A) Course Code : **2129571(020)**

B) Course Title : Fire Safety Engineering-III

C) Pre- requisite Course Code and Title :

D) Rationale : Fire safety is an essential requirement for any building or industrial premises today. It has many challenges during construction with respect to complying legal requirements and for the safe execution. Globally, fire risk is a major catastrophe and based on its level suitable techniques are available which is to be taught, and students should aware about it minimizing loses due to fire. On building fire safety, national building code has given guidelines, which covers various classifications of building and their general requirements. This course is based on practical aspect of firefighting and the hurdles coming in during building evacuation at the time of fire emergency. Mainly the focus of NBC part IV is to covers various aspect of fire safety parameters, which can be helpful in planning and designing of building and evacuation routes/ exit. To ensure the fire safety requirements and complying legal requirements or recommendation stated in NBC, learning of audit and inspections are important. Students will learn about various types of building and apply their learning to cope up from fire and other emergencies by suitable control measures.

E) Course Outcomes:

CO-1: To know the effect of temperature on the properties of materials.

CO-2: To know the experimental determination of fire resistance.

CO-3: To learn about various design of fire-resistant walls.

CO-4: To understand the calculation of building fire areas.

CO-5: To understand the reparability of fire damaged structures

F) Scheme of Studies:

Board of Study	Course Code	Course Titles	Scheme of Studies (Hours/Week)			Credits L+T+(P/2)
			L	P	T	
Civil Engineering	2129571(020)	Fire Safety Engineering-III	2	-	1	3
Civil Engineering	2129561(020)	Fire Safety Engineering-III (Lab)	-	2	-	1

L- Lecture, T- Tutorial, P- Practical,

Legend: Lecture (L) →CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture and others).

Practical (P) → LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies).

Tutorial (T) →SL: Self Learning.

G) Scheme of Assessment:

Board of Study	Course Code	Course Titles	Scheme of Examination					
			Theory			Practical		Total
			ESE	CT	TA	ESE	TA	Marks
Civil Engineering	2129571 (020)	Fire Safety Engineering-III	70	20	30	-	-	120
Civil Engineering	2129561 (020)	Fire Safety Engineering-III (Lab)	-	-	-	40	60	100

ESE: End Semester Exam, CT: Class Test, TA: Teachers Assessment

Legend- PRA: Process Assessment, PDA: Product Assessment

Note:

i) TA in Theory includes Sessional work (SW) and attendance (ATT) with weightage of 70% and 30% of total respectively.

ii) TA in practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%,40% and 10% respectively.

iii) 85% attendance is essential in theory and practical classes to appear in Examination.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

Convert unit of the given physical quantity from one unit system to other.

CO-1: To know the effect of temperature on the properties of materials.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Define different Combustibility of building materials. SO1.2 To Learn the Fire resistance of structural members. SO1.3 To Learn the Fire resistance of buildings.	LI1.1 To test the of non-combustibility of Building Materials. LI1.2 To Study of fire resistant of Building Materials. LI1.3 To study the test of Fire protection in concrete structure.	**UNIT-1.0 EFFECT OF TEMPERATURE ON THE PROPERTIES OF MATERIALS** 1.1 Effect of temperature on material Concrete, Steel, Masonry and Wood. 1.2 Combustibility of building materials and structures. 1.3 Fire resistance of structural members. 1.4 Fire resistance of buildings. 1.5 Material Fire Properties.	SL1.1 Learn about effect of temperature. SL1.2 Learning about Concrete, steel, masonry and wood. SL1.3 Learning about Combustibility of building materials and structures.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

1. What is combustible construction materials?
2. Explain Fire Resistance Characteristics of Common Building Materials?
3. What are the effects of temperature in building Material?

b. Mini Project:

1. Collect different types of building materials and analyze its property?
2. prepare list of Fire resistance building Materials?

CO-2: To know the experimental determination of fire resistance.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 To learn about Approximate method for calculating the fire resistance of structures. SO2.2 To learn about Fire resistance limits of structures. SO2.3 To know the coefficient of fire resistance and fire duration.	LI2.1 To Study of fire fighting equipment and accessories. LI2.2 To Study of automatic water sprinkler system. LI2.3 To Study of automatic fire detections system.	**Unit 2.0 EXPERIMENTAL DETERMINATION OF FIRE RESISTANCE** 2.1 Approximate method for calculating the fire resistance of structures. 2.2 Fire resistance limits of structures. 2.3 Experimental Study and Calculation of Fire Resistance. 2.4 Coefficient of fire resistance. 2.5 Fire Duration.	SL2.1 Demonstrate the fire resistance of structures. SL2.2 Learning about calculating the fire resistance of structures. SL2.3 Learning about determination of fire resistance.

SW-2 Suggested Sessional Work (SW):

a. Assignments

1. Explain approximate method for calculating the fire resistance of structures.
2. Define following Terms
   (1) Fire Duration (2) Fire Resistance
3. Explain Fire resistance limits of different structures?

b. Mini Project:

1. Prepare the list Fire Resistant Construction of a various Structural Elements

CO-3: To learn about various design of fire-resistant walls.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain different Types-building structures. SO3.2 Learning about Fire protection of building structures. SO3.3 Define Steel structures, Reinforced concrete structures, Plastic structures.	LI3.1 To Study of different types of fire proof Walls. LI3.2To study of determination of flash point and fire point of hydrocarbons. LI3.3 To study the test of fire properties in steel structure.	**UNIT-3.0 DESIGN OF FIRE RESISTANT WALLS** 3.1 Ceilings-screens -local barriers- Roof separations and partitioned fire areas. 3.2 Fire stopped areas in connecting constructions. 3.3 Fire protection of building structures: Wooden structures. 3.4 Different types of fireproof walls. 3.5 Fire protection in Steel structures, Reinforced concrete structures, Plastic structures.	SL3.1 To learn design of fire-resistant walls. SL3.2 Learning about Roof separations and partitioned fire areas. SL3.3 Learning about Fire protection Structures.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

1. What are 4 examples of a fire barrier ?
2. What is the difference between fire walls and fire barriers?
3. What are the different Types of firestops?

b. Mini Project:

1. Perform and analyze fire properties in diffrent type of structure like Steel structures, Reinforced concrete structures, Plastic structures.

CO-4: To understand the calculation of building fire areas.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 To Learn about Fire transmission in building. SO4.2 Calculation of fire areas, subdivision of fire areas in Residential and Public buildings. SO4.3 To Learn about openings for conveyors.	LI4.1 To study calculations of fire area in commercial building. LI4.2 To study calculations of fire area in residential building. LI4.3 To study the test of combustible and non-combustible properties of door. LI4.4 To study the fire transmission between buildings.	**UNIT-4.0 BUILDING FIRE AREAS.** 4.1 Calculation of fire areas, subdivision of fire areas, Industrial, Residential and Public buildings. 4.2 Fire transmission between buildings, and propagation of fire. 4.3 Protection of openings: Openings for conveyors. 4.4 Opening for doors – low combustible doors – Non-combustible doors - Spark proof doors. 4.5 Suspension of doors - Air-tight sealing of doors – Windows.	SL4.1 building fire areas. Industrial, residential and public buildings. SL4.2 Learning about propagation of fire. SL4.3 Learning about opening for doors – low combustible doors – Non-combustible doors - Spark proof doors/

SW-4 Suggested Sessional Work (SW):

a. Assignments:

1. How do you calculate the fire load of an industrial building?
2. Explain fire propagation?
3. What are the different types of fire doors?

b. Mini Project:

1. To draw and calculation of fire areas in industrial, residential and public buildings.

CO-5: To understand the reparability of fire damaged structures

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Design of fire assessment of fire severity. SO5.2 Define Assessment of damage-concrete, steel, masonry, timber. SO5.3 Explain case study on building reinstatement.	LI5.1 To study the preparation of post fire damage inspection report. LI5.2 To study and assessment of damage concrete and steel materials. LI5.3 To study the building reinstatement process.	**UNIT-5.0 REPARABILITY OF FIRE DAMAGED STRUCTURES** 5.1 Assessment of fire severity. 5.2 Assessment of damage-concrete, steel, masonry, timber. 5.3 Post-Fire Damage Inspection of Concrete Structures. 5.4 Feasibility of repair -Repair techniques Columns, beams, floors, etc. 5.5 A case study on building reinstatement.	SL5.1 learn about feasibility of repair. SL5.2 Learning about reparability of fire damaged structures. SL5.3 Learning about case study on building reinstatement.

SW-5 Suggested Sessional Work (SW) :

a. Assignments:

1. How the fire damaged structures can be repaired?
2. Explain, Assessment of concrete structures after fire?
3. What are the different types of reinstatement?
4. Explain a case study on building reinstatement?

b. Mini Project:

1. Prepare Assessment chat of concrete structures after fire?

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction CI+SW+SL):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	EFFECT OF TEMPERATURE ON THE PROPERTIES OF MATERIALS	4	6	4	14
II	EXPERIMENTAL DETERMINATION OF FIRE RESISTANCE	4	6	4	14
III	DESIGN OF FIRE RESISTANT WALLS	4	6	4	14
IV	BUILDING FIRE AREAS	4	6	4	14
V	REPARABILITY OF FIRE DAMAGED STRUCTURES	4	6	4	14
Total		20	30	20	70

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Title	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LI1.1	To study test of non-combustibility of building materials.	20	15	5
LI1.2	To Study of fire resistant building materials.			
LI1.3	To study test of fire protection in concrete structure.			
LI2.1	To Study of fire fighting equipments and accessories.			
LI2.2	To Study of automatic water sprinkler system.			
LI2.3	To Study of automatic fire detections system.			
LI 3.1	To Study of different types of fire proof walls.			
LI3.2	To study the determination of flash point and fire point of hydrocarbons.			
LI3.3	To study the test of fire properties in steel structure.			
LI4.1	To study calculations of fire area in commercial building.			
LI4.2	To study calculations of fire area in residential building.			
LI4.3	To study the test of combustible and non combustible properties in door.			
LI4.4	To study the fire transmission between buildings.			
LI5.1	To prepare post fire damage inspection report.			
LI5.2	To study and assessment of damage concrete and steel materials.			
LI5.3	To study the building reinstatement process.			

