ECE 3071 – Modern Electric Energy Systems

Topical Outline

Energy Requirements, Resources, and Sustainability.
- Modern societal energy requirements; Electricity consumption across the US, options for reducing demand
- Non-Renewable sources of energy: coal, oil, natural gas, and nuclear; reserves, energy density, economic costs
- Renewable sources of energy: hydro, geo-thermal, photovoltaic, wind, tidal, ocean-wave, biomass, and ethanol; energy density, and economic costs.
- Long term sustainability of these energy sources.

Conversion of Non-Renewable and Renewable Energy Sources to Electric Energy.
- Advantages of electric energy.
- Fundamental structure, quantitative analysis, and efficiency of different sources. Cost per unit of electric energy produced, safety issues
- Environmental impact of energy conversion processes, trade-offs with process efficiency
- Economic, political, and infrastructure barriers to the conversion from non-renewable energy sources to renewable sustainable sources of energy

Principles of Electric Power Delivery
- Significance of the lack of energy storage in the electric power system
- Fundamentals of three-phase power, including per-phase calculations, complex power, power factor and utility billing practices
- Equivalent circuit model of generators, transformers, lines and loads; need for VAR compensation
- Simple two-bus system to demonstrate principles of power flow, stability, and other constraints
- Electric Safety; Electric shock, body resistance, and grounding.

Principles of Electric Energy Processing and Conversion
- Matching source characteristics to load requirements
- Principles of power electronic converters; types of power converters (dc/dc, ac/dc and dc/ac); duty cycle control, filtering, input-output characteristics, efficiency and dynamic response
- Power supplies for electronic equipment, characteristics, limitations and challenges
- Electromechanical systems based on variable reluctance principles: solenoids, stepper motors, and transducers
- Rotating electromechanical transducers: brushed and brushless dc- and induction- machines
- Principles of power electronic variable speed drives for rotating transducers
- System considerations including dynamics, control, load interaction and utility grid interface issues including power-factor, harmonics, and start-up

Case Study Project

Laboratory Topics:

- Understanding limitations of energy – generation, delivery, storage and use
- Sinusoidal steady-state single- and three-phase circuit analysis, including single- and three-phase transformers
- Photovoltaic and wind energy conversion
- Steady-state operation of a synchronous generator synchronized onto an infinite bus; computer study of a multi-bus interconnected power system
- Power electronics – Operation of a dc/dc converter; measurement of I/O characteristics of a commercial power supply
- Steady-state operating characteristics of magnetic circuits, dc- and induction-motors
- Ac-drive characteristics of an inverter driven induction motor