Form 2B

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: **Severe Accident Phenomenology and Emergency Preparedness of Nuclear Power Plants**

Course Code: **MBE5102**

Course Duration: **One Semester**

No. of Credit Units: **3**

Level: **P5**

Medium of Instruction: **English**

Prerequisites: **Nil**

Precursors: **MBE3107 Principles of Fission Reactors / MBE4105 Nuclear Reactor Safety / AP4230/5230 Radiation 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 core melt accidents of light water reactor are also termed severe accidents or, in US Nuclear Regulatory Commission's accident classification, Class 9 accidents. In a core melt accident, large amount of radionuclides embedded in the fuel matrix may release into the reactor coolant system and into the containment subsequently. If the containment also fails in the accident, the released radionuclides may escape to the environment, which is termed source sources. The dispersion of these radionuclides in the atmosphere of environment results in contamination and dose to the public. Plant specific Severe Accident Management Guidelines (SAMGs) are developed to help the plant operators to cope with the accidents. To protect the public in the vicinity of nuclear power plant (NPP), emergency planning of NPP is part of regulatory requirement. The emergency preparedness of NPP is considered as part of the Defense in Depth safety concepts of NPPs.

The course aims to introduce the fundamental of phenomena involved in a severe accident of light water reactors, the phenomena in containment, the characterization of accident sources terms, dispersion of radionuclides in the environment, the elements in a emergency preparedness of NPP. Finally, the severe accident mitigation features in Generation III and III+ reactor are introduced.

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 phenomena involved in severe accidents of light water reactors	1
2.	Describe the source terms of severe accident and the way to quantify source terms	1
3.	Describe the atmospheric dispersion of radionuclides and assessment of radioactive dose to the public	1
4.	Describe the strategy of severe accident mitigations	1
5.	Describe the elements involved in the emergency preparedness of nuclear power plant	2
6.	Describe the TMI, Chernobyl, and Fukushmia accidents and their impact on nuclear safety	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	Hours/week (if applicable)
CILO 1	15	(5)	15(+5) = 20
CILO 2	6	(2)	6(+2) = 8
CILO 3	3	(1)	3(+1) = 4
CILO 4	6	(2)	6(+2) = 8
CILO 5	3	(1)	3(+1) = 4
CILO 6	6	(2)	6(+2) = 8
Total (hrs)	**39**	**(13)**	**39(+13) = 52**

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	Quiz	Term Paper	Total (%)
CILO 1	14	10	6	10	40
CILO 2	5	4	2	4	15
CILO 3	3	2	2	2	9
CILO 4	5	4	2	4	15
CILO 5	3	2	1	2	8
CILO 6	5	3	2	3	13
Total (%)	**35**	**25**	**15**	**25**	**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:

Four homework (25% of term grade).
One examination (Final Examination) (35% of term grade).
Quiz during the regulatory classes (15% of term grade).
One term paper (submitted at the end of semester) (25% of term grade).

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:

- The Safety Features of Generation II and II+ Light Water Reactors
- Introduction to the Methodology of Probabilistic Safety Assessment
- Overview of Severe Accidents Phenomenology of Light Water Reactors
- In-Vessel Phenomenon (Blowdown, Boiloff, Core Melting, Molten Core Relocation, Water Coolant Interactions, Vessel Attack and Failure Modes)
- Ex-Vessel Phenomenon (Molten Core Concrete Interactions)
- Containment Responses in Severe Accidents (Steam Explosion, Hydrogen Explosion, Direct Containment Heating, Over-Pressurization due to Non-condensible Gases Generation, Over-Temperature Failure)
- Integrated Analysis of Severe Accident of Light Water Reactor (MAAP and MELCOR Code)
- Introduction to Emergency Operating Procedures (EOPs) and Severe Accident Management Guidelines (SAMGs)
- Introduction to Source Terms (Regulatory Source Terms: TID-14844, NUREG-1465; Plant Specific Source Terms; Accident specific Source Terms)

- Atmospheric Dispersion of Source Terms and Health Effect of Radiological Doses (MACCS code and other code of similar purpose)
- Emergency Preparedness and Accident Classifications
- Three Mile Island Incident (1979), Chernobyl Accident (1986) and Fukushmia Accident (2011) and Lesson Learned
- Severe Accident Mitigation Feature of Generation III and III+ Reactors

Recommended Reading:

Text(s)
There is no standard textbook for this subjects

References

Lamarsh J R and Baratta A J, Introduction to Nuclear Engineering, Prentice Hall,
ISBN: 0-201-82498-1

E.E. Lewis, “Nuclear Power Reactor Safety”, John Wiley & Sons Inc (March 1978)

Online Resources
To be Provided