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals

Legend : PRA: Process Assessment, PDA : Product Assessment

Note : Only one experiment has to performed at the end semester examination of 40 Marks as per assessment scheme.

(K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Industrial visits
4. Industrial Training
5. Demonstration
6. Others

L) Suggested Learning Resources:

(a) Books :

S.No.	Title	Author	Publisher	Edition & Year
1	Accident Prevention manual for industrial operations" N.S.C., Chicago, 1982	Accident Prevention manual for industrial operations" N.S.C., Chicago, 1982	Accident Prevention manual for industrial operations" N.S.C., Chicago, 1982	1982
2	"Hand Book of fire technology"	Davis Daniel		
3	"Fire Prevention and firefighting", Loss prevention Association, India.			
4	"Fire Prevention Hand Book", Butter Worths and Company, London, 1986	Derek, James		1986
5	Fire fighters hazardous materials reference book Fire Prevention in Factories", an Nostrand Rein	Fire fighters hazardous materials reference book Fire Prevention in Factories", an Nostrand Rein	Fire fighters hazardous materials reference book Fire Prevention in Factories", an Nostrand Rein	

(b) Open source software and website address:

1. https://www.govinfo.gov/content/pkg/GOVPUB-C13-590dac3d03839ce75bf91b25a9759abb/pdf/GOVPUB-C13-590dac3d03839ce75bf91b25a9759abb.pdf
2. https://www.govinfo.gov/content/pkg/GOVPUB-C13-4ffea768ffdae46c47873e9d360804a3/pdf/GOVPUB-C13-4ffea768ffdae46c47873e9d360804a3.pdf
3. https://dgfscdhg.gov.in/national-building-code-india-fire-and-life-safety
4. https://www.osha.gov/personal-protective-equipment
5. https://dgt.gov.in/sites/default/files/Fire%20Tech%20_%20Ind.%20Safety%20Mgmt_CTS%202.0_NSQF-3.pdf
6. https://www.hse.gov.uk/comah/sragtech/techmeasfire.htm
7. https://www.hse.gov.uk/construction/safetytopics/generalfire.htm.

M) Mapping of POs & PSOs with COs:

Course Outcomes (COs) Titles	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	Basic knowledge PO-1	Discipline knowledge PO-2	Experiments & Practice PO-3	Engineering Tools PO-4	The Engineer& Society PO-5	Environment & Sustainability PO-6	Ethics PO-7	Individual & Team work PO-8	Communication PO-9	Life Long learning PO-10	PSO-1	PSO-2
CO-1: To know the effect of temperature on the properties of materials.	2	3	2	2	2	0	0	2	0	1	2	1
CO-2: To know the experimental determination of fire resistance.	2	2	3	2	2	0	0	1	0	2	2	1
CO-3: To learn about various design of fire-resistant walls.	2	2	3	2	2	0	0	1	0	2	2	1
CO-4: To understand the calculation of building fire areas.	2	2	3	2	2	0	0	1	0	2	2	2
CO-5: To understand the reparability of fire damaged structures.	2	2	3	2	2	0	0	1	0	2	2	1

Legend: 1 – Low, 2 – Medium, 3 – High

N) Course Curriculum Map:

POs & PSOs No.	COs No.& Title	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4,5,8,10 PSO-1,2	CO-1: To know the effect of temperature on the properties of materials.	SO1.1 SO1.2 SO1.3	LI1.1 LI1.2 LI1.3	1.1 1.2 1.3 1.4 1.5	SL1.1 SL1.2 SL1.3
PO-1,2,3,4,5,8,10 PSO-1,2	CO-2: To know the experimental determination of fire resistance.	SO2.1 SO2.2 SO2.3	LI2.1 LI2.2 LI2.3	2.1 2.2 2.3 2.4 2.5	SL2.1 SL2.2 SL2.3
PO-1,2,3,4,5,8,10 PSO-1,2	CO-3: To learn about various design of fire-resistant walls.	SO3.1 SO3.2 SO3.3	LI3.1 LI3.2 LI3.3	3.1 3.2 3.3 3.4 3.5	SL3.1 SL3.2 SL3.3
PO-1,2,3,4,5,8,10 PSO-1,2	CO-4: To understand the calculation of building fire areas.	SO4.1 SO4.2 SO4.3	LI4.1 LI4.2 LI4.3 LI4.4	4.1 4.2 4.3 4.4 4.5	SL4.1 SL4.2 SL4.3
PO-1,2,3,4,5,8,10 PSO-1,2	CO-5: To understand the reparability of fire damaged structures.	SO5.1 SO5.2 SO5.3	LI5.1 LI5.2 LI5.3 LI5.4 LI5.5	5.1 5.2 5.3	SL5.1 SL5.2 SL5.3

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

A) Course Code : 2129572(020)

B) Course Title : Hazard Identification and Risk Assessment

C) Pre- requisite Course Code and Title :

D) Rationale : Hazard identification is part of the process used to evaluate if any particular situation, item, thing, etc. may have the potential to cause harm. The term often used to describe the full process is risk assessment: Identify hazards and risk factors that have the potential to cause harm (hazard identification) Hazard Identification and Risk Assessment – HIRA in Safety is a process that consists of a number of sequential steps such as hazard identification, likelihood and consequence assessment, risk evaluation based on the existing controls and recommendations to reduce those risks which are not under acceptable limits.

E) Course Outcomes:

CO-1: Student will learn about hazard, risk issues and hazard assessment.

CO-2: Student will understand about computer aided instruments.

CO-3: Student will know about risk analysis quantification.

CO-4: Student will understand consequences analysis of risk assessment.

CO-5: Student will understand credibility of risk assessment techniques management.

F) Scheme of Studies:

Board of Study	Course Code	Course Titles	Scheme of Studies (Hours/Week)			Credits L+T+(P/2)
			L	P	T	
Civil Engineering	2129572(020)	Hazard Identification and Risk Assessment	2	-	1	3

L- Lecture, T- Tutorial, P- Practical,

Legend: Lecture (L) →CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture and others).

Practical (P) → LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies).

Tutorial (T) → SL: Self Learning.

G) Scheme of Assessment:

Board of Study	Course Code	Course Titles	Scheme of Examination					
			Theory			Practical		Total
			ESE	CT	TA	ESE	TA	Marks
Civil Engineering	2129572 (020)	Hazard Identification and Risk Assessment	70	20	30	-	-	120

ESE: End Semester Exam, CT: Class Test, TA: Teachers Assessment

Legend- PRA: Process Assessment, PDA: Product Assessment

Note:

i) TA in Theory includes Sessional work (SW) and attendance (ATT) with weightage of 70% and 30% of total respectively.

ii) TA in practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%,40% and 10% respectively.

iii) 85% attendance is essential in theory and practical classes to appear in Examination.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

Convert unit of the given physical quantity from one unit system to other.

CO-1: Student will learn about hazard, risk issues and hazard assessment.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 To know about hazard analysis. SO1.2 To learn about Hazard identification and risk assessment method. SO1.3 To understand HAZOP study.	--	**UNIT-1.0** **HAZARD, RISK ISSUES AND HAZARD ASSESSMENT** 1.1 Introduction, hazard, hazard monitoring-risk issue, group or societal risk, individual risk. 1.2 Voluntary and involuntary risk. 1.3 social benefits Vs technological risk, approaches for establishing risk acceptance levels, Risk estimation. 1.4 Hazard assessment, procedure. 1.5 Hazard analysis methodology- safety audit, checklist analysis what-if analysis, safety review, preliminary hazard analysis (PHA), human error analysis, hazard operability studies (HAZOP), safety warning systems.	SL1.1 Student will learn about Preliminary hazard analysis.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

1. Explain Preliminary hazard analysis.
2. Define following terms (a) What-if analysis, (b) Safety Audit, (c) HAZOP.
3. Explain HIRA in detail.

b. Mini Project:

1. Prepare HIRA using matrix method of your University?

CO-2: Student will understand about computer aided instruments

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Understand the principles of operation for advanced equipment such as Differential Scanning Calorimeter (DSC), SO2.2 Explore the controlling parameters involved in operating these instruments and their significance in obtaining accurate and reliable results.	--	**UNIT 2.0 COMPUTER AID INSTRUMENTS** 2.1 Applications of Advanced Equipments and Instruments. 2.2 Thermo Calorimetry, Differential Scanning Calorimeter (DSC). Thermo Gravimetric Analyser (TGA), Accelerated Rate Calorimeter (ARC). 2.3 Reactive Calorimeter (RC), Reaction System Screening Tool (RSST). 2.4 Principles of operations, Controlling parameters, Applications, advantages. 2.5 Explosive Testing, Deflagration Test, Detonation Test. 2.6 Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test(BAM)	SL2.1 Student will learn real-world applications of these instruments in various scientific and industrial fields. SL2.2 Student will understand how RC is used for safety assessment and process optimization in industries.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

