GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA (JHAJJAR)
An Autonomous Institute

'A' GRADE ACCREDITED BY NAAC

Evaluation Scheme & Syllabus For

3rd Year

Bachelor of Technology Fire Technology and Safety

(Effective from the Session: 2026-27)

APPROVED BY AICTE, NEW DELHI AND AFFILIATED TO MDU, ROHTAK

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA, JHAJJAR (HR.)

Scheme of Studies and Examinations

B.Tech (Fire Technology and Safety)– 5th Semester

w.e.f. 2026-27

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Schedule (Marks)				Exam Duration in H
				L	T	P			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	Professional Core Courses	PCC-FT-301A	Fire Safety Risk Assessment	3	0	0	3	3	40	60		100	3
2	Professional Core Courses	PCC-FT-303A	Fire Dynamics	3	0	0	3	3	40	60		100	3
3	Professional Core Courses	PCC-FT-305A	Fire Safety Codes and Standards	3	0	0	3	3	40	60		100	3
4	Engineering Science Courses	ESC-ME-307A	Strength of Materials	3	0	0	3	3	40	60		100	3
5	Professional Core Courses	PCC-FT-309A	Fire Protection	3	0	0	3	3	40	60		100	3
6	Professional Elective Courses	Refer Table 2	Professional Elective-II	3	0	0	3	3	40	60		100	3
7	Professional Core Courses	LC-FT-311A	Fire Dynamics Lab	0	0	2	2	1	25		25	50	3
8	Engineering Science Courses	LC-ME-313A	Strength of Materials Lab	0	0	2	2	1	25		25	50	3
9	Professional Core Courses	LC-FT-315A	Fire Ground Operations-V	0	0	2	2	1	25		25	50	3
10	Internship	INT-FT-317A	Internship Seminar-I	0	0	2	2	1	50		-	50	3
11	Mandatory Non Credit Courses – Audit Courses	MC-301A	Essence of Indian Traditional Knowledge	2	0	0	2	-	40	-	60	100	3
Total Credits								**22**				**800**	

Notes:

I. MC-301A is a mandatory non –credit course in which the students will be required passing marks in theory. However these marks will not be added in the total marks.

II. They may also opt for Massive Open Online Courses (MOOCs) offered through SWAYAM, SWAYAM Plus, or NPTEL platforms subject to approval by the concerned Chairperson, Board of Studies (BoS)/Head of the Department.

Table 2 Professional Elective – II

Sr. No.	Code	Subject
1	PEC-FT-319A	Special Fire Hazards
2	PEC-FT-321A	Offshore Structures under Special Environmental Loads including Fire Resistance
3	PEC-FT-323A	Fire Service Communication and Mobilizing
4	PEC-FT-325A	Fire and Life Safety Audit
5	----------	MOOCs offered through SWAYAM, SWAYAM Plus, or NPTEL platforms

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA, JHAJJAR (HR.)

Scheme of Studies and Examinations

B.Tech (Fire Technology and Safety) – 6th Semester

w.e.f. 2026-27

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Schedule (Marks)				Exam Duration in H
				L	T	P			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	Professional Core Courses	PCC-FT-302A	Fire Testing	3	0	0	3	3	40	60		100	3
2	Professional Core Courses	PCC-FT-304A	Fire Appliances and Rescue Equipments	3	0	0	3	3	40	60		100	3
3	Professional Core Courses	PCC-FT-306A	Automobile Engineering Safety	2	0	0	2	2	40	60		100	3
4	Professional Elective Courses	Refer Table 3	Professional Elective-III	3	0	0	3	3	40	60		100	3
5	Open Elective Courses	Refer Table 4	Open Elective-I	3	0	0	3	3	40	60		100	3
6	Humanities and Social Sciences including Management courses	HSMC-FT-308A	Energy Environment Ethics and Society	3	0	0	3	3	40	60		100	3
7	Professional Core Courses	LC-FT-310A	Fire Testing Lab	0	0	2	2	1	25		25	50	3
8	Professional Core Courses	LC-FT-312A	Automobile Safety Lab	0	0	2	2	1	25		25	50	3
9	Professional Core Courses	LC-FT-314A	Basic Computer Skills and AutoCAD Lab	0	0	2	2	1	25		25	50	3
10	Professional Core Courses	LC-FT-316A	Fire Ground Operations-VI (Rescue Operations)	0	0	2	2	1	25		25	50	3
Total Credits								**21**				**800**	

Notes:

I. At the end of the 6th Semester, each student shall undergo 4–6 weeks of Practical Training in any one of the following areas: Fire and Safety, Fire and Safety Equipment Installation, Care and Maintenance, Fire and Safety Audits, or any certificate course related to Fire and Safety (minimum contact hours: 30 hours). The training may be undertaken in a Fire Service Department, Industry, Multi-Speciality Hospital, Professional Organization, Research Laboratory, Training Centre, Educational Institute, or any other building occupancy having fire-fighting installations. The student shall submit a typed training report along with a certificate issued by the concerned organization. The evaluation of the training shall be carried out in the 7th Semester.

II. **For Working Professionals:** Students shall submit a Training/Project Report based on their work in their respective company/organization for the period of the summer/industrial training. The evaluation shall be carried out in the 7th Semester.

III. Students must choose one course from the Professional Elective–III category (Table 3) and one course from the Open Elective–I category (Table 4). They may also opt for Massive Open Online Courses (MOOCs) offered through the SWAYAM, SWAYAM Plus, or NPTEL platforms, subject to the approval of the concerned Chairperson, Board of Studies/Head of the Department.

Table 3 Professional Elective – III

Sr. No.	Code	Subject
1	PEC-FT-318A	Fire Modelling
2	PEC-FT-320A	Safety Practice in Chemical and Nuclear Industries
3	PEC-FT-322A	Building Design and Drawing
4	PEC-FT-324A	Industrial Hygiene and Occupational Health
5	PEC-FT-326A	Nuclear Reactors and Safety
6	PEC-FT-328A	Computational Fluid Dynamics
7	----------	MOOCs offered through SWAYAM, SWAYAM Plus, or NPTEL platforms

Table 4 Open Elective Courses – I

Sr. No.	Code	Subject	Offered by	Departments Eligible to Choose the Course
1	OEC-01A	Engineering Ethics	Department of Electronics and Communication Engineering	All Engineering Departments
2	OEC-02A	Waste Management	Department of Civil Engineering	All Engineering Departments except the Department of Civil Engineering
3	OEC-03A	Internet of Things and Edge Computing	Department of Computer Science and Engineering	All Engineering Departments
4	OEC-04A	Project Management	Department of Mechanical Engineering	All Engineering Departments
5	OEC-05A	Renewable Energy Resources	Department of Electrical Engineering	All Engineering Departments
6	OEC-06A	United Nation's Sustainable Development Goals	Department of Electronics and Communication Engineering	All Engineering Departments
7	OEC-07A	Computer Aided Risk Analytics	Department of Fire Technology and Safety	All Engineering Departments
8	OEC-08A	Health, Safety and Environment	Department of Fire Technology and Safety	All Engineering Departments except the Department of Fire Technology and Safety
9	OEC-09A	Fundamentals of Additive Manufacturing	Department of Mechanical Engineering	All Engineering Departments except the Department of Mechanical Engineering
10	----------	MOOCs offered through SWAYAM, SWAYAM Plus, or NPTEL platforms	Online Platforms	All Engineering Departments

Course Code	**PCC-FT-301A**				
Category	Professional Core Courses				
Course Title	**Fire Safety Risk Assessment**				
Scheme and Credits	L	T	P	**Credits**	**Semester -V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to the concepts of hazards, risk assessment and fire safety evaluation in industrial and engineering systems. • To develop understanding of risk analysis methodologies, accident causation theories and safety performance measurement techniques. • To familiarize students with qualitative and quantitative risk assessment tools used for identification and evaluation of fire and industrial hazards. • To provide knowledge of human reliability analysis techniques and their role in accident prevention and safety management				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe hazards, risk, accident causation, fire risk scenarios and safety performance parameters used in fire safety risk assessment and evaluation.	Level 1: Remember
CO2	Explain the principles of hazard identification, qualitative and quantitative risk assessment, accident analysis and human reliability evaluation techniques.	Level 2: Understand
CO3	Apply risk assessment methodologies and analytical tools for evaluation of fire, explosion and industrial safety hazards.	Level 3: Apply
CO4	Analyze fire safety risks, accident scenarios, human reliability factors and consequences associated with industrial processes and hazardous systems.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Risk and Hazards: Definition, Accepted and Imposed risk, Perception and Qualification of Risk, ALARP, Cost Benefit Analysis, Fire explosion and toxic gas release, General principles of Fire Risk Assessment, Risk indices, Acceptance Criteria for Risk, As Low As Reasonably Practicable (ALARP), Risk Contour, F-N Curve, Individual Risk and Societal Risk, Hazards, Types of Hazards, Structure of Hazard Identification and Risk Assessment (HIRA), Fire Risk Scenarios, Fire Protection Measures as Fire Barriers, Hazardous Area Classification Study, Vulnerability Analysis.

Unit-II

Safety Performance: Introduction to Indian standard IS-3786, Accident,Classification of industrial accidents and special cases according to IS-3786,Theories of Accident Prevention, Principles of accident causation, Incident, Dangerous occurrence, Disabling (Lost-Time), Injury, Non-disabling injury, Reportable lost-time injury, Non-reportable lost- Time injury, Days of disablement (Lost time), Frequency rate, Weighed Frequency rate, Severity rate, Incidence rate, Frequency-severity index, Safe-T-score, Fatal accidents frequency rate.

Unit-III

Risk Assessment: Introduction, Basic Quantitative Risk Assessment (QRA), Principles of QRA, Probability Theory, Set Theory and Boolean Algebra, Use of Boolean Algebra and Cut Sets, Combination of frequencies, Logic Tree Approach, Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Qualitative risk assessment, Types of Consequences, Consequence Analysis Methodologies and Source Models, HAZOP, Conducting a HAZOP study, Computerized Reporting System, HAZOP of batch process, Extension of HAZOP, Application of HAZOP to human reliability, Failure Mode and Effects Analysis (FMEA), Methodology of FMEA, Critically Analysis, Corrective Action, Preventive Action and Follow up.

Unit-IV

Human Reliability Analysis (HRA): Factors Leading to Human Error, Characteristics of HRA Techniques, Techniques for Human Error Rate Prediction (THERP), Accident Sequence Evaluation Program (ASEP), Techniques using Expert Judgement, Operator Action Tree (OAT).

Suggested Readings:

- Fundamentals of Industrial Safety & Health- K.U.Mistry, SiddharthPrakashan.
- Industrial Safety Health and Environment management Systems by Jain and Rao, Khanna Publishers
- Safety Management- R.K. Mishra- AITBS Publishers.
- Safety Management in Industry by N.V. Krishnan, Jaico Publishing House, 1997
- Industrial Safety by Ronald P. Blake, Prentice Hall, New Delhi, 1973
- Occupational Safety and health by David L. Goetsch, Prentice Hall
- Modern Accident Investigation and Analysis by Ted S. Ferry, John Wiley & Sons
- Hazard Analysis Techniques for System by Clifton A. Erison, A John Wiley & Sons, Inc., Publication
- An Introduction to Reliability and Maintainability Engineering by Charles E. Ebeling, McGraw Hill.
- Probabilistic Risk Assessment and Management for Engineers and Scientists by Hiromitsu Kumamoto and E.J. Henley, IEEE Press.
- Quantitative Risk Assessment in Fire Safety by Ganapathy Ramachandran and David Charters, Spon Press

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Safety Engineering & Accident-Causing Mechanisms	https://youtu.be/91YpCY-1Fy0?si=9m7dc3xTVnvlrINi	NPTEL (IIT Kharagpur)
Unit-II	Safety Performance Indicators Part-I	https://youtu.be/NI89F0ISMog?si=no1jVjb6NRo52Xbl	NPTEL (IIT Kharagpur)

	Safety and Accident Loss Statistics	https://youtu.be/dlhXg7KkD0M?si=sb4EekkmyQFYBDqA	NPTEL (IIT Roorkee)
Unit-III	Fault Tree Analysis (FTA)-Construction	https://youtu.be/ZEShNJX3kcg?si=v4BPg658xrIST1kZ	NPTEL (IIT Kharagpur)
	Event Tree Analysis (ETA)	https://youtu.be/ikbC5_6qTvs?si=UV_joy0Ou7HMGV9I	NPTEL (IIT Kharagpur)
	Hazard and operability study (HAZOP)	https://youtu.be/n1s1UB80JgA?si=5E90ZscSGd1Sj7QE	NPTEL (IIT Kharagpur)
	Failure Mode Effect Analysis (FMEA)	https://youtu.be/7bFjH_ZVARI?si=_tg9BGYp1RTi9zwp	NPTEL (IIT Kharagpur)

Course Code	**PCC-FT-303A**				
Category	Professional Core Courses				
Course Title	**Fire Dynamics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To make students familiar with the fundamentals of fire science, combustion phenomena and heat transfer processes involved in fire dynamics. • To provide an understanding of flame behavior, flammability characteristics and combustion mechanisms of gases, liquids and solids. • To expose students to compartment fire development, flashover phenomena and fire growth behavior in enclosed spaces. • To develop knowledge of smoke movement, smoke control principles and computational approaches used in fire dynamics analysis.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the principles of combustion, heat transfer, ignition and fire behavior associated with fire dynamics.	Level 1: Remember
CO2	Explain the characteristics of flames, burning phenomena, compartment fire development and smoke movement processes under fire conditions.	Level 2: Understand
CO3	Apply fire dynamics concepts for interpretation of combustion behavior, heat release, fire growth and smoke control mechanisms.	Level 3: Apply
CO4	Analyze the influence of combustion, ventilation, compartment conditions and smoke movement on fire development and fire safety performance.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fire Science and Combustion: Fire, Classification of Fire, Fire triangle, Fire tetrahedron, The Physical Chemistry of Combustion in Fire, Thermodynamics of Combustion – Stoichiometry, Thermo-chemistry, Chemical equilibrium, Thermal equilibrium, Summary of the heat transfer equations, Conduction, Convection and radiation, Pyrolysis, Ignition mechanisms.

