



ECE 8920: INTELLIGENT SYSTEMS APPLICATIONS IN ENERGY SYSTEMS

All Sections (001, 400, 843)
SPRING SEMESTER 2024

MEETING TIME: Mondays: 9.30 am to 12 pm

MEETING LOCATION: SB3 (RTPIS Lab)

INSTRUCTOR: Dr. G. Kumar Venayagamoorthy, Duke Energy Distinguished Professor of Electrical and Computer Engineering, Riggs 303D, Tel. 864 656-5936, email: gvenaya@clemson.edu

OFFICE HOURS AND PROCEDURES: Email is the best way to contact me. In-person meeting by appointment only.

COURSE MODALITY: In-person.

COURSE OBJECTIVES/LEARNING OUTCOMES:

The objectives of the ECE 8920 course are to enable graduate students to:

- Apply Intelligent Systems technologies learned from this course to design energy systems, the next generation intelligent energy system which is a system of systems.
- Differentiate traditional energy systems from intelligent energy systems.
- Be able to think through the A to Z process needed to transform a traditional energy system into an intelligent energy system
- Demonstrate the breadth and some depth of intelligent energy systems via a working laboratory prototype semester-long project.

COURSE DESCRIPTION:

The electricity infrastructure is undergoing a dramatic change - decarbonization, decentralization and digitalization. Intelligent systems will need to operate and manage the modern energy system at a much larger scale and at a much faster pace to speed up the energy transition and lower the associated costs if we are to transition rapidly, safely and economically to carbon-free fuels.

The growing need to address climate emergence requires new ways of operating and managing the evolving electricity infrastructure. Many of our energy systems students need to be informed and knowledgeable in the applications of intelligent systems to many challenging problems in energy systems.

This is special problem 3 hour-credit course will provide this knowledge to our graduate students. The course will educate and provide our graduate students with the multidisciplinary skills and ability to analyze current and future energy engineering problems. The knowledge gained from this course will equip our students to competitive in modern energy systems industry.

The course specifically will be focused on the following three parts:

Part I: Intelligent Systems - Examine several intelligent systems methods, including computational intelligence algorithms, decision making under uncertainty, adaptive critic designs, graphical methods, and machine learning.

Part II: Application of Intelligent Systems in Energy Systems – Students will review the state-of-the-art in i) energy systems and electrification systems including multi-energy systems (electric power, gas and electric transportation), power generation, electric grid, renewables, energy storage, electric vehicles, and prosumers; and ii) current and emerging operation and management technologies for energy systems (SCADA, Energy Management Systems, Internet of Energy and Computational Platforms for Energy Informatics). Students will identify a problem(s) where the traditional approaches are not suitable or cannot handle the growing complexities.

COURSE PREREQUISITES:

The basic requirement is a graduate student standing with background in MATLAB and other programming language, Microsoft Office skills (word, presentation and spreadsheet) and creation of PDF documents. Some systems simulation knowledge required.

REQUIRED MATERIALS:

Students are required to have a laptop computer, internet connectivity capable of transmitting and receiving video, a video camera, a microphone, and a cell phone.

REFERENCE MATERIALS:

1. Papers from IEEExplore and Sciencedirect databases.
2. Additional material may be provided by the instructor.

CLASS CANCELLATION POLICY: Class is cancelled if the instructor is more than 15 minutes late to class.

GRADING POLICY:

The grading is based on the project deliverables:

- Assignments (10%)
- Project proposal (5%), due January 29, 2024
- Two interim reports (35%), due February 26, 2024 and March 25th, 2024
- Presentation (10%) and Demonstration (10%), due April 15th, 2024 and demo on April 22nd, 2024.
- *Final Report (40%) in of form a journal/conference paper, due no later than Friday, April 26th, 2024.

*A – 90% - 100%; A- – 87.5 to < 90%; B⁺ – 85 to < 87.5%; B – 82.5 to < 85%; B- – 80 to < 82.5%;
C⁺ – 77.5 to < 80%; C – 72.5 to < 77.5%; C- – 70 to < 72.5%; & F – < 70%

*Students are encouraged to pursue a publication in consultation with the instructor.