1. Write down the difference between Deflagration and Detonation.
2. Define following terms (1) TGA (2) DSC
3. Explain Reactive Calorimeter (RC) and their advantage.

b. Mini Project: Draw the neat and clean picture of DSC, TGA and ARC

CO-3: Student will know about risk analysis quantification

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain FTA which is a deductive method used to analyze the causes of system failures. SO3.2 Define fire explosion and toxicity index(FETI), various indices	--	**Unit-3.0 RISK ANALYS QUANTIFICATION** 3.1 Fault Tree Analysis and Event Tree Analysis. 3.2 Logic symbols, methodology, minimal cut set ranking 3.3 fire explosion and toxicity index(FETI), various indices 3.4 Hazard analysis(HAZAN). 3.5 Failure Mode and Effect Analysis (FMEA) 3.6 Basic concepts of Reliability.	SL3.1 Student will be able to assessing the severity, likelihood, and detectability of each failure mode in any system.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

1. What is failure mode effect analysis?
2. Explain, HAZAN is a systematic process for identifying and assessing hazards associated with a system or process.
3. Explain a) Fire Index b) Explosion Index c) Toxicity Index

b. Mini Project: Prepare a fault tree analysis and event tree analysis of chemical process industry.

c. Other Activities (Specify): Prepare chart of Difference between FI, EI and TI.

CO-4: Student will understand consequences analysis of risk assessment

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Understand the fundamental principles and concepts of consequence analysis in the context of chemical processes. SO4.2 Identify and classify processes within a facility that have the potential for hazardous events. SO4.3 Analyze the heat radiation effects	--	**Unit-4.0 CONSEQUENCES ANALYSIS** 4.1 Logics of consequences analysis-Estimation 4.2 Hazard identification based on the properties of chemicals 4.3 Chemical inventory analysis. 4.4 Identification of hazardous processes 4.5 Estimation of source term, Gas or vapour release, liquid release, two phase release. 4.6 Heat radiation effects, BLEVE, Pool fires and Jet fire.	SL4.1 Student will understand the principles of gas/vapor dispersion and its role in consequence analysis. SL4.2 Student will be able to understand model and analyze the dispersion of hazardous

associated with different hazardous events such as BLEVE, pool fires, and jet fires.		4.7 Gas/vapour dispersion 4.8 Explosion, UVCE and Flash fire, Explosion effects and confined explosion, Toxic effects	substances in various scenarios.

SW-4 Suggested Sessional Work (SW) :

a. Assignments:

1. Explain the Flash Fires, Pool Fire, Jet Fire, UVCE and BLEVEs
2. Explain the key principles of consequences analysis in the context of chemical processes.
3. Analyze the chemical inventory of a hypothetical facility and identify potential hazards associated with the stored chemicals.
4. Discuss the factors influencing gas/vapor dispersion and how dispersion modeling contributes to consequence analysis.

b. Mini Project: Prepare the list of various example BLEVE?

c. Other Activities (Specify): Prepare the list of various example of Pool Fire and Jet Fire?

CO-5: Student will understand credibility of risk assessment techniques management.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Understand the significance of past accident analyses in informing hazard and consequence assessments. SO5.2 Examine the Mexico disaster in detail, including its causes and consequences. SO5.3 Analyze the Flixborough incident and its root causes. SO5.4 Evaluate the applicability of Rijnmond recommendations to nonnuclear installations globally. SO5.5 Analyze the evolving landscape of nuclear reactor safety in the context of technological advancements.	--	**UNIT-5 CREDIBILITY OF RISK ASSESSMENT TECHNIQUES** 5.1 Past accident analysis as information sources for Hazard analysis and consequences analysis of chemical accident. 5.2 Mexico disaster, Flixborough, Bhopal, Seveso, Pasadena, Feyzin disaster (1966), Port Hudson disaster- convey report. 5.3 Hazard assessment of nonnuclear installation- Rijnmond report. 5.4 Risk analysis of size potentially Hazardous Industrial objects- Rasmussen masses report. 5.5 Reactor safety study of Nuclear power plant. .	SL5.1 To learn about Propose preventive measures based on Flixborough lessons. SL5.2 To learn about Selection and Training- Body Size and Posture SL5.3 To learn about Evaluation and Methods of Reducing Posture Strain

SW-5 Suggested Sessional Work (SW) :

a. Assignment:

1. Evaluate the effectiveness of the emergency response and recovery efforts following the Mexico disaster.
2. Discuss the importance of utilizing past accident analyses as valuable information sources.
3. Analyze the key findings of a reactor safety study for a nuclear power plant, emphasizing advancements in safety measures.
4. Examine the Rijnmond report, discussing its key principles for hazard assessment in nonnuclear installations.

b. Mini Project: To study brief about Five Steps of the Risk Management Process

c. Other Activities (Specify): Prepare the list of technological advancements in process safety since the Feyzin incident.

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction CI+SW+SL):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	HAZARD, RISK ISSUES AND HAZARD ASSESSMENT	4	6	4	14
II	COMPUTER AIDI INSTRUMENTS	4	6	4	14
III	RISK ANALYS QUANTIFICATION	4	6	4	14
IV	CONSEQUENCES ANALYSIS	4	6	4	14
V	CREDIBILITY OF RISK ASSESSMENT TECHNIQUES	4	6	4	14
Total		20	30	20	70

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*): Nil

Laboratory Instruction Number	Short Laboratory Experiment Title	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
-	-	-	-	-

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals.

Legend : PRA: Process Assessment, PDA : Product Assessment

Note : Only one experiment has to performed at the end semester examination of 40 Marks as per assessment scheme.

(K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Industrial visits
4. Industrial Training
5. Demonstration
6. Others

L) Suggested Learning Resources:

(a) Books :

S.No.	Title	Author	Publisher	Edition & Year
1	Loss Prevention in Process Industries, (Vol.I, II and III)	Frank P. Less,	Butterworth-Hein UK	1990
2	Major Hazard control- A practical Manual	ILO	ILO, Geneva	1988
3	Methodologies for Risk and Safety Assessment in Chemical Process Industries	Commonwealth Science Council, UK	Commonwealth Science Council, UK	-
4	Hazop and Hazom	Trevor A Klett	Institute of Chemical Engineering	1983
5	System analysis and Design for safety	Brown, D.B.	Prentice Hall	1976
6	Guidelines for Hazard Evaluation Procedures,	Centre for Chemical Process safety	Centre for Chemical Process safety, AICHE	1992
7	Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries	Centre for Chemical process safety	Centre for Chemical process safety	1992

(b) Open source software and website address:

1. https://www.osha.gov/
2. https://www.csb.gov/
3. https://echa.europa.eu/
4. https://www.nist.gov/
5. https://www.usgs.gov/programs/earthquake-hazards
6. https://www.howardcountymd.gov/emergency-management/hazard-information
7. https://pages.nist.gov/fds-smv/
8. https://jasp-stats.org/

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs) Titles	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	Basic knowledge PO-1	Discipline knowledge PO-2	Experiments & Practice PO-3	Engineering Tools PO-4	The Engineer& Society PO-5	Environment & Sustainability PO-6	Ethics PO-7	Individual & Team work PO-8	Communication PO-9	Life Long learning PO-10	PSO-1	PSO-2
CO:1 Student will learn about hazard, risk issues and hazard assessment.	2	3	2	2	2	0	0	2	0	1	2	1
CO-2: Student will understand about computer aided instruments.	2	2	3	2	2	0	0	1	0	2	2	1
CO-3: Student will know about risk analysis quantification.	2	2	3	2	2	0	0	1	0	2	2	1
CO-4: Student will understand consequences analysis of risk assessment.	2	2	3	2	2	0	0	1	0	2	2	2
CO-5: Student will understand credibility of risk assessment techniques management.	2	2	3	2	2	0	0	1	0	2	2	1

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Title	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4,5,8,10 PSO-1,2	**CO:1 Student will learn about hazard, risk issues and hazard assessment.**	SO1.1 SO1.2 SO1.3	-	1.1 1.2 1.3 1.4 1.5	SL1.1
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-2: Student will understand about computer aided instruments.**	SO2.1 SO2.2	-	2.1 2.4 2.2 2.5 2.3 2.6	SL2.1 SL2.2
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-3: Student will know about risk analysis quantification.**	SO3.1 SO3.2	-	3.1 3.2 3.3 3.4 3.5 3.6	SL3.1
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-4: Student will understand consequences analysis of risk assessment.**	SO4.1 SO4.2 SO4.3	-	4.1 4.6 4.2 4.7 4.3 4.8 4.4 4.5	SL4.1 SL4.2
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-5: Student will understand credibility of risk assessment techniques management.**	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	-	5.1 5.2 5.3 5.4 5.5	SL5.1 SL5.2 SL5.3

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

A) Course Code : 2129573(020)

B) **Course Title : Electrical System Safety**

C) Pre- requisite Course Code and Title :

D) Rationale : Various Industries and Power stations may have a large number of appliances that pose electrical hazards. Examples include: power systems supplies, power generation company, pumps, compressors, power transmission, power distributions etc. In addition, some laboratories may need to house equipments that require high voltage / power for operation. All electrical devices need to be maintained and operated following safe practices; in absence of either precautions such equipments may pose serious hazards to an user, which in the worst case may prove fatal. The major hazards associated with electricity are electrical shock and fire. In a flammable atmosphere electrical equipment discharges cause fires and/or explosions. Electrical shocks may have minor to major consequences: a shiver to severe burns, and in the extreme case a cardiac arrest. Electrical system safety provides safety use and precautionary measures from such dangerous equipment.

