



FRANCIS XAVIERTM **ENGINEERING COLLEGE** **AUTONOMOUS INSTITUTION**

ACCREDITED BY NBA

ISO 9001:2015 Certified | DST-FIST Supported Institution
Recognized under Section 2(f) & 12(B) of the UGC Act, 1956
Vannarpettai, Tirunelveli - 627003, Tamil Nadu

CURRICULUM AND SYLLABUS



M.E. Industrial Safety Engineering

Regulations 2019



FRANCIS XAVIER[™]
ENGINEERING COLLEGE
AN AUTONOMOUS INSTITUTION

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Department of Mechanical Engineering

M.E. Industrial Safety Engineering

Curriculum & Syllabus

**REGULATIONS 2019
(CBCS)**

Approved by

VISION AND MISSION OF THE DEPARTMENT

VISION

To produce competent Mechanical Engineers of excellent technical and managerial skills for national and global development

MISSION

To provide best education in Mechanical Engineering, encouraging innovation and entrepreneurship through professional and moral ethics and to improve the quality of the people worldwide.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO I: To provide students with a good understanding of philosophy and integrated approach to managing safety, industrial hygiene and environment.

PEO II: To inculcate the students in hazardous identification techniques, reliability analysis of the process system, event trees & fault trees analysis, hazards and operability analysis (HAZOP).

PEO III: To introduce students to recent developments in analytical techniques, such as computer modeling of risk, reliability and safety problems.

PEO IV: To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach and an ability to think and act an individual safety consultant.

PEO V: To impart the students with the understanding the professional practice of industrial safety & industrial acts.

PROGRAM OUTCOMES (POs)

On successful completion of the Programme,

- a. **Safety knowledge:** Apply knowledge of basics of hazards and its types to assess the risk.
- b. **Problem Analysis:** Identify, formulate and solve the current problems related to industrial safety.
- c. **Design/Development of Solutions:** Evaluate existing system / design safety models identify the problems, evaluate and implement the remedial measures in the industries.
- d. **Conduct Investigations of Complex Problems:** Conduct detailed audit, collect data and analyze accident investigation report.
- e. **Modern Tool Usage:** Apply various hazard assessment tools and techniques to identify the hazard estimate risk and reduce the accident occurrence to improve the safety levels.
- f. **The Engineer and Society:** Adequate knowledge about technical aspects with safety legislation to uphold professional and social obligations.
- g. **Environment and Sustainability:** Uphold environment legislation and developing sustainable work environment.
- h. **Ethics:** Cultivate and uphold ethical practices in workplace and society
- i. **Individual and Team Work:** Develop documentation individually in an effectively manners and work efficiently in team environment.
- j. **Communication:** Develop communication skills to manage workers and management.
- k. **Project Management and Finance:** Effective knowledge of safety management aspect helps in efficient project management and reduces budgetary overshoot.
- l. **Life-Long Learning:** Continue knowledge updating and develop holistically as a learner to become leader of tomorrow.

PROGRAM SPECIFIC OBJECTIVES (PSOs)

PSO1. Knowledge - To apply the acquired Industrial Safety Knowledge for the advancement of self and the society

PSO2. Development - To implement the learned principles of Industrial safety to develop advanced safety systems and processes

MAPPING OF PROGRAM EDUCATIONAL OBJECTIVES WITH PROGRAM OUTCOMES

PROGRAM EDUCATIONAL OBJECTIVES (PEO)	PROGRAM OUTCOMES (PO)											
	1	2	3	4	5	6	7	8	9	10	11	12
PEO 1	X	X	X	X	X	X			X			
PEO 2		X	X	X	X				X	X	X	
PEO 3			X		X	X				X		X
PEO 4						X	X	X		X	X	X
PEO 5				X	X		X	X	X	X	X	X

**M.E. - INDUSTRIAL SAFETY ENGINEERING
REGULATIONS 2019
CHOICE BASED CREDIT SYSTEM
CREDIT DISTRIBUTION**

Sl. No	CATEGORY	CREDITS PER SEMESTER				TOTAL CREDIT	CREDITS IN %
		I	II	III	IV		
1	BS	4	-	-	-	4	5.3
2	PC	16	15	3	-	34	45.4
3	PE	3	6	6	-	15	20
4	EEC	1	1	8	12	22	29.3
TOTAL		24	22	17	12	75	100%

- BS - Basic Sciences
 PC - Professional Core
 PE - Professional Elective
 EEC - Employability Enhancement Course

**M.E. - INDUSTRIAL SAFETY ENGINEERING
REGULATIONS 2019
CHOICE BASED CREDIT SYSTEM
CURRICULUM AND SYLLABI**

FIRST SEMESTER							
Code No.	Course	Category	L	T	P	C	H
19MA1252	Probability and Statistical Methods	BS	4	0	0	4	4
19IS1002	Principles of Safety Management	PC	3	0	0	3	3
19IS1003	Environmental Safety	PC	4	0	0	4	4
19IS1004	Occupational Health and Industrial Hygiene	PC	3	0	0	3	3
19IS1005	Industrial Safety, Health and Environment Acts	PC	4	0	0	4	4
E1	Elective I	PE	3	0	0	3	3
19IS1011	Industrial Safety Laboratory I	PC	0	0	4	2	4
19IS1912	Technical Seminar I	EEC	0	0	2	1	2
TOTAL			21	0	6	24	27

SECOND SEMESTER							
Code No.	Course	Category	L	T	P	C	H
19IS2001	Fire Engineering and Explosion Control	PC	3	0	0	3	3
19IS2002	Computer Aided Hazard Analysis	PC	4	0	0	4	4
19IS2003	Electrical Safety	PC	3	0	0	3	3
19IS2004	Safety in Engineering Industry	PC	3	0	0	3	3
19IS2005	Behavior Based Safety	PC	3	0	0	0	3
E2	Elective II	PE	3	0	0	3	3
E3	Elective III	PE	3	0	0	3	3
19IS2011	Industrial Safety Laboratory II	PC	0	0	4	2	4
19IS2912	Technical Seminar II	EEC	0	0	2	1	2
TOTAL			22	0	6	22	28

THIRD SEMESTER							
Code No.	Course	Category	L	T	P	C	H
19IS3001	Reliability Engineering	PC	3	0	0	3	3
E4	Elective IV	PE	3	0	0	3	3
E5	Elective V	PE	3	0	0	3	3
19IS3911	Project Work Phase I	EEC	0	0	12	6	12
19IS3912	Industrial Safety Assessment - Internship	EEC	0	0	4	2	4
TOTAL			9	0	16	17	25

FOURTH SEMESTER							
Code No.	Course	Category	L	T	P	C	H
19IS4911	Project Work Phase II	EEC	0	0	24	12	24
TOTAL			0	0	24	12	24

L - Lecture; T - Tutorial; P - Practical; H - Hours

Code No.	Course	L	T	P	C
PROFESSIONAL ELECTIVES					
PROFESSIONAL ELECTIVE I					
19IS1101	Plant Layout and Materials Handling	3	0	0	3
19IS1102	Work System Design and Ergonomics	3	0	0	3
19IS1103	Dock Safety	3	0	0	3
19IS1104	Human Factors in Engineering	3	0	0	3
19IS1105	Maintenance Engineering and Management	3	0	0	3
19IS1106	Industrial Vibration and Noise Control	3	0	0	3
PROFESSIONAL ELECTIVE II & III					
19IS2101	Transport Safety	3	0	0	3
19IS2102	Fireworks Safety	3	0	0	3
19IS2103	Safety in Construction	3	0	0	3
19IS2104	Nuclear Engineering and Safety	3	0	0	3
19IS2105	Safety in Textile Industry	3	0	0	3
19IS2106	Safety in Mines	3	0	0	3
19IS2107	Environmental Impact Assessment	3	0	0	3
19IS3108	Safety in On and Off Shore Drilling	3	0	0	3
PROFESSIONAL ELECTIVE IV & V					
19IS3101	Safety in Chemical Industries	3	0	0	3
19IS3102	Quality Engineering in Production Systems	3	0	0	3
19IS3103	Disaster Management	3	0	0	3
19IS3104	OHSAS 18000, ISO 14000 and ISO 9000	3	0	0	3
19IS3105	Artificial Intelligence and Expert Systems	3	0	0	3
19IS3106	Research Methodology	3	0	0	3
19IS3107	Business Data Analytics	3	0	0	3
19IS3108	Optimization Techniques	3	0	0	3
AUDIT COURSE					
19IS4101	English For Research Paper Writing	2	0	0	0
19IS4102	Stress Management by Yoga	2	0	0	0
VALUE ADDED COURSE					
19IS5101	Hazard and Operability Studies	1	0	0	1

19MA1252	PROBABILITY AND STATISTICAL METHODS	L-T-P	C
		4-0-0	4

Programme: M.E, - Industrial Safety Engineering

Objective : This course is designed to provide the solid foundation on topics in probability and various statistical methods which form the basis for many other areas in the mathematical sciences including statistics, modern optimization methods and risk modeling. It is framed to address the issues and the principles of estimation theory, testing of hypothesis, design of experiments and time series analysis.

Prerequisite:

PROBABILITY AND RANDOM VARIABLES **12**

Probability – Axioms of probability – Conditional probability – Baye’s theorem - Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

ESTIMATION THEORY **12**

Principle of least squares – Regression – Multiple and partial correlations – Estimation of parameters - Maximum likelihood estimates – Method of moments.

TESTING OF HYPOTHESIS **12**

Sampling distributions – Small and large samples and problems – Tests based on Normal, t - distribution, Chi - square, Goodness of fit and F – distributions.

DESIGN OF EXPERIMENTS **12**

Analysis of variance – Completely randomized design – Randomized block design – Latin square design – 2^2 Factorial designs.

TIME SERIES **12**

Characteristics and representation – Moving averages – Exponential smoothing – Auto regressive processes.

Total Periods: 60

REFERENCES:

1. Anderson, O.D, “Time Series Analysis: Theory and Practice”, North - Holland, Amsterdam, 1982.
2. Devore, J. L., “Probability and Statistics for Engineering and Sciences”, 8th Edition, Cengage Learning, 2014.
3. Gupta, S.C and Kapoor, V.K., “Fundamentals of Mathematical Statistics”, Sultan and Chand Company, New Delhi, 1999.
4. Johnson, R.A., Miller, I and Freund J., “Miller and Freund’s Probability and Statistics for Engineers, Pearson Education, Asia, 8th Edition, 2015.
5. Montgomery D.C and Johnson, L.A, “Forecasting and Time Series”, 6th Edition, McGraw Hill, 1990.

Course Outcomes:

The students will be able to

- CO1 Learn basic probability axioms and rules and the moments of discrete and continuous random variables
- CO2 Understand Least squares, correlation, regression, consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- CO3 Use statistical tests in testing hypotheses on data.
- CO4 List the guidelines for designing experiments and recognize the key historical figures in Design of Experiments.
- CO5 Differentiate between various time series models and application of these models appropriately to engineering problems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1	1						1
CO2	1				1	1						
CO3		2		1	2							
CO4			1			1				1		1
CO5		1		1	1	1				1		1

HOD/MECH

19IS1002**PRINCIPLES OF SAFETY MANAGEMENT****L-T-P****C****3-0-0****3****Programme:** M.E, - Industrial Safety Engineering**Objectives:**

- 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.

Prerequisite:**CONCEPTS AND TECHNIQUES****9**

History of Safety movement –Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity -productivity, quality and safety-line and staff functions for safety-budgeting for safety-safety policy.

Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety.

SAFETY AUDIT – INTRODUCTION**9**

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.

ACCIDENT INVESTIGATION AND REPORTING**9**

Concept of an accident, 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.

SAFETY PERFORMANCE MONITORING**9**

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 – problems.

SAFETY EDUCATION AND TRAINING**9**

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 – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

Total Periods: 45**REFERENCES:**

1. “Accident Prevention Manual for Industrial Operations”, N.S.C.Chicago, 1982.
2. Blake R.B., “Industrial Safety” Prentice Hall, Inc., New Jersey, 1973.
3. Dan Petersen, “Techniques of Safety Management”, McGraw-Hill Company, Tokyo, 1981.
4. Heinrich H.W. “Industrial Accident Prevention” McGraw-Hill Company, New York, 1980
5. John Ridley, “Safety at Work”, Butterworth and Co., London, 1983

6. Lees, F.P., "Loss Prevention in Process Industries" Butterworth publications, London, 2nd edition, 1990.
7. Relevant Indian Standards and Specifications, BIS, New Delhi.
8. "Safety and Good House Keeping", N.P.C., New Delhi, 1985.

Course Outcomes:

The students will be able to

- CO1 Understand the functions and activities of safety engineering department.
 CO2 Carry out a safety audit and prepare a report for the audit.
 CO3 Prepare an accident investigation report.
 CO4 Estimate the accident cost using supervisors report and data.
 CO5 Evaluate the safety performance of an organization from accident records.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			2		1		1				
CO2	3			3		2		1				
CO3	3			3								2
CO4	3			2		2						2
CO5	3			2		2						2

HOD/MECH

19IS1003**ENVIRONMENTAL SAFETY****L-T-P****C****4-0-0****4****Programme:** M.E, - Industrial Safety Engineering

- Objectives :**
- 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.

Prerequisite:**AIR POLLUTION****12**

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.

WATER POLLUTION**12**

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.

HAZARDOUS WASTE MANAGEMENT**12**

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 MEASUREMENT AND CONTROL**12**

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

POLLUTION CONTROL IN PROCESS INDUSTRIES**12**

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

Total Periods: 60**REFERENCES:**

1. E. C Wolfe, Race to Save to Save Planet, Wadsworth Publishing Co., Belmont, CA 2006.
2. G. T Miller, Environmental Science: Working with the Earth, 11th Edition, Wadsworth Publishing Co., Belmont, CA, 2006
3. M.J Hammer,, and M.J Hammer,, Jr., Water and Wastewater Technology, Pearson Prentice Hall, 2006
4. Rao, CS, “Environmental pollution engineering:, Wiley Eastern Limited, New Delhi, 1992.
5. S. P. Mahajan, “Pollution control in process industries”, Tata McGraw Hill Publishing Company, New Delhi, 1993.
6. Varma and Braner, “Air pollution equipment”, Springer Publishers, Second Edition.

Course Outcomes:

The students will be able to

- CO1. Illustrate and familiarize the basic concepts scope of environmental safety.
- CO2. Understand the standards of professional conduct that are published by professional safety organizations and/or certification bodies.
- CO3. Explain the ways in which environmental health problems have arisen due to air and water pollution.
- CO4. Illustrate the role of hazardous waste management and use of critical thinking to identify and assess environmental health risks.
- CO5. Discuss concepts of measurement of emissions and design emission measurement devices.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1					1	3					
CO2	1					1	3					
CO3	1					1	3		2			
CO4	1		2	3		1	3		2			1
CO5	1			3					2			1

HOD/MECH

19IS1004**OCCUPATIONAL HEALTH AND INDUSTRIAL
HYGIENE****L-T-P****C****3-0-0****3****Programme:** M.E, - Industrial Safety Engineering

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

Prerequisite:**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- hot environments, thermal comfort, heat stress indices, acclimatization, estimation and control

CHEMICAL HAZARDS**9**

Recognition of chemical hazards-dust, fumes, mist, vapour, 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 Vapour monitors, dust sample collection devices, personal sampling

Methods of Control - Engineering Control, Design maintenance considerations, design specifications - General Control Methods - training and education

BIOLOGICAL AND ERGONOMICAL HAZARDS**9**

Classification of Biohazardous 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.

9**OCCUPATIONAL HEALTH AND TOXICOLOGY**

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, lead-nickel, chromium and manganese toxicity, gas poisoning (such as CO, ammonia, coal and dust etc) their effects and prevention – cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests.

Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems

OCCUPATIONAL PHYSIOLOGY**9**

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 – categorization of job heaviness – work organization – stress – strain – fatigue – rest pauses – shift work – personal hygiene.

Total Periods: 45**REFERENCES:**

1. Benjamin O.Alli, Fundamental Principles of Occupational Health and Safety ILO 2008.
2. Danuta Koradecka, Handbook of Occupational Health and Safety, CRC, 2010.
3. E.J. McCornick, and M. S Sanders, Human Factors in Engineering and Design, Tata McGraw-Hill, 1992.
4. Encyclopedia of “Occupational Health and Safety”, Vol.I and II, published by International Labour Office, Geneva, 1985
5. Hand book of “Occupational Safety and Health”, National Safety Council, Chicago, 1982.
6. Hand book of “Occupational Safety and Health”, National Safety Council, Chicago, 1982
7. Lawrence Slote , Handbook of occupational safety and health, Wiley, 2001.
8. Louis J. Di Berardinis, Handbook of occupational safety and health Wiley, 1999.

Course Outcomes:

The students will be able to

- CO1. Understand the various physiological functions of our body and the test methods for periodical monitoring of health.
- CO2. Understand the functions and activities of Occupational health services.
- CO3. Identify various types of hazards arising out of physical, chemical and biological agents in a process.
- CO4. Identify notifiable occupational diseases arising out of Occupation and suggest methods for the prevention of such diseases
- CO5. Evaluate physiological requirements of jobs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		2			2	3					
CO2	1		2			2	3					
CO3	1		2			2	3					
CO4	1					2	3					
CO5	1						3					2

HOD/MECH

19IS1005**INDUSTRIAL SAFETY, HEALTH AND ENVIRONMENT ACTS****L-T-P****C****4-0-0****4****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- To provide exposure to the students about safety and health provisions related to hazardous processes as laid out in Factories act 1948.
 - To familiarize students with powers of inspectorate of factories.
 - To help students to learn about Environment act 1986 and rules framed under the act.
 - To provide wide exposure to the students about various legislations applicable to an industrial unit.

Prerequisite:**FACTORIES ACT – 1948****10**

Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young persons – special provisions – penalties and procedures- Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948

ENVIRONMENT ACT – 1986**10**

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.

MANUFACTURE, STORAGE AND IMPORT OF HAZARDOUS CHEMICAL RULES 1989**10**

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.

OTHER ACTS AND RULES**20**

Indian Boiler Act 1923, static and mobile pressure vessel rules (SMPV), motor vehicle rules, mines act 1952, 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

INTERNATIONAL ACTS AND STANDARDS**10**

Occupational Safety and Health act of USA (The Williames - Steiger Act of 1970) – Health and safety work act (HASAWA 1974, UK) – OSHAS 18000 – ISO 14000 – American National Standards Institute (ANSI)

Total Periods: 60**REFERENCES:**

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
3. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt.Ltd., New Delhi.

4. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
5. The Indian boilers act 1923, Commercial Law Publishers (India) Pvt. Ltd., Allahabad.
6. The Mines Act 1952, Commercial Law Publishers (India) Pvt. Ltd., Allahabad.
7. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book agency, Chennai.
8. National seminar on hazardous waste management organized by National Safety council, Ministry of environment and forests, Government of India, United States – Asia environmental partnership, Tamilnadu pollution control board and Indian chemical manufacturers association, April 2001.

Course Outcomes:

The students will be able to

CO1. List out important legislations related to health, Safety and Environment.

CO2. List out requirements mentioned in factories act for the prevention of accidents.

CO3. Understand the health and welfare provisions given in factories act.

CO4. Understand the statutory requirements for an Industry on registration, license and its renewal.

CO5. Prepare onsite and offsite emergency plan.

Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1					3						2
CO2	1					3	2					2
CO3	1					3	2					2
CO4						3						1
CO5						3						1

HOD/MECH

19IS1011**INDUSTRIAL SAFETY LABORATORY I****L-T-P C****0-0-4 2****Programme:** M.E, - Industrial Safety Engineering**Objectives:**

- To provide opportunity to operate the equipment to acquire practical knowledge.
- To know the various PPEs and standards
- To carry out experiments to find out the environmental parameters.
- To know the Fire Extinguisher operations and types.

Prerequisite:**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

ILLUMINATION MEASUREMENT AND ANALYSIS

Measurement of intensity of light was measured in LUX, continuous and intermittent sources at various places was analysed

ENVIRONMENTAL PARAMETER MEASUREMENT

Dry Bulb Temperature, Wet Bulb Temperature, Determination of relative humidity, wind flow measurement

Particle size Measurement

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, anti static and conducting plastics/rubber materials, apron and leg guard.

FIRE EXTINGUISHERS AND ITS OPERATIONS

Water, Foam

Carbon dioxide (CO₂)

Dry chemical powder and

Currently amendment fire safety systems

SAFETY MEASURES

Lockout tagout, Fire Hydrant, Fire alarm, Sprinklers.

Total Periods:45**Equipments Required**

- | | | | |
|----|-----------------------|---|------|
| 1. | Noise level meter | : | 1No |
| 2. | Lux meter | : | 1 No |
| 3. | Sling Physcrometer | : | 1No |
| 4. | Anemometer | : | 1 No |
| 5. | Gyratory Sieve Shaker | : | 1 No |
| 6. | PPE Set | : | 1 No |
| 7. | Fire extinguisher set | : | 1 No |
| 8. | Lockout/Tag out | : | 1No |

Course Outcomes:

The students will be able to

- CO1. Run the various equipments to bring out the safety environment in the industry.
- CO2. Identify the different illumination test for determination of intensity of light.
- CO3. Analyze the various environmental parameters and measure the particle size.
- CO4. Use personal protective equipment.
- CO5. Operate fire extinguishers in emergency situations

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		2	2	1	2		1	1			2
CO2	1		2	2	1	2		1	1			2
CO3	1		2	2	1	2		1	1			2
CO4	1		2	2	1	2			1			1
CO5	1		2	2	1	2			1			1

HOD/MECH

19IS1912**TECHNICAL SEMINAR - I****L-T-P****C****0-0-2****1****Programme:** M.E, - Industrial Safety Engineering

Objectives:

- To develop journal paper reading and understanding skill.
- To improve communication and presentation skill of students

Prerequisite:**GUIDELINES**

- The students are expected to make a presentation on the state of research on a particular topic based on current journal publications in that topic.
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- Students are encouraged to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

Total Periods: 30**Course Outcomes:**

The students will be able to

CO1 Read the journal paper thoroughly and identify the research gap

CO2 Present the state of research with good communication

CO3 Make use of various teaching aids for presentation.

CO4 Select the method, analysis and optimize the given problem for the given field applications

CO5 Suggest a solution for a proposed problem in an industrial safety engineering

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1								2		1
CO2	1	1								2		
CO3	1	1								2		1
CO4	1	1								2		1
CO5	1	1								2		

HOD/MECH

19IS2001 FIRE ENGINEERING AND EXPLOSION CONTROL L-T-P C
3-0-0 3

Programme: M.E, - Industrial Safety Engineering

- Objectives:**
- To provide an in depth knowledge about the science of fire.
 - To understand the causes and effects of fire.
 - To know the various fire prevention systems and protective equipments.
 - To understand the science of explosion and its prevention techniques.
 - To understand the various fire prevention techniques to be followed in a building.

