



Department of Electrical & Computer Engineering

## **ECE6604PD: Distributed Generation**

### **Course Description:**

Application of state-of-the-art Distributed Resources (DR) (known as Distributed Generation DG) to power transmission and distribution systems. The emphasis will be on the technical and economic issues relating to the distribution generation. The course introduces to various generating technologies, with some detailed discussion of various applications of power electronics used in different types of DGs. The impacts of DG on distribution systems will be presented. The focus will be on electrical issues such as grid connection, protection, control, and power quality. In addition, the economic and regulatory issues will be addressed.

### **Objectives:**

The objective of this course is to expand the knowledge and expertise of the practicing engineer in the area of distributed generation and its applications in power systems. The course reviews the available standards for distributed generation interconnection provides an understanding of the operation of different traditional and non-traditional power sources. This course will address the operating principles, models and simulation of power distribution systems to investigate different DG interfacing and provides in-depth understanding of the impact of DG on distribution system performance, reliability, safety, protection and quality.

### **Lectures:**

- There will be 12 three-hour lectures in the course.
- In Fall 2023, live sessions will be held on Tuesdays, 2:00-5:00 pm.

### **Marking Scheme:**

- Two assignments, each is 10% (total of 20%)
- Course Project; 30%
- Final examination; 50%

### **Prerequisites:**

Open to electrical engineering graduate students. Basic understanding of modeling of power system elements and analysis techniques is required and familiarity with a programming language and/or a simulation package such as EMTDC/PSCAD and MATLAB is desirable.

## Content:

No. of Lectures	Topics	Sub-Topics
3	DG Definitions and Standards, DG potential	<ul style="list-style-type: none"><li>• Definitions and terminologies; current status and future trends</li><li>• Technical and economic impacts</li></ul>
3	DG Technologies	<ul style="list-style-type: none"><li>• DG from renewable energy sources</li><li>• DG from non-renewable energy sources</li></ul>
6	Distributed generation applications, Operating Modes	<ul style="list-style-type: none"><li>• Base load; peaking; peak shaving and emergency power</li><li>• Isolated, momentary parallel and grid connection</li></ul>
6	DG interconnection, Interconnection Requirements	<ul style="list-style-type: none"><li>• Characteristics of DG interface: Rotating machines</li><li>• Characteristics of DG interface: Static power converters</li><li>• General protection requirement; effect of transformer connections</li></ul>
6	Power Quality Issues, Reliability	<ul style="list-style-type: none"><li>• Voltage regulation; harmonics from DG; improving distribution system PQ via the DG interface</li><li>• Improving reliability with DG; Adverse impacts of DG on utility reliability</li></ul>
6	Protection Issues, Islanding,	<ul style="list-style-type: none"><li>• Utility Issues</li><li>• Protective relays coordination</li><li>• Islanding prevention techniques</li><li>• Safety of personnel; utility-generator load match frequency; utility re-closing; synchronizing</li></ul>
6	DG Cost Issues	<ul style="list-style-type: none"><li>• Energy (kWh), demand (kW), power factor penalties and utility standard cost, connection and operating costs and charges; life cycle cost and rate of return analysis</li></ul>

## References:

1. H. Lee Willis, and Walter G. Scott “Distributed Power Generation: Planning and Evaluation (Power Engineering, 10)”, Marcel Dekker (January, 2000).
2. Anne-Marie Borbely, and Jan F. Kreider, “Distributed Generation”, CRC Press, 2001, ISBN 0-8493-0074-6
3. N. Jenkins, R. Allan, P. Crossley, D. Kirschen and G. Strbac, “Embedded Generation”, The Institute of Electrical Engineering, 2000, ISBN 0-85296-774-8
4. Lecturer Notes and Journal Papers

**Note:** It is not compulsory to purchase a textbook, but it is recommended to acquire one of the top-two references listed above.