ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY

(AUTONOMOUS)

(Anjugramam-Kanyakumari Main Road, Palkulam,Variyoor P.O.-629 401, K.K.Dist.)

Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai

Accredited with A+ Grade by NAAC

Department of Mechanical Engineering

(M.E Industrial Safety Engineering)

Curriculum & Syllabus

(*2024-2025 Admitted Students Onwards*)

Vision Statement of RCET

To be an academic institute of continuous excellence towards education and research in rural regime and provide service to nation in terms of nurturing potentially higher social, ethical and engineering companion graduands.

Mission Statement of RCET

To foster and promote technically competent graduands by imparting the state of art engineering education in rural regime.

To enunciate research assisted scientific learning by dissemination of knowledge towards science, agriculture, industry and national security.

Vision of the Department

To inculcate competence in the field of mechanical engineering for the students by providing quality education and learning opportunities to become ethically strong engineers for the development of society.

Mission of the Department

To provide fundamentals and technical skills in Mechanical Engineering through effective teaching-learning methodologies.

To provide an ambience for research through collaborations with industry and academia.

To inculcate the students' leadership quality through employability skills with ethical values.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1	Graduates will apply the knowledge of Mechanical Engineering concepts and innovative methods to solve real-world engineering problems.
PEO2	Graduates will have the required qualities for a successful carrier in Mechanical Engineering and related fields.
PEO3	Graduates will exhibit professional skills with ethical values and teamwork.

PROGRAMME OUTCOMES (POs)

PO #	**Programme Outcomes**
PO1	An ability to independently carry out research/investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the Industrial Safety Engineering. The mastery should be at a level higher than the requirements in the appropriate bachelor program

CREDIT INFO		
Sl.No	Category	Credits
1	**FOUNDATION COURSES (FC)**	4
2	**PROGRAM CORE COURSES (PCC)**	29
3	**RESEARCH METHODOLOGY AND IPR COURSES (RMC)**	2
4	**PROFESSIONAL ELECTIVES (PEC)**	15
5	**EMPLOYABILITY ENHANCEMENT COURSES (EEC)**	22
6	**OPEN ELECTIVES (OEC)**	3
Total Credits		75

FOUNDATION COURSES (FC)							
Sl.no	Course Code	Course Title	Course Type	L	T	P	Credit
1.	24IS101	Probability and Statistical Methods	FC	**4**	**0**	**0**	**4**
PROGRAM CORE COURSES (PCC)							
Sl.no	Course Code	Course Title	Course Type	L	T	P	Credit
1	24IS102	Principles of Safety Management	PCC	3	0	0	3
2.	24IS103	Environmental Safety	PCC	3	0	0	3
3.	24IS104	Occupational Health and Industrial Hygiene	PCC	3	0	0	3
4.	24IS105	Industrial Safety, Health and Environment Acts	PCC	3	0	0	3
5.	24IS201	Fire Engineering and Explosion Control	PCC	3	0	0	3
6.	24IS202	System Simulation and Hazard Analysis	PCC	4	0	0	4
7.	24IS203	Electrical Safety	PCC	3	0	0	3
8.	24IS204	Safety in Process Industries	PCC	3	0	0	3
9.	24IS231	Industrial Safety and Simulation Laboratory	PCC	0	0	2	1
10.	24IS301	Reliability Engineering	PCC	3	0	0	3
RESEARCH METHODOLOGY AND IPR COURSES (RMC)							
Sl.no	Course Code	Course Title	Course Type	L	T	P	Credit
1.	24RM101	Research Methodology and IPR	RMC	2	0	0	2
PROFESSIONAL ELECTIVES-1 (PEC)							
S.No	Course Code	Course Title	Course Type	L	T	P	Credit
1.	24IS111	Plant Layout and Material Handling	PEC	3	0	0	3
2.	24IS112	Work Study and Ergonomics	PEC	3	0	0	3
3.	24IS113	Human Factors in Engineering	PEC	3	0	0	3

4.	24IS114	Maintainability Engineering	PEC	3	0	0	3
5.	24IS115	Optimization Techniques	PEC	3	0	0	3
EMPLOYABILITY ENHANCEMENT COURSES (EEC)							
1.	24IS151	Safety Audit	EEC	0	0	2	1
2.	24IS251	Technical Seminar - I	EEC	0	0	2	1
3.	24IS351	Project Work I	EEC	0	0	12	6
4.	24IS352	Industrial Safety Assessment – Internship	EEC	0	0	4	2
5.	24IS451	Project Work II	EEC	0	0	24	12
PROFESSIONAL ELECTIVES-II & III (PEC)							
1.	24IS211	Transport Safety	PEC	3	0	0	3
2.	24IS212	Fireworks Safety	PEC	3	0	0	3
3.	24IS213	Safety in Construction	PEC	3	0	0	3
4.	24IS214	Nuclear Engineering and Safety	PEC	3	0	0	3
5.	24IS215	Safety in Textile Industry	PEC	3	0	0	3
6.	24IS216	Safety in Mines	PEC	3	0	0	3
7.	24IS217	Dock Safety	PEC	3	0	0	3
PROFESSIONAL ELECTIVES- IV & V (PEC)							
1.	24IS311	Safety in Engineering Industry	PEC	3	0	0	3
2.	24IS312	Quality Engineering in Production Systems	PEC	3	0	0	3
3.	24IS313	ISO 45001 and ISO 14000	PEC	3	0	0	3
4.	24IS314	Artificial Intelligence and Expert Systems	PEC	3	0	0	3
5.	24IS315	Design of Experiments	PEC	3	0	0	3
6.	24IS316	Data Analytics	PEC	3	0	0	3

OPEN ELECTIVES (OEC)

S.No	Course Code	Course Title	Course Type	L	T	P	Credit
1.	24CI 341	Integrated Water Resources Management	OEC	3	0	0	3
2.	24CI 342	Water, Sanitation and Health	OEC	3	0	0	3
3.	24CI 343	Principles of Sustainable Development	OEC	3	0	0	3
4.	24CI 344	Environmental Impact Assessment	OEC	3	0	0	3
5.	24CP 311	Block chain Technologies	OEC	3	0	0	3
6.	24CP 310	Deep Learning	OEC	3	0	0	3
7.	24CI 345	Sustainable Management	OEC	3	0	0	3
8.	24IS 341	Micro and Small Business Management	OEC	3	0	0	3
9.	24IS 343	Intellectual Property Rights	OEC	3	0	0	3
10.	24IS 344	Ethical Management	OEC	3	0	0	3
11.	24EM 341	IoT for Smart Systems	OEC	3	0	0	3
12.	24EM 342	Smart Grid	OEC	3	0	0	3
13.	24CP 301	Security Practices	OEC	3	0	0	3
14.	24CP 206	Cloud Computing Technologies	OEC	3	0	0	3
15.	24TE 344	Design Thinking	OEC	3	0	0	3
16.	24CP 341	Principles of Multimedia	OEC	3	0	0	3
17.	24CP 342	Big Data Analytics	OEC	3	0	0	3
18.	24CM 341	Medical Robotics	OEC	3	0	0	3

19.	24EM 343	Embedded Automation	OEC	3	0	0	3
20.	24CI 346	Environmental Sustainability	OEC	3	0	0	3
21.	24TE 345	Textile Reinforced Composites	OEC	3	0	0	3

 # denotes no credit

Recommended Courses for I SEMESTER

S. No.	Course Code	Course Title	Course Category	L	T	P	C
FOUNDATION COURSES							
1.	24IS101	Probability and Statistical Methods	FC	4	0	0	4
PROFESSIONAL CORE COURSES							
2.	24IS102	Principles of Safety Management	PCC	3	0	0	3
3.	24IS103	Environmental Safety	PCC	3	0	0	3
4.	24IS104	Occupational Health and Industrial Hygiene	PCC	3	0	0	3
5.	24IS105	Industrial Safety, Health and Environment Acts	PCC	3	0	0	3
RESEARCH METHODOLGY AND IPR COURSES							
6.	24RM101	Research Methodology and IPR	RMC	2	0	0	2
PROFESSIONAL ELECTIVE COURSES							
7.	24IS11X	Professional Elective - I	PEC	3	0	0	3
AUDIT COURSES							
8.	24AC2XX	Audit Course – I*	AC	2	0	0	0
EMPLOYABILITY ENHANCEMENT COURSES							
9.	24IS151	Safety Audit	EEC	0	0	2	1
		Total		**23**	**0**	**2**	**22**

Recommended Courses for II SEMESTER

S. No.	Course Code	Course Title	Course Category	L	T	P	C
PROFESSIONAL CORE COURSES							
1.	24IS201	Fire Engineering and Explosion	PCC	3	0	0	3
2.	24IS202	System Simulation and Hazard Analysis	PCC	4	0	0	4
3.	24IS203	Electrical Safety	PCC	3	0	0	3
4.	24IS204	Safety in Process Industries	PCC	3	0	0	3
5.	24IS231	Industrial Safety and Simulation Laboratory	PCC	0	0	2	1
PROFESSIONAL ELECTIVE COURSES							
6.	24IS21X	Professional Elective - II	PEC	3	0	0	3
7.	24IS21X	Professional Elective- III	PEC	3	0	0	3
AUDIT COURSES							
8.	24AC2XX	Audit Course - II*	AC	2	0	0	0
EMPLOYABILITY ENHANCEMENT COURSES							
9.	24IS251	Technical Seminar - I	EEC	0	0	2	1
		Total		**21**	**0**	**4**	**21**

Course Code:	24IS101	Course Title:	Probability and Statistical Methods
Credits:	4	L – T – P	4-0-0

Course objectives:

To impart knowledge on the

- To provide students with basic concepts of probability theory.
- To provide the most appropriate estimator of the parameter in statistical inference.
- To decide whether to accept or reject a specific value of a parameters.
- To avoid or at least to minimize, the problems of estimating the effects of the independent variable by experimental designs.
- To learn methods for analyzing time series data to extract meaningful statistical characteristic of data.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. Project based Learning
4. NPTEL and Other Videos
5. Smart Class Room
6. Flipped Class

