



**KALASALINGAM**  
**ACADEMY OF RESEARCH AND EDUCATION**  
**(DEEMED TO BE UNIVERSITY)**

Under sec. 3 of UGC Act 1956.



Anand Nagar, Krishnankoil - 626126. Srivilliputtur (Via), Virudhunagar (Dt), Tamil Nadu | [info@kalasalingam.ac.in](mailto:info@kalasalingam.ac.in) | [www.kalasalingam.ac.in](http://www.kalasalingam.ac.in)

DEPARTMENT OF MECHANICAL ENGINEERING

MASTER OF TECHNOLOGY

(INDUSTRIAL SAFETY ENGINEERING)



CURRICULUM AND SYLLABUS

(For the Students Admitted from the Academic Year 2022-23 Onwards)

## KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION

### VISION

To be a Centre of Excellence of International Repute in Education and Research.

### MISSION

To Produce Technically Competent, Socially Committed Technocrats and Administrators through Quality Education and Research.

## DEPARTMENT OF MECHANICAL ENGINEERING

### VISION

To be recognized globally as a lead in Mechanical Engineering through excellence in education and innovative research in emerging areas

### MISSION

1. To mold a graduate in mechanical engineering capable of solving contemporary problems through technical skills, lifelong learning and cutting-edge research
2. To impart interdisciplinary domain knowledge through collaboration with industry.
3. To inculcate ability to provide sustainable solutions and practice ethics through scholarship and innovation.

### **Program Educational Objectives**

**PEO 1: Graduate will serve as a solution provider through interactive learning to prevent accidents in industry by adapting latest technology.**

**PEO 2: Graduate will be able to apply research knowledge gained from safety analytics to develop unique safety models and protocols across industries.**

**PEO 3: Graduate will be able to formulate sustainable safety policy documents as per the need of the industries based on prescribed principles and acts.**

### **Program 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 program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.**

**PO4: Demonstrate the implementation of cutting-edge occupational safety, health, legal, and cultural, procedures, in reducing hazards associated with fireworks, chemicals, and construction industries.**

**PO5: An ability to engage in independent and life-long learning to augment the technology for safety and maintenance in Industry 4.0**



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### M.Tech (Industrial Safety Engineering) - Curriculum Structure

S. No	Course Category	Credits
1.	Supportive Core Courses	05
2.	Program Core Courses	40
3.	Experiential Core Courses	20
4.	Experiential Elective Courses	15
<b>Total</b>		<b>80</b>

**KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION**  
**Anand Nagar, Krishnankoil - 626 190**  
**Department of Mechanical Engineering**

**I. PROGRAM CORE COURSES**

Course Code	Course Name	Course Type	L	T	P	X	C	
222MEC1101	Safety Management	TC	4	0	0	0	4	
222MEC1102	Occupational Health and Hygiene	TC	4	0	0	0	4	
222MEC1103	Regulation for Health, Safety and Environment	TC	4	0	0	0	4	
222MEC1104	Fire Engineering and Explosion Control	TC	4	0	0	0	4	
222MEC1201	Industrial Safety Lab	PC	0	0	4	0	2	
222MEC3101	Safety in Construction	TP	3	0	3	0	5	
222MEC3102	Safety In Engineering Industry	TP	3	0	3	0	5	
222MEC2101	Electrical Safety	TP	3	0	2	0	4	
222MEC2102	Environmental safety	TP	3	0	2	0	4	
222MEC2103	Safety in Plant Layout and Material Handling	PC	4	0	0	0	4	
		<b>Total</b>						<b>40</b>

**II. SUPPORTIVE CORE COURSES**

Course Code	Course Name	Course Type	L	T	P	X	C	
221MAT1101	Statistics and Computational techniques	TC	3	0	0	0	3	
PGM18R5001	Research Methodology for Engineers	TC	2	0	0	0	2	
		<b>Total</b>						<b>05</b>

**III. EXPERIENTIAL CORE COURSES**

Course Code	Course Name	Course Type	L	T	P	X	C	
223MEC4201	Dissertation Phase – I	PC	0	0	20	0	10	
223MEC4202	Dissertation Phase – II	PC	0	0	20	0	10	
		<b>Total</b>						<b>20</b>

**IV. EXPERIENTIAL ELECTIVE COURSES**

<b>Course Code</b>	<b>Course Name</b>	<b>Course Type</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>X</b>	<b>C</b>	
224MEC4201	Internship	PC	0	0	30	0	15	
		<b>Total</b>						<b>15</b>

