



# **ERODE SENGUNTHAR ENGINEERING COLLEGE**

**(An Autonomous Institution, Affiliated to Anna University)  
PERUNDURAI, ERODE - 638 057**



## **PG Curriculum and Syllabus (1 to 4 Semesters)**

**M.E – INDUSTRIAL SAFETY ENGINEERING**

**Choice Based Credit System (CBCS)**

**REGULATION 2019**



**ERODE SENGUNTHAR ENGINEERING COLLEGE, ERODE**  
DEPARTMENT OF MECHANICAL ENGINEERING

**REGULATIONS – 2019**  
**CHOICE BASED CREDIT SYSTEM**  
**I TO IV SEMESTERS CURRICULUM**

M.E. INDUSTRIAL SAFETY ENGINEERING Total Credits : 70												
SEMESTER I												
THEORY												
Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19IS101	Probability and Statistical Methods	I	1,2,3,4	-	3	1	0	4	40	60	100	BS
19IS102	Principles of Safety Management	I, II,III	1,6,8	2	3	0	0	3	40	60	100	PC
19IS103	Occupational Health and Industrial Hygiene	I,II, III	1,5,6,8	2	3	0	0	3	40	60	100	PC
19IS104	Industrial Safety, Health and Environment (SHE) Acts	I, II,III, IV	1,5,6,7,8,10	2	3	1	0	4	40	60	100	PC
19IS105	Environmental Safety	I,II,III	1,5,6,7,8,10,11	2	3	1	0	4	40	60	100	PC
	Professional Elective I	-	-		3	0	0	3	40	60	100	PE
19IS106	Technical Seminar I	I,II,III, IV	1,5,6,7	2	0	0	2	0	60	40	100	PC
TOTAL					21	2	4	21	-	-	-	-

SEMESTER II												
THEORY												
Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19IS201	Fire Engineering and Explosion Control	I,II,III	1,4,5,6,10	2	3	1	0	3	40	60	100	PC
19IS202	Computer Aided Hazard Analysis	I,II,III	1,2,3,5	2	3	1	0	4	40	60	100	PC

*N. / m*  
**Chairman - BoS**  
Dept. of Mech Engg. - ESEC

19IS203	Safety in Process Industries	I, II, III, IV	1,2,3, 5	2	3	0	0	3	40	60	100	PC
19IS204	Electrical Safety	I, II, III, IV	1,2,3, 5	2	3	0	0	3	40	60	100	PC
19IS205	Reliability Engineering	I, II, III	1,2,3, 5	2	4	0	0	4	40	60	100	PC
	Professional Elective II	-	-	-	3	0	0	3	40	60	100	PE
<b>PRACTICAL</b>												
19IS206	Industrial Safety and Environmental Laboratory	I, II, III	3,4, 5,7, 10	2	0	0	4	2	60	40	100	PC
19IS207	Technical Seminar II	I, II, III, IV	1,5, 6,7	2	0	0	2	0	60	40	100	PC
<b>TOTAL</b>					<b>20</b>	<b>2</b>	<b>4</b>	<b>22</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

### SEMESTER III

#### THEORY

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
	Professional Elective III	-	-	-	3	0	0	3	40	60	100	PE
	Professional Elective IV	-	-	-	3	0	0	3	40	60	100	PE
	Professional Elective V	-	-	-	3	0	0	3	40	60	100	PE

#### PRACTICAL

19IS301	Project Work - Phase I	I, II, III, IV	1,2,3, 4,5,6, 7,8,9, 10,11	2	-	-	12	6	60	40	100	PC
<b>TOTAL</b>					<b>9</b>	<b>0</b>	<b>12</b>	<b>15</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

### SEMESTER IV

#### PRACTICAL

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19IS401	Project Work - Phase II	I, II, III, IV	1,2,3, 4,5,6, 7,8,9, 10,11	2	-	-	24	12	60	40	100	PC
<b>Total</b>					<b>-</b>	<b>-</b>	<b>24</b>	<b>12</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC



## PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVES								
Code No.	Course	Objective & Outcomes			L	T	P	C
		PEOs	POs	PSOs				
PROFESSIONAL ELECTIVE I								
19ISX01	Principles of Disaster Management	I,II,III	1,6,8	2	3	0	0	3
19ISX02	Fireworks Safety	I,II,III, IV	1,2,3,5	2	3	0	0	3
19ISX03	Chemical Process Quantitative Risk Analysis	I,II,III	1,2,3,5	2	3	0	0	3
PROFESSIONAL ELECTIVE II								
19ISX04	Dock Safety	I,II,III, IV	1,2,5	2	3	0	0	3
19ISX05	Plant Layout and Materials Handling	I,II,III	1,2,3,5	2	3	0	0	3
19ISX06	Design of Industrial Ventilation System	I,II,III	1,2,3,5	2	3	0	0	3
PROFESSIONAL ELECTIVE III								
19ISX07	OHSAS 18000 & ISO 14000	I,II,III, IV	1,5,6,7,8, 10	2	3	0	0	3
19ISX08	Safety in Petrochemical Industries	I,II,III, IV	1,2,3,5	2	3	0	0	3
19ISX09	Safety in Textile Industry	I,II,III, IV	1,2,3,5	2	3	0	0	3
PROFESSIONAL ELECTIVE IV								
19ISX10	Vibration and Noise Control	I,II	1,2,3,4	2	3	0	0	3
19ISX11	Safety in Mines	I,II,III, IV	1,2,3,5	2	3	0	0	3
19ISX12	Physical and chemical treatment of water and wastewater	I,II	1,2,3,5	2	3	0	0	3
PROFESSIONAL ELECTIVE V								
19ISX13	Safety in Construction	I,II,III, IV	1,2,3,5	2	3	0	0	3
19ISX14	Bridge Maintenance and Management	I,II,III	1,2	2	3	0	0	3
19ISX15	Transport Safety	I,II,III, IV	1,2,5	2	3	0	0	3

- BS - Basic Sciences  
 PC - Professional Core  
 PE - Professional Elective  
 CA - Continuous Assessment  
 ES - End Semester Examination

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC





Department	MECHANICAL ENGINEERING				R 2019	Semester I	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19IS101	PROBABILITY AND STATISTICAL METHODS	3	1	0	4	60	100

**Course Objective(s):** The purpose of learning this course is:

- To review the basic concept of probability and to give the applications of probability distributions.
- To understand the concept of correlation, regression and Estimation Theory.
- To provide information about testing of hypothesis.
- To acquire knowledge of various statistical techniques useful in making rational decision in real life Problems using non-parametric methods.
- To forecast the future trends using various forecasting methods.

**Course Outcome(s):** At the end of this course, learners will be able to:

- Apply the concept of probability and probability distributions in their field.
- Acquire the concept of estimation theory.
- Do testing of hypothesis which will be useful in solving engineering problems.
- Design and analyze the statistical experiments.
- Be exposed to statistical methods designed to contribute the process of making scientific judgments in the face of uncertainty and variation.

<b>Unit I</b>	<b>RANDOM VARIABLES</b>	<b>12</b>
---------------	-------------------------	-----------

Random variables - Moments - Moment generating function – Binomial, Poisson and Normal distributions - Functions of one random variables –Two dimensional Random variables – Joint probability density function- Linear correlation and regression.

<b>Unit II</b>	<b>ESTIMATION THEORY</b>	<b>12</b>
----------------	--------------------------	-----------

Principle of least squares - Estimation of Parameters - Maximum likelihood estimates - Method of moments.

<b>Unit III</b>	<b>PARAMETRIC METHODS</b>	<b>12</b>
-----------------	---------------------------	-----------

Sampling distributions – Types of Sampling- Type I and Type II errors, Large sample test for proportion and mean – Test of significance for small samples – t and F distributions.


<b>Unit IV</b>	<b>NON-PARAMETRIC METHODS</b>	<b>12</b>
----------------	-------------------------------	-----------

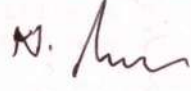
Chi-square tests - independence of attributes and goodness of fit - Sign test for paired data - Rank sum test – Kolmogorov Smirnov test for goodness of fit - Mann-Whitney U test - Kruskal Wallis test - One sample run test - Rank correlation.

<b>Unit V</b>	<b>TIME SERIES</b>	<b>12</b>
---------------	--------------------	-----------

Characteristics and Representation - Moving Averages - Exponential smoothing - Auto Regressive Processes

<b>REFERENCE(S):</b>	
1.	Fruend John, E. and Miller, Irwin, "Probability and Statistics for Engineers ", PHI, 8 <sup>th</sup> edition, 2011.
2.	Jay, L. Devore, "Probability and Statistics for Engineering and Sciences", Cengage Learning, Inc., 8 <sup>th</sup> edition, 2010.
3.	Montgomery D.C and Johnson, L.A., "Forecasting and Time Series", McGraw-Hill, New York, 1990.
4.	Anderson, O.D., "Time Series Analysis: Theory and practice ", I. North - Holland, Amsterdam, 1982.
5.	Gupta, S.C. and Kapur, V.K. "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi, 2014.

  
**Chairman - BoS**  
**Dept. of Maths - ESEC**

  
**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



Department	MECHANICAL ENGINEERING				R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Total Hours	Maximum Marks	
		L	T	P			
19IS102	PRINCIPLES OF SAFETY MANAGEMENT	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To achieve an understanding of principles of safety management.
- To enable the students to learn about various functions and activities of safety department.
- To enable students to conduct safety audit and write audit reports effectively in auditing situations.
- To have knowledge about sources of information for safety promotion and training.
- To familiarize students with evaluation of safety performance.

**Course Outcome(s):** At the end of this course, learners will be able:

- To understand the functions and activities of safety engineering department.
- To carry out a safety audit and prepare a report for the audit.
- To prepare an accident investigation report and to evaluate the safety performance of an organization from the accident records.
- To evaluate the safety performance of an organization from accident records.
- To identify various agencies, support institutions and government organizations involved in safety training and promotion.

<b>Unit I</b>	<b>CONCEPTS AND TECHNIQUES</b>	<b>9</b>
---------------	--------------------------------	----------

History of Safety movement –Evolution of general concepts of management –line and budgeting for safety-safety policy. Incident disaster control, job safety analysis, safety - modern safety concept-staff functions for safety-Recall Technique (IRT), survey, safety inspection- safety sampling, evaluation of performance of supervisors on safety.

<b>Unit II</b>	<b>SAFETY AUDIT - INTRODUCTION</b>	<b>9</b>
----------------	------------------------------------	----------

Components of safety audit, types of audit, audit methodology, non-conformity reporting (NCR), audit checklist and report – review of inspection, remarks by government agencies, consultants, experts – perusal of accident and safety records, formats – implementation of audit indication - liaison with departments to ensure co-ordination – check list – identification of unsafe acts of workers and unsafe conditions in the shop floor-IS 14489 : 1998 Code of practice on occupational Safety and health audit.

<b>Unit III</b>	<b>ACCIDENT INVESTIGATION AND REPORTING</b>	<b>9</b>
-----------------	---	----------

Concept of an accident, near miss incident, reportable and non-reportable accidents, reporting to statutory authorities – principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – role of safety committee –cost of accident.

<b>Unit IV</b>	<b>SAFETY PERFORMANCE MONITORING</b>	<b>9</b>
----------------	--------------------------------------	----------

ANSI (Z16.1) Recommended practices for compiling and measuring work injury experience – permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate, Total Injury illness incidence rate, Lost workday cases incidence rate (LWDI ), Number of lost workdays rate-problems.

<b>Unit V</b>	<b>SAFETY EDUCATION AND TRAINING</b>	<b>9</b>
---------------	--------------------------------------	----------

Importance of training-identification of training needs-training methods – programmes, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training DGFASLI, NSC, ASSE, HSE, OSHA-NEBOSH – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge,safety incentive scheme, safety campaign.

#### REFERENCE(S):

1. Ray Asfahl. C "Industrial Safety and Health Management" Pearson Prentice Hall, 2003.
2. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973.
3. John V.Grimaldi and Rollin H. Simonds, "Safety Management", Richard D Irwin, 1994.

*N. / m*



4.	Dan Petersen, "Techniques of Safety Management", McGraw-Hill Company, Tokyo, 1981.
5.	Philip Hagan, "Accident Prevention Manual for Business and Industry", N.S.C.Chicago, 13 <sup>th</sup> edition, 2009.
6.	Lees, F.P & M. Sam Mannan, "Loss Prevention in Process Industries: Hazard Identification, Assessment and Control", Butterworth-Heinemann publications, London, 4 <sup>th</sup> edition, 2012.
7.	John Ridley, "Safety at Work", Butterworth and Co., London, 1983.
8.	Subramanian.V., "The Factories Act 1948 with Tamilnadu factories rules 1950", Madras Book Agency, 21 <sup>st</sup> ed., Chennai, 2000.
9.	Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.
10.	Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.

*N. Man*

**Chairman - BoS**  
Dept. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING				R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Total Hours	Maximum Marks	
		L	T	P			
19IS103	OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To understand the basic knowledge on anatomy of few important human organs and its basic functions.
- To enable the students to learn about various functional and activities of occupational health services.
- To enable the students to compare the hazards of chemicals with the permissible levels.
- To acquire knowledge about types of hazards arising out of physical, chemical and biological agents.

**Course Outcome(s):** At the end of this course, learners will be able:

- To understand the various physiological functions of our body and the test methods for periodical monitoring of health.
- To understand the various functions and activities of occupational health services and Toxicity of various materials.
- To identify and analyze various types of hazards present in physical, chemical, biological agents and ergonomical aspects in a process.
- To analyze various types of biological hazards and ergonomical aspects.
- To identify and understand notifiable occupational diseases arising out of occupation and suggest methods for the prevention of such diseases.