UNIT I – Probability and Random Variables	[12 hours]
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.	
UNIT II – ESTIMATION THEORY	**[12 hours]**
Principle of least squares – Regression – Multiple and partial correlations – Estimation of parameters – Maximum likelihood estimates – Method of moments	

UNIT III – TESTING OF HYPOTHESIS	[12 hours]
Sampling distributions – Small and large samples and problems – Tests based on Normal, t - distribution, Chi - square, Goodness of fit and F – distributions	
UNIT IV – DESIGN OF EXPERIMENTS	**[12 hours]**
Analysis of variance – Completely randomized design – Randomized block design – Latin square design – 22 Factorial designs.	
UNIT V – TIME SERIES	**[12 hours]**
Characteristics and representation – Moving averages – Exponential smoothing – Auto regressive processes.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Apply the ideas of probability and random variables in solving engineering problems.	K3
CO2	Obtain the regression line using the method of least square and also to calculate the partial and multiple correlation coefficient for the given set of data points.	K3
CO3	Apply the various statistical methods in hypothesis testing for mean and variances of large and small samples.	K3
CO4	Apply various ANOVA techniques like CRD, RBD, and LSD etc. to obtain the variances.	K3
CO5	Apply various time series models to predict the forecast level using exponential smoothing techniques.	K3

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	3	2	2
CO2	3	2	2
CO3	2	2	2
CO4	2	1	2
CO5	3	2	2

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	**2**	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

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", 9th Edition, Cengage Learning, 2016.

Reference Books:

1. Gupta S.C. and KapoorV.K.," Fundamentals of MathematicalStatistics", 12th Edition, Sultan and Sons, New Delhi, 2020.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers, 9th Edition, Pearson Education, Asia, 2016.
3. Montgomery D.C and Johnson, L.A, "Forecasting and Time Series", 6th Edition, McGraw Hill, 1990.

Web Links and Video Lectures (E-Resources):

1. Statistical methods for scientist and Engineers : http://digimat.in/nptel/courses/video/111105077/L01.html
2. Introduction to probability and Statistics: http://acl.digimat.in/nptel/courses/video/111106112/L10.html
3. Probability and Statistics: http://acl.digimat.in/nptel/courses/video/111105090/L24.html

Suggested Skill Activities:

- Creating frequency tables.
- Creating dot plots.
- Reading dot plots & frequency tables.
- Create histograms.
- Read histograms.

Course Code:	24IS102	Course Title:	Principles of Safety Management
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

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

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Experiential Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – CONCEPTS AND TECHNIQUES	[9 hours]

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.

UNIT II – SAFETY AUDIT	[9 hours]

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.	
UNIT III – ACCIDENT INVESTIGATION AND REPORTING	**[9 hours]**
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.	
UNIT IV – SAFETY PERFORMANCE MONITORING	**[9 hours]**
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.	
UNIT V – SAFETY EDUCATION AND TRAINING	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	To understand the functions and activities of safety engineering department.	K2
CO2	To carry out a safety audit and prepare a report for the audit	K2
CO3	To plan an accident investigation report.	K3
CO4	To identify the safety performance of an organization from accident records.	K3
CO5	To identify various agencies, support institutions and government organizations involved in safety training and promotion.	K3

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	3	-	2
CO2	-	-	3
CO3	-	-	-
CO4	-	-	-
CO5	-	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	**2**	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. "Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 13th Edition 2009.
2. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey,. 3rd Edition 2000.

Reference Books:

1. Dan Petersen, "Techniques of Safety Management", McGraw-Hill Company, Tokyo, 1981.
2. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980
3. John Ridley, "Safety at Work", Butterworth and Co., London, 1983
4. Lees, F.P., "Loss Prevention in Process Industries" Butterworth publications, London, 2nd edition, 1990.
5. Relevant Indian Standards and Specifications, BIS, New Delhi.
6. "Safety and Good House Keeping", N.P.C., New Delhi, 1985.

Web Links and Video Lectures (E-Resources):

1. Industrial safety Engineering:

http://acl.digimat.in/nptel/courses/video/110105094/L51.html

2. Industrial safety Engineering

:http://acl.digimat.in/nptel/courses/video/110105094/L18.html

3. Introduction to safety and risk management

:https://www.youtube.com/watch?v=GeKBDv2lSfM

Suggested Skill Activities:

- Prepare a report about the risk of workplace incidents, injuries, and fatalities through data-driven measurements and improvements.
- Visit the people from different parts of the organization to make safety a shared responsibility and prepare the report.

Course Code:	24IS103	Course Title:	ENVIRONMENTAL SAFETY
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – AIR POLLUTION	[9 hours]
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.	
UNIT II – WATER POLLUTION	**[9 hours]**

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.

UNIT III – HAZARDOUS WASTE MANAGEMENT	**[9 hours]**
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 verification - hazards due to bio-process- dilution-standards and restrictions – recycling and reuse.	

UNIT IV – ENVIRONMENTAL MEASUREMENT AND CONTROL	**[9 hours]**
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	

UNIT V – POLLUTION CONTROL IN PROCESS INDUSTRIES	**[9 hours]**
Pollution control in process industries - cement, paper, petroleum-petroleum products-textile-tanneries-thermal power plants – dying and pigment industries - eco-friendly energy.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Illustrate and familiarize the basic concepts scope of environmental safety.	K2
CO2	Explain the standards of professional conduct that are published by professional safety organizations and/or certification bodies.	K2
CO3	Experiment the ways in which environmental health problems have arisen due to air and water pollution.	K3
CO4	Develop the role of hazardous waste management and use of critical thinking to identify and assess environmental health risks.	K3
CO5	Identify the concepts of measurement of emissions and design emission measurement devices.	K3

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	3	-	2
CO2	-	-	3
CO3	-	-	-
CO4	-	-	-
CO5	-	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

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

Reference Books:

1. M.J Hammer,., and M.J Hammer,., Jr., Water and Wastewater Technology, Pearson Prentice Hall, 2006
2. Rao, CS, "Environmental pollution engineering:, Wiley Eastern Limited, New Delhi, 1st January 2018.
3. S. P. Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 2006.
4. Varma and Braner, "Air pollution equipment", Springer Publishers, Second Edition.

Web Links and Video Lectures (E-Resources):

1. Safety, Health, Report: https://www.youtube.com/watch?v=KoDiuL6NqgQ

2. Health, Safety and Environmental Management in Petroleum and Offshore Engineering **:** http://digimat.in/nptel/courses/video/114106017/L06.html

Suggested Skill Activities:

1. Access the Wisdom of Local Community
2. Make Classroom Own Paint
3. Visit the Local Recycling Center
4. Write Found Object Short Stories
5. Collect Weather Data

Course Code:	24IS104	Course Title:	Occupational Health and Industrial Hygiene
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – PHYSICAL HAZARDS	[9 hours]

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.

UNIT II – CHEMICAL HAZARDS	[9 hours]
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	
UNIT III – BIOLOGICAL AND ERGONOMICAL HAZARDS	**[9 hours]**
Classification of Biohazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases – Covid SARS - Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design. Work Related Musculoskeletal Disorders –carpal tunnel syndrome CTS- Tendon pain-disorders of the neck- back injuries.	
UNIT IV – OCCUPATIONAL HEALTH AND TOXICOLOGY	**[9 hours]**
Concept and spectrum of health - functional units and activities of occupational health services, pre-employment and post-employment medical examinations - occupational related diseases, levels of prevention of diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax, 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.	
UNIT V – OCCUPATIONAL PHYSIOLOGY	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	To Compare the various physiological functions.	K2
CO2	To Demonstrate the various test methods for periodical monitoring of health.	K2
CO3	To Identify the functions and activities of Occupational health services.	K3
CO4	To identify various types of hazards arising out of physical, chemical and biological agents in a process.	K3
CO5	To identify notifiable occupational diseases arising out of Occupation and suggest methods for the prevention of such diseases.	K3

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	3	-	2
CO2	3	-	2
CO3	-	-	3
CO4	-	-	-
CO5	-	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	**Type of assessment**	**Max Marks**	**Reduced Marks**	**Total**	**Final marks**
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Benjamin O.Alli, Fundamental Principles of Occupational Health and Safety ILO 2008.
2. Danuta Koradecka, Handbook of Occupational Health and Safety, CRC, 2010.

Reference Books:

1. E.J. McCornick, and M. S Sanders, Human Factors in Engineering and Design, Tata McGraw-Hill, 1992.

2. Encyclopedia of "Occupational Health and Safety", Vol.I and II, published by International Labour Office, Geneva, 1985

3. Hand book of "Occupational Safety and Health", National Safety Council, Chicago, 2002.
4. Lawrence Slote , Handbook of occupational safety and health, Wiley, 2001.
5. Louis J. Di Berardinis, Handbook of occupational safety and health Wiley, 1999.
6. Interim guidance "COVID-19: Occupational health and safety for health workers", WHO & ILO,2021.

Web Links and Video Lectures (E-Resources):

1. Course Introduction SAFM 3423 Industrial Hygiene : https://www.youtube.com/watch?v=y4ZdUFhwfUU
2. Occupational Hazards : https://www.youtube.com/watch?v=OPqTjnqejnQ

Suggested Skill Activities:

- Prepare a report about the risk of industrial hazards, injuries, and fatalities through data-driven measurements and improvements.
- Visit nearby industry and learn about real world industrial hazards and prepare the report.

Course Code:	24IS105	Course Title:	Industrial Safety, Health and Environment Acts
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – FACTORIES ACT – 1948	[9 hours]

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. Forms, Registers and notices – Tamilnadu Safety Officer Rules 2005- with updated Amendments.

UNIT II – ENVIRONMENT ACT – 1986	[9 hours]

General powers of the central government, prevention, control and abatement of environmental pollution-Biomedical waste (Management and handling Rules, 1989-The noise pollution (Regulation and control) Rules, 2000-The Batteries (Management and Handling Rules) 2001- No Objection certificate from statutory authorities like pollution control board.