Unit - II

Flames: Flammability, Limits of flammability, Analysis of the Structure of the reaction zone and flame temperature, Measurement and Interpretation of flammability diagram, The structure of a premixed flame, Heat losses from premixed flames, Measurement of burning velocities, Variation of burning velocity with experimental parameters, Introduction to diffusion flame, Structure of diffusion flame, Burning of condensed phases, Burning of droplet clouds, Diffusion flame height, Flame spread theory, Fire plume dynamics.

Unit-III

Burning of Liquids and Solids: Classification of liquids, Flash points and their relationship to flammability limits. The wick effect and its relevance to the ignition of high flashpoint liquid pools, Application of the flash point and fire point to the ignition of solids, Spread of flame in solid, Burning of liquids, Burning of solids, Simple thermal model for the steady burning of liquids and solids, Combustion efficiency, Ventilation-controlled fires, Heat release rate.

Unit-IV

The Pre –Flashover Compartment Fire: The growth period and the definition of flashover, Growth to flashover.
The Post- Flashover Compartment Fire: Regimes of burning, Fully-developed fire behavior, Temperatures achieved in full – developed fire, Fire resistance and fire severity, Methods of calculating fire resistance, Projection of flames from burning compartments, Spread of fire from a compartment.
Smoke Movement and Smoke Control: Smoke production, Average plume temperature, Volumetric plume flow, Hazard of smoke, Principal of smoke movement, Flow through openings, Stack effect, Influence of floor and partition, Wind effect, Smoke management, Computational tool for design.

Suggested Readings:

- Fundamental of Fire Safety in Building Design by Dr. Than Singh Sharma, Aayush Publications,2014
- NBCS-2026 (National Building Construct Code 2026)
- Fire Dynamics by Gregory Gorbett, James Pharr, Shijin Kozhurnal, 3rd Edition, 2026
- Fire Dynamics (Fire Prevention & Protection System) by Mr. MahendraPartap Singh, 2025
- Large Outdoor Fire Dynamics by Keisuke Himoto, CRC Press, 2022
- Manual of Fire Safety by N Sesha Prakash, CBS Publishers & Distributors Pvt. Ltd.
- Fire Dynamics by V.K. Jain, New Age International Publishers,2020

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Fuel and the Combustion Process	https://youtu.be/s57q7CiWrT8?si=kHUvFUW9FmsuhU6Y	NPTEL (IIT Kanpur)
	Thermodynamics of Combustion	https://youtu.be/R80x6F1kp7g?si=a4BaBwXCEt48Q0Dg	NPTEL (IIT Kanpur)
Unit-II	Limit of Flammability	https://youtu.be/Oc02lDGAVJ0?si=W5srtC60NVCKLS1Q	NPTEL (IIT Kanpur)
Unit-III	Steady Burning of Liquid and Solid Fuels	https://youtu.be/wJUU-wsJUWE?si=9hwrKDBRcoFpClYG	NPTEL (IIT Kanpur)
	Ignition of Liquids and Solids	http://elearn.psgcas.ac.in/nptel/courses/video/103107156/lec22.pdf	NPTEL (IIT Roorkee)

Unit-IV	The Pre- Flashover Compartment Fire	http://elearn.psgcas.ac.in/nptel/courses/video/105102176/105102176.html	NPTEL (IIT Delhi)
	The Post-Flashover Compartment Fire	http://elearn.psgcas.ac.in/nptel/courses/video/105102176/lec6.pdf	NPTEL (IIT Delhi)
	Description of Smoke	https://www.nptelprep.in/courses/105107213/materials	NPTEL (IIT Roorkee)
	Smoke Management	https://youtu.be/JV1yoFaB-0o?si=QEkKNUMvZYyYdrpm	NPTEL (IIT Delhi)

Course Code	**PCC-FT-305A**				
Category	Professional Core Courses				
Course Title	**Fire Safety Codes and Standards**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to national and international fire safety codes, standards and regulations used in fire protection engineering practice. • To develop understanding of standards related to fire detection, alarm systems and fixed fire protection systems for buildings and industrial occupancies. • To familiarize students with standards and specifications associated with fire extinguishers, firefighting equipment, hose systems and fire service appliances. • To provide knowledge of standards related to firefighter personal protective equipment, rescue equipment and operational safety requirements in fire service practice.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the terminology, codes, standards, and specifications related to fire safety engineering.	Level 1: Remember
CO2	Explain the requirements and provisions of fire safety codes and standards for fire protection systems, firefighting equipment, and personal protective equipment.	Level 2: Understand
CO3	Apply fire safety codes and standards for the selection, inspection, testing, and maintenance of fire protection and firefighting systems.	Level 3: Apply
CO4	Analyze the suitability and implementation of fire safety standards, firefighting equipment and protective systems in engineering and fire service applications.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit – I

Fire Safety Codes and Fire Detection Standards: Introduction to fire safety codes and standards, Role and significance of BIS, ISO and NFPA standards in fire safety engineering, Terminology and glossary associated with fire safety, National Building Code provisions related to fire and life safety, Fire safety signs and graphical symbols used in fire protection plans, Standards related to fire brigade control rooms and drill towers, Fire safety

requirements and Fire No Objection Certificate provisions for buildings and industrial occupancies, Standards and specifications related to fire detection and alarm systems, Heat, Smoke, Flame and gas detectors, VESDA systems, Notification appliances, Interconnections and integration of fire alarm systems, Standards related to sprinkler systems and fixed fire protection systems, Interpretation and application of fire safety standards in engineering practice.

Relevant Standards: IS 8757, IS 957, IS 5888, IS 12349, IS 12407, IS 15394, IS 18006, IS 2189, IS/ISO 7240 Series, IS 15908, IS 9972, IS 15105, IS 16088, IS 16534 and relevant NFPA Standards.

Unit – II

Standards for Fire Extinguishers and Extinguishing Media: Classification and specification of portable and fixed fire extinguishers, Standards related to extinguishing agents including water, Foam, Dry chemical powder and carbon dioxide, Installation, Inspection, Testing and maintenance requirements of extinguishers, Performance and safety requirements of extinguishers and extinguishing media, Operational requirements and marking systems for extinguishers and extinguishing agents, Interpretation and application of standards related to fire extinguishers and extinguishing systems in fire safety engineering practice.

Relevant Standards: IS 2190, IS 4152, IS 4308, IS 4862 Part 1, IS 4947, IS 4989, IS 11108, IS 11833, IS 12835 Part 1, IS 14951, IS 15220, IS 15221, IS 15222, IS 15493, IS 15496, IS 15497, IS 15501, IS 15505, IS 15506, IS 15517, IS 15519, IS 15525, IS 15528, IS 15683, IS 15835, IS 16018, IS 19452 and relevant NFPA Standards.

Unit – III

Standards for Fire Hose Systems, Pumps and Fire Service Appliances: Standards and specifications related to fire hoses, Hose fittings, Couplings, Branches, Nozzles and delivery equipment, Performance requirements of fire hose systems and accessories, Inspection, Testing and maintenance requirements of hose systems and fittings, Classification, Specification and operational requirements of fire pumps, Fire tenders and fire service appliances, Pump performance standards, Testing and operational standards for firefighting vehicles and fire service equipment, Interpretation and application of standards related to firefighting equipment and fire service operations.

Relevant Standards: IS 636, IS 884, IS 2930, IS 3844, IS 8423, IS 14851, IS 14933, IS 15051, IS 901–909, IS 937, IS 952, IS 2871, IS 3582, IS 4643, IS 5131, IS 5612 Part 1 & 2, IS 5714, IS 8090, IS 8442, IS 9668, IS 11101, IS 942, IS 943, IS 944, IS 947, IS 948, IS 950, IS 951, IS 955, IS 5896 Part 1, IS 6067, IS 6070, IS 10460, IS 10993, IS 12469, IS 12717, IS 15301 and relevant NFPA Standards.

Unit – IV

Standards for Personal Protective Equipment and Rescue Equipment: Standards related to firefighter personal protective equipment, Protective clothing, Helmets, Gloves, Boots and respiratory protection equipment, Standards related to self-contained breathing apparatus and firefighter safety equipment, Specification and performance requirements of firefighter protective systems, Standards related to rescue equipment, Ropes, Ladders and small firefighting gear, Inspection, Testing and maintenance requirements of rescue and firefighting equipment, Interpretation and application of PPE and rescue equipment standards in fire service practice.

Relevant Standards: IS 2745, IS 4355, IS 9995, IS 15381, IS 16874, IS 16890, IS 18582 Part 6, IS 18589 Part 3, 4 & 6, IS 18804, IS 19198, IS 926, IS 927, IS 928, IS 8096, IS 12796, IS 12859, IS 12861, IS 12862, IS 939, IS 4571, IS 5896 Part 3, NFPA 1983 and NFPA 1932.

Suggested Readings:

- Relevant Indian Standards (IS codes)
- Relevant NFPA standards

Course Code	**ESC-ME-307A**				
Category	Engineering Science Courses				
Course Title	**Strength of Materials**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to the concepts of force systems, equilibrium conditions and analysis of engineering structures. • To develop understanding of stresses, strains and mechanical behavior of materials under different loading conditions. • To familiarize students with the principles of truss analysis, moment of inertia, shear force and bending moment in structural members. • To provide knowledge of bending stresses, beam deflection and pressure vessel behavior along with associated safety considerations.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts of force systems, equilibrium, stresses, strains and structural behavior of engineering materials and members.	Level 1: Remember
CO2	Explain the concepts of force, behavior of trusses, beams and pressure vessels under different loading and support conditions.	Level 2: Understand
CO3	Apply the laws, principles of force, stress analysis, moment of inertia, shear force, bending moment, beam bending and deflection for solving engineering problems.	Level 3: Apply
CO4	Analyze the force system, structural response, bending behavior and safety aspects of beams, trusses and pressure vessels subjected to different loading conditions.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Force and its effects: Units and measurement of force, Characteristics of force vector representation, Bow's notation, Types of forces, action and reaction, tension & thrust.

Force Systems: Coplanar and space force systems, Coplanar, concurrent and non -concurrent forces, Free body diagrams, Resultant and components of forces, concept of equilibrium, parallelogram law of forces,

Equilibrium of two forces, super-position and transmissibility of forces, Newton's third law, triangle law of forces, parallelogram law, Lami's theorem.

Unit-II

Simple Stresses & Strains: Introduction, types of stresses and strains, Poisson's ratio, stresses and strain in simple and compound bars under axial loading, stress strain diagrams, Hooks law, elastic constants & their relationships, temperature stress & strain in simple & compound bars under axial loading, Numericals.

Trusses and Frames: Truss, classification of truss, assumptions in truss analysis, perfect truss, analysis of perfect plane truss using method of joints and method of sections, Numericals.

Unit-III

Moment of Inertia: Area moment of inertia, mass moment of inertia, parallel axis and perpendicular axis theorems, radius of gyration, polar moment of inertia, product of inertia, problem based on composite figures and solid objects, centroid and center of gravity, Numericals.

Shear Force & Bending Moments: Definitions, SF & BM diagrams for cantilevers, simply supported beams with or without over-hang and calculation of maximum BM & SF and the point of contra-flexure under (i) concentrated loads, (ii) uniformly distributed loads over whole span or a part of it, (iii) combination of concentrated loads and uniformly distributed loads, (iv) uniformly varying loads and (v) application of moments, Numericals.

Unit-IV

Bending Stresses in Beams: Theory of bending, Flexural formula, Moment of resistance and section modulus, Bending of symmetrical sections.

Deflection of beams: Slope and deflection concept, Differential equation of elastic curve, slope and deflection in different type of beams.

Pressure Vessels: Introduction, Classification of pressure vessels, materials used, Stresses in pressure vessels, Hazards associated with pressure vessels, Safety devices, Inspection and testing, Fire protection systems for pressure vessels.