## **I. PROGRAM CORE COURSES**

222MEC1101	SAFETY MANAGEMENT	L	T	P	C
		4	0	0	4

**Objective(s):** This course aims to introduce the concept of Management skills and ability to know about the various documentation systems followed in industries

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to apply the fundamental knowledge acquired to frame the perspectives questions to analyze the safety management system.	3	2	3	1	
2	Able to make a systematic investigation and to write reports scientifically.	2	3	2		
3	Able to explain the leadership qualities needed and present the various training methods required for the employees.	1	3	3	2	1
4	Able to use personal protective equipment and able to demonstrate to the industrial employees.			3		1
5	Able to motivate the employee by investigating the situation and preparing the technical document to solve the problem.		2			2

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

**Course Topic(s)**

**CONCEPTS**

Evolution of modern safety concept- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety. Techniques: Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit.

**ACCIDENT INVESTIGATION AND REPORTING**

Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee - Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports- Class exercise with case study.

**SAFETY EDUCATION, TRAINING AND PERFORMANCE MONITORING**

Importance of training-identification of training needs-training methods – programme, 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. 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.

### **PERSONAL PROTECTIVE EQUIPMENT**

Need for personal protection equipment - non-respiratory personal protective devices: Head protection, Ear protection. Face and Eye protection. Hand protection, Foot protection, body protection. Respiratory personal protective devices: Classification of hazards. Classification of respiratory personal protective devices. Selection of respiratory personal protective devices. Instructions and training in the use, maintenance and care of self containing breathing apparatus. Testing Procedures and Standards.

### **BEHAVIOUR BASED SAFETY**

Human behavior: Individual differences, behavior as function of self and situation, perception of danger and acceptance of risk, knowledge, and responsibility vs.-avis safety performance, theories of motivation and their application to safety, role of, supervisors and safety departments in motivation. Conflict & Frustration: Identification of situations leading to conflict and frustration and techniques of management. BBS Program

### **References**

1. Frank Lees, Sam Mannan , Lees' Loss Prevention in the Process Industries (Hazard Identification, Assessment and Control ) -2005
2. Carsten Busch., Preventing Industrial Accidents Reappraising H.W. Heinrich--more Than Triangles and Dominoes - 2021
3. John V.Grimaldi and Rollin H.Simonds, Safety Management, All India Travellers Bookseller, New Delhi – 1993.
4. Industrial Safety Management 21st Century Perspectives of Asia, Springer Nature Singapore-2019

222MEC1102	OCCUPATIONAL HEALTH AND HYGINE	L	T	P	C
		4	0	0	4

**Objective(s):** This course aims to introduce the concept of Occupational Illness and Diseases present in Industrial Workers and hazards takes place in Industries.

### Course Outcome(s)

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to select and apply the suitable investigation process to identify the different physical hazards and solve and report the problem in various industries.	3		2		
2	Able to identify and report the appropriate methods to reduce and control the chemical hazards in fireworks industries.	3		2		
3	Able to identify, create and report the appropriate methods to reduce and control the biological and ergonomic hazards in process industries.	2	3	3		
4	Able to formulate cutting-edge technology to reduce and control the health hazard and toxicology.				3	
5	Able to categorize the different parameters to increase the strength of the physiology behaviour of the employee through real-time learning.					3

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

### PHYSICAL HAZARDS

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- remedial measures to physical hazards

### CHEMICAL HAZARDS

Recognition of chemical hazards-dust, fumes, mist, vapor, fog, gases, types, concentration, Exposure vs. dose, TLV - Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard. Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapour monitors, dust sample collection devices, personal sampling Methods of Control - Engineering Control, Design maintenance considerations, design specifications - General Control Methods - training and education- environmental policy

### BIOLOGICAL AND ERGONOMICAL HAZARDS

Classification of Bio hazardous agents –bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases - Biohazard control program,

employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design- medical safety- Ergonomics-Work Related Musculoskeletal Disorders –carpal tunnel syndrome CTS- Tendon pain- disorders of the neck- back injuries-Ergonomical Tools-RULA-REBANIOSH LIFTING Equations.

### **OCCUPATIONAL HEALTH AND TOXICOLOGY**

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-remedial measures

### **OCCUPATIONAL PHYSIOLOGY**

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 – Motivation of employees, Insurance coverage of Industrial plant & personnel-categorization of job heaviness – work organization – stress – strain – fatigue – rest pauses – shift work – personal hygiene.

### **REFERENCES**

1. Handbook of Occupational Health and Safety, CRC Press, 2010
2. Encyclopedia of Occupational Health and Safety, International Labor Organization, Geneva, 2012.
3. McCormick, E.J. and Sanders, M.S., Human Factors in Engineering and Design, Tata McGraw-Hill, 2019.