Prerequisite:

PHYSICS AND CHEMISTRY OF FIRE 9

Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - theory of combustion and explosion – vapour clouds – flash fire – jet fires – pool fires – unconfined vapour cloud explosion, shock waves - auto-ignition – boiling liquid expanding vapour explosion – case studies – Flixborough, Mexico disaster, Pasedena Texas, Piper Alpha, Peterborough and Bombay Victoria dock ship explosions.

FIRE PREVENTION AND PROTECTION 9

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E – 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 notice-first aid for burns.

INDUSTRIAL FIRE PROTECTION SYSTEMS 9

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 – CO₂ 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-fire fighting systems.

BUILDING FIRE SAFETY 9

Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design - exists – width calculations - fire certificates – fire safety requirements for high rise buildings – snookers.

EXPLOSION PROTECTING SYSTEMS 9

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 (CO₂) and halons-hazards in LPG, ammonia (NH₃), sulphur dioxide (SO₃), chlorine (CL₂) etc.

Total Periods: 45

REFERENCES:

1. "Accident Prevention manual for industrial operations" N.S.C., Chicago, 1982.
2. "Davis Daniel et al, "Hand Book of fire technology"
3. "Fire Prevention and firefighting", Loss prevention Association, India.
4. Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London, 1986.
5. Dinko Tuhtar, "Fire and explosion protection"
6. Fire fighters hazardous materials reference book "Fire Prevention in Factories", an Nostrand Rein Hold, New York, 1991.
7. Gupta, R.S., "Hand Book of Fire Technology" Orient Longman, Bombay 1977.
8. Relevant Indian Acts and rules, Government of India.

Course Outcomes:

The students will be able to

- CO1. Familiarize about the basic concepts of fire and explosion science.
 CO2. Know the different source of ignition and their prevention techniques.
 CO3. Understand the operation of various types of firefighting equipments.
 CO4. Understand the causes and prevention of explosion
 CO5. Equip the students to effectively employ explosion protection techniques and their significances to suit the industrial requirement.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2					1	1	1		2		
CO2	1		3		2	1						1
CO3	2		2		2	1						1
CO4	1		2		2	2	1			1		1
CO5			2		2	1	1					1

HOD/MECH

19IS2002**COMPUTER AIDED HAZARD ANALYSIS****L-T-P****C****4-0-0****4****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- To provide knowledge on risk, hazard and their assessment techniques in Industry
 - To understand the principles of operation of various equipment for safety application
 - To know the consequences of fire, explosion and toxic release
 - To know the various software available for risk quantification
 - To conduct a risk assessment technique in Industries.

Prerequisite:**HAZARD, RISK ISSUES AND HAZARD ASSESSMENT****12**

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.

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.

COMPUTER AIDED INSTRUMENTS**12**

Applications of Advanced Equipments and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter(DSC), Thermo Gravimetric Analyser(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.

RISK ANALYSIS QUANTIFICATION AND SOFTWARES**12**

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)- Basic concepts of Reliability- Software on Risk analysis, CISCON, FETI, HAMGARS modules on Heat radiation, Pool fire, Jet, Explosion. Reliability softwares on FMEA for mechanical and electrical systems.

CONSEQUENCES ANALYSIS**12**

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 vapour release, liquid release, two phase release- Heat radiation effects, BLEVE, Pool fires and Jet fire- Gas/vapour dispersion- Explosion, UVCE and Flash fire, Explosion effects and confined explosion- Toxic effects- Plotting the damage distances on plot plant/layout.

CREDIBILITY OF RISK ASSESSMENT TECHNIQUES**12**

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- convey report, hazard assessment of non-nuclear installation- Rijnmond report, risk analysis of size potentially Hazardous Industrial objects- Rasmussen masses report, Reactor safety study of Nuclear power plant.

Total Periods: 60

REFERENCES:

1. Brown, D.B. System analysis and Design for safety, Prentice Hall, 1976.
2. Course Material Intensive Training Programme on Consequence Analysis, by Process Safety Centre, Indian Institute of Chemical Technology, Tarnaka and CLRI, Chennai.
3. Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process safety, AICHE 1992
4. Hazop and Hazom, by Trevor A Klett, Institute of Chemical Engineering.
5. ILO- Major Hazard control- A practical Manual, ILO, Geneva, 1988.
6. Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK 1990 (Vol.I, II and III)
7. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK
8. Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries, Centre for Chemical process safety.

Course Outcomes:

The students will be able to

- CO1 Make familiarizing of basic concepts in risk and hazard
- CO2 Understand the application of various instruments to bring safety in Industries
- CO3 Find solution for risk assessment studies through the use of software
- CO4 Utilize the different risk assessment techniques to quantify the risk
- CO5 Effectively employ the hazard analysis techniques in Industry and help in preventing the accidents in Industry

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2		2	2	1			2	1		
CO2	1		2	2	3		1		1	1		
CO3	2		3	2	2		1		1	2		1
CO4	3		3	2	2		1		1			1
CO5	2		3	2	2		1		2	1		1

HOD/MECH

19IS2003**ELECTRICAL SAFETY****L-T-P****C****3-0-0****3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- 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

Prerequisite:**CONCEPTS AND STATUTORY REQUIREMENTS****9**

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).

ELECTRICAL HAZARDS**9**

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-Safety in handling of war equipments-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.

PROTECTION SYSTEMS**9**

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 test-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.

SELECTION, INSTALLATION, OPERATION AND MAINTENANCE**9**

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 devices- safety in the use of portable tools-cabling and cable joints-preventive maintenance.

HAZARDOUS ZONES**9**

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.

Total Periods: 45

REFERENCES:

1. “Accident prevention manual for industrial operations”, N.S.C., Chicago, 1982.
2. Indian Electricity Act and Rules, Government of India.
3. Power Engineers – Handbook of TNEB, Chennai, 1989.
4. Martin Glov Electrostatic Hazards in powder handling, Research Studies Pvt. Ltd., England, 1988.
5. Fordham Cooper, W., “Electrical Safety Engineering” Butterworth and Company, London, 1986.

Course Outcomes:

The students will be able to

- CO1. Familiarize the basic concepts in electrical circuit.
 CO2. Understand the electrical hazards in Industries.
 CO3. Infer the operation of various protection systems from electrical hazards
 CO4. Select appropriate tools for operation and maintenance
 CO5. Recognize different hazardous zones in Industries.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				1	2					1	
CO2	2				2			1			2	1
CO3	1				2			1			1	1
CO4	1		3		3		1	2			2	1
CO5	3		2			1		1	2	2		

HOD/MECH

19IS2004**SAFETY IN ENGINEERING INDUSTRY****L-T-P****C****3-0-0****3****Programme:** M.E, - Industrial Safety Engineering**Objectives:**

- To know the safety rules and regulations, standards and codes
- To study various mechanical machines and their safety importance
- To understand the principles of machine guarding and operation of protective devices.
- To know the working principle of mechanical engineering processes such as metal forming and joining process and their safety risks.
- Developing the knowledge related to health and welfare measures in engineering industry

Prerequisite:**SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES 9**

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards.

PRINCIPLES OF MACHINE GUARDING 9

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearing-presses-forgehammer-flywheels-shafts-couplings-gears sprockets wheels and chains-pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

SAFETY IN WELDING AND GAS CUTTING 9

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.

SAFETY IN COLD FORMING AND HOT WORKING OF METALS 9

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.

SAFETY IN FINISHING, INSPECTION AND TESTING 9

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry- industrial waste disposal.

Total Periods: 45

REFERENCES

1. "Accident Prevention Manual" – NSC, Chicago, 1982.
2. "Occupational safety Manual" BHEL, Trichy, 1988.
3. "Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
4. "Safety in Industry" N.V. Krishnan Jaico Publishery House, 1996.
5. Indian Boiler acts and Regulations, Government of India.
6. Safety in the use of wood working machines, HMSO, UK 1992.
7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

Course Outcomes:

The students will be able to

- CO1 Gain knowledge in safety rules, standards and codes in various mechanical engineering processes
- CO2 Design machine guarding systems for various machines such as lathe, drilling, boring, milling etc.,
- CO3 Implement the safety concepts in welding, gas cutting, storage and handling of gas cylinders, metal forming processes etc.,
- CO4 Demonstrate their knowledge in testing and inspection as per rules in boilers, heat treatment operations etc.,
- CO5 Take preventive measures in health and welfare of workers' aspects in engineering industry.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2		1	2						
CO2	1	1	2		1	2		1		1	1	1
CO3			2		1							2
CO4	1		1		1	2	1				1	
CO5	1		1		1	2	2		1		1	

HOD/MECH

19IS2005**BEHAVIOR BASED SAFETY****L-T-P C****3-0-0 0****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- To learn about behavior based safety program, ABC model and BBS - case study.
 - To gain the knowledge about psychological aspects of safety and safety culture system.
 - To learn about main pillar of process safety management, theories of motivation and their application.
 - To gain knowledge on work men compensation act, direct and indirect cost of accidents.
 - To learn about element of disaster management plan, aid schemes mineral exploitation.

Prerequisite:**BBS - INTRODUCTION****9**

Behaviour based safety – overview – psychology of behaviour based management – focus on behaviour to manage the risk – leadership – behaviour safety programme for employees – measure safety programme – ABC model – BBS – case studies

HUMAN BEHAVIOUR CHARACTERS**9**

Organizational behaviour – human factors contributing to accident – psychological aspects of safety – safety culture system – individual difference – behaviour function of self and situation – perception of danger and acceptance of risks

SAFETY CULTURE**9**

PSM and Safety Culture – An Overview – Main Pillar of Process Safety Management – Organization – Monitoring – Reporting – theories of motivations and their application to safety – role of management, supervisors and safety department in motivation – ethical issues.

ACCIDENTS**9**

Types and severity of accidents – accident classification – accident – entitlement under workmen's Compensation Act – objectives and methodology of conducting accident investigation – Direct and Indirect costs of accident.

DISASTER MANAGEMENT**9**

Objectives of Disaster Management Plans – on-site & off-site emergencies' – levels of emergencies – Elements of Disaster Management Plan – Mutual –aid schemes – Mineral exploitation – material Handling Process – Manufacturing plant.

Total Periods: 45**REFERENCES:**

1. "Handbook of applied behavior Analysis", wayne W. Fisher, Calhleen C. Piazza, Hentry S. Roane – 2015.
2. "An introduction to production management techniques" (Wickens Christopher, Lee john).
3. Operation forecasting and modeling, CLYDE.B, STROPNG.M.S

Course Outcomes:

The students will be able to

- CO1. Understand about psychological of behavior based safety and focus on behavior to manage the risk.
 CO2. Obtain knowledge about organizational behavior, perception of danger and acceptance of risk.
 CO3. Know about PSM, safety culture and ethical issue.
 CO4. Understand about the types and severity of accidents and accident investigation.
 CO5. Analyze various disasters, on-site and off-site emergencies.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	1		1						
CO2	1	1	1	1	1							
CO3	1	1	2	1								
CO4	2	2	2	2		2						
CO5	1	2	2	2		2						2

HOD/MECH

19IS2011**INDUSTRIAL SAFETY LABORATORY II****L-T-P****C****0-0-4****2****Programme:** M.E, - Industrial Safety Engineering

Objectives:

- To provide opportunity to operate the equipment to acquire practical knowledge.
- To know the various First aid techniques and safety measures.
- To carry out experiments to find out the mixtures in exhaust gas.
- To assess the impact of sensitivity of chemicals on explosivity.
- To run the software to assess the consequence effects of major accidents.