Suggested Readings:

- Strength of Materials by Sadhu Singh, Dhanpat Rai Publishing Company, New Delhi
- Strength of Materials by G. H. Ryder, Macmillan, India
- Mechanics of Materials by R. C. Hibbeler, Cengage Learning India Pvt. Ltd., New Delhi
- Strength of Materials by R.K. Rajput, S. Chand Publication, New Delhi
- Engineering Mechanics by Irving H. Shames, PHI Publication, New Jersy
- Engineering Mechanics by Dr. D. S. Kumar, Kataria& Sons, New Delhi
- Strength of Materials by S. Ramamrutham, Dhanpat Rai Publishing Company, New Delhi

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Introduction to Forces	https://www.youtube.com/watch?v=YXuGB2Fd4Eg	NPTEL(IIT Madras)
	Force System-I	https://nptel.ac.in/courses/112106286	NPTEL(IIT Madras)
	Force System-II	https://nptel.ac.in/courses/112106286?utm	NPTEL(IIT Madras)
	Equilibrium of rigid bodies	https://www.youtube.com/watch?v=g2Vwjk-rAuM&list=PLq7jO-L_k0yUk2tfPwhea9asGRBXcUEpL&index=11	NPTEL(IIT Kanpur)
Unit-II	Basic Introduction of Stresses	https://nptel.ac.in/courses/112106319	NPTEL(IIT Madras)
	Analysis of Strain	https://www.youtube.com/watch?v=iJTHPgYAqvQ&list=PL27C4A6AEA552F9E6&index=7	NPTEL(IIT Kharagpur)
	Truss	https://nptel.ac.in/courses/122104015	NPTEL(IIT Kanpur)
	Truss – Method of Joints	https://www.youtube.com/watch?v=GKLEysulS08&list=PLLy_2iUCG87AgdE8-bSTgt-Id4lhzWf7p&index=17	NPTEL(IIT Roorkee)
	Truss – Method of Sections	https://www.youtube.com/watch?v=NlBjOIwfKhE&list=PLLy_2iUCG87AgdE8-bSTgt-Id4lhzWf7p&index=18	NPTEL(IIT Roorkee)
Unit-III	Friction	https://nptel.ac.in/courses/112107539	NPTEL(IIT Roorkee)
	Moment of Inertia	https://nptel.ac.in/courses/112107539	NPTEL(IIT Roorkee)
	Moments and Product of Inertia	https://www.youtube.com/watch?v=ZwuwzE1qAi4	NPTEL(IIT Delhi)
	Shear Force and Bending Moment	https://nptel.ac.in/courses/112107146	NPTEL(IIT Roorkee)
Unit-IV	Bending Stress in Beams	https://nptel.ac.in/courses/105105108	NPTEL(IIT Kharagpur)
	Deflection of Beams	https://nptel.ac.in/courses/105105108	NPTEL(IIT Kharagpur)
	Column Buckling Theory	https://www.youtube.com/watch?v=q6WPVDgiWjQ	NPTEL(IIT Guwahati)
	Pressure Vessels	https://www.youtube.com/watch?v=aI-oyoaiCpU	NPTEL(IIT Madras)

Course Code	**PCC-FT-309A**				
Category	Professional Core Courses				
Course Title	**Fire Protection**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To provide knowledge of the principles, components and operation of fire detection, alarm and notification systems used in fire protection engineering. • To develop understanding of water-based, water spray, water mist and foam fire suppression systems and their applications in different occupancies and hazards. • To familiarize students with gaseous, chemical and industrial fire protection systems, explosion protection methods and associated safety considerations. • To enable students to learn inspection, testing, maintenance and design considerations of various fire protection systems in accordance with standard engineering practices and codes.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the principles, components, and terminology of fire detection, alarm, and fire protection systems used in fire and safety engineering.	Level 1: Remember
CO2	Explain the working principles, design concepts, and applications of fire detection, water-based, foam, gaseous, and chemical fire protection systems.	Level 2: Understand
CO3	Apply the principles of fire detection and fire protection systems to select appropriate fire safety measures for buildings and industrial occupancies.	Level 3: Apply
CO4	Analyze the performance of fire protection systems and industrial fire and explosion hazards to recommend suitable fire protection strategies.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit – I

Fire Detection and Alarm Systems: Active and passive fire protection systems, components of fire detection and alarm systems, heat, smoke, flame and gas detectors, VESDA systems, notification appliances, detector selection and spacing concepts, false alarm management, interconnections and integration, gas and vapor

detection systems, electrochemical sensors, inspection, testing and maintenance of fire detection and alarm systems.

Unit – II

Water-Based Fire Protection Systems: Extinguishing mechanism and limitations of water, automatic sprinkler systems, principles and types of sprinkler systems, sprinkler heads and classification, k-factor, deluge systems, water supply requirements as per NBC, fire pumps and pump house arrangements, terrace tanks and terrace pumps, overview of fire pump sizing concepts, Standpipe and hose systems, wet risers, internal and external hydrants, zoning in standpipe systems, hose reels, inspection, testing and maintenance of water-based fire protection systems.

Unit – III

Water Spray, Water Mist and Foam Systems: Water spray systems, components and applications, ultra-high-speed water spray systems, methods of extinguishment, response time and design considerations, water mist systems, methods of generating water mist, mist classification, spray characteristics, applications and limitations, Firefighting foams, types and properties of foam concentrates, extinguishing mechanism and limitations of foam, expansion ratio, low, medium and high expansion foam systems, foam generating equipment, foam protection systems for storage tanks and industrial hazards, foam application concepts.

Unit – IV

Gaseous, Chemical and Industrial Fire Protection Systems: Carbon dioxide fire suppression systems, extinguishing mechanism and limitations of CO_2, total flooding and local application systems, components and safety precautions, Clean agent fire suppression systems, inert gas and synthetic agents, extinguishing mechanisms, design concentration concepts, pressure relief vents, applications and limitations, Dry chemical powder, aerosol and wet chemical extinguishing systems, extinguishing mechanisms, applications and maintenance, overview of agent quantity calculations, Industrial fire and explosion hazards, Explosion prevention and protection systems, deflagration venting and explosion suppression systems, fire protection considerations in industrial occupancies.

Suggested Readings:

- Industrial Safety, Health & Environment Management System by R.K. Jain & Sunil S. Rao, Khanna Publishers.
- Fire Safety in Buildings by V.K. Jain, New Age International Publishers.
- Fire Protection and Prevention: The Essential Handbook Volume 1 & 2 by B.M. Sen, UBS Publishers.
- Principles of Fire Safety Engineering: Understanding Fire and Fire Protection byAkhil Kumar Das, PHI Learning Private Limited (Prentice Hall India).
- Industrial Safety and Health Management by C. Ray Asfahl and David W. Rieske, Pearson India
- Relevant IS Standards.
- SFPE Handbook of Fire Protection Engineering by Morgan J. Hurley, Society of Fire Protection Engineers (SFPE) / Springer.
- Relevant NFPA Standards.

Course Code	**LC-FT-311A**				
Category	Professional Core Courses				
Course Title	**Fire Dynamics Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To provide practical exposure to the ignition, combustion and burning characteristics of gaseous, liquid and solid fuels. • To develop experimental understanding of flame behavior, flame spread and fire growth phenomena under different fire conditions. • To familiarize students with measurement techniques for burning rate, heat release rate, smoke production and toxic gas emissions in fire experiments. • To enable students to study the influence of ventilation and compartment conditions on smoke movement and compartment fire dynamics.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Explain the ignition characteristics, and flame behavior of combustible solids, liquid fuels and gas-air mixtures through laboratory experiments.	Level 2: Understand
CO2	Apply experimental methods to determine flash point, fire point, flame spread, flame height, burning rate and mass loss characteristics of combustible materials during combustion.	Level 3: Apply
CO3	Apply fire testing techniques to measure heat release rate, smoke production and toxic gas emissions of combustible materials.	Level 3: Apply
CO4	Analyze the effect of compartment conditions and ventilation on smoke movement, smoke stratification and compartment fire growth behavior.	Level 4: Analyze

List of Experiments

Sr. No.	Contents
1	To determine the flash point and fire point of liquid fuels using Pensky-Martens Closed Cup and Cleveland Open Cup apparatus.
2	To study the ignition behavior of combustible solids under radiant heat exposure.
3	To study the ignition behavior of liquid fuels under radiant heat exposure.
4	To determine the burning velocity of gas-air mixtures using cone angle method.
5	To study the characteristics of premixed and diffusion flames.

6	To determine the flame spread rate over solid combustible surfaces.
7	To determine the flame height and burning rate of liquid pool fires.
8	To determine the burning rate and mass loss rate of solid fuels during combustion.
9	To measure the heat release rate of combustible materials using cone calorimeter.
10	To measure smoke production and toxic gas emissions during combustion.
11	To study smoke layer formation and smoke stratification in compartment fires.
12	To study the effect of ventilation on compartment fire growth and smoke movement.

Note: At least 8 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

<table>
<tr><td>Course Code</td><td colspan="6">LC-ME-313A</td></tr>
<tr><td>Category</td><td colspan="6">Engineering Science Courses</td></tr>
<tr><td>Course Title</td><td colspan="6">Strength of Materials Lab</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td colspan="2" rowspan="2">Semester-V</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Course Objectives</td><td colspan="6">The objectives of this course are
To familiarize the students with the operation and applications of material testing machines and equipment used in strength of materials laboratory experiments.
To develop the understanding of students regarding the mechanical behavior and strength characteristics of engineering materials under different loading conditions.
To enable the students to perform experimental determination of shear force, bending moment, hardness, impact strength, mechanical advantage, and efficiency of engineering systems.
To make the students learn the analysis and evaluation of experimental results related to material properties and structural behavior.</td></tr>
<tr><td>Assessment</td><td colspan="6">25 Marks</td></tr>
<tr><td>End Semester Practical Examination</td><td colspan="6">25 Marks</td></tr>
<tr><td>Total</td><td colspan="6">50 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="6">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Apply the principles of shear force and bending moment for drawing shear force and bending moment diagrams of simply supported beams under different loading conditions.	Level 3: Apply
CO2	Apply standard testing procedures for conducting tensile, compression, bending, and shear tests on engineering materials using the Universal Testing Machine (UTM).	Level 3: Apply
CO3	Analyze the mechanical behavior and strength characteristics of engineering materials under tensile, compressive, bending, shear, and impact loading conditions using experimental observations and test data.	Level 4: Analyze
CO4	Analyze the hardness characteristics and surface resistance of engineering materials using Brinell, Rockwell, and Vickers hardness testing methods.	Level 4: Analyze
CO5	Evaluate the mechanical advantage, efficiency, and performance characteristics of winch crabs and screw jacks through experimental testing and calculations.	Level 5: Evaluate

List of Experiments

Sr. No.	Contents
1	To draw shear force and bending moment diagrams for simply supported beams subjected to point loads and distributed loads.
2	To study the Universal Testing Machine (UTM) and perform tensile tests on engineering materials.

3	To perform compression and bending tests using the Universal Testing Machine (UTM).
4	To perform shear tests on engineering materials using the Universal Testing Machine (UTM).
5	To study the impact testing machine and perform Izod and Charpy impact tests.
6	To study the Brinell hardness testing machine and perform the Brinell hardness test.
7	To study the Rockwell hardness testing machine and perform the Rockwell hardness test.
8	To study the Vickers hardness testing machine and perform the Vickers hardness test.
9	To determine the mechanical advantage and efficiency of single purchase and double purchase winch crabs.
10	To determine the mechanical advantage and efficiency of simple and compound screw jacks.