**Unit I ANATOMY, PHYSIOLOGY, HAZARD AND PATHOLOGY**

**9**

Definition- Anatomy and Physiology of human organs – The lungs, Skin, Ear, Eyes and skin – Functions of organs – Impairment of organs – Effects of various hazards on organs - Cardio pulmonary resuscitation - audiometric tests, eye tests, vital functional tests. Exposure routes of toxic materials and protective mechanisms, Recognition of health hazards, Methods for measuring and evaluating health hazards.

**Unit II PHYSICAL HAZARDS**

**9**

Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control program, industrial audiometry, hearing conservation programs-vibration, types, effects, instruments, surveying procedure, permissible exposure limit. Ionizing radiation, types, effects, monitoring instruments, control programs, OSHA standard- non-ionizing radiations, effects, types, radar hazards, microwaves and radio waves, lasers, TLV- cold environments, hypothermia, wind chill index, control measures of hot environments, thermal comfort, heat stress indices, Methods for controlling thermal exposures, acclimatization, estimation and control, Industrial illumination and design of lighting system.

**Unit III CHEMICAL HAZARDS**

**9**

Recognition of chemical hazards-dust, fumes, mist, vapor, fog, gases, types, concentration, Exposure vs. Dose, TLV - Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard. Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapor monitors, dust sample collection devices, personal sampling Methods of Control - Engineering Control, Design maintenance considerations, design specifications - General Control Methods - training and education. Toxicology, classes of toxicants, metals, agriculture chemicals, solvents, food additives, cosmetics.- human health risk assessment and Environmental risk assessment.

**Unit IV BIOLOGICAL AND ERGONOMICAL HAZARDS**

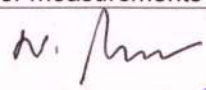
**9**

Classification of Bio-hazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases – Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design. Work Related Musculoskeletal Disorders –Carpal Tunnel Syndrome CTS- Tendon pain disorders of the neck- back injuries.

**Unit V OCCUPATIONAL HEALTH, PHYSIOLOGY AND TOXICOLOGY**

**9**

Concept and spectrum of health - functional units and activities of occupational health services, pre-employment and post-employment medical examinations – occupational related diseases, levels of prevention of diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax. Man as a system component – allocation of functions – efficiency – occupational work capacity – aerobic and anaerobic work – evaluation of physiological requirements of jobs – parameters of measurements –

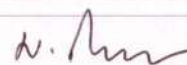
  
Chairman - BoS  
Dept. of Mech Engg. - ESEC



categorization of job heaviness – work organization – stress – strain – fatigue – rest pauses – shift work – personal hygiene. Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems. Lead-nickel, chromium and manganese toxicity, gas poisoning (such as CO, ammonia, coal and dust) and their effects and prevention.

**REFERENCE(S):**

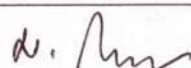
1.	Danuta Koradecka, Hand book of "Occupational Safety and Health", CRC Press, 2010.
2.	Hand book of "Occupational Safety and Health", National Safety Council, Chicago, 1982.
3.	Barbara A.Plog, Patricia J.Quinlan, MPH, CIH and Jennifer Villareal "Fundamentals of Industrial Hygiene", 6 <sup>th</sup> edition 2012, National Safety Council, 2012.
4.	Jearne Mager Stellman, "Encyclopedia of Occupational Health and Safety", Vol.I and II, published by International Labour Organisation, Geneva, 1998.



**Chairman - BoS**  
Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19IS104	INDUSTRIAL SAFETY, HEALTH AND ENVIRONMENT (SHE) ACTS	3	1	0	4	60	100	
<b>Course Objective(s):</b> The purpose of learning this course is: <ul style="list-style-type: none"><li>• To provide exposure to the students about safety and health provisions related to hazardous processes as laid out in Factories act 1948.</li><li>• To familiarize students with powers of inspectorate of factories.</li><li>• To help students to learn about Environment act 1948 and rules framed under the act.</li><li>• To provide wide exposure to the students about various legislations applicable to an industrial unit.</li></ul>								
<b>Course Outcome(s):</b> At the end of this course, learners will be able: <ul style="list-style-type: none"><li>• To list out important legislations related to health, Safety and Environment.</li><li>• To list out requirements mentioned in factories act for the prevention of accidents.</li><li>• To understand the health and welfare provisions given in factories act.</li><li>• To understand the statutory requirements for an Industry on registration, license and its renewal.</li><li>• To prepare onsite and off-site emergency plan.</li></ul>								
Unit I	FACTORIES ACT – 1948						12	
Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare – special provisions – penalties and procedures-Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948 - Tamilnadu safety officer rules 2005.								
Unit II	ENVIRONMENT ACT – 1986						12	
General powers of the central government, prevention, control and abatement of environmental pollution-Biomedical waste (Management and handling Rules), 1989-The noise pollution (Regulation and control) Rules, 2000-The Batteries (Management and Handling Rules) 2001- No Objection certificate from statutory authorities like pollution control board. Air Act 1981 and Water Act 1974. Central and state boards for the prevention and control of air pollution-powers and functions of boards – prevention and control of air pollution and water pollution – fund – accounts and audit, penalties and procedures.								
Unit III	MANUFACTURE, STORAGE & IMPORT OF HAZARDOUS CHEMICAL RULES 1989						12	
Definitions – duties of authorities – responsibilities of occupier – notification of major accidents – information to be furnished – preparation of offsite and onsite plans – list of hazardous and toxic chemicals – safety reports – safety data sheets.								
Unit IV	OTHER ACTS AND RULES						12	
Indian Boiler (Amendments) Act 2007, static and mobile pressure vessel rules (SMPV), motor vehicle rules, the Mines and Minerals (Development & Regulation) Act, 2010, workman compensation act, rules – electricity act and rules – hazardous wastes (management and handling) rules, 1989, with amendments in 2000- the building and other construction workers act 1996., Petroleum rules, Gas cylinder rules-Explosives Act 1983-Pesticides Act – Tamilnadu lifts act 1997.								
Unit V	INTERNATIONAL ACTS AND STANDARDS						12	
Occupational Safety and Health act of USA (The William- Steiger's Act of 1970) – Health and safety work act (HASAWA 1974, UK) – OHSAS 18000 – ISO 14000- Benefits and Elements.								

REFERENCE(S):	
1.	Subramanian, V., "The Factories Act 1948 with Tamilnadu factories rules 1950", Madras Book Agency, Chennai, 21 <sup>st</sup> edition., 2000.
2.	"The Environment Act (Protection) 1986 with allied rules", Law Publishers (India) Pvt. Ltd., Allahabad.
3.	"Water (Prevention and control of pollution) act 1974", Law publishers (India) Pvt. Ltd., Allahabad.
4.	"Air (Prevention and control of pollution) act 1981", Law Publishers (India) Pvt. Ltd., Allahabad.
5.	"The Indian boilers act 1923 with amendments", Law Publishers (India) Pvt. Ltd., Allahabad.
6.	"The Indian Electricity act 2003 with rules", Law publishers (India) Pvt. Ltd., New Delhi.

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC



7. Indian School of Labour education, "Industrial safety and Laws", Chennai, 1982.

N. Ann

Chairman - BoS  
Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING				R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Total Hours	Maximum Marks	
		L	T	P			
19IS105	ENVIRONMENTAL SAFETY	3	1	0	4	60	100

**Course Objective(s):** The purpose of learning this course is:

- To provide in depth knowledge in Principles of Environmental safety and its applications in various fields.
- To give understanding of air and water pollution and their control.
- To expose the students to the basis in hazardous waste management.
- To design emission measurement devices.

**Course Outcome(s):** At the end of this course, learners will be able:

- Illustrate and familiarize the basic concepts scope of environmental safety.
- Understand the standards of professional conduct that are published by professional safety organizations and / or certification bodies.
- Explain the ways in which environmental health problems have arisen due to air and water pollution.
- Illustrate the role of hazardous waste management and use of critical thinking to identify and assess environmental health risks.
- Discuss concepts of measurement of emissions and design emission measurement devices.

<b>Unit I</b>	<b>AIR POLLUTION</b>	<b>12</b>
---------------	----------------------	-----------

Classification and properties of air pollutants – Pollution sources – Effects of air pollutants on human beings, Animals, Plants and Materials - automobile pollution hazards of air pollution-concept of clean coal combustion technology - ultra violet radiation, infrared radiation, radiation from sun-hazards due to depletion of ozone - deforestation-ozone holes-automobile exhausts-chemical factory stack emissions-CFC. Guide lines on Air (prevention and control of pollution) act, 1981 and rules 1982.

<b>Unit II</b>	<b>WATER POLLUTION</b>	<b>12</b>
----------------	------------------------	-----------

Classification of water pollutants-health hazards-sampling and analysis of water-water treatment - different industrial effluents and their treatment and disposal –advanced wastewater treatment - effluent quality standards and laws- chemical industries, tannery, textile effluents-common treatment.

<b>Unit III</b>	<b>HAZARDOUS WASTE MANAGEMENT</b>	<b>12</b>
-----------------	-----------------------------------	-----------

Hazardous waste management in India-waste identification, characterization and classification-technological options for collection, treatment and disposal of hazardous waste-selection charts for the treatment of different hazardous wastes-methods of collection and disposal of solid wastes-health hazards-toxic and radioactive wastes incineration and vitrification - hazards due to bio-process-dilution-standards and restrictions – recycling and reuse.

Environmental impact assessment (EIA)-scope, guidelines, activities and methodologies.

<b>Unit IV</b>	<b>ENVIRONMENTAL MEASUREMENT AND CONTROL</b>	<b>12</b>
----------------	--	-----------

Sampling and analysis – dust monitor – gas analyzer, particle size analyzer – lux meter, pH meter – gas chromatograph – atomic absorption spectrometer. Gravitational settling chambers-cyclone separators-scrubbers-electrostatic precipitator - bag filter – maintenance - control of gaseous emission by adsorption, absorption and combustion methods- Pollution Control Board-laws.

<b>Unit V</b>	<b>POLLUTION CONTROL IN PROCESS INDUSTRIES</b>	<b>12</b>
---------------	--	-----------

Pollution control in process industries like cement, paper, petroleum-petroleum products textile- tanneries-thermal power plants – dyeing and pigment industries - eco-friendly energy.

#### REFERENCE(S):

1.	Rao C S, "Environmental Pollution Control Engineering", New Age International, 2007.
2.	Mahajan S.P, "Pollution Control in Process Industries", Tata McGraw Hill Publishing Company, New Delhi, 2004.
3.	Varma and Braner, "Air pollution equipment", Springer Publishers, Second Edition.
4.	"Guidelines for EIA of Industrial and other Projects" Ministry of Environment and Forests, Government of

  
**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**

	India, 2009.
5.	Pollution Control Law Series: Pollution Control Acts, Rules and Notification Issued There under, Central Pollution Control Board, Ministry of Environment and Forest, Government of India, 2006.
6.	Cheremisinoff N.P. and Graffia M.L., "Environmental Health and Safety Management: A Guide to Compliance", William Andrew Publishing/Noyes, 1995.
7.	Cheremisinoff N.P. "Pressure Safety Design Practices for Refinery and Chemical Operations", Jaico Publication, 2003.
8.	Canter L.W., "Environmental Impact Assessment", McGraw Hill, 1996.

*N. Puri*

**Chairman - BoS**  
Dept. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours		Maximum Marks
		L	T	P	C			
19IS106	TECHNICAL SEMINAR I	0	0	2	1	30		100
<b>Course Objective(s):</b> The purpose of learning this course is: <ul style="list-style-type: none"> <li>To develop self-learning skills of utilizing various technical resources to make a technical presentation</li> <li>To promote the technical presentation and communication skills.</li> <li>To impart the knowledge on intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.</li> <li>To promote the ability for Interacting and sharing attitude.</li> <li>To engarauge the commitment-attitude to complete tasks.</li> </ul>								
<b>Course Outcome(s):</b> At the end of this course, learners will be able to: <ul style="list-style-type: none"> <li>Refer and utilize various technical resources available from multiple fields</li> <li>Improve the technical presentation and communication skills</li> <li>Analyze the importance of intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.</li> <li>Interact and share their technical knowledge to enhance the leadership skills</li> <li>Prepare report and present oral demonstrations</li> </ul>								
<b>METHOD OF EVALUATION:</b> In this course. A students has to present three technical papers or recent advanced in engineering/technology that will be evaluated by a committee constitutes by the head of the department.								