222MEC1103	<b>REGULATIONS FOR HEALTH SAFETY &amp; ENVIRONMENT</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**Objective(s)** This course aims to deal with the safety standard which has been followed in industry and helps to know about the various accidents and safety measures in industry.

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Ability to propose and report the solution to solve the problems of construction/firework industries by recommending various procedures recommended by the Tamilnadu factories act.	3		3	3	
2	Able to conduct independent studies and document the report of environmental problems by mastering various environmental norms and procedures.		3			2
3	Able to formulate and develop the framework for various hierarchies to augment the latest technology to control the various hazards	2				3
4	Intellectual to demonstrate the recent acts proposed by several agencies by investigating and reporting the industrial problem.		2		2	
5	Proficient to differentiate and compose the National and International Safety norms		2			2

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

**Course Topic(s)**

**FACTORIES ACT – 1948**

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

**ENVIRONMENT ACT – 1986**

General powers of the central government, prevention, control and abatement of environmental pollution. Latest amendment for environmental act -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, Latest Amendments and rules

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

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- Latest amendment for MHSI rules.

### **OTHER ACTS AND RULES**

Indian Boiler Act 1923, static and mobile pressure vessel rules (SMPV), motor vehicle rules, mines act 1952, workman compensation act, rules – electricity act and rules – hazardous wastes (management and handling) rules, 1989, with amendments in 2000- the building and other construction workers act 1996., Petroleum rules, Gas cylinder rules Explosives Act 1983-Pesticides Act, Latest Amendments and rules

### **INTERNATIONAL ACTS AND STANDARDS**

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

### **REFERENCES**

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt. Ltd., New Delhi.
3. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt. Ltd. New Delhi.
4. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt. Ltd., New Delhi.
5. The Indian boilers act 1923, Commercial Law Publishers (India) Pvt.Ltd., Allahabad.
6. The Mines Act 1952, Commercial Law Publishers (India) Pvt.Ltd., Allahabad.
7. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book Agency, Chennai.
8. Explosive Act, 1884 and Explosive rules, 1883 (India), (2002), Eastern Book company, Lucknow, 10th Edition
9. ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria & Sons, Delhi, 2012.

222MEC1104	<b>FIRE ENGINEERING AND EXPLOSION CONTROL</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**Objective(s):** This course aims to provide knowledge about the science of fire, explosion and various fire and explosion prevention systems and protective equipment.

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to investigate the reasons for fire accidents by conducting scientific research to control the explosion behaviour of chemicals in fireworks/oil refineries/ or relevant industries.	2		3		
2	Able to demonstrate and recommend the fire prevention system to control the rate of fire by implementing cutting-edge technology.	2			3	2
3	Able to design and develop the firefighting system required for various industries by understanding the kind of industrial fire.	2				
4	Understanding and preparing the documents for high-rise buildings to meet the safety standard by augmenting cutting-edge technology.		3			3
5	Able to investigate and present the various explosion protection system required for various onshore and offshore industries.	2				

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

**Course Topic(s)**

**PHYSICS AND CHEMISTRY OF FIRE**

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

**FIRE PREVENTION AND PROTECTION**

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 – layout of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – notice-first aid for burns.

**INDUSTRIAL FIRE PROTECTION SYSTEMS**

Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO system, foam system, dry chemical powder (DCP) system, halon system – need for halon replacement – smoke venting.

Portable extinguishers – flammable liquids – tank farms – indices of inflammability-fire fighting systems.

### **BUILDING FIRE SAFETY**

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

### **EXPLOSION PROTECTING SYSTEMS**

Principles of explosion-detonation and blast waves-explosion parameters – Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure-explosion venting-inert gases, plant for generation of inert gas rupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO<sub>2</sub>) and halons-hazards in LPG, ammonia (NH<sub>3</sub>), sulphur dioxide (SO<sub>2</sub>), chlorine (CL) etc.

### **Text Book**

1. Derek, James, Fire Prevention Hand Book, Butterworth's and Company, London,1986.

### **References**

1. Gupta, R.S., Hand Book of Fire Technology, Orient Longman, Bombay 1993.
2. Frank Lees, Sam Mannan , Lees' Loss Prevention in the Process Industries (Hazard Identification, Assessment and Control ) -2005
3. Handbook of Fire and Explosion Protection Engineering Principles for Oil, Gas, Chemical, and Related Facilities 4<sup>th</sup> edition - 2018
4. Joseph Lowe, Jeffrey Pricher Wildland Fire Fighter: Principles and Practice - 2020
5. Dennis P. Nolan, “Handbook of Fire & Explosion Protection Engineering Principles for Oil, Gas, Chemical, & Related Facilities “,Elsevier Science, 2018
6. Daniel J.Davis,Julie A.Davis Hazardous materials reference book, Fire Prevention in Factories, Wiley 2006.