Prerequisite:**FRICITION TEST**

Explosive materials like barium nitrate, white powder, amorces composition etc.

IMPACT TEST

Explosive materials like barium nitrate, white powder, amerce composition etc.

Burst strength test of packaging materials like paper bags, corrugated cartoons, wood etc.

Auto ignition temperature test.

EXHAUST GAS MEASUREMENT AND ANALYSISMeasurement of SO_x, NO_x, CO_x, hydrocarbons.**ENVIRONMENTAL PARAMETER MEASUREMENT**

Air sampling analysis

TRAINING IN USAGE AND SKILL DEVELOPMENT

Road safety signals and symbols

First-Aid training

STATIC CHARGE TESTING

On plastic, rubber, ferrous and non-ferrous materials.

ELECTRICAL SAFETY

Insulation resistance for motors and cables

Estimation of earth resistance

Earth continuity test

SOFTWARE USAGE

Dispersion modeling of various highly dangerous chemicals using ALOHA software

Total Periods: 45**Equipment's Required:**

- | | | | |
|----|-------------------------|---|-------------|
| 1. | Friction tester | : | 1No |
| 2. | Impact tester | : | 1No |
| 3. | Exhaust gas analyser | : | 1 No |
| 4. | High volume sampler | : | 1 No |
| 5. | First aid kid | : | 1No |
| 6. | Static charge tester | : | 1 No |
| 7. | Earth continuity tester | : | 1 No |
| 8. | Earth resistance meter | : | 1 No |
| 9. | Software | : | ALOHA,CAMEO |

Course Outcomes:

The students will be able to

- CO1 Know and run the various equipment's to bring out the safety environment in the industry.
 CO2 Measure the particulate matter and assess the impact of air pollution.
 CO3 Conduct experiments to find out various environmental parameters.
 CO4 Select suitable insulation material for electrical safety in industry
 CO5 Recognize the various problems with the use of software and hence to predict the real situations on major accidents

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1						1		1	2		
CO2	2	2		2	1	1	2			1		
CO3	1	1		1	1		2		1	1		2
CO4	1	1	1	1		2	2			1		
CO5	2		2			2					2	2

HOD/MECH

19IS2912**TECHNICAL SEMINAR-II****L-T-P****C****0-0-2****1****Programme:** M.E, - Industrial Safety Engineering**Objective:**

- To enrich the communication skills of the student through presentation of topics in recent advances in Industrial safety engineering/technology

Prerequisite:**GUIDELINES**

- The students are expected to make a presentation on the state of research on a particular topic based on current journal publications in that topic.
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- Students are encouraged to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

Total Periods: 30**Course Outcomes:**

The students will be able to

CO1. Develop skills to read, write, comprehend and present research papers.

CO2. Present the state of research with good communication

CO3. Make use of various teaching aids for presentation.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1									3		3
CO2	1					2	1					2
CO3										2		3

HOD/MECH

19IS3001 **RELIABILITY ENGINEERING** **L-T-P** **C**

3-0-0 **3**

Programme: M.E, - Industrial Safety Engineering

Objectives:

- To provide basic knowledge in failure rate and time between failures.
- To educate the students about the root cause analysis
- To know about the lifecycle cost and allocation.
- To provide knowledge on risk assessment techniques...

Prerequisite:

RELIABILITY CONCEPT **9**

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.

FAILURE DATA ANALYSIS **9**

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

RELIABILITY PREDICTION MODELS **9**

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.

RELIABILITY MANAGEMENT **9**

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

RISK ASSESSMENT **9**

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

Total Periods: 45

REFERENCES:

1. Srinath L.S, “Reliability Engineering”, Affiliated East-West Press Pvt Ltd, New Delhi, 1998.
2. Modarres, “Reliability and Risk analysis”, Maral Dekker Inc.1993.
3. John Davidson, “The Reliability of Mechanical system” published by the Institution of Mechanical Engineers, London, 1988.
4. Smith C.O. “Introduction to Reliability in Design”, McGraw Hill, London, 1976.

Course Outcomes:

The students will be able to

- CO1. Identify failure rate, analysis of failure and mean time between failures.
- CO2. Explain the different failure distribution and probability plotting techniques.
- CO3. Express the RBD approach and Fault Tree Analysis.
- CO4. Measure reliability allocations and non-parametric methods.
- CO5. Understand the difficulties during the risk assessment to reduce consequences.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		1	1							1
CO2	1	1		1	1	1						1
CO3	1	2		1	1			1			1	2
CO4	1	1		1	1	1						
CO5	1		2		2		1	1	1	1	2	2

HOD/MECH

19IS3912 INDUSTRIAL SAFETY ASSESSMENT-INTERNSHIP L-T-P C

3-0-0 2

Programme: M.E, - Industrial Safety Engineering

Objectives:

- To get an industrial exposure through various industrial environmental experiences and learning safety measures.
- To enhance the collective skills between theoretical knowledge and real time safety implementations.

Prerequisite:

GUIDELINES:

- The students are expected to undergo meaningful, practical and hands-on-work experiences related to safety measures through industrial training.
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the Student's training activities and maintain attendance also.
- Minimum duration of internships period is 3-4 weeks.
- Post internship program, Students should submit a report (within 50 pages) which contains brief observations of training (process, product, layout, safety measures and methods and give a presentation.
- Internship should be evaluated through final presentation with viva-voce exam.

Total Periods: 45

Course Outcomes:

The students will be able to

CO1. Classify the various types of production process

CO2. Identify hazards in process and categorize zone level

CO3. Evaluate risk assessment and eliminate hazard by engineering control.

CO4. Implement safety projects in the field applications

CO5. Draft a report and present the same.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1					2					2	2
CO2	3					3	1				2	2
CO3	2	2	2	3		3	1		1	1	2	1
CO4	1					2	1				2	1
CO5									1	3	2	2

HOD/MECH

19IS1101**PLANT LAYOUT AND MATERIALS HANDLING****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- Explain the basic principles in facilities planning and plant location
 - Interpret the basic principles in facility layout design decisions through proper analysis.
 - Illustrate and explain various techniques while designing a layout
 - Impart knowledge in line balancing concepts to implement improved system
 - Summarize the basic principles in designing, measuring and analyzing material flow to improve the efficiency of the system

Prerequisite:**PLANT LOCATION****9**

Plant location analysis – factors, costs, location decisions – Single facility location models, Multi facility location models - Mini-sum model - Mini-max model - Gravity location models, Brown & Gibbs model

FACILITIES LAYOUT

Facilities requirement, need for layout study – types of layout, Systematic layout planning, Relationship diagram, Designing the product layout – Line balancing - mixed model assembly line balancing.

LAYOUT DESIGN**9**

Designing the process layout - computerized layout planning procedure – ALDEP, CORELAP, CRAFT – Trends in computerized layout

GROUP TECHNOLOGY**9**

Group technology – OPTIZ classification system - Production Flow analysis (PFA), ROC (Rank Order Clustering)

MATERIALS HANDLING**9**

Principles, unit load concept, material handling system design, handling equipment types, selection and specification, containers and packaging.

Total Periods: 45**REFERENCES:**

1. James Apple, M.Plant layout and “Material Handling”, John Wiley, 1977.
2. Pannerselvam,R, “Production and Operations Management”, PHI,2017
3. Richard Francis.L. and John A.White, “Facilities Layout and location - an analytical approach”, PHI., 2002
4. Tompkins, J.A. and J.A.White, “Facilities planning”, John Wiley, 2010.

Course Outcomes:

The students will be able to

- CO1 Apply and evaluate appropriate location models for various facility types
- CO2 Effectively design and analyze various facility layouts
- CO3 Apply and analyze various computerized techniques while designing a layout.
- CO4 Effectively design and analyze a layout using grouping techniques.
- CO5 Implement smooth and cost effective system in the material handling process

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1	1		1							
CO2		2	2									
CO3			2		3	1					2	
CO4					2						2	
CO5			2									1

HOD/MECH

19IS1102 WORK SYSTEM DESIGN AND ERGONOMICS L-T-P C**3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- Impart knowledge in the area of method study
 - Train the students in stop watch time study
 - Summarize time standards using predetermined motion time systems.
 - Explain the anthropometry measures and its use in the work place design
 - Articulate the effect of environmental factors on human performance.

Prerequisite:**METHOD STUDY****9**

Work design and Productivity – Productivity measurement - Total work content, Developing methods – operation analysis, motion & micro motion study, graphic tools.

WORK MEASUREMENT**9**

Stop watch time study, Performance rating, allowances, standard data-machining times for basic operations, learning effect.

APPLIED WORK MEASUREMENT**9**

Methods time measurement (MTM), Introduction to MOST standards, Work sampling, organization and methods (O & M), Wage incentive plans.

PHYSICAL ERGONOMICS**9**

Physical work load and energy expenditure, Anthropometry – measures – design procedure, Work postures-sitting, standing - measurement – ergonomic implications. Design of displays and controls.

ENVIRONMENTAL FACTORS**9**

Sources & effects of Noise, Vibration, lighting, temperature, humidity & atmosphere. Measures for monitoring, control & mitigation.

Total Periods:45**REFERENCES:**

1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., Seventh Edition, 2002
2. Barnes, R.M. Motion and Time Study, John Wiley, 2002.
3. Introduction to work study, ILO, 3rd edition, Oxford & IBH publishing,2001
4. Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006.

Course Outcomes:

The students will be able to

- CO1 Understand the purpose of method study and its method.
- CO2 Understand the work measurement methods.
- CO3 Know about Work sampling
- CO4 Know the better working postures for better working.
- CO5 Know about the environmental factors which affect the working condition.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2	1	2						2	
CO2			2	1	3							
CO3			2	1	1						2	
CO4			3								2	1
CO5							3					2

HOD/MECH

19IS1103**DOCK SAFETY****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- To understand safety legislation related to dock activities in India.
 - To understand the causes and effects of accidents during dock activities.
 - To know the various material handling equipment and lifting appliances in dock.
 - To know the safe working on board the ship and storage in the yards.
 - To understand the safe operation of crane, portainers, lift trucks and container handling equipment.

Prerequisite:**HISTORY OF SAFETY LEGISLATION****9**

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.

WORKING ON BOARD THE SHIP**9**

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 forklift trucks-pay loaders etc. Working with electricity and electrical management – Storage – types, hazardous cargo.

LIFTING APPLIANCES**9**

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 toplift 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.

TRANSPORT EQUIPMENT**9**

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.

EMERGENCY ACTION PLAN AND DOCK WORKERS (SHW) REGULATIONS 1990 9

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

Total Periods: 45

REFERENCES:

1. "Dock Safety" Thane Belapur Industries Association, Mumbai.
2. Bindra SR "Course in Dock and Harbour Engineering"
3. Safety and Health in Dock work, IInd Edition, ILO, 1992.
4. Srinivasan "Harbour, Dock and Tunnel Engineering"
5. Taylor D.A., "Introduction to Marine Engineering".

Course Outcomes:

The students will be able to

CO1 Familiar of various operations carried out in a dock.

CO2 Know the different acts and rules for safe dock operations.

CO3 Understand the operation of various types of material handling equipments.

CO4 Response at the time of emergency in a dock.