E) Course Outcomes:

CO-1: Student will know introduction and statutory requirements of electrical safety.

CO-2: Student will understand the electrical hazards and its safety.

CO-3: Student will know various protection systems used in electrical systems.

CO-4: Student will be able to know the selection, installation, operation and maintenance of various electrical system.

CO-5: Student will learn about various electrical hazardous zones and its safety.

F) Scheme of Studies:

Board of Study	Course Code	Course Titles	Scheme of Studies (Hours/Week)			Credits L+T+(P/2)
			L	P	T	
Civil Engineering	2129573(020)	Electrical System Safety	2	-	1	3
Civil Engineering	2129562(020)	Electrical System Safety (Lab)	-	2	-	1

L- Lecture, T- Tutorial, P- Practical,

Legend: Lecture (L) →CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture and others).

Practical (P) → LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies).

Tutorial (T) → SL: Self Learning.

G) Scheme of Assessment:

Board of Study	Course Code	Course Titles	Scheme of Examination					
			Theory			Practical		Total
			ESE	CT	TA	ESE	TA	Marks
Civil Engineering	2129573 (020)	Electrical System Safety	70	20	30	-	-	120
Civil Engineering	2129562 (020)	Electrical System Safety (Lab)	-	-	-	40	60	100

ESE: End Semester Exam, CT: Class Test, TA: Teachers Assessment

Legend- PRA: Process Assessment, PDA: Product Assessment

Note:

i) TA in Theory includes Sessional work (SW) and attendance (ATT) with weightage of 70% and 30% of total respectively.

ii) TA in practical includes performance of PRA,PDA and Viva-Voce with weightage of 50%,40% and 10% respectively.

iii) 85% attendance is essential in theory and practical classes to appear inExamination.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

Convert unit of the given physical quantity from one unit system to other.

CO-1: Student will know introduction and statutory requirements of electrical safety

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Define electrostatics and electro-magnetism. SO1.2 Identify and explain the working principles of common electrical equipment. SO1.3 Discuss key guidelines and recommendations outlined in the ANSI code for ensuring electrical safety.	LI1.1 Demonstrate the CPR for electric shock. LI1.2 To understand and study the electrical drawing symbols and electrical tools.	**UNIT-1.0 INTRODUCTION AI STATUTORY REQUIREMENT** 1.1 Introduction – electrostatics, electro magnetism. 1.2 Stored energy, energy radiation and electromagnetic interference 1.3 Working principles of electrical equipment 1.4 Indian electricity act and rules-statutory requirements from electrical inspectorate- 1.5 International standards on electrical safety 1.6 First aid-cardio pulmonary resuscitation (CPR) 1.7 National electrical safety	SL1.1 To learn about Demonstrate knowledge of basic first aid principles in the context of electrical accidents. SL1.2 Student will be able to identify potential risks associated with electrical

Session Outcomes (SOs)	Laboratory Instruction	Class room Instruction (CI)	Self Learning
		code ANSI.	systems.

SW-1 Suggested Sessional Work (SW):

a. Assignments

1. Differentiate between electrostatics and electro-magnetism.
2. Explain how the working principles of electrical equipment contribute to safe operation.
3. Discuss potential consequences for non-compliance with electrical safety regulations.
4. Discuss the concept of stored energy in the context of electrical systems.

b. Mini Project:

1. List three important rules related to electrical safety as per the Indian Electricity Rules.

c. Other Activities (Specify):

1. Outline the basic steps of providing first aid in the event of an electrical injury.

CO-2: Student will understand the electrical hazards and its safety.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Recognize and differentiate between primary hazards and secondary hazards associated with electricity. SO2.2 Identify and address hazards associated with ionization, sparks, and arcs, and implement safety measures to prevent ignition energy-related incidents. SO2.3 Classify insulation types and voltage levels, and apply appropriate safety measures based on these classifications.	LI2.1 To study the effects of electric shock. LI2.2 To study safe work practices to prevent injury and accidents. LI2.3 To study different types of plugs LI2.4 To study wiring of sockets and plugs with color coding and socket. LI2.5 To study and understand the electrical house wiring system.	**Unit 2.0 ELECTRICAL HAZARDS** 2.1 Primary and secondary hazards-Shocks, burns-types of burn, scalds, falls. 2.2 Human safety in the use of electricity. 2.3 Energy leakage-clearances and insulation-classes of insulation 2.4 voltage classifications-excess energy-current surges-over current and short circuit current-heating effects of current-electromagnetic forces 2.5 corona effect-static electricity-sources, hazardous conditions, control, causes of fire and explosion 2.6 Ionization, spark and arc-ignition energy 2.7 Lightning hazards, lightning arrestor, installation – 2.8 Earthing specifications, earth resistance, earth bit maintenance.	SL2.1 Understand and apply principles for ensuring human safety in the use of electricity, emphasizing preventive measures and emergency response.

SW-2 Suggested Sessional Work (SW):

a. Assignments

1. Outline key principles for ensuring human safety in the use of electricity. Highlight preventive measures and emergency response strategies..
2. Discuss the significance of energy leakage in electrical systems.
3. Explain the role of clearances and insulation in preventing energy leakage incidents.
4. Discuss potential consequences for non-compliance with electrical safety regulations.
5. Explain the concepts of overcurrent and short circuit currents. How can these issues be effectively managed to prevent hazards?

b. Mini Project:

1. Investigate the sources and causes of static electricity nearby you. Provide detailed measures for controlling static electricity to enhance safety.

c. Other Activities (Specify):

1. Outline the basic steps of providing first aid in the event of an electrical burn injury.

CO-3: Student will know various protection systems used in electrical systems.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Define the purpose and functioning of fuses, circuit breakers, and overload relays. SO3.2 Explain safe limits for amperage and voltage in electrical systems. SO3.3 Define the concept and importance of no-load protection. S03.4 Explain ELCB functionality and its role in preventing electric shocks.	LI3.1 To study various types of fuses and its operation. LI3.2 To study various types of circuit breakers used in electrical system. LI3.3 To study difference between earthing and grounding.	**Unit-3.0 PROTECTION SYSTEMS** 3.1 Fuse, circuit breakers and overload relays. 3.2 Protection against over voltage and under voltage, safe limits of amperage, voltage. 3.3 Safe distance from lines-capacity and protection of conductor. 3.4 Joints-and connections. 3.5 Overload and short circuit protection-no load protection-earth fault protection, Earthing devices. 3.6 Flame Retardant Low Smoke (FRLS) insulation-insulation and continuity test. 3.7 System grounding-equipment grounding- 3.8 Earth leakage circuit breaker (ELCB)-cable wires maintenance of ground-ground fault circuit interrupter. **3.9** Use of low voltage-electrical guards-personal protective	SL3.1 Understanding the importance of maintaining a safe distance from power lines. SL3.2 learn about Practical application of protection methods in electrical systems.

Session Outcomes	Laboratory Instruction (LI)	Class room Instruction	Self Learning
		equipment – safety in handling hand held electrical appliances tools and medical equipments.	

SW-3 Suggested Sessional Work (SW):

a. Assignments:

1. Explain the function of fuses, circuit breakers, and overload relays in an electrical system. Provide examples of situations where each is most suitable.
2. Define the safe limits of amperage and voltage in electrical systems.
3. Explain why it is crucial to maintain a safe distance from power lines? Provide guidelines for determining a safe distance in different scenarios.
4. Differentiate between overload and short circuit protection. Provide examples of devices used for each type of protection and their applications.
5. Differentiate between system grounding and earthing.
6. Discuss the functionality and purpose of ELCBs in preventing electric shocks.

b. Mini Project:

1. Outline the types of PPE suitable for working with electrical appliances and tools. Discuss the importance of safety protocols in preventing accidents.

c. Other Activities (Specify):

1. Provide guidelines for safely handling hand-held electrical devices and tools. Discuss specific safety considerations for medical equipment.

CO-4: Student will be able to know the selection, installation, operation and maintenance of various electrical system.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Identify safety aspects in the application of equipment. SO4.2 Analyze the significance of protection and interlock features. SO4.3 Identify common challenges and solutions in implementing lockout/tagout. SO4.4 Discuss the benefits of a proactive maintenance approach in minimizing downtime.	LI 4.1 To study various safety equipment used in electrical systems. LI4.2 To study the different type of Lock Out and Tag Out (LOTO) for electrical system.	**Unit-4.0 SELECTION, INSTALLATION, OPERATION AND MAINTENANCE** 4.1 Introduction and safety in selection, role of environment in selection, safety aspects in application of equipment. 4.2 Protection and interlock features, self diagnostic features and fail safe concepts of equipments. 4.3 Lock Out & Tag Out (LOTO) and work permit system. 4.4 Discharge rod -safety in the use of portable tools-disease of figure in use of portable hand tools and its safety. 4.5 Cabling and cable joints. 4.6 Preventive maintenance.	SL4.1 Learn about different types of cables and their applications.