222MEC1201	INDUSTRIAL SAFETY LAB	L	T	P	C
		0	0	4	2

**Objective(s):** This course helps to operate the equipment, use PPE and acquire practical knowledge related to safety problems in industry

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to conduct the study, investigate and prepare reports on the reasons for noise and vibration and recommend the solution to control or minimize.	2	2	3		
2	Able to conduct the study, investigate and prepare the reports of hazardous chemicals employed in the industry using friction and impact sensitivity test.	2	2	3		
3	Able to conduct a study, investigate and prepare reports to understand the breathing zone concentration of dust and fumes in real-time	2	2	3		
4	Able to conduct a study, investigate and prepare reports to measure the respirable and non-respirable dust in the ambient air	2	2	3		
5	Able to conduct a study to understand the fire, explosion and dispersion by developing suitable systems	2	2	3		

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

**Course Topic(s)**

**NOISE LEVEL AND VIBRATION MEASUREMENT AND ANALYSIS**

Measurement of noise level for various sources – Impact, continuous and intermittent. Frequency and spectrum analysis of noise: Instrument – precision type of Noise level meter with frequency and spectrum analyzer. Measurement of whole body vibration for various acceleration: Instrument – vibration simulator and vibration analyzer

**FRICTION AND IMPACT SENSITIVITY TEST**

Measurement of friction sensitivity for unstable materials: Instrument – BAM friction tester  
Measurement of impact sensitivity for unstable materials: Instrument – BAM fall hammer

**THERMAL REACTIVITY TEST**

Measurement of thermal reactivity for unstable materials: Instrument – DSC/TGA

**EXHAUST GAS MEASUREMENT AND ANALYSIS**

Measurement of Exhaust gas measurement of IC engines: Instrument – Gas analyzer

**BREATHING ZONE CONCENTRATION**

Measurement of breathing zone concentration of dust and fumes: Instrument – personal air sampler

**AMBIENT AIR MONITORING**



Measurement of respirable and non-respirable dust in the ambient air: Instrument – High volume sampler

### **CONSEQUENCE ANALYSIS**

Soft computing skills on developing effects of fire & explosion and dispersion: Software – PHAST 1 and ALOHA

### **ELECTRICAL SAFETY**

- Experiment on the basic circuit explaining the effects of grounding
- Test the strength of insulators like oil, thermal insulation
- Experiment on fuses/relays/MCBs to understand the operational differences
- Test on the discharge rod to understand the operation of it
- Circuit connection explaining the use of isolators
- Static charge testing & illumination testing: On plastic, rubber, ferrous and non-ferrous materials – by Lux meter – photometer

### **SAFETY MANGEMENT**

- Identification of Unsafe Acts and Unsafe Condition
- Preparation of JSA in Workplace
- Hazard Analysis using ETA, FTA and FMEA
- Design a types of Work Permit system in Workplace

### **STUDY OF FIRST AID, PERSONAL PROTECTIVE EQUIPMENT AND FIRE EXTINGUISHERS**

Respiratory and non-respiratory – demonstration – self-contained breathing apparatus -Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, apron and leg guard. Selection and demonstration of first-aid - fire extinguishers: soda acid, foam, carbon dioxide (CO<sub>2</sub>), dry chemical powder, halon.

### **RISK ANALYSIS TECHNIQUES AND ERGONOMICS ANALYSIS TECHNIQUES**

Risk Assessment in Process Industries, Ergonomics Analysis using RULA, REBA, NIOSH Lifting Equations, WERA and MOST Techniques.

### **REFERENCES**

1. Industrial Safety Laboratory Manual, Kalasalingam Academy of Research and Education, 2022.

222MEC3101	SAFETY IN CONSTRUCTION	L	T	P	C
		3	0	3	5

**Objective(s):** This course aims to introduce the concept of construction management system, construction machinery used in industries and erection, demolition work in construction industry.