CO5 Recognize the various problems associated with the use of lifting equipments and in the storage yards.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2					2	
CO2						2					2	
CO3	1	1	2	1	2	1			1			
CO4	1		1			1	2	1		3	2	
CO5	1		2			1	1	2		2		2

HOD/MECH

19IS1104**HUMAN FACTORS IN ENGINEERING****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- Studying the work procedure and understanding the relationships between the workers and working environments.
 - To study the applications of ergonomic principles and physiology of workers.
 - To know the concepts of personal protective equipment and its usages.
 - To create the knowledge in process and equipment design in safety aspects.

Prerequisite:**ERGONOMICS AND ANATOMY****9**

Introduction to ergonomics: The focus of ergonomics, ergonomics and its areas of application in the work system, a brief history of ergonomics, attempts to humanize work, modern ergonomics, future directions for ergonomics

Anatomy, Posture and Body Mechanics: Some basic body mechanics, anatomy of the spine and pelvis related to posture, posture stability and posture adaptation, low back pain, risk factors for musculoskeletal disorders in the workplace, behavioural aspects of posture, effectiveness and cost effectiveness, research directions

HUMAN BEHAVIOR**9**

Individual differences, Factors contributing to personality, Fitting the man to the job, Influence of difference on safety, Method of measuring characteristics, Accident Proneness. Motivation, Complexity of Motivation, Job satisfaction. Management theories of motivation, Job enrichment theory. Frustration and Conflicts, Reaction to frustration, Emotion and Frustration. Attitudes- Determination of attitudes, Changing attitudes Learning, Principles of Learning, Forgetting, Motivational requirements.

ANTHROPOMETRY AND WORK DESIGN FOR STANDING AND SEATED WORKS**9**

Designing for a population of users, percentile, sources of human variability, anthropometry and its uses in ergonomics, principals of applied anthropometry in ergonomics, application of anthropometry in design, design for everyone, anthropometry and personal space, effectiveness and cost effectiveness

Fundamental aspects of standing and sitting, an ergonomics approach to work station design, design for standing workers, design for seated workers, work surface design, visual display units, guidelines for design of static work, effectiveness and cost effectiveness, research directions

MAN - MACHINE SYSTEM AND REPETITIVE WORKS AND MANUAL HANDLING TASK**9**

Applications of human factors engineering, man as a sensor, man as information processor, man as controller – Man vs Machine.

Ergonomics interventions in Repetitive works, handle design, key board design- measures for preventing in work related musculoskeletal disorders (WMSDs), reduction and controlling, training Anatomy and biomechanics of manual handling, prevention of manual handling injuries in the work place, design of manual handling tasks, carrying, postural stability

HUMAN SKILL AND PERFORMANCE AND DISPLAY, CONTROLS AND VIRTUAL ENVIRONMENTS**9**

A general information-processing model of the users, cognitive system, problem solving, effectiveness. Principles for the design of visual displays- auditory displays- design of controls- combining displays and controls- virtual (synthetic) environments, research issues.

Total Periods: 45

REFERENCES:

1. Ergonomic design for organizational effectiveness, Michael O'Neill
2. Human factors in engineering and design, MARK S.SANDERS
3. Introduction to Ergonomics, R.S. Bridger, Taylor and Francis
4. The Ergonomics manual, Dan McLeod, Philip Jacobs and Nancy Larson

Course Outcomes:

The students will be able to

CO1 Knowledge in work procedure and applications in hazardous workplaces.

CO2 Design their own safety devices and equipment to reduce the accidents possibilities.

CO3 Incorporate human factors in design of Personal protective equipment.

CO4 Know the risk factors, guide lines for safe design of man machine systems considering human factors.

CO5 Utilize the skill in designing of visual displays and auditory displays

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		2		1			1				1
CO2	2					2		1	2	1	2	
CO3	1		3	1	2	1		1		1		1
CO4	1					1		1	2	2	2	
CO5	1		2		2	2		1		1		1

HOD/MECH

19IS1105 MAINTENANCE ENGINEERING AND MANAGEMENT L-T-P C**3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- Describe basic maintenance concepts
 - Extract optimum maintenance decisions
 - Illustrate the root cause for maintenance problems
 - Plan the spare parts for maintenance activity
 - Discover the losses and improve the Overall Equipment Effectiveness.

Prerequisite:**MAINTENANCE CONCEPT 9**

Maintenance definition – Maintenance objectives - Maintenance challenges – Tero Technology
Maintenance costs - Scope of maintenance department.

MAINTENANCE MODELS 9

Proactive/reactive maintenance - Maintenance policies – Imperfect maintenance Preventive /
breakdown maintenance – Optimal PM schedule and product characteristics – Inspection decisions
- Maximizing profit - Minimizing downtime – Replacement decisions.

MAINTENANCE QUALITY 9

Five zero concept – FMEA- FMECA – Root cause analysis – Repair time distribution – Analysis of
downtime – Maintainability prediction – Design for maintainability – Reliability Centered
Maintenance.

MAINTENANCE MANAGEMENT 9

Human factors – Maintenance staffing - Learning curves – Simulation – Optimal size of service
facility – Optimal repair effort – Spare parts management – Maintenance planning –
Maintenance scheduling.

TOTAL PRODUCTIVE MAINTENANCE 9

TPM Philosophy – Chronic and sporadic losses – Equipment defects – Six major losses – Overall
Equipment Effectiveness – TPM pillars – Autonomous maintenance.

Total Periods: 45**REFERENCES:**

1. Andrew K.S.Jardine & Albert H.C. Tsang, “Maintenance, Replacement and Reliability”, Taylor and Francis, 2006.
2. Bikas Badhury & Basu S K, “Tero Technology: Reliability Engineering and Maintenance Management”, Asian Books, 2003.
3. Mishra R C and Pathak K., “Maintenance Engineering and Management”, PHI,2012
4. Seichi Nakajima, “Total Productive Maintenance”, Productivity Press, 1993.

Course Outcomes:

The students will be able to

- CO1 Describe basic maintenance concepts.
- CO2 Extract maintenance policies for maximizing the profit
- CO3 Make a diagnosis of maintenance problems
- CO4 Improve uptime of machines by effective spare parts management
- CO5 Improve the overall Equipment Effectiveness

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1					2		1	1		2	
CO2	1				1	2		2	1	1	1	
CO3	1				1			1		1	1	1
CO4	1	1	2	2	1	1		1		1	2	
CO5	1				1	2		2	2	2	1	2

HOD/MECH

19IS1106**INDUSTRIAL VIBRATION AND NOISE CONTROL****L-T-P****C****3-0-0****3****Programme:** M.E, - Industrial Safety Engineering**Objectives:**

- 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.

BASICS OF VIBRATION

9

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear 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.

BASICS OF NOISE

9

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.

SOURCE OF NOISE AND CONTROL

9

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.

VIBRATION CONTROL

9

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.

EXPERIMENTAL METHODS IN VIBRATION ANALYSIS

9

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.

Total: 45 PERIODS**REFERENCES:**

1. Singiresu S. Rao - “Mechanical Vibrations” - Pearson Education, ISBN –81297-0179-0 -2004.
2. Kewal Pujara “Vibrations and Noise for Engineers, Dhanpat Rai & Sons, 1992.
3. Bernard Challen and Rodica Baranescu - “Diesel Engine Reference Book” – Second edition – SAE International - ISBN 0-7680-0403-9 – 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 J. Srinivas," Text book of Mechanical Vibrations",

Course Outcomes:

The students will be able to

- CO1 Understanding causes, source and types of vibrations
- CO2 Gaining knowledge in basic parameters and measurement standard of noise.
- CO3 Gaining knowledge in sources and measurement standards of noise.
- CO4 Discuss the control techniques for vibration
- CO5 Illustrate the vibration measuring experiments and selection of sensors.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3								
CO2	2	2	3	3								
CO3	2	2	3	3								
CO4	2	2	3	3								
CO5	2	2	3	3								

HOD/MECH

19IS2101**TRANSPORT SAFETY****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- 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.

Prerequisite:**TRANSPORTATION OF HAZARDOUS GOODS****9**

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.

ROAD TRANSPORT**8**

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 lists-motor vehicles act – motor vehicle insurance and surveys.

DRIVER AND SAFETY**9**

Driver safety programme – selection of drivers – driver training-tacho-graph-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 Haz mat codes

ROAD SAFETY**10**

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-track-warning methods-loading and unloading-moving cars-safety practices.

SHOP FLOOR AND REPAIR SHOP SAFETY**9**

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.

Total Periods: 45**REFERENCES:**

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

Course Outcomes:**The students will be able to**

CO1: Recognize various safety activities undertaken in transporting of hazardous goods

CO2: Understand the various symbols which are specific to the road safety and able to reduce the accidents occurred in the roads.

CO3: Know the driver safety awareness and trainings.

CO4: Apply for the safe transportation of hazardous goods, creating TREM card and safe loading and unloading procedure.

CO5: Apply the various safety measures on repair shop floor.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2	1	2	2		1		1	2	
CO2	1				1	3		2			2	3
CO3	1			2	1		1		1	2	2	
CO4	1	1	1	2	1		2	2		2		
CO5	1					2		1	2	2		2

HOD/MECH

19IS2102**FIREWORKS SAFETY****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- 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

Prerequisite:**PROPERTIES OF FIREWORKS CHEMICALS 9**

Fire properties – potassium nitrate (KN03), potassium chlorate (KClO3), barium nitrate (BaNO3), calcium nitrate (CaNO3), Sulphur (S), Phosphorous (P), antimony (Sb), Pyro Aluminum (Al) powder- Reactions-metal powders, Borax, ammonia (NH3) – Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.

STATIC CHARGE AND DUST 9

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-desirable, non-respirable-biological barriers-hazards-personal protective equipment-pollution prevention.

PROCESS SAFETY 8

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 – risk related fireworks industries.

MATERIAL HANDLING AND TRANSPORTATION: 10

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. 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

WASTE CONTROL AND USER SAFETY 9

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.

Total Periods: 45**REFERENCES:**

1. "Seminar on explosives", Dept.of of explosives.
2. J.A.Purkiss, "Fireworks-Fire Safety Engineering"
3. Bill of once, "Fireworks Safety manual"
4. "Goeff, "Dust Explosion prevention, Part 1"
5. A.Chelladurai, "Fireworks related accidents"
6. A.Chelladurai, "Fireworks principles and practice"
7. A.Chelladurai, "History of the fireworks in India" Brock, "History of fireworks"
8. K.N.Ghosh, "Principles of fireworks", H.Khatsuria, Sivakasi, 1987.
9. "Proceedings of National seminar on Fireworks Safety-1999", MSEC-1999

Course Outcomes:

The students will be able

- CO1 To gain knowledge of the chemical reactions of Fireworks chemicals
 CO2 To know safe manufacture of Fireworks items
 CO3 To improve process safety in fireworks industries
 CO4 To analyse safety measures applicable against static electricity
 CO5 To suggest safe practices for handling of fireworks in factories, transport and at user end.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		2			3	2					
CO2	1		2		1	3	1					2
CO3	1		2		1	2	1					1
CO4	1		1		2	2	1					1
CO5	1				2	2	1					

HOD/MECH

19IS2103**SAFETY IN CONSTRUCTION****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- 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

Prerequisite:**ACCIDENTS CAUSES AND MANAGEMENT SYSTEMS****9**

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 activates, preconstruction meeting - design aids for safe construction – permits to work – quality assurance in construction – compensation. Recording of accidents and safety measures – Education and training.

