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: **Probabilistic Risk Assessment for Nuclear Power Systems**

Course Code: **MBE6104**

Course Duration: **One Semester**

No. of Credit Units: **3**

Level: **P6**

Medium of Instruction: **English**

Prerequisites: **Nil**

Precursors: **MBE3107 Principles of Fission Reactors / MBE4105 Nuclear Reactor Safety or equivalent**

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

The methodology of Probabilistic Safety Assessment (PSA) was originated from the Reactor Safety Study (RSS) or WASH-1400 report published in 1975. PSA employs the theory of statistics and probability and the technique of fault trees and event trees to quantify the risk to the public associated with operating of a nuclear power reactor. The Three Mile Island nuclear power plant incident in 1979 proved that the PSA technique is very effective in identifying the vulnerability of nuclear power reactors. The nuclear industries around the world have used the techniques to improve the safety of nuclear power plant. The risk insight from PSA study is adopted by regulatory bodies around the world to allocate the resources of safety oversight.

Traditionally, the analyses involved in PSA can be divided into three major steps (or levels). In Level I, the accident scenarios and core melt frequency are quantified using fault trees and event trees. The reliability data analysis and human reliability are part of the analysis of Level I. In Level II analysis, the containment failure probability of the accident scenarios identified in Level I study are analyzed and the accident source terms are quantified. In Level III analysis, the risk to the public for each source term category identified in Level II analysis is quantified.

All the major elements involved in PSA will be covered in this course. The major focus will be on the statistical and probability theory, the techniques of fault trees and event trees analysis, human reliability analysis, and external event tree analysis. The work involved in Level II and Level III will be covered briefly. Finally, the concept of risk insight regulation is covered.

2. Course Intended Learning Outcomes (CILOs)

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

No.	CILOs	Weighting* (if applicable)
1.	Calculate the reliability parameters	1
2.	Adopt the techniques of Fault Trees and Event Trees Analyses to quantify core damage frequency	1
3.	Describe the external event analysis	1
4.	Describe Level II and Level III analyses	1
5.	Describe the application of PSA	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	Total hours/week (if applicable)
CILO 1	9	3	9(+3) = 12
CILO 2	12	6	12(+6) = 18
CILO 3	3	1	3(+1) = 4
CILO 4	9	3	9(+3) = 12
CILO 5	6	2	6(+2) = 8
Total (hrs)	**39**	**15**	**39(+15) = 54**

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 (3 hours)	Test	Quiz	Total (%)
CILO 1	9	7	7	23
CILO 2	12	10	9	31
CILO 3	3	2	2	7
CILO 4	8	8	7	23
CILO 5	6	5	5	16
Total (%)	**38**	**32**	**30**	**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:

Examination: 38%
Test: 32%
Quiz: 30%

Grade Table

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

Please refer the SGS's website for details.

Part III

Keyword Syllabus:

- General Introduction (1 hours)
- Probability and Statistical Concepts (3 hours)
- System Reliability； Defining Reliability, Computation Reliability Parameter, Reliability Prediction (3 hours)
- Data Analyses (2 hours)
- Event Tree Analysis (3 hours)
- Fault Tree Analysis (5 hours)
- Sequence Quantification (2 hours)
- Human Reliability Analysis (2 hours)
- External Event Analysis (3 hours)
- Severe Accident Phenomenology (3 hours)
- Containment Integrity Analysis and Source Terms Quantification (3 hours)
- Consequence Analyses (Level III PSA) (3hours)
- Application of PSA in Daily Operation of NPP and Risk Informed Regulation (6 hours)

Recommended Reading:

Text(s)

R.R. Fullwood, “Probabilistic Safety Assessment in the Chemical and Nuclear Industries”, Butterworth-Heinemann, October, 1999

Hiromitsu Kumamoto, Ernest J. Henley, "Probabilistic Risk Assessment for Engineers and Scientists", 2nd Edition, 1998, IEEE Press.

M. Modarres, "Reliability And Risk Analysis", 1993, Marcel Dekker, Inc.

E.A. Elsayed, “Reliability Engineering”, 1996, Addison Wesley Longman, Inc.

E.E. Lewis, "Introduction to Reliability Engineering”, 2nd Edition, 1996, John Wiley & Sons, Ltd.