City University of Hong Kong

Information on a Course
offered by Department of Mechanical and Biomedical Engineering
with effect from Semester A in 2013/2014

Part I

Course Title: Advanced Nuclear Reactor Physics

Course Code: MBE5104

Course Duration: One Semester

No. of Credit Units: 3

Level: P5

Medium of Instruction: English

Prerequisites: MBE5101 Principle of Nuclear Engineering
or equivalent

Precursors: Nil

Equivalent Courses: Nil

Exclusive Courses: Nil

Note:
Students may repeat a course, or an equivalent course, to improve course grade only if the previous course grade obtained is C or below.

Part II

1. Course Aims

This course aims to provide nuclear engineering students with highly progressive knowledge governing nuclear fission chain reaction in a manner that renders the transition to practical nuclear reactor design methods most natural. This goal has led to a very considerable emphasis on numerical methods suitable for digital computation. Further, a stress is made throughout this development the very close interplay between the nuclear analysis of a reactor core and those non-nuclear aspects of core physics, such as thermal-hydraulics or materials studies, which play a major role in determining a reactor design. Finally, illustrations of various concepts regarding a number of more practical problems arising in the nuclear design of different types of power reactors are included.

2. Course Intended Learning Outcomes (CILOs)

Upon successful completion of this course, students should be able to:

No.	CILOs	Weighting* (if applicable)
1.	**Describe** the spontaneous nuclear radioactive decay as an example of a nuclear reaction, the concept of a nuclear cross section via nuclear collision reactions, and the nuclear fission reaction and the accompanying radiation.	2
2.	**Explain** the concepts of nuclear fission chain reactions, including the relevant nuclear physics and modern power reactors.	3
3.	**Analyze** the central problem of nuclear reactor theory, i.e. the determination of the distribution of neutrons in the reactor. Both the transport treatment and diffusion approximation of the neutron motion in the reactor core are detailed and compared.	1
4.	**Perform** the calculations and numerical simulations of nuclear reactor behaviour while neutrons attempt to sustain the fission chain reaction by means of one- and multi-energy-group diffusion theories under various reactor geometrical configurations and boundary conditions.	1

***Weighting ranging from 1,2,3 to indicate the relative level of importance in an ascending order.**

3. Teaching and Learning Activities (TLAs)

(Indicative of likely activities and tasks designed to facilitate students' achievement of the CILOs. Final details will be provided to students in their first week of attendance in this course)

Activity Type	Timetabled Activity (Hours per week)
Lecture/Tutorial/Laboratory Mix	Lecture (3)

TLAs	Large class activities	Self-study activities	Hours/week (if applicable)
CILO 1	9	(9)	9(+9) = 18
CILO 2	6	(6)	6(+6) = 12
CILO 3	12	(12)	12(+12) = 24
CILO 4	12	(12)	12(+12) = 24
Total (hrs)	**39**	**(39)**	**39(+39) = 78**

Large class activities: Delivery of the course will be achieved through a series of formal lectures supported by practical case studies.

Small class activities: Students will be provided with reading lists to assist their study of the subject, and they will be expected to prepare material in advance of the sessions for discussion.

4. Assessment Tasks/Activities

(Indicative of likely activities and tasks designed to assess how well the students achieve the CILOs. Final details will be provided to students in their first week of attendance in this course)

ATs	Examination (2 hrs)	Homework	Mini-project	Total (%)
CILO 1	15	5	-	20
CILO 2	8	2	-	10
CILO 3	17	8	5	30
CILO 4	20	10	10	40
Total (%)	**60**	**25**	**15**	**100**

For a student to pass the course, at least 30% of the maximum mark for the examination should be obtained.

5. Grading of Student Achievement:

The grading is assigned based on students' performance in assessment tasks/activities.
The 2-hour examination (60%), homework (25%), and mini-project (15%) will be marked numerically and grades will be awarded accordingly.

Grade Table

Letter Grade	Grade Point	Grade Definitions
A+ A A-	4.3 4.0 3.7	Excellent
B+ B B-	3.3 3.0 2.7	Good
C+ C C-	2.3 2.0 1.7	Adequate
D	1.0	Marginal
F	0.0	Failure
P	-	Pass

Please refer the SGS's website:
http://www.sgs.cityu.edu.hk/student/tpg/assessment/coursegrades#01 for more details.

Part III

Keyword Syllabus

- radioactive decay
- differential scattering cross section
- nuclear fission / fusion
- fission chain reaction
- prompt / delayed neutrons
- fissile / fissionable / fertile isotopes
- nuclear conversion / breeding
- neutron flux / current
- neutron transport / diffusion
- reflector
- criticality
- geometric / material buckling
- multiplication factor

Recommended Reading:

Textbook
Duderstadt J J and Hamilton L J, "*Nuclear Reactor Analysis*," John Wiley & Sons, Inc., 1976, ISBN: 0-471-22363-8.

References

1. Lamarsh J R and Baratta A J, "*Introduction to Nuclear Engineering*," 3rd edition, Prentice Hall, 2001, ISBN: 0-201-82498-1.
2. Henry A F, "*Nuclear Reactor Analysis*," The MIT Press, Cambridge, 1975.
3. Glasstone S and Sesonske A, "*Nuclear Reactor Engineering*," Van Nostrand, Princeton, N.J., 1975.
4. Almenas K and Lee R, "*Nuclear Engineering, An Introduction*," Springer Verlag, 1992.
5. Eisberg R and Resnick R, "*Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*," 2nd edition, John Wiley & Sons, 1985.
6. Connolly T J, "*Foundations of Nuclear Engineering*," John Wiley & Sons, 1978.
7. Foster A R and Wright R L Jr., "*Basic Nuclear Engineering*," 2nd edition, Allyn and Bascon, 1973.
8. Meyerhof W E, "*Elements of Nuclear Physics*," McGraw-Hill, 1967.
9. Glasstone S and Edlund M C, "*The Elements of Nuclear Reactor Theory*," Van Nostrand, Princeton, N.J., 1952.
10. Almenas K and Lee R, "*Nuclear Engineering, An Introduction*," Springer Verlag, 1992.