### Course Outcome(s)

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to examine the construction site to identify the block spot and probable accident zones by conducting the studies scientifically.	3				
2	Able to investigate and prepare the documents to reduce and control confined space accidents and contaminated sites		3		2	
3	Able to select and justify the selection for the standard to be adopted in high-rise buildings, scaffoldings, and fragile roofs by demonstrating the occupational safety procedures	2			2	
4	Able to investigate and explore the possible accident-prone machines and prepare the report to minimize the accident by adopting the latest technology		2		2	3
5	Able to inspect and develop the methodology to conduct the study in the demolition area by understanding the pre-inspection method, and safe clearance zone.	2	2		3	

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

### Course Topic(s)

#### ACCIDENTS CAUSES AND MANAGEMENT SYSTEMS

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 – Black Spot Identification-Recording of accidents and safety measures – Education and training

#### HAZARDS OF CONSTRUCTION AND PREVENTION

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

#### WORKING AT HEIGHTS

Fall protection in construction OSHA 3146 – OSHA requirement for working at heights, Safe access and egress – safe use of ladders- Scaffoldings, requirement for safe work platforms, stairways, gangways and ramps – fall prevention and fall protection, safety belts,

safety nets, fall arrestors, controlled access zones, safety monitoring systems – working on fragile roofs, work permit systems, height pass – accident case studies.

### **CONSTRUCTION MACHINERY**

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

### **SAFETY IN DEMOLITION WORK**

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. Understand basic physics related to crash reconstruction

### **REFERENCES**

1. Hudson, R., Construction hazard and Safety Hand book, Butterworth's Publication, 1985.
2. Jnathea D.Sime, Safety in the Build Environment, London, 1988.
3. V.J.Davies and K.Thomasin, Construction Safety Hand Book, Thomas Telford Ltd., London, 1990.
4. Handbook of OSHA Construction safety and health, Charles D. Reese and James V. Edison
5. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982 6. Fulman, J.B., Construction Safety, Security, and Loss Prevention, John Wiley and Sons, 1979.

222MEC3102	SAFETY IN ENGINEERING INDUSTRY	L	T	P	C
		3	0	3	5

**Objective(s):**

- To know the safety rules and regulations, standards and codes
- To study various mechanical machines, processes and their safety importance
- To understand the principles of machine guarding and operation of protective devices.

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to understand the plant layout of the manufacturing industry and provide a recommendation to solve/minimize the accidents	3				2
2	Demonstrate the working principle of the Machine guarding System and identify the suitable guarding system for the various Machines.			3		2
3	Able to demonstrate the different types of personal protection systems required to solve the accident-prone area by adopting suitable standards.			3		
4	Able to demonstrate the required safety precaution that needs to be taken during welding and cutting by augmenting the regular maintenance and safety procedure.			3		3
5	Able to distinguish, and investigate the types of safety equipment and procedures needed to minimize accidents in metal forming industries			3		

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

**Course Topic(s)****SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES**

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

**PRINCIPLES OF MACHINE GUARDING**

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

**SAFETY IN WELDING AND GAS CUTTING**

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

### **SAFETY IN COLD FORMING AND HOT WORKING OF METALS**

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal shears press brakes.

Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes, Precaution to reduce hazardous in hot working

### **SAFETY IN FINISHING, INSPECTION AND TESTING**

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

### **REFERENCES**

1. Frank Lees, Sam Mannan , Lees' Loss Prevention in the Process Industries (Hazard Identification, Assessment and Control ) -2005
2. S.z. Mansdorf Handbook of Occupational safety and Health, Wiley - 2019.
3. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1991.
4. Ralph King, Safety in the process Industries, Elsevier Science - 2016.
5. Indian Boiler Acts and Regulations, Government of India.
6. David R. Bates Safety in the use of wood working machines, CRC Press - 2014.
7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 2006.

222MEC2101	ELECTRICAL SAFETY	L	T	P	C
		3	0	2	4

**Objective(s):** This course aims to safeguard the Electrical and Electronics Equipments from the Overvoltage and Explosion hazards.

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to understand the electrical safety standards followed at national and international levels.				3	
2	Able to investigate and declare the reason for electrical accidents and recommend the safety norms to be followed.			3	3	
3	Able to handle electrical systems to acquire data from the fault areas and able to recommend the safety procedure.	3				3
4	Able to demonstrate and implement the safety procedure using recent technology to install new machines by considering the safety codes and acts.				3	3
5	Able to investigate and classify the reasons for various electrical fire accidents by submitting an extensive technical report.	2	2	3		

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

**Course Topic(s)**

**INTRODUCTION AND STATUTORY REQUIREMENTS**

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) – national electrical safety code ANSI.

**ELECTRICAL HAZARDS**

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 equipment's-over current and short circuit current-heating effects of current-electromagnetic forces-corona effect-static electricity –definition, sources, hazardous conditions, control, causes of fire and explosion-ionization, spark and arc-ignition energy-Lightning, hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth bit maintenance.

