relief for any final examination or its equivalent.</li></ul>

- 2) For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has not been used previously in that term:

Students must visit their Associate Dean's Office (Faculty Office) and provide supporting documentation.

### **E-Learning Policy**

Consistent with the Bachelor of Technology's policy to utilize e-learning as a complement to traditional classroom instruction, students are expected to obtain appropriate passwords and accounts to access Avenue To Learn for this course. Materials will be posted by class for student download. It is expected that students will avail themselves of these materials prior to class. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail account, and program affiliation may become apparent to all other students in the course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about this disclosure please discuss this with the course instructor. Avenue can be accessed via <http://avenue.mcmaster.ca>.

### **Communications**

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the University provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their @mcmaster.ca alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- Check the McMaster/Avenue email and course websites on a regular basis during the term.

### **Turnitin (Optional)**

This course will be using a web-based service (Turnitin.com) to reveal plagiarism. Students submit their assignment/work electronically to Turnitin.com where it is checked against the internet, published works and Turnitin's database for similar or identical work. If Turnitin finds similar or identical work that has not been properly cited, a report is sent to the instructor showing the student's work and the original source. The instructor reviews what Turnitin has found and then determines if he/she thinks there is a problem with the work. Students who do not wish to submit their work to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to

<http://www.mcmaster.ca/academicintegrity/turnitin/students/>

### **Protection of Privacy Act (FIPPA)**

The Freedom of Information and Protection of Privacy Act (FIPPA) applies to universities. Instructors should take care to protect student names, student numbers, grades and all other personal information at all times. For example, the submission and return of assignments and posting of grades must be done in a manner that ensures confidentiality.

<http://www.mcmaster.ca/univsec/fippa/fippa.cfm>

### **Academic Accommodation of Students with Disabilities Policy**

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail [sas@mcmaster.ca](mailto:sas@mcmaster.ca). For further information consult McMaster's policy for Academic Accommodation of Students with Disabilities

<http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicAccommodation-StudentsWithDisabilities.pdf>

Students must forward a copy of the SAS accommodation to the instructor of each course and to the Program Administrator of the B.Tech. Program immediately upon receipt. If a student with a disability chooses NOT to take advantage of a SAS accommodation and chooses to sit for a regular exam, a petition for relief may not be filed after the examination is complete. <http://sas.mcmaster.ca>

### **Student Code of Conduct**

The Student Code of Conduct (SCC) exists to promote the safety and security of all the students in the McMaster community and to encourage respect for others, their property and the laws of the land. McMaster University is a community which values mutual respect for the rights, responsibilities, dignity and well-being of others. The purpose of the Student Code of Conduct is to outline accepted standards of behavior that are harmonious with the goals and the well-being of the University community, and to define the procedures to be followed when students fail to meet the accepted standards of behavior. All students have the responsibility to familiarize themselves with the University regulations and the conduct expected of them while studying at McMaster University.

[http://studentconduct.mcmaster.ca/student\\_code\\_of\\_conduct.html](http://studentconduct.mcmaster.ca/student_code_of_conduct.html)