

ज्ञानम् अमृतम्

JKLU

HAND BOOK

of

CURRICULUM STRUCTURE AND SYLLABUS

**Master of Technology in Health, Safety, and
Environmental Engineering (Programme Code: 3203)**

Batch: 2020-2022

Institute of Engineering and Technology



Vision

To be one of India's most innovative higher education institutions.

Mission

To realise its vision, the University will:

Practice teaching that inculcates critical thinking and problem solving,

Pursue research that leads to innovation and enhancement of real-life applications,

Offer experience that leads to all round development, and

Develop a culture that is strongly rooted in interdisciplinarity and learning by building, not just doing.

Values

Caring for people.

Integrity including intellectual honesty, openness, fairness, and trust.

Commitment to excellence.

IQAC Documentation

Document Name: Curriculum Structure and Syllabus Handbook, Master of Technology in Health, Safety, and Environmental Engineering (Programme Code: 3203) - Batch 2020-2022

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Document Description: This document supplements the document titled Curriculum Structure: MTech Programs and is prepared by the Institute of Engineering and Technology (IET), JKLU to serve as an information baseline for further planning and delivery of courses w.r.t Master of Technology in Health, Safety, and Environmental Engineering (M.Tech HSEE), Batch 2020-22.

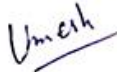
It includes Program Education Objectives, Programme Outcomes, Programme Specific Outcomes, Curriculum Structure, collation of Semester wise Course Description, and Course Articulation Matrix (CAM) of each course (including electives and additional courses, if any, opted by students) prepared by respective faculty members. The document also includes Programme Articulation Matrix (PAM).

This document is in compliance with BoS (upto 13th meeting) and approvals of the Academic Council (upto 20th meeting).

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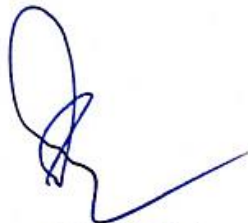
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Program Education Objectives

The B.Tech and M.Tech. Programs at IET, JKLU are designed to prepare students for continued learning and successful careers. Our alumni are expected to:

- PEO1:** Apply their technical knowledge, complex problem solving and research skills in professional practice.
- PEO2:** Continue their intellectual development through critical thinking, self-study, apprenticeship, higher education, professional development courses, as well as participation in research groups and professional networks.
- PEO3:** Serve as ambassadors for engineering and sustainability by exhibiting high professional standards with a deep sense of civic responsibility.
- PEO4:** Effectively communicate about technical and related issues.
- PEO5:** Embrace the roles of team members and leaders in their careers.

Program Outcomes

“Competence is a demonstrated ability to apply knowledge, skills and attributes for achieving desirable results.” The graduates of B.Tech. and M.Tech. Programs at IET, JKLU will have following competencies:

PO 1: Life-long learning: Demonstrate inquisitiveness, open mindedness, and the ability to engage in independent and life-long learning in the broadest context of technological, organizational, economic, and societal changes.

PO 2: Citizenship, Sustainability, and Professional ethics

PO 2a: Demonstrate knowledge of constitutional values of liberty, equity, justice, and fraternity with understanding of the impact of the engineering solutions in societal and environmental contexts as well as a sense of responsibility for sustainable development.

PO 2b: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, cultural, and environmental issues and the consequent responsibilities relevant to the professional engineering practice.

PO 2c: Demonstrate commitment for professional integrity and excellence and respect for ethics, responsibilities and norms as prescribed for the engineering practice.

PO 3: Engineering knowledge and Modern tool usage

PO 3a: Demonstrate clear conceptual understanding of fundamentals of engineering specialization and cognitive flexibility to appropriately ‘transfer’ what has been learned in a context, to different situations.

PO 3b: Apply engineering thinking, computational thinking, and the knowledge of mathematics, natural and social sciences, engineering fundamentals, information technology, engineering specialization, and engineering management to the solution of complex engineering problems.

PO 3c: Create, select, modify, and apply appropriate techniques, best practices, standards, resources, and modern engineering and IT tools including prediction and modelling to engineering and social activities with an understanding of the limitations.

PO 4: Complex problem solving, Design and Research

PO 4a: Identify, formulate, review research literature, and analyze complex engineering problems to arrive at substantiated conclusions using critical thinking along with principles of mathematics, computing, engineering as well as natural and social sciences.

PO 4b: Use systems thinking and reflection to identify and consider underlying structures, patterns, volatility, uncertainties, complexities, ambiguities, complications, and risks to design and develop engineering solutions for complex problems to meet the specified and anticipated needs with appropriate concern for constraints, performance, sustainability, and professional ethics.

PO 4c: Use research-based knowledge and research methods including design of experiments, simulation, analysis and interpretation of data, and synthesis of the information to evaluate and improve the engineering solutions and practice.

PO 5: Individual & team work and Engineering management

PO 5a: Ability to work effectively as an individual and as a team member or leader in diverse and distributed teams, and in multidisciplinary settings.

PO 5b: Ability to apply engineering management principles to one’s own and team’s work to manage engineering projects and operations and in multidisciplinary environment.

PO 6: Communication: Ability to communicate effectively on complex engineering and technology activities, situations, problems, and solutions using verbal, textual, and pictorial elements with the colleagues, engineering community, users, clients, policy makers, and society at large with intellectual honesty, clarity, empathy, and compassion.

PO 7: Innovation and entrepreneurship:

PO 7a: Demonstrate enthusiasm and understanding to identify opportunities and translate research in engineering and other disciplines to conceive and design innovative engineering solutions for business, industry, and societal problems.

PO 7b: Demonstrate enthusiasm and understanding to conceive and plan technology based new ventures either as independent start-up businesses or within existing corporate structures.

Program Specific Outcome

The Health, Safety and Environmental Engineering graduates of JKLU will be able to:

HSEPSO1: Interpret and apply legislative requirements, industry standards, and best practices in a variety of workplaces.

HSEPSO2: Collect, manage, and interpret information and data to identify hazardous conditions and practices in a variety of workplaces.

HSEPSO3: Prevent and control harm to workers, property, the environment and the general public by conceiving, designing, and implementing alternative engineering and management systems and practices in compliance with laws and/or employer policies by using principles of engineering, industrial safety, risk management, data analytics, automation, and state of the art platforms, components and tools.

HSEPSO4: Serve in fields of environmental health and safety, safety engineering, industrial hygiene, safety and occupational health in business, consultancy, industry, government, healthcare, education, research, etc.

Program specific desired minimum level of competence for POs and PSOs

PO/PSO	Competence Level
PO 1	Competent
PO 2a	Advanced Beginner
PO 2b	Advanced Beginner
PO 2c	Advanced Beginner
PO 3a	Competent
PO 3b	Advanced Beginner
PO 3c	Advanced Beginner
PO 4a	Advanced Beginner
PO 4b	Advanced Beginner
PO 4c	Advanced Beginner
PO 5a	Competent
PO 5b	Advanced Beginner
PO 6	Advanced Beginner
PO 7a	Advanced Beginner
PO 7b	Novice
HSEPSO1	Competent
HSEPSO 2	Competent
HSEPSO 3	Competent
HSEPSO4	Competent

Following process has been adopted to create Course Articulation Matrix (CAM) and Program Articulation Matrix (PAM).

1. Course Outcome of each Course is mapped to Program Outcome (PO) / Program Specific Outcome (PSO) using three Levels viz., Low Correlation (1), Moderate Correlation (2) and Substantial Correlation (3).
2. Average of these Levels of each Course Outcome w.r.t each specific PO/PSO is calculated and it indicates expectations laid in a course to attain different PO/PSO. In order to avoid over commitment of a course w.r.t its contribution to POs/PSOs, the following validation check is applied on the sum of PO/PSO wise averages in each course.

$$\sum (\text{Average}) \leq \text{Min} (\text{Credits} * \text{Year}, 20)$$

In above equation, Credits are the credits assigned to the course, Year (5 for 1st Year and 6 for 2nd Year) indicates the level of the students from 1st and 2nd year. In case this sum exceeds the upper limit, CO-PO mappings are revised. This check ensures that early or low credit courses are not over burdened with very high expectations.

3. For creation of Program Articulation Matrix, sum of these averages of different courses w.r.t each PO/PSO is calculated and interpreted as per following Table.

Competence Level *	M.Tech
Novice	<5
Advanced Beginner	5 - 10
Competent	>=10

Novice* (N): Knows objective facts, features, and rules for determining actions wrt this PO/PSO without being context-sensitive. The student has studied the basic concepts.

Advanced beginner* (AB): Recognizes common situations wrt this PO/PSO that help in recalling which rules should be exercised, starts to recognize and handle situations not covered by given facts, features and rules. The student has problem-solving and repeated practice experience for common situations wrt this PO/PSO.

Competent* (C): Performs most standard actions wrt PO/PSO without conscious application of rules after considering the whole situation. Handles new situations through the appropriate application of rules, can design systems, and may lead. Has demonstrated this PO/PSO through repeated engagements in advanced problem-solving, projects, extensive practice in common and exception situations, and participated in professional networks.

JK Lakshmipat University, Jaipur
Institute of Engineering and Technology
Curriculum Structure

Master of Technology in Health, Safety, and Environmental Engineering (Batch 2020-2022)

Courses						Credits
Semester I						
Statistical Data Analysis AS2101 (3 0 4) 5	Industrial Automation and IoT-I EE2101 (3 0 2) 4	Industrial Safety Management ME2101 (3 0 4) 5	Project-I PR2101/ Research Methodology –I IL2107 (2 0 0) 2	Critical Thinking for Developing Perspectives CC2171 (2 0 0) 2	Elective-I (3 0 0) 3	21
Semester II						
Health, Safety, and Environment Audit IL2106 (4 0 2) 5	Risk and Hazard Management IL2103A (3 0 2) 4	Regulation for Health, Safety, and Environment Management IL2104 (4 0 2) 5	Project-II PR2102/ Research Methodology-II IL2108 (2 0 0) 2	Critical Thinking for Decisions at Workplace CC2114 (2 0 0) 2	Elective-II (3 0 0) 3	21
Internship (6- 8 weeks) PS2101						4
Exit Option with PG Diploma						
Semester III						
Dissertation-I/ Industrial Project-I/ Entrepreneurial Project-I PR2103/ PR2104/ PR2105 10		Elective-III (3 0 0) 4		Elective – IV (3 0 0) 4		18
Semester IV						
Dissertation-II/ Industrial Project-II/ Entrepreneurial Project-II PR2106/ PR2107/ PR2108 16						16
Total Credits						80
List of Electives						
SEMESTER-I			SEMESTER-II			
Elective-I			Elective -II			
Industrial Waste Management- CE2201			Occupational Hygiene and Health- IL2201			
Structural Health and Monitoring			Safety in Construction and Mining- CE2204			
Electrical Safety			Statistical Data Analysis-II-AS2104			
			Industrial Automation and IoT-II			
SEMESTER-III						
Elective-III, IV						
Fire Engineering and Management-ME2201						
Transportation Safety Engineering						
Green Building Technology						
Chemical Safety-ME2202						
Environmental Impact Assessment- CE2205						
Biomechanics for Ergonomics						
NOTE:						
<ol style="list-style-type: none"> Students have the option to exit the program with a PG Diploma after completing one year and internship. For every credit, in each course, every student is expected to put in a total work of 35-36 hours including the class time. The specified teaching scheme is applicable if the course is taught as full semester course. However, sometimes, a few courses may actually be completed in a shorter duration by increasing the weekly contact hours. Learning outcomes focus on higher order thinking and practical skills. Rote learning is completely de-emphasized and assessment scheme includes several components like assignments, labs, projects, reports etc. The exams are designed to assess problem solving ability through questions focusing on analysis, synthesis, and evaluation. Relevant engineering standards and sustainability issues are incorporated in all engineering courses. A student may sometimes be allowed to take a few additional courses for earning extra credits, fulfilling credit deficiency or completion of academically equivalent core course requirements in special cases. 						