**PROTECTION SYSTEMS**

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 - earthing devices. Flame Retardant Low Smoke (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 appliance stools and medical equipment's.

### **SELECTION, INSTALLATION, OPERATION AND MAINTENANCE**

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

### **HAZARDOUS ZONES**

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.

### **TEXT BOOK**

1. Fordham Cooper, W., Electrical Safety Engineering, Butterworth and Company, London, 1986.

### **REFERENCES**

1. Frank Lees, Sam Mannan , Lees' Loss Prevention in the Process Industries (Hazard Identification, Assessment and Control ) -2005
2. Indian Electricity Act and Rules, Government of India.
3. Power Engineers – Handbook of TNEB, Chennai, 1989.
4. Günter Lüttgens „Static Electricity Understanding, Controlling, Applying-2017.

222MEC2102	ENVIRONMENTAL SAFETY	L	T	P	C
		3	0	2	4

**Objective(s):** This course aims to introduce the concept of Environmental Pollution like air, Water pollution and solid hazardous waste management in Industry.

### Course Outcome(s)

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to understand and suggest the personal protective equipment's to reduce the air pollution in the different industries.	3		2	3	
2	Able to understand and suggest the personal protective equipment's to reduce the water pollution in the different industries.	3		2	3	
3	Able to apply to recent technology to handle the hazardous solid waste management		1		3	3
4	Able to understand the recent advanced sampling techniques to solve industry problem by using cutting-edge technology			3	3	3
5	Able to prepare report by understanding the nature of the problem in industries	2	3			

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

### Course Topic(s)

#### AIR POLLUTION

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

#### WATER POLLUTION

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.

#### SOLID AND HAZARDOUS WASTE MANAGEMENT

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-processing and energy recovery – waste minimization, health hazards-toxic and radioactive wastes-incineration and vitrification - hazards due to bio-process-dilution-standards and restrictions – recycling and reuse.

#### ENVIRONMENTAL MEASUREMENT AND CONTROL



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

### **POLLUTION CONTROL IN PROCESS INDUSTRIES**

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

### **TEXT BOOK**

1. Rao, CS, Environmental pollution engineering, Wiley Eastern Limited, New Delhi, 1992.

### **REFERENCES**

1. Danny Reible ,Fundamentals of Environmental Engineering, CRC Press-2019.
2. Adrian Belcham ,Manual of Environmental Management, Routledge-2015.
3. Richard O. Mines ,Environmental Engineering Principles and Practice, Wiley-2014.
4. G. Masters Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd, New Delhi, 2013.
5. Paul Mac Berthouex, Linfield C. Brown .,Chemical Processes for Pollution Prevention and Control, CRC Press-2017.
6. H. Brauer, Y. B. G. Varma., Air Pollution Control Equipment, Springer My Copy UK - 2012

222MEC2103	SAFETY IN PLANT LAYOUT AND MATERIAL HANDLING	L	T	P	C
		3	0	2	4

**Objective(s):**

- To educate the students about the basic things of work conditions which include ventilation, comfort, lighting and its effect based on various nature of work.
- To provide the skill of handling the Manual material handling and lifting techniques of various shapes of machine and heavy objects.
- To give an input of handling the hazardous materials of liquid, solids and cryogenic liquids with proper packing.

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to identify the safe location of hazards machines/chemical sites in the plant	2		2		
2	Able to locate the suitable in firefighting equipment's in place by augmenting recent tools and techniques					3
3	Able investigate, demonstrate, and implement the ambient condition required for suitable working condition	2			3	
4	Able to formulate the safety procedure for manual material handling and lifting tackles		3		2	
5	Able to formulate the safety procedure for mechanical material handling and lifting tackles					

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

**Course Topic(s)****PLANT LOCATION**

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

**PLANT LAYOUT**

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

**WORKING CONDITIONS**

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, Welfare Facilities to workers.

**MANUAL MATERIAL HANDLING AND LIFTING TACKLES**

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 and safety 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 – ergonomic and safety considerations, Arresting Gears.

**MECHANICAL MATERIAL HANDLING**

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 – ergonomic and safety considerations 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 – ergonomic and safety considerations, Storage and Retrieval of common goods of various shapes and sizes in a general store of a big industry.

**TEXT BOOKS**

1. Apple .M. James, Plant layout and material handling, 3rd edition, John Wiley and sons, 1991
2. Fred E. Meyers and Matthew P. Stephens, “Manufacturing Facilities Design and Material Handling”, Prentice Hal, 3rd edition, 2004.