Note: At least 8 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

Course Code	**LC-FT-315A**				
Category	Professional Core Courses				
Course Title	**Fire Ground Operations-V**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	0	0	2	**1**	
Course Objectives	The objectives of this course are ● To develop the understanding of students regarding ropes, ladders, hoses, pumps, water relay systems, and water tenders used in firefighting operations. ● To familiarize the students with testing procedures, operational methods, and maintenance practices of firefighting equipment and accessories. ● To make the students learn firefighting drills, foam generation techniques, pumping operations, and salvage procedures used during fire emergencies. ● To develop the practical skills of students in handling firefighting equipment, conducting operational tests, and performing coordinated firefighting and rescue drills.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Explain the construction, types, operational features, testing methods, and applications of ropes, ladders, hoses, pumps, water relay systems, and water tenders used in firefighting operations.	Level 2: Understand
CO2	Perform rolling, testing, operational handling, and maintenance procedures of ropes, ladders, hoses, pumps, and firefighting equipment during practical firefighting exercises.	Level 3: Apply
CO3	Demonstrate foam drills, extinguisher drills, pumping drills, water relay operations, and salvage procedures using firefighting appliances and foam-making equipment.	Level 3: Apply
CO4	Analyze the operational performance, testing results, and functional suitability of firefighting equipment, pumping systems, and relay operations under different firefighting conditions.	Level 4: Analyze

List of Experiments

Sr. No.	**Contents**
1	To study and perform rolling of Ropes.
2	To study and perform testing of Ropes.
3	To study different types of Ladders and their parts.
4	To study and perform rolling of Hoses.
5	To perform different ladder test

	(a) Round test (b) String test (c) Extension line test
6	To perform Hose tests (a) Suction hose test (b) Delivery hose test (c) Hose reel hose test
7	To study and perform extinguisher drill.
8	To study and perform the drill using Foam making equipment: (a) FB-2 with (Knap Sack Tank) (b) FB-5X (c) FB- 10X (d) FB-20 (e) FM Generator (f) Inline inductor (g) Foam Monitor
9	To perform foam drill with foam test.
10	To perform four men pump drill with pump test.
11	To perform six men pump drill with pump test.
12	To perform close water pumping drill.
13	To perform open water pumping drill.
14	Salvage: (a) Types of Salvage sheet (b) Salvage before fire (c) Salvage during fire (d) Salvage after fire
15	Pump: (a) Bucket pump (b) Portable pump (c) Trailer pump
16	Test: (a) Pump output test (b) Vacuum test (c) Suction test
17	Water Relay: (a) Types of water relay (b) Close relay (c) Open relay (d) Uses of Portable dam
18	Types of Water tender: (a) Type A (b) Type B (c) Type X

Other drills and tests can be performed as decided by department (time to time) depending upon the scope of course.

<table>
<tr><td>Course code</td><td colspan="5">INT-FT-317A</td></tr>
<tr><td>Category</td><td colspan="5">Seminar/Internship</td></tr>
<tr><td>Course Title</td><td colspan="5">Industrial Seminar -I</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-V</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
To make the students familiar with industrial practices, fire safety systems, emergency response procedures, and safety management activities followed in industries, fire academies, and related organizations.
To develop the understanding of students regarding practical applications of fire protection engineering, industrial safety practices, firefighting operations, and hazard control measures in real working environments.
To familiarize the students with professional work culture, technical documentation, safety regulations, reporting procedures, and operational responsibilities in industries and fire service organizations.
To make the students learn practical problem-solving approaches, communication skills, technical report writing, seminar presentation, and professional ethics through industrial training exposure..</td></tr>
<tr><td>Assessment</td><td colspan="5">50 Marks</td></tr>
<tr><td>Total</td><td colspan="5">50 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Assessment of Industrial Seminar–I shall be based on the case study, seminar presentation, viva-voce, training report, and certificate of practical training undergone by the student at the end of the IV Semester from an Industry/Institute/Professional Organization/Research Laboratory/Training Centre/Software Organization, with the prior approval of the Director of the Institute/Head of the Department.

Course Outcomes: After successful completion of this course, the students will be able to

CO	Skill Demonstrated	Level
CO1	Describe the organizational structure, fire safety systems, industrial operations, emergency response procedures, and safety practices followed in industries and fire service organizations.	Level 1: Remember
CO2	Explain the working principles, operational procedures, safety regulations, and fire protection practices observed during industrial training.	Level 2: Understand
CO3	Apply fire safety practices, operational procedures, safety rules, and technical knowledge for performing assigned activities during industrial training.	Level 3: Apply
CO4	Analyze industrial operations, fire hazards, emergency response systems, and safety management practices based on observations and training experience.	Level 4: Analyze
CO5	Evaluate the effectiveness of fire protection measures, industrial safety practices, emergency preparedness systems, and operational procedures followed in the organization.	Level 5: Evaluate
CO6	Prepare and present a comprehensive industrial training report and seminar based on practical learning, observations, technical findings, and professional experience gained during training.	Level 6: Create

Course Code	**MC-301A**				
Category	Mandatory Non Credit Courses – Audit Courses				
Course Title	**Essence of Indian Traditional Knowledge**				
Scheme and Credits	L	T	P	**Credits**	**Semester -V**
	2	0	0	-	
Course Objectives	The objectives of this course are • To make the students familiar with the fundamentals, structure, and components of the Indian Knowledge System including Vedas, Upavedas, Vedangas and Upangas. • To develop the understanding of students regarding the relationship between modern science and the Indian Knowledge System. • To familiarize the students with the principles of yoga, holistic healthcare, and their significance in physical and mental well-being. • To make the students learn the practical relevance and applications of the Indian Knowledge System through case studies and interdisciplinary approaches.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the concepts related to the Indian Knowledge System, Vedas, Upavedas, Vedangas, Upangas, yoga and holistic healthcare.	Level 1: Remember
CO2	Explain the structure, principles, and interdisciplinary relevance of the Indian Knowledge System in relation to modern science and healthcare practices.	Level 2: Understand
CO3	Apply the concepts of yoga, holistic healthcare, and Indian Knowledge traditions for promoting well-being and understanding their practical significance in contemporary society.	Level 3: Apply
CO4	Analyze the contributions and applications of the Indian Knowledge System in science, healthcare, education, and societal development through case studies and interdisciplinary perspectives.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Course Contents

- Basic Structure of Indian Knowledge System: Ashtadasha Vidya (Eighteen Branches of Knowledge in the Indian Knowledge System), Veda, Upaveda (Ayurveda, Dhanurveda, Gandharvaveda, Sthapatyaveda etc.), Vedanga (Shiksha, Kalpa, Nirukta, Vyakarana, Jyotisha, Chhanda), Upanga (Dharmashastra, Mimansa, Purana, Tarkashastra).
- Modern Science and Indian Knowledge System.
- Yoga and Holistic Healthcare.
- Case Studies.

Suggested Readings:

- Cultural Heritage of India – Course Materials by V. Sivaramakrishnan, Bharatiya Vidya Bhavan, Mumbai
- Modern Physics and Vedant by Swami Jitatmanand, Bharatiya VidyaBhavan
- Holistic Science and Vedant by Swami Jitatmanand, Bharatiya VidyaBhavan
- Tarkasangraha of Annam Bhatta by V. N. Jha (English Translation), International Chinmaya Foundation, Veliyanad, Ernakulam
- Yoga Sutra of Patanjali by Ramakrishna Mission, Kolkata
- Yoga-Darshanam with Vyasa Bhashya by G. N. Jha (English Translation), Edited by R. N. Jha, Vidyanidhi Prakashan, Delhi
- Science of Consciousness, Psychotherapy and Yoga Practices by R. N. Jha, VidyanidhiPrakashan, Delhi
- Shodashang Hridayam by P. B. Sharma (English Translation)

<table>
<tr><td>Course Code</td><td colspan="6">PEC-FT-319A</td></tr>
<tr><td>Category</td><td colspan="6">Professional Electives Courses</td></tr>
<tr><td>Course Title</td><td colspan="6">Special Fire Hazards</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td colspan="2" rowspan="2">Semester-V</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="6">The objectives of this course are
• To provide knowledge of fire hazards, emergency response procedures and preventive measures associated with transportation and railway systems.
• To develop understanding of marine, port and aviation fire safety systems, rescue operations and firefighting strategies.
• To familiarize students with fire and explosion hazards in industrial occupancies, high-rise buildings and specialized hazardous environments.
• To acquaint students with fire safety management, evacuation strategies, firefighting challenges and safety measures related to complex infrastructures and nuclear facilities.</td></tr>
<tr><td>Assessment</td><td colspan="6">40 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="6">60 Marks</td></tr>
<tr><td>Total</td><td colspan="6">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="6">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the fire hazards, safety features, emergency response procedures and preventive measures associated with transportation, marine, aviation, industrial and building fire safety systems.	Level 1: Remember
CO2	Explain the fire protection systems, firefighting operations, evacuation procedures and safety management practices used in different hazardous occupancies and infrastructures.	Level 2: Understand
CO3	Apply fire safety principles and emergency response concepts for management of fire and explosion hazards in transportation, industrial, marine, aviation and high-rise building environments.	Level 3: Apply
CO4	Analyze fire risk scenarios, operational challenges and mitigation strategies associated with complex fire emergencies and hazardous installations.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Transportation Safety: Fundamentals of transportation fire safety, Passenger and commercial vehicle fires, Hazardous material transportation, MSDS, HAZCHEM code, Placards and TREM cards, LNG/LPG transportation hazards, Electric vehicle and lithium-ion battery fire hazards, Emergency response procedures, Preventive measures and case studies.

Trains Safety: Structural features of trains, Railway stations, Tunnels and metro rail systems, Railway fire hazards, passenger evacuation, Tunnel fire safety, Rescue operations, Emergency response strategies and case studies.

Unit-II

Marine and Port Fire Safety: The maritime environment, Types of vessels, Constructional features of passenger and cargo ships, Fire detection and suppression systems in ships, Cargo hazards and safety measures, Marine firefighting and rescue operations, Emergency planning, Preventive measures and strategic management**,** Fire protection facilities for ports handling hydrocarbons as per OISD-STD-156, Ships and marine technology fire extinguishing systems for protection of galley cooking equipment as per IS 17564,Ships and Marine technology windows and side scuttles for fire-resistant constructions as per IS 18280,Shipbuilding testing, Installation and maintenance of marine portable fire appliances- Code of practice as per IS3947, Loading and unloading hazards, Firefighting systems in ports and terminals, Emergency response systems, Preventive measures and case studies.

Unit-III

Aviation Fire Safety: Constructional features of aircraft, Aircraft fire hazards, Air crashes and emergency landings, Rescue operations in aircraft fires, Airport fire hazards, Hangar protection systems, Crash fire tenders and rapid intervention vehicles, Airport categorization and firefighting appliances as per international standards and case studies.

Industrial and High-Rise Fire Safety: Fire safety in iron and steel industries, Petroleum refineries, Fertilizer plants, Pharmaceutical industries, Coal-based industries and thermal power plants, Hydrogen hazards, BLEVE, Vapor cloud explosions, Rocket propellants, Industrial emergency response procedures, Preventive measures and case studies.

Unit-IV

Building Fire Safety: Fundamentals of fire-safe building design, Life safety systems for high-rise buildings, Structural fire protection, Alarm and signaling systems, Smoke movement and smoke control systems, Refuge areas, Fire lifts, Façade fire hazards, Evacuation strategies, Firefighting challenges in high-rise buildings and case studies**.**

Nuclear Safety: Radiation and its types, Nuclear reactors, Radiation emergencies, Firefighting and rescue operations in radiation hazard areas, Radiation safety measures, Radioactive waste management, Nuclear accidents, Mitigation measures and strategic management.

Suggested Readings:

- Radioactive Materials by B.M. Rao, Himalaya Publishing House.
- Fire Safety in Buildings by V K Jain, New Age Publishers, New Delhi.
- Indian Buildings Congress Manual of Fire Safety in Buildings by Indian Building Congress, Nabhi Publication
- Industrial Safety, Health and Environment Management Systems by R. K. Jain and Sunil S. Rao,Khanna Publishers

- Handbook on Fire and Life Safety in Buildings by Barendra Mohan Sen, Techno World
- Airport, Aircraft and Aviation Fire Safety by P. K. Sarkar,S. K. Kataria and Sons
- Marine Fire Prevention, Firefighting and Fire Safety by D. K. Gupta,CBS Publishers and Distributors
- OISD-STD-156

<table>
<tr><td>Course Code</td><td colspan="5">PEC-FT-321A</td></tr>
<tr><td>Category</td><td colspan="5">Professional Elective Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Offshore Structures under Special Environmental Loads including Fire Resistance</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-V</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
To introduce students to offshore structures, environmental loading conditions and hydrodynamic effects associated with offshore engineering systems.
To develop understanding of structural behavior, stress analysis and dynamic response of offshore structural members and riser systems.
To familiarize students with offshore fire hazards, fire development behavior and fire protection systems used in offshore installations.
To provide knowledge of structural design methodologies and material behavior of steel, concrete and composite members under fire conditions.</td></tr>
<tr><td>Assessment</td><td colspan="5">40 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">60 Marks</td></tr>
<tr><td>Total</td><td colspan="5">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Define the terminology related to offshore structures, environmental loading, structural behavior, and fire safety engineering.	Level 1: Remember
CO2	Explain the principles of offshore structural systems, environmental loading, structural response, fire safety, and structural behavior under fire.	Level 2: Understand
CO3	Apply the principles of offshore structural analysis, fire safety, and structural fire design to offshore engineering applications.	Level 3: Apply
CO4	Analyze the structural performance and fire safety of offshore structures under environmental and fire loading conditions.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit–I

Offshore Structures and Environmental Loading: Introduction to offshore structures, Classification and novelty of offshore platforms, Fixed platforms, Compliant platforms, Guyed towers, Articulated towers, Tension leg platforms (TLP), SPAR platforms, Semisubmersibles, Floating production storage and offloading systems (FPSO), Jack-up rigs, Drill ships, Buoyant leg structures (BLS), Triceratops and regasification platforms. Environmental loading on offshore structures, Wave loads, Airy wave theory, Wheeler's and Chakrabarti's modifications, Random waves and wave spectra, Pierson–Moskowitz spectrum, ISSC spectrum, JONSWAP spectrum, Wind loads and wind spectra, Current loads, Ice loads, Seismic loads, Springing and ringing effects, Blast loads and fire loads.