**Index of Course Description
(Batch: 2020-2022)**

Course Code	Course Name	Page No.
Semester-I		
AS2101	Statistical Data Analysis	1
EE2101	Industrial Automation and IoT-I	3
ME2101	Industrial Safety Management	6
PR2101	Project-I	8
CC2171	Critical Thinking for Developing Perspectives	10
Elective-I		
CE2201	Industrial Waste Management	13
Semester-II		
IL2106	Health, Safety, and Environment Audit	15
IL2103A	Risk and Hazard Management	18
IL2104	Regulation for Health, Safety, and Environment Management	21
PR2102	Project-II	24
CC2114	Critical thinking for Decisions at Workplace	26
Elective-II		
IL2201	Occupational Hygiene and Health	28
CE2204	Safety in Construction and Mining	31
Semester-III		
PS2101	Internship	34
PR2103/ PR2104/ PR2105	Dissertation-I/ Industrial Project-I/ Entrepreneurial Project-I	35
Elective-III		
ME2201	Fire Engineering and Management	37
Elective-IV		
ME2202	Chemical Safety	40
CE2205	Environmental Impact Assessment	43
Semester-IV		
PR2106/ PR2107/ PR2108	Dissertation-II /Industrial Project-II /Entrepreneurial Project-II	45

Course Title and Code: Statistical Data Analysis (AS2101)		
Hours per Week	L-T-P: 3-0-4	
Credits	5	
Students who can take	M.Tech Semester-I (Batch: 2020-2022) Core	
Course Objective: This course aims to introduce basic concepts in descriptive and inferential statistics, as well as data exploration methods. Topics covered include probability distributions, hypothesis testing, frequency analysis, correlation, regression and design of experiments.		
Course Outcomes After course completion, the student will be able to: [AS2101.1]. Frame real world analysis problems using statistical concepts and solve those using standard techniques. [AS2101.2]. Use professional level tools to support the study of statistics. [AS2101.3]. Communicate quantitative ideas to a range of audiences. [AS2101.4]. Apply recommended practices for data analysis.		
	Prerequisites	
Sr. No	Specifications	Marks
1	Attendance	Nil
2	Assignment	Nil
3	Class Participation	10
4	Quiz	10
5	Theory Exam-I	Nil
6	Theory Exam-II	Nil
7	Theory Exam-III	30
8	Report-I	Nil
9	Report-II	Nil
10	Report-III	Nil
11	Project-I	20
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	30
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
	Total (100)	Nil

SYLLABUS

Principles of Statistical Data Analysis: Data Elements, Variables, and Data categorization, Levels of Measurement: Nominal, Ordinal, Interval, or Ratio, Data management and indexing, Tabular data, Measures of dispersions, Skewness – Karl Pearson and Bowley, Skewness – Kelly coefficient of Skewness and Kurtosis,

Probability Theory, Mathematical expectation, moments, probability and moment generating function, Chebyshev's inequality, Mean and Variance of a Random Variable, product moments, independence of random variables, Joint, marginal and conditional distributions, Discrete and continuous distribution function, Introduction to statistical learning using R-Programming/Python

Basic Statistical Techniques: Sampling Theory and Distributions for Normal and Non-normal Populations, Central Limit Theorem, Point and Interval Estimates, Estimator and Estimates, Sample size calculations Sample Size for Estimating Means and Proportions, Maximum likelihood test, The Central Limit Theorem, p-values and power, Parametric and Non-

Parametric test of Hypothesis, Goodness of fit, Analysis of contingency tables, Non-parametric tests of location and dispersion, Statistical inference using R/Python

Analysis of Continuous and Categorical Data: Estimation Using the Regression Line, Method of Least Squares, Standard Error of Estimate, Prediction Intervals, Multi Variate regression, generalized linear models, Logistic regression, Ordinal logistic regression, Proportional odds models, Multinomial logistic regression, Poisson regression, negative binomial regression, zero-inflated models, Log linear models for (paired) tables. Procedures for stepwise building of a regression model, Introduction to random intercept models, penalized linear regression methods, Graphical and formal diagnostic methods for the inspection of residuals, Correlation Analysis, autocorrelation and cross correlation, Regression and Correlation analysis using R/Python

Design of experiments: Basic principles of experimental designs, Analysis of variance: one-way, Two-way classifications, Latin square design, Two Factorial Design.

Text Book(s)

1. Prem S Mann. Introductory statistics. Wiley. Edition: 7th ed. 2010.
2. Ronald E Walpole, Raymond H Myers, Sharon L Myers and Keying Ye. Probability and statistics for engineers and scientists. 8th ed - New Delhi. Pearson. 2007.

Web Resources

1. Statistics full Course for Beginners. <https://www.youtube.com/watch?v=74oUwKezFho>
2. Introduction to R and RStudio. <https://www.youtube.com/watch?v=IL0s1coNtRk>

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
AS2101.1	1	1			2			2		2							3		
AS2101.2	2		1		1		3	1		2							1		
AS2101.3		1			1								3						
AS2101.4	2				3					2							3		1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Industrial Automation and IoT-I (EE2101)		
Hours per Week	L-T-P: 3-0-2	
Credits	4	
Students who can take	M.Tech Semester-I (Batch: 2020-2022) Core	
Course Objective: The course focuses on the application of technologies to control and monitor the industrial processes. Course aims to introduce industrial automation, IoT technologies and standards. Its emphasis is on theoretical principles and applications for problem solving		
Course Outcomes		
After course completion, the student will be able to:		
EE2101.1 Analyze the link between Information Technology and Operational Technology.		
EE2101.2 Specify the key components to design an Industrial automation & IoT system.		
EE2101.3 Choose technologies for communication and real time data collection.		
EE2101.4 Design, deploy and test a basic Industrial automation & IoT system.		
EE2101.5 Apply recommended engineering practices to meet desired requirements for applications, considering sustainability, security and safety as design constraints.		
	Prerequisites	
Sr. No	Specifications	Marks
1	Attendance	NIL
2	Assignment	15
3	Class Participation	05
4	Quiz	10
5	Theory Exam-I	NIL
6	Theory Exam-II	10
7	Theory Exam-III	20
8	Report-I	NIL
9	Report-II	NIL
10	Report-III	NIL
11	Project-I	15
12	Project-II	NIL
13	Project-III	NIL
14	Lab Evaluation-I (Continuous)	15
15	Lab Evaluation-II (Exam)	10
16	Course Portfolio (MOOC Course)	NIL
	Total (100)	100

Evaluation Scheme for Retest:

S. No.	Specifications	Marks
1	Theory Exam-III (End Term)	20
2	Lab Evaluation-II (Exam)	10
3	Total	30

Syllabus

Theory

UNIT1: Introduction: Classical hierarchical industrial automation model. Essential functions of each level. Elements of industrial control (sensors, actuators, transmitters, controllers, etc.). ISA 95 / ISA S88 – Enterprise integration. Emergent architectures.

UNIT2: Instrumentation: Characteristics of instruments: accuracy, precision, sensitivity, etc. Units and standards. Voltage, current and electrical power measurements. Measurement of temperature, position, speed, force, pressure, light, level, humidity and other variables. Signal conditioning and transmission. Indicators, recorders. Actuators. Valves and motors.

Instrumentation symbols. Functional identification. Standards: ISA 5.1 – Instrument symbols and identification. IEC 61511 Safety Instrumented Systems.

UNIT 3: IoT fundamentals, Architecture and protocols,

UNIT 4: Industrial IoT fundamentals. Convergence of IT and OT. Industrial communication: principles, protocols and technologies. Design methodology. Design of IoT systems for industrial safety processes.

UNIT5: CASE STUDIES

Design and test a basic IIoT system involving prototyping, programming and data analysis. Application to sustainability problems: health, energy, water, smart cities, etc.

Practical

1. Characteristics of sensors. Calibration. Temperature, moisture, displacement, voltage, current, etc. Signal conditioning and processing.
2. Interfacing LEDs. Serial port. DC-motor.
3. IoT communication. Standards: MODBUS, OPC, MQTT etc.
4. PLC programming.
5. Mini-project

Text Book(s)

1. Krishna Kant. “*Computer-based Industrial Control*”. PHI Learning Private Limited, 2010.
2. Hanes, Salgueiro, Grossetete, Barton and Henry (2017). “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things”. Cisco Press.
3. Curtis Johnson. “Process Control Instrumentation Technology”. PHI Learning Private Limited, 2013.

Reference Book(s)

1. Gilchrist (2016). “*Industry 4.0: The Industrial Internet of Things*” Apress.
2. John P. Bentley. Principles of Measurement Systems. 4th Edition, Addison Wesley Longman Ltd.,UK, 2004

Web Resources

1. <https://nptel.ac.in/courses/108/105/108105062/>
2. <https://nptel.ac.in/courses/106/105/106105195/>

Online Courses:

1. Developing Industrial Internet of Things
https://www.coursera.org/programs/j-k-lakshmipat-university-on-coursera-kzogk/browse?index=prod_enterprise_products&productId=84QbLYtsEeicuBLWaYs1_g&productType=s12n&query=industrial+iiot&showMiniModal=true
2. Design of Internet of Things
<https://nptel.ac.in/courses/108/108/108108098/>

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
EE2101.1	2				2	1	1				1	1	1	1					
EE2101.2		1			1	1	1	1											
EE2101.3					1	2	1	1	1		1								
EE2101.4	1	1	1		1	1	1	1	1		1		1						
EE2101.5	1		1	1	1	1	1	1	1		1	1							

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Industrial Safety Management (ME2101)		
Hours per Week	L-T-P: 3-0-4	
Credits	5	
Students who can take	M.Tech Semester-I HSEE (Batch: 2020-2022) Core	
Course Objective:		
The goal of this course is to develop understanding about Industrial safety programs and toxicology, Industrial laws, regulations and source models. The course also aims to impart knowledge of the industrial hazard, fire and explosion, preventive methods, relief, and sizing methods.		
Course Outcomes		
After course completion, the student will be able to:		
ME2101.1 Analyse the effect of the release of toxic substances.		
ME2101.2 Explain the industrial laws, regulations and source models.		
ME2101.3 Apply the methods of prevention of fire and explosions.		
ME2101.4 Identified the relief and its sizing methods.		
ME2101.5 Explain the methods of hazard identification and preventive measures.		
ME2101.6 Apply standard safety procedures in an industrial environment.		
	Prerequisites	Engineering Chemistry, Chemical Process Calculation, Mass Transfer, Heat Transfer
Sr. No	Specifications	Marks
1	Attendance	05
2	Assignment	05
3	Class Participation	05
4	Quiz	05
5	Theory Exam-I	10
6	Theory Exam-II	10
7	Theory Exam-III	30
8	Report-I	05
9	Report-II	Nil
10	Report-III	Nil
11	Project-I	05
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	10
15	Lab Evaluation-II	10
16	Course Portfolio	Nil
	Total (100)	100

Syllabus (Theory)

Introduction to Industrial Safety: Statutory Requirements Pertaining To OHS, Organizing For Safety, Material Handling; Electrical Safety; Fire Prevention and Protection; Machine Guarding; Work Permit System; Personal Protective Equipment; Housekeeping;

Basics of Accident Prevention: Basic Philosophy of Industrial Accidents – Causation & Prevention; Types of Hazards; Role of Supervisor in Promoting Safety & Health; Reporting & Classification of Accidents; Hazard Identification & its Techniques.