SW-4 Suggested Sessional Work (SW):

a. Assignments:

1. How does the surrounding environment impact the choice of equipment, and what factors should be considered to ensure compatibility??
2. Discuss fail-safe concepts and their role in preventing critical failures.
3. Discuss its significance in ensuring the safety of personnel during maintenance and operation.
4. Discuss safety protocols and best practices in the use of portable tools. Provide recommendations for minimizing risks associated with portable tool usage.
5. Highlight the importance of proper cabling in equipment installation. Discuss different types of cables and their applications.
6. Explain the purpose and usage of a discharge rod.

b. Mini Project:

1. Provide real-world examples where safety considerations significantly influence the application of specific equipment ?

b. Other Activities (Specify):

1. Identify critical components and systems that require preventive maintenance

CO-5: Student will learn about various electrical hazardous zones and its safety

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Define hazardous zones in the context of electrical installations. SO5.2 Differentiate between different hazardous zone classifications (Zone 0, Zone 1, Zone 2). SO5.3 Define intrinsic safety in the context of electrical equipment.	LI 5.1 To study the different types of electrical barrier and isolators.	**UNIT-5.0 ELECTRICAL HAZARDOUS ZONES** 5.1 Classification of hazardous zones 5.2 Intrinsically safe and explosion proof electrical apparatus-increase safe equipment 5.3 Selection criteria of different zones 5.4 Temperature classification, Grouping of gases 5.5 Use of barriers and isolators 5.6 Equipment certifying agencies.	SL5.1 Describe the role of barriers and isolators in hazardous zones. SL5.2 Understand the construction and certification requirements for explosion-proof electrical devices.

SW-4 Suggested Sessional Work (SW) :

a. Assignments:

1. Explain the importance of classifying hazardous zones in industrial settings.
2. Explain the design principles and limitations of intrinsically safe devices.
3. Provide guidelines for choosing suitable apparatus based on zone classification.
4. Explain the concept of temperature classification in hazardous areas.
5. Explore ways to enhance the overall safety of electrical installations in hazardous zones.

b. Mini Project:

1. Prepare the list of electrical equipment certifying agencies and standards.

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction CI+SW+SL):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	INTRODUCTION AND STATUTOI REQUIREMENTS	4	6	4	14
II	ELECTRICAL HAZARDS	4	6	4	14
III	PROTECTION SYSTEMS	4	6	4	14
IV	SELECTION, INSTALLATION, OPERATION AND MAINTENANCE	4	6	4	14
V	ELECTRICAL HAZARDOUS ZONES	4	6	4	14
Total		20	30	20	70

Legend: R: Remember, U: Understand, A: Apply and above

J. Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Title	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LI1.1	Demonstrate the CPR for electric shock.	20	15	5
LI1.2	To understand and study the electrical drawing symbols and electrical tools.			
LI2.1	To study the effects of electric shock.			
LI2.2	To study safe work practices to prevent injury and accidents.			
LI2.3	To study different types of plugs.			
LI2.4	To study wiring of sockets and plugs with color coding and socket.			
LI2.5	To study and understand the electrical house wiring system.			
LI3.1	To study various types of fuses and its operation.			
LI3.2	To study various types of circuit breakers used in electrical system.			
LI3.3	To study difference between earthing and grounding.			

LI4.1	To study various safety equipment used in electrical systems.			
LI4.2	To study the different type of Lock Out and Tag Out (LOTO) for electrical system.			
LI5.1	To study the different types of electrical barrier and isolators.			

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals

Legend : PRA: Process Assessment, PDA : Product Assessment

(K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Industrial visits
4. Industrial Training
5. Demonstration
6. Others

L) Suggested Learning Resources:

(a) Books :

S.No.	Title	Author	Publisher	Edition & Year
1	Accident prevention manual for industrial operations	National Safety Council	N.S.C., Chicago,	1982
2	Electrical Safety a Guide to the Causes and Prevention of Electrical Hazards,	J. Maxwell Adams	IEE Power series-19.	
3	Practical Electrical Safety	D.C. Winburn	Marcal Dekker	
4	Electrical Safety	S.Rao, Prof. H.L. Saluja	Fire Safety Engineering and Safety Management.	
5	Electrical Safety Engineering	Fordham Cooper, W.	Butterworth and Company, London,	1986
6	Electrostatic Hazards in powder handling,	Martin Glov.	Research Studies Pvt. Ltd., England	1988

(b) Open source software and website address:

1. https://www.osha.gov/electrical
2. https://www.hse.gov.uk/electricity/
3. https://www.esfi.org/

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs) Titles	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	Basic knowledge PO-1	Discipline knowledge PO-2	Experiments & Practice PO-3	Engineering Tools PO-4	The Engineer& Society PO-5	Environment & Sustainability PO-6	Ethics PO-7	Individual & Team work PO-8	Communication PO-9	Life Long learning PO-10	PSO-1	PSO-2
CO-1: Student will know introduction and statutory requirements of electrical safety.	2	3	2	2	2	0	0	2	0	1	2	1
CO-2: Student will understand the electrical hazards and its safety.	2	2	3	2	2	0	0	1	0	2	2	1
CO-3: Student will know various protection systems used in electrical systems.	2	2	3	2	2	0	0	1	0	2	2	1
CO-4: Student will be able to know the selection, installation, operation and maintenance of various electrical system.	2	2	3	2	2	0	0	1	0	2	2	2
CO-5: Student will learn about various electrical hazardous zones and its safety.	2	2	3	2	2	0	0	1	0	2	2	1

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Title	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-1: Student will know introduction and statutory requirements of electrical safety.**	SO1.1 SO1.2 SO1.3	LI1.1 LI1.2	1.1, 1.6 1.2, 1.7 1.3 1.4 1.5	SL1.1 SL1.2
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-2: Student will understand the electrical hazards and its safety.**	SO2.1 SO2.2 SO2.3	LI2.1 LI2.2 LI2.3 LI2.4 LI2.5	2.1, 2.6 2.2, 2.7 2.3, 2.8 2.4 2.5	SL2.1
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-3: Student will know various protection systems used in electrical systems.**	SO3.1 SO3.2 SO3.3 SO3.4	LI3.1 LI3.2 LI3.3	3.1, 3.6 3.2, 3.7 3.3, 3.8 3.4, 3.9 3.5	SL3.1 SL3.2
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-4: Student will be able to know the selection, installation, operation and maintenance of various electrical system.**	SO4.1 SO4.2 SO4.3	LI4.1 LI4.2	4.1 4.2 4.3 4.4 4.5	SL4.1 SL4.2 SL4.3
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-5: Student will learn about various electrical hazardous zones and its safety.**	SO5.1 SO5.2 SO5.3	LI5.1	5.1 5.2 5.3 5.4 5.5	SL5.1 SL5.2 SL5.3

Legend:CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

A) Course Code : 2129574(020)

B) Course Title : Industrial Environmental and Pollution Control

C) Pre- requisite Course Code and Title :

D) Rationale : Industrial pollution is caused by significant industries such as power plants, steel mills, sewage treatment facilities, heating plants, and glass casting, among other producing, refining, and manufacturing organizations. Industrial Environmental play the very crucial role for the working employee.

E) Course Outcomes:

CO-1: Students will be able to attain ability to choose the most suitable technique for air pollution monitoring and control technique for a given application.

CO-2: Students will be able to describe suitable techniques for water treatments and control technique for water pollution management.

CO-3: Students will be able to identify the techniques for the disposal and management of urban solid wastes and hazardous wastes.

CO-4: Students will be able to demonstrate the ability to recognize the tools for environmental management in industries.

CO-5: Students will be able to demonstrate an ability to recognize the type of health care waste and processes involved in Transport & storage of waste treatment and disposal of health care waste.

F) Scheme of Studies:

Board of Study	Course Code	Course Titles	Scheme of Studies (Hours/Week)			Credits L+T+(P/2)
			L	P	T	
Civil Engineering	2129574 (020)	Industrial Environmental and Pollution Control	2	-	1	3
Civil Engineering	2129563 (020)	Industrial environmental and pollution control (Lab)	-	2	-	1

L- Lecture, T- Tutorial, P- Practical,

Legend: Lecture (L) →CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture and others).

Practical (P) → LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies).

Tutorial (T) →SL: Self Learning.

