NucE 505 Nuclear Reactor Control
Spring Semester 2008

This three credit course is an introduction to control theory for nuclear engineers. Important nuclear reactor dynamics which can pose potentially significant operational problems are analyzed using both time and frequency domain system descriptions. A major emphasis is the introduction and application of elementary control theory to specify reactor design parameters that improve inherent reactor stability and performance for integration in a power producing system. A secondary objective is the design of feedback control for automatic control of reactor power including control rod drive mechanisms and power and temperature sensing devices. A summary of the topics covered is given below:

1. **Neutron kinetics:**
   Point kinetics and response to reactivity step
   System characteristic equation and inhour equation
   Time varying reactivity: problems, sources and characteristics
   Linearization of nonlinear reactor kinetics

2. **Laplace methods:**
   Spring-mass-damper systems
   Complex variables
   Laplace Transform
   Transfer function
   System response to sinusoidal input

3. **Bode and Nyquist Analysis:**
   Rules for sketching Bode magnitude and phase plots
   Nyquist stability criteria and analysis
   gain, Proportional-Integral, and other compensation
   Nichols Chart, Sensitivity and Sensitivity Functions

4. **Root locus analysis** (rules for sketching Root-locus plots):

5. **Application to reactor analysis and control:**
   Feedback control system characteristics and design objectives
   Reactor kinetics with single temperature feedback model
   Control rod drive dynamics effects in feedback control
   Reactor kinetics and control with two temperature feedback model
   Xenon and other poison dynamics
   Boiling and void dynamics
   Other control techniques and their applicability to reactor control

Text books:

Control of Nuclear Reactors and Power Plants, M.A. Schultz, 2nd edition, McGraw Hill (1961).

This classic and still useful text book on reactor control will be supplemented with course notes. An up-to-date text book providing a general introduction to feedback control is also required.

Laboratory Manual for NucE451, Experiments in Reactor Physics, 1994-96.

Feedback Control of Dynamic Systems, Franklin and Powell, Addison-Wesley (2006 5th edition)

Grading:

Midterm exam	20%
Final	30%
Homework and quizzes	50%

INSTRUCTOR and OFFICE HOURS:

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