Basics of Fire Prevention & Protection: Fire & Explosion Hazards; Chemistry & Classification of Fire; Principles of Extinguishment; Portable Fire Fighting System; Fixed Fire Fighting Systems

Personal Protection Equipment: Introduction; Categories of PPE; Care, Maintenance & Effective use of PPE; Safety in Material Handling.

Industrial Hygiene & Occupational Health: An Overview; Occupational Exposure Limits; Toxicology; Workplace Monitoring; Statutory Provision Related To Industrial Hygiene

Accidents Case Studies & Case Histories

Bhopal gas tragedy, Gas-cutting a contaminated drum, tractor overturn, uncalled-for Enthusiasm, Lapse in safety organization, Lack of Procedural System and Supervision, Static Electricity, Failure of Anticipate Hazards, Malfunction and Failure of an ID Fan, Faulty Handling Equipment; Process and chemical handling; Machines and Equipment; Fire; Explosions; Electricity; Other Categories: Collapse of a factory Floor, An unplanned Operation, fall during Erection of a Pipeline, Lack of Safe Operating Procedure.

Syllabus (Practical)

1. Identified Chemical hazard in the JKLU laboratories/related case study.
2. Identified Noise hazard in the JKLU campus /related case study.
3. Identified Biological hazard in the JKLU campus /related case study.
4. Identified Fire hazard in the JKLU laboratories /related case study.
5. Identified Physical hazard in the JKLU campus /related case study.
6. Identified Ergonomic hazard in the JKLU Campus /related case study.

Main References

Textbooks

1. L.M. Deshmukh, “Industrial Safety Management” 15th edition, McGraw Hill Education (India) Pvt. Ltd.(2018).
2. NSC Study materials.

Reference books

1. D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice-Hall, 2011.
2. Fawcett H.H. and W.S.Wood, Safety and accident prevention in Chemical operations 2nd edition John Wiley and Sons Inc. (1982).

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
ME2101.1	1	2	2		2	2		1						2	1		3	2	2
ME2101.2	2	2		1					1							3			
ME2101.3	1									3				1	2	2		3	
ME2101.4						1		1			2	3		1	1	3	2		
ME2101.5	2			1			2						3					3	
ME2101.6		2	3			2	1		2		2			1	1		2		3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Project-I (PR-2101)		
Hours per Week :	L-T-P: 2 0 0	
Credits	02	
Students who can take	M.Tech Semester-I HSEE (Batch: 2020-2022) Core	
Course Objective: This course aims to develop scientific aptitude and lab skills in students and also understand the important role of solid waste management for society and industry. And apply knowledge for preparation of organic compost and generation of methane gas from bio-digester.		
Course Outcomes After course completion, the student will be able to: PR2101.1 Identify project goals, constraints, deliverables, performance criteria, control needs, and resource requirements. PR2101.2 Use appropriate tools and techniques for problem solving. PR2101.3 Utilize technology tools for communication, collaboration, information management, and decision support. PR2101.4 Design appropriate solution/system for given problem. PR2101.5 Test the system with varied test cases.		
	Prerequisites	Basics of Civil Engineering
Sr. No	Specifications	Marks
1	Specifications	Marks
2	Attendance	NIL
3	Assignment	NIL
4	Class Participation	NIL
5	Quiz	NIL
6	Theory Exam-I	NIL
7	Theory Exam-II	NIL
8	Theory Exam-III	NIL
9	Report-I	10
10	Report-II	NIL
11	Report-III	NIL
12	Project-I (Mid-term exam)	20
13	Project-II (Day to day observation)	30
14	Project-III (End term exam)	40
15	Lab Evaluation-I	NIL
16	Lab Evaluation-II	NIL
	Total	100

SYLLABUS

Types and Sources of solid wastes; Need for solid and hazardous waste management; Elements of integrated waste management; Legislations on management and handling of municipal solid wastes.

References:

Textbooks

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated Solid Waste Management, McGraw- Hill, New York, 1993
2. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.
3. Environmental engineering, HS Paevy, DR Rowe, G Tchobanoglous, McGraw Hill
4. Industrial waste treatment by Nelson Leonard Nemarow

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PS O 1	PS O 2	PS O 3	PS O 4
PR2101.1	2		1		2						2		1				2	2	2
PR2101.2	1		1			1				1	2		1			1	2		2
PR2101.3	1				2		1										1		1
PR2101.4	1	1			2	1				2				1				2	2
PR2101.5	1										1								2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Critical Thinking for Developing Perspectives CC2171	
Hours per Week	L-T-P: 2-0-0
Credits	2
Students who can take	M.Tech Semester-I HSEE (Batch: 2020-2022) Core

Course Objective:

The ability to clearly reason through problems and to present arguments in a logical, and compelling way, have become a key skill for survival in today's world. In this course, students will learn to dissect and evaluate the components of argument. Students will learn to raise vital questions, think from multiple perspectives, become aware of their biases, gather and assess information and come to a well-reasoned position.

Course Outcomes

After course completion, the student will be able to:

CC2171.1 Explain the relevance of critical thinking

CC2171.2 Formulate significant questions for inquiry.

CC2171.3 Evaluate information and evidence for correctness, consistency, and relevance.

CC2171.4 Compose well-structured and well-reasoned arguments.

CC2171.5 Recognize their own beliefs, biases, claims and assumptions by viewing the issues from multiple perspectives

Prerequisites		
Sr. No	Specifications	Marks
1	Attendance	Nil
2	Assignment	Nil
3	Class Participation	20
4	Quiz	20
5	Theory Exam-I	Nil
6	Theory Exam-II	Nil
7	Theory Exam-III	20
8	Report-I	Nil
9	Report-II	Nil
10	Report-III	Nil
11	Project-I	40
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	Nil
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
Total (100)		100

Evaluation Scheme for Retest:

S. No.	Specifications	Marks
1	Theory Exam-III	20
3	Total	40

SYLLABUS:

Pedagogy: This course will be an amalgamation of lectures and activity-based learning i.e. films, group discussions, debates, and case studies. The objective behind utilizing activity-based learning is for the learners to have a more hands on experience.

Topics to be covered

I. Introduction to the concept of critical thinking:

- Evolution of the concept: Philosophy and Cognitive psychology as origins of critical thinking
- Revisit Paul-Elder Critical Thinking Framework

II. Questioning for Critical Thinking

- Importance of questioning
- Models of Questioning: Questioning Circles Model, Christenbury and Kelly (1983), Webb's Depth of Knowledge (1997). Elder & Paul (2007). Socratic Questioning Taxonomy.

III. Understanding Arguments

The sessions under this topic will make use of the context of current media, social and political debates to comprehend the topics.

- Meaning and Elements of Reasoning
- Formation of Arguments: Premise and Conclusion
- Inductive –Deductive reasoning: Difference between valid and invalid arguments/ between sound and unsound arguments.
- Evaluating Arguments: Examining data and information critically
- Cognitive Biases and Fallacies: Distinguishing between fact and opinion

Reference Books:

R1. Moore, B. N., & Parker, R. (2009). Critical thinking. Boston, MA: McGraw-Hill. eBook
R2. Sinnott-Armstrong, W., & Fogelin, R. J. (2014). Cengage Advantage Books: Understanding Arguments: An Introduction to Informal Logic. Cengage Learning eBook

Readings/Video(s)

1. The Evolution of Critical Thinking (Research project by Barba Albers, Washington, State University, 2004

2. Bowker, M. H., & Fazioli, K. P. (2016). Rethinking Critical Thinking: A Relational and Contextual Approach. *Pedagogy and the Human Sciences*, 6(1), 1-26.

3. Bauer, N. J. (1991). Dewey and Schon: An Analysis of Reflective Thinking.

4. Nappi, J. S. (2017). The importance of questioning in developing critical thinking skills. *Delta Kappa Gamma Bulletin*, 84(1), 30.

5. <https://cpb-us-e1.wpmucdn.com/cobblearning.net/dist/6/3101/files/2018/05/The-Importance-of-Questioning-2aqkc5j.pdf>

Bloom, B. S. (1956). Taxonomy of educational objectives. Vol. 1: Cognitive domain. New York: McKay, 20-24.

6. Paul, R., & Binker, A. J. A. (1990). Socratic questioning. Critical thinking. Center for Critical Thinking and Moral Critique.

<http://www.criticalthinking.org/files/SocraticQuestioning2006.pdf>

7. The Art of Asking Questions | Dan Moulthrop | TEDxSHHS

<https://www.youtube.com/watch?v=hZSY0PssqH0>

8. Analysing the argument - Part 1 of 2 (Video)

Course Articulation Matrix: (Mapping of COs with POs)

CO	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES				
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PS O 1	PS O 2	PS O 3	PS O 4	
CC2171.1	2						1	2												
CC2171.2	2		1					2							1					
CC2171.3	2		2	1			1	1		1										
CC2171.4	2								1				1							
CC2171.5	2										2									

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Industrial Waste Management (CE2201)		
Hours per Week	L-T-P: 3-0-0	
Credits	3	
Students who can take	M.Tech Semester-I HSEE (Batch: 2020-2022) Elective-I	
Course Objective: This course provides an in-depth understanding of solid and hazardous waste characteristics and management. This course also covers the principles of integrated solid waste management and provides an overview of industrial waste and hazardous waste management.		
Course Outcomes After course completion, the student will be able to: CE2201.1 Analyze key sources, typical quantities generated, composition, and properties of solid and hazardous wastes. CE2201.2. Compare effective methods of solid & hazardous wastes handling and segregation of wastes at source. CE2201.3. Test the most common techniques for preventing, minimizing, recycling, disposing and treatment of waste and their application on-site remediation. CE2201.4. Recognize the relevant regulations that apply for facilities used for disposal, and destruction of waste. CE2201.5. Identify, formulate, and solve engineering problems, and an understanding of professional and ethical responsibility.		
	Prerequisites	
Sr. No	Specifications	Marks
1	Attendance	05
2	Assignment	10
3	Class Participation	05
4	Quiz	-
5	Theory Exam-I	15
6	Theory Exam-II	15
7	Theory Exam-III	30
8	Report-I	-
9	Report-II	-
10	Report-III	-
11	Project-I	20
12	Project-II	-
13	Project-III	-
14	Lab Evaluation-I	-
15	Lab Evaluation-II	-
16	Course Portfolio	-
	Total (100)	100

Evaluation Scheme for Retest:

S. No.	Specifications	Marks
1	Theory Exam-III	30
3	Total	30

SYLLABUS

UNIT-1 SOLID AND HAZARDOUS WASTE: Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management - Legislations on management and handling of municipal solid wastes, hazardous wastes, and biomedical wastes.

UNIT-2 WASTE GENERATION: Waste generation rates – Composition - Hazardous Characteristics – TCLP tests – waste sampling- Source reduction of wastes – Recycling and reuse. Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations - labelling and handling of hazardous wastes.

UNIT-3 WASTE PROCESSING: Processing technologies – biological and chemical conversion technologies – Composting - thermal conversion technologies - energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes.

