NRE 4266 Light Water Reactor Technology (Elective)

Catalog Description: NRE 4266 Light Water Reactor Technology (3-0-3)
Prerequisite:NRE 4204, NRE 4214
A systematic survey of the technology of both pressurized and boiling water reactors with emphasis on the nuclear steam supply system and its associated safety and control systems.

Textbook: El-Wakil, M. M., Nuclear Energy Conversion, American Nuclear Society (1982).

References: The Westinghouse Pressurized Water Reactor Nuclear Power Plant (1984).
BWR/6 – General Description of a Boiling Water reactor, General Electric (1980)

Topics Covered:

1. Reactivity Considerations in LWRs
   - Coefficients of Reactivity
   - Control Rod Worth
   - Chemical Shim and Burnable Poisons
   - Fission Product Poisons
2. PWR Systems
   - PWR Primary Loop Equipment
   - Reactor Vessel, Internals, Fuel, Control Rods
   - PWR Auxiliary Systems
   - PWR Safety Systems
   - PWR Instrumentation
3. PWR Operations
   - Normal Operating Procedures
   - Abnormal /Transient Operating Procedures
   - Emergency Operating Procedures
4. BWR Systems
   - BWR System Equipment and Flows
   - BWR Auxiliary Systems
   - BWR Safety Systems
   - BWR Protection and Control Systems
   - BWR Instrumentation
5. BWR Operations
   - Normal Operating Procedures
   - Abnormal/Transient Operating Procedures
   - Emergency Operating Procedures

Course Outcomes:

Outcome 1: To familiarize the student with reactivity considerations in LWRs including reactivity coefficients, burn-up effects and control effects.
- 1.1 Students will demonstrate understanding of the physical principles of reactivity including the effects of various design and operational parameters on the reactivity coefficients.
- 1.2 Students will demonstrate the ability to calculate the differential and integral reactivity worth of full and part-length control rods.

Outcome 2: To teach the student the underlying principles involved in PWR systems design and operation, including primary and secondary parameters selection.
- 2.1 Students will understand the principles involved in PWR primary and Secondary systems parameters selection, including primary pressure and temperatures, sliding TAVG program, primary flow and core delta T, and secondary pressure selection.

Outcome 3: To teach the students the principles involved in PWR operations, including pressure control, reactivity control, power control, plant startup, power transients, and emergency operating procedures.
- 3.1 Students will be able to understand and apply the principles involved in PWR pressure control, including pressurizer design and sizing requirements.
- 3.2 Students will demonstrate the ability to setup and apply reactivity balances for PWR operation, including calculation of critical boron concentrations at various burn-ups.
- 3.3 Students will understand the various steps involved in PWR plant startup and shutdown.
- 3.4 Students will be able to perform power and reactivity balances to determine plant conditions following various transients.

3.5 Students will be familiar with the underlying principles for symptom-based emergency operating procedures.

Outcome 4: To familiarize the students with various PWR plant systems and components and their interrelationships.

4.1 Students will understand the design and operation of various PWR Plant systems and components, including the primary system, reactor vessel, reactor core, reactor coolant pumps, steam generators, emergency core cooling system, and auxiliary systems.

Outcome 5: To teach the students the fundamentals of BWR systems design including mass and heat balances, reactivity coefficients, and BWR stability.

5.1. Students will be able to perform heat and mass balances for various BWR systems configurations.

5.2 Students will understand the principles of pressure coefficient of reactivity and its impact on load following in BWRs.

Outcome 6: To teach the students the principles involved in BWR operations, including, power control, flow maps, and plant startup.

6.1 Students will understand types of load following control in BWRs, including bypass, subcooling, recirculation, and positive void coefficient.

6.2 Students will understand the operating maps for BWRs, Power control, reactor startup, and shutdown procedures.

Outcome 7: To familiarize the students with various BWR plant systems and components and their interrelationships.

7.1 Students will become familiar with the evolution of BWR technology from BWR/1 plants to the BWR/6 design.

7.2 Students will understand the design and operation of various BWR systems and components, including, the reactor vessel, reactor core, control rods, recirculating system, and reactor water cleanup system.

Correlation between Course Outcomes and Program Educational Outcomes:

NRE 4266 Light Water Reactor Technology	Outcome a			Outcome b	Outcome c	Outcome d	Outcome e	Outcome f	Outcome g	Outcome h	Outcome i	Outcome j	Outcome k
Course Outcomes	i	ii	iii										
Course Outcome 1.1							X						
Course Outcome 1.2			X				X						
Course Outcome 2.1					X		X						
Course Outcome 3.1					X		X						
Course Outcome 3.2							X						
Course Outcome 3.3							X						
Course Outcome 3.4							X						
Course Outcome 3.5							X						
Course Outcome 4.1							X						
Course Outcome 5.1			X		X		X						
Course Outcome 5.2					X		X						
Course Outcome 6.1							X						
Course Outcome 6.2							X						
Course Outcome 7.1							X						
Course Outcome 7.2							X						

Prepared by: Said Abdel-Khalik
Revised: October 2007