*W. Am*


**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



Department	MECHANICAL ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19IS201	FIRE ENGINEERING AND EXPLOSION CONTROL	4	0	0	3	60	100	
<b>Course Objective(s):</b> The purpose of learning this course is: <ul style="list-style-type: none"><li>• To provide an in depth knowledge about the science of fire.</li><li>• To understand the causes and effects of fire.</li><li>• To know the various fire prevention systems and protective equipment.</li><li>• To understand the science of explosion and its prevention techniques.</li><li>• To understand the various fire prevention techniques to be followed in a building.</li></ul>								
<b>Course Outcome(s):</b> At the end of this course, learners will be able: <ul style="list-style-type: none"><li>• To make familiar of basic concepts of fire and explosion science.</li><li>• To know the different source of ignition and their prevention techniques.</li><li>• To understand the operation of various types of firefighting equipment.</li><li>• To understand the causes and prevention of explosion.</li><li>• To equip the students to effectively employ explosion protection techniques and their significances to suit the industrial requirement.</li></ul>								
<b>Unit I</b>	<b>PHYSICS AND CHEMISTRY OF FIRE</b>						<b>12</b>	
Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - theory of combustion and explosion – vapor clouds – flash fire – jet fires – pool fires – unconfined vapor cloud explosion, shock waves - auto-ignition – boiling liquid expanding vapor explosion – case studies – Flixborough, Mexico disaster, Pasedena Texas, Piper Alpha, Bombay Victoria dock ship explosions, Mahul refinery explosion, Nagothane vapor cloud explosion and Vizag refinery disaster.								
<b>Unit II</b>	<b>FIRE PREVENTION AND PROTECTION</b>						<b>12</b>	
Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E-Fire extinguishing agents- Water ,Foam, Dry chemical powder, Carbon-dioxide- Halon alternatives Halocarbon compounds-Inert gases , dry powders – types of fire extinguishers – fire stoppers – hydrant pipes– hoses – monitors – fire watchers – lay out of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – first aid for burns.								
<b>Unit III</b>	<b>INDUSTRIAL FIRE PROTECTION SYSTEMS</b>						<b>12</b>	
Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO <sub>2</sub> system, foam system, dry chemical powder (DCP) system, halon system – need for halon replacement – smoke venting. Portable extinguishers – flammable liquids – tank farms – indices of inflammability-firefighting systems.								
<b>Unit IV</b>	<b>BUILDING FIRE SAFETY</b>						<b>12</b>	
Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design - exit – width calculations - fire certificates – fire safety requirements for high rise buildings.								
<b>Unit V</b>	<b>EXPLOSION PROTECTING SYSTEMS</b>						<b>12</b>	
Principles of explosion-detonation and blast waves-explosion parameters – Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure-explosion venting-inert gases, plant for generation of inert gas rupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO <sub>2</sub> ) and halons-hazards in LPG, ammonia (NH <sub>3</sub> ).								
<b>REFERENCE(S):</b>								

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC

1.	Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London, 1986.
2.	Arthur E Cote "Fire protection Handbook" NFPA 2008.
3.	Jain V K "Fire Safety in Building" New Age International 1996.
4.	Purandare D.D & Abhay D, Purandare, "Hand book on Industrial Fire Safety" P & A Publications, New Delhi, 2006.
5.	Gupta, R.S., "Hand Book of Fire Technology" Orient Blackswan, 2010.
6.	McElroy, Frank E "Accident Prevention manual for industrial operations" N.S.C., Chicago, 1988.
7.	Dinko Tuhtar, "Fire and explosion protection – A System Approach" Ellis Horwood Ltd, Publisher, 1989.
8.	"Fire fighters hazardous materials reference book", Van Nostrand Rein Hold, New York, 1993.
9.	Dennis P. Nolan "Handbook of Fire & Explosion Protection Engineering Principles for Oil, Gas, Chemical, & Related Facilities", William Andrew Publishers, 1996.
10.	James G. Quintiere, "Fundamentals of Fire Phenomena", John Wiley & Sons Ltd, England, 2006.

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING				R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19IS202	COMPUTER AIDED HAZARD ANALYSIS	3	1	0	4	60	100

**Course Objective(s):** The purpose of learning this course is:

- To provide basic knowledge on risk, hazard and their assessment techniques in Industry.
- To understand and acquire the principles of operating various equipment for safety application.
- To inculcate knowledge on consequences of fire, explosion and toxic releases.
- To acquire the knowledge on application of safety software in quantifying the risk assessment.
- To expose the students, the consequences and credibility of various risk factors.

**Course Outcome(s):** At the end of this course, learners will be able to:

- This course would familiarize the students with the basic concepts in risk and hazard.
- Course will be helpful to understand the various instruments and equipment in the industrial field with respect to safety.
- Students will be trained to find solution for risk assessment studies through the use of software.
- Students will get the knowledge of consequence analysis
- Students would be able to make use of a risk assessment technique to quantify the risk.

<b>Unit I</b>	<b>HAZARD, RISK ISSUES AND HAZARD ASSESSMENT</b>	<b>12</b>
---------------	--	-----------

Introduction, hazard, hazard monitoring-risk issue, group or societal risk, individual risk, voluntary and involuntary risk, social benefits vs technological risk, approaches for establishing risk acceptance levels, Risk estimation. Risk communication, Implementation and review, Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), human error analysis, hazard operability studies (HAZOP), safety warning systems.

<b>Unit II</b>	<b>INSTRUMENTATION IN SAFETY APPLICATIONS</b>	<b>12</b>
----------------	---	-----------

Applications of Advanced Equipment and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter(DSC), Thermo Gravimetric Analyzer (TGA), Accelerated Rate Calorimeter(ARC), Reactive Calorimeter(RC), Reaction System Screening Tool(RSST) - Principles of operations, Controlling parameters, Applications, advantages. Explosive Testing, Deflagration Test, Detonation Test, Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test(BAM) and Friction Sensitiveness Test (BAM), Shock Sensitiveness Test, Card Gap Test.

<b>Unit III</b>	<b>RISK ANALYSIS QUANTIFICATION AND SOFTWARES</b>	<b>12</b>
-----------------	---	-----------

Fault Tree Analysis and Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and toxicity index (FETI), various indices - Hazard analysis (HAZAN)- Failure Mode and Effect Analysis (FMEA)- Layer of Protection Analysis (LOPA)-Safety Integrity Level (SIL) - Basic concepts of Reliability- Software on Risk analysis, CISCON, FETI, ALOHA.

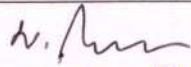
<b>Unit IV</b>	<b>CONSEQUENCES ANALYSIS</b>	<b>12</b>
----------------	------------------------------	-----------

Logics of consequences analysis- Estimation- Hazard identification based on the properties of chemicals- Chemical inventory analysis-identification of hazardous processes- Estimation of source term, Gas or vapor release, liquid release, two phase release- Heat radiation effects, BLEVE, Pool fires and Jet fire- Gas/vapor dispersion- Explosion, UVCE and Flash fire, Explosion effects and confined explosion- Toxic effects-Plotting the damage distances on plot plant/layout.

<b>Unit V</b>	<b>CREDIBILITY OF RISK ASSESSMENT TECHNIQUES</b>	<b>12</b>
---------------	--	-----------

Past accident analysis as information sources for Hazard analysis and consequences analysis of chemical accident, Mexico disaster, Flixborough, Bhopal, Seveso, Pasadena, Feyzin disaster(1966), Port Hudson disaster- Canvey report, hazard assessment of nonnuclear installation- Rijnmond report, risk analysis of potentially Hazardous Industrial objects- Rasmussen masses report, Reactor safety study of Nuclear power Plant.

<b>REFERENCE(S):</b>		
1.	Frank P. Lees Butterworth-Hein, "Loss Prevention in Process Industries" (Vol.I, II and III), Elsevier Butterworth- Heinemann, 3 <sup>rd</sup> edition, 2005.	

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC



2.	Raghavan K. V., Asad Ali Khan, "Methodologies for Risk and Safety Assessment in Chemical Process Industries", Commonwealth Science Council, UK, 1990
3.	Tarnaka and CLRI Course Material, "Intensive Training Programme on Consequence Analysis", by Process Safety Centre, Indian Institute of Chemical Technology, Chennai.
4.	ILO- Major Hazard control- A practical Manual, ILO, Geneva, 1993.
5.	Brown, D.B., "System Analysis and Design for safety," Prentice Hall, 1976.
6.	Trevor A Klett, "Hazop and Hazan," Institute of Chemical Engineers, 2006
7.	Centre for Chemical Process Safety, "Chemical Process Quantitative Risk analysis", Institute of Chemical Engineers, 2000
8.	"Guidelines for Hazard Evaluation Procedures", Centre for Chemical Process safety, AIChE 3 <sup>rd</sup> edition, 2008.
9.	Layer of Protection Analysis, Centre for Chemical Process Safety, AIChE.

*N. Anurag*

**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



Department	MECHANICAL ENGINEERING				R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19IS203	SAFETY IN PROCESS INDUSTRIES	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To provide knowledge on design features for a process industry and safety in the operation of various equipment in industry.
- To understand the various hazards and prevention in commissioning stage of industry.
- To recognize and identify the safe operation of equipment in process industry.
- To plan and train for emergency planning in a process industry.
- To get fundamental knowledge on safe storage of chemicals.

**Course Outcome(s):** At the end of this course, learners will be able to:

- This course would make familiar of safe design of equipment which are the essential to chemical industry and leads to design of entire process industries.
- Course would be helpful to understand the design of pressure systems.
- Students would understand the problems and find innovative solutions while industries facing problems in commissioning and maintenance stages.
- Students can prepare the emergency planning for chemical industry problems.
- Students would be able to create safe storage systems.

<b>Unit I</b>	<b>SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN</b>	<b>9</b>
---------------	--	----------

Design process, conceptual design and detail design, assessment, inherently safer design chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipment, utilities. Pressure system, pressure vessel design, standards and codes- pipe works and valves heat exchangers-process machinery- over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems- failures in pressure system.

<b>Unit II</b>	<b>PLANT COMMISSIONING AND INSPECTION</b>	<b>9</b>
----------------	---	----------

Commissioning phases and organization, pre-commissioning documents, process commissioning, commissioning problems, post commissioning documentation Plant inspection, pressure vessel, pressure piping system, non-destructive testing, pressure testing, leak testing and monitoring- plant monitoring, performance monitoring, condition, vibration, corrosion, acoustic emission-pipe line inspection.

<b>Unit III</b>	<b>PLANT OPERATIONS</b>	<b>9</b>
-----------------	-------------------------	----------

Operating discipline, operating procedure and inspection, format, emergency procedures hand over and permit system- start up and shut down operation, refinery units- operation of fired heaters, driers, storage- operating activities and hazards- trip systems- exposure of personnel-colour coding of pipes and cylinders – Corrosion prevention for underground pipes.

<b>Unit IV</b>	<b>PLANT MAINTENANCE, MODIFICATION AND EMERGENCY PLANNING</b>	<b>9</b>
----------------	---	----------

Management of maintenance, hazards- preparation for maintenance, isolation, purging, cleaning, confined spaces, permit system-maintenance equipment- hot works- tank cleaning, repair and demolition- online repairs- maintenance of protective devices modification of plant, problems- controls of modifications. Emergency planning, disaster planning, onsite emergency- offsite emergency, APELL.

<b>Unit V</b>	<b>STORAGES</b>	<b>9</b>
---------------	-----------------	----------

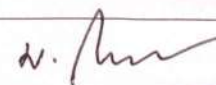
General consideration, petroleum product storages, storage tanks and vessel- storages layout- segregation, separating distance, secondary containment- venting and relief, atmospheric vent, pressure, vacuum valves, flame arrestors, fire relief- fire prevention and protection- LPG storages, pressure storages, layout, instrumentation, vaporizer, refrigerated storages- LNG storages, hydrogen storages, toxic storages, chlorine storages, ammonia storages, other chemical storages-underground storages- loading and unloading facilities- drum and cylinder storage- ware house, storage hazard assessment of LPG and LNG.

#### REFERENCE(S):

1. Lees, F.P., "Loss Prevention in Process Industries" Butterworth publications, London, 3rd edition, 2005.

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC

2.	Sanoy Banerjee, "Industrial hazards and plant safety", Taylor & Francis, London, 2003.
3.	Fawcett, H. and Wood, "Safety and Accident Prevention in Chemical Operations" Wiley inters, 2nd Edition, 1984.
4.	McElroy, Frank E., "Accident Prevention Manual for Industrial Operations", NSC, Chicago, 1988.
5.	Green, A.E., "High Risk Safety Technology", John Wiley and Sons, 1984.



**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



Department	MECHANICAL ENGINEERING				R 2019	Semester II	P C
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19IS204	ELECTRICAL SAFETY	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To provide knowledge on basics of electrical fire and statutory requirements for electrical safety
- To understand the causes of accidents due to electrical hazards
- To know the various protection systems in Industries from electrical hazards
- To know the importance of earthing
- To distinguish the various hazardous zones and applicable fire proof electrical devices

**Course Outcome(s):** At the end of this course, learners will be able to:

- This course would make familiar of basic concepts in electrical circuit and hazards involved in it.
- Course would be helpful to understand the electrical hazards in Industries.
- Students would be able to understand the operation of various protection systems from electrical hazards
- Recognize different hazardous zones in Industries
- Students would be able to gain knowledge on selection of suitable electrical equipment in different hazardous zone.

<b>Unit I</b>	<b>CONCEPTS AND STATUTORY REQUIREMENTS</b>	<b>12</b>
---------------	--	-----------

Introduction – electrostatics, electro magnetism, stored energy, energy radiation and electromagnetic interference – Working principles of electrical equipment-Indian electricity act and rules-statutory requirements from electrical inspectorate-international standards on electrical safety – first aid-cardio pulmonary resuscitation(CPR).

<b>Unit II</b>	<b>ELECTRICAL HAZARDS</b>	<b>12</b>
----------------	---------------------------	-----------

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity. Energy leakage-clearances and insulation-classes of insulation-voltage classifications excess energy-current surges- over current and short circuit current-heating effects of current-electromagnetic forces-corona effect-static electricity – definition, sources, hazardous conditions, control, electrical causes of fire and explosion-ionization, spark and arc-ignition energy-national electrical safety code ANSI. Lightning, hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth pit maintenance.

<b>Unit III</b>	<b>PROTECTION SYSTEMS</b>	<b>12</b>
-----------------	---------------------------	-----------

Fuse, circuit breakers and overload relays – protection against over voltage and under voltage – safe limits of amperage – voltage –safe distance from lines-capacity and protection of conductor-joints-and connections, overload and short circuit protection-no load protection-earth fault protection. FRLS insulation-insulation and continuity tests-system grounding-equipment grounding earth leakage circuit breaker (ELCB)-cable wires-maintenance of ground-ground fault circuit interrupter-use of low voltage-electrical guards-Personal protective equipment – safety in handling hand held electrical appliances tools and medical equipments.

<b>Unit IV</b>	<b>SELECTION, INSTALLATION, OPERATION AND MAINTENANCE</b>	<b>12</b>
----------------	---	-----------

Role of environment in selection-safety aspects in application - protection and interlock self-diagnostic features and fail safe concepts-lock out and work permit system discharge rod and earthing device-safety in the use of portable tools-cabling and cable joints-preventive maintenance.