**REFERENCES**

1. Encyclopedia of occupational safety and health, ILO Publication, 2012
2. Frank Lees, Sam Mannan , Lees' Loss Prevention in the Process Industries (Hazard Identification, Assessment and Control ) -2005.
3. Wilbur G. Hudson, Conveyors and related Equipment,Wiley - 2008.
4. K.C. Arora, Material handling Equipments,Laxmi Publications - 2011.
5. Reymond, A.Kulwice, Material Handling Hand Book – II, John Wiley and Sons, New York, 1991.
6. Safety and good housekeeping, N.P.C. Pearson Education India - 2015.
7. Industrial ventilation (A manual for recommended practice), American conference of Governmental Industrial Hygiene, USA, 1985.

## **II. SUPPORTIVE CORE COURSES**

221MAT1101	STATISTICS AND COMPUTATIONAL TECHNIQUES	L	T	P	C
		3	0	0	3

**Course Objective(s):**

The purpose of this course is to acquire more knowledge in statistics and its applications to engineering fields.

**Course Outcomes:**

CO	CO Statement	PO				
		1	2	3	4	5
1	Construct discrete and continuous probability distribution for the appropriate random variable and make further predictions on the probability.	1	2	2		
2	Calculate correlation and regression for the given data for presenting necessary interpretations.	1	2			
3	Estimate parameter using multiple criteria such as estimator, maximum likelihood estimate, method of moments and least square principles from sample data.	1	2			
4	Perform hypothesis testing for small, large samples which are identified as Parametric Test and do Testing of Goodness of Fit, Independence of attributes which are identified as Non-Parametric Test.	1	2			
5	Design experiment and appropriately interpret results of analysis of variance tests.	1	2			

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

**Course Topic(s)****PROBABILITY DISTRIBUTIONS**

Probability basic concepts - Binomial, Poisson, Geometric, Normal, Uniform, Exponential, Gamma and Weibull - distributions - Mean, Variance, Moment generating functions.

**CORRELATION AND REGRESSION ANALYSIS**

Bivariate correlation – correlation in multivariate systems; Bivariate linear regression – statistical optimization – principle of least squares – reliability of the regression equation – reliability of point estimates of regression coefficients – confidence interval of the regression equation – correlation versus regression - Multiple Regression Analysis: Matrix solution of the standardized model - criteria for evaluating a multiple regression model – Analysis of residuals

**ESTIMATION THEORY**

Estimation of parameters - Principles of least squares - Maximum likelihood estimation - Method of moments - Interval estimation

### **TESTING OF HYPOTHESIS**

Sampling distribution, large sample tests - Mean and Proportion, Small sample tests - t -test, F- test and Chi-Square test. -Goodness of fit -Independence of attributes.

### **DESIGN OF EXPERIMENTS**

Design of Experiments: Basic Designs, Factorial Design, ANOVA

#### **Text Books:**

1. Probability and Statistics for Engineering. Freund John, E and Miller, Prentice Hall, 5th Edition, 2011.
2. Probability and Statistics for Engineering and Sciences. Jay, L. Devore, Brooks Cole Publishing Company, Monterey, California, 2016

#### **Reference Books:**

1. Probability and Statistics with Reliability, Queuing and Computer Science Applications. Trivedi, K.S., PHI, 2008.
2. Mathematical Statistics. Kapur, J.N. and Saxena, H.C, S.Chand and Co. Ltd.,18th Revised Edition, 2005.

PGM18R5001	<b>RESEARCH METHODOLOGY FOR ENGINEERS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**Course Objective(s):**

This course helps the students to formulate the research problems and select the methods used for the studies.

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Understand purpose, role, types, importance and formulate Research	1	2	2		
2	Apply suitable statistical methods to research studies	2	2	2		
3	Understand and apply research data presentation and analysis methods	1	1	1		
4	Understand and Develop algorithms to optimize the variables and to solve the problems in research	2	2	1		
5	Understand and apply the knowledge acquired in writing and generating a research report	2	1	1		

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

**Course Topic(s)****INTRODUCTION**

Definition and objectives of Research – Types of research, Various Steps in Research process, Mathematical tools for analysis, developing a research question-Choice of a problem Literature review, Surveying, synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.

**QUANTITATIVE METHODS FOR PROBLEM SOLVING**

Statistical modeling and analysis, time series analysis probability distributions, Fundamentals of statistical analysis and interference, multivariate methods, concepts of correlation and regression, fundamentals of time series, analysis and spectral analysis, error analysis, applications of spectral analysis.