HAZARDS OF CONSTRUCTION AND PREVENTION**9**

Excavations, basement and wide excavation, trenches, shafts – scaffolding , types, causes of accidents, scaffold inspection checklist – false work – erection of structural frame work, dismantling – tunneling – 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.

WORKING AT HEIGHTS**9**

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.

CONSTRUCTION MACHINERY**9**

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.

SAFETY IN DEMOLITION WORK**9**

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.

TOTAL: 45 PERIODS**REFERENCES:**

1. Handbook of OSHA Construction safety and health Charles D. Reese and James V. Edison
2. Hudson, R., "Construction hazard and Safety Hand book, Butter Worth's, 1985.
3. Jnathea D.Sime, "Safety in the Build Environment", London, 1988.
4. V.J.Davies and K.Thomasin "Construction Safety Hand Book" Thomas Telford Ltd., London, 1990.

Course Outcomes:

The students will be able

- CO1 To identify the types and causes of accidents and designing aids for safe construction.
- CO2 To understand the hazards during construction of power plant, road works and high rise buildings.
- CO3 To understand the safety procedure for working at heights during construction.
- CO4 To have knowledge in selection, operation, inspection and testing of various construction machinery.
- CO5 To understand the standards and hazards in demolition work.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2				1		
CO2	3		3		1		3				2	
CO3	1		2		1		1				2	2
CO4	1		1		1		1				2	
CO5	2			2		2	2				1	

HOD/MECH

19IS2104**NUCLEAR ENGINEERING AND SAFETY****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- To know about nuclear energy and fission fusion process.
 - To gain knowledge in reactor types, design considerations and their operational problems.
 - To know the current status of India in nuclear energy.

Prerequisite:**INTRODUCTION****9**

Binding energy – fission process – radio activity – alpha, beta and gamma rays radioactive decay – decay schemes – effects of radiation – neutron interaction – cross section – reaction rate – neutron moderation – multiplication – scattering – collision – fast fission – resonance escape – thermal utilization – criticality.

REACTOR CONTROL**9**

Control requirements in design considerations – means of control – control and shut down rods – their operation and operational problems – control rod worth – control instrumentation and monitoring – online central data processing system.

REACTOR TYPES**9**

Boiling water reactors – radioactivity of steam system – direct cycle and dual cycle power plants-pressurized water reactors and pressurized heavy water reactors – fast breeder reactors and their role in power generation in the Indian context – conversion and breeding – doubling time – liquid metal coolants – nuclear power plants in India.

SAFETY OF NUCLEAR REACTORS**9**

Safety design principles – engineered safety features – site related factors – safety related systems – heat transport systems – reactor control and protection system – fire protection system – quality assurance in plant components – operational safety – safety regulation process – public awareness and emergency preparedness. Accident Case studies- Three Mile island and Chernobyl accident.

RADIATION CONTROL**9**

Radiation shielding – radiation dose – dose measurements – units of exposure – exposure limits – barriers for control of radioactivity release – control of radiation exposure to plant personnel – health physics surveillance – waste management and disposal practices – environmental releases.

TOTAL: 45 PERIODS**REFERENCES:**

1. “Loss prevention in the process Industries” Frank P.Lees Butterworth-Hein-UK, 1990.
2. Loffness, R.L., “Nuclear Power Plant” Van Nostrand Publications, 1979.
3. M.M.E.L.Wakil, “Nuclear Energy Conversion”, International Text Book Co.
4. M.M.E.L.Wakil, “Nuclear Power Engineering”, International Text Book Co.
5. R.L.Murray, “Introduction to Nuclear Engineering”, Prentice Hall.
6. Sri Ram K, “Basic Nuclear Engineering” Wiley Eastern Ltd., New Delhi, 1990.
7. Sterman U.S.”Thermal and Nuclear Power Stations”, MIR Publications, Moscow, 1986.

Course Outcomes:

The students will be able to

- CO1 Demonstrate nuclear fission and fusion process and their utilization.
- CO2 Explain the design considerations for reactor control.
- CO3 Understand types of reactors and their control requirements.
- CO4 Explain the safety design principles and safety regulation process for Nuclear reactors.
- CO5 Know about the controlling methods of radiation hazard.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		1		2						
CO2	1	1	3	1	1	1			1	1		1
CO3	1		1	1	1	2				1		2
CO4	1	1	2	2	1		1	1		1		
CO5	1				1		1			2	2	2

HOD/MECH

19IS2105**SAFETY IN TEXTILE INDUSTRY****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- 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

Prerequisite:**INTRODUCTION****9**

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.

TEXTILE HAZARDS I**9**

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

TEXTILE HAZARDS II**9**

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

HEALTH AND WELFARE**9**

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.

SAFETY STATUS**9**

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

TOTAL: 45 PERIODS**REFERENCES:**

1. 100 Textile fires – analysis, findings and recommendations LPA
2. Groover and Henry DS, “Hand book of textile testing and quality control”
3. “Quality tolerances for water for textile industry”, BIS
4. Shenai, V.A. “A technology of textile processing”, Vol.I, Textile Fibres
5. Little, A.H., “Water supplies and the treatment and disposal of effluent”
6. “Safety in Textile Industry” Thane Belapur Industries Association, Mumbai.

Course Outcomes:

The students will be able to

- CO1 Know about the overall picture about the textile industries and its operations.
- CO2 Understand the various concepts underlying in the processes involved in processing of fibers to yarn.
- CO3 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.
- CO4 Handle the various health and welfare activities as per the Factories act and could implement statutory requirements.
- CO5 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				1						2	
CO2	1		3	1	1							2
CO3	3			1	2	1					2	1
CO4	1			3	1		1	2		1		1
CO5	1					2	1			1		1

HOD/MECH

19IS2106**SAFETY IN MINES****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- 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.

Prerequisite:**OPENCAST MINES****9**

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.

UNDERGROUND MINES**9**

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

TUNNELLING**9**

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.

RISK ASSESSMENT**9**

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.

ACCIDENT ANALYSIS AND MANAGEMENT**9**

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.

TOTAL: 45 PERIODS**REFERENCES:**

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

Course Outcomes:

The students will be able to

- CO1 Familiar with the concept of safety aspects in the mining industries.
- CO2 Understanding the various types of mining activities like open case mines, underground mines and tunnel ling.
- CO3 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.
- CO4 Implement the techniques like risk assessment Disaster management and emergency preparedness with the proper knowledge on accident prevention.
- CO5 Effectively employ their knowledge on accident prevention in mines.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2			1	1	2	2			1		2
CO2	1		1	1	1	2	2			1		1
CO3	3		2	2	2	2	1					1
CO4	2			2	2			1	1			
CO5	1			2	1			2	2			

HOD/MECH

19IS2107**ENVIRONMENTAL IMPACT ASSESSMENT****L-T-P C****3-0-0 3**

Programme: M.E, - Industrial Safety Engineering

Objectives

- To provide the basic knowledge on the importance and regulatory requirement of EIA towards sustainable development
- To understand about various terminologies used and Assessment techniques used for evaluating Environmental Impact
- To familiarize the procedure for conducting environmental impact assessment (EIA) or strategic environmental assessment (SEA)

INTRODUCTION**9**

Environmental Impact Assessment (EIA) - Environmental Impact Statement (EIS)-Environmental Risk Assessment (ERA) - Legal and Regulatory aspects in India – Types and limitations of EIA - Terms of Reference in EIA- Issues in EIA - national – cross sectorial - social and cultural.

ENVIRONMENTAL ANALYSIS AND ASSESSMENT TECHNIQUES**9**

Components - screening - setting - analysis - prediction of impacts - mitigation. Matrices Networks – Checklists - Importance assessment techniques - cost benefit analysis - analysis of alternatives - methods for Prediction and assessment of impacts - air - water - soil - noise - biological - cultural - social - economic environments. Standards and guidelines for evaluation. Public Participation in environmental decision-making.

ENVIRONMENTAL IMPACT ASSESSMENT EVALUATION**9**

Trends in EIA practice and evaluation criteria - capacity building for quality assurance. Expert System in EIA - use of regulations and AQM.

ENVIRONMENTAL MANAGEMENT PLAN**9**

Document planning – collection and organization of relevant information - use of visual display materials – team writing - reminder checklists. Environmental monitoring - guidelines - policies - planning of monitoring programmes. Environmental Management Plan. Post project audit.

CASE STUDIES**9**

Case studies of EIA of developmental projects.

Total: 45 Hours**Reference(s)**

1. L W Canter, Environmental Impact Assessment, McGraw Hill, New York, 1996.
2. J Petts, Handbook of Environmental Impact Assessment, Vol. I and II, Blackwell Science, London, 1999.
3. The World Bank Group, Environmental Assessment Sourcebook, Vol. I, II and III, The World Bank, Washington, 1991.
4. G. Burke, B. R. Singh and L. Theodore, Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000
5. C. H. Eccleston, Environment Impact Statements: A Comprehensive Guide to Project and Strategic Planning, John Wiley & Sons, 2000.

6. <http://envfor.nic.in/>

7. www.cpcb.nic.in

Course Outcomes:

CO1: Recognize the basic things about Environmental Impact assessment and its relevance to the Legal and regulatory aspects.

CO2: Understand about the EIA and various components involved in maintaining the environment in a balanced way.

CO3: Demonstrate the operation, techniques, associated hazards, and safety measure of petroleum drilling

CO4: Analyze the contemporary issues and the ability to assess the impact on the community

CO5: Solve environmental Impact Assessments case studies

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1								1
CO2	2	1	1	1								1
CO3	2	1	1	2								1
CO4	2	1	1	2								1
CO5	2	1	2	2								1

HOD/MECH

19IS2108**SAFETY IN ON AND OFF SHORE DRILLING****L-T-P C****3-0-0 3**

Programme: M.E, - Industrial Safety Engineering

Objectives

- 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.

PETROLEUM PRODUCTS**10**

Petroleum and Petroleum products – Fuels- Petroleum solvents – Lubricating oils – Petroleum wax, greases – Miscellaneous product

ON AND OFF SHORE OPERATIONS**9**

On and off shore oil operation – Construction of Installation – Pipe line Construction – Maintenance and repair activities – Safety and associated hazards

DRILLING**9**

Drilling oil – Technique and equipment- Work position –Working condition – safety and associated hazards- lighting and its effects

EXTRACTION AND TRANSPORTATION**9**

Petroleum Extraction and transport by sea – Oil field products – Operation – Transport of crude by sea – Crude oil hazards.

STORAGE AND CLEANING**8**

Petroleum product storage and transport –Storage equipment –Precaution –Tank cleaning

Total: 45 Hours

Reference(s)

1. Encyclopedia of Occupational Health and Safety, Vol. II, International Labour Organisation, Geneva, 1985 & I.
2. Dr. Paul Bommer A Primer of Oilwell Drilling A Basic Text of Oil and Gas Drilling Seventh Edition published by The University of Texas Continuing Education petroleum extension service.2008
3. S. Tanaka, Y. Okada, Y. Ichikawa, Offshore Drilling and Production Equipment, in Civil Engineering, in Encyclopedia of Life Support Systems, Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK, 2005
4. Management and Engineering of Fire Safety and Loss Prevention: Onshore and offshore group & Taylor and francis,1991.
5. Ian Sutton, Off shore safety Management, Elsevier, 2007.
6. Huacan Fang, Menglan Duan, Offshore Oil and Gas Drilling Engineering and Equipment, Offshore Operation Facilities-2014, Pages 141–340

7. Majeed Abimbola, Dynamic safety risk analysis of offshore drilling, Journal of Loss Prevention in the Process Industries-2014, pg.no 74-85

Course Outcomes:

CO1: Explain and compare petroleum products

CO2: Describe on-shore and off-shore operation of petroleum extraction

CO3: Demonstrate the operation, techniques, associated hazards, and safety measure of petroleum drilling

CO4: Demonstrate the operation, techniques, associated hazards, and safety measure of petroleum extraction and transportation

CO5: Describe and choose storage equipment and associated hazards and safety precautions of petroleum extraction

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1								
CO2	1	1	2	1								
CO3	3	1	2	2								
CO4	2	1	2	2								
CO5	1	1	2	2								

HOD/MECH

19IS3101**SAFETY IN CHEMICAL INDUSTRIES****L-T-P C****3-0-0 3****Programme:**

M.E, - Industrial Safety Engineering

Objectives:

- 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 trained for emergency planning in a process industry.
- To get fundamental knowledge on safe storage of chemicals.