Air Act 1981 and Water Act 1974: Central and state boards for the prevention and control of air pollution-powers and functions of boards – prevention and control of air pollution and water pollution – fund – accounts and audit, penalties and procedures.	
UNIT III – MANUFACTURE, STORAGE AND IMPORT OF HAZARDOUS CHEMICAL RULES 1989 AND MAJOR ACCIDENT HAZARD CONTROL RULES AND AMENDMENT	**[9 hours]**
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. Major Accident Hazard Control Rules. Hazardous Wastes (management, handling and Transboundary Movement) Rules 2016.	
UNIT IV – OTHER ACTS AND RULES	**[9 hours]**
Indian Boiler (Amendments) Act 2007, static and mobile pressure vessel rules (SMPV), motor vehicle rules, The Mines and Minerals (Development & Regulation) Amendment Act, 2015, workman compensation act, rules – electricity act and rules – hazardous wastes (management, handling and transboundary) rules, 2008 - the building and other construction workers act 1996., Petroleum rules, Gas cylinder rules 2016, Explosives Act 1884 - Pesticides Act – E waste (management) rules 2016.	
UNIT V – INTERNATIONAL ACTS AND STANDARDS	**[9 hours]**
Occupational Safety and Health act of USA (The Williames - Steiger Act of 1970) – Health and safety work act (HASAWA 1974, UK) – ISO 14001 – ISO 45001 , European Safety and Health Legislations, American Petroleum Institute (API) Standards, Oil Industry Safety Directorate (OISD) Standards, National Fire Protection Association (NFPA) Standards, Atomic Energy Regulatory Board (AERB), American National Standards Institute(ANSI).	

Course outcomes:

On completion of the course, the student will have the ability :

CO1	To Explain out important legislations related to health, Safety and Environment.	K2
CO2	To show out requirements mentioned in factories act for the prevention of accidents.	K2
CO3	To develop the health and welfare provisions given in factories act.	K3
CO4	To organize the statutory requirements for an Industry on registration, license and its renewal.	K3
CO5	To compare onsite and offsite emergency plan.	K2

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	3		2
CO2	-		3
CO3	-		-
CO4	-		-
CO5	-		-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	**2**	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.

Reference Books:

1. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt.Ltd.,New Delhi.
2. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
3. The Indian boilers act 1923, Commercial Law Publishers (India) Pvt.Ltd., Allahabad.
4. The Mines Act 1952, Commercial Law Publishers (India) Pvt.Ltd., Allahabad.
5. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book Agency, Chennai.
6. Srinivasan S , "The Tamil Nadu Safety Officers Rules 2005" Madras Book Agency, Chennai, 28th Edition, 2017.

Web Links and Video Lectures (E-Resources):

1. Environmental Laws : https://www.youtube.com/watch?v=CTUOchYZG2k

2.Environment Protection Act 1986 : https://www.youtube.com/watch?app=desktop&v=ILeQ2E9yVDA

Suggested Skill Activities:

- Frame the safety rules for a medium scale industry as per Environmental Acts
- Prepare a report about the risk of industrial safety measures.
- Visit nearby industry and learn about real world industrial safety measures and prepare the report.

Course Code:	24RM101	Course Title:	RESEARCH METHODOLOGY AND IPR
Credits:	2	L – T – P	2-0-0

Course objectives:

To impart knowledge on the

Formulation of research problem, research methodology, ethics involved in doing research and importance of IPR protection.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – RESEARCH DESIGN	[9 hours]
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.	
UNIT II – DATA COLLECTION AND SOURCES	**[9 hours]**
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.	
UNIT III – DATA ANALYSIS AND REPORTING	**[9 hours]**
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.	
UNIT IV – INTELLECTUAL PROPERTY RIGHTS	**[9 hours]**

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.	
UNIT V – PATENTS	**[9 hours]**
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Formulate research problem	**K6**
CO2	Analyze literature review and find research gaps to finalize research objectives	**K4**
CO3	Identify the need of ethics in research	**K3**
CO4	Identify the need of IPR of research projects for economic growth and social benefits	**K3**
CO5	Apply their research work for patent through IPR	**K3**

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	3	-	2
CO2	-	-	3
CO3	-	-	-
CO4	-	-	-
CO5	-	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	20	30	20
Apply	30	40	40
Analyze	10	10	10
Evaluate	10	10	10
Create	20	-	10

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Ranjit Kumar, Research Methodology- A step by step guide for beginners, Pearson Education, Australia, 2005.
2. Ann M. Korner, Guide to Publishing a Scientific paper, Bioscript Press 2004.

Reference Books:

1. Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, New Delhi, 2004.
2. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students', Juta & Company, 1996.
3. Robert P. Merges, Peter S. Menell and Mark A. Lemley, "Intellectual Property in New Technological Age", Aspen Publishers, 2016.
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974.
7. Asimov , "Introduction to Design", Prentice Hall, 1962.

Web Links and Video Lectures (E-Resources):

1. Introduction to Intellectual Property :
https://www.youtube.com/watch?v=6BArSbZ2Gcw
2. Research Methodology and IPR Introduction :
https://www.youtube.com/watch?v=Ju4ov_ZBZn4

Suggested Skill Activities:

1. Participate Expert Session on Intellectual Property Rights
2. Participate Workshop on Research Methods Tools: Basics of R.
3. Innovation and Prototyping.

Course Code:	24IS151	Course Title:	Safety Audit
Credits:	1	L – T – P	0-0-2

Course objectives:

To impart knowledge on the

- To Inculcate the Industrial Safety Environment to the students
- To Explore the Human Capital Management and Hazardous System

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Experiential Learning

Laboratory Component: **[30 hours]**

Any 12 experiments have to be completed from the following list of experiments.

S.No.	Name of the Experiment
1	Safety Management systems.
2	Fire and Explosion prevention, protection and emergency management.
3	Work injury prevention.
4	Health hazards control.
5	Evaluating emergency plan.
6	First aid practices
7	Management of health and safety
8	Accidents and accident reporting
9	Asbestos
10	Contractors
11	Display screen equipment
12	Electrical safety
13	Emergency lighting
14	Environmental protection
15	Fire prevention and emergencies
16	Hazardous substances
17	Housekeeping and cleanliness
18	Information and communication
19	Kitchens, catering and food safety
20	Lifts and lifting equipment
21	Manual handling operations
22	Noise
23	Occupational health

24	Personal protective equipment
25	Plant rooms, machinery and equipment
26	Risk assessment requirements
27	Safety Policy
28	Safety signs and notices
29	Training
30	Use of vehicles / vehicle safety
31	Water services
32	Welfare provision
33	Working time
34	Work at heights
35	Workplace environment
36	Accident prevention
37	Identifying and correcting Regulatory Deficiencies
38	Improvement of Employee Morale
39	Identification and Elimination of Safety Hazards

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Explain the Labor turn over by existence of Safety Measures of an Employee.	K2
CO2	Identify the Fatigue Study it will lead to good production.	K3
CO3	Develop the Human Resource Management Practices.	K3
CO4	Choose the Health Consciousness to the Working Community.	K3
CO5	Demonstrate the Human Capital Management and Hazardous System	K2

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	-	3	-
CO2	-	2	2
CO3	-	-	-
CO4	-	2	-
CO5	-	-	2

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE) - Laboratory	Continuous Assessment	75	75	100	60
	Model Lab Exam	25	25		
End Semester Examination (ESE)	Lab Exam	100	15	40	40
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Course Code:	24IS201	Course Title:	Fire Engineering and Explosion Control
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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 equipment's.
- To understand the science of explosion and its prevention techniques.
- To understand the various fire prevention techniques to be followed in a building.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

6. Chalk and Talk
7. Blended Mode of Learning
8. NPTEL and Other Videos
9. Smart Class Room
10. Flipped Class

UNIT I – PHYSICS AND CHEMISTRY OF FIRE	[9 hours]

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.

UNIT II – FIRE PREVENTION AND PROTECTION	[9 hours]

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.	
UNIT III – INDUSTRIAL FIRE PROTECTION SYSTEMS	**[9 hours]**
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.	
UNIT IV – BUILDING FIRE SAFETY	**[9 hours]**
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	
UNIT V – EXPLOSION PROTECTING SYSTEMS	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	To Identify familiar about basic concepts of fire and explosion science.	K3
CO2	To show the different source of ignition and their prevention techniques.	K2
CO3	To choose the operation of various types of firefighting equipment's.	K3
CO4	To Explain the causes and prevention of explosion.	K2
CO5	To develop the students to effectively employ explosion protection techniques and their significances to suit the industrial requirement.	K3

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	-	3	-
CO2	-	-	3
CO3	-	-	-
CO4	-	-	-
CO5	-	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	**2**	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. "Accident Prevention manual for industrial operations" N.S.C., Chicago, 1982.
2. "Davis Daniel et al, "Hand Book of fire technology"

Reference Books:

1. "Fire Prevention and firefighting", Loss prevention Association, India.
2. Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London, 1986.
3. Dinko Tuhtar, "Fire and explosion protection"
4. Fire fighters hazardous materials reference book Fire Prevention in Factories", an Nostrand Rein Hold, New York, 1991.
5. Gupta, R.S., "Hand Book of Fire Technology" Orient Longman, Bombay 1977.
6. Relevant Indian Acts and rules, Government of India.

Web Links and Video Lectures (E-Resources):

1. HSE for offshore Engineers : https://ggsestc.digimat.in/nptel/courses/video/114106042/L54.html
2. Fire and Explosion Preventive Measures : https://www.youtube.com/watch?v=PJhjs3gtfEU

Suggested Skill Activities:

1. Identifying potential fire and explosion hazards within a specific environment and create a report.
2. Participate workshop on fire hazards and submit the certificate.