UNIT-4 DISPOSAL: Disposal in landfills - site selection - design and operation of sanitary landfills- secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – landfill remediation

UNIT-5 Integrated waste management: Elements of integrated waste management

References

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated Solid Waste Management, McGraw- Hill, New York, 1993
2. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES														CORRELATION WITH PROGRAM SPECIFIC OUTCOMES				
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PS O 1	PS O 2	PS O 3	PS O 4
CE2201.1	2	2										2		2			3		2
CE2201.2	2	2					2			1	1	2				1	2		2
CE2201.3	2		2				1			2		1		1		1		2	2
CE2201.4			1										1			3		2	
CE2201.5	2		1			2				2	1		2	2				3	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Health, Safety, and Environment Audit (IL2106)		
Hours per Week	L-T-P: 4-0-2	
Credits	5	
Students who can take	M.Tech. Semester-II (Batch: 2020-2022) Core	
Course Objective: This course introduces the fundamental concepts of health, safety, environment audit techniques and their applications in the industry.		
Course Outcomes		
After course completion, the student will be able to:		
IL2106.1 Explain the elements of the auditing system for safety, health, and the environment.		
IL2106.2 List out all the requirements for audit preparation as per the legislation/standards.		
IL2106.3 Conduct environmental audits, water audits, carbon footprint audits, fire audit, electrical audit, process safety audit, energy audit and critically evaluate its outcomes.		
IL2106.4 Evaluate the outcome of the HSE audit and prepare a report for the suggestion /recommendation.		
IL2106.5 Develop checklists/protocols and the guidelines for Auditing Management Systems as per National and International HSE Auditing Standards.		
Sr. No	Specifications	Marks
1	Attendance	Nil
2	Assignment	15
3	Class Participation	Nil
4	Quiz	15
5	Theory Exam I	10
6	Theory Exam	Nil
7	Theory Exam (End Term)	25
8	Report-1	15
9	Report-2	Nil
10	Report-3	Nil
11	Project -1	Nil
12	Project -2	Ni
13	Project -3	Nil
14	Lab Evaluation1	10
15	Lab Evaluation2	10
16	Course portfolio	Nil
	Total (100)	100
Evaluation Scheme for Retest		
1	Theory Exam-III	25
2	Lab Evaluation2	10
	Total (40)	35

Course Syllabi (Theory):

Unit-I: Elements of a Good Safety, Health and Environmental System; Management Systems; Auditing the Principles: Management Audits. Specialist Audits; Operational Audits; Purpose and Benefits; the Standard or Requirement; Preparation; Protocols and Checklists; the Entry Meeting; Area Familiarisation; Audit Observation Skills; The Importance of Verification and the Audit Trail; Conformity; Documentary Review; Audit Uniformity and Credibility; Auditor Training; Managing Auditee Expectations;

Unit-II: Auditing and Its Relevance to Regulatory Compliance; Reporting Quantitative and Qualitative Assessment; Follow-Up; Choosing the Audit Process; Audit Team Composition; EHS Aspects of Due Diligence Audits; International EHS Auditing Standards; Process Safety Audits; Fire Life Safety Audit; Occupational Health and Safety Audits.

Unit-III: Definition of Environment Audit and its importance for industries. Types of audits, General audit methodology and basic structure of audit. Elements of an audit process and its importance, Urban Environment Audit.

Unit-IV: Requirements of Rule 14 for Environmental Audit under Environmental protection Act 1986, Definitions of Signatory, Consumption Audit, Pollution audit, Hazardous audit, Solid waste audit, Disposal audit, Cost audit, Investment audit, Voluntary. Introduction to ISO 14001 series, OHSAS 18001, ISO 45001 2018; case studies.

Unit-V: Transformers, HT/LT distribution panels, Diesel generator and its availability, Lightning protection system, Emergency power distribution system, Grounding & earthing, CEA Regulations 2010 Compliance Review, Emergency control procedures, Training competence evaluation, Systems and document review, Contractor management.

Unit-VI: Electrical Energy Management, energy conservation in industries and buildings, energy conservation in motors, Pumps and fan systems, energy efficient motors, Adoption to sustainable resources, process and technologies, Identification and Techno-economic Analysis of Energy Conservation Measures, outlines of Energy Audit Report Format.

SYLLABUS (Practical):

1. Fire Safety Audit of JKLU Campus / related case study
2. Occupational health and safety audit of JKLU/related case study
3. Environmental Auditing of JKLU campus/Related Case study
4. Electrical safety audit of JKLU campus/related case study.

References

1. Simon Watson Pain, Safety, Health and Environmental Auditing “A Practical Guide”, Second Edition, CRC Press.
2. Albert Thumann, Terry Niehus, William J. Younger, Handbook of Energy Audits, CRC Press.
3. Sonal Desai, Handbook of Energy Audit, McGraw Hill Education (India) Private Limited New Delhi

Course Articulation Matrix: (Mapping of Los with POs)

CO	CORRELATION WITH PROGRAM OUTCOMES														CORRELATION WITH PROGRAM SPECIFIC OUTCOMES				
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
IL2106.1	1		2	1		1		1			2		1			1		3	2
IL2106.2	2		2		1	2		2		1	1					2	1	2	
IL2106.3	1		3	1		2	2	2	1	1	3	2	1			1	2	3	3
IL2106.4	2		3		1	1	1	2		2	2	2	2			2		2	3
IL2106.5	2		2	1		1	2	2		1	3		1					2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Risk and Hazard Management (IL2103A)		
Hours per Week	L-T-P: 3-0-2	
Credits	4	
Students who can take	M.Tech Semester-II (Batch: 2020-2022) Core	
Course Objective:		
The goal of this course is to introduce the student into the process for conducting a hazard/risk analysis and developing a hazard/risk management plan to support safety requirements as per safety standards. The course also aims to equip students with an understanding of basic electrical safety, identify, electrical hazards, plan & precautions to avoid injury at the workplace.		
Course Outcomes		
After course completion, the student will be able to:		
IL2103A.1 Explain the basic concepts in risk and hazard and use of a risk assessment technique to quantify the risk		
IL2103A.2 Identify hazards in workplace activities using hazard identification techniques and hazard assessment process.		
IL2103A.3 Assess health risks at different workplaces by integrating relevant data from a variety of sources.		
IL2103A.4 Take appropriate corrective action in emergency situations, i.e., fire, explosion, and accident.		
IL2103A.5 Assess risk and vulnerability for the electrical system considering both natural and manmade failures.		
IL2103A.6 Employ hazard analysis techniques in Industry and helpful to prevent the accidents in Industry		
	Prerequisites	
Sr. No	Specifications	Marks
1	Attendance	Nil
2	Assignment	10
3	Class Participation	Nil
4	Quiz	10
5	Theory Exam-I	15
6	Theory Exam-II	15
7	Theory Exam-III	30
8	Report-I	Nil
9	Report-II	Nil
10	Report-III	Nil
11	Project-I	Nil
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	10
15	Lab Evaluation-II	10
16	Course Portfolio	Nil
	Total (100)	100
Evaluation Scheme for Retest		
1	Theory Exam-III	30
2	Lab Evaluation-II	10
	Total (40)	40

Syllabus (Theory)

Physical, Chemical & Biological Hazards: Noise, Ionizing radiation, non-ionizing radiations, cold environments, hot environments, Recognition of chemical hazards, Exposure vs. dose, TLV-Methods of Evaluation, Classification of Biohazardous agents, General Control Methods; training and education, employee health program. Control measures, OSHA standard. (09)

Hazard, Risk Issues, And Hazard Assessment: 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, Failure Mode and Effect Analysis (FMEA), fire explosion and toxicity index (FETI). (12)

Credibility of Risk Assessment Techniques: 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. (09)

Electrical risk management: Risk Management Process, Identify the hazards, Assess the risks, Control the risks, Review the control measures, Specific hazards and risk control of electrical equipment installations at the workplace, risk controls – energized electrical work, low voltage isolation, and access, risk Controls– energized electrical work, risk controls – working near energized electrical parts.(10)

Syllabus (Practical)

1. To identify the different classes of hazards in the JKLU Campus.
2. To study HAZOP and Hazid analysis of petrochemical industries.
3. To study a quantitative risk analysis of one refinery.
4. Design of earthing system for HV/EHV substation
5. To study electrical safety hazards awareness on the basic rule(s) for all electrical work as per OSHA regulation

Reference Book(s)

1. Frank P. Less, Loss Prevention in Process Industries, (Vol.I, II and III), Butterworth-Hein UK 1990.
2. Methodologies for Risk and Safety Assessment in Chemical Process Industries, commonwealth Science Council, UK.
3. Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process Safety, AIChE 1992
4. ILO- Major Hazard control- A practical Manual, ILO, Geneva, 1988.
5. Trevor A Klett, "HAZOP and HAZOM," Institute of Chemical Engineering, 1983
6. Fordham Cooper, W., Electrical Safety Engineering, Butterworth and Company, London, 1986.
7. Accident prevention manual for industrial operations, National Safety Council, N.S.C., Chicago, 1982.
8. Indian Electricity Act and Rules, Government of India.
9. Moja SJ, Van Zuydam CS, Mphephu (2016) Hazard and Risk Assessment in Electricity Sector: A Case of Swaziland Electricity Company. J Geogr Nat Disast S6.
10. Health and Safety. Executive. Electricity at work. Safe working practices. HSG85 (Third edition). Published 2013.

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
IL2103A.1	2	2	2		1	3	2	2	3			2	2	2			2	2	2
IL2103A.2	2		2		2	2			2									3	2
IL2103A.3							2	2	2	2							2		
IL2103A.4									3	3									3
IL2103A.5								2				2					3		
IL2103A.6									2		3					2			2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Regulation for Health, Safety, and Environment Management (IL2104)		
Hours per Week	L-T-P: 4-0-2	
Credits	5	
Students who can take	M.Tech Semester-II (Batch: 2020-2022) Core	
Course Objective: This course aims to develop understanding of the regulatory standards and acts for applying policies, procedures, and occupational safety and health principles, and best practices for ensuring health and safety at workplace and protect environment.		
Course Outcomes		
After course completion, the student will be able to:		
IL2104.1 List out important legislations related to health, Safety and Environment.		
IL2104.2 List out requirements mentioned in factories act for the prevention of accidents.		
IL2104.3 Implement the health and welfare provisions as given in the factories act.		
IL2104.4 Explain the statutory requirements for an Industry on registration, license and its renewal.		
IL2104.5 Design Safety and Occupational Health Plans for different projects according to the OSHA 18001 standard and the current laws		
IL2104.6 Evaluate and deploy appropriate control systems for air pollutants.		
	Prerequisites	
Sr. No	Specifications	Marks
1	Attendance	Nil
2	Assignment	10
3	Class Participation	Nil
4	Quiz	10
5	Theory Exam-I	10
6	Theory Exam-II	10
7	Theory Exam-III	25
8	Report-I	15
9	Report-II	Nil
10	Report-III	Nil
11	Project-I (Case Study	Nil
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	10
15	Lab Evaluation-II	10
16	Course Portfolio	Nil
	Total (100)	100
Evaluation Scheme for Retest		
1	Theory Exam-III	25
2	Lab Evaluation-II	10
	Total (35)	35

SYLLABUS

Factories Act–1948: Statutory authorities, inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young persons, special provisions, penalties and procedures, State 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, Biomedical waste (Management and Handling Rules, 1989, the noise pollution (Regulation and Control) Rules, 2000, The Batteries (Management and Handling Rules) 2001, No Objection certificate from statutory authorities like pollution control board. Air Act 1981 and Water Act 1974: Central and state boards for the prevention and control of air pollution-powers and functions of boards, prevention and control of air pollution and water pollution, fund, accounts and audit, penalties and procedures.