G) Scheme of Assessment:

Board of Study	Course Code	Course Titles	Scheme of Examination					
			Theory			Practical		Total
			ESE	CT	TA	ESE	TA	Marks
Civil Engineering	2129574 (020)	Industrial environmental and pollution control	70	20	30	-	-	120
Civil Engineering	2129563 (020)	Industrial environmental and pollution control (Lab)	-	-	-	40	60	100

ESE: End Semester Exam, CT: Class Test, TA: Teachers Assessment

Legend- PRA: Process Assessment, PDA: Product Assessment

Note:

i) TA in Theory includes Sessional work (SW) and attendance (ATT) with weightage of 70% and 30% of total respectively.

ii) TA in practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%,40% and 10% respectively.

iii) 85% attendance is essential in theory and practical classes to appear in Examination.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1: Students will be able to attain ability to choose the most suitable technique for air pollution monitoring and control technique for a given application.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Understand the classification and properties of air pollutants. SO1.2 Evaluate and apply pollution. prevention and control measures. SO1.3 Identify and assess environmental risks and impacts.	LI1.1 To demonstrate Air quality monitoring equipment. LI1.2 To study the particulate matter monitors and gas analyzer. LI1.3 To demonstrate the gas analyzer. LI1.4 To demonstrate the safety goggles.	**UNIT-1.0 AIR POLLUTION** 1.1 Classification and properties of air pollutants. 1.2 Pollution sources – Effects of air pollutants on human beings, Animals, plants and Materials - automobile pollution hazards of air pollution. 1.3 Concept of clean coal combustion technology - ultra violet radiation, infrared radiation, radiation from sun-hazards due to depletion of ozone - deforestation-ozone holes-automobile exhausts-chemical factory stack emissions-Chloro Fluoro Carbon(CFC).	SL1.1 Learn about automobile pollution hazards of air pollution. SL1.2 Learning about coal combustion technology.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

1. Explain the Classification and properties of air pollutants.
2. Explain the of Pollution sources.
3. Define Chloro Fluoro Carbon (CFC).
4. Write short notes on automobile pollution hazards of air pollution.

b. Mini Project:

1. Working process of a Air quality monitoring equipment.
2. Design the setup to control automobile pollution hazards of air pollution

CO-2: Students will be able to describe suitable techniques for water treatments and control technique for water pollution management.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Identify and classify water pollutants. SO2.2 Evaluate health hazards associated with water pollution. SO2.3 To know the Demonstrate proficiency in water sampling and analysis.	LI2.1 Determine total hardness, and permanent hardness of water sample by EDTA method. LE2.2 Determine the alkalinity and Acidity of given water sample. LE2.3 Determine the turbidity, pH, Electric conductivity in given water sample. LE2.4 Determine the total dissolved and suspended solids in given water sample. LE2.5 Determine the biological oxygen demand and Chemical oxygen demand in the given water sample.	**UNIT 2.0 WATER POLLUTION** 2.1 Classification of water pollutants-health hazards-sampling and analysis of water- 2.2 water treatment - different industrial effluents and their treatment and disposal. 2.3 Advanced wastewater treatment – effluent quality standards and laws-chemical industries, tannery, textile effluents-common treatment	SL2.1 Learning about advanced wastewater treatment methods, including activated sludge, membrane filtration. SL2.2 Learning about treatment methods to effectively remove pollutants and meet regulatory requirements for disposal. SL2.3 Learning about collection of water sampling and analysis

SW-2 Suggested Sessional Work (SW):

a. Assignments

1. Discuss the classification of water pollutants based on their sources and characteristics and provide examples of each type of water pollutant.
2. Explain the health hazards associated with water pollution. Identify at least three waterborne diseases and discuss their causes and symptoms.
3. Describe the sampling and analysis techniques used to assess water quality.

b. Mini Project:

1. Water Quality Analysis (Conduct a comprehensive water quality analysis of a local water body (such as a river, lake, or pond) to assess its pollution levels)
2. Designing a Small-scale Water Treatment System.
3. Industrial Effluent Treatment Case Study.

CO-3: Students will be able to identify the techniques for the disposal and management of urban solid wastes and hazardous wastes.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Understand hazardous waste management practices in India. SO3.2 Learning about characterization, and classification hazardous waste. SO3.3 Understand technological options for the collection, treatment, and disposal of hazardous.	LI3.1 "Hazardous Waste Profiling: Identification and Characterization". LI3.2 Practices for Hazardous Waste Storage and Labeling: Safety and Compliance. LI3.3 Effective Emergency Response and Spill Management Protocols: A Laboratory Study.	**UNIT-3.0 HAZARDOUS WASTE MANAGEMENT** 3.1Hazardous waste m anagement in India-waste identification, characterization and classification-technological options for collection, treatment and disposal of hazardous waste. 3.2 Selection charts for the treatment of different hazardous wastes. 3.3 Methods of collection and disposal of solid wastes-health hazards-toxic and radioactive wastes incineration and vitrification 3.4 Hazards due to bio-process-dilution-standards and restrictions – recycling and reuse.	SL3.1 knowledge of the regulatory framework and policies related to hazardous waste management in India SL3.2 Learning about knowledge of various collection methods and disposal techniques for solid hazardous waste SL3.3 Learning about the potential hazards and risks associated with bio-processes, dilution practices, and adherence to standards and restrictions in hazardous waste management.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

1. Explain the potential hazards and risks associated with bio-processes, dilution practices, and adherence to standards and restrictions in hazardous waste management.
2. Explain the one successful solid waste management practices in India or other countries.
3. Classify hazardous wastes based on their physical, chemical, and biological properties.

b. Mini Project:

1. Technological Options for Collection, Treatment, and Disposal of Hazardous Wastes.
2 Methods of Collection and Disposal of Solid Wastes.
3 Health Hazards and Management of Toxic and Radioactive Wastes.

CO-4: Students will be able to demonstrate the ability to recognize the tools for environmental management in industries.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Introduction of Environmental Measurement and Control SO4.2 Identify types and operational use of modern oxygen breathing apparatus.	LI4.1 To demonstrate Dust monitor: Working principles and applications. LI4.2 To demonstrate Gas analyzer: Measurement of gases and their concentrations. LI4.3 To study the Gas chromatograph: Separation and analysis of complex gas mixture. LI4.4 To perform Gas analyzer: Measurement of gases and their concentrations.	**UNIT-4.0 ENVIRONMENTAL MEASUREMENT AND CONTROL** 4.1 Sampling and analysis – dust monitor. 4.2 Gas analyzer, particle size analyzer, pH meter, gas chromatograph. 4.3 Atomic absorption spectrometer. Gravitational settling chambers-cyclone. separators, scrubbers electrostatic precipitator 4.4 Bag filter maintenance, control of gaseous emission by adsorption, absorption and combustion methods, Pollution Control Board laws.	SL4.1 Types and operational use of gas analyzer SL4.2 Learning about particle size analyzer SL4.3 Learning about absorption and combustion methods.

SW-4 Suggested Sessional Work (SW):

a. Assignments:

1. Write the specification, use and maintenance of Gas analyzer.
2. Explain various types and operation of Atomic absorption spectrometer apparatus.
3. What short notes Pollution Control Board laws.

b. Mini Project:

1. Sampling and analysis techniques in Environmental Measurement and Control
2. Gas Chromatograph: Separating and Analyzing Volatile Compounds in the Environment
3. Sampling and Analysis Techniques in Environmental Measurement and Control

CO-5: Students will be able to demonstrate an ability to recognize the type of health care waste and processes involved in Transport & storage of waste treatment and disposal of health care waste.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Understand the environmental impact of process industries. SO5.2 Explain the principles and applications of emission reduction methods. SO5.3 Evaluate the role of eco-friendly energy sources.	LI 5.1 Water Pollution Control: Biological Treatment. LI5.2 Wastewater pH Adjustment. LI5.3 Noise Pollution Measurement and Control. LI5.4 Solid Waste Management: Recycling. LI5.5Green Technologies and Sustainable Practices.	**UNIT-5 POLLUTION CONTROL IN PROCESS INDUSTRIES** 5.1 Pollution control in process industries like cement, paper, petroleum. 5.2 petroleum products textile-tanneries. 5.3 Thermal power plants dying and pigment industries eco-friendly energy.	SL5.1 learn about eco-friendly energy sources. SL5.2 Learning about Analyze the policies, regulations, and government initiatives related to pollution control in process industries. SL5.3 Learning about cost-effective pollution control measures for industries.

a. Assignments:

1. Write the notes on Regulatory Framework for Pollution Control in Process Industries: Case Studies and Implications.
2. Explain, Integrated Pollution Control Strategies in Process Industries

b. Mini Project:

1. Assessment and Implementation of Air Pollution Control Measures in Cement Industry
2. Prepare the Treatment and Water Conservation Strategies in Paper Manufacturing.
3. Sustainable Practices in Textile and Tannery Industries: Wastewater Treatment and Chemical Management.

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction CI+SW+SL):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	AIR POLLUTION	4	6	4	14
II	WATER POLLUTION	4	6	4	14
III	HAZARDOUS WASTE MANAGEMENT	4	6	4	14
IV	ENVIRONMENTAL MEASUREMENT AND CONTROL	4	6	4	14
V	POLLUTION CONTROL IN PROCESS INDUSTRIES	4	6	4	14
Total		20	30	20	70

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Title	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LI1.1	To demonstrate Air quality monitoring equipment.	20	15	5
LI1.2	To study the particulate matter monitors and gas analyzer.			
LI1.3	To demonstrate and using method of the safety goggles.			
LI1.4	To demonstrate the safety goggles			
LI2.1	Determine total hardness, and permanent hardness of water sample by EDTA method.			
LI2.2	Determine the alkalinity and Acidity of given water sample.			
LI2.3	Determine the turbidity, pH, Electric conductivity in given water sample.			
LI2.4	Determine the total dissolved and suspended solids in given water sample.			
LI2.5	Determine the Biological Oxygen Demand and Chemical Oxygen Demand in the given water sample.			
LI 3.1	Hazardous Waste Profiling: Identification and Characterization.			
LI3.2	Practices for Hazardous Waste Storage and Labeling: Safety and Compliance.			
LI3.3	Effective Emergency Response and Spill Management Protocols: A Laboratory Study.			
LI4.1	To demonstrate Dust monitor: Working principles and applications.			
LI4.2	To demonstrate Gas analyzer: Measurement of gases and their concentrations.			