Course Code:	24IS202	Course Title:	System Simulation and Hazard Analysis
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – HAZARD, RISK ISSUES AND HAZARD ASSESSMENT	[9 hours]

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.

UNIT II – COMPUTER AIDED INSTRUMENTS	[9 hours]

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.
UNIT III – RISK ANALYSIS QUANTIFICATION AND SOFTWARES **[9 hours]**
Introduction to Discrete and Continuous Systems Simulation- 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.
UNIT IV – CONSEQUENCES ANALYSIS **[9 hours]**
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.
UNIT V – CREDIBILITY OF RISK ASSESSMENT TECHNIQUES **[9 hours]**
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

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Explain about the basic concepts in risk and hazard	K2
CO2	Develop the various instruments to bring safety in Industries	K3
CO3	Relate the risk assessment studies through the use of software	K2
CO4	Make use of a risk assessment technique to quantify the risk	K3

CO5	Illustrate hazard analysis techniques in Industry and helpful to prevent the accidents in Industry.	K2

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	-	3	-
CO2	-	-	-
CO3	-	-	-
CO4	-	-	-
CO5	-	-	2

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	**2**	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

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.

Reference Books:

1. Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process safety, AICHE 1992
2. Hazop and Hazom, by Trevor A Klett, Institute of Chemical Engineering.
3. ILO- Major Hazard control- A practical Manual, ILO, Geneva, 1988.
4. Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK 1990 (Vol.I, II and III)
5. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Common wealth Science Council, UK
6. Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries, Centre for Chemical process safety.

Web Links and Video Lectures (E-Resources):

1. Industrial Safety Engineering : http://acl.digimat.in/nptel/courses/video/110105094/L07.html

2. Project Management : http://acl.digimat.in/nptel/courses/video/110107430/L22.html

Suggested Skill Activities:

1. Assess the risk for a particular work area and create the report.
2. Create the report for safe Guards of a particular work area.
3. Document and present the risk and safety measures of a particular work area.

Course Code:	24IS203	Course Title:	ELECTRICAL SAFETY
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – CONCEPTS AND STATUTORY REQUIREMENTS	[9 hours]

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).

UNIT II – ELECTRICAL HAZARDS	[9 hours]
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.	
UNIT III – PROTECTION SYSTEMS	**[9 hours]**
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.	
UNIT IV – SELECTION, INSTALLATION, OPERATION AND MAINTENANCE	**[9 hours]**
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.	
UNIT V – HAZARDOUS ZONES	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Demonstrate the basic concepts in electrical circuit and hazards involved in it.	K2
CO2	Identify the electrical hazards in Industries.	K3
CO3	Develop the operation of various protection systems from electrical hazards	K3
CO4	Explain the operation and maintenance from electrical hazards	K2
CO5	Identify different hazardous zones in Industries	K3

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	-	3	-
CO2	-	-	2
CO3	-	-	-
CO4	-	-	-
CO5	-	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	**Type of assessment**	**Max Marks**	**Reduced Marks**	**Total**	**Final marks**
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. "Accident prevention manual for industrial operations", N.S.C., Chicago, 1982.
2. Indian Electricity Act and Rules, Government of India.

Reference Books:

1. Power Engineers – Handbook of TNEB, Chennai, 1989.
2. Martin Glov Electrostatic Hazards in powder handling, Research Studies Pvt. Ltd., England, 1988.
3. Fordham Cooper, W., "Electrical Safety Engineering" Butterworth and Company, London, 1986.

Web Links and Video Lectures (E-Resources):

1. Safety in Construction : https://hits.digimat.in/nptel/courses/video/105102206/L19.html
2. Earthing / Grounding: https://www.youtube.com/watch?v=lnM3J5auQBk

Suggested Skill Activities:

1. Assess the risk regarding electrical safety for a particular work area and create the report.
2. Create the report for safe Guards of a particular work area regarding electrical safety.
3. Document and present the risk and safety measures of a particular work area.

Course Code:	24IS204	Course Title:	SAFETY IN PROCESS INDUSTRIES
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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 recognise 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN	[9 hours]

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.

UNIT II – PLANT COMMISSIONING AND INSPECTION	[9 hours]

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.

UNIT III – PLANT OPERATIONS	**[9 hours]**
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	

UNIT IV – PLANT MAINTENANCE, MODIFICATION AND EMERGENCY PLANNING	**[9 hours]**
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	

UNIT V – STORAGES	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Show of safe design of equipment which are the essential to chemical industry and leads to design of entire process industries.	K2
CO2	Utilize the design of pressure systems	K3
CO3	Identify the problems and find innovative solutions while industries facing Problems in commissioning and maintenance stages.	K3
CO4	Develop the emergency planning for chemical industry problems	K3

CO5	Demonstrate safe storage systems.	K2

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	-	-	-
CO2	-	-	2
CO3	-	-	-
CO4	-	3	-
CO5	-	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	**2**	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).

- All the fifteen questions have to be answered.

Text Books:

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.

Reference Books:

1. Carbide of Calcium Rules, Government of India.
2. Fawcett, H.h. and Wood, "Safety and Accident Prevention in Chemical Operations" Wiley inters, Second Edition.
3. GREEN, A.E., "High Risk Safety Technology", John Wiley and Sons,. 1984.
4. Lees, F.P. "Loss Prevention in Process Industries" Butterworths and Company, 1996
5. Petroleum Act and Rules, Government of India.

Web Links and Video Lectures (E-Resources):

1. Safety Consideration in the Process of Industries : https://www.youtube.com/watch?v=OjHBgv7a1GU

2 Industrial Safety : https://www.youtube.com/watch?v=z8WuzF0Eeuk

Suggested Skill Activities:

1. Assess the risk regarding safety for a particular work area and create the report.
2. Create the report for safe Guards of a particular work area regarding safety.
3. Document and present the risk and safety measures of a particular work area.

Course Code:	24IS231	Course Title:	Industrial Safety and Simulation Laboratory
Credits:	1	L – T – P	0-0-2

Course objectives:

To impart knowledge on the

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

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

2. Experiential Learning

Laboratory Component: **[30 hours]**

Any 12 experiments have to be completed from the following list of experiments.

S.No.	Name of the Experiment
1	Study of Safety Software
2	Study of Emergency Kits ,First – aid, road safety signs and signals.
3	Measurement of sound pressure level in dB for Impact, continuous and intermittent sources at various networks, peak and average values.
4	Burst strength test of packaging materials like paper bags, corrugated cartoons, wood etc.
5	Auto ignition temperature test
6	Impact test on Explosive materials like gun powder, white powder, amerce composition etc.
7	Friction test on Explosive materials like gun powder, white powder, amerce composition etc.
8	Exhaust gas measurement and analysis
9	Environmental parameter measurement (dbt, wbt etc)
10	Static charge testing on plastic, rubber, ferrous and non-ferrous materials
11	Illumination testing - by lux meter and photo meter

12	Study of personal protective equipment
13	Study of Fire extinguishers and its operation.

Course outcomes:

On completion of the course, the student will have the ability to

CO1	Compare the various equipments to bring out the safety environment in the industry.	K2
CO2	Make use of various measure on particulate matter and assess the impact of air pollution.	K3
CO3	Construct experiments to find out various environmental parameters.	K3
CO4	Develop personal protective equipment in-dependently.	K3
CO5	Demonstrate the various problems with the use of software and hence to predict the real situations on major accidents.	K2

COs and POs Mapping:

COs	**POs**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	-	2	-	-	-	-
CO2	-	-	3	-	-	-
CO3	-	-	-	3	-	-
CO4	-	-	-	-	3	-
CO5	-	-	-	-	-	2

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	**Type of assessment**	**Max Marks**	**Reduced Marks**	**Total**	**Final marks**
Continuous Internal Examination (CIE) - Laboratory	Continuous Assessment	75	75	100	60
	Model Lab Exam	25	25		
End Semester Examination (ESE)	Lab Exam	100	15	40	40

Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Course Code:	24IS251	Course Title:	Technical Seminar - I
Credits:	1	L – T – P	0-0-2

Course objectives:

To impart knowledge on the

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

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Experiential Learning

[30hours]

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Develop skills to read, write, comprehend and present research papers.	K3
CO2	Demonstrate on recent areas of research in industrial safety engineering in two cycles.	K2
CO3	Explain the Depth of understanding, coverage, quality of presentation material (PPT/OHP)	K2
CO4	Develop the Communication skill.	K3
CO5	Explain the advances in Industrial safety engineering/technology	K2

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	**3**		**3**
CO2			
CO3			
CO4	**2**		2
CO5	**2**		2

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped,
Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE) - Laboratory	Continuous Assessment	75	75	100	60
	Model Lab Exam	25	25		
End Semester Examination (ESE)	Lab Exam	100	15	40	40
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

PROFESSIONAL ELECTIVES SEMESTER I, (ELECTIVE)

S. No.	Course Code	Course Title	Course Category	L	T	P	C
1.	24IS111	Plant Layout and Material Handling	PEC	3	0	0	3
2.	24IS112	Work Study and Ergonomics	PEC	3	0	0	3
3.	24IS113	Human Factors in Engineering	PEC	3	0	0	3
4.	24IS114	Maintainability Engineering	PEC	3	0	0	3
5.	24IS115	Optimization Techniques	PEC	3	0	0	3

Course Code:	24IS111	Course Title:	Plant Layout And Material Handling
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- To provide provided with the knowledge of the process of analyzing and developing information to produce a plant layout based on the locations and working conditions.
- To educate the students about the basic things of work conditions which includes ventilation, comfort, lighting and its effect based on various nature of work.
- To provide knowledge on effective and safe layout design of an industry.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. NPTEL and Other Videos
3. Smart Class Room
4. Field visit
5. Project based learning
6. Industrial Visit

UNIT I – Plant Location	[9 hours]

Selection of plant locations, territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal, further expansions
Safe location of chemical storages, LPG, LNG, CNG, acetylene, ammonia, chlorine, explosives and propellants

UNIT II – Plant Layout	[9 hours]

Safe layout, equipment layout, safety system, fire hydrant locations, fire service rooms, facilities for safe effluent disposal and treatment tanks, site considerations, approach roads, plant railway lines, security towers.
Safe layout for process industries, engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, metal powders manufacturing, fireworks and match works.