Manufacture, Storage and Import of Hazardous Chemical Rules 1989: Definitions, duties of authorities, responsibilities of the 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.

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 precipitators, bag filter, maintenance, control of gaseous emission by adsorption, absorption and combustion methods, Pollution Control Board-laws. Pollution control in process industries like cement, paper, and petroleum, petroleum products, textile, tanneries, thermal power plants, dyeing and pigment industries, eco-friendly energy.

International Acts, Standards 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. Occupational Safety and Health act of USA (The Williams, Steiger Act of 1970), Health and safety work act (HASAWA 1974, UK), OSHAS 18000, OHSAS 18001, ISO 14000, and American National Standards Institute (ANSI). ILO Conventions; The Workmen's Compensation Act, ESIC Act., The Bio-Medical Waste Rules; Mines Act.1952 & Mines Rules, 1955; Water (Prevention & control of pollution) Act, 1974 and Rules; Air (Prevention & control of pollution) Act, 1981 and Rules.; Environment protection Act 1986 (Amended) and Rules; The Dock Workers (Safety, Health, and Welfare) Act, 1986 and the Regulations 1990 framed thereunder.

Syllabus (Practical):

Characterization physical, chemical and biological properties of water, wastewater, air and solid wastes.

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 P18001, Dr. K.C. Arora, S.K. Kataria & Sons, Delhi
10. Rao, CS, Environmental pollution engineering, Wiley Eastern Limited, New Delhi, 1992.
11. H. S. Peavy, D. R. Rowe, G. Tchobanoglous Environmental Engineering - McGraw- Hill Book Company, New York, 1987.
12. H.Ludwig, W.Evans, Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands, N.J., 1991.
13. Arcadio, P. Sincero and G. A. Sincero, Environmental Engineering – A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002.
14. G. Masters Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd, New Delhi, 2003.
15. S.P. Mahajan, Pollution control in process industries, Tata McGraw Hill Publishing Company, New Delhi, 1993
16. Varma and Braner, Air pollution equipment, Springer Publishers, Second Edition

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
IL2104.1	1	2	2	1					1				1			3		2	2
IL2104.2						3										3		2	
IL2104.3	2				2	2	3	2				2		1		3		3	
IL2104.4	2			2					2		1					2			2
IL2104.5	1	2									2	2					3		
IL2104.6			2							2					1	2		2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Project-II (PR2102)		
Hours per Week :	L-T-P: 2 0 0	
Credits	02	
Students who can take	M.Tech Semester-II (Batch: 2020-2022) Core	
Course Objective:		
This course is aimed at introducing the primary important concepts of project related to Health Safety and environment in realistic manner. Students will also get familiar with the different activities involved in Project work. Further, they will also come to know how to successfully plan and implement the project activity, and to complete a specific project in time with the available resources.		
Course Outcomes		
After course completion, the student will be able to:		
PR2102.1: Apply relevant tools and be able to find data to estimate parameters.		
PR2102.2: Identify and describe the key phases of project work.		
PR2102.3: Carry out an independent limited research and development projects.		
PR2102.4: Analyze the estimated parameters and assess the validity of the results.		
PR2102.5: Communicate about technical issues, analysis and conclusions in the field.		
	Prerequisites	Basics of Civil Engineering
Sr. No	Specifications	Marks
1	Attendance	NIL
2	Assignment	NIL
3	Class Participation	NIL
4	Quiz	NIL
5	Theory Exam-I	NIL
6	Theory Exam-II	NIL
7	Theory Exam-III	NIL
8	Report-I	NIN
9	Report-II	NIL
10	Report-III	NIL
11	Project-I	50
12	Project-II	50
13	Project-III	NIL
14	Lab Evaluation-I (Continuous Evaluation)	NIL
15	Lab Evaluation-II (Lab Examination)	NIL
16	Course Portfolio	NIL
	Total	100

**Retest is not applicable for PR2102. If student fails, he/she has to repeat the course in next semester

References:

Textbooks

1. Environmental engineering, HS Paevy, DR Rowe, G Tchobanoglous, McGraw Hill
2. Environmental engineering: Wastewater engineering, SK Garg, Khanna Publishers
3. Water supply and sanitation engineering, GS Birdie, JS Birdie, Galgotia Publishing Ltd.

4. Water Supply Engineering, Dr. B.C. Punmia Laxmi Publications Pvt. Ltd.
5. Water and wastewater engineering, Metcalf and Eddy, McGraw Hill
6. Standard Handbook of Environmental Engineering, by Robert A. Corbitt, McGraw-Hill Professional publication.
7. Industrial waste treatment by Nelson Leonard Nemarow

E-books

- 1) Textbook Of Environmental Engineering by P. Venugopala Rao
- 2) Environmental Engineering by D. Srinivasan.

Video Lectures

- 1) NPTEL >> Civil Engineering >> Water and Waste Water Engineering (Video) >>
- 2) Civil Engineering - Environmental Air Pollution >> NPTEL videos

Websites (related to the course)

- 1) <http://www.cpcb.nic.in/>
- 2) <http://www.rpcb.rajasthan.gov.in>
- 3) <http://www.bis.org.in/>
- 4) <http://www.who.int/en/>
- 5) <http://www.moef.gov.in/>
- 6) <http://www.greentribunal.gov.in/>
- 7) <http://npTEL.ac.in/courses/105/104/105104099/>

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
PR2102.1	2		1		2						2						2	2	2
PR2102.2	1		1			1				1	2					1	2		
PR2102.3	1				2		1										1		
PR2102.4	1	1			2	1				2					1			2	2
PR2102.5	1										1								2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Critical Thinking for Decisions at Workplace (CC2114)		
Hours per Week :	L-T-P: 2 0 0	
Credits	02	
Students who can take	M.Tech Semester-II HSEE (Batch: 2020-2022) Core	
Course Description: In today's world, the idea of right and wrong is being challenged by businesses, use of technology, economic conditions, and norms of societies. The relevance of a well-reasoned decision is crucial. This course intends to make students take better decisions keeping in mind purpose, context, and ethics.		
Course Outcomes		
After course completion, the student will be able to:		
CC2114.1 Apply techniques of critical thinking to analyze organizational problems through positive inquiry		
CC2114.2 Describe and analyse appropriate problem-solving and ethical decision-making processes		
CC2114.3 Choose the most effective and logical decision among multiple alternatives		
CC2114.4 Evaluate solutions and anticipate likely risks based on purpose, context and ethics		
Prerequisites		N/A
Sr. No	Specifications	Weightage
01	Attendance	Nil
02	Assignment	20
03	Class Participation	20
04	Quiz	Nil
05	Theory Exam-I	Nil
06	Theory Exam-II	20
07	Theory Exam-III	30
08	Report-I (Presentation)	10
09	Report-II	Nil
10	Report-III	Nil
11	Project-I	Nil
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I (Continuous Evaluation)	Nil
15	Lab Evaluation-II (Lab Examination)	Nil
16	Course Portfolio	Nil
	Total (100)	100
Evaluation Scheme for Retest		
1	Theory Exam-III	30
	Total (30)	30

References for Readings:

1. Lehrer, J. (2010). *How we decide*. Houghton Mifflin Harcourt.
2. Heath, C., & Heath, D. (2013). *Decisive: How to make better choices in life and work*. Random House.
3. Hammond, J. S., Keeney, R. L., & Raiffa, H. (2015). *Smart choices: A practical guide to making better decisions*. Harvard Business Review Press.
4. Cases and scenario will be shared in the class.

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES														CORRELATION WITH PROGRAM SPECIFIC OUTCOMES				
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PS O 1	PS O 2	PS O 3	PS O 4
CC2114.1	2						1	2	2										
CC2114.2	2		1	1					1		2		1						
CC2114.3	2		2	1			1	1		1			1	1					
CC2114.4	2								1		1		1						

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Occupational Hygiene and Health (IL2201)		
Hours per Week	L-T-P: 3-0-0	
Credits	3	
Students who can take	M.Tech Semester-II HSEE (Batch: 2020-2022) Elective-II	
Course Objective:		
This course aims to develop understanding of the broad principles in occupational hygiene as the basis for anticipation, recognition, evaluation, and control of hazards that can be encountered at the workplace.		
Course Outcomes		
After course completion, the student will be able to:		
IL2201.1 Identify the health hazard and the importance of occupational hygiene.		
IL2201.2 Explain the role of the occupational hygienist in the workplace.		
IL2201.3 Apply the Hazard recognition techniques and use Methods of controlling exposure.		
IL2201.4 Identify Ergonomic & psychosocial Hazards in the workplace.		
IL2201.5 Apply the basic principles for measurement, control, and evaluation of occupational hygiene.		
IL2201.6 Interpret data and apply recommendations of occupational hygiene reports.		
IL2201.7 Characterize the common hazards in a wide range of production processes found in India.		
	Prerequisites	N/A
Sr. No	Specifications	Marks
1	Attendance	05
2	Assignment	10
3	Class Participation	05
4	Quiz	10
5	Theory Exam-I	15
6	Theory Exam-II	15
7	Theory Exam-III	30
8	Report-I	10
9	Report-II	Nil
10	Report-III	Nil
11	Project-I	Nil
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	Nil
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
	Total (100)	100
Evaluation Scheme for Retest		
1	Theory Exam-III	30
	Total (30)	30

Syllabus (Theory)

Overview of Occupational Health: Present status of occupational health; Nationally and Internationally including public health & social welfare, strategy and programme of health protection; role of National and International Organizations, Government, employer, safety committee, trade union & employees.; Occupational Health Policy in India; Occupational Health Surveillance and Health Service at work place; Workplace Health Monitoring, maintenance of health register & records; Prevention of Occupational Health Hazards; Occupational health audit and occupational Health Survey.; in the field of occupational health. ; OHS its principles & functions. First aid centre, first aid box and industrial hospitals. Diagnosis of Occupational Diseases.; Occupational health hazards and its preventive measures.

Occupational Diseases & its Diagnosis: (Notifiable Occupational Diseases in India as per Factories Act, 1948.)- Occupational Lung Diseases like Silicosis, Asbestosis, Coal Worker's Pneumoconiosis, Mixed Dust Fibrosis.; Occupational Asthma(i.e. Bysinosis) & Extrinsic Allergic Alveolitis (like Bagassosis).; Occupational Health related other diseases (i.e. Anorexia, Hemoptysis, Rales, Sarcoidosis, Emphysema, Bronchitis, Scleroderma); Musculoskeletal Injuries; Biological hazards (Bacterial, Viral, Fungi, Moulds, rickettsial and chlamydial agents).; Occupational Zoonotic Disease.; ILO list of Occupational Diseases globally; Hospital Waste management.

Ergonomics & Psychosocial Hazards : Introduction to Ergonomics, application of ergonomics in industry, Stress and performance, anthropometry and work physiology, physical fitness test in industry, VO₂Max, workload. Psychosocial Hazards in Occupation and application of industrial psychology in occupational health, occupational health disorders of psychological origin, principle of behavioral toxicology, parameters of measurements for evaluation of physiological (categorization of job, heaviness , work organization and work load, stress & strain, fatigue , rest pauses and shift work , personal hygiene).