<b>Unit V</b>	<b>HAZARDOUS ZONES</b>	<b>12</b>
---------------	------------------------	-----------

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies

<b>REFERENCE(S):</b>	
1.	Fordham Cooper, W., "Electrical Safety Engineering" Butterworth and Company, London, 1986.
2.	"Accident prevention manual for industrial operations", N.S.C., Chicago, 1982
3.	Indian Electricity Act and Rules, Government of India.

*d. Anur*  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC

4.	Power Engineers – Handbook of TNEB, Chennai, 1989.
5.	Martin Glov "Electrostatic Hazards in powder handling', Research Studies Pvt.Ltd., England, 1988.
6.	Massim A. G. Mitolo Electrical safety of Low voltage systems, McGraw Hill 2009
7.	John Cadick et al., Electrical safety Handbook, Third Edition, McGraw Hill 2006

*d. Anur*

**Chairman - BoS**  
Dept. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING				R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19IS205	RELIABILITY ENGINEERING	4	0	0	4	45	100

**Course Objective(s):** The purpose of learning this course is:

- To provide in depth knowledge about the concept of reliability.
- To impart knowledge on various reliability prediction models.
- To learn about various techniques for improving reliability in industries.
- To develop knowledge on risk assessment study.

**Course Outcome(s):** At the end of this course, learners will be able to:

- This course will familiarize students with the concepts of reliability.
- This course will be helpful to know about various failure modes of equipment and their effects.
- Students would be trained to maintain reliability by reducing failure time in Industry to maintain safety and productivity. Students will know about various reliability models.
- This course will equip the students to effectively conduct risk assessment study in industries.

<b>Unit I</b>	<b>RELIABILITY CONCEPT</b>	<b>12</b>
---------------	----------------------------	-----------

Reliability function – failure rate – mean time between failures (MTBF) – mean time to failure (MTTF) – A priori and a posteriori concept - mortality curve – useful life – availability – maintainability – system effectiveness.

<b>Unit II</b>	<b>FAILURE DATA ANALYSIS</b>	<b>12</b>
----------------	------------------------------	-----------

Time to failure distributions – Exponential, normal, Gamma, Weibull - ranking of data – probability plotting techniques – Hazard plotting.

<b>Unit III</b>	<b>RELIABILITY PREDICTION MODELS</b>	<b>12</b>
-----------------	--------------------------------------	-----------

Series and parallel systems – RBD approach – Standby systems – m/n configuration – Application of Bayes' theorem – cut and tie set method – Markov analysis – Fault Tree Analysis – limitations.

<b>Unit IV</b>	<b>RELIABILITY MANAGEMENT</b>	<b>12</b>
----------------	-------------------------------	-----------

Reliability testing – Reliability growth monitoring – Non-parametric methods – Reliability and life cycle costs – Reliability allocation – Replacement model.

<b>Unit V</b>	<b>RISK ASSESSMENT</b>	<b>12</b>
---------------	------------------------	-----------

Definition and measurement of risk – risk analysis techniques – risk reduction resources – industrial safety and risk assessment.

**REFERENCE(S):**

1.	Charles E Ebeling, "An Introduction to Reliability and Maintainability Engineering", Tata McGraw Hill, 2009.
2.	Srinath L.S, "Reliability Engineering", East West Press, 2005.
3.	Modarres, "Reliability Engineering and Risk analysis", CRC Press, 2009.
4.	John Davidson, "The Reliability of Mechanical Systems" Mechanical Engineering Publications Limited, 1994.
5.	Smith C.O. "Introduction to Reliability in Design", McGraw Hill, London, 1976.

N. Anu

**Chairman - BoS**  
Dept. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING				R 2019	Semester II	PC
Course Code	Course Name	Hours / Week		Credit	Total Hours	Maximum Marks	
19IS206	INDUSTRIAL SAFETY AND ENVIRONMENTAL LABORATORY	L	T	P	C	30	100
		0	0	4	2		

**Course Objective(s):** The purpose of learning this course is:

- To provide opportunity to operate the equipment to acquire practical knowledge.
- To know the various PPEs and software.
- To carry out experiments to find out the environmental parameters.
- To assess the impact of sensitivity of chemicals on explosivity.
- To run the software to assess the consequence effects of major accidents.

**Course Outcome(s):** At the end of this course, learners will be able to:

- This course would make students to know and run various equipment to bring out the safety environment in the industry.
- Course would be helpful for the students to measure the particulate matter and assess the impact of air pollution.
- Students would be trained to conduct experiments to find out various environmental parameters.
- Students would be able to use personal protective equipment independently.
- Students can recognize the various problems with the use of software and hence to predict the real situations on major accidents.

Exp. No.	Name of Experiments
1.	NOISE LEVEL MEASUREMENT AND ANALYSIS: Measurement of sound pressure level in dB for Impact, continuous and intermittent sources at various networks, peak and average values.
2.	FRICTION TEST: Explosive materials like barium nitrate, gun powder, white powder, amorces composition etc.
3.	IMPACT TEST: EXPLOSIVE materials like gun powder, white powder, amorces composition etc. Burst strength test of packaging materials like paper bags, corrugated cartoons, wood etc. Auto ignition temperature test.
4.	EXHAUST GAS MEASUREMENT and analysis: Measurement of Sox, Nox, Cox, hydrocarbons. Waste water analysis, Sampling and Analysis of water (pH, COD, DO, Sulphate and heavy metals).
5.	ENVIRONMENTAL PARAMETER measurement: Dry Bulb Temperature, Wet Bulb Temperature, Determination of relative humidity, wind Flow, Particle size Measurement & Air sampling analysis.
6.	TRAINING IN USAGE AND SKILL DEVELOPMENT PERSONAL PROTECTIVE EQUIPMENT: Respiratory and non-respiratory-demonstration-self-contained breathing apparatus. Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, antistatic and conducting plastics/rubber materials, apron and leg guard.
7.	FIRE EXTINGUISHERS AND ITS OPERATIONS: Water CO <sub>2</sub> , Foam, Carbon dioxide (CO <sub>2</sub> ), Dry chemical powder.
8.	Static charge testing on plastic, rubber, ferrous and non-ferrous materials. Illumination testing - by lux meter and photo meter.
9.	ELECTRICAL SAFETY - Insulation resistance for motors and cables, Estimation of earth resistance, Earth continuity test, Sensitivity test for ELCB.
10.	SOFTWARE USAGE - Accident Analysis, Safety Audit Packages, Consequence Analysis (CISCON), Fire, Explosion and Toxicity Index (FETI), Reliability Analysis for Mechanical system and Electrical System, Failure Mode Analysis.
11.	FIRST AID, Road safety signals and symbols.

Equipments Required		Quantity
1.	Noise level meter	01
2.	Friction tester	01
3.	Impact tester	01

  
**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



4.	Exhaust gas analyzer	01
5.	High volume sampler	01
6.	PPE Set	01
7.	Fire extinguisher set	01
8.	Static charge tester	01
9.	First aid kit	01
10.	Lock out/Tag out	01
11.	Software: ALOHA, CAME	

*W. Ann*

**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**

Department	MECHANICAL ENGINEERING				R 2019	Semester II	PC
Course Code	Course Name	Hours / Week		Credit	Total Hours	Maximum Marks	
19IS207	TECHNICAL SEMINAR II	L	T	P			
		0	0	2	1	15	100
<b>Course Objective(s):</b> The purpose of learning this course is: <ul style="list-style-type: none"> <li>To develop self-learning skills of utilizing various technical resources to make a technical presentation</li> <li>To promote the technical presentation and communication skills.</li> <li>To impart the knowledge on intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.</li> <li>To promote the ability for Interacting and sharing attitude.</li> <li>To engarauge the commitment-attitude to complete tasks.</li> </ul>							
<b>Course Outcome(s):</b> At the end of this course, learners will be able to: <ul style="list-style-type: none"> <li>Refer and utilize various technical resources available from multiple fields</li> <li>Improve the technical presentation and communication skills</li> <li>Analyze the importance of intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.</li> <li>Interact and share their technical knowledge to enhance the leadership skills</li> <li>Prepare report and present oral demonstrations</li> </ul>							
<b>METHOD OF EVALUATION:</b> In this course. A students has to present three technical papers or recent advanced in engineering/technology that will be evaluated by a committee constitutes by the head of the department.							

*Dr. Anu*

**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**

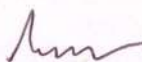


Department	MECHANICAL ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19IS301	PROJECT WORK (PHASE I)	0	0	12	6	30	100	
<b>Course Objective(s):</b> The purpose of learning this course is:								
<ul style="list-style-type: none"><li>● To develop the skill of students for analyzing safety problems to control the hazard.</li><li>● To expose the students to identify and evaluate the hazards in an industry under study.</li><li>● To expose the students to assess the Compliance level of safety norms and procedures.</li></ul>								
<b>Course Outcome(s):</b> At the end of this course, learners will be able to:								
<ul style="list-style-type: none"><li>● This course would make students to train themselves to conduct hazard analysis and suggest solutions to control risks.</li><li>● Course would be helpful for the students to know the norms and standards for an Industry.</li><li>● Students can recognize hazards and assess or evaluate them by using various techniques.</li><li>● Students would be able to suggest suitable measures to prevent hazards by referring the literature and comprehensive hazard analysis.</li></ul>								
<b>Methodology of Evaluation:</b>								
<ul style="list-style-type: none"><li>● The student will identify and select a problem based on comprehensive literature survey.</li><li>● The student should submit a proposal and get it approved by the Head of the department.</li><li>● Three reviews will be conducted by Project review committee.</li><li>● Students will be evaluated by the committee during the review and suggestions will be offered by members.</li><li>● The report for PHASE - I should be submitted by the students at the end of course.</li></ul>								

*N. An*

**Chairman - BoS**  
Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester IV	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19IS401	PROJECT WORK (PHASE II)	0	0	24	12	360	100	
<b>Course Objective(s):</b> The purpose of learning this course is: <ul style="list-style-type: none"> <li>To develop the skill of students for analyzing safety problems to control the hazard.</li> <li>To expose the students to identify and evaluate the hazards in an industry under study.</li> <li>To expose the students to assess the Compliance level of safety norms and procedures.</li> </ul>								
<b>Course Outcome(s):</b> At the end of this course, learners will be able to: <ul style="list-style-type: none"> <li>Train themselves to conduct hazard analysis and suggest solutions to control risks.</li> <li>Know the norms and standards for an Industry.</li> <li>Recognize hazards and assess or evaluate them by using various techniques.</li> <li>Suggest suitable measures to prevent hazards by referring the literature and comprehensive hazard analysis.</li> </ul>								
<b>Methodology of Evaluation:</b> (It is the continuation of Phase I project) <ul style="list-style-type: none"> <li>Three reviews will conducted by Project review committee.</li> <li>Students will be evaluated by the committee during the review and suggestions will be offered by members.</li> <li>At least one paper should be published by the student in international / national conference.</li> <li>The report should be submitted by the students at the end of course.</li> </ul>								

N. 

**Chairman - BoS**  
Dept. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING				R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Total Hours	Maximum Marks	
		L	T	P			
19ISX01	PRINCIPLES OF DISASTER MANAGEMENT	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To study the disaster types and their control using space technology with case studies.
- To study about on site and off site emergency plans.
- To create awareness on global warming, eco-friendly products, environmental impact assessment and environmental policies with proper case studies.
- To study about the marine pollution and earth quake disasters and their effects.
- To give the knowledge on environmental education including laws, risk & disaster assessment disaster profile of India.

**Course Outcome(s):** At the end of this course, learners will be able:

- To explain the philosophy of disaster management and their control using the sophisticated technologies.
- To understand the emergency measures and how to control with monitoring devices.
- To understand earth quake disasters and nuclear wastes disposals.
- To perform environmental disaster assessment.
- To gain knowledge in risk and disaster assessment processes including standards, and national policies.

<b>Unit I</b>	<b>INTRODUCTION</b>	<b>9</b>
---------------	---------------------	----------

Philosophy of Disaster management-Introduction to Disaster mitigation-Hydrological, Coastal and Marine Disasters- Geological, meteorological phenomena-Mass Movement and Land Disasters-Forest related disasters – Wind and w deforestation-Use of space technology for control of geological disasters-Master thesis.

<b>Unit II</b>	<b>TECHNOLOGICAL DISASTERS</b>	<b>9</b>
----------------	--------------------------------	----------

Technological Disasters-Case studies of Technology disasters with statistical details-Emergencies and control measures-APELL-Onsite and Offsite emergencies-Crisis management groups-Emergency centers and their functions throughout the country Software on emergency controls-Monitoring devices for detection of gases in the atmosphere-Right to know act.

<b>Unit III</b>	<b>ENVIRONMENTAL IMPACT ASSESSMENT</b>	<b>9</b>
-----------------	--	----------

Introduction to Sustainable Development-Bio Diversity-Atmospheric pollution-Global warming and Ozone Depletion-ODS banking and phasing out-Sea level rise-El Nino and climate changes-Eco friendly products-Green movements-Green philosophy - Environmental Policies-Environmental Impact Assessment-case studies-Life cycle.

<b>Unit IV</b>	<b>POLLUTION ASPECTS</b>	<b>9</b>
----------------	--------------------------	----------

Offshore and onshore drilling-control of fires-Case studies-Marine pollution and control-Toxic, hazardous and Nuclear wastes-state of India's and Global environmental issues carcinogens-complex emergencies-Earthquake disasters-the nature-extreme event analysis-the immune system-proof and limits.

<b>Unit V</b>	<b>POLICY INITIATIVES</b>	<b>9</b>
---------------	---------------------------	----------

Environmental education-Population and community ecology-Natural resources conservation-Environmental protection and law-Research methodology and systems analysis-Natural resources conservation-Policy initiatives and future prospects-Risk assessment process, assessment for different disaster types-Assessment data use, destructive capacity-risk adjustment-choice-loss acceptance-disaster aid- public liability insurance-stock taking and vulnerability analysis-disaster profile of the country-national policies-objectives and standards-physical event modification-preparedness, forecasting and warning, land use planning.