UNIT III – Working Conditions	[9 hours]

Principles of good ventilation, purpose, physiological and comfort level types, local and exhaust ventilation, hood and duct design, air conditioning, ventilation standards, application.
Purpose of lighting, types, advantages of good illumination, glare and its effect, lighting requirements for various work, standards- Housekeeping, principles of 5S.

UNIT IV- Manual Material Handling and Lifting Tackles	[9 hours]
Preventing common injuries, lifting by hand, team lifting and carrying, handling specific shape machines and other heavy objects – accessories for manual handling, hand tools, jacks, hand trucks, dollies and wheel barrows – storage of specific materials - problems with hazardous materials, liquids, solids – storage and handling of cryogenic liquids - shipping and receiving, stock picking, dock boards, machine and tools, steel strapping and sacking, glass and nails, pitch and glue, boxes and cartons and car loading – personal protection – ergonomic considerations. Fiber rope, types, strength and working load inspection, rope in use, rope in storage - wire rope, construction, design factors, deterioration causes, sheaves and drums, lubrication, overloading, rope fitting, inspection and replacement – slings, types, method of attachment, rated capacities, alloy chain slings, hooks and attachment, inspection	
UNIT V- Mechanical Material Handling	**[9 hours]**
Hoisting apparatus, types - cranes, types, design and construction, guards and limit devices, signals, operating rules, maintenance safety rules, inspection and inspection checklist – conveyors, precautions, types, applications. Powered industrial trucks, requirements, operating principles, operators selection and training and performance test, inspection and maintenance, electric trucks, gasoline operated trucks, LPG trucks –power elevators, types of drives, hoist way and machine room emergency procedure, requirements for the handicapped, types- Escalator, safety devices and brakes, moving walks – man lifts, construction, brakes, inspection.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Classify equipment requirements for a specific process and for various locations and working conditions.	K2
CO2	Develop an efficient material handling system.	K3
CO3	Identify the difficulties during the design and implementation of the plant layout.	K3
CO4	Plan about material handling requirements and methods	K3
CO5	Demonstrate the inspection and maintenance techniques.	K2

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	**2**	**-**	**-**
CO2	**-**	**-**	**-**
CO3	**2**	**-**	**-**
CO4	**-**	**-**	**-**
CO5	**-**	**-**	**-**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	60	100	40
	CIE – II	100			
	Skill Assessment – I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	**2**	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. ”Accident prevention manual for industrial operations” N.S.C., Chicago, 1982.

2. Alexandrov. M.P. ”Material handling equipment” Mir Publishers, Moscow, 1981

Reference Books:

1. APPLE M. JAMES “Plant layout and material handling”, 3rd edition, John Wiley and sons.

2. “Encyclopedia of occupational safety and health”, ILO Publication, 1985

Web Links and Video Lectures (E-Resources):

1. Plant Location**:** https://nptel.ac.in/courses/112107292
2. Plant Layout**:** https://archive.nptel.ac.in/courses/112/107/112107292/
3. Manual Material Handling and Lifting Tackles**:** https://archive.nptel.ac.in/courses/112/107/112107142/
4. Mechanical Material Handling**:** https://archive.nptel.ac.in/courses/112/107/112107143/

Suggested Skill Activities:

1. Which of the following is an important consideration in plant layout design?
2. Which of the following layout manufactures part in small or medium batches?
3. Which of the following material handling device is used in process layouts?
4. Which of the following represent a versatile means of handling different load configurations?
5. Which of the following layout produces identical products?
6. Inventories are usually kept stored on the floor near to the next scheduled machines.
7. Which of the following is carried out using product layout?

8. Which of the following system is typically characterized as fixed routes and flow rates?
9. Should an employer only consider lifting and lowering?
10. Is my employer required to provide training for manual handling?

Course Code:	24IS112	Course Title:	Work Study and Ergonomics
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. NPTEL and Other Videos
3. Smart Class Room
4. Field visit
5. Project based learning
6. Industrial Visit

UNIT I – Work Study	[9 hours]
Study of operations – work content – work procedure – breakdown – human factors – safety and method study – methods and movements at the workplace – substitution with latest devices – robotic concepts – applications in hazardous workplaces – productivity, quality and safety (PQS).	
UNIT II – Ergonomics	**[9 hours]**
Definition – applications of ergonomic principles in the shop floor – work benches – seating arrangements – layout of electrical panels- switch gears – principles of motion economy – location of controls – display locations – machine foundations – work platforms, fatigue, physical and mental strain – incidents of accident – physiology of workers.	
UNIT III – Personal Protection	**[9 hours]**
Concepts of personal protective equipment – types – selection of PPE – invisible protective barriers procurement, storage, inspection and testing – quality – standards – ergonomic considerations in personal protective equipment design.	
UNIT IV– Process and Equipment Design	**[9 hours]**

Process design – equipment – instrument – selection – concept modules – various machine tools – inbuilt safety – machine layout-machine guarding-safety devices and methods – selection, inspection, maintenance and safe usage – statutory provisions, operator training and supervision – hazards and prevention.

UNIT V- Man Machine Systems	**[9 hours]**
Job and personal risk factors – standards-selection and training-body size and posture-body dimension (static/dynamic) – adjustment range – penalties – guide lines for safe design and postures – evaluation and methods of reducing posture strain. Man-machine interface-controls -types of control-identification and selection-types of displays compatibility and stereotypes of important operations-fatigue and vigilance-measurement characteristics and strategies for enhanced performance.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Explain the work procedure in hazardous.	K2
CO2	Choose the applications in hazardous.	K3
CO3	Identify the Process of Personal protective System.	K3
CO4	Make use of human factors in design of Personal protective equipment.	K3
CO5	Explain the risk factors, guide lines for safe design of man machine systems considering human factors	K2

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	**-**	**2**	**2**
CO2	**2**	**-**	**-**
CO3	**-**	**2**	**2**
CO4	**2**	**-**	**2**
CO5	**-**	**2**	**-**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped,
Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	60	100	40
	CIE – II	100			
	Skill Assessment – I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. "Accident prevention manual for industrial operations" N.S.C., Chicago, 1982.
2. E.J.Mc Cormick and M.S.Sanders "Human Factors in Engineering and Design", TMH, New Delhi, 1982.

Reference Books:

1. "Work Study", National Productivity Council, New Delhi, 1995.
2. Hunter, Gomas, "Engineering Design for Safety", Mc Graw Hill Inc., 1992.
3. Introduction to Work Study", ILO, Oxford and IBH Publishing company, Bombay, 1991".
4. Mundel, Motion and Time Study, 6th Edition, Allied Publishers, Madras, 1989.
5. W.Benjamin Neibal Motion and Time Study, 9th Edition 1993.

Web Links and Video Lectures (E-Resources):

1. Ergonomics**:** https://nptel.ac.in/courses/107103004
2. Personal Protection**:** https://archive.nptel.ac.in/courses/112/104/112104222/
3. Process and Equipment Design**:** https://archive.nptel.ac.in/courses/107/103/107103004/
4. Man Machine Systems**:** https://archive.nptel.ac.in/courses/112/107/112107249/

Suggested Skill Activities:

1. Have any shop workers been previously diagnosed with any of the following CTD's: Carpal tunnel, Tendonitis, Tenosynovitis, De Quervain's disease, Trigger Finger, White finger, Hand Arm Segmental Vibration Syndrome, Muscle strains, or Back ailments?
2. Have there been any worker complaints concerning ergonomic issues?
3. Do employees perform high repetition tasks? (100 reps/hour to 2000 per/day)
4. Do the employee's routine tasks require repeated heavy lifting? (>20 lbs) or occasional heavy lifting (>50 lbs)
5. Are employees using awkwardly designed tools, which cause the worker to operate the tool outside of a neutral position for an extended period of time? (> 1 hour)
6. Do employees perform tasks with an awkward head or neck position for an extended period of time? (1 to 3 hours)
7. Do employees perform tasks that require awkward back angles to be held for extended periods of time (2 to 3 hours)? i.e…hunching, bending, or squatting
8. Do employees perform tasks with an awkward elbow angle for an extended period of time (1 to 3 hours) or with extreme force application?
9. Do employees perform tasks with an awkward elbow abduction angle for an extended period of time (1 to 3 hours) or with extreme force application?
10. Do employees perform tasks with an extreme reaching distance for an extended period of time (1 to 3 hours) or with extreme force application?

Course Code:	24IS113	Course Title:	Human Factors In Engineering
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. NPTEL and Other Videos
3. Smart Class Room
4. Field visit
5. Project based learning
6. Industrial Visit

UNIT I – Ergonomics and Anatomy	[9 hours]

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 sprine 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

UNIT II – Human Behavior	[9 hours]

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.	
UNIT III – Anthropometry And Work Design For Standing and Seated Works	**[9 hours]**
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.	
UNIT IV– Man - Machine System And Repetitive Works and Manual Handling Task	**[9 hours]**
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.	
UNIT V- Human Skill and Performance and Display, Controls And Virtual Environments	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Explain the knowledge in work procedure and applications in hazardous workplaces.	K2
CO2	Develop their own safety devices and equipment to reduce the accidents possibilities.	K3
CO3	Organize human factors in design of Personal protective equipment.	K3
CO4	Identify the risk factors, guide lines for safe design of man machine systems considering human factors.	K3
CO5	Explain the knowledge in Display, Controls And Virtual Environments	K2

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	-	-	-
CO2	-	-	**3**
CO3	**2**	-	-
CO4	-	-	-
CO5	-	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	60	100	40
	CIE – II	100			
	Skill Assessment – I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	**2**	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Ergonomic design for organizational effectiveness, Michael O'Neill 1st Edition 1998.
2. Introduction to Ergonomics, R.S. Bridger, Taylor and Francis 3rd Edition 2008.