LI4.3	To study the Gas chromatograph: Separation and analysis of complex gas mixture.			
LI4.4	To perform Gas analyzer: Measurement of gases and their concentrations.			
LI 5.1	Water Pollution Control: Biological Treatment.			
LI5.2	Wastewater pH Management.			
LI5.3	Noise Pollution Measurement and Control.			
LI5.4	Solid Waste Management: Recycling.			
LI5.5	Green Technologies and Sustainable Practices.			

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals

Legend : PRA: Process Assessment, PDA : Product Assessment

Note : Only one experiment has to performed at the end semester examination of 40 Marks as per assessment scheme.

(K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Industrial visits
4. Industrial Training
5. Demonstration
6. Others

L) Suggested Learning Resources:

(a) Books :

S.No.	Title	Author	Publisher	Edition & Year
1.	Environmental pollution engineering	CS Rao,	Wiley Eastern Limited, NewDelhi	1992
2.	Pollution control in process industries	S.P.Mahajan	Tata McGraw Hill Publishing Company, New Delhi,	1993.
3.	Air pollution equipment",	Varma and Braner,	Springer Publishers,	1996

(b) Open source software and website address:

Environmental Protection Agency: https://www.epa.gov/air-pollution-transportation Hazardous Waste Management: https://www.unep.org/resources/hazardous-waste-management United States Geological Survey (USGS): Water Pollution: https://www.usgs.gov/mission-areas/water-resources/science/water-pollution Indian Ministry of Environment, Forest and Climate Change: Pollution Control in Industries: http://envfor.nic.in/pollution-control-boards Ministry of Environment, Forest and Climate Change: Pollution Control in Industries: http://envfor.nic.in/pollution-control-boards.

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications/description	Relevant Experiment Number
1	Electronic balance,	scale range of 0.001g to 500g. pan size 100 mm; response time 3-5 sec.; power requirement 90- 250 V, 10 watt.	All experiments
2	Particle Counter	Laser-based, handheld or stationary. Measurement Range: PM1.0, PM2.5, PM10, and particle count. Accuracy: Typically within ±10%.	LI1.1
4	Gas Analyzers	Electrochemical or non-dispersive infrared (NDIR) sensors for specific gases. Common Gases to Measure: CO2, CO, O3, SO2, NO2, VOCs:, Measurement Range: Depends on the specific gas being measured. Accuracy: Typically within ±5%.	LI1.2
5	Weather Station	Multi-sensor station,Parameters: Temperature (range: -40°C to 70°C), Humidity (range: 0-100%),Atmospheric Pressure (range: 800-1100 hPa).	LI1.3
6	Protective Gear	N95 masks, safety goggles, gloves.	LI1.1
7	pH meter	Working range 0-14; resolution 0.1/0.01 pH; temperature compensation 0-1000 C	LI2.3
8	Conductometer	Range 0-199.9ms; resolution 0.1ms/0.01ms/0.001ms/0.1µs/0.01µs; accuracy ±0.5% ±2 digits	LI2.3
9	Nephelometer	Auto-ranging from 20-200 NTU,+/- 2% of reading plus 0.1 NTU, power 220 Volts +/- 10% AC 50 Hz.	LI2.3
10	TDS Meter	TDS typically measured in parts per million (ppm) or milligrams per liter (mg/L), An accuracy of ±2% or better is common for quality TDS meters resolution of 1 ppm or lower.	LI2.4
11	Gas Chromatograph-Mass Spectrometer (GC-MS)	High sensitivity and resolution, Wide range of detectable compounds	LI4.2

12	Liquid Chromatograph-Mass Spectrometer (LC-MS)	Suitable for liquid samples, High sensitivity and selectivity	LI4.3
13	UV-Vis Spectrophotometers	UV Range: Typically 190 to 400 nanometers (nm), Vis Range: Typically 400 to 800 nm	LI4.4
14	Dissolved Oxygen (DO) Meter, Chemical Oxygen Demand (COD) Analyzer, Automated BOD Analyzers	Typically measures BOD and COD values ranging from 0 to 1,000 mg/L or higher. Measures dissolved oxygen concentration in water, typically ranging from 0 to 20 mg/L or higher.	LI5.1
15	Sound Level Meter (SLM)	Common ranges include 30 dB to 130 dB or wider.	LI5.3

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs) Titles	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	Basic knowledge PO-1	Discipline knowledge PO-2	Experiments& Practice PO-3	Engineering Tools PO-4	The Engineer& Society PO-5	Environment & Sustainability PO-6	Ethics PO-7	Individual & Team work PO-8	Communication PO-9	Life Long learning PO-10	PSO-1	PSO-2
CO-1: Students will be able to attain ability to choose the most suitable technique for air pollution monitoring and control technique for a given application.	2	3	2	2	2	0	0	2	0	1	2	1
CO-2: Students will be able to describe suitable techniques for water treatments and control technique for water pollution management.	2	2	3	2	2	0	0	1	0	2	2	1
CO-3: Students will be able to identify the techniques for the disposal and management of urban solid wastes and hazardous wastes.	2	2	3	2	2	0	0	1	0	2	2	1
CO-4: Students will be able to demonstrate the ability to recognize the tools for environmental management in industries.	2	2	3	2	2	0	0	1	0	2	2	1
CO-5: CO-5: Students will be able to demonstrate an ability to recognize the type of health care waste and processes involved in Transport & storage of waste treatment and disposal of health care waste.	2	2	3	2	2	0	0	1	0	2	2	2

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Title	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-1: Students will be able to attain ability to choose the most suitable technique for air pollution monitoring and control technique for a given application.**	SO1.1 SO1.2 SO1.3	LI1.1 LI1.2 LI1.3 LI1.4	1.1 1.2 1.3	SL1.1 SL1.2
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-2: Students will be able to describe suitable techniques for water treatments and control technique for water pollution management.**	SO2.1 SO2.2 SO2.3	LI2.1, 2.4 LI2.2, 2.5 LI2.3	2.1 2.2 2.3	SL2.1 SL2.2 SL2.3
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-3: Students will be able to identify the techniques for the disposal and management of urban solid wastes and hazardous wastes.**	SO3.1 SO3.2 SO3.3	LI3.1 LI3.2 LI3.3	3.1 3.2 3.3 3.4	SL3.1 SL3.2 SL3.3
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-4: Students will be able to demonstrate the ability to recognize the tools for environmental management in industries.**	SO4.1 SO4.2	LI4.1 LI4.2 LI4.3 LI4.4	4.1 4.2 4.3 4.4	SL4.1 SL4.2 SL4.3
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-5: CO-5: Students will be able to demonstrate an ability to recognize the type of health care waste and processes involved in Transport & storage of waste treatment and disposal of health care waste.**	SO5.1 SO5.2 SO5.3	LI5.1 LI5.2 LI5.3 LI5.4 LI5.5	5.1 5.2 5.3	SL5.1 SL5.2 SL5.3

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

A) Course Code : 2129575(020)

B) Course Title : **Disaster Management and Emergency Planning**

C) Pre- requisite Course Code and Title :

D) Rationale : Disaster management and emergency planning are crucial components of ensuring public safety and minimizing the impact of natural or man-made disasters. These processes involve a comprehensive set of measures and strategies designed to prepare, respond to, and recover from emergencies effectively.

E) Course Outcomes:

CO-1: Student will able to evaluate the principles and practices of disaster risk reduction and management.

CO-2: Student will able to know the basic role of public, national/international organizations in disaster management.

CO-3: Student will able to prevention, mitigation preparedness, and response and recovery process in disaster management.

CO-4: Students will able to understand distinguish between the different approaches needed to manage pre-during and post disaster periods.

CO-5: Student will able to apply the knowledge in conducting independent DM study including data search and analysis from disaster case study.

F) Scheme of Studies:

Board of Study	Course Code	Course Titles	Scheme of Studies (Hours/Week)			Credits L+T+(P/2)
			L	P	T	
Civil Engineering	2129575 (020)	Disaster Management and Emergency Planning	2	-	1	3

L- Lecture, T- Tutorial, P- Practical,

Legend: Lecture (L) →CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture and others).

Practical (P) → LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies).

Tutorial (T) →SL: Self Learning.

G) Scheme of Assessment:

Board of Study	Course Code	Course Titles	Scheme of Examination					
			Theory			Practical		Total
			ESE	CT	TA	ESE	TA	Marks
Civil Engineering	2129575 (020)	Disaster Management and Emergency Planning	70	20	30	-	-	120

ESE: End Semester Exam, CT: Class Test, TA: Teachers Assessment

Legend- PRA: Process Assessment, PDA: Product Assessment

Note:

i) TA in Theory includes Sessional work (SW) and attendance (ATT) with weightage of 70% and 30% of total respectively.

ii) TA in practical includes performance of PRA,PDA and Viva-Voce with weightage of 50%,40% and 10% respectively.

iii) 85% attendance is essential in theory and practical classes to appear inExamination.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1: Student will able to evaluate the principles and practices of disaster risk reduction and management.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Awareness of the complexity of disasters SO1.2 Awareness of the complexity of disasters control measures SO1.3 Awareness of the complexity of disasters.	--	**UNIT-1.0 PHILOSOPHY OF DISASTER MANAGEMENT** 1.1 Introduction to Disaster mitigation-Hydrological. 1.2 Coastal and Marine Disasters-Atmospheric disasters-Geological, meteorological phenomena. 1.3 Mass Movement and Land Disasters-Forest related disasters-Wind and water related disasters.	SL1.1 Learn about Forest related disasters. SL1.2 Exploration of different philosophical approaches.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
		1.4 disasters deforestation-Use of space technology for control of geological disasters-Master thesis.	