REFERENCE(S):	
1.	Gilbert, Masters.M., "Introduction to Environmental Engineering and Science", 3 <sup>rd</sup> edition, 2008.
2.	Miller, Tylor.G., "Environmental Science", 14 <sup>th</sup> edition 2012.
3.	Tylor.G., Miller., "Environmental Science Sustaining The Earth", 2005.
4.	Bagad Vilas. "Principles of Environmental Science and Engineering", 2004.
5.	Sivakumar, R., "Principles of Environmental Science and Engineering", 2005.

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING				R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19ISX02	FIREWORKS SAFETY	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To study the properties of pyrotechnic chemicals.
- To know about the hazards in the manufacture of various fireworks.
- To understand the hazards in fireworks industries related processes.
- To study the effects of static electricity.
- To learn pyrotechnic material handling, transportation and user safety.

**Course Outcome(s):** At the end of this course, learners will be able:

- To gain knowledge of the chemical reactions of Fireworks chemicals.
- To know safe manufacture of Fireworks items.
- To improve process safety in fireworks industries.
- To analyze safety measures applicable against static electricity.
- To suggest safe practices for handling of fireworks in factories, transport and at user end.

<b>Unit I</b>	<b>PROPERTIES OF FIREWORKS CHEMICALS</b>	<b>9</b>
---------------	--	----------

Fire properties – potassium nitrate ( $\text{KNO}_3$ ), potassium chlorate ( $\text{KClO}_3$ ), barium nitrate ( $\text{BaNO}_3$ ), calcium nitrate ( $\text{CaNO}_3$ ), Sulphur (S), Phosphorous (P), antimony (Sb), Pyro Aluminium (Al) powder-Reactions-metal powders, Borax, ammonia ( $\text{NH}_3$ ) – Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.

<b>Unit II</b>	<b>STATIC CHARGE AND DUST</b>	<b>9</b>
----------------	-------------------------------	----------

Concept-prevention-earthing-copper plates-dress materials-static charge meter lightning, Causes-effects-hazards in fireworks factories-lightning arrestor: concept-installation earth pit-maintenance-resistance-legal requirements-case studies. Dust: size-respirable, non-respirable-biological barriers-hazards-personal protective equipment-pollution prevention.

<b>Unit III</b>	<b>PROCESS SAFETY</b>	<b>9</b>
-----------------	-----------------------	----------

Safe-quantity, mixing-filling-fuse cutting – fuse fixing – finishing – drying at various stages-packing-storage-hand tools-materials, layout: building-distances- factories act – explosive act and rules – fire prevention and control – emergency planning in fireworks – Automation of manual process.

<b>Unit IV</b>	<b>MATERIAL HANDLING</b>	<b>9</b>
----------------	--------------------------	----------

Manual handling – wheel barrows-trucks-bullock carts-cycles-automobiles-fuse handling – paper caps handling-nitric acid handling in snake eggs manufacture-handling the mix in this factory-material movement-godown-waste pit.

Transportation: Packing-magazine-design of vehicles for explosive transports loading into automobiles transport restrictions-case studies-overhead power lines-driver habits-intermediate parking-fire extinguishers-loose chemicals handling and transport.

<b>Unit V</b>	<b>WASTE CONTROL AND USER SAFETY</b>	<b>9</b>
---------------	--------------------------------------	----------

Concepts of wastes – Wastes in fireworks-Disposal-Spillages-storage of residues. Consumer anxiety-hazards in display-methods in other countries-fires, burns and scalds – sales outlets-restrictions-role of fire service.

**REFERENCE(S):**

1. Ghosh, K.N. "The Principles of Firecrackers", Economic Enterprises, Sivakasi; 1981.
2. Shanmugam. G. et al, "Fireworks safety 1999: Proceedings of the National seminar held at MSEC", Sivakasi, on July 17 & 18, 1999.
3. Pyrotech 2013, Proceedings of the 2<sup>nd</sup> National Fireworks Conference, TamilNadu Fireworks and Amorges Manufacturers' Association (TANFAMA), 2013.
4. Conkling J., "Chemistry of Pyrotechnics: Basic Principles and Theory
5. Shimizu. T., "Firecrackers: The Art, Science and Technique", Maruzen Co, Tokyo; 1981.

  
**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ISX03	CHEMICAL PROCESS QUANTITATIVE RISK ANALYSIS	3	0	0	3	45	100	
<b>Course Objective(s):</b> The purpose of learning this course is: <ul style="list-style-type: none"><li>• To understand the fundamentals of Quantitative risk analysis.</li><li>• To know the procedure for risk assessment.</li><li>• To gain knowledge on various tools on consequence analysis.</li><li>• To develop the skill of risk estimation in a process plant.</li><li>• To familiarize with international risk assessment reports like Canvey report, Rijnmond report etc.</li></ul>								
<b>Course Outcome(s):</b> At the end of this course, learners will be able: <ul style="list-style-type: none"><li>• To carryout CPQRA studies and its utilization.</li><li>• To estimate the consequences of discharges and its various models.</li><li>• To assess the risk for the given fire or dispersion scenario.</li><li>• To analyze the various data pertaining to chemical process.</li></ul>								
Unit I	INTRODUCTION TO QUANTITATIVE RISK ANALYSIS						9	
Definitions of Quantitative Risk Analysis –Component Techniques-System description-Hazard identification-Incident enumeration-CPQRA Model construction – Consequence estimation-Likelihood estimation-Risk estimation-Utilization risk estimation-Scope of CPQRA studies-Management of incident list-Applications of CPQRA-Limitations of CPQRA—Utilization of results-Project management – maintenance of result.								
Unit II	CONSEQUENCY ANALYSIS						9	
Source models, discharge rate models-fundamental equations –Liquid discharges-Gas discharges-Two phase discharge-Dispersion models-Wind speed –local terrain effects-Height of release above ground-momentum of material released and buoyancy-Dense gas dispersion-Vapour cloud Explosions –TNT equivalency model-TNT multi energy model-Modifier baker model –Equations for blast parameters-Damage estimate –Flash fire – Physical explosion-Projectiles-Determination of fragment velocity-BLEVE and Fire ball –Effects –Fragments-Empirical equations for fire ball diameter, duration, Height, radiation –Confined explosion-Toxic gas effect-Problems.								
Unit III	FREQUENCY ANALYSIS						9	
Incident frequencies from the historical records –frequency modelling techniques –Fault tree analysis-Construction –Qualitative evaluation-Event tree analysis-logic diagram-Estimation of Probability and quantification of outcome-Common cause failure analysis-Human reliability analysis-External event analysis-Solved problems.								
Unit IV	RISK ESTIMATION						9	
Risk measures, Risk presentation –Risk indices-Individual and societal risk –Risk calculation for individual and societal risk –Procedure- General approach and simplified approaches-other individual risk measures-Average rate of death-Equivalent social cost-Fatal accident rate-Individual hazard index-Mortality index and economic loss-Problems.								
Unit V	DATA AND SPECIAL TECHNIQUES FOR QRA						9	
Historical incident data–Process and plant data-plant layout, description –Ignition source data- chemical data-Environmental data-population data –Meteorological data-Geographical-Topographical data-Equipment reliability data-special techniques –domino effects – Unavailability analysis of protection systems-MORT – Markov models-case studies –Canvey report-Rijnmond report.								

REFERENCE(S):	
1.	"Guidelines for Chemical Process Quantitative Risk Analysis", Centre for Chemical Process Safety CCPS- American Institute of Chemical Engineers, Wiley, 2 <sup>nd</sup> edition, 1999.
2.	"Guidelines for Hazard Evaluation Procedures" Centre for Chemical Process Safety CCPS - American Institute of Chemical Engineers, Wiley, 3 <sup>rd</sup> edition, 2008.
3.	"Guidelines for Developing Quantitative Safety Risk Criteria" Centre for Chemical Process Safety CCPS- American Institute of Chemical Engineers, Wiley, 2009.

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC


4.	Lees F.P., "Loss Prevention in Process Industries" Butterworth publications, London, 3 <sup>rd</sup> edition, 2005.
5.	"Guidelines for Determining the Probability of Ignition of a Released Flammable Mass" Centre for Chemical Process Safety CCPS- American Institute of Chemical Engineers, Wiley, 2014.
6.	Arendt J.S, Lorenzo D. K. "Evaluating Process Safety in the Chemical Industry: A User's Guide to Quantitative Risk Analysis" Wiley, 2000.

*N. Am*

**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ISX04	DOCK SAFETY	3	0	0	3	45	100	
<b>Course Objective(s):</b> The purpose of learning this course is: <ul style="list-style-type: none"><li>• To understand safety legislation related to dock activities in India.</li><li>• To understand the causes and effects of accidents during dock activities.</li><li>• To know the various material handling equipment and lifting appliances in dock.</li><li>• To know the safe working on board the ship and storage in the yards.</li><li>• To understand the safe operation of crane, portainers, lift trucks and container handling equipment.</li></ul>								
<b>Course Outcome(s):</b> At the end of this course, learners will be able to: <ul style="list-style-type: none"><li>• This course would make the student to familiar of various operations carried out in a dock.</li><li>• Students would know the different acts and rules for safe dock operations.</li><li>• Students could be able to understand the operation of various types of material handling equipment.</li><li>• Students would be prepared to response at the time of emergency in a dock.</li><li>• Students can recognize the various problems associated with the use of lifting equipment and in the storage yards.</li></ul>								
<b>Unit I</b>	<b>HISTORY OF SAFETY LEGISLATION</b>							<b>9</b>
History of dock safety statues in India-background of present dock safety statues- dock workers (safety, health and welfare) act 1986 and the rules and regulations framed there under, other statues like marking of heavy packages act 1951 and the rules framed there under - manufacture, storage and import of hazardous chemicals. Rules 1989 framed under the environment (protection) act, 1989 – few cases laws to interpret the terms used in the dock safety statues. Responsibility of different agencies for safety, health and welfare involved in dock work –responsibilities of port authorities – dock labour board – owner of ship master, agent of ship – owner of lifting appliances and loose gear etc. – employers of dock workers like stevedores – clearing and forwarding agents – competent persons and dock worker. Forums for promoting safety and health in ports – Safe Committees and Advisory Committees. Their functions, training of dock workers.								
<b>Unit II</b>	<b>WORKING ON BOARD THE SHIP</b>							<b>9</b>
Types of cargo ships – working on board ships – Safety in handling of hatch beams – hatch covers including its marking, Mechanical operated hatch covers of different types and its safety features – safety in chipping and painting operations on board ships – safe means of accesses – safety in storage etc. – illumination of decks and in holds – hazards in working inside the hold of the ship and on decks – safety precautions needed – safety in use of transport equipment - internal combustible engines like fort-lift trucks pay loaders etc. Working with electricity and electrical management – Storage – types, hazardous cargo.								
<b>Unit III</b>	<b>LIFTING APPLIANCES</b>							<b>9</b>
Different types of lifting appliances – construction, maintenance and use, various methods of rigging of derricks, safety in the use of container handling/lifting appliances like portainers, transtainer, top lift trucks and other containers – testing and examination of lifting appliances – portainers – transtainers – top lift trucks – derricks in different rigging etc. Use and care of synthetic and natural fiber ropes – wire rope chains, different types of slings and loose gears.								
<b>Unit IV</b>	<b>TRANSPORT EQUIPMENT</b>							<b>9</b>
The different types of equipment for transporting containers and safety in their use safety in the use of self-loading container vehicles, container side lifter, fork lift truck, dock railways, conveyors and cranes. Safe use of special lift trucks inside containers – Testing, examination and inspection of containers – carriage of dangerous goods in containers and maintenance and certification of containers for safe operation Handling of different types of cargo – stacking and unstacking both on board the ship and ashore – loading and unloading of cargo identification of berths/walking for transfer operation of specific chemical from ship to shore and vice versa – restriction of loading and unloading operations.								
<b>Unit V</b>	<b>EMERGENCY ACTION PLAN AND DOCK WORKERS (SHW) REGULATIONS 1990</b>							<b>9</b>
Emergency action Plans for fire and explosions - collapse of lifting appliances and buildings, sheds etc., - gas leakages and precautions concerning spillage of dangerous goods etc., - Preparation of on-site emergency plan and safety report. Dock workers (SHW) rules and regulations 1990-related to lifting appliances, Container								

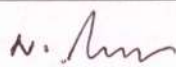
  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC



handling, loading and unloading, handling of hatch coverings and beams, Cargo handling, conveyors, dock railways, forklift.

**REFERENCE(S):**

1. International Labour Organization, "Safety and Health in Dock Work", 2<sup>nd</sup> ed. 1997.
2. "Indian Dock Labourers Act 1934 with rules 1948", Law Publishers (India) Pvt. Ltd., Allahabad.
3. Taylor D.A., "Introduction to Marine Engineering", 2<sup>nd</sup> ed., Butterworth-Heinemann, 1996.
4. Srinivasan "Harbour, Dock and Tunnel Engineering", Charotar Publishing House Pvt. Limited, 2011.
5. Bindra SR "Course in Dock and Harbour Engineering", Dhanpat Rai Publications (P) Ltd., New Delhi, 2013.