Unit–II

Structural Behavior and Dynamic Response of Offshore Structures: Unsymmetrical bending, Shear center, Curved beams with small and large initial curvature, Stress analysis in curved beams, Circular, Rectangular, Triangular, Trapezoidal, T and I sections, Simplified stress estimation methods, Marine risers and offshore structural components, Low-pressure risers, High-pressure drilling risers, Flexible risers, Top tensioned risers (TTR), Vortex-induced vibration (VIV), Dynamic response of offshore structural members, Hydrodynamic effects on offshore structures, Fatigue behavior of offshore components, VIV suppression systems and research case studies.

Unit–III

Fire Safety in Offshore Structures: Introduction to offshore fire safety, Fire and explosion characteristics in offshore platforms, Classification of fire, Pool fire, Jet fire, Flash fire and fireball, Minimum ignition energy, Fire risk assessment, Fire scenarios in offshore installations, Causes of offshore fire accidents and lessons learned, Fire development and behavior, Combustion characteristics of materials, Ignition and spread of fire, Open fires, Compartment fires, T-squared fire model, Pre-flashover, Flashover and post-flashover behavior, Fire protection systems in offshore structures, Active and passive fire protection systems, Fire detection and alarm systems, Firefighting equipment, Compartmentation, Fire-resistant construction, Egress and human behavior during emergencies, Offshore evacuation systems, Fire resistance and equivalent fire severity, Fire resistance testing methods and fire-resistance ratings.

Unit–IV

Structural Design under Fire: Material behavior at elevated temperatures, Thermal properties of steel and concrete, Specific heat, density, Thermal conductivity and thermal diffusivity, Mechanical properties and constitutive models of steel and concrete under fire conditions, Temperature assessment methods for structural members, Eurocode approach, Fire rating methods, Bare and protected steel sections, Strength assessment of steel members under fire, Design of concrete members under fire, Temperature analysis methods, Wickstrom's method, Hertz's method, 500°C isotherm method and zone method, Composite structures under fire, Composite beams and columns, Critical temperature approach, Moment capacity approach, Numerical examples on steel, Concrete and composite structural members exposed to fire.

Suggested Readings:

- Design Aids of Offshore Structures Under Special Environmental Loads Including Fire Resistance by Srinivasan Chandrasekaran and Gaurav Srivastava.
- Dynamics of Offshore Structures by James F. Wilson.
- Offshore Structures: Design, Construction and Maintenance by Mohammad H. El-Reedy.
- Design of Offshore Concrete Structures by M. S. Troitsky.
- Structural Fire Engineering by VenkateshKodur.
- Fire Safety Engineering Design of Structures by John A. Purkiss.
- Offshore Engineering: An Introduction by Srinivasan Chandrasekaran.
- Handbook of Offshore Engineering by SubrataChakrabarti.
- Environmental Engineering and Management by Suresh K. Dhameja, S.K. Kataria& Sons.
- Environmental Impact Assessment: Methodologies by Y. Anjaneyulu and ValliManickam, B.S. Publications.
- Industrial Safety and Environment by Amit Gupta, University Science Press.
- Industrial Safety and Environment by A. Prashar, P.Bansal, Kataria Press.
- Process Safety Management and Risk Hazard Analysis by Srinivasan Chandrasekaran, CRC Press.
- Fire and Explosion Protection Engineering Principles by Dennis P. Nolan, CRC Press.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Introduction of offshore structures	https://youtu.be/pyvR3uN1nRQ	NPTEL (IIT Madras)
	Fixed offshore platform	https://youtu.be/Q4ptPBcKtiM	NPTEL (IIT Madras)
	Wave load on off shore structure	https://youtu.be/r7XVuxkTi80	NPTEL (IIT Madras)
Unit-II	Dynamics of offshore structures	https://nptel.ac.in/courses/114106038?utm	NPTEL (IIT Madras)
	Shear center	https://youtu.be/UexSV-vDS98	NPTEL (IIT Madras)
Unit-III	Offshore fire safety	https://youtu.be/n6HAyxdup_U	NPTEL (IIT Delhi)
Unit-IV	Fire resistance steel	https://youtu.be/uOegFI_jNEc	NPTEL (IIT Delhi)

<table>
<tr><td>Course Code</td><td colspan="5">PEC-FT-323A</td></tr>
<tr><td>Category</td><td colspan="5">Professional Elective Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Fire Service Communication and Mobilizing</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-V</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
• To introduce students to the organization, layout and operational requirements of fire service control rooms, watch rooms and fire stations.
• To develop understanding of the roles, responsibilities and communication procedures associated with fire service personnel and emergency response systems.
• To familiarize students with equipment, signaling systems and call handling arrangements used in fire control and mobilization systems.
• To provide knowledge of testing procedures, standby arrangements and radio communication systems used in fire service operations.</td></tr>
<tr><td>Assessment</td><td colspan="5">40 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">60 Marks</td></tr>
<tr><td>Total</td><td colspan="5">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the terminology related to fire service organization, communication systems, emergency call handling, and wireless communication.	Level 1: Remember
CO2	Explain the principles of fire service control rooms, communication systems, call handling procedures, and wireless communication.	Level 2: Understand
CO3	Apply fire service communication, mobilization, and emergency response procedures for effective fire service operations.	Level 3: Apply
CO4	Analyze fire service communication systems and operational procedures to improve emergency response efficiency.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fire Service Control Room and Watch Room: Introduction, Control rooms, General requirements and considerations-. General requirements, Centralization problems, Administrative system implications, Safeguard against breakdown, Watch rooms, The station ground, The turn out area, The telephone call area.

Roles and Responsibilities of Fire Personnel: Introduction to the fire department, Roles and responsibilities of fire personnel.

Unit-II

Equipment In Control Room, Watch Room, and Fire Stations: Automatic fire alarm system terminations, Fire telephone, Running call facilities, Enquiry bell, Station bells, Firemen's call bell systems, Public address system, Tele printer, Turn out lighting, Alternative lighting, Control of traffic light, Automatic appliance starter, Appliance room door control, Exchange telephone lines and switchboards, Key and lamp units, Private telephone circuit, Priority signaling facilities, Appliance turn out indicator lights, Radio apparatus, Clock and calendar, Tape recorder, Control room consoles, Maps and diagrams, Availability and fire situation displays, Records – log book, occurrence book, First attendance and other mobilizing data, Route and special risk cards, General information, Microfilm systems.

Unit-III

Fire Call Handling Procedures: General principles calls by exchange telephone, Running calls, Fire telephones and other private circuits, Automatic fire detection system, Calls received from various radio systems, Part time station arrangements, Salutations.

Call-Out Systems: Firemen's call bell system, Fire sirens – siren installations, Maintenance and testing, War emergency use, Radio pocket alerting system – General description, The transmitter, The pocket alerter, The home battery charger, Alerter transmitter battery chargers, Public address call out systems, Methods of controlling call out systems – Local control, Remote control.

Unit-IV

Testing, Fault Reporting and Alternative Arrangements: Testing arrangements, Fault reporting and alternative arrangements, Fusing and identification of electrical circuits, Standby power arrangements.

Radios And Wireless Communication: Frequency spectrum, Characteristics, Selection, and Allocation, Types of radio scheme, Mobile radio equipment, Transportable and personal sets, Personal paging system, "figaro" low frequency communication systems, Hazards attending the use of radio equipment in flammable atmosphere or in the vicinity of explosives.

Suggested Readings:

- Manual of Firemanship.
- HMSO Fire Service Manual Fire Service Communication and Mobilizing (Volume 1).
- Relevant NFPA Manual and IS code

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Introduction Fire Service Control Room	https://youtu.be/8QIny3MFXzI?si=D83353CbM6-IVS_g	NPTEL (IIT Delhi)
Unit-II	Records in Fire Stations	https://youtu.be/mKecK1byRk8?si=iMHbRqtRg3KuRNgf	NPTEL (IIT Delhi)
Unit-III	Fire call Handling Procedures	https://youtu.be/9_LvrgKEnCM?si=1QuHdL23oFJY93ht	NPTEL (IIT Delhi)
Unit-IV	Testing, Fault Reporting	https://youtu.be/TNCyIw9JC6k?si=G4zml-7wtVBZS4CT	NPTEL (IIT Hy.)
	Radios and Wireless Communication	https://youtu.be/F3slBe2r8vA?si=1Oo7YJ4Fww4I6h0K	NPTEL (IIT Kanpur)

Course Code	**PEC-FT-325A**				
Category	Professional Elective Courses				
Course Title	**Fire and Life Safety Audit**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to the principles, procedures and statutory requirements associated with fire and life safety audits. • To develop understanding of audit standards, quality assurance systems and documentation practices used in fire safety management. • To familiarize students with fire safety planning, organizational responsibilities and emergency management practices in industrial and commercial occupancies. • To provide knowledge of evaluation, monitoring and continual improvement techniques for effective fire safety performance management.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the terminology, standards, procedures, and documentation related to fire and life safety audits.	Level 1: Remember
CO2	Explain the principles of fire and life safety auditing, fire safety management, and performance evaluation.	Level 2: Understand
CO3	Apply fire and life safety audit procedures, standards, and management practices to evaluate fire safety compliance.	Level 3: Apply
CO4	Analyze fire safety performance, audit findings, and corrective actions to improve fire and life safety management.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fire & Life Safety Audit Fundamentals: Introduction, objectives and need of fire and life safety audit, types of audits and inspections, legal and statutory requirements for fire safety audit, audit planning and methodology, pre-audit preparation, collection and verification of information, site inspection and cross verification, identification of non-compliance, audit documentation, preparation and submission of audit report, recommendations and corrective actions, advantages and limitations of fire and life safety audit, opening and closing meetings**.**

Unit-II

Audit Standards and Quality Assurance: Types of audits, components of fire and life safety audit, audit model and audit process, audit checklist and documentation, non-conformity reporting (NCR), fire load calculation and occupancy classification, reports from government agencies, consultants and experts, analysis of fire and property damage records, implementation of audit recommendations and corrective actions, organizational responsibilities for fire safety, audit report and action planning, standardization and quality assurance, overview of NBCS 2026 fire and life safety provisions, IS 14489:2018, ISO 9001, ISO 14001, ISO 45001, OISD standards, TAC guidelines, checklist for fire safety audit and inspection.

Unit-III

Fire Safety Management and Planning: Fire safety policy, scope and objectives of fire safety management, fire prevention strategies, organizational structure, roles and responsibilities, stakeholder consultation and participation, legal and regulatory compliance, provision of resources and support, leadership and commitment, management of change, fire safety training and competency requirements, emergency response planning, evacuation procedures, assembly points, mock drills, permit-to-work systems, emergency incident planning and post-incident management.

Unit-IV

Evaluation, Monitoring and Review: Workplace fire safety inspection, evaluation of compliance with fire safety legislation and standards, fire incident and near miss reporting and investigation, fire loss and damage analysis, performance monitoring indicators, internal fire safety audits, corrective and preventive actions, continual improvement techniques, management review, documentation and record keeping, review of fire safety performance and audit effectiveness.

Suggested Readings:

- Fundamentals of fire safety in building design by Dr. Than Singh Sharma, Aayush Publications.
- Essentials of Building Life and Fire Safety by Virendra Kumar Paul, COPAL Publishing Group.
- Fire Safety in Buildings by V. K. Jain, New Age International Publishers.
- National Building Construction Standards, 2026 by BIS New Delhi, India
- Occupational Health and Safety management by Chales D. Reese, Taylor & Francis Group.
- A Hand Book of Fire Technology by R.S. Gupta, Universities Press (India) Pvt. Ltd.
- Manual of Fire Safety by N. Sesha Prakash, CBS Publishers.

Course Code	**PCC-FT-302A**				
Category	Professional Core Courses				
Course Title	**Fire Testing**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to the objectives, standards, instrumentation and reporting procedures associated with fire testing practices. • To impart knowledge of the fire performance, combustion behavior and testing characteristics of different engineering materials. • To develop understanding of fire resistance evaluation methods for structural elements and passive fire protection systems. • To acquaint students with performance testing, inspection and quality assurance practices related to fire detection and fire suppression systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the principles, standards, terminology and testing methods associated with fire testing and evaluation procedures.	Level 1: Remember
CO2	Explain the fire behavior, combustion characteristics and performance evaluation of materials, structural elements and fire protection systems under fire conditions.	Level 2: Understand
CO3	Apply fire testing concepts and standard procedures for interpretation, inspection and performance assessment of fire protection materials and systems.	Level 3: Apply
CO4	Analyze fire test results, fire resistance performance and reliability of materials, structural assemblies and fire protection systems for safety evaluation.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit–I

Fundamentals of Fire Testing and Fire Test Standards: Objectives and significance of fire testing, Classification of fire tests, Reaction-to-fire and fire resistance tests, Standard fire exposure curves, Overview of BIS, ASTM, ISO, NFPA and UL fire testing standards, Laboratory instrumentation and measurement techniques, Sample preparation methods, Calibration procedures, Repeatability and reproducibility in fire testing, Fire test reporting and interpretation.

