MEMORIAL UNIVERSITY

Department of Electrical and Computer Engineering
Faculty of Engineering and Applied Science

Course Outline

ENGI 9863

Fall 2021-2022

ENGINEERING 9863: Grid Integration of Energy Systems

Instructor	**Mohsin Jamil**	**Teaching Assistants: Luqman Ahsan**
E-mail	**mjamil@mun.ca**	**E-mail: lahsan@mun.ca**
Phone	**864-2751**	**Phone :**
Office Location	**EN-3031 / CSF-3124**	**Office Location :**
Office Hours	**Tuesday 12:00 – 1:00 pm**	
	Thursday 12:00–1:00 pm	
Communication	**Email: mjamil@mun.ca**	

Website **http://online.mun.ca (D2L)**

CALENDAR ENTRY:

Grid integration of Energy Systems study the various renewable energy systems and their requirements for the correct integration into the grid. Other topics include dynamic of power system, interactions of distributed generation and grid, grid integration standards, grid integration of energy storage system, grid integration of photovoltaic systems, the island detection systems and tracking of the maximum power point, the configurations of wind farms, wind inverter's structure and their control, grid integration of micro-hydro systems, modeling and simulation of power systems with distributed generation.

SCHEDULE: LECTURE: Tuesday and Thursday 03:30-5:00 PM
Location: EN1001 or online

CREDIT VALUE: 3 credit hours

COURSE DESCRIPTION:

This course studies the various renewable energy systems and their requirements for the correct integration into the grid; topics include dynamic of power system, interactions of distributed generation and grid, grid integration standards, grid integration of energy storage system, grid integration of photovoltaic systems, the island detection systems and tracking of the maximum power point, the configurations of wind farms, wind inverters structure and their control, grid integration of micro-hydro systems, modeling and simulation of power systems with distributed generation. The students will be able to analyze, model, and simulate basic control strategies required for grid connection and finally implement a complete system, including power sources, converters, control, storage, and grid using Matlab/Simulink.

RESOURCES:

TEXTBOOK

- Teodorescu, R.; Liserre, M.; Rodríguez, P. Grid converters for photovoltaic and wind power systems [online]. Wiley, 2011.
- Bollen, M.H.J.; Hassan, F. Integration of distributed generation in the power system. Hoboken,

New Jersey: Wiley-IEEE Press, 2011.

REFERENCES

- Hoboken N.J. Power conversion and control of wind energy systems.Wiley, 2011
- Sharkh S.M.; Abusara M.A.; Orfanoudakis G.I.; Hussain. B. Power electronic converters for microgrids. Wiley 2014.

NOTES

- Lecture slides or notes provided by the instructor

MAJOR TOPICS:

- Historical development of the electrical system
- Dynamic response of the electrical system
- Microgrid/ Smart Grid System
- Grid integration issues and challenges
    - Power quality (harmonic control) and stability
    - Synchronization
    - Energy storage
    - Power flow control
    - Islanding / anti-island modes of operation
- Codes and standards for grid integration
- Grid filter design (e.g., L, LC and LCL filters)
- Power electronic converters: grid converter topologies
    - Two-level LCL filter-based grid-connected inverter
    - Multi-level grid-connected converters
    - Interleaved gird connected inverter
- Grid current control methods
    - Classical PID control
    - Proportional resonant control
    - Repetitive control
    - Robust control
- Grid converter control for wind turbines
- Grid requirements for photovoltaic systems
- Control of island detection and MPPT
- Control of active power, reactive power, and frequency control
- The electric vehicle in the grid -
- Load management and Power Flow
- HVDC interconnection
- Case study1: Matlab/Simulink implementation of two-level LCL filter grid-connected inverter
- Case study 2: Matlab/Simulink implementation of interleaved grid-connected inverter
- Case study 3: Matlab/Simulink implementation of matrix converters
- Design Project and Practical Issues

ASSESSMENTS:

		Approximate Due Dates
Assignments	30%	
Assignment 1		September 27
Assignment 2		October 11
Assignment 3		November 01
Assignment 4		November 15
Midterm Exam	20%	October 20
Design Project	40%	Stepwise Deadlines [Mid Report: Oct 22, Final Report and Present: Nov 22)
Final Presentation	10%	TBA (08-17 December 2021)

ACADEMIC INTEGRITY AND PROFESSIONAL CONDUCT:

Students are expected to conduct themselves in all aspects of the course at the highest level of academic integrity. Any student found to commit academic misconduct will be dealt with according to the Faculty and University practices. More information is available at http://www.mun.ca/engineering/undergrad/academicintegrity.php

Students are encouraged to consult the Faculty of Engineering and Applied Science Student Code of Conduct at http://www.mun.ca/engineering/undergrad/academicintegrity.php and Memorial University's Code of Student Conduct at http://www.mun.ca/student/conduct/.

INCLUSION AND EQUITY:

Students who require accommodations are encouraged to contact the Glenn Roy Blundon Centre, http://www.mun.ca/blundon/about/index.php. The mission of the Blundon Centre is to provide and co-ordinate programs and services that enable students with disabilities to maximize their educational potential and to increase awareness of inclusive values among all members of the university community.

The university experience is enriched by the diversity of viewpoints, values, and backgrounds that each class participant possesses. In order for this course to encourage as much insightful and comprehensive discussion among class participants as possible, there is an expectation that dialogue will be collegial and respectful across disciplinary, cultural, and personal boundaries.

STUDENT ASSISTANCE:

Student Affairs and Services offers help and support in a variety of areas, both academic and personal. More information can be found at www.mun.ca/student

Graduate Attributes
(Canadian Engineering Accreditation Board)

All above-mentioned learning outcomes comply with graduate attributes.

PA-D (Problem Analysis ability – Developed)

INV.-D (Investigation ability- Developed)

Des.-D (Design ability- Developed)

Tools-D (Use of Engineering Tools- Developed)

The learning outcomes are assed in assignments, the midterm exam, laboratory reports and the final exam.

Course Instructional Level: D (Intermediate Development)

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COVID-19 RELATED INFORMATION:
Welcome to the fall 2021 term! This course is designed to be held in-person and remotely as well. Our class lectures have been carefully designed to emphasize safety while providing a rich learning experience for all students. Following campus-wide policy, masks are required for all students in our classroom. Should other health directives or the overall situation connected to COVID-19 change over the course of the term, a back-up plan for remote delivery is in place to ensure that the course will continue and to

minimize disruption to the student experience

There is nothing more important than your mental and physical health. Doctors' notes are not required for medical absences in this course. You are encouraged to seek appropriate medical attention from the Student Wellness and Counselling Centre. I am committed to working with students with pre-existing medical and mental health needs, as well as new needs that may arise within the semester. I encourage you to reach out to the Blundon Centre as early as possible to discuss any adjustments you think may be necessary in this course. Let's explore the options to help you succeed, no matter what is going on.

If Memorial University campus operations are required to change because of health concerns related to the COVID-19 pandemic, it is possible that this course will rapidly move to a fully online delivery format. Should that be necessary, students will need to have access to a networked PC or Mac computer with webcam and microphone for remote delivery of the class. The university has published minimum computer requirements which you can review.

While the COVID-19 pandemic is slowly subsiding in many parts of the world and vaccination rates are increasing, this is still a stressful time for many. It's important that we support each other and keep informed of current information. The Memorial COVID-19 website is an excellent source of information and support, with specific links for students, supports and services, and health and wellness.