  
**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ISX05	PLANT LAYOUT AND MATERIALS HANDLING	3	0	0	3	45	100	
<b>Course Objective(s):</b> The purpose of learning this course is: <ul style="list-style-type: none"><li>• To provided with the knowledge of the process of analyzing and developing information to produce a plant layout based on the locations and working conditions.</li><li>• To educate the students about the basic things of work conditions which include ventilation, comfort, lighting and its effect based on various nature of work.</li><li>• To provide the skill of handling the Manual material handling and lifting techniques of various shapes of machine and heavy objects. Also give an input of handling the hazardous materials of liquid, solids and cryogenic liquids with proper packing.</li><li>• To provided with expert knowledge of arriving plant locations and creating the plant layout based on nature of industries and working conditions with better experience in material handling techniques.</li></ul>								
<b>Course Outcome(s):</b> At the end of this course: <ul style="list-style-type: none"><li>• The students will be able to identify equipment requirements for a specific process and for various locations and working conditions.</li><li>• The students will be able to understand the benefit of an efficient material handling system.</li><li>• The students will be able to recognize the effect of process layout on the material handling system.</li><li>• The students will be able to recommend improvements to existing plant layouts based on material handling factors.</li><li>• The students will be able to integrate concepts and techniques learned through this course in order to design an efficient plant layout.</li></ul>								
<b>Unit I</b>	<b>PLANT LOCATION</b>							<b>9</b>
Selection of plant locations, territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal, further expansions Safe location of chemical storages in the form of bullets, spheres, cylinders for LPG, LNG, CNG, acetylene, ammonia, chlorine – explosives and propellants.								
<b>Unit II</b>	<b>PLANT LAYOUT</b>							<b>9</b>
Safe layout, equipment layout, safety system, fire hydrant locations, fire service rooms, facilities for safe effluent disposal and treatment tanks, site considerations, approach roads, plant railway lines, security towers. Safe layout for process industries, engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, metal powders manufacturing, fireworks and match works.								
<b>Unit III</b>	<b>WORKING CONDITIONS</b>							<b>9</b>
Principles of good ventilation, purpose, physiological and comfort level types, local and exhaust ventilation, hood and duct design, air conditioning, ventilation standards, application. Purpose of lighting, types, advantages of good illumination, glare and its effect, lighting requirements for various work, standards-Housekeeping, principles of 5S.								
<b>Unit IV</b>	<b>MANUAL MATERIAL HANDLING AND LIFTING TACKLES</b>							<b>9</b>
Preventing common injuries, lifting by hand, team lifting and carrying, handling specific shape machines and other heavy objects – accessories for manual handling, hand tools, jacks, hand trucks, dollies and wheel barrows – storage of specific materials - problems with hazardous materials, liquids, solids – storage and handling of cryogenic liquids - shipping and receiving, stock picking, dock boards, machine and tools, steel strapping and sacking, glass and nails, pitch and glue, boxes and cartons and car loading – personal protection – ergonomic considerations. Fiber rope, types, strength and working load inspection, rope in use, rope in storage - wire rope, construction, design factors, deterioration causes, sheaves and drums, lubrication, overloading, rope fitting, inspection and replacement – slings, types, method of attachment, rated capacities, alloy chain slings, hooks and attachment, inspection.								
<b>Unit V</b>	<b>MECHANICAL MATERIAL HANDLING</b>							<b>9</b>
Hoisting apparatus, types - cranes, types, design and construction, guards and limit devices, signals, operating								

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC

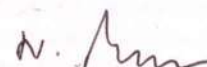


rules, maintenance safety rules, inspection and inspection checklist – conveyors, precautions, types, applications.

Powered industrial trucks, requirements, operating principles, operators selection and training and performance test, inspection and maintenance, electric trucks, gasoline operated trucks, LPG trucks – power elevators, types of drives, hoist way and machine room emergency procedure, requirements for the handicapped, types- Escalator, safety devices and brakes, moving walks – man lifts, construction, brakes, inspection.

**REFERENCE(S):**

1. "Encyclopaedia of Occupational Safety and Health", ILO Publication, 4<sup>th</sup> edition 1998.
2. "Accident Prevention Manual for Industrial Operations" N.S.C., Chicago, 1982.
3. Alexandrov. M.P. "Material Handling Equipment" Mir Publishers, Moscow, 1981.
4. Apple M. James "Plant Layout and Material Handling", 3<sup>rd</sup> edition, John Wiley & Sons, 1977.
5. Spivakosky, "Conveyors and Related Equipment", Vol.I & II, Peace Pub., Moscow, 1982.
6. Rudenko, N., "Material Handling Equipments", Mir Publishers, 1981.
7. Reymond, A. Kulwice, "Material Handling Hand Book - II", John Wiley and Sons, New York, 1985.
8. "Safety and Good Housekeeping", N.P.C. New Delhi, 1985.
9. "Industrial Ventilation (A manual for recommended practice), American conference of Governmental Industrial Hygiene, USA, 25<sup>th</sup> edition 2004.



**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



Department	MECHANICAL ENGINEERING				R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Total Hours	Maximum Marks	
		L	T	P			
19ISX06	DESIGN OF INDUSTRIAL VENTILATION SYSTEM	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To provide the basic knowledge on principles of ventilation and its applicability in industries.
- To enforce the knowledge on various types ventilating system, the mechanism of ventilation and the relationship between heat generation and ventilation.
- To educate the designing of Exhaust system based on various exhaust system taking into consideration of various parameters and validating the same with proper testing methods.
- To provide knowledge on how to select the ventilation system for the specific usage based on industrial experience.

**Course Outcome(s):** At the end of this course, learners will be able to:

- Remember the basic knowledge and principles of ventilation and exhaust system.
- Understand the various types of Ventilation systems and the mechanism and testing processes behind each ventilation systems.
- Apply the acquired knowledge in selection various ventilation systems based upon end use.
- Analyze the salient feature of various ventilation systems and the role of individual parameters in controlling the efficiency of the ventilation systems.
- Design or create the required type of ventilation systems and local exhaust hoods of their choice, based on the knowledge acquired by them after knowing the test methods and design procedures.

<b>Unit I</b>	<b>GENERAL PRINCIPLES OF VENTILATION</b>	<b>9</b>
---------------	--	----------

Introduction,-supply and Exhaust systems-Basic definitions-Principles of air flow-Acceleration of air and Hood entry losses-Duct losses-Multiple hood exhaust system.

<b>Unit II</b>	<b>GENERAL INDUSTRIAL VENTILATION</b>	<b>9</b>
----------------	---------------------------------------	----------

Dilution Ventilation Principles- Dilution Ventilation for health- Dilution Ventilation for fire and explosion-Heat Control-Heat balance and Exchange-Adaptive mechanisms of the body-Acclimatisation-Acute heat disorders-Assessment of heat stress and strain-Ventilation control-and ventilation system - Radiant heat control - Enclosures and Insulation - Personal Protective Equipments-Protective suits and refrigerated suits.

<b>Unit III</b>	<b>LOCAL EXHAUST HOODS AND AIR CLEANING 9 DEVICES</b>	<b>9</b>
-----------------	---	----------

Air contamination Characteristics -Hood types-Hood design factors-Hood losses-Minimum Duct velocity-Special hood requirements-Push

-pull ventilation-Hot processes-Air cleaning devices-selection -types - Explosion venting.

<b>Unit IV</b>	<b>DESIGN AND TESTING OF INDUSTRIAL 9 VENTILATION</b>	<b>9</b>
----------------	---	----------

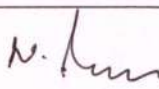
Exhaust system design procedure-steps-duct segment calculations - Distribution of air flow-Plenum Exhaust system-Fan Pressure calculations-Corrections for velocity changes-Duct material -friction losses- Construction guidelines for local Exhaust system - Fan selection -Replacement and recirculated air-Distribution -Flow rate-Air conservation-Ventilation aspects of indoor air quality-Testing of ventilation system-Measurement of volumetric flow rate-Calibration of air measuring instrument- pressure measurement-Check out procedure.

<b>Unit V</b>	<b>VENTILATION SYSTEM FOR SPECIFIC 9 OPERATIONS</b>	<b>9</b>
---------------	---	----------

Cleaner rooms-Filling operations-foundry operations-Gas treatment-Laboratory Ventilation-Machining-Metal melting furnaces-Mixing operations- Movable exhaust hoods-open surface tanks-painting operations-Mechanical surface cleaning and finishing -Welding and cutting - wood working.

#### REFERENCE(S):

1. ACGIH Industrial Ventilation "A Manual of Recommended Practice for Design", 28<sup>th</sup> edition, 2013.
2. "Accident Prevention Manual for Industrial Operations" N.S.C., Chicago, 1992.
3. Jeanne Mager Stellman, "Encyclopaedia of Occupational Health and Safety", Vol. I and II, 4<sup>th</sup> edition, published by International Labour office, Geneva, 1998.

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING					R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ISX07	OHSAS 18000 & ISO 14000	3	0	0	3	45	100	
<b>Course Objective(s):</b> The purpose of learning this course is: <ul style="list-style-type: none"><li>• To provide the basic knowledge on Occupational Health and Safety Management System and Environmental Management System standards.</li><li>• To inculcate the knowledge on various terms and terminologies which are used in the Occupational Health, Safety and Environmental Management system.</li><li>• To educate about the various steps to be taken for certification of Occupational Health and Safety Assessment Series (OHSAS) and ISO14001 (Environmental Management Systems) standards.</li><li>• To impart knowledge on Environment Impact Assessment (EIA), Life Cycle Assessment of product and principles of Eco labelling.</li></ul>								
<b>Course Outcome(s):</b> At the end of this course, learners will be able: <ul style="list-style-type: none"><li>• To acquire the basic concepts and knowledge about occupational health and safety management systems.</li><li>• To identify the difference between the ISO 9000 series and OHSAS 18001 and ISO 14000 standards and the various clauses which governs the system in maintaining the standard.</li><li>• To prepare the OHSAS and EMS manual for certification from the external certifying agencies.</li><li>• To acquire the basic concepts and knowledge about Environmental management systems.</li><li>• To develop procedures in accordance with the standards and able to establish occupational health and safety management system.</li></ul>								
<b>Unit I</b>	<b>OHSAS STANDARD</b>						<b>9</b>	
Introduction – Development of OHSAS standard – Structure and features of OSHAS 18001 – Benefits of certification-certification procedure – OH and S management system element, specification and scope - Correspondence between OHSAS 18001:2007, ISO 14001:2004 and ISO 9001:2000-Correspondence between OHSAS 18001, OHSAS 18002, and the ILO-OSH:2001.								
<b>Unit II</b>	<b>OHSAS 18001 POLICY AND PLANNING, IMPLEMENTATION AND OPERATION</b>						<b>9</b>	
General requirements, OH&S policy, Planning - Hazard identification, risk assessment and determining controls - Legal and other requirements - Objectives and programme(s), Implementation and operation - Resources, roles, responsibility, accountability and authority - Competence, training and awareness - Communication, participation and consultation - Communication - Participation and consultation, Documentation - Control of documents-Operational control - Emergency preparedness and response.								
<b>Unit III</b>	<b>CHECKING AND REVIEW AND GUIDELINES</b>						<b>9</b>	
Checking- Performance measurement and monitoring-Evaluation of compliance-Incident investigation, nonconformity, corrective action and preventive action-Control of records-Internal audit-Management review - guidelines for implementation of 18001:2007 -Examples of items for hazard identification checklist –Comparison of risk assessment tool and methodologies.								
<b>Unit IV</b>	<b>ISO 14001</b>						<b>9</b>	
EMS, ISO 14001-Environmental management systems — Requirements with guidance for use- Environmental management system requirements- Environmental policy- Environmental aspects- Legal and other requirements-Objectives, targets and programme(s)-Implementation and operation- Checking- Management review-Guidance for use Principles (ISO 14004), clauses 4.1 to 4.5. Documentation requirements, 3 levels of documentation for an ISO 14000 based EMS, steps in ISO 14001.Implementation plan, Registration, Importance of ISO 14000 to the Management. Auditing Guidelines for environmental management systems auditing -General principles, Managing audit programme- Audit activities, steps in audit, Audit plan. Competence of auditors.								
<b>Unit V</b>	<b>ENVIRONMENT IMPACT ASSESSMENT</b>						<b>9</b>	
ISO 14040(LCA), General principles of LCA, Stages of LCA, Report and Review. ISO 14020 (Eco labelling) – History, 14021, 14024, Type I labels, Type II labels, ISO 14024, principles, rules for eco labelling before company attempts for it. Advantages. EIA in EMS, Types of EIA, EIA methodology EIS, Scope, Benefits. Audit-methodology. Auditors Audit results management review-Continual improvement.								

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC



REFERENCE(S):	
1.	"Occupational Health and Safety Assessment Series BS (OHSAS) 18001:2007" BSI, UK, 2007.
2.	"OHSAS 18002, Occupational Health and Safety Management Systems – Guidelines for the Implementation of OHSAS 18001", OHSAS project group, 2008.
3.	"ISO14001:2004, Environmental Management Systems-Requirements with Guidance for Use", ISO, 2004.
4.	"Guidelines on Occupational Health and Safety Management Systems (OSH-MS)" International Labour Organization, 2001.
5.	"BS 8800: 2004 Occupational Health and Safety Management Systems-Guide" BSI, UK, 2004.
6.	"ISO 19011:2011 Guidelines for Auditing Management Systems", ISO, 2011.
7.	"ISO 14040:2006 Environmental Management- Life Cycle Assessment - Principles and Framework" ISO, 2006.
8.	"ISO 14025:2006 Environmental Labels and Declarations -Type III Environmental Declarations - Principles and Procedures", ISO, 2006.
9.	"ISO 14021:1999 Environmental Labels and Declarations - Self-Declared Environmental Claims (Type II environmental labelling)", ISO, 1999.
10.	"ISO 14020:2000 Environmental Labels and Declarations-General Principles", ISO, 2000.

*N. Rana*

**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**

Department	MECHANICAL ENGINEERING				R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19ISX08	SAFETY IN PETROCHEMICAL INDUSTRIES	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To provide about the various risks and hazards involved in petrochemical industries and its control measures.
- To impart knowledge on risk analysis, toxic effect and planning for onsite and offsite emergency planning in petrol chemical industries.
- To acquire knowledge on Controlling of safety systems and Relief systems and to acquire knowledge on design activities of safety and relief systems.
- To know fundamentals in identifying the hazards and the controlling measures against leakages, spillage of liquids, solids and gaseous toxic materials.