Unit–II

Fire Testing of Materials: Combustibility and non-combustibility tests, Flammability tests, Flame spread tests, limiting oxygen index test, Smoke density measurement, Toxic gas emission analysis, Heat release rate measurement using cone calorimeter, Fire testing of wood, Plastics, Rubber, Textiles, Cables and composite materials, Evaluation of thermal degradation and combustion characteristics of materials.

Unit–III

Structural Fire Resistance Testing: Fire resistance and fire endurance concepts, Furnace testing methods, Fire resistance rating, Testing of steel, Reinforced concrete and timber structural elements, Testing of fire doors, Fire walls and fire partitions, Temperature-time curves for structural fire testing, Passive fire protection systems and their evaluation, Interpretation of structural fire test results.

Unit–IV

Fire Testing of Detection and Suppression Systems: Performance testing of smoke, Heat and flame detectors, Testing and evaluation of fire alarm systems, Sprinkler discharge and performance testing, Testing of portable fire extinguishers, Foam quality and foam system performance tests, Fire testing of electrical cables and insulation systems, Quality assurance in fire testing laboratories, Inspection, Testing and maintenance practices for fire protection systems.

Suggested Readings:

- Fire Safety in Buildings by V.K. Jain, New Age International Publishers
- Fire Safety in Building by Dr. Than Singh Sharma
- Manual of Fire Safety by N Sesha Prakash, CBS Publishers and Distributors
- Fire Protection and Prevention: The Essential Handbook Volume 1 & 2 by B.M. Sen, UBS Publishers
- National Building Construction Standard 2026 by Bureau of Indian Standards (BIS)
- An Introduction to Fire Dynamics by Dougal Drysdale, Wiley
- Fire Protection Handbook by Arthur E. Cote, National Fire Protection Association (NFPA)
- SFPE Handbook of Fire Protection Engineering by Morgan J. Hurley, Springer
- ASTM Standards on Fire Testing of Materials and Structures by ASTM International
- NFPA Codes and Standards by National Fire Protection Association (NFPA)
- Enclosure Fire Dynamics by BjörnKarlsson and James G. Quintiere, CRC Press
- Fire from First Principles: A Design Guide to Fire Safety Engineering by Paul Stollard and John Abrahams, Routledge

Course Code	**PCC-FT-304A**				
Category	Professional Core Courses				
Course Title	**Fire Appliances and Rescue Equipments**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To make the students familiar with different types of fire appliances, firefighting vehicles, fire pumps and associated operational systems used in fire services. • To develop the understanding of students regarding firefighting equipment, rescue tools, ladders, ropes and operational safety procedures used during emergency response. • To familiarize the students with rescue operations, casualty handling methods, incident command systems and personal protective equipment used in fire and rescue services. • To make the students learn about specialized rescue systems, modern firefighting technologies and advanced emergency response equipment used in contemporary fire services.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the terminology related to fire appliances, rescue equipment, personal protective equipment and modern firefighting technologies.	Level 1: Remember
CO2	Explain the principles, functions, and operational features of fire appliances, rescue equipment, personal protective equipment and modern firefighting technologies.	Level 2: Understand
CO3	Apply fire appliances, rescue equipment, personal protective equipment and rescue techniques in emergency response operations.	Level 3: Apply
CO4	Analyze the suitability and performance of fire appliances, rescue systems and modern firefighting technologies for different emergency scenarios.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fire Appliances and Firefighting Vehicles: Introduction to Fire Appliances, Classification of Fire Appliances, Functional Requirements of Fire Appliances, Fire Tender Chassis and Vehicle Design, Water

Tender, Foam Tender, Multipurpose Tender, Crash Fire Tender, Rescue Tender, Hose Laying Tender and Control Van, Fire Pumps and Priming Systems, Midship and PTO Pump Configurations, Hose Reels and Hose Management Systems, Water and Foam Monitors, Vehicle Stability and Load Distribution, Technical Specifications of Fire Appliances, Preventive Maintenance and Inspection Procedures.

Unit-II

Firefighting Equipment and Rescue Tools: Portable Fire Extinguishers and their Applications, Hydraulic Rescue Equipment, Hydraulic Cutters, Spreaders, Rams and Combi Tools, Pneumatic Rescue Equipment, Air Lifting Bags and Jacks, Electric Power Tools, Electric Cutters, Electric Saws and Chain Saws, Portable Lighting Systems and Power Sources, Ladders and Ladder Appliances, Extension Ladders, Hook Ladders, Turntable Ladders and Snorkels, Ropes and Lines Used in Fire Services, Knots, Hitches and Their Applications, Testing and Safety Procedures of Rescue Equipment.

Unit-III

Rescue Operations: Principles of Rescue Operations, Search and Rescue Techniques, Rescue Planning and Operational Safety, Casualty Handling Methods, One Rescuer and Two Rescuer Techniques, Multi Rescuer Techniques, Stretchers and Casualty Transportation Methods, Rescue from Fire Incidents and High-Rise Buildings, Rescue During Earthquakes, Floods and Other Disasters, Incident Command System (ICS) in Rescue Operations,

Personal Protective Equipments: Personal Protective Equipment (PPE), Safety Belts and Harnesses, Breathing Apparatus and Associated Equipment, Oxygen Breathing Apparatus, Compressed Air Breathing Apparatus, BA Control Systems and Cylinder Management, Gas Masks and Respirators, Airline and Filter Type Respirators.

Unit-IV

Specialized Rescue Systems and Modern Firefighting Technologies: SCUBA and Water Rescue Equipment, HAZMAT Rescue Equipment, Emergency Rescue Tender (ERT), HAZMAT Van and Decontamination Systems, Robotics in Firefighting and Rescue Operations, Drones in Fire and Rescue Services, Thermal Imaging Systems, Ultra High Pressure Systems (UHPS), Compressed Air Foam Systems (CAFS), Communication and Monitoring Systems in Emergency Response, Smart Fire Appliances and Sensor Networks, Artificial Intelligence in Fire and Rescue Operations, Recent Developments in Firefighting and Rescue Technologies.

Suggested Readings:

- Fire Safety in Buildings by V.K. Jain, New Age International Publishers
- Safety Management by R.K. Mishra, AITBS Publishers
- Manual of Fire Safety by N Sesha Prakash, CBS Publishers and Distributors
- Fire Protection and Prevention: The Essential Handbook Volume 1 & 2 by B.M. Sen, UBS Publishers
- National Building Construction Standard by Bureau of Indian Standards, New Delhi
- Related IS Codes, Standards and NFPA Manual

Course Code	**PCC-FT-306A**				
Category	Professional Core Courses				
Course Title	**Automobile Engineering Safety**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	2	0	0	**2**	
Course Objectives	The objectives of this course are • To introduce students to the construction, classification and working principles of automobile engines and associated fuel systems. • To develop understanding of transmission, braking, suspension, steering and electrical systems used in automobiles. • To familiarize students with lubrication, cooling, pollution control techniques and modern developments in electric and hybrid vehicles. • To provide knowledge of fire fighting vehicles, automobile safety devices and relevant rules, regulations and standards related to automotive systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the terminology related to automobile systems, fire service vehicles, hybrid vehicles, and safety regulations.	Level 1: Remember
CO2	Explain the principles of automobile systems, transmission, steering, suspension, electrical systems, fire service vehicles, and safety standards.	Level 2: Understand
CO3	Apply the principles of automobile systems and safety regulations in the operation and maintenance of fire service vehicles.	Level 3: Apply
CO4	Analyze the performance of automobile systems and fire service vehicles to enhance operational safety and efficiency.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Introduction: Automobiles, Types of automobiles, Various systems in automobiles, Engine classification, Construction, Details of engine components, Combustion in S.I. engines, Combustion in C.I. engines, Study of fuel system components, Function of carburetors, Construction details, Diesel fuel feed systems, Carburetion and mass distribution of mixture, Supercharging, Fuel injection and injection sections.

Unit II

Transmission System: Components of transmission system, PTO.
Clutch: Types, Construction, Operation and fault finding of clutches.
Gear Box: Types of gear box, Functions of gear box, Operation and maintenance of gear box.
Differential: Necessity, Construction of differential systems, Axles, Types and application.
Brakes: Types, Construction and operation of hydraulic, Pneumatic brake systems, Maintenance of brakes, Wheels and tyres.

Unit-III

Suspension: Necessity, Types, Construction and operation, Shock absorber, Coil springs, Independent suspension.

Steering System: Constructional details, Types of steering gear box, Steering geometry, Caster, Camber, King pin inclination, Effect of steering geometry on directional stability, Power steering.

Electrical System: Ignition systems, Magnet ignition, Battery ignition, Electronic ignition, Merits and demerits, Working, Self-starter, Dynamo voltage regulator, Battery construction, Operation and maintenance, Pollution, Air pollution, Euro norms, Pollution control techniques.

Lubricating System: Types, Components, Lubricating oil, Cooling system.

Unit-IV

Introduction to Electric and Hybrid Vehicles: Invention of hybrid automobile, Key features of hybrid automobile, Early hybrid vehicles, Woods gas-electric car, Hybrid automobiles.

Fire Fighting Vehicles

Fire Bikes: Construction & operation of fire bikes.

Tenders: Construction & operation of fire tenders and trucks.

Fire Boats: Construction & operation of fire boats & other water borne applications.

Rules and Regulations: CMV rules regarding safety devices for drivers, Passengers, Rules & regulations of RTO, Laboratory testing of vehicles, Road testing of vehicles, Automobile safety devices.

I.S. Codes: 15682, 15702, 15715, 15718, 15721, 15811, 15355, 19026, 19032.

Suggested Readings:

- Automobile Engineering Vol.I & II, Kirpal Singh, Standard Publishers.
- Automobile Engineering Vol.I, II & III, P.S. Gill, Kataria and Sons.
- Automobile Engineering, R. K. Rajput, Laxmi Publications.
- Automobile Engineering , R. B. Gupta, Satya Prakashan New Delhi.
- Automobile Engineering, Ramakrishna, PHI Learning Pvt. Ltd.
- Automobile Engineering , K. K. Jain, R. B. Asthana, Tata Mc Graw Hill.
- Automobile Mechanics, Crause, W. H.,Tata McGraw Hill.
- Automotive Mechanics, Joseph Heitner, East West Press.
- Course in Automobile Engineering, Sharma R. P, Dhanpat Rai and Sons
- Automotive Engines, Srinivasan S., Tata McGraw Hill.
- Motor Vehicle Technology, J.A. Dolan, Heinemann Educational Books.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Introduction to Automobile	https://youtu.be/H_RgFXjg-5s?si=yvCwREZctTNUVkoQ	NPTEL (IIT Madras)
	Vehicle Dimensions Engines	https://youtu.be/2b0YaDrdO1I?si=PQAU2EXqdeUcYEz4	NPTEL (IIT Madras)
Unit-II	Power Transmission System	https://youtu.be/0UhDnbsTuU8?si=vHC7cz_5xI80-qoA	NPTEL (IIT Madras)
	Wheels and Tyres	https://youtu.be/fVmBXtSKDw8?si=rtLK8GmGBTLxolhT	NPTEL (IIT Madras)
	Brakes	https://youtu.be/k3SeZgZWIqM?si=K-JySea_7QiE8gdB	NPTEL (IIT Madras)
Unit-III	Lubricating System	https://youtu.be/AGm2QSxYsVA?si=S7NWKIahRJb54CX7	NPTEL (IIT Guwahati)
	Steering Systems	https://youtu.be/HQr343nWLuI?si=I-CK4i-YXvjSJIO6	NPTEL (IIT Madras)
Unit-IV	Introduction to Electric and Hybrid Vehicles	https://youtu.be/_xM7X8k9g0s?si=nw2zatZCDZT5ULw9	NPTEL (IIT Kanpur)

Course Code	**HSMC-FT-308A**				
Category	Humanities and Social Sciences including Management courses				
Course Title	**Energy Environment Ethics and Society**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To make the students familiar with conventional and renewable energy resources, global energy scenarios, environmental challenges, and sustainable energy solutions. • To develop the understanding of students regarding the interaction between society, environment, population growth, technology, and environmental management practices. • To familiarize the students with ecosystem structure, biodiversity, environmental sustainability concepts, lifecycle assessment, environmental ethics, and international environmental standards. • To make the students learn ethical principles, professional ethics, moral values, organizational culture, and codes of ethics relevant to engineering and professional practices.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the terminology related to energy, environment, ecosystems, sustainability, and professional ethics.	Level 1: Remember
CO2	Explain the principles of energy resources, environmental systems, sustainable development, and ethical practices.	Level 2: Understand
CO3	Apply sustainability principles, environmental assessment methods, and ethical practices to engineering problems.	Level 3: Apply
CO4	Analyze the interrelationship between energy, environment, sustainability, and professional ethics in engineering applications.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Energy Linkage with Development: World energy scenario, Fossil fuel resource- estimates and duration, India's energy scenario, Finite/ depleting energy resources, Coal, Oil, Gas, Nuclear fission, Promises and present status of nuclear fusion energy, Renewable energy, Solar, Hydro, Wind, Biomass, Ocean, Tidal, Wave and geothermal, Synergy between energy and environment, Global environment issues, Greenhouse gas emission, Global warming, Green energy solutions.

