THE UNIVERSITY OF WESTERN ONTARIO
FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 9040/9400 – FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)
COURSE OUTLINE – Summer 2020 (M.Eng., M.E.Sc. & Ph.D.)

OBJECTIVE:
This course will introduce students to the transmission challenges of emerging modern electrical power systems. The course will present the basic concepts, principles and operation of fast high power electronic Controllers known as Flexible AC Transmission Systems (FACTS) that enhance power system stability, and effectively increase transmission capacity thus yielding significantly higher flexibility of operation.

CONTACT HOURS: 3 lecture hours/week, half course

ANTIREQUISITE: None

PREREQUISITES: Bachelor's degree in Electrical Engineering. An undergraduate course in power electronics is desirable.

COURSE CONTENT:
- Introduction to emerging power transmission networks
- Reactive Power Control in Transmission Systems
- Concept of Flexible AC Transmission Systems
- Principle of Thyristor-based FACTS Controllers
- Static Var Compensator (SVC): Control, Components and Models
- Concepts of voltage control by Static Var Compensator
- Applications of Static Var Compensator
- Thyristor Controlled Series Capacitor (TCSC)
- Applications of Thyristor Controlled Series Capacitor
- Principles of Voltage Source Converter (VSC) based FACTS Controllers – STATCOM, SSSC and UPFC
- Applications of Voltage Source Converter (VSC) based FACTS Controllers
- Coordination and Placement of FACTS Controllers

SPECIFIC LEARNING OBJECTIVES:
1) To introduce the operating principles, control systems and modeling of different FACTS Controllers
2) To understand the influence of measurement systems, network resonances and harmonic interactions on the performance of FACTS control systems
3) To provide the techniques of FACTS controller design for enhancing power transfer, stability and damping, mitigating sub-synchronous resonances, preventing voltage instability, etc.
4) To understand the interactions amongst various FACTS Controllers and techniques for their coordination and placement

TEXTBOOK:

[1] R.M. Mathur and R.K. Varma, "*Thyristor-Based FACTS Controllers for Electrical Transmission Systems*", IEEE Press and John Wiley & Sons, New York, USA, Feb. 2002

REFERENCE BOOKS:

[2] N.G. Hingorani and L. Gyugyi, "*Understanding FACTS"*, IEEE Press, New York, USA, 1999.

[3] K.R. Padiyar, *FACTS Controllers in Power Transmission and Distribution*, New Age International Publishers, New Delhi, 2007

[4] V.K. Sood, *HVDC and FACTS Controllers - Applications of Static Converters in Power Systems*, April 2004, ISBN 1-4020-7890-0, Kluwer Academic Publishers

[5] Y.H. Song and A.T. Johns, et., *Flexible AC Transmission Systems (FACTS)*, IEE Press, U.K., 1999

[6] IEEE/Other Transactions and Conference Papers

[7] K.R. Padiyar, *HVDC Power Transmission Systems - Technology and System Interactions*, John Wiley & Sons, 1990, ISBN 0-470-21706-5

[8] E.W. Kimbark, *Direct Current Transmission - Volume I*, Wiley Interscience, 1971, ISBN 0-471-35550-X

[9] P. Kundur, *Power System Stability and Control*, McGraw-Hill, 1994, ISBN 0-07-035958- X.

PROJECT AND ORAL PRESENTATION:

The students in the course will be required to perform a computer modeling/simulation project or study project on an assigned topic related to FACTS Controller application and submit the project report. Also, the students will be required to develop/deliver an oral presentation for their project.

- Project for ECE 9400 (Ph.D and MESc.): Modeling/Simulation Studies for a FACTS Application
- Project for ECE 9040 (MEng): Real-life projects studies for a FACTS Application

EVALUATION:

For the purpose of evaluation, the course is divided into three components, namely

- Project Presentation
- Project Report
- Final Examination

The final course grade will be determined from the student's performance in developing/delivering project presentation, project report, and the final examination. The online final examination will be of three hours duration. Emphasis in the final exam will be both on the understating of core concepts taught in class and the ability to apply those concepts to solve power system problems. The examination shall be open book; non-programmable calculators will be allowed. In order to pass the course, a student must obtain a passing grade in each component. A student who fails either component shall receive a final grade not greater than 48%. The weighting of each of these components will be as follows:

Course Component	Weight
Project Presentation	10%
Project Abstract	5%
Project Report	45%
Final Examination	40%

USE OF ENGLISH:

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

ATTENDANCE:

Any student, who in the opinion of the instructor is absent too frequently from class in this course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

ABSENCE DUE TO ILLNESS OR OTHER CIRCUMSTANCES:

Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached "Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled"). The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf
For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

CHEATING and PLAGIARISM:

Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (http://www.turnitin.com).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

USE OF ELECTRONIC DEVICES:

Exams (non-online format)
The use of non-programmable calculators is permitted on exam. Any electronic device capable of wireless communication and/or displaying various file formats (e.g. pdf, mp3) is not permitted in the possession of students during the exams, even if turned off. Consequently, devices such as, PDAs, smart-phones and cellular-phones may not be used as a substitute for a calculator or as a clock.

Lectures
Students are permitted to use electronic devices (such as Laptops, PDAs, and smart-phones) in class for the purpose of taking notes and research related to the lecture. Students are expected to use these devices in such a manner as not to distract their peers.

Recording of Lectures
Students are permitted to make audio only recordings of lectures for the exclusive purpose of their own study. Students may not distribute these recordings and are expected to destroy them at the end of the semester. Students should record only the instructor unless specific permission of the speaker is given.
Projected material (such as PowerPoint slides) is subject to copyright and licensing restrictions, as a result still image or video recordings are not permitted in any lectures. Students who are having difficulty following the pace of material presented are encouraged to contact the instructor.

INTERNET and ELECTRONIC MAIL:
Students are responsible for regularly checking their Western e-mail and the course web site (https://owl.uwo.ca/portal/) and making themselves aware of any information that is posted about the course.

ACCESSIBILITY:
Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

SUPPORT SERVICES:

Office of the Registrar, http://www.registrar.uwo.ca/
Student Development Centre, http://www.sdc.uwo.ca/
Engineering Undergraduate Services,
http://www.eng.uwo.ca/undergraduate/
USC Student Support Services, http://westernusc.ca/services/

Students who are in emotional/mental distress should refer to Mental Health @ Western, http://www.health.uwo.ca/mental_health/, for a complete list of options about how to obtain help.

COURSE INSTRUCTOR

Dr. Rajiv K. Varma
Room: TEB 233
Phone: 519-661-2111 ext. 85111
Email: rkvarma@uwo.ca
Consultation hours: By appointment