**Course Outcome(s):** At the end of this course, learners will be able to:

- Remember the various terms and terminologies involved in the safety of petrochemical industries.
- Understand the various concepts involved in the Risk analysis, hazard assessment, toxicity in petrol chemical industries and able to control the safety and relief systems.
- Know the various risk factors and controlling systems the student could be able to apply the various techniques of safety in preventing and mitigating the hazards in petrochemical industries.
- Analyse and compare the various safety and relief system and controlling the toxicity and leakages of hazardous gases, liquids and solids.
- Design on-site and off-site emergencies plan for all types of emergencies.

<b>Unit I</b>	<b>RISK MANAGEMENT</b>	<b>9</b>
---------------	------------------------	----------

Overall risk analysis – E and FI model– Methods for determining consequences effects: Effect of fire, Effect of explosion and toxic effect – Disaster management plan – Emergency planning – Onsite and offsite emergency planning – Risk management – Gas processing complex, refinery – First aids.

<b>Unit II</b>	<b>CONTROL OF SAFETY SYSTEMS</b>	<b>9</b>
----------------	----------------------------------	----------

Concept of risk, selection of design bases for safety systems, guidelines for risk tolerability, potential process safety systems and design solutions. Control of safety systems, safety system characteristic and design - Safety system computer control - Control of trip, interlock and emergency shut-down systems - Programmable logic and electronic system - Layered control systems for safety.

<b>Unit III</b>	<b>CONTROL OF RELIEF SYSTEM</b>	<b>9</b>
-----------------	---------------------------------	----------

Relief Systems: Preventive and protective management from fires and explosion-inerting, static electricity passivation, ventilation, and sprinkling, proofing, relief systems – relief valves, flares, scrubbers. Design of flares, scrubbers and condensers for toxic release from chemical process industries; Design of tank farms for liquid/gaseous fuel storage.

<b>Unit IV</b>	<b>TOXICOLOGY OF PETRO CHEMICAL INDUSTRIES</b>	<b>9</b>
----------------	--	----------

Toxicology: Hazards identification-toxicity, fire, static electricity, noise and dust concentration; Material safety data sheet, hazards indices-Dow and Mond indices, hazard operability (HAZOP) and hazard analysis (HAZAN).

<b>Unit V</b>	<b>CONTROLLING OF LEAKAGES AND HAZARDS ASSOCIATED</b>	<b>9</b>
---------------	---	----------

Leaks and Leakages: Spill and leakage of liquids, vapors, gases and their mixture from storage tanks and equipment; Estimation of leakage/spill rate through hole, pipes and vessel burst; Isothermal and adiabatic flows of gases, spillage and leakage of flashing liquids, pool evaporation and boiling; Release of toxics and dispersion. Naturally buoyant and dense gas dispersion models; Effects of momentum and buoyancy; Mitigation measures for leaks and releases.

Hazards associated with Hydrocarbon and other Chemical Products: Crude oil, natural gas, LPG, CNG, LNG, oxygenated hydrocarbons, chlorine, ammonia, hydrogen fluoride.

#### REFERENCE(S):

1. Crowl D.A. and Louvar J.F., "Chemical Process Safety: Fundamentals with Applications", 3<sup>rd</sup> Edition,

  
**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



	Prentice Hall, 2011.
2.	Mannan S., "Lee's Loss Prevention in the Process Industries", Vol. III, 4 <sup>th</sup> Ed., Butterworth-Heinemann, 2012.
3.	Sanders R.E., "Chemical Process Safety: Learning from Case Histories", 3 <sup>rd</sup> edition, 2004.
4.	Davletshina T.A. and Cheremisinoff N.P., "Fire and Explosion Hazards Handbook of Industrial Chemicals" Elsevier Publication, 2008.
5.	Cheremisinoff N.P. and Graffia M.L., "Environmental Health and Safety Management. A Guide to Compliance", Pressure safety design practices for refinery and chemical operations", Jaico Publication, 2003.
6.	"Guidelines for Design Solutions for Process Equipment Failures", ISBN: 978-0-8169-0684-0, Centre for Chemical Process Safety (CCPS), 2003.
7.	Cheremisinoff N.P., "Pressure Safety Design Practices for Refinery and Chemical Operations" Noyes Publications, 2004.
8.	Jones, J.C., "Hydrocarbon Process Safety", Penn Well Books, 2003.
9.	Sanders R.E., "Chemical process safety: learning from case histories" Elsevier, 2005.
10.	Henley E.J., et al., "Designing for Reliability and Safety Control" Prentice Hall, Englewood Cliffs, 2007.

N. Mann

**Chairman - BoS**  
Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING				R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Total Hours	Maximum Marks	
		L	T	P			
19ISX09	SAFETY IN TEXTILE INDUSTRY	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To provide the student about the basic knowledge about the textile industries and its products by using various machineries.
- To enforce the knowledge on textile processing and various processes in making the yarn from cotton or synthetic fibres.
- To understand the various hazards of processing textile fibres by using various activities.
- To inculcate the knowledge on health and welfare activities specific to the Textile industries as per the Factories Act.

**Course Outcome(s):** At the end of this course, learners will be able to:

- Know the about the overall picture about the textile industries and its operations.
- Understand the various concepts underlying in the processes involved in processing of fibres to yarn.
- Find out various hazards in the textile industry and will be able to apply the control measures to mitigate the risk emanating from the hazard.
- Handle the various health and welfare activities as per the Factories act and could implement statutory requirements.
- Create of his own arrangement in designing various methods meant for mitigating the risk and able to guide his subordinates in executing the work safely.

<b>Unit I</b>	<b>INTRODUCTION</b>	<b>9</b>
---------------	---------------------	----------

Introduction to process flow charts of i) short staple spinning, ii) long staple spinning, iii) viscose rayon and synthetic fibre, manufacturer, iv) spun and filament yarn to fabric manufacture, v) jute spinning and jute fabric manufacture-accident hazard, guarding of machinery and safety precautions in opening, carding, combing, drawing, flyer frames and ring frames, doubles, rotor spinning, winding, warping, softening/spinning specific to jute.

<b>Unit II</b>	<b>TEXTILE HAZARDS I</b>	<b>9</b>
----------------	--------------------------	----------

Accident hazards i) sizing processes- cooking vessels, transports of size, hazards due to steam ii) Loom shed – shuttle looms and shuttles looms iii) knitting machines iv) nonwovens.

<b>Unit III</b>	<b>TEXTILE HAZARDS II</b>	<b>9</b>
-----------------	---------------------------	----------

Scouring, bleaching, dyeing, punting, mechanical finishing operations and effluents in textile processes.

<b>Unit IV</b>	<b>HEALTH AND WELFARE</b>	<b>9</b>
----------------	---------------------------	----------

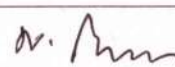
Health hazards in textile industry related to dust, fly and noise generated-control measures-relevant occupational diseases, personal protective equipment-health and welfare measures specific to textile industry, Special precautions for specific hazardous work environments.

<b>Unit V</b>	<b>SAFETY STATUS</b>	<b>9</b>
---------------	----------------------	----------

Relevant provision of factories act and rules and other statues applicable to textile industry – effluent treatment and waste disposal in textile industry.

#### REFERENCE(S):

- "Safety in Textile Industry", Thane Belapur Industries Association, Mumbai.
- "100 Textile Fires – Analysis, Findings and Recommendations", LPA.
- Elliot B. Grover and Hamby D.S, "Hand Book of Textile Testing and Quality Control" Textile Book Publishers (Inderscience), New York, 1960.
- "Quality Tolerances for Water for Textile Industry", BIS.
- Shenai, V.A. "A Technology of Textile Processing", Vol. I, Evak Publications, 1980.
- Little, A.H., "Water Supplies and the Treatment and Disposal of Effluent", The Textile Institute, Manchester, 1975.

  
**Chairman - BoS**  
 L. pt. of Mech Engg. - ESE@



Department	MECHANICAL ENGINEERING				R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19ISX10	VIBRATION AND NOISE CONTROL	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To provide in depth knowledge about the vibration and noise control.
- to get an exposure about the fundamentals and terminology of noise, vibration and its source
- To analyze and to design the component in such a way that noise and vibration may be controlled by suitable experimental methods.

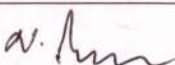
**Course Outcome(s):** At the end of this course, learners will be able to:

- Understand the basic concepts about the vibration and its types.
- Gain knowledge about the fundamentals of noise and sound pressure level.
- Understand the source of noise and means to control the same.
- Apply the knowledge on vibration control of rotating masses, etc.
- Gain knowledge about vibration instrumentation and perform experimental vibration analysis.

<b>Unit I</b>	<b>BASICS OF VIBRATION</b>	<b>9</b>
Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and nonlinear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.		
<b>Unit II</b>	<b>BASICS OF NOISE</b>	<b>9</b>
Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.		
<b>Unit III</b>	<b>SOURCE OF NOISE AND CONTROL</b>	<b>9</b>
Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers.		
<b>Unit IV</b>	<b>VIBRATION CONTROL</b>	<b>9</b>
Specification of Vibration Limits –Vibration severity standards-Vibration as condition Monitoring tool-Vibration Isolation methods- - Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber-Damped Vibration absorbers-Static and Dynamic Balancing-Balancing machines-Field balancing – Vibration Control by Design Modification- - Active Vibration Control.		
<b>Unit V</b>	<b>EXPERIMENTAL METHODS IN VIBRATION ANALYSIS</b>	<b>9</b>
Vibration Analysis Overview – Experimental Methods in Vibration Analysis - Vibration Measuring Instruments - Selection of Sensors-Accelerometer Mountings – Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics – Frequency Measuring Instruments - System Identification from Frequency Response - Testing for resonance and mode shapes.		

**REFERENCE(S):**

1.	Singiresu S.Rao - "Mechanical Vibrations" - Pearson Education, 5 <sup>th</sup> edition, 2010.
2.	Kewal Pujara "Vibrations and Noise for Engineers", Dhanpat Rai & Sons, 2004.
3.	Bernard Challen and Rodica Baranescu, "Diesel Engine Reference Book", SAE International- ISBN 0-7680-0403-9, Second edition, 1999.
4.	Julian Happian-Smith - "An Introduction to Modern Vehicle Design"- Butterworth- Heinemann, ISBN 0750-5044-3 – 2004.
5.	John Fenton - "Handbook of Automotive body Construction and Design Analysis" –Professional Engineering Publishing, ISBN 1-86058-073-1998.
6.	Rao V. Dukkipati and Srinivas J., "Text book of Mechanical Vibrations", Prentice-Hall of India P Ltd, New Delhi, 2004.

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING				R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Total Hours	Maximum Marks	
		L	T	P			
19ISX11	SAFETY IN MINES	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To provide in depth knowledge on Safety of mines of various types.
- To study, know and understand about the types of mines and various risk involved in the mining operations.
- To get exposed to various types of accidents happened in mines and how to manage during accidents.
- To analyse the nature of mining activities and developing a safety system to reduce the risk and also to implement the Emergency preparedness in the working environment of mines and to plan for the disaster management.

**Course Outcome(s):** At the end of this course, learners will be able to:

- Familiar with the concept of safety aspects in the mining industries.
- Understand the various types of mining activities like open case mines, underground mines and tunneling.
- Understand about the various risks involved in the mining activities and come to know about the various safety activities to be taken to ensure the safety of the workers.
- Implement the techniques like risk assessment, Disaster management and emergency preparedness with the proper knowledge on accident prevention.
- Effectively employ their knowledge on accident prevention in mines.

<b>Unit I</b>	<b>OPENCASE MINES</b>	<b>9</b>
---------------	-----------------------	----------

Causes and prevention of accident from: Heavy machinery, belt and bucket conveyors, drilling, hand tools-pneumatic systems, pumping, water, dust, electrical systems, fire prevention. Garage safety – accident reporting system-working condition-safe transportation – handling of explosives.

<b>Unit II</b>	<b>UNDERGROUND MINES</b>	<b>9</b>
----------------	--------------------------	----------

Fall of roof and sides-effect of gases-fire and explosions-water flooding-warning sensors-gas detectors-occupational hazards-working conditions-winding and transportation.

<b>Unit III</b>	<b>TUNNELLING</b>	<b>9</b>
-----------------	-------------------	----------

Hazards from: ground collapse, inundation and collapse of tunnel face, falls from platforms and danger from falling bodies. Atmospheric pollution (gases and dusts) – trapping – transport-noise-electrical hazards-noise and vibration from: pneumatic tools and other machines - ventilation and lighting – personal protective equipment.

<b>Unit IV</b>	<b>RISK ASSESSMENT</b>	<b>9</b>
----------------	------------------------	----------

Basic concepts of risk-reliability and hazard potential-elements of risk assessment – statistical methods – control charts-appraisal of advanced techniques-fault tree analysis-failure mode and effect analysis – quantitative structure-activity relationship analysis-fuzzy model for risk assessment.

<b>Unit V</b>	<b>ACCIDENT ANALYSIS AND MANAGEMENT</b>	<b>9</b>
---------------	---	----------

Accidents classification and analysis-fatal, serious, minor and reportable accidents – safety audits-recent development of safety engineering approaches for mines-frequency rates-accident occurrence-investigation-measures for improving safety in mines-cost of accident-emergency preparedness – disaster management.

**REFERENCE(S):**

1. Michael Karmis ed., "Mine Health and Safety Management", SME, Littleton, Co. 2001.
2. Kejiriwal, B.K. "Safety in Mines", Publisher Gyan Prakashan, Dhanbad, 2002.
3. DGMS Circulars-Ministry of Labour, Government of India press, OR Lovely Prakashan-DHANBAD, 2002.

  
**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



Department	MECHANICAL ENGINEERING				R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19ISX12	PHYSICAL AND CHEMICAL TREATMENT OF WATER AND WASTEWATER	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To know the Sources of pollutants in water and wastewater and characterization.
- To study the physical treatments processes such as sedimentation, reverse osmosis, nano filtration, electro dialysis etc.,
- To study the chemical treatment processes such as coagulation flocculation, precipitation, flotation, ion exchange, electrolytic etc.,
- To design different type of treatment plants for industrial effluents.