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 – cardiopulmonary resuscitation, audiometric tests, eye tests, vital function tests. Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems.

Main References

1. Toxicology Fundamentals, Target organs, and Risk Assessment, 2nd edition, Hemisphere Publishing Corps, 1991Lu, Frank C, Basic,
2. The Basic Science of Poisons Amdur M. Doull, J and Klassen, C.D.
3. Handbook of Occupational Safety & Health Lawrance Slote,
4. U S Department of Labor, Occupational Outlook Handbook
5. Industrial toxicology Philip L. Williams and James L. Burson,
6. Inhalation Toxicology Research Methods, Applications and Evaluationm, Harry Salem
7. Industrial hygiene & Toxicology, Volume –2, Frank a. Petty
8. Occupational Safety & Health Management –Thomas J Anton2. Safety Professional's reference & study guide –W David Yates3. Fundamental Principles of Occupational Health & Safety –Benjamin.O.Alli

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES														CORRELATION WITH PROGRAM SPECIFIC OUTCOMES				
	PO 1	PO 2a	PO 2b	PO 2C	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PS O 1	PS O 2	PS O 3	PS O 4
IL2201.1	1		1									1	1				2		1
IL2201.2	1										2						2		
IL2201.3	2		1			1											3		2
IL2201.4	2						1			1				1			2	1	2
IL2201.5	2		2																2
IL2201.6	1			1							1						3	2	1
IL2201.7	1															1			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Safety in Construction and Mining (CE2204)		
Hours per Week :	L-T-P: 3-0-0	
Credits	03	
Students who can take	M.Tech Semester-II HSEE (Batch: 2020-2022) Elective-II	
Course Objective		
Objective of this course is to apply skills on technical, managerial and legal framework for safety and health in the construction as well as in mining sector.		
Course Outcomes		
After course completion, the student will be able to:		
CE2204.1 Define key safety requirements in construction and mining sectors.		
CE2204.2 Identify hazards and risks involved in construction and mines sites.		
CE2204.3 Implement Effective Safety Management System.		
CE2204.4 Reduce workplace injuries through incident prevention methods.		
CE2204.5 Improve safety culture within an organization.		
CE2204.6 Apply Indian Standards for safety in Construction and mining at work place.		
	Prerequisites	Basics of Civil Engineering
Sr. No	Specifications	Marks
1	Attendance	NIL
2	Assignment	10
3	Class Participation	10
4	Quiz	10
5	Theory Exam-I	NIL
6	Theory Exam-II	15
7	Theory Exam-III	25
8	Report-I	15
9	Report-II	15
10	Report-III	NIL
11	Project-I	NIL
12	Project-II	NIL
13	Project-III	NIL
14	Lab Evaluation-I(Continuous Evaluation)	NIL
15	Lab Evaluation-II(Lab Examination)	NIL
16	Course Portfolio	NIL
	Total	100

SYLLABUS

Unit:1Safety management and regulatory framework: Importance and current situation on safety in construction, safety actions & planning, Construction Project: General features, key tasks, safety planning, personal safety equipment, worker participation, hazard identification and assessment, hazard prevention and control, education and training, program.

The building and other construction workers, (Regulation of employment and conditions of service) acts, 1996, The building and other construction workers, (Regulation of employment and conditions of service) central rules, 1998, labor laws.

Unit 2: Safety during construction works- Basic terminology in safety, types of injuries, safety pyramid, planning for safety budget, safety culture. Safety practice during construction - Earthwork, masonry and concrete construction, railway line construction, sewer construction. Safety during demolition and dismantling of structures.

Unit:3: Safety in highway construction: Introduction, Components of the construction zone, Traffic control devices, Traffic management practices, Planning and implementation of safety measures during construction/maintenance of roads as per guidelines of IRC: SP:55, Road safety audit during construction as per IRC: SP 88.

Unit-04 Safety and Health in Mining: Occupational hazards of mining and diseases; accidents and their classification; frequency rates and severity rates of accidents; cause-wise analysis; basic causes of accident occurrence; investigations into accidents and accident reports; Cost of Accidents. Emergency measures and emergency organization, Disaster Management Plans for major disasters of explosions, Measures for improving safety in mines, risk assessment.

Unit-05 Mining regulations and laws: Development of mining laws in India. Sources of legislations, mining laws of India. General provisions of Mines and Minerals (Regulation and Development Act 1957, Mineral Concession Rules 1960, Salient features of Mines Act 1952, Mines Rules 1955, General provisions of Coal Mines Regulations 1957.

References:

1. Tang, S.L., Ahmed, S.M., Aoieong, Raymond T. and Poon, S.W. (2005), Construction quality management, Hong Kong University Press, Hong Kong.*
2. Poon, S.W., Tang, S.L. and Wong, Francis K.W. (2008), Management and economics of construction safety in Hong Kong, Hong Kong University Press.*
3. International Journal of Quality and Reliability Management. (Emerald's journal)
4. The TQM Journal (Emerald's journal)
5. Safety Science (Elsevier's journal)
6. IRC:SP:55-2001 "Guidelines on safety in road construction zones, The Indian Road Congress, New-Delhi.
7. Building & other construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 (BOCWA)
8. Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Central Rules, 1998 (BOCWR)
9. OSHA Field Safety and Health Manual
10. Hudson, R., Construction hazard and Safety Handbook, Butterworth's Publication, 1985.
11. InatheaD.Sime, Safety in the Build Environment, London, 1988.
12. V.J.Davies and K.Thomasin, Construction Safety Hand Book, Thomas Telford Ltd., London, 1990.
13. Handbook of OSHA Construction safety and health, Charles D. Reese and James V. Edison
14. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982
15. Fulman, J.B., Construction Safety, Security, and Loss Prevention, John Wiley and Sons, 1979.
16. Indian Mining Legislation – A Critical Appraisal by Rakesh & Prasad
17. NIOSH Publications

18. DGMS Circulars by L.C.Kaku

19. Safety in Mines : A survey of accidents, their causes and prevention by Prof. Kejriwal

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES				
	PO 1	PO 2a	PO 2b	PO 2C	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4	
CE2204.1	2																			
CE2204.2	2													1		2	3			
CE2204.3	1							3			3			3				2		
CE2204.4																				
CE2204.5	1	2												2						2
CE2204.6	2			2												3				

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Internship (PS2101)		
Total Duration	6-8 Weeks	
Credits	04	
Students who can take	M.Tech Semester-III (Batch: 2020-2022) Core	
Course Objective: The purpose of the internship is to give students the opportunity to develop an understanding of their profession in a professional context.		
Course Outcomes After course completion, the student will be able to: PS2101.1 Identify skills and capabilities that intersect effectively with the needs of industry. PS2101.2 Apply and practice good communication skills in the workplace setting. PS2101.3 Reflect and evaluate on experiences that might lead to future employment.		
Evaluation Scheme:		
Supervisor Evaluation	Evaluation Component	Marks
External Supervisor	Day to Day task Record, External supervisor feedback form	50
Faculty Supervisor	Reporting Activity Fortnightly, Presentation & Viva	30
	Report	20
Total		100

Course Articulation Matrix: (Mapping of COs with POs)

CO	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
PS2101.1	2		2		3	3	1	3			3			1		2			
PS2101.2		2			2						2		3				2		2
PS2101.3	2		2	2	2	2	2				3	3						2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Industrial Project-I (PR2104)		
Hours per Week	Minimum 20 hrs. Per week for full semester.	
Credits	10	
Students who can take	M.Tech Semester-III (Batch: 2020-2022) Core	
Course Objective: The purpose of the Industrial Project-I is to give students the opportunity to develop an understanding of their profession in a professional context. They will prepare a research, development, or other type of engineering project with the guidance of an industrial and academic supervisors.		
Course Outcomes After course completion, the student will be able to: PR2104.1 Identify skills and capabilities that intersect effectively with the needs of industry. PR2104.2 Apply and practice good communication skills in the workplace setting. PR2104.3 Reflect and evaluate on experiences that might lead to future employment. PR2104.4 Report research findings in written and verbal forms. PR2104.5 Demonstrate and apply industry observation/research skills to complete a project.		
Evaluation Scheme: Weightages of different evaluation components		
Mid-Term		
Expert Evaluation	Evaluation Component	Marks
Panel of Examiner	Synopsis	15
Panel of Examiner	Report Content & Presentation	15
Internal Mentor	Reporting Activity Fortnightly	10
Industry Expert	Industry Expert Feedback	15
M.Tech Coordinator	M.Tech Coordinator Feedback	5
Total		60
Final Term		
Industry Expert	Industry Feedback	50
Internal Mentor	Reporting Activity Fortnightly	20
Panel of Examiner	Presentation, Report, Viva	60
M.Tech Coordinator	M.Tech Coordinator Feedback	10
Total		140
Total (Mid-term Final Term)		200

Syllabus:

Dissertation-I/ Industrial Project-I/ Entrepreneurial Project-I, Research and development projects based on problems of practical and theoretical interest. Students may choose a project based on any subject of Health, safety and Environmental Engineering. The student will submit a synopsis at the beginning of the semester for approval from the departmental committee in a specified format. Evaluation will be based on student seminars, written reports, and evaluation of the developed system and/or theories.

Operation Procedure

- Student has to devote full semester for Dissertation-I/ Industrial Project-I/ Entrepreneurial Project-I.
- Student has to report to the Supervisor regularly.

- Seminars evaluation has to be carried out in the presence of a two member Committee comprising.
- Experts in the relevant area constituted by the Supervisor.
- Final Dissertation-I/ Industrial Project-I/ Entrepreneurial Project-I Report to be submitted has to be in formal hard bound cover bearing of the Institute emblem.

Reference Books and Tools:

Based on literature survey to be done with peer reviewed journals and magazines and relevant tools required to build the project.

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PS O 1	PS O 2	PS O 3	PS O 4
PR2104.1	2		2		3	3	1	3			3			1		2			
PR2104.2		2			2						2		3				2		2
PR2104.3	2		2	2	2	2	2				3	3						2	
PR2104.4		3		3	3		1				2		2	3	2			2	2
PR2104.5	2			3	3	2					3			3	3	2			3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Fire Engineering and Management (ME2201)		
Hours per Week	L-T-P: 3-0-0	
Credits	4	
Students who can take	M.Tech Semester-III (Batch: 2020-2022) Elective	
Course Objective:		
The goal of this course is to impart knowledge of the Fire Chemistry, Major Organizations in the Field of Fire Safety, Fire Detection Systems, Care, Maintenance, and Inspection, Legal Aspects, Organization, and Legislation, Emergency Response Planning for Safety Professionals, and Fire Codes and Standards.		
Course Outcomes		
After course completion, the student will be able to:		
ME2201.1 Distinguish and select the most suitable portable and fixed fire extinguishing systems for different kinds of fire.		
ME2201.2 Describe the number system used by the United Nations and Department of Transportation (DOT) in classifying hazardous materials.		
ME2201.3 Determine the factors necessary when selecting an appropriate fire detection and controlling system for any kind of buildings.		
ME2201.4 Describe the suitable and effective methods for proper care and maintenance of automatic/manual and portable/ fixed fire protection systems.		
ME2201.5 Prepare, review, and/or approve all the applicable safe-practice methods/standards as per legislation to protect life, society, and property from fire hazards.		
ME2201.6 Develop and implementing the key elements of an emergency response action program.		
ME2201.7 Explain the development and implementation of the National Fire Incident Reporting System (NFIRS).		
	Prerequisites	
Evaluation Scheme		
Sr. No	Specifications	Marks
01	Attendance	Nil
02	Assignment	20
03	Class Participation	05
04	Quiz	20
05	Theory Exam-I	10
06	Theory Exam-II	Nil
07	Theory Exam-III	30
08	Report-I	15
09	Report-II	Nil
10	Report-III	Nil
11	Project-I	Nil
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	Nil
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
	Total (100)	100
Evaluation Scheme for Retest		
07	Theory Exam-III	30

SYLLABUS

PHYSICS AND CHEMISTRY OF FIRE: 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; Understanding & Implementing Standards National Fire Protection Act 1407 and 1021. Case studies: Flixborough, Mexico disaster, Pasedena 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 standpipes, 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, standpipes, 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; the need for Halon replacement, smoke venting. Portable extinguishers, flammable liquids, tank farms, indices of inflammability, firefighting systems.