SW-1 Suggested Sessional Work (SW)

a. Assignments:

1. Explain the philosophical underpinnings of disaster management and its implications for mitigating various types of disasters.
2. Explain the ethical considerations, community engagement, and proactive approaches necessary for effective disaster mitigation.
3. Define Chloro Fluoro Carbon(CFC).

c. Mini Project:

1. Introduction to Disaster Mitigation and Assessing the Role of Climate Change in intensifying Extreme Weather Events: Implications for Disaster.
2. Design the setup to control Forest-Related Disasters.
3. Design the setup to use Space Technology for Control of Geological Disasters Forest-Related Disasters.

CO-2: Student will able to know the basic role of public, national/international organizations in disaster management.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1Understanding Technological Disasters. SO2.2 Learn about emergency response and control measures implemented. SO2.3 To know the differentiate between onsite and offsite emergencies that can occur during technological disasters.	--	**UNIT 2.0 TECHNOLOGICAL DISASTERS** 2.1 Case studies of Technology disasters with statistical details Emergencies and control measures-APELL-Onsite and Offsite emergencies-Crisis management groups-Emergency centers and their functions throughout the country-Softwares on emergency controls-Monitoring devices for detection of gases in the atmosphere-Right to know act	SL2.1 Learning about concept of crisis management groups. SL2.2 Learning about Understand how these technologies aid in decision-making, resource allocation, and communication.

SW-2 Suggested Sessional Work (SW):

a. Assignments

1. Discuss about technological disaster, such as the Chernobyl nuclear accident.
2. Explain the plan for emergency response and control during technological disasters, such as monitoring devices or software systems.

b. Mini Project:

1. Explain the "Technological Disasters: Analysis and Emergency Response Measures".

CO-3: Student will able to prevention, mitigation preparedness, response and recovery process in disaster management.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Understand Bio Diversity. SO3.2 Learning about pollution-Global warming and Ozone Depletion. SO3.3 Understand technological options for the Eco friendly products.	--	**UNIT-3.0 INTRODUCTION TO SUSTAINABLE DEVELOPMENT** 3.1 Bio Diversity-Atmospheric pollution-Global warming and Ozone Depletion-ODS banking and phasing out-Sea level rise-El Nino and climate changes. 3.2 Eco friendly products-Green movements-Green philosophy-Environmental Policies-Environmental Impact Assessment-case studies-Life cycle.	SL3.1 knowledge of the causes of pollution-Global warming and Ozone. SL3.2 Learning about knowledge of various causes of Environmental Impact Assessment in human life.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

1. Explain the Bio Diversity.
2. Explain the Global warming and Ozone Depletion.
3. Explain the Environmental Policies-Environmental Impact Assessment.

b. Mini Project:

1. Make a model for climate changes
2. Methods of reduction of global warming and Ozone Depletion.

CO-4: Student will able to prevention, mitigation preparedness, response and recovery process in disaster management.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Introduction of Marine pollution and control Toxic, hazardous. SO4.2 Identify causes of nuclear wastes in Global environmental issues.	--	**UNIT-4.0 OFFSHORE AND ONSHORE DRILLING** 4.1 Control of fires-Case studies-Marine pollution and control Toxic, hazardous & Nuclear wastes-state of India's. 4.2 Nuclear wastes in Global environmental issues carcinogens-complex emergencies Earthquake. 4.3 Earthquake disasters-the nature-extreme event analysis the immune system-proof and limits.	SL4.1 Learning about Control of fires cases in Marine pollution. SL4.2 Learning about Nuclear wastes. SL4.3 Learning about disasters.

SW-4 Suggested Sessional Work (SW):

a. Assignments:

1. Write the nots on control Toxic, hazardous & Nuclear wastes-state of India's.
2. Explain various causes of earthquake disasters-the nature-extreme event analysis

b. Mini Project:

1. Explain the techniques to reduce the Marine pollution.
2. Nuclear wastes.

CO-5: Student will able to apply the knowledge in conducting independent DM study including data search and analysis from disaster case study.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Understand the Population and community ecology. SO5.2 Explain the Risk assessment process. SO5.3 Evaluate the role of stock taking and vulnerability analysis in stock	--	**UNIT-5.0 ENVIRONMENTAL EDUCATION** 5.1 Population and community ecology-Natural resources conservation-Environmental protection and law-Research methodology and systems analysis 5.2 Natural resources conservation-Policy initiatives and future prospects-Risk assessment process, assessment for different disaster	SL5.1 learn about ecology. SL5.2 Learning about assessment for different disaster SL5.3 Learning about destructive capacity.

taking and vulnerability analysis.		types-Assessment data use, destructive capacity-risk adjustment-choice-loss acceptance-disaster aid-public liability insurance-stock taking and vulnerability analysis-stock taking and vulnerability analysis profile of the country-national policies-objectives and standards-physical event modification-preparedness, forecasting and warning, land use planning.	

a. Assignments:

1. Write the notes on Risk assessment process,.
2. Explain, stock taking and vulnerability analysis profile of the country.

b. Mini Project:

1. Environmental Education: Promoting Awareness and Action for Sustainable Living"

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction CI+SW+SL):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	PHILOSOPHY OF DISASTER MANAGEMENT	4	6	4	14
II	TECHNOLOGICAL DISASTERS	4	6	4	14
III	INTRODUCTION TO SUSTAINABLE DEVELOPMENT	4	6	4	14
IV	OFFSHORE AND ONSHORE DRILLING	4	6	4	14
V	ENVIRONMENTAL EDUCATION	4	6	4	14
Total		20	30	20	70

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*): Nil

Laboratory Instruction Number	Short Laboratory Experiment Title	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
-	-	-	-	-

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals

Legend : PRA: Process Assessment, PDA : Product Assessment

Note : Only one experiment has to performed at the end semester examination of 40 Marks as per assessment scheme.

(K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Industrial visits
4. Industrial Training
5. Demonstration
6. Others

L) Suggested Learning Resources:

(a) Books :

S.No.	Title	Author	Publisher	Edition & Year
1.	Environmental pollution engineering	CS Rao,	Wiley Eastern Limited, NewDelhi	1992
2.	Pollution control in process industries	S.P.Mahajan	Tata McGraw Hill Publishing Company, New Delhi,	1993.
3.	Air pollution equipment"	Varma and Braner,	Springer Publishers,	1996

(b) Open source software and website address:

1. Environmental Protection Agency: https://www.epa.gov/air-pollution-transportation

2. Hazardous Waste Management: https://www.unep.org/resources/hazardous-waste-management

3. United States Geological Survey (USGS): Water Pollution: https://www.usgs.gov/mission-areas/water-resources/science/water-pollution

4. Indian Ministry of Environment, Forest and Climate Change: Pollution Control in Industries: http://envfor.nic.in/pollution-control-boards

5. Ministry of Environment, Forest and Climate Change: Pollution Control in Industries: http://envfor.nic.in/pollution-control-boards

M) List of Major Laboratory Equipment and Tools: Nil

S. No.	Name of Equipment	Broad Specifications/description	Relevant Experiment Number
-	-	-	-

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs) Titles	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	Basic knowledge PO-1	Discipline knowledge PO-2	Experiments& Practice PO-3	Engineering Tools PO-4	The Engineer& Society PO-5	Environment & Sustainability PO-6	Ethics PO-7	Individual & Team work PO-8	Communication PO-9	Life Long learning PO-10	PSO-1	PSO-2
CO-1: Student will able to evaluate the principles and practices of disaster risk reduction and management.	2	3	2	2	2	0	0	2	0	1	2	1
CO-2: Student will able to know the basic role of public, national/international organizations in disaster management.	2	2	3	2	2	0	0	1	0	2	2	1
CO-3: Student will able to prevention, mitigation preparedness, and response and recovery process in disaster management.	2	2	3	2	2	0	0	1	0	2	2	1
CO-4: Students will able to understand distinguish between the different approaches needed to manage pre-during and post disaster periods.	2	2	3	2	2	0	0	1	0	2	2	2
CO-5: Student will able to apply the knowledge in conducting independent DM study including data search and analysis from disaster case study.	2	2	3	2	2	0	0	1	0	2	2	1

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Title	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-1: Student will able to evaluate the principles and practices of disaster risk reduction and management.**	SO1.1 SO1.2 SO1.3	-	1.1 1.2 1.3 1.4	SL1.1 SL1.2
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-2: Student will able to know the basic role of public, national/international organizations in disaster management.**	SO2.1 SO2.2 SO2.3	-	2.1	SL2.1 SL2.2
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-3: Student will able to prevention, mitigation preparedness, and response and recovery process in disaster management.**	SO3.1 SO3.2 SO3.3	-	3.1 3.2	SL3.1 SL3.2
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-4: Students will able to understand distinguish between the different approaches needed to manage pre-during and post disaster periods.**	SO4.1 SO4.2	-	4.1 4.2 4.3	SL4.1 SL4.2 SL4.3
PO-1,2,3,4,5,8,10 PSO-1,2	**CO-5: Student will able to apply the knowledge in conducting independent DM study including data search and analysis from disaster case study.**	SO5.1 SO5.2 SO5.3	-	5.1 5.2	SL5.1 SL5.2 SL5.3

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.