Prerequisite: Nil**SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN****9**

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 equipments, 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.

PLANT COMMISSIONING AND INSPECTION**9**

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.

PLANT OPERATIONS**9**

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.

PLANT MAINTENANCE, MODIFICATION AND EMERGENCY PLANNING**9**

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

STORAGES**9**

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, vapourizer, 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

TOTAL: 45 PERIODS

REFERENCES:

1. "Accident Prevention Manual for Industrial Operations" NSC, Chicago, 1982.
2. "Quantitative Risk Assessment in Chemical Process Industries" American Institute of Chemical Industries, Centre for Chemical Process safety.
3. Carbide of Calcium Rules, Government of India.
4. Fawcett, H.h. and Wood, "Safety and Accident Prevention in Chemical Operations" Wiley inters, Second Edition.
5. GREEN, A.E., "High Risk Safety Technology", John Wiley and Sons,. 1984.
6. Lees, F.P. "Loss Prevention in Process Industries" Butterworths and Company, 1996
7. Petroleum Act and Rules, Government of India.

Course Outcomes:

The students will be able to

- CO1 Familiar of safe design of equipment which are the essential to chemical industry and leads to design of entire process industries.
- CO2 Understand the design of pressure systems.
- CO3 Understand the problems and find innovative solutions while industries facing Problems in commissioning and maintenance stages.
- CO4 Prepare the emergency planning for chemical industry problems
- CO5 Create safe storage systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		3		1	1	1			1		1
CO2	1		3			2		1			1	
CO3	1	1	1	3				2				1
CO4	1		3	2	1	2	1				2	
CO5	1		2	1	1	1	2				2	

HOD/MECH

19IS3102 QUALITY ENGINEERING IN PRODUCTION SYSTEMS L-T-P C**3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- To know the quality engineering concepts in product design and development processes.
 - To know the control and process parameters' characteristics with feedback system.
 - To know the methods for production and diagnosis process improvements.
 - To have knowledge on ISO quality systems and types of quality tools such as failure and effect analysis.
 - To understand the six-sigma concepts and its implementation in engineering industries

Prerequisite:**INTRODUCTION TO QUALITY ENGINEERING AND LOSS FUNCTION 9**

Quality value and engineering- overall quality system-quality engineering in product design - quality engineering in design of production processes - quality engineering in production - quality engineering in service. Loss function Derivation – use-loss function for products/system- justification of improvements-loss function and inspection- quality evaluations and tolerances-N type, S type, L type

ON-LINE QUALITY CONTROL 9

On-line feedback quality control variable characteristics-control with measurement interval- one unit, multiple units-control systems for lot and batch production. On-line process parameter control variable characteristics- process parameter tolerances- feedback control systems-measurement error and process control parameters.

ON-LINE QUALITY CONTROL ATTRIBUTES AND METHODS FOR PROCESS IMPROVEMENTS 9

Checking intervals- frequency of process diagnosis. Production process improvement method-process diagnosis improvement method- process adjustment and recovery improvement methods.

QUALITY ENGINEERING AND TPM 9

Preventive maintenance schedules- PM schedules for functional characteristics- PM schedules for large scale systems. Quality tools–fault tree analysis, event tree analysis, failure mode and effect analysis. ISO quality systems.

SIX SIGMA AND ITS IMPLEMENTATION 9

Introduction- definition-methodology- impact of implementation of six sigma-DMAIC method-roles and responsibilities –leaders, champion, black belt, green belts. Do's and dont's - readiness of organization – planning-management role- six sigma tools – sustaining six sigma.

TOTAL: 45 PERIODS**REFERENCES:**

1. Brue G, "Six Sigma for Managers", Tata-McGraw Hill, New Delhi, Second reprint, 2002.
2. De Feo J A and Barnard W W, "Six Sigma: Breakthrough and Beyond", Tata McGraw-Hill, New Delhi, 2005.
3. Pyzdek T and Berger R W, "Quality Engineering Handbook", Tata-McGraw Hill, New Delhi, 1996
4. Taguchi G, Elsayed E A and Hsiang, T.C., "Quality Engineering in Production Systems", Mc-Graw- Hill Book company, Singapore, International Edition, 1989

Course Outcomes:

The students will be able to

- CO1 Understand the loss function derivation and quality engineering in product design and development processes.
- CO2 Develop their knowledge in online quality control systems and process control parameters.
- CO3 Improve the production and process diagnosis and production process.
- CO4 Gain knowledge in FMEA and ISO quality management systems.
- CO5 Improve knowledge in Six sigma concept and implementation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1							1		2
CO2	1				1	1		1	1			
CO3	1				1	2		1	2			
CO4	1	2	2	3	2	2	3	1		1		
CO5	1					3		1	1	2	2	2

HOD/MECH

19IS3103**DISASTER MANAGEMENT****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- 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.

Prerequisite:**INTRODUCTION****9**

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

ONSITE – OFFSITE EMERGENCY PLAN**10**

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-Softwares on emergency controls-Monitoring devices for detection of gases in the atmosphere-Right to know act

ENVIRONMENTAL ASSESSMENT**8**

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

DISASTER ASSESSMENT**8**

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

EMERGENCY MEASURES**10**

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

TOTAL: 45 PERIODS**REFERENCES:**

1. Introduction to Environmental Engineering and Science, Gilbert, M. Masters
2. Environmental Science, Miller, G. Tylor
3. Environmental Science sustaining the earth, G. Tylor, Miller
4. Principles of Environmental Science and Engineering, Bagad Vilas.
5. Principles of Environmental Science and Engineering, R. Sivakumar

Course Outcomes:

The students will be able to

- CO1 Explain the philosophy of disaster management and their control using the sophisticated technologies.
- CO2 Understand the emergency measures and how to control with monitoring devices.
- CO3 Understand earth quake disasters and nuclear wastes disposals.
- CO4 Gain knowledge in risk and disaster assessment processes including standards, and national policies.
- CO5 React during emergency situation and to apply the existing safety measures.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1			1	2	1				2		2
CO2	2		3		3	2	2			1		
CO3	1			2		2	2			1		1
CO4	2				2		1	1		1		2
CO5	1			3		2	2					3

HOD/MECH

19IS3104**OHSAS 18000, ISO 14000 AND ISO 9000****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- The course could provide the basic knowledge on Occupational Health and Safety Management System and Environmental Management System standards.
 - To inculcate the knowledge on various terms and terminologies which are used in the Occupational Health, Safety and Environmental Management systems.
 - 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.
 - To impart knowledge on ISO 9000 and ISO 18000 for Quality Management systems.

Prerequisite:**OHSAS STANDARD****9**

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, ISO 14001 and ISO 9001:2018 – Guidelines (18002:2000) for implementing OHSAS 18001.

OHSAS 18001 POLICY AND PLANNING**9**

Developing OH and S policy– Guidelines – Developments - procedure - Content of OH and S policy – General principle, strategy and planning, specific goals, compliance – methodology.

Planning – Guidelines, methodology steps developing action plan – Analysis and identify the priorities, objective and Targets, short term action plan, benefits and cost of each option, Development of action plan.

IMPLEMENTATION AND OPERATION, CHECKING AND REVIEW**9**

Guidelines for structure and Responsibilities, Top Management, middle level management, co-ordinator and employees - Developing procedures, identifying training needs, providing training, documentation of training, Training methodology consultation and communications.

Checking and Review; performance measurement and monitoring, Proactive and Reactive monitoring, measurement techniques, inspections, measuring equipment - Accidents reports, Process and procedures, recording, investigation corrective action and follow up - records and records management. Handling documentation, information, records.

ISO 14001**9**

EMS, ISO 14001, specifications, objectives, Environmental Policy, Guidelines and Principles (ISO 14004), clauses 4.1 to 4 5. Documentation requirements, 3 levels of documentation for a ISO 14000 based EMS, steps in ISO 14001. Implementation plan, Registration, Importance of ISO 14000 to the Management. Auditing ISO14000- General principles of Environmental Audit, Auditor, steps in audit, Audit plan

ISO 9000**9**

ISO 9000 – Introduction, Quality Management systems, ISO 9001:2008 model, Seven quality management principles, ISO 9001:2015 model, Ten quality management principles, Documentation, ISO 9001:2018 model, Companies transition from ISO 9001:2015 to ISO 9001:2018, Implementation , Certification, Auditing, Report.

TOTAL: 45 PERIODS

REFERENCES:

1. ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria and Sons, Delhi.
2. OHSAS 18001 Step by Step: A Practical Guide by Naeem Sadiq (Author), IT Governance Publishing (Editor)
3. Szymanski, M.; Tiwari, P. (2004). "ISO 14001 and the Reduction of Toxic Emissions". The Journal of Policy Reform.
4. Delmas, M. (2004). "Erratum to "Stakeholders and Competitive Advantage: The Case of ISO 14001"". Production and Operations Management.
5. Martin, R. (10 March 1998). "ISO 14001 Guidance Manual" (PDF). National Center for Environmental Decision-Making Research. Archived from the original(PDF) on 28 July 2011. Retrieved 29 November 2017.

Course Outcomes:

The students will be able to

- CO1 Remember the various standards which is meant mainly for maintaining the Health of the employee and for the maintenance of the Environment.
- CO2 Understand the basic 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.
- CO3 Provide the sufficient knowledge on various clauses and subsequent preparation of procedures and related documents and could be able to apply their knowledge in preparing the OHSAS manual for getting the certification from the external certifying agencies.
- CO4 Acquire knowledge on various standards and provide the skill in analyzing the various clauses and its suitability and applicability on the nature of organization.
- CO5 Understand the concept of ISO 9000

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1					3	3				3	
CO2	1						2	2		2	2	2
CO3	1					2	2			2	2	
CO4	1					3	2			2	3	2
CO5	1					2			2	2	3	3

HOD/MECH

Course Outcomes:

The students will be able to

- CO1 Apply various aspects of intelligence to diverse industrial situations
- CO2 Apply the fundamentals of Cognitive Psychology
- CO3 Implement the knowledge Engineering principles
- CO4 List out the applications of expert system to develop a simple expert system related to industrial safety Engineering.
- CO5 Apply neural network concepts in safety engineering discipline

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					2			1		1	2	
CO2	1				1						2	2
CO3	2				2	1						
CO4	1					1		2				
CO5	2				2			1		1		2

HOD/MECH

19IS3106**RESEARCH METHODOLOGY****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering**Objective:** To impart scientific, statistical and analytical knowledge for carrying out research work effectively.**Prerequisite:****INTRODUCTION TO RESEARCH****9**

The hallmarks of scientific research – Building blocks of science in research – Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques – Need for theoretical framework - Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing.