All disputes about an evaluation of any graded work during the semester must be submitted in writing (typed, not handwritten) within one week after an assignment, test or project has been distributed to students in the class. Any grade challenges must provide specific justifications for why the grade would be changed.

CLASS PARTICIPATION:

Class participation is critical to the learning process. The optimal classroom learning experience depends on both a professional teaching environment and student participation. You need to prepare prior to coming each class. Preparation includes having read the required materials or completed the expected assignments/homework. Class discussions are critical to learning and everyone in the class is expected to

contribute. If you are not prepared you will weigh down the rest of the class besides losing class participation points.

COURSE DELIVERABLES:

All course submissions shall be submitted using Canvas no later than 11.55 pm of the posted due date. No late submissions beyond a day will be accepted. Late submissions require approval of the instructor and may be subjected to a 50% loss of points. Any homework assigned will not be required for submission but they are mandatory readings. Quizzes and class discussions may be based on homework (missed quizzes will have no make-ups).

PROJECT REPORTS:

The projects will require written reports (in IEEE PES conference or a journal paper format) consisting of the following items:

- Title
- Abstract
- Introduction and motivation to the project topic with references
- Development of applied theory
- Description (algorithm, flowchart) and implementation of the computer program
- Results and discussions
- Summary (including future work).

ATTENDANCE POLICY:

Regular class attendance and participation including online in discussions is expected with attendance taken as iROAR requires entry of student's last date of class attendance. Students are responsible for all material covered and assigned readings during the semester. If you anticipate not being able to attend a class including online meetings for a particular reason, please e-mail me with the information (before the class to be missed). The optimal classroom learning experience depends on both a professional teaching environment and student participation.

Using the Notification of Absence module in Canvas or email to inform the instructor of student absences is required.

In case of in-person class and/or lab meetings: maintaining physical distancing required, individuals arriving first to the classroom should sit farthest from the door. Similarly, at the conclusion of class, students closest to the door should leave first.

While on campus, face coverings are required in all buildings and classrooms. Face coverings are also required in outdoor spaces where physical distance cannot be guaranteed. If a student does not have a face covering or refuses to wear an approved face covering without valid documented accommodation, the instructor will ask the student to leave the academic space and may report the student's actions to the Office of Community & Ethical Standards as a violation of the Student Code of Conduct. If the student's actions disrupt the class to the extent that an immediate response is needed, the instructor may call the Clemson University Police Department at 656-2222.

ACCESSIBILITY STATEMENT: Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary

injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to a class should let the instructor know and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848 or by emailing studentaccess@lists.clemson.edu. Students who receive Academic Access Letters are strongly encouraged to request, obtain, and present these to their instructors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student's responsibility to follow this process each semester. You can access further information here: <http://www.clemson.edu/campus-life/campus-services/sds/>.

TITLE IX STATEMENT: Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972.

SAFE CAMPUS: Clemson University is committed to providing a safe campus environment for students, faculty, staff, and visitors. As members of the community, we encourage you to take the following actions to be better prepared in case of an emergency:

- a. Ensure you are signed up for emergency alerts (<https://www.getrave.com/login/clemson>)
- b. Download the Rave Guardian app to your phone
(<https://www.clemson.edu/cusafety/cupd/rave-guardian/>)
- c. Learn what you can do to prepare yourself in the event of an active threat
(<http://www.clemson.edu/cusafety/EmergencyManagement/>)

ACADEMIC INTEGRITY: As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately to charges of violations of academic integrity. Further information on Academic Integrity can be found in the *Undergraduate Announcements* and in the *Graduate School Policy Handbook*.

COPYRIGHT STATEMENT: Materials in this course are copyrighted. They are intended for use only by students registered and enrolled in this course and only for instructional activities associated with and for the duration of the course. They may not be retained in another medium or disseminated further. They are provided in compliance with the provisions of the Teach Act. Students should be reminded to refer to the Use of Copyrighted Materials and "Fair Use Guidelines" policy in on the Clemson University website for additional information: <https://clemson.libguides.com/copyright>.

MODIFICATION STATEMENT: The instructor reserves the right to modify any aspect of the syllabus at any time during the semester and will notify the students of any modification.

Updated: January 9, 2024