Reference Books:

1. Human factors in engineering and design, MARK S.SANDERS 1992.
2. The Ergonomics manual, Dan Mc Leod, Philip Jacobs and Nancy Larson

Web Links and Video Lectures (E-Resources):

1. Ergonomics and Anatomy**:** https://archive.nptel.ac.in/courses/112/104/112104222/
2. Anthropometry**:** https://archive.nptel.ac.in/courses/107/103/107103004/
3. Man Machine Systems**:** https://archive.nptel.ac.in/courses/112/107/112107249/
4. Human Skill Performance and Display**:** https://archive.nptel.ac.in/courses/107/103/107103004/

Suggested Skill Activities:

1. What is the study of physical dimensions and abilities of the human body called?
2. Why is training an important element in the ergonomics process?
3. What are the benefits of ergonomics?
4. Why is anthropometry important in various fields such as ergonomics, nutrition assessment, and healthcare?
5. How are anthropometric measurements used to assess growth and nutritional status?
6. What are the different methods used in anthropometry to measure body dimensions accurately?
7. What are the Characteristics of a Man-Machine System?

Course Code:	24IS114	Course Title:	Maintainability Engineering
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- To enable the students know about the basic concept of maintainability engineering.
- To impart knowledge on various maintenance models, maintenance policies and replacement model of various equipment.
- To provide knowledge on logistics for the effective utilization of existing resources and facilities availability of spares parts.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. NPTEL and Other Videos
3. Smart Class Room
4. Field visit
5. Project based learning
6. Industrial Visit

UNIT I – Maintenance Concept	[6 hours]
Maintenance definition – Need for maintenance – Maintenance objectives and challenges – Tero technology – Maintenance costs - Scope of maintenance department.	
UNIT II – Maintenance Models	**[12 hours]**
Proactive/Reactive maintenance – Imperfect maintenance – Maintenance policies – PM versus b/d maintenance – PM schedule and product characteristics – Inspection models-Optimizing profit/downtime – Replacement decisions.	
UNIT III – Maintenance Logistics	**[11 hours]**
Human factors – Maintenance staffing: Learning curves – Simulation – Maintenance resource requirements: Optimal size of service facility – Optimal repair effort – Maintenance planning and scheduling – Spare parts planning.	

UNIT IV – Maintenance Quality	[8 hours]
Maintenance excellence – Five Zero concept –FMECA –Root cause analysis – System effectiveness – Design for maintainability – Reliability Centered Maintenance.	
UNIT V- Total Productive Maintenance	**[8 hours]**
TPM features – Chronic and sporadic losses – Equipment defects – Six major losses – Overall Equipment Effectiveness – TPM pillars – Autonomous maintenance – TPM implementation	

Course outcomes: On completion of the course, the student will have the ability to:

CO1	Explain the various terms and terminologies about the maintenance concept.	K2
CO2	Identify the various maintenance models in various services.	K3
CO3	Identify the logistics meant for the execution of various services.	K3
CO4	Identify the various terms and terminologies about the maintenance quality.	K3
CO5	Demonstrate their knowledge in areas where the down time, over replacement are existing and could lead to improve the productivity and quality.	K2

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	**-**	**-**	**-**
CO2	**-**	**-**	**3**
CO3	**-**	**2**	**-**
CO4	**-**	**-**	3
CO5	**-**	**2**	**-**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped,
Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	60	100	40
	CIE – II	100			
	Skill Assessment – I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Andrew K.S.Jardine & Albert H.C.Tsang, "Maintenance, Replacement and Reliability", Taylor and Francis, 2006.

Reference Books:

1. Bikas Badhury & S.K.Basu, "Tero Technology: Reliability Engineering and Maintenance Management", Asian Books, 2003.

2. Seichi Nakajima, "Total Productive Maintenance", Productivity Press, 1993.

Web Links and Video Lectures (E-Resources):

1. Maintenance Models**:** https://nptel.ac.in/courses/112107292
2. Maintenance Logistics: https://nptel.ac.in/courses/112107143
3. Total Productive Maintenance: https://nptel.ac.in/courses/112107142

Suggested Skill Activities:

1. What is the purpose of a squirrel cage?
2. What is the primary maintenance model currently employed by the organization?
3. How is the effectiveness of the current maintenance model measured?
4. Are there any specific challenges or limitations associated with the current maintenance model?
5. How does the current maintenance model align with industry best practices and standards?
6. What is the primary goal of maintenance logistics in a supply chain?
7. Did the maintenance team respond promptly to your requests or issues?
8. Were there any recurring maintenance problems that were not adequately addressed?
9. Were there any unexpected delays or disruptions in the maintenance work? If yes, how were they handled?
10. What does routine preventive maintenance tasks in Autonomous Maintenance (AM) include?
11. What is the role of autonomous maintenance in Total Productive Maintenance (TPM)?

Course Code:	24IS115	Course Title:	Optimization Techniques
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- To understand the non-linear problem.
- To know about multi-objective problem.
- To create awareness of Meta heuristic algorithms.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. NPTEL and Other Videos
3. Smart Class Room
4. Field visit
5. Project based learning
6. Industrial Visit

UNIT I – Introduction	[5 hours]
Classification of optimization problems, concepts of design vector, Design constraints, constrains surface, objective function surface and multi-level optimization, parametric linear programming.	
UNIT II – Decision Analysis	**[10 hours]**
Decision Trees, Utility theory, Game theory, Multi Objective Optimization, MCDM- Goal Programming, Analytic Hierarchy process, ANP	
UNIT III – Non-Linear Optimization	**[15 hours]**
Unconstrained one variable and multi variable optimization, KKT Conditions, Constrained optimization, Quadratic programming, Convex programming, Separable programming, Geometric programming, Non-Convex programming	
UNIT IV– Non-Traditional Optimization -1	**[10 hours]**

Classes P and NP, Polynomial time reductions, Introduction to NP- Hard problems, Overview of Genetic algorithms, Simulated Annealing, neural network based optimization.	
UNIT V– Non-Traditional Optimization -2	**[5 hours]**
Particle Swarm optimization, Ant Colony Optimization, Optimization of Fuzzy Systems.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Explain the familiarity with some of the well-known optimization techniques and their applicability in a real setting.	K2
CO2	Utilize the process of decision making.	K3
CO3	Develop awareness on the usefulness and limitation of optimization.	K3
CO4	Develop the concepts of polynomial time and nondeterministic polynomial time	K3
CO5	Explain the concepts of Optimization techniques.	K2

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1		**2**	
CO2	**2**		
CO3			2
CO4		**2**	
CO5		**2**	

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped,
Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	60	100	40
	CIE – II	100			
	Skill Assessment – I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Christos H. Papadimitriou, Kenneth Steiglitz, Combinatorial Optimization, PHI 2006

2. Fredrick S.Hillier and G.J.Liberman, "Introduction to Operations Research", McGraw Hill Inc. 1995.

Reference Books:

1. Kalymanoy Deb, "Optimization for Engineering Design",PHI,2003

2. Ravindran – Phillips –Solberg, "Operations Research – Principles and Practice", John Wiley India, 2006.

3. Singiresu S.Rao, "Engineering optimization – Theory and practices", John Wiley and Sons, 1996.

Web Links and Video Lectures (E-Resources):

1. Decision Analysis**:** https://archive.nptel.ac.in/courses/110/104/110104094/
2. Geometric Programming**:** https://archive.nptel.ac.in/courses/111/107/111107104/
3. Genetic algorithms**:** https://nptel.ac.in/courses/112105235
4. Particle Swarm optimization**:** https://nptel.ac.in/courses/112103301

Suggested Skill Activities:

1. How do artificial ants and real ants differ in the context of ACO?
2. Discuss the Role of Constraints in Optimization Problems
3. Describe Linear Programming and its Applications
4. Provide an Overview of Evolutionary Algorithms for Optimization
5. What are the key components of a PSO algorithm?
6. What are some common variations or enhancements to traditional PSO algorithms
7. What are some applications where artificial ants and local search algorithms are commonly used for optimization tasks?
8. Describe a common approach employed in Derivative-Free Optimization when applicable.
9. What are the core steps in a typical genetic algorithm cycle?
10. How does optimization contribute to the interpretability and accuracy of fuzzy systems?

PROFESSIONAL ELECTIVES SEMESTER II, (ELECTIVE II & III)

S. No.	Course Code	Course Title	Course Category	L	T	P	C
1.	24IS211	Transport Safety	PEC	3	0	0	3
2.	24IS212	Fireworks Safety	PEC	3	0	0	3
3.	24IS213	Safety in Construction	PEC	3	0	0	3
4.	24IS214	Nuclear Engineering and Safety	PEC	3	0	0	3
5.	24IS215	Safety in Textile Industry	PEC	3	0	0	3
6.	24IS216	Safety in Mines	PEC	3	0	0	3
7.	24IS217	Dock Safety	PEC	3	0	0	3

Course Code:	24IS211	Course Title:	Transport Safety
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. NPTEL and Other Videos
3. Smart Class Room
4. Field visit
5. Project based learning
6. Industrial Visit

UNIT I –Transportation of Hazardous Goods	[9 hours]
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.	
UNIT II – Road Transport	**[9 hours]**
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.	
UNIT III – Driver and Safety	**[9 hours]**
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

UNIT IV- Road Safety	**[9 hours]**
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.	

UNIT V- Shop Floor and Repair Shop Safety	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Identify the various safety activities undertaken in transporting of hazardous goods	K3
CO2	Demonstrate the operation and maintenance of motor trucks.	K2
CO3	Explain the various safety programs for drivers	K2
CO4	Explain the various symbols which are specific to the road safety and able to reduce the accidents occurred in the roads.	K2
CO5	Apply for the safe transportation of hazardous goods, creating TREM card and safe loading and unloading procedure.	K3

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	**2**	**-**	**2**
CO2	**-**	**-**	**2**
CO3	**2**	**-**	**-**
CO4	**2**	**-**	**-**
CO5	**-**	**-**	**2**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped,
Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	60	100	40
	CIE – II	100			
	Skill Assessment – I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. "Accident prevention manual for industrial operations" N.S.C., Chicago, 1982.