Unit-II

Society and environment: Exponential growth in population, Environment and optimum sustainable population, Free access resources and the tragedy of commons, Environment problems and impact of P.A.T (Population, Affluence and Technology), Environmentally beneficial and harmful technologies, Environment impact assessment policies and auditing, Interaction between environment, Life support systems and socio-culture system.

Unit-III

Ecosystem: Definition, Concepts, Structure, Realm of ecology, Lithosphere, Hydrosphere, Biosphere, Atmosphere, Energy balance to earth, Matter and nutrient recycling in ecosystems, Nitrogen, Oxygen, Carbon and water cycles, Food producers, Consumers and decomposers, Food chains, Biodiversity, Threat and conservation of biodiversity, Environmentally sustainable economic growth, Introduction to design for environment (DFE), Product lifecycle assessment for environment and ISO 14000, Triple bottom-line of economic, Environment and social performance, Environmental ethics, Its world impact and challenges.

Unit-IV

Ethics and Moral Values: Ethical situations, Objectives of ethics and its study, Role morality and conflicts, Values, Policies and organization Culture, Non-professional, Quasi- and hard professionals, Preventive, Personal, Common and professional ethics, Different ethical value criteria like utilitarian, Virtue, Right and duty ethics with discussion on the case of priority for improvement of urban (high traffic) or rural (low traffic) intersections causing equal number of fatalities, Codes of ethics and their limitations, Institute of engineers code for corporate member, IEEE and ACM professional-code.

Suggested Readings:

- A Textbook of Energy, Environment, Ethics and Society by H. K. Gupta and K. Gupta, Laxmi Publications Private Limited.
- Principles of Energy, Environment, Ethics and Society by R. Sivakumar and Vijay Nicole Pvt. Ltd.
- Energy, Environment Ecology & Society by D. K. Gupta and D. Gupta, Dhanpat Rai & Co. (P) Ltd
- Energy and Environment Management by R. Jain and A. Gupta, CBS Publishers.
- Energy and Environment in India: A Study of Energy Management by K.C. Gupta, Gyan Publishing House.
- Professional ethics in engineering by V Jayakumar, Lakshmi Publications
- Professional ethics - for engineers by D. G. Harkut and G.R. Bamnote, Notion press books.
- Environmental Engineering by M. P. Poonia, S.C. Sharma and S. Kumar, Khanna Book Publishing
- Environmental Issues in India by Ragarajan, Pearson India Publisher.
- Textbook of Environmental Engineering by P.V. Rao, PHI Learning Pvt Ltd

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Environment and development	https://youtu.be/moZIHBsP5fM?list=PLwdnzlV3ogoXmzczhk-7vTPBXBMhz56Hx	NPTEL (IIT Guwahati)
	Solar energy utilization methods	https://youtu.be/UHOZeiKgGAk	NPTEL (IIT Guwahati)
	Climate change and green house	https://youtu.be/iJDpJ3ODvVw	NPTEL (IIT Kanpur)
Unit-II	Ecology and environment	https://youtu.be/47Wtk0sGOng?list=PLyqSpQzTE6M_vO7rLpxKZWqai4uJP2bDa	NPTEL (IIT Madras)

	Environment Impact assessment	https://youtu.be/9-MEVIXr3Ko?list=PLLy_2iUCG87CkrNdXME16BCptwGx1fl67	NPTEL (IIT Roorkee)
Unit-III	Ecology and environment	https://youtu.be/ib97cb6rNBg	NPTEL (IIT Madras)
	Biodiversity	https://youtu.be/SHxAOoxhKTA	NPTEL (IIT Kanpur)
	EIA and life cycle assessment	https://youtu.be/sOdmK34gn3c	NPTEL (IIT Madras)
Unit-IV	Engineering ethics	https://youtu.be/EVWcuFXeSgk?list=PLbRMhDVUMngdL7ofhT7uH9_XBk4-2qsIL	NPTEL (IIT Kharagpur)
	Ethical Theories	https://youtu.be/HtOlPvsu7CE	NPTEL (IIT Kharagpur)

Course Code	**LC-FT-310A**				
Category	Professional Core Courses				
Course Title	**Fire Testing Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To impart practical knowledge of fire testing procedures and standard methods used for evaluation of combustible and structural materials. • To develop experimental understanding of flammability, flame spread, smoke generation and heat release behavior of materials under fire conditions. • To acquaint students with fire resistance assessment techniques for structural components, fire doors and electrical insulation systems. • To provide hands-on exposure to testing, calibration and performance evaluation of fire detection and firefighting equipment.				
Assessment	25 Marks				
End Semester Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Conduct flammability, limiting oxygen index, flame spread and smoke density tests on combustible and building materials using standard fire testing procedures.	Level 3: Apply
CO2	Determine the heat release characteristics and fire resistance performance of structural, insulation and electrical materials through laboratory fire testing methods.	Level 3: Apply
CO3	Test and calibrate fire detection and firefighting equipment for evaluation of operational and discharge performance characteristics.	Level 3: Apply
CO4	Evaluate the fire performance and resistance characteristics of materials, structural elements and fire protection equipment based on experimental observations and test results.	Level 4: Analyze

List of Experiments:

Sr. No.	Contents
1	To conduct horizontal and vertical flammability tests on combustible materials.
2	To determine the limiting oxygen index (LOI) of solid combustible materials.
3	To conduct flame spread test on building materials.
4	To measure smoke density generated from combustible materials.

5	To determine the heat release rate of materials using cone calorimeter.
6	To conduct fire resistance test on steel structural specimens.
7	To conduct fire resistance test on RCC structural elements.
8	To evaluate the fire integrity and insulation performance of fire doors.
9	To conduct fire resistance test on electrical cables and insulation materials.
10	To test and calibrate smoke detectors.
11	To determine the foam expansion ratio and drainage time of firefighting foam.
12	To evaluate the performance and discharge characteristics of portable fire extinguishers.

At least 8 experiments to be studied/performed from the above list and other experiments can be studied/performed depending upon the scope of course as decided by the department.

Course Code	**LC-FT-312A**				
Category	Professional Core Courses				
Course Title	**Automobile Safety Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To provide practical knowledge of automobile engine systems, fuel systems and vehicle subsystems with emphasis on operational safety and hazard prevention. • To develop understanding of transmission, steering, suspension and braking systems used for vehicle stability and safe operation. • To familiarize students with automotive safety devices, intelligent vehicle safety technologies and accident prevention systems. • To provide hands-on exposure to emission control technologies, vehicle safety inspection procedures and safety systems in electric and hybrid vehicles.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Explain the construction, working and safety aspects of automobile engines, ignition systems and fuel systems.	Level 2: Understand
CO2	Discuss the operation and safety features of transmission, suspension and steering systems used in automobiles.	Level 2: Understand
CO3	Apply automotive safety principles for understanding braking systems, stability systems and passenger protection systems.	Level 3: Apply
CO4	Analyze the performance and safety aspects of emission control systems and electric and hybrid vehicle safety systems.	Level 4: Analyze

List of Experiments

Sr. No.	Contents
1	To study the constructional details, working principles, operational safety, and hazard prevention methods in multi-cylinder petrol and diesel engines.
2	To study the role of cooling and lubrication systems in preventing overheating, frictional wear, fire hazards, and engine failure.
3	To study the safe operation and functioning of engine starting systems, contact point ignition systems, and electronic ignition systems.
4	To study the construction, working principles, and safety aspects of carburetors, diesel fuel injection systems, and gasoline fuel injection systems.
5	To study the constructional details, working principles, and safe operation of coil spring clutch, diaphragm spring clutch, and double disc clutch systems.
6	To study the operation and safety features of synchromesh gearbox, transaxle with dual-speed range, four-wheel drive systems, and transfer cases.

7	To study rear-wheel drive, front-wheel drive, differentials, drive axles, and four-wheel drive systems with emphasis on stability and safe torque transmission.
8	To study front and rear suspension systems and their role in ride comfort, vehicle stability, vibration reduction, and accident prevention.
9	To study manual steering, rack and pinion steering, power steering systems, tilt and telescopic steering wheels, and collapsible steering columns.
10	To study various types of bias-ply tyres, radial tyres, wheel constructions, wheel balancing, and tyre safety parameters.
11	To study the construction, operation, and safety aspects of hydraulic and pneumatic braking systems.
12	To study the working principles, efficiency, and operational safety of drum brake and disc brake systems.
13	To study the operation and safety features of ABS, parking brake systems, and auxiliary braking systems.
14	To study seat belts, airbags, headrests, crumple zones, side-impact protection systems, and child safety features.
15	To study traction control systems (TCS), electronic stability control (ESC), lane departure warning systems, adaptive cruise control, and collision avoidance systems.
16	To study emission control technologies such as catalytic converters, exhaust gas recirculation (EGR), evaporative emission control systems, and vehicular pollution standards.
17	To study vehicle safety inspection procedures, lighting systems, warning devices, mirrors, and accident prevention measures.
18	To study battery safety, electrical isolation systems, thermal runaway prevention, charging safety, and emergency shutdown systems in electric and hybrid vehicles.

Note:At least 10 experiments to be performed from the above list and other experiment can be performed depending upon the scope of course as decided by the department.

Course Code	**LC-FT-314A**				
Category	Professional Core Courses				
Course Title	**Basic Computer Skills and AutoCAD Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To develop the understanding of students regarding the use of Microsoft Office tools for document preparation, spreadsheet management, data analysis, and technical presentations. • To familiarize the students with formatting, editing, graphical representation, and file management techniques using MS Word, MS Excel, and MS PowerPoint. • To make the students learn the fundamentals of AutoCAD software, drawing environment setup, and preparation of engineering drawings using standard drafting practices. • To develop the practical skills of students in creating, editing, analyzing, and presenting technical and engineering drawings using computer-based applications and drafting tools.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Explain the functions and applications of Microsoft Word, Excel and PowerPoint tools used for document processing, data handling and presentation preparation.	Level 2: Understand
CO2	Apply formatting, calculation, chart creation and presentation techniques using Microsoft Office applications.	Level 3: Apply
CO3	Apply AutoCAD commands and drawing tools for creation of engineering drawings and drafting layouts.	Level 3: Apply
CO4	Analyze and prepare engineering component drawings and sectional views using AutoCAD software.	Level 4: Analyze

List of Experiments

1. To study the basics of Microsoft Word.

a) File Management:

- Opening, creating and saving a document, locating files, copying contents in some different file(s)

b) Editing a document:

- Entering text, cut, copy, paste using toolbars,
- Use of spell check
- PDF file and its conversion in different file formats (MS Word/Excel etc.)
- Scanning, editing and printing of a document

c) Formatting a document:

- Using different fonts, changing font size and colour, changing the appearance through bold/ italic/ underlined, highlighting a text, changing case, using subscript and superscript, using different underline methods
- Aligning of text in a document, justification of document, Inserting bullets and numbering Formatting paragraph,

- Inserting page breaks and column breaks, line spacing
- Use of headers, footers, inserting footnote, end note,
- use of comments, Inserting date, time, special symbols, importing graphic images, drawing tools

d) Tables and Borders:

- Creating a table, formatting cells, use of different border styles, shading in tables, merging of cells, partition of cells, inserting and deleting a row in a table
- How to change docx file to doc file
- Print preview, zoom, page setup, printing options
- Using Find, Replace options

2. To study the basics of Microsoft Excel.
   a) **Starting Excel open worksheet**: enter, edit data, formulae to calculate values, format data, create chart, printing chart, save worksheet, switching between different spreadsheets.
   b) **Menu commands:** Create, format charts, organize, manage data, solving problem by analyzing data, creating graphs
   c) **Work books:** Managing workbooks (create, open, close, save, rename), working in work books Editing a worksheet: copying, moving cells, pasting, inserting, deleting cells, rows, columns, find and replace text, numbers of cells, formatting worksheet
   d) **Creating a chart:** Working with chart types, changing data in chart, formatting a chart, use chart to analyze data using a list to organize data, sorting and filtering data in list
   e) **Formulas:** Addition, subtraction, division, multiplication, percentage and auto sum
3. To study the Microsoft Power point Presentation.
   a) **Introduction to PowerPoint** How to start PowerPoint Working environment: concept of toolbars, slide layout, templates etc. Opening a new/existing presentation Different views for viewing slides in a presentation: normal, slide sorter etc.
   b) Addition, deletion and saving of slides
   c) **Insertion of multimedia elements:** Adding text boxes, importing pictures, tables and charts etc.
   d) Formatting slides, Text formatting, changing slide layout, changing slide colour scheme Changing background, Applying design template
   e) **Slide Show:** Viewing the presentation using slide navigator, Slide transition Animation effects etc.
4. To study various commands used in Auto- CAD software.
5. Setting up of drawing environment by setting drawing limits, drawing units, naming the drawing, naming layers, setting line types for different layers using various type of lines in engineering drawing, saving the file with .dwg extension.
6. Layout drawing of a building using different layer and line colors indicating all Building details.
7. To make a drawing of line, arc, circle, ellipse, triangle etc.
8. To make a drawing of a flange.
9. To make a drawing of a bushing assembly.
10. To make an isometric dimensioned drawing of a connecting rod using isometric grid and snap.
11. To make different types of bolts and nuts with internal and external threading in ACME and square threading standards.
12. To make a quarter sectional isometric view of a cotter joint.