BUILDING FIRE SAFETY: Objectives of fire-safe building design, Fire load, fire-resistant material and fire testing, structural fire protection, structural integrity, the concept of egress design, exists, width calculations; fire certificates, fire safety requirements for high rise buildings, snooker.

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 (CO₂) and halons, hazards in LPG, ammonia (NH₃), sulphur dioxide (SO), chlorine (Cl) etc.

Text Book

- T1 Derek, James, Fire Prevention Hand Book, Butterworths and Company, London, 1986.
- T2 Daniel E. Della-Giustina, Fire Safety Management Handbook, Third Edition, CRC Press, Taylor & Francis Group, 2014

References

- R1 Gupta, R.S., Hand Book of Fire Technology, Orient Longman, Bombay 1977.
- R2 Accident Prevention manual for industrial operations, N.S.C., Chicago, 1982.
- R3 Dinko Tuhtar, Fire and explosion protection– A System Approach, Ellis Horwood Ltd, Publisher, 1989
- R4 William E. Clark, “Firefighting Principles & Practices”, Fire Engineering Books and Videos, 2nd edition 1991.
- R5 Dennis P. Nolan, “Handbook of Fire & Explosion Protection Engineering Principles for Oil, Gas, Chemical, & Related Facilities “, William Andrew Publishers, 1997
- R6 Firefighters hazardous materials reference book, Fire Prevention in Factories, a Nostrand Rein Hold, New York, 1991.

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2C	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
ME2201.1	3	1	2		2	1					1					2		3	2
ME2201.2	2			1	2											3	3	3	2
ME2201.3	2	1	2		2	1	1	1			1						2	2	2
ME2201.4	2		2						1	1						1	2	2	1
ME2201.5		3	1		2	2		1	2				1			3	2	3	2
ME2201.6	3		3	2		2					2					3	2	2	2
ME2201.7	2			2					2							3		2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Chemical Safety (ME2202)		
Hours per Week	L-T-P: 3-0-0	
Credits	4	
Students who can take	M.Tech Semester-III (Batch: 2020-2022) Elective-IV	
Course Objective:		
The objective of this course is to improve the skills of students to recognize chemical hazards and their preventive and corrective safety work practices during the use, storage, handling, and production of any kinds of chemicals.		
Course Outcomes		
After course completion, the student will be able to:		
ME2202.1 Assess the severity of the consequences of incidents.		
ME2202.2 Identify the hazard by different techniques in a chemical processing plant.		
ME2202.3 Assess the level of risk for different kind of hazards in a chemical processing plant.		
ME2202.4 Explain the legal framework controlling process plant safety in India.		
ME2202.5 Analyze the root cause of accidents in chemical industry.		
ME2202.6 Evaluate the onsite and offsite emergency plan for chemical spill or fire.		
	Prerequisites	
Evaluation Scheme		
Sr. No	Specifications	Marks
01	Attendance	Nil
02	Assignment	20
03	Class Participation	05
04	Quiz	20
05	Theory Exam-I	10
06	Theory Exam-II	Nil
07	Theory Exam-III	30
08	Report-I	15
09	Report-II	Nil
10	Report-III	Nil
11	Project-I	Nil
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	Nil
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
	Total (100)	100
Evaluation Scheme for Retest		
07	Theory Exam-III	30

SYLLABUS:

Introduction of Chemical Safety: Chemical Safety is good for business; HAZCOM; Employ training: Initial orientation Training, job specific training, annual refresher training, and immediate on-the Spot training; Non-Routine Tasks, routine tasks: safety inspection, daily

inspection, annual inspection; tasks evaluation; chemical storage; container labels; emergency and spills; housekeeping; chemical waste disposal.

Statutory Provisions: the factories Act, 1948 (amended 2001) and other relevant state factories rules; the environment (protection) Act, 1986 (amended 1991); the environment (protection) rules, 1986 (amended 2010); the water (prevention & Control or pollution) act, 1974 (amended 1988); The air (prevention & Control of Pollution) Act,1981 (Amended 1987); The manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (Amended 2000); the hazardous wastes (management, Handling and transboundary Movement) Rule, 2008 (amended 2010); The petroleum Act, 1934; The petroleum Rules,2002 (amended 2011); The explosive Act,1884 (amended 1983); The explosive Rules, 2008; The static & Mobile Pressure Vessels (Unfired) Rules, 1981 (amended 2002); The Gas Cylinder Rules,2004; The Indian Boiler, Act 1923 (Amended2007); The Indian Boiler Regulation, 1950 (Amended 2010); other applicable Acts and rules: The Public liability Insurance Act, 1991 (amended 1992); The Public Liability Insurance Rules, 1991 (Amended 1993); The Chemical Accidents (Emergency Planning, Preparedness & Response) Rules, 1996.

Basic Principals of Accident Prevention: Basic Philosophy of Industrial Accidents-causation & Prevention, reporting of Near-miss and learning lessons; safety & health policy, physical hazards, chemical hazards, electrical hazards, mechanical hazards, bio-chemical hazards, radiological hazards; role of supervisor in promoting safety & Health (with special reference to chemical industry); accident and root cause analysis.

Chemical Hazards & Control Measures: Storage of hazardous chemicals (in bulk), handling of hazardous/ dangerous chemicals, transportation of hazardous chemicals, process safety-an overview; work permit system; safety in start-up and shut-down procedures; instrumentation for safe operating plant procedures (SOPs); personal hygiene (and health awareness); Industrial classification of labelling; chemical safety data sheet, housekeeping (and safety); personal protective equipment.

Fire & Explosion hazards : Fire & explosion Hazards, chemistry& Classification of fire, flash point and explosive limit; portable firefighting system-first aid firefighting appliance, fixed firefighting systems, health hazards due to fire and explosion; classification of hazards area and safety aspects including flameproof electrical equipment; Dow index, fire and explosion index.

Health Hazards due to chemical exposure: Factors contributing to hazardous situation, threshold limit values; routes of entry of chemicals to cause health hazards; concentration and types of exposures; work environment monitoring-techniques & procedures; toxic effects of chemicals, health monitoring.

Techniques of identification of hazards by risk management: Techniques of identification of hazards; plant safety inspection; accident investigation; job safety analysis (JSA); Fault tree analysis (FTA); Failure Modes and effects analysis (FEMA); Hazards and operability (HAZOP) study; Risk and risk management.

Control of hazards by Industrial Hygiene: Industrial Hygiene control methods; substitution-a control technique of industrial hygiene; Dilution-a control techniques; segregation- a control techniques; isolation-a control techniques; Enclosure-a control techniques; Barricading-a control technique.

Management of Safety Health & Environment by Chemical Emergency Procedures & Tool Box Talk and Safety Audit,: On-Site Emergency Plan: appointment of Key Personnel And fixing Their Responsibilities, The Alarms system, Control Room (Emergency Control Centre), Evacuation; Assembly points; Rehearsals, Rehabilitation, other action in the plan; off-site emergency plan; medical response in chemical emergency; safety audit; Occupational Health and Safety Assessment Series (OHSAS); Environmental management System (EMS); Training Cycle; training techniques; tool box talk.

Chemical Process Industry Safety: Introduction; Basic Principles; Material Hazards; Process and Plant Hazards; Hazard Analysis; Preventive and Protective Measures.

Reference Book

- R1: Crowl D.A. and Louvar J.F., Chemical Process Safety: Fundamentals With Applications.
 R2: Lees F.P. Lee’s Loss Prevention in Process industries: Hazard Identification, Assessment and control
 R3: Kletz T, What Went Wrong? Case Histories of Process Plant Disasters: How They Could Have Been Avoided
 R4: “Quantitative Risk Assessment in Chemical Process Industries” American Institute of Chemical Industries, Centre for Chemical Process safety.
 R5: Fawcett, H.h. and Wood, “Safety and Accident Prevention in Chemical Operations” Wiley inters, Second Edition.
 R6: “Accident Prevention Manual for Industrial Operations” NSC, Chicago, 1982.
 R7: GREEN, A.E., “High Risk Safety Technology”, John Wiley and Sons,. 1984.
 R8: Petroleum Act and Rules, Government of India. 6. Carbide of Calcium Rules, Government of India.

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PS O 1	PS O 2	PS O 3	PSO 4
ME2202.1	2				2													2	2
ME2202.2					3	2		2	2								2		
ME2202.3	2				2												3		
ME2202.4	2	2	2	3	1							2				3			
ME2202.5			2							2							2	3	
ME2202.6	3				2	2				2								2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code:	Environmental Impact Assessment CE2205	
Hours per Week	L-T-P: 3-0-0	
Credits	04	
Students who can take	M.Tech Semester-III (Batch: 2020-2022) Elective	
Prerequisites	Basic Knowledge of Environmental Engineering	
Course Objective: This course aims to develop knowledge and skills for identifying, predicting, and evaluating economic, environmental, and social impacts of development activities and also providing information on the environmental consequences for decision making.		
Course Outcomes After course completion, the student will be able to: CE2205.1 Identify objectives of environmental impact assessment. CE2205.2 Use the basic steps and elements of an EIA. CE2205.3 Apply legislation and rules for EIA, EMA. CE2205.4 Identify, assess and address environmental concerns and adopt EIA as tools for sustainable development. CE2205.5 Conduct EIA and pollution prevention assessments and critically evaluate its outcomes.		
Evaluation Scheme:		
Sr. No.	Evaluation Component	Marks
1	Attendance	NIL
2	Assignment	10
3	Class Participation	10
4	Quiz	10
5	Theory Exam-I	NIL
6	Theory Exam-II	20
7	Theory Exam-III	30
8	Report-I	20
9	Report-II	NIL
10	Report-III	NIL
11	Project-I	NIL
12	Project-II	NIL
13	Project-III	NIL
14	Lab Evaluation-I	NIL
15	Lab Evaluation-II	NIL
16	Course Portfolio	NIL
Total (100)		100
Evaluation Scheme for Retest		
Sr. No	Specifications	Marks
1	Theory Exam-III	30

Course Syllabi (Theory):

Introduction: Environmental Assessment process, objectives of EIA, Terminology, and Hierarchy in EIA, Historical Review of EIA, and Concepts related to EIA, Basic data collection for EIA, Strategic environmental assessment (SEA).

Legislation and Procedures: National Environmental Policy Act and Implementation, EIA legislative requirements and administrative procedures in India/Indian States, EIA notification 2006.

Techniques and Methodology: Description of the environmental setting, Methods of Impact Analysis, Environmental risk assessment, baseline data collection for EIA

Public Participation in environmental decision making, regulatory requirement, techniques, advantages and disadvantages of public participation.