2. Babkov, V.F., "Road Conditions and Traffic Safety" MIR Publications, Moscow, 1986. **Reference Books:**

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, 1986.

Web Links and Video Lectures (E-Resources):

1. Hazardous Goods**:** https://archive.nptel.ac.in/courses/105/106/105106056/
2. Road Transport**:** https://nptel.ac.in/courses/105101087
3. Driver and Safety**:** https://onlinecourses.nptel.ac.in/noc20_mg43/preview
4. Road Safety**:** https://archive.nptel.ac.in/courses/105/105/105105215/

Suggested Skill Activities:

1. What should you do when encountering an aggressive driver on the road?
2. What transportation services are offered and who receives them?
3. What were the barriers and challenges that affected implementation of transportation activities? Who facilitated the implementation?
4. How did community members or clients perceive the program?
5. Did community members or clients report any changes in their use of transportation? Were there changes in their knowledge of what transportation services are available?
6. What programmatic or policy changes have occurred in state or local jurisdictions as a result of the transportation program?
7. Has the program helped to improve access to healthcare, food, physical activity, or other services in the target population?

Course Code:	24IS212	Course Title:	Fireworks Safety
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. NPTEL and Other Videos
3. Smart Class Room
4. Field visit
5. Project based learning
6. Industrial Visit

UNIT I – Properties of Fireworks Chemicals	[9 hours]

Fire properties – potassium nitrate (KN03), potassium chlorate (KCl03), barium nitrate (BaNO3), calcium nitrate (CaNO3), Sulphur (S), Phosphorous (P), antimony (Sb), Pyro Aluminum (A1) powder-Reactions-metal powders, Borax, ammonia (NH3) – Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.

UNIT II – Static Charge and Dust	[9 hours]

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.

UNIT III – Process Safety	[8 hours]

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.

UNIT IV– Material Handling and Transportation	[10 hours]
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.	
UNIT V- Waste Control and User Safety	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Extend the knowledge of the chemical reactions of Fireworks chemicals.	K2
CO2	Develop safe manufacture of Fireworks items	K3
CO3	Make use of process safety in fireworks industries	K3
CO4	Apply safety measures against static electricity	K3
CO5	Demonstrate safe practices for handling of fireworks in factories, transport and at user end	K2

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	**-**	**3**	**-**
CO2	**-**	**-**	**-**
CO3	**-**	**-**	**2**
CO4	**-**	**-**	**-**
CO5	**-**	**-**	**2**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped,
Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	60	100	40
	CIE – II	100			
	Skill Assessment – I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. J.A.Purkiss, "Fireworks-Fire Safety Engineering"
2. Bill of once, "Fireworks Safety manual"
3. "Goeff, "Dust Explosion prevention, Part 1"

Reference Books:

1. "Seminar on explosives", Dept.of of explosives.
2. A.Chelladurai, "Fireworks related accidents"
3. A.Chelladurai, "Fireworks principles and practice"

4. A.Chelladurai, "History of the fireworks in India" Brock, "History of fireworks"

5. K.N.Ghosh, "Principles of fireworks", H.Khatsuria, Sivakasi, 1987.

6. "Proceedings of National seminar on Fireworks Safety-1999", MSEC-1999.

Web Links and Video Lectures (E-Resources):

1. Fire Properties**:** https://archive.nptel.ac.in/courses/105/102/105102176/
2. Lightning arrestor**:** https://www.digimat.in/nptel/courses/video/108106138/L23.html

Suggested Skill Activities:

1. What is inside a firework?
2. How should human factors be addressed in the PHA
3. Can you describe your experience in managing and optimizing material flow within a production facility?
4. Is the phenomenon described in the video an example of charging by induction?

Course Code:	24IS213	Course Title:	Safety in Construction
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. NPTEL and Other Videos
3. Smart Class Room
4. Field visit
5. Project based learning
6. Industrial Visit

UNIT I –Accidents Causes and Management Systems	[9 hours]

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

UNIT II – Hazards Of Construction and Prevention	[9 hours]

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.

UNIT III – Working at Heights	[9 hours]

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.	
UNIT IV– Construction Machinery	**[9 hours]**
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.	
UNIT V- Safety in Demolition Work	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Identify the problems impeding safety in construction industries.	K3
CO2	Identify types and causes of accidents, and designing aids for safe construction.	K3
CO3	Explain the hazards during construction of power plant, road works and high rise buildings.	K2
CO4	Choose the safety procedure for working at heights during construction.	K3
CO5	Explain the knowledge in selection, operation, inspection and testing of various construction machinery.	K2

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	**2**	**-**	**-**
CO2	**-**	**-**	**-**
CO3	**-**	**3**	**-**
CO4	**-**	**-**	**-**
CO5	**-**	**-**	**2**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	60	100	40
	CIE – II	100			
	Skill Assessment – I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

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.

Reference Books:

1. Jnathea D.Sime, "Safety in the Build Environment", London, 1988.

2. V.J.Davies and K.Thomasin “Construction Safety Hand Book” Thomas

Telford Ltd., London, 1990.

Web Links and Video Lectures (E-Resources):

1. Construction Machinery**:** https://archive.nptel.ac.in/courses/105/103/105103206/
2. Accidents Causes**:** https://archive.nptel.ac.in/courses/110/105/110105094/
3. Hazardous Goods**:** https://archive.nptel.ac.in/courses/105/106/105106056/

Suggested Skill Activities:

1. What have I done today to make my job site safer?
2. Are the employees working here today using the safety equipment that they have been provided?
3. Have I talked to any workers in the past two days to learn another thing about safety on this job?
4. Has anything changed on the job site since yesterday that introduces a new hazard that wasn't here yesterday?
5. Have I walked the job site today looking for unsafe behavior or equipment?
6. Have I talked to my boss lately about safety issues on this job site?
7. When was the last time I checked the OSHA regulations to make sure there are no new requirements that affect my employer's job sites?
8. Do employees feel that they can come to me about safety concerns so that they don't "drop a dime" on my employer with OSHA?
9. Have I done what I promised others that I would do to take care of potential safety hazards on this job site?

Course Code:	24IS214	Course Title:	Nuclear Engineering and Safety
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. NPTEL and Other Videos
3. Smart Class Room
4. Field visit
5. Project based learning
6. Industrial Visit

UNIT I – Introduction	[9 hours]
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.	
UNIT II – Reactor Control	**[9 hours]**
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.	
UNIT III – Reactor Types	**[9 hours]**
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.	
UNIT IV – Safety of Nuclear Reactors	**[9 hours]**

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.

UNIT V- Radiation Control	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Demonstrate nuclear fission and fusion process and their utilization.	K2
CO2	Explain the reactors Control requirements.	K2
CO3	Explain the types of reactors	K2
CO4	Explain the safety design principles and safety regulation process	K2
CO5	Explain the Control system requirements for radiation.	K2

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	**2**		**2**
CO2	**2**		**2**
CO3	**2**		
CO4	**2**		2
CO5	**2**		2

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped,
Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	60	100	40
	CIE – II	100			
	Skill Assessment – I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	40	30
Understand	80	60	70
Apply	0	0	0
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

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.

Reference Books:

1. M.M.E.L.Wakil, "Nuclear Energy Conversion", International Text Book Co.

2. R.L.Murray, “Introduction to Nuclear Engineering”, Prentice Hall.

3. Sri Ram K, “Basic Nuclear Engineering” Wiley Eastern Ltd., New Delhi, 1990.
4. Sterman U.S.’”Thermal and Nuclear Power Stations”, MIR Publications, Moscow, 1986.

Web Links and Video Lectures (E-Resources):

1. Reactor Control**:** https://archive.nptel.ac.in/courses/103/106/103106101/
2. Reactor Types: https://archive.nptel.ac.in/courses/103/106/103106117/
3. Safety of Nuclear Reactors: https://nptel.ac.in/courses/112107142
4. Radiation Control: https://archive.nptel.ac.in/courses/112/107/112107256/

Suggested Skill Activities:

1. What is nuclear engineering, and how do you see its role in the energy sector evolving in the future?
2. What is the role of a nuclear reactor coolant in a nuclear power plant?
3. Explain the types of Nuclear reactor?
4. What is the recertification process for the Waste Isolation Pilot Plant?
5. The radiation dose may be reduced by?

Course Code:	24IS215	Course Title:	Safety in Textile Industry
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – Introduction	[9 hours]

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

UNIT II – Textile Hazards I	[9 hours]

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.

UNIT III – Textile Hazards II	[9 hours]
Scouring, bleaching, dyeing, punting, mechanical finishing operations and effluents in textile processes.	
UNIT IV – Health and Welfare	**[9 hours]**
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.	
UNIT V – Safety Status	**[9 hours]**
Relevant provision of factories act and rules and other statues applicable to textile industry – effluent treatment and waste disposal in textile industry.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Demonstrate the overall picture about the textile industries and its operations.	K2
CO2	Make use of the various concepts underlying in the processes involved in processing of fibres to yarn.	K3
CO3	Demonstrate various hazards in the textile industry and will be able to apply the control measures to mitigate the risk emanating from the hazard.	K2
CO4	Develop capability to handle the various health and welfare activities as per the Factories act and could implement statutory requirements.	K3
CO5	Apply his own arrangement in designing various methods meant for mitigating the risk and able to guide his subordinates in executing the work safely.	K3

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	-	-	-
CO2	-	-	-
CO3	-	-	2
CO4	-	-	-

CO5	-	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. 100 Textile fires – analysis, findings and recommendations LPA
2. Groover and Henry DS, "Hand book of textile testing and quality control"

Reference Books:

1. "Quality tolerances for water for textile industry", BIS
2. Shenai, V.A. "A technology of textile processing", Vol.I, Textile Fibres
3. Little, A.H.,"Water supplies and the treatment and disposal of effluent"
4. "Safety in Textile Industry" Thane Belapur Industries Association, Mumbai.