**DATA ANALYSIS**

Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables, relation between frequency distributions and other graphs, preparing data for analysis.

**SOFT COMPUTING APPLICATION**

Computer and its role in research, Use of statistical software SPSS, GRETL etc. in research. Introduction to evolutionary algorithms- fundamentals of genetic algorithms, simulated annealing, and neural network-based optimization, optimization of fuzzy systems.

**REPORT WRITING**

Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, referencing in academic writing

**TEXT BOOKS**

1. C.R. Kothari, Research Methodology Methods and Techniques, 2/e, Vishwa Prakashan, 2019
2. Donald H. Mc Burney, Research Methods, 5th Edition, Thomson Learning, ISBN:81-315-0047-0, 2006

**REFERENCE BOOKS**

1. Donald R.Cooper, Pamela S.Schindler, Business Research Methods, 8/e, Tata McGraw Hill Co. Ltd. 2014.
2. Timothy J.Ross, Fuzzy Logic with Engg Applications, Wiley Publications- 2016.
3. Simulated Annealing: Theory and Applications (Mathematica and its applications, by P.J.Van Laarhoven E.H.Aarts)
4. David E Goldberg, Genetic Algorithms in search, optimization and machine learning, 2013.



### **III. EXPERIENTIAL CORE COURSES**

223MEC4201	DISSERTATION PHASE - I	L	T	P	C
		0	0	20	10

**METHODOLOGY OF THE PROJECT WORK:**

The student will identify and select a problem based on comprehensive literature survey. The student should submit a proposal and get it approved by the HOD. Three reviews will conduct by Project review committee. Students will be evaluated by the committee during the review and suggestions will be offered by members. The report for PHASE -I should be submitted by the students at the end of course.

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to conduct systematic literature surveys to understand the problem and able investigate the constraints in the studies.	3				
2	Able to summarize and communicate the outcome of the literature survey.		3			
3	Able to identify the research gap and ability prepare the objective of the study.		3			
4	Able to propose a scientific approach to solve the problem by supplementing the recent tools and technology.					3

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

223MEC4202	DISSERTATION PHASE – II	L	T	P	C
		0	0	20	10

**Objective(s) :**

- To develop the skill of students for analyzing safety problems to control the hazard.
- To expose the students to identify and evaluate the hazards in an industry under study
- To expose the students to assess the Compliance level of safety norms and procedures

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Able to plan and develop the framework to solve the industrial problem through systematic studies and writing a technical report.	3				
2	Able to identify suitable tools and techniques to be adopted to address the nature of the problem by considering all the safety protocols.		3			
3	Ability to propose new cutting-edge tools and techniques to solve real-time problems	3				3
4	Able to write, communicate and prepare the technical document to present the finding of the studies		3			
5	Able to communicate and publish the finding through a scientific article or in conference and journals.		3		3	

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation

**Course Topic(s)****METHODOLOGY OF THE PROJECT WORK:**

It is the continuation of Phase I project. Three reviews will be conducted by Project review committee. Students will be evaluated by the committee during the review and suggestions will be offered by members. At least one paper should be published by the student in international / national conference and reputed Journals (H Index Citation). The report should be submitted by the students at the end of course

## **IV. EXPERIENTIAL ELECTIVE COURSES**

224MEC4201	INTERNSHIP	L	T	P	C
		0	0	30	15

**METHODOLOGY OF THE INTERNSHIP:**

The student will visit a industry/R&D Lab identify and select a problem based on comprehensive training. The student should submit an industry/R&D Lab permission letter to undergo paid or unpaid internship and get it approved by the HOD. Two reviews will conduct by the review committee on the basis of rubrics. Students will be evaluated by the committee during the review and suggestions will be offered by members. The report for internship should be submitted by the students at the end of course.

**Course Outcome(s)**

CO	CO Statement	PO				
		1	2	3	4	5
1	Know the real Industrial Scenarios and Safety Activities followed in reputed MNC and Process Industries.	2	2	1		
2	Identify the potential problems and Hazards Encountered in the Industries through the physical inspections of various departments.	3	2			
3	Conduct a real time survey from the workers and collect accident data from the identified Problems.	3	3	2		3
4	Understand suitable methodology and techniques for the potential Hazardous scenarios and risk environments.	1	3			
5	Recommend and Innovate the Safety precautions that can be followed in the recent Industrial Hazardous Situations and Plan for publishing his/her work in Scopus Index Journals.	2	2	1	3	

3 – Strong correlation, 2 – Medium correlation, 1 – Low correlation