Preparation and writing of EIA report.

Prediction and Assessment of Impacts on Air, Water, Noise, Biological, Cultural and socio-economic Environment, Mining, blasting.

Case studies of EIA for Industries like Oil, Petrochemical, iron and steel, fertilizer, sugar and distillery, projects of road/dams and housing etc.

Text Book(s)/ Reference Book(s)

1. Larry W. Canter, "Environment Impact Assessment", McGraw-Hill Book Company, New York
2. G.J. Rau and C.D. Weeten, "Environmental Impact Analysis Hand book, McGraw Hill, 1980.
3. Vijay Kulkarni and T V Ramchandra. "Environmental management" Capital Publishing Co
4. Mhaskar A.K., "Environmental Audit" Enviro Media Publications.
5. S.K. Dhameja, "Environmental Engineering and Management" S.K. Kalaria and Sons Publishers

Web Resources:

- 1) <http://environmentclearance.nic.in/>
- 2) <http://www.environmentwb.gov.in/pdf/EIA%20Notification,%202006.pdf>
- 3) <http://www.fao.org/3/v9933e/v9933e02.htm>
- 4) <http://environmentclearance.nic.in/writereaddata/EIA%20Notifications.pdf>
- 5) <https://www.youtube.com/watch?v=3fbEVytyJck>
- 6) <https://www.youtube.com/watch?v=nmeYMF2pdVs>
- 7) <https://www.youtube.com/watch?v=6NrZThAObpM>
- 8) <https://www.youtube.com/watch?v=0RZhK-lLp6E>

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
CE2205.1	2	2	1									1						1	2
CE2205.2	1	1	2													2	1	2	2
CE2205.3	1	1	2													3	1	1	1
CE2205.4	1	2					2					1				2	1	1	2
CE2205.5	1	2	2	2			2			2	2					1		1	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code: Industrial Project-II (PR2107)		
Hours per Week	Minimum 20 hrs. Per week for full semester.	
Credits	16	
Students who can take	M.Tech Semester-IV (Batch: 2020-2022) Core	
Course Objective: The purpose of the Industrial Project-II is to give students the opportunity to develop an understanding of their profession in a professional context. They will prepare a research, development, or other type of engineering project with the guidance of an industrial and academic supervisors.		
Course Outcomes After course completion, the student will be able to: PR2107.1 Identify skills and capabilities that intersect effectively with the needs of industry. PR2107.2 Apply and practice good communication skills in the workplace setting. PR2107.3 Reflect and evaluate on experiences that might lead to future employment. PR2107.4 Report research findings in written and verbal forms. PR2107.5 Demonstrate and apply industry observation/research skills to complete a project.		
Evaluation Scheme: Weightages of different evaluation components		
Mid-Term		
Expert Evaluation	Evaluation Component	Marks
Panel of Examiner	Synopsis	15
Panel of Examiner	Report Content & Presentation	15
Internal Mentor	Reporting Activity Fortnightly	10
Industry Expert	Industry Expert Feedback	15
M.Tech Coordinator	M.Tech Coordinator Feedback	5
Total		60
Final Term		
Industry Expert	Industry Feedback	50
Internal Mentor	Reporting Activity Fortnightly	20
Panel of Examiner	Presentation, Report, Viva	60
M.Tech Coordinator	M.Tech Coordinator Feedback	10
Total		140
Total (Mid-term Final Term)		200

Course Syllabi:

Dissertation-II/ Industrial Project-II/Entrepreneurial Project-II - The students who work on a project are expected to work towards the goals and milestones set in Dissertation-II / Industrial Project-II/ Entrepreneurial Project-II. The problem can be extension of Dissertation-I/ Industrial Project-I/Entrepreneurial Project-I or a new problem. The student will submit a synopsis at the beginning of the semester for approval from the departmental committee in a specified format. At the end there would be a demonstration of the solution and possible future work on the same problem. The student will have to present the progress of the work through seminars and progress reports.

Operation Procedure

- Student has to devote full semester for Dissertation/Industrial Project/Entrepreneurial Project.
- Student has to report to the Supervisor regularly.
- Dissertation-II/ Industrial Project-II/Entrepreneurial Project-II evaluation has to be carried out in the presence of a two member Committee comprising.
- Experts in the relevant area constituted by the Supervisor.
- Final Seminar Report to be submitted has to be in formal hard bound cover bearing of the Institute emblem.

Reference Books and Tools:

Based on literature survey to be done with peer reviewed journals and magazines and relevant tools required to build the project.

Course Articulation Matrix: (Mapping of COs with POs)

Course Outcome	CORRELATION WITH PROGRAM OUTCOMES															CORRELATION WITH PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2	PSO 3	PSO 4
PR2107.1	2		2		3	3	1	3			3			1		2			
PR2107.2		2			2						2		3				2		2
PR2107.3	2		2	2	2	2	2				3	3						2	
PR2107.4		3		3	3		1				2		2	3	2			2	2
PR2107.5	2			3	3	2					3			3	3	2			3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Program Articulation Matrix (MTech-HSEE) Batch 2020-2022																									
S.No.	Course Code	Course Title	Credit	Year	Semester	Target Student Groups	PO1	PO2a	PO2b	PO2c	PO3a	PO3b	PO3c	PO4a	PO4b	PO4c	PO5a	PO5b	PO6	PO7a	PO7b	PO51	PO52	PO53	PO54
1	AS2101	Statistical Data Analysis	5	5	1	M.Tech HSEE	1.3	0.5	0.3	0.0	1.8	0.0	0.8	0.8	0.0	1.5	0.0	0.0	0.8	0.0	0.0	0.0	1.8	0.0	0.3
2	EE2101	Industrial Automation and Ir	4	5	1	M.Tech HSEE	0.8	0.4	0.4	0.2	1.2	1.2	1.0	0.8	0.6	0.0	0.8	0.4	0.4	0.2	0.0	0.0	0.0	0.0	0.0
3	ME2101	Industrial Safety Manage	5	5	1	M.Tech. HSEE	1.0	1.0	0.8	0.3	0.3	0.8	0.5	0.3	0.5	0.5	0.7	0.5	0.5	0.8	0.8	1.3	1.2	1.3	0.8
4	PR2101	Project-I	2	5	1	M.Tech. HSEE	1.2	0.2	0.4	0.0	1.2	0.4	0.2	0.0	0.0	0.6	1.0	0.0	0.4	0.2	0.0	0.2	1.0	0.8	1.8
5	CC2171	Critical Thinking for Develop	2	5	1	M.Tech. HSEE	2.0	0.0	0.6	0.2	0.0	0.0	0.4	1.0	0.2	0.2	0.4	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0
6	CE2201	Industrial Waste Manage	3	5	1	M.Tech. HSEE	1.6	0.8	0.8	0.0	0.0	0.4	0.6	0.0	0.0	1.0	0.4	1.0	0.6	1.0	0.0	1.0	1.0	1.4	1.2
7	IL2106	Health, Safety, and Environn	5	5	2	M.Tech. HSEE	1.6	0.0	2.4	0.6	0.4	1.4	1.0	1.8	0.2	1.0	2.2	0.8	1.0	0.0	0.0	0.6	0.0	0.4	1.8
8	IL2103A	Risk and Hazard Manager	4	5	2	M.Tech. HSEE	0.7	0.3	0.7	0.0	0.5	0.8	0.7	1.0	2.0	0.8	0.5	0.7	0.3	0.3	0.0	0.3	1.2	0.8	1.5
9	IL2104	Regulation for Health, Safet	5	5	2	M.Tech. HSEE	1.0	0.7	0.7	0.5	0.3	0.8	0.5	0.3	0.5	0.3	0.5	0.7	0.2	0.2	0.2	2.2	0.5	1.5	0.7
10	PR2102	Project-II	2	5	2	M.Tech. HSEE	1.2	0.2	0.4	0.0	1.2	0.4	0.2	0.0	0.0	0.6	1.0	0.0	0.4	0.2	0.0	0.2	1.0	0.8	1.2
11	CC2114	Critical Thinking for Decisior	2	5	2	M.Tech. HSEE	1.6	0.0	0.6	0.4	0.0	0.0	0.4	0.0	0.6	0.8	0.2	0.6	0.0	0.6	0.2	0.0	0.0	0.0	0.0
12	IL2201	Occupational Hygiene and H	3	5	2	M.Tech. HSEE	1.4	0.0	0.6	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.4	0.1	0.1	0.1	0.0	0.1	1.7	0.4	1.1
13	CE2204	Safety in Construction and N	3	5	2	M.Tech. HSEE	1.3	0.3	0.0	0.3	0.0	0.0	0.0	0.5	0.0	0.0	0.5	0.0	0.0	1.0	0.0	0.8	0.5	0.3	0.3
14	PS2101	Internship	4	5	3	M.Tech. HSEE	1.3	0.7	1.3	0.7	2.3	1.7	1.0	1.0	0.0	0.0	2.7	1.0	1.0	0.3	0.0	0.7	0.7	0.7	0.7
15	PR2104	Industrial Project-I	10	6	3	M.Tech. HSEE	1.2	1.0	0.8	1.6	2.6	1.4	0.8	0.6	0.0	0.0	2.6	0.6	1.0	1.4	1.0	0.8	0.4	0.8	1.4
16	ME2201	Fire Engineering and Manag	4	6	3	M.Tech. HSEE	2.0	0.7	1.4	0.7	1.1	0.9	0.1	0.3	0.7	0.1	0.6	0.0	0.1	0.0	0.0	2.1	1.6	2.4	1.9
17	ME2202	Chemical Safety	4	6	3	M.Tech. HSEE	1.5	0.3	0.7	0.5	1.7	0.7	0.0	0.3	0.3	0.7	0.0	0.3	0.0	0.0	0.0	0.5	1.2	1.2	0.8
18	CE2205	Environmental Impact Asses	4	6	3	M.Tech. HSEE	1.5	2.0	1.8	0.5	0.0	0.0	1.0	0.0	0.0	0.5	0.5	0.5	0.0	0.0	0.0	2.0	0.8	1.5	1.8
19	PR2107	Industrial Project-II	16	6	4	M.Tech. HSEE	1.2	1.0	0.8	1.6	2.6	1.4	0.8	0.6	0.0	0.0	2.6	0.6	1.0	1.4	1.0	0.8	0.4	0.8	1.4
						Total	25.4	10.1	15.4	8.3	17.3	12.4	10.1	9.9	5.8	8.2	17.9	7.2	8.6	7.4	3.2	13.7	14.8	15.2	18.6
		Program Articulation Expectation					C	AB	C	AB	C	C	AB	AB	AB	AB	C	AB	AB	AB	N	C	C	C	C
		Nomenclature																							Sum (PG)
		Novice (N)																							(sum <5)
		Advanced beginner (AB)																							(5<=sum<10)
		Competent (C)																							(sum >=10)
		Description																							
		Knows objective facts, features, and rules for determining actions with respect to this PO/PSO without being context-sensitive. Has studied the basic concepts.																							
		Recognizes common situations with respect to this PO/PSO that help in recalling which rules should be exercised, starts to recognize and handle situations not covered by given facts, features and rules. Has problem solving and repeated practice experience for common situations with respect to this PO/PSO.																							
		Performs most standard actions with respect to this PO/PSO without conscious application of rules after considering the whole situation. Handles new situations through the appropriate application of rules, can design systems. May lead. Has demonstrated this PO/PSO through repeated engagements in advanced problem																							