Web Links and Video Lectures (E-Resources):

1. Safety and Risk Analytics

: http://ec2-52-32-140-135.us-west-2.compute.amazonaws.com/nptel/courses/video/110105160/L01.html

2. Industrial Safety Engineering :

http://www.digimat.in/nptel/courses/video/110105094/L54.html

Suggested Skill Activities:

1. Assess the risk for a particular work area and create the report.
2. Create the report for safe Guards of a particular work area.
3. Document and present the risk and safety measures of a particular work area.
4. Visit nearby textile industry and learn the safety measures.

Course Code:	24IS216	Course Title:	Safety in Mines
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- To provide in depth knowledge on Safety of mine s 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – Opencast Mines	[9 hours]
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.	
UNIT II – Underground Mines	**[9 hours]**
Fall of roof and sides-effect of gases-fire and explosions-water flooding-warning sensors-gas detectors-occupational hazards-working conditions-winding and transportation	
UNIT III – Tunnelling	**[9 hours]**

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.	
UNIT IV – Risk Assessment	**[9 hours]**
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.	
UNIT V – Accident Analysis and Management	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Explain the various operations carried out in a dock.	K2
CO2	Identify the different acts and rules for safe dock operations.	K3
CO3	Make use of the operation of various types of material handling equipments.	K3
CO4	Choose to response at the time of emergency in a dock.	K3
CO5	Explain the various problems associated with the use of lifting equipments and in the storage yards.	K2

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	-	3	-
CO2	-	-	-
CO3	-	2	-
CO4	-	-	-
CO5	-	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. DGMS Circulars-Ministry of Labour, Government of India press, OR Lovely Prakashan - DHANBAD, 2002.

Reference Books:

1. Kejiriwal, B.K. Safety in Mines, Gyan Prakashan, Dhanbad, 2001.

2. “Mine Health and Safety Management”, Michael Karmis ed., SME, Littleton, Co.2001.

Web Links and Video Lectures (E-Resources):

1. Industrial Safety Engineering :
http://www.digimat.in/nptel/courses/video/110105094/L54.html
2. Port and Harbour Structures :
http://www.digimat.in/nptel/courses/video/114106025/L14.html

Suggested Skill Activities:

1. Assess the risk for a particular work area and create the report.
2. Create the report for safe Guards of a particular work area.
3. Document and present the risk and safety measures of a particular work area.

Course Code:	24IS217	Course Title:	Dock Safety
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- 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.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Blended Mode of Learning
3. NPTEL and Other Videos
4. Smart Class Room
5. Flipped Class

UNIT I – History of Safety Legislation	[9 hours]

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.

UNIT II – Working On Board the Ship	[9 hours]
Types of cargo ships – working on board ships – Safety in handling of hatch beams – hatch covers including its marking, Mechanical operated hatch covers of different types and its safety features – safety in chipping and painting operations on board ships – safe means of accesses – safety in storage etc. – illumination of decks and in holds – hazards in working inside the hold of the ship and on decks – safety precautions needed – safety in use of transport equipment - internal combustible engines like fort-lift trucks-pay loaders etc. Working with electricity and electrical management – Storage – types, hazardous cargo	
UNIT III – Lifting Appliances	**[9 hours]**
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.	
UNIT IV – Transport Equipment	**[9 hours]**
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.	
UNIT V – Emergency Action Plan and Dock Workers (SHW) Regulations 1990	**[9 hours]**
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.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Identify the various operations carried out in a dock.	K3
CO2	Explain the different acts and rules for safe dock operations.	K2
CO3	Identify the operation of various types of material handling equipment's.	K3
CO4	Develop to response at the time of emergency in a dock.	K3
CO5	Explain the various problems associated with the use of lifting equipment's and in the storage yards.	K2

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	-	-	-
CO2	-	3	-
CO3	-	-	-
CO4	-	-	-
CO5	-	-	2

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped,
Level 0- Not Mapped

Scheme of Evaluation:

Component	**Type of assessment**	**Max Marks**	**Reduced Marks**	**Total**	**Final marks**
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. "Dock Safety" Thane Belapur Industries Association, Mumbai.
2. Bindra SR "Course in Dock and Harbour Engineering"

Reference Books:

1. Safety and Health in Dock work, IInd Edition, ILO, 1992.
2. Srinivasan "Harbour, Dock and Tunnel Engineering"
3. Taylor D.A., ""Introduction to Marine Engineering".

Web Links and Video Lectures (E-Resources):

1. Port and Harbour Structures :
http://www.digimat.in/nptel/courses/video/114106025/L04.html

2. Port and Harbour Structures :
http://www.digimat.in/nptel/courses/video/114106025/L14.html

Suggested Skill Activities:

1. Assess the risk for a particular work area and create the report.
2. Create the report for safe Guards of a particular work area.
3. Document and present the risk and safety measures of a particular work area.

AUDIT COURSES SEMESTER I & II,

S. No.	Course Code	Course Title	Course Category	L	T	P	C
AUDIT COURSES							
1.	24AC201	English for Research Paper Writing	PEC	2	0	0	0
2.	24AC202	Disaster Management	PEC	2	0	0	0
3.	24AC203	Constitution of India	PEC	2	0	0	0

Course Code:	24AC201	Course Title:	ENGLISH FOR RESEARCH PAPER WRITING
Credits:	0	L – T – P	2-0-0

Course objectives:

To impart knowledge on the

- To analyze the basic energy generation cycles.
- To detail about the concept of cogeneration, its types and probable areas of applications.
- To study the significance of waste heat recovery systems and carry out its economic analysis.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Lab experiment videos
3. Blended Mode of Learning
4. Project based Learning
5. Experiential Learning
6. NPTEL and Other Videos
7. Smart Class Room
8. Flipped Class

UNIT I – INTRODUCTION TO RESEARCH PAPER WRITING	[6 hours]
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.	
UNIT II – PRESENTATION SKILLS	**[6 hours]**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction	
UNIT III – TITLE WRITING SKILLS	**[6 hours]**
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check	

UNIT IV - RESULT WRITING SKILLS	[6 hours]
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.	
UNIT V – VERIFICATION SKILLS	**[6 hours]**
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification and comparison of energy management strategies, implementation issues.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1		
CO2		
CO3		
CO4		
CO5		

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	**2**	**1**	**-**
CO2	**2**	**1**	**-**
CO3	**-**	**1**	**-**
CO4	**2**	**-**	**-**
CO5	**2**	**1**	**-**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal	CIE – I	100	50	100	40

Examination (CIE)	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006

Reference Books:

1. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
2. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

Course Code:	24AC202	Course Title:	DISASTER MANAGEMENT
Credits:	0	L – T – P	2-0-0

Course objectives:

To impart knowledge on the

- To analyze the basic energy generation cycles.
- To detail about the concept of cogeneration, its types and probable areas of applications.
- To study the significance of waste heat recovery systems and carry out its economic analysis.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Lab experiment videos
3. Blended Mode of Learning
4. Project based Learning
5. Experiential Learning
6. NPTEL and Other Videos
7. Smart Class Room
8. Flipped Class

UNIT I – INTRODUCTION TO RESEARCH PAPER WRITING	[6 hours]
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.	
UNIT II – REPERCUSSIONS OF DISASTERS AND HAZARDS	**[6 hours]**
Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	
UNIT III – DISASTER PRONE AREAS IN INDIA	**[6 hours]**
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics	

UNIT IV - DISASTER PREPAREDNESS AND MANAGEMENT	[6 hours]
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.	
UNIT V – RISK ASSESSMENT	**[6 hours]**
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1		
CO2		
CO3		
CO4		
CO5		

COs and POs Mapping:

COs	POs		
	1	**2**	**3**
CO1	**2**	**1**	**-**
CO2	**2**	**1**	**-**
CO3	**-**	**1**	**-**
CO4	**2**	**-**	**-**
CO5	**2**	**1**	**-**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal	CIE – I	100	50	100	40
	CIE – II	100			

Examination (CIE)	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.

Reference Books:

1. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.
2. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi, 2001.

Course Code:	24AC203	Course Title:	CONSTITUTION OF INDIA
Credits:	0	L – T – P	2-0-0

Course objectives:

To impart knowledge on the

- To analyze the basic energy generation cycles.
- To detail about the concept of cogeneration, its types and probable areas of applications.
- To study the significance of waste heat recovery systems and carry out its economic analysis.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Chalk and Talk
2. Lab experiment videos
3. Blended Mode of Learning
4. Project based Learning
5. Experiential Learning
6. NPTEL and Other Videos
7. Smart Class Room
8. Flipped Class

UNIT I – HISTORY OF MAKING OF THE INDIAN CONSTITUTION	[3 hours]
History, Drafting Committee, (Composition & Working)	
UNIT II – PHILOSOPHY OF THE INDIAN CONSTITUTION	**[3 hours]**
Preamble, Salient Features	
UNIT III – CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	**[6 hours]**
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.	
UNIT IV - ORGANS OF GOVERNANCE	**[6 hours]**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.
UNIT V – LOCAL ADMINISTRATION **[6 hours]**
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

Course outcomes:

On completion of the course, the student will have the ability to:

CO1		
CO2		
CO3		
CO4		
CO5		

COs and POs Mapping:

COs	**POs**		
	1	**2**	**3**
CO1	**2**	**1**	-
CO2	**2**	**1**	-
CO3	-	**1**	-
CO4	**2**	-	-
CO5	**2**	**1**	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	**Type of assessment**	**Max Marks**	**Reduced Marks**	**Total**	**Final marks**
	CIE – I	100	50		
	CIE – II	100			

Continuous Internal Examination (CIE)	MCQ	20	10	100	40
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	60	40
Apply	60	20	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.

Reference Books:

1. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
2. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.