EXPERIMENTAL DESIGN**9**

Laboratory and the Field Experiment – Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales and measurements of variables. Developing scales – Rating scale and attitudinal scales – Validity testing of scales – Reliability concept in scales being developed – Stability Measures.

DATA COLLECTION METHODS**9**

Interviewing, Questionnaires, etc. Secondary sources of data collection. Guidelines for Questionnaire Design – Electronic Questionnaire Design and Surveys. Special Data Sources: Focus Groups, Static and Dynamic panels. Review of Advantages and Disadvantages of various Data-Collection Methods and their utility. Sampling Techniques – Probabilistic and non-probabilistic samples. Issues of Precision and Confidence in determining Sample Size. Hypothesis testing, Determination of Optimal sample size.

MULTIVARIATE STATISTICAL TECHNIQUES**9**

Data Analysis – Factor Analysis – Cluster Analysis – Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical (SPSS) Software Package in Research.

RESEARCH REPORT**9**

Purpose of the written report – Concept of audience – Basics of written reports. Integral parts of a report – Title of a report, Table of contents, Abstract, Synopsis, Introduction, Body of a report – Experimental, Results and Discussion – Recommendations and Implementation section – Conclusions and Scope for future work.

TOTAL : 45 PERIODS**REFERENCES:**

1. C.R.Kothari, Research Methodology, Wishva Prakashan, New Delhi, 2001.
2. Donald H.McBurney, Research Methods, Thomson Asia Pvt. Ltd. Singapore, 2002.
3. Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000
4. G.W.Ticehurst and A.J.Veal, Business Research Methods, Longman, 1999.
5. Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi, 1999.
6. Raymond-Alain Thie'tart, *et.al.*, Doing Management Research, Sage Publications, London, 1999
7. Uma Sekaran, Research Methods for Business, John Wiley and Sons Inc., New York, 2000

Course Outcomes:

The students will be able to

- CO1 Get knowledge about the different research techniques and research report.
- CO2 Apply the concept of reliability and stability measures.
- CO3 Analyze the collected data by using sampling techniques.
- CO4 Examine the data, factor, cluster by using SPSS software.
- CO5 Draft the research report.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2			3	2		1				1
CO2	2	2	2	1	2	1		1				
CO3	1	3				1		1	1			1
CO4	1	3		2	3	1			1			
CO5	2		2		2			1		2		2

HOD/MECH

19IS3107**BUSINESS DATA ANALYTICS****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- To understand the basics of business analytics and its life cycle.
 - To gain knowledge about fundamental business analytics.
 - To learn modeling for uncertainty and statistical inference.
 - To understand analytics using Hadoop and Map Reduce frameworks.
 - To acquire insight on other analytical frameworks.

Prerequisite:**OVERVIEW OF BUSINESS ANALYTICS****9**

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

ESSENTIALS OF BUSINESS ANALYTICS**9**

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

MODELING UNCERTAINTY AND STATISTICAL INFERENCE**9**

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK**9**

Introducing Hadoop– RDBMS versus Hadoop–Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop– Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

OTHER DATA ANALYTICAL FRAMEWORKS**9**

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

TOTAL: 45 PERIODS**REFERENCES:**

1. VigneshPrajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, UmeshaNayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

Course Outcomes:

The students will be able to

- CO1 Identify the real world business problems and model with analytical solutions
- CO2 Solve analytical problem with relevant mathematics background knowledge.
- CO3 Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- CO4 Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- CO5 Use open source frameworks for modeling and storing data.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2		1	2	1				1		1
CO2		2	1	1		1				1		
CO3		2	3	2								2
CO4		1	2	2	1	1						
CO5		1	1		1	1				2		2

HOD/MECH

19IS3108**OPTIMIZATION TECHNIQUES****L-T-P C****3-0-0 3****Programme:** M.E, - Industrial Safety Engineering

- Objectives:**
- To provide students the knowledge of optimization techniques and approaches. Formulate a real-world problem as a mathematical model and finding solutions
 - To enable the students to learn about revised simplex method and sensitivity analysis of LPP.
 - To solve networking problems like transportation, Assignment, Maximal flow , Minimum spanning tree and shortest path problems
 - To learn about Decision making under uncertainty and certainty conditions,
 - To learn various Queuing models

Prerequisite:**LINEAR PROGRAMMING****9**

Introduction to Operations Research – assumptions of Linear Programming Problems - Formulations of linear programming problem – Graphical method. Solutions to LPP using simplex algorithm – Two phase method – Big M method.

ADVANCES IN LINEAR PROGRAMMING**9**

Revised simplex method - primal dual relationships – Dual simplex algorithm – Sensitivity analysis –changes in RHS value – changes in Coefficient of constraint – Adding new constraint – Adding new variable.

NETWORK ANALYSIS**9**

Transportation problems : Northwest corner rule , Least cost method , Vogel's approximation method - stepping stone method - MODI method – Unbalanced transportation – Assignment problem – Hungarian algorithm – Travelling salesman problem – project management. Minimum spanning tree problem: prim's algorithm, Kruskal's algorithm - Shortest path problem: Dijkstra's algorithms, Floyds algorithm - maximal flow problem : Maximal-flow minimum-cut theorem - Maximal flow algorithm.

DECISION AND GAME THEORY**9**

Decision making under certainty – Decision making under risk – Decision making under uncertainty – Decision tree analysis –Introduction to MCDM; AHP. Game Theory – Two person zero sum games, pure and mixed strategies – Theory of dominance - Graphical Solution – Solving by LP.

QUEUING THEORY**9**

Queuing theory terminology – Single server, multi server- limited and unlimited queue capacity- limited and unlimited population.

TOTAL: 45 PERIODS

REFERENCES:

1. Hamdy A Taha, "Operations Research – An Introduction", Pearson, 2017.
2. Panneerselvam .R, "Operations Research", PHI, 2009 .
3. Philips, Ravindran and Solberg, "Operations Research principles and practices", John Wiley, 2007.
4. Ronald L Rardin, "Optimisation in Operations Research", Pearson, 2018.
5. Srinivasan.. G, "Operations Research Principles and Applications", PHI, 2017.

Course Outcomes:

The students will be able to

- CO1 Learned how to translate a real-world problem, given in words, into a mathematical Formulation
- CO2 Learn to apply simplex algorithm for LPP
- CO3 Build and solve Transportation Models and Assignment Models, maximal flow problem, minimum spanning tree and shortest path problem.
- CO4 Handle issues in Decision making under various conditions.
- CO5 Acquire capability in applying and using of queuing models for day today problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2		1								
CO2	1	2		1								
CO3	1	1	1	1								
CO4	2	2	2	2								
CO5	1	2	2	1								

HOD/MECH

19IS4101**ENGLISH FOR RESEARCH PAPER WRITING****L-T-P C****2-0-0 0****Programme:** M.E, - Industrial Safety Engineering

Outcomes:

At the end of the course, the students will be able to

- ✓ Demonstrate research writing skills both for research articles and thesis
- ✓ Frame suitable title and captions as sub-headings for articles and thesis
- ✓ Write each section in a research paper and thesis coherently
- ✓ Use language appropriately and proficiently for effective written communication
- ✓ Exhibit professional proof-reading skills to make the writing error free

Unit – I**6**

Planning and preparation, word order, breaking up long sentences, organising ideas into paragraphs and sentences, being concise and avoiding redundancy, ambiguity and vagueness

Unit – II**6**

Interpreting research findings, understanding and avoiding plagiarism, paraphrasing sections of a paper/abstract.

Unit- III**6**

Key skills to frame a title, to draft an abstract, to give an introduction

Unit – IV**6**

Skills required to organise review of literature, methods, results, discussion and conclusions

Unit – V**6**

Usage of appropriate phrases and key terms to make the writing effective - proof-reading to ensure error-free writing.

Text Books:

1. Adrian Wall work, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book, 1998.
3. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.
4. Goldbort R, Writing for Science, Yale University Press, 2006. (available on Google Books)

Total: 30 hours**REFERENCES**

Martin Cutts, Oxford Guide to Plain English, Oxford University Press, Second Edition, 2006

19IS4102**STRESS MANAGEMENT BY YOGA****L-T-P C****2-0-0 0****Programme:** M.E, - Industrial Safety Engineering**Outcomes:**

At the end of completion of this course, students will be able to

1. Develop physical and mental health thus improving social health
2. Increase immunity power of the body and prevent diseases
3. Accelerate memory power
4. Achieve the set goal with confidence and determination
5. Improve stability of mind, pleasing personality and work with awakened wisdom

UNIT – I**6**

Yoga-Introduction - Astanga Yoga- 8 parts-Yam and Niyam etc.- Do`s and Don`ts in life-Benefits of Yoga and sana- Yoga Exercise- and benefits- Pranayam Yoga- Nadisuthi, Practice and Spinal Sclearance Practice- Regularization of breathing techniques and its effects-Practice and kapalapathy practice.

UNIT – II**6**

Neuromuscular breathing exercise and Practice- Magarasa Yoga, 14 points Acupressure techniques and practice- Body relaxation practice and its benefits- Raja Yoga- 1. Agna –explanation and practice- Activation of Pituitary- Raja Yoga-2. Santhi Yoga-Practice-Balancing of physical and mental power.

UNIT – III**6**

Raja Yoga- 3. Sagasrathara yoga –practice- Activation of dormant brain cells-Kayakalpa-theory- Kayakalpa –practice-Yogic exercise to improve physical and mental health and practice-Asanas – explanation-Practice-benefits

UNIT –IV**6**

Sun namaskar- 12 poses-explanation and practice-Yoga –Asana-Padmasana, vajrasana, chakrasana, viruchasanaetc-Stress management with Yoga-Role of women and Yoga Equality, nonviolence, Humanity, Self- control- Food and yoga Aware of self-destructive habits Avoid fault thinking (thought analysis-Practice)-Yoga Free from ANGER (Neutralization of anger) & practice

UNIT – V**6**

Moralisation of Desire & practice- Punctuality-Love-Kindness-Compassion Eradication of worries-Practice -Personality development, positive thinking-Good characters to lead a moral life How to clear the polluted mind- Benefits of blessing- Five- fold culture –explanation- Karma Yoga Practice in Geetha- Sense of duty-Devotion, self- reliance, confidence, concentration, truthfulness, cleanliness.

Total: 30 hours**Reference Books**

1. ‘Yogic Asanas for Group Tarining-Part-I’ Janardan Swami YogabhyasiMandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

19IS5101**HAZARD AND OPERABILITY STUDIES****L-T-P C****1-0-0 1****Programme:** M.E, - Industrial Safety Engineering**Objective:**

- To provide knowledge on Hazard operability studies.
- To provide procedural knowledge on HAZOP.

Course Outcomes (COs)

The student will be able to

1. Understand the importance of HAZOP in process industries
2. Understand procedure for carrying out HAZOP.
3. Conduct HAZOP for the real time scenario

Course Contents

Introduction to HAZOP- history of HAZOP-intensions and deviations – causes and consequences- method outline - node identification- guide words-parameter deviation – deviation recognition- examples of deviations- different guide words and applicable examples- HAZOP recommendations- protection measures- additional measures- HAZOP and human errors – HAZOP limitations – HAZOP standards- HAZOP worksheet-detailed HAZOP - case study: process description, the plant, P&ID, carrying out HAZOP, an audit of HAZOP - assessment .

Total: 20 hours