**Course Outcome(s):** At the end of this course, learners will be able to:

- To gain knowledge about the classification of water pollution and its characteristics.
- To understand physical treatment methods and its recent advancements.
- To list out various chemical treatment methods.
- To design water treatment plants for industrial applications

<b>Unit I</b>	<b>INTRODUCTION</b>	<b>9</b>
---------------	---------------------	----------

Pollutants in water and wastewater – Characteristics – Standards for performance –Significance and need for physico-chemical treatment.

<b>Unit II</b>	<b>PHYSICAL TREATMENT PRINCIPLES</b>	<b>9</b>
----------------	--------------------------------------	----------

Principles of Screening – Mixing, equalisation – Sedimentation – Filtration – Modelling – Back washing – Evaporation – Incineration – Gas transfer – Mass transfer coefficients – Adsorption – Isotherms – Principles, equilibria and kinetics, reactors, regeneration, membrane separation, Reverse Osmosis, nano filtration, ultra filtration and hyper filtration – Electrodialysis, distillation – Stripping and crystallization – Recent Advances.

<b>Unit III</b>	<b>CHEMICAL TREATMENT PRINCIPLES</b>	<b>9</b>
-----------------	--------------------------------------	----------

Principles of Chemical treatment – Coagulation flocculation – Precipitation – flotation, solidification and stabilization – Disinfection – Ion exchange, Electrolytic methods, Solvent extraction – advance oxidation /reduction – Recent Advances

<b>Unit IV</b>	<b>DESIGN OF CONVENTIONAL TREATMENT PLANTS</b>	<b>9</b>
----------------	--	----------

Selection of unit operations and processes – Design of conventional water treatment plant units – Aerators – chemical feeding – Flocculation – clarifier – filters – Rapid sand filter, slow sand filter, pressure filter – Chlorinators – Displacement and gaseous type. Layouts – flow charts – Hydraulic Profile – O and M aspects – Case studies – Residue management – Upgradation of existing plants – Recent Advances.

<b>Unit V</b>	<b>DESIGN OF INDUSTRIAL WATER TREATMENT AND RECLAMATION</b>	<b>9</b>
---------------	---	----------

Selection of process – Design of softeners – Demineralisers – Wastewater reclamation – Reverse osmosis plants – Residue management – O and M aspects – Recent Advances – Case studies.

#### REFERENCE(S):

1.	Metcalf and Eddy, "Wastewater Engineering, Treatment and Reuse", Tata McGraw-Hill, Fourth Edition, 2009.
2.	"Manual on Water Supply and Treatment", CPHEEO, Ministry of Urban Development, Government of India, 1999.
3.	Lee, C.C. and Shun dar Lin, "Handbook of Environmental Engineering Calculations", McGraw-Hill, Second edition, 2007.
4.	Qasim, S.R., Motley, E.M. and Zhu, G., "Water works Engineering – Planning, Design and Operation", Prentice Hall, 2002.
5.	Casey, T.J., "Unit Treatment Processes in Water and Wastewater Engineering", John Wiley and Sons, 1997.

  
**Chairman - BoS**  
 Jt. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING				R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Total Hours	Maximum Marks	
		L	T	P			
19ISX13	SAFETY IN CONSTRUCTION	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To know causes of accidents related to construction activities and human factors associated with these accident
- To understand the construction regulations and quality assurance in construction
- To have the knowledge in hazards of construction and their prevention methods
- To know the working principles of various construction machinery
- To gain knowledge in health hazards and safety in demolition work

**Course Outcome(s):** At the end of this course, learners will be able to:

- To identify the problems impeding safety in construction industries.
- To identify types and causes of accidents, and designing aids for safe construction.
- To understand the hazards during construction of power plant, road works and high rise buildings.
- To understand the safety procedure for working at heights during construction.
- To have knowledge in selection, operation, inspection and testing of various construction machinery.
- To list out construction regulations and Indian standards for construction and demolition work.

<b>Unit I</b>	<b>ACCIDENTS CAUSES AND MANAGEMENT SYSTEMS</b>	<b>9</b>
---------------	--	----------

Problems impeding safety in construction industry- causes of fatal accidents, types and causes of accidents related to various construction activities, human factors associated with these accident – construction regulations, contractual clauses – Pre contract activities, preconstruction meeting - design aids for safe construction – permits to work – quality assurance in construction - compensation – Recording of accidents and safety measures – Education and training.

<b>Unit II</b>	<b>HAZARDS OF CONSTRUCTION AND PREVENTION</b>	<b>9</b>
----------------	---	----------

Excavations, basement and wide excavation, trenches, shafts – scaffolding, types, causes of accidents, scaffold inspection checklist – false work – erection of structural frame work, dismantling – tunnelling – blasting, pre blast and post blast inspection – confined spaces – working on contaminated sites – work over water - road works – power plant constructions – construction of high rise buildings.

<b>Unit III</b>	<b>WORKING AT HEIGHTS</b>	<b>9</b>
-----------------	---------------------------	----------

Fall protection in construction OSHA 3146 – OSHA requirement for working at heights, Safe access and egress – safe use of ladders- Scaffoldings, requirement for safe work platforms, stairways, gangways and ramps – fall prevention and fall protection, safety belts, safety nets, fall arrestors, controlled access zones, safety monitoring systems – working on fragile roofs, work permit systems, height pass – accident case studies.

<b>Unit IV</b>	<b>CONSTRUCTION MACHINERY</b>	<b>9</b>
----------------	-------------------------------	----------

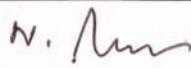
Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - builder's hoist, winches, chain pulley blocks – use of conveyors - concrete mixers, concrete vibrators – safety in earth moving equipment, excavators, dozers, loaders, dumpers, motor grader, concrete pumps, welding machines, use of portable electrical tools, drills, grinding tools, manual handling scaffolding, hoisting cranes – use of conveyors and mobile cranes – manual handling.

<b>Unit V</b>	<b>SAFETY IN DEMOLITION WORK</b>	<b>9</b>
---------------	----------------------------------	----------

Safety in demolition work, manual, mechanical, using explosive - keys to safe demolition, pre survey inspection, method statement, site supervision, safe clearance zone, health hazards from demolition - Indian standard - trusses, girders and beams – first aid – fire hazards and preventing methods – interesting experiences at the construction site against the fire accidents.

#### REFERENCE(S):

1.	Davies V.J and Thomasin K "Construction Safety Hand Book" Thomas Telford Ltd., London, 1996.
2.	David L. Goetsch, "Construction Safety and the OSHA Standards", Prentice Hall, 2009
3.	Hudson, R."Construction hazard and Safety Hand book", Butter Worth's, 1985.

N.   
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC



Department	MECHANICAL ENGINEERING				R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19ISX14	BRIDGE MAINTENANCE AND MANAGEMENT	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To introduce the philosophy behind bridge maintenance and management.
- To provide exposure on reliability concepts.
- To provide training on various type of NDT.
- To know the causes of bridge deterioration.
- To familiarize the stress monitoring in bridge structures.

**Course Outcome(s):** At the end of this course, learners will be able to:

- Understand the basics of bridge maintenance and management.
- Acquire knowledge on the assessment and evaluation procedure of bridges.
- Perform nondestructive testing and monitoring of bridge structures.
- Identify the causes of bridge deterioration.
- Carryout stress measurements in bridge structures.

Unit I	INTRODUCTION	9
Bridge maintenance management - The system - Inspection - Inspection equipment - planning - condition rating.		
Unit II	ASSESSMENT AND EVALUATION	9
Basic consideration - structural safety - analysis method - Reliability concepts.		
Unit III	NON-DESTRUCTIVE TESTING	9
Concrete Elements - Corrosion analysis equipment - Resistivity measurements - Rebar locators - Ultrasonic testing - Rebound hammer - carbonation test - permeability testing - internal fracture tester - impulse radar - infrared thermography - Endoscopy - Impact echo - Radiography- coring - steel elements - masonry elements.		
Unit IV	BRIDGE DETERIORATION	9
Basic Theory - Discount rate - Traffic disruption - Future development - maintenance strategy - performance profiles - whole life assessment.		
Unit V	STRESS MEASUREMENTS AND BRIDGE MONITORING	9
In - situ residual stresses - stress relief principle - Indirect stress management - Live load stresses - Monitoring - scour sensing - load cells - displacement transducers - Traffic monitoring.		

**REFERENCE(S):**

1.	Ryall M J, "Bridge Management", Butterworth Heinemann, Oxford, 2009.
2.	K. S. Rakshit, "Construction Maintenance Restoration & Rehabilitation of Highway Bridges", New Central Book Agency (P) Ltd., 2003.
3.	Bojidar Yanev, "Bridge Management", John Wiley & Sons INC., 2007.
4.	Mohiuddin A. Khan, "Bridge and Highway structure Rehabilitation and Repair", McGraw Hill Pvt. Ltd., 2010.

*N. Am*

**Chairman - BoS**  
Dept. of Mech Engg. - ESEC

4.	Jonathan D.Sime, "Safety in the Built Environment", London, 1988.
5.	Charles D. Reese and James V.Edison "Handbook of OSHA Construction safety and health' CRC Press, 2nd edition, 2012.
6.	Philip Hagan, "Accident Prevention Manual for Business and Industry", N.S.C.Chicago, 13th edition 2009.
7.	R. K. Mishra, "Construction Safety", AITBS Publishers, 2011

*Dr. [Signature]*

**Chairman - BoS**  
**Dept. of Mech Engg. - ESEC**



Department	MECHANICAL ENGINEERING				R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Total Hours	Maximum Marks	
		L	T	P			
19ISX15	TRANSPORT SAFETY	3	0	0	3	45	100

**Course Objective(s):** The purpose of learning this course is:

- To provide the students about the various activities/steps to be followed in safe handling the hazardous goods transportation from one location to another location.
- To educate the reasons for the road accident and the roles and responsibilities of a safe Driver and the training needs of the driver.
- To inculcate the culture of safe driving and fuel conservation along with knowing of basic traffic symbols followed throughout the highways.
- To impart knowledge on maintenance of vehicle and other preventive measure to avoid the accident.
- To educate the student to visualize the status of road conditions, its characteristics with reference to the speed of the vehicle and to impart knowledge on shop floor maintenance and shop safety.

**Course Outcome(s):** At the end of this course, learners will be able to:

- The students will be able to know various safety activities undertaken in transporting of hazardous goods.
- The students could be able to understand the various symbols which are specific to the road safety and able to reduce the accidents occurred in the roads.
- The course could lead the student to apply for the safe transportation of hazardous goods, creating TREM card and safe loading and unloading procedure.
- The students could be able to analyse the causes for the accidents and to suggest preventive measures for the accident.
- The student could design the shop floor and could handle the various maintenance activities by using various mechanical equipment meant for servicing.

<b>Unit I</b>	<b>TRANSPORTATION OF HAZARDOUS GOODS</b>	<b>9</b>
---------------	--	----------

Transport emergency card (TREM) – driver training-parking of tankers on the highways speed of the vehicle – warning symbols – design of the tanker lorries -static electricity responsibilities of driver – inspection and maintenance of vehicles-check list- loading and decanting procedures – communication.

<b>Unit II</b>	<b>ROAD TRANSPORT</b>	<b>9</b>
----------------	-----------------------	----------

Introduction – factors for improving safety on roads – causes of accidents due to drivers and pedestrians-design, selection, operation and maintenance of motor trucks preventive maintenance-check listsmotor vehicles act – motor vehicle insurance and surveys.

<b>Unit III</b>	<b>DRIVER AND SAFETY</b>	<b>9</b>
-----------------	--------------------------	----------

Driver safety programme – selection of drivers – driver training-tachograph-driving test driver's responsibility-accident reporting and investigation procedures-fleet accident frequency-safe driving incentives-slogans in driver cabin-motor vehicle transport workers act- driver relaxation and rest pauses – speed and fuel conservation – emergency planning and Hazmat codes.

<b>Unit IV</b>	<b>ROAD SAFETY</b>	<b>9</b>
----------------	--------------------	----------

Road alignment and gradient-reconnaissance-ruling gradient-maximum rise per k.m.- factors influencing alignment like tractive resistance, tractive force, direct alignment, vertical curves-breaking characteristics of vehicle-skidding-restriction of speeds- significance of speeds- Pavement conditions – Sight distance – Safety at intersections – Traffic control lines and guide posts-guard rails and barriers – street lighting and illumination overloading-concentration of driver. Plant railway: Clearance-trackwarning methods-loading and unloading-moving cars safety practices.

<b>Unit V</b>	<b>SHOP FLOOR AND REPAIR SHOP SAFETY</b>	<b>9</b>
---------------	--	----------

Transport precautions-safety on manual, mechanical handling equipment operations safe driving-movement of cranes-conveyors etc., servicing and maintenance equipment grease rack operation-wash rack operation-battery charging-gasoline handling-other safe practices-off the road motorized equipment.

**REFERENCE(S):**

1. Popkes, C.A. "Traffic Control and Road Accident Prevention" Chapman and Hall Limited, 1986

  
**Chairman - BoS**  
 Dept. of Mech Engg. - ESEC

2.	Babkov, V.F., "Road Conditions and Traffic Safety" MIR Publications, Moscow, 1986.
3.	Kadiyali, "Traffic Engineering and Transport Planning" Khanna Publishers, New Delhi, 1983.
4.	Motor Vehicles Act, 1988(amendment 2007), Government of India.
5.	"Accident Prevention Manual for Industrial Operations", NSC, Chicago, 1982.
6.	Pasricha, "Road Safety guide for drivers of heavy vehicle" Nasha Publications, Mumbai, 1999.
7.	Ogden K.W, "Safer Roads – A guide to Road Safety Engineering" 1996.

*V. Anur*

**Chairman - BoS**  
Dept. of Mech Engg. - ESEC