MAINTENANCE ENGINEERING AND SAFETY
ENCH 414

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 0

Course Objectives:
The objective of this course is to introduce students to different maintenance systems and their practical applications within chemical process plants. It enables students to understand process safety concepts, identify major industrial hazards and implement effective hazard management strategies.

1 Introduction to maintenance (5 hours)

1.1 Concept, challenges and objective
1.2 Types of maintenance and their applications
1.3 Preventive Maintenance (PM): elements, steps and measures
1.4 Corrective Maintenance (CM): types, steps and time reduction techniques

2 Maintenance management (10 hours)

2.1 Functions, objectives, program evaluation and review technique (PERT) and critical path method (CPM)
2.2 Predictive testing and inspection (PTI) technologies/approaches
2.3 Guidelines for reducing human error
2.4 Maintenance personnel safety
2.5 Maintenance labor cost estimation
2.6 Lubrication programs
2.7 Equipment maintenance: pipe, pumps, valves and cooling tower

3 Introduction to safety (4 hours)

3.1 Process safety
3.2 Accident and loss statistics
3.3 Nature of the accident process
3.4 Inherent safety
3.5 Four Significant Disasters: Flixborough, Bhopal, Seveso and Pasadena

4 Toxicology (6 hours)

4.1 Toxic materials and its route and effect to biological organisms
4.2 Dose response relationships
4.3 Threshold limit values

4.4 Industrial hygiene identification: Material safety data sheets
4.5 Industrial hygiene evaluation: monitoring, dust, noise, toxic vapors
4.6 Industrial hygiene control: Personal protective equipment, respirators, ventilations
4.7 Hazards and Operability studies (HAZOP)

5 Source Models and Dispersion (6 hours)

5.1 Flow of liquid through holes, pipes and fittings
5.2 Flow of gas through holes
5.3 Parameters affecting dispersion
5.4 Neutrally Buoyant Dispersion Models, plume and puff model
5.5 Pasquill-Gifford plume and puff model

6 Fires and Explosions (8 hours)

6.1 Fires and explosions, flammability characteristics
6.2 Flammability diagram, Ignition sources
6.3 Inerting, vacuum purging, pressure purging
6.4 Static electricity and its controlling techniques
6.5 Ventilation and sprinkler systems

7 Relief systems (4 hours)

7.1 Relief method
7.2 Classification and selection for vapour/gas, liquid and run-away reaction services
7.3 Relief sizing, conventional Spring-Operated Reliefs in Liquid Service and Vapor or gas service

8 Risk Assessment (2 hours)

8.1 Probability theory
8.2 Event trees and fault tree analysis

Tutorial (15 hours)

1. Executing equipment maintenance procedures for pipes, pumps, valves, and cooling towers.
2. Analyzing the four significant industrial disasters of Flixborough, Bhopal, Seveso, and Pasadena.
3. Identifying industrial hygiene practices using material safety data sheets.
4. Conducting hazard and operability studies for process safety evaluation.
5. Applying the Pasquill-Gifford plume and puff models to predict dispersion behavior.
6. Constructing and interpreting flammability diagrams for fire and explosion prevention.

7. Sizing and evaluating conventional spring-operated reliefs for liquid and vapor/gas services.
8. Performing risk assessment using event tree and fault tree analysis.

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1 and 3	9	10
2	10	10
3	10	10
4 and 7	10	10
5 and 8	8	10
6	8	10
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References:

1. Banerjee, S. (2003). Industrial hazards and plant safety. Taylor & Francis.
2. Crawley, F., Preston, M., & Tyler, B. (2008). HAZOP: Guide to best practice (Latest ed.). IChemE.
3. Crowl, D. A., & Louvar, J. F. (2019). Chemical process safety: Fundamentals with applications (Latest ed.). Pearson Education.
4. Deshmukh, L. M. (2010). Industrial safety management. McGraw-Hill Education.
5. Dhillon, B. S. (2002). Engineering maintenance: A modern approach. CRC Press.
6. Higgins, L. R., Mobley, R. K., & Smith, R. (2002). Maintenance engineering handbook (Latest ed.). McGraw-Hill.
7. Mishra, R. C., & Pathak, K. (2012). Maintenance engineering and management (Latest ed.). PHI Learning.