At least 8 experiments to be performed from the above list and other experiment can be performed depending upon the scope of course as decided by department.

<table>
<tr><td>Course Code</td><td colspan="5">LC-FT-316A</td></tr>
<tr><td>Category</td><td colspan="5">Professional Core Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Fire Ground Operations–VI (Rescue Operations)</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VI</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
● To develop the understanding of students regarding rescue techniques, lifting and carrying methods, knots, and emergency response procedures used in firefighting and rescue operations.
● To familiarize the students with firefighting tenders, rescue tools, power tools, firefighting equipment, and personal protective equipment used during rescue and emergency operations.
● To make the students learn the construction, operation, technical specifications, and practical applications of breathing apparatus sets and rescue equipment used in hazardous environments.
● To develop the practical skills of students in performing rescue drills, confined space rescue, well rescue, building rescue, and emergency response operations under different accident scenarios.</td></tr>
<tr><td>Assessment</td><td colspan="5">25 Marks</td></tr>
<tr><td>End Semester Practical Examination</td><td colspan="5">25 Marks</td></tr>
<tr><td>Total</td><td colspan="5">50 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Explain the principles, applications, and operational procedures of rescue techniques, rescue tools, firefighting equipment, personal protective equipment, and breathing apparatus sets.	Level 2: Understand
CO2	Demonstrate lifting and carrying methods, knot practices, breathing apparatus drills, pump drills, and rescue procedures using appropriate rescue and firefighting equipment.	Level 3: Apply
CO3	Perform rescue operations in confined spaces, wells, buildings, and accident scenarios using suitable rescue tools, harness systems, and emergency response techniques.	Level 3: Apply
CO4	Analyze the operational requirements, equipment selection, and safety considerations involved in firefighting and rescue operations under different emergency conditions.	Level 4: Analyze

List of Experiments

Sr. No.	Contents
1	To practice different lift and carries.
2	To practice different types of knots using ropes.
3	To study different types of tenders (through industrial visits).
4	To study different types of Rescue tools and their applications.
5	To study different types of Power tools and their applications.
6	To study different types of Fire Fighting tools and their applications.
7	To study personal protecting equipments and their uses.
8	To study B.A. Set, its technical specifications and to perform drill using B.A. Set.
9	To study the types of B.A. Set: a) Open circuit b) Closed circuit
10	To perform rescue drill using full body harness.
11	To perform six men pump drill with pump test.
12	To perform drills on rescue from well.
13	To perform drill on rescue from confined space like tunnels.
14	To perform drills on Rescue from building.
15	To perform drills on rescue from accidents/incident.

Other drills and tests can be performed as decided by department (time to time) depending upon the scope of course.

<table>
<tr><td>Course Code</td><td colspan="5">PEC-FT-318A</td></tr>
<tr><td>Category</td><td colspan="5">Professional Elective Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Fire Modelling</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VI</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
To introduce students to the fundamentals of fire modelling, simulation techniques and computational approaches used in fire safety engineering.
To develop understanding of numerical methods, thermodynamic principles and simulation analysis tools used in fire simulations.
To familiarize students with turbulence modelling, combustion phenomena and advanced fire dynamics simulations.
To provide knowledge of fire suppression modelling, model validation techniques and applications of fire simulations in engineering systems.</td></tr>
<tr><td>Assessment</td><td colspan="5">40 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">60 Marks</td></tr>
<tr><td>Total</td><td colspan="5">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the terminology related to fire modelling, numerical methods, fire dynamics, combustion, and fire suppression.	Level 1: Remember
CO2	Explain the principles of fire simulation, numerical modelling, turbulence, combustion, and model validation.	Level 2: Understand
CO3	Apply fire modelling and numerical simulation techniques to predict fire behavior and suppression performance.	Level 3: Apply
CO4	Analyze fire simulation results and model performance to assess fire safety in engineering applications.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question no. one will have 6 parts of 2 marks each from all units and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Fire Simulation and Modelling: Introduction to fire modelling and simulation, Basic model forms, Deterministic and probabilistic models, Basic simulation approaches, Handling stepped and event-based time in simulations, Discrete and continuous modelling, Numerical techniques in simulations, Sources and propagation of errors, Dynamical system simulations, Finite state simulations, Complex model simulations, Graph and network-based simulations, Actor-based simulations, Mesh-based simulations, Hybrid simulations, Introduction to parallel and distributed simulations, Data partitioning, Algorithm partitioning, Handling inter-partition dependencies, Introduction to probability and statistics for simulations, Queuing systems, Random noise, Random variate generation, Sensitivity analysis.

Unit-II

Numerical Methods and Simulation Analysis: Simulation result analysis and visualization tools, Display forms, Tables, Graphs, Multidimensional visualization techniques, User interfaces and web-based visualization tools, Validation and verification of model results, Index notation and matrix operations, Fundamentals of thermodynamics, Equation of state, Chemical and phase equilibrium, Droplet mass, Momentum and energy transfer, Taylor series expansion, Order of accuracy, Numerical time integration methods, Explicit and implicit numerical schemes, Finite difference methods, Stability restrictions, Lax equivalence theorem, Derivation of mass, Momentum and energy conservation equations, Pressure Poisson equation, Projection methods, Scalar transport schemes, Godunov's theorem.

Unit-III

Advanced Fire Dynamics and Turbulence Modelling: Time-splitting methods for source terms, Non-dimensional governing equations, Compressible and low-Mach number flow formulations, Velocity divergence constraints for low-Mach number flows, Thermal radiation modelling, Discrete ordinates method, Beer's law, Fundamentals of turbulence theory, Vortex dynamics, Kolmogorov and Batchelor theories, Energy and power spectra, Direct Numerical Simulation (DNS), Length scale requirements, Parallel computing in fire simulations, Estimation of computational cost, Reynolds Averaged Navier–Stokes (RANS) models, Turbulence modelling approaches, Statistical correlations, Large Eddy Simulation (LES), Sub-grid scale closures, Filtering techniques, Energy spectrum analysis, Nyquist limit and aliasing effects.

Unit-IV

Combustion, Fire Suppression and Model Validation: Turbulent boundary layers, Grid generation and mesh design, Mesh quality metrics, Models for mean chemical source terms, Turbulent combustion modelling, Extinction and ignition phenomena, Under-ventilated combustion, Formation of toxic products including carbon monoxide and soot, Pyrolysis, Flame spread mechanisms, Fire suppression modelling techniques, Water mist and suppression systems, Smoke movement and control, Model validation techniques, Verification procedures, Uncertainty quantification in fire modelling, Analysis of model input and output uncertainties, Applications of fire modelling in buildings, industrial facilities, and transportation systems.

Suggested Readings

- Introduction to Mathematical Fire Modeling, Second Edition By Marc L.Janssens.
- Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's
- Surface Fire Spread Model by Joe H. Scott, Robert E. Burgan.

Course Code	**PEC-FT-320A**					
Category	Professional Elective Courses					
Course Title	**Safety Practice in Chemical and Nuclear Industries**					
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**	
	3	0	0	**3**		
Course Objectives	The objectives of this course are • To introduce students to the fundamentals of chemical process safety, industrial toxicology and occupational safety practices in chemical industries. • To develop understanding of fire, explosion and electrical hazards associated with chemical process industries and their preventive measures. • To familiarize students with process safety engineering, hazard evaluation techniques and risk assessment methodologies used in chemical plants. • To provide knowledge of nuclear safety engineering, radiation hazards and emergency preparedness measures in nuclear installations.					
Assessment	40 Marks					
End Semester Examination	60 Marks					
Total	100 Marks					
Duration of Exam	03 Hours					

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the terminology related to chemical process safety, fire and explosion hazards, risk assessment and nuclear safety.	Level 1: Remember
CO2	Explain the principles of chemical process safety, fire and explosion prevention, process risk assessment and nuclear safety systems.	Level 2: Understand
CO3	Apply process safety, fire protection, risk assessment and nuclear safety principles to industrial applications.	Level 3: Apply
CO4	Analyze chemical process hazards, fire and explosion risks and nuclear safety systems to recommend appropriate control measures.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Chemical Process Safety: Introduction to chemical process industries, Major chemical and oil industry disasters: Flixborough disaster, Seveso disaster, Mexico LPG disaster, Bhopal disaster, Phillips disaster, Chemical hazards and hazard symbols, Incompatible chemicals, Fire classification, occupational safety and health regulations, The Factories Act, personal protective equipment (PPE), Toxic substances and industrial toxicology, Classes of toxicity, Routes of exposure, Effects of toxic substances, Dose-response relationship, Threshold limit values (TLV), Exposure standards, Airborne contaminants, confined space hazards, Respiratory protection, Prevention and control measures.

Unit-II

Fire, Explosion and Electrical Hazards in Chemical Industries: Workplace hazards, Dangerous substances, Fire triangle and fire tetrahedron, Ignition sources, Static electricity, Flammable and combustible liquids, Flash point, Flammability limits, Limiting oxygen concentration (LOC), Flammability diagrams, Explosion phenomena: BLEVE, Vapor cloud explosion (VCE), Detonation and deflagration, Electrical hazards, Causes and effects of electric shock, Path of electric current, Sources of electrostatic discharge, Grounding and bonding, Control of static electricity, Electrical hazard reduction techniques**.**

Unit-III

Process Safety Engineering and Risk Assessment: Decomposition and runaway reactions, Initiating factors, reactive chemical hazards, Thermal explosion hazards, Process hazard evaluation techniques, Process flow diagrams (PFD), Piping and instrumentation diagrams (P&ID), Process control systems, Alarms and interlocks, Chemical plant layout, Passive and active fire protection systems, Emergency shutdown systems, Safety integrity level (SIL), Inherent safety techniques, Hazard identification and risk assessment, HAZOP, Dow Fire and Explosion Index, Reliability concepts, Fault tree analysis (FTA), Event tree analysis (ETA), case studies: T2 Laboratories, Florida Synthon, North Carolina incident, Phenol-formaldehyde reaction.

Unit-IV

Nuclear Safety Engineering: Comparison of coal and nuclear power plants, Indian nuclear power scenario, three-stage nuclear power program, Nuclear fuels and fuel cycle, Types of nuclear reactors, Environmental aspects of nuclear power, Radiation and radiation hazards, Radiation protection principles, Defense in depth, multiple barrier concept, Reactor shutdown systems, Emergency core cooling systems, Passive safety systems, Sodium leak and fire protection, Design basis and beyond design basis accidents, Nuclear power plant licensing, PHWR, CANDU and FBR safety features, International Nuclear and Radiological Event Scale (INES).

Major Nuclear Accidents: Chernobyl and Fukushima, Risk management and emergency preparedness in nuclear installations.

Suggested Readings:

- Chemical Process Safety: Fundamentals with Applications by Daniel A. Crowl and Joseph F. Louvar, Prentice Hall, Sterling book House
- Industrial Safety and Health Management by R.K. Jain, Sunil S. Rao, Khanna Publications.
- Safety Management, 1st Edition by R.K. Mishra, AITBS Publisher India.
- Fundamental of industrial safety and health by KU Mistry, Shyamaraj Global Commerce.
- Industrial Safety Management by Pravin M. Pathak, Jayant P. Khairnar, Notion Press.
- Principles of Industrial Safety Management: Understanding the Ws of Safety at Work by Akhil Kumar Das, PHI Learning
- Industrial Safety Management by Naseer Elahi, Kalpaz Publications.
- Safety Management System and Documentation Training Programme Handbook (Pb 2019) by SV Paul, CBS Publication.
- Safety, Occupational Health and Environmental Management in Construction by S.C.Sharma, Vinit Kumar, Khanna Publishers.
- Industrial Safety and Maintenance Managementby M.P. Poonia, S.C. Sharma, P. Sojan Lal, Khanna Publishing House, New Delhi
- A Handbook On Industrial Safety and Fire Managementby Ravi Kant Pandey, ChetanPrakashan

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Chemical industry accident	https://youtu.be/VhuZ6M7a8N8	NPTEL (IIT Kharagpur)
	Chemical hazard	https://youtu.be/n1s1UB80JgA	NPTEL (IIT Kharagpur)
	PPE confined space safety	https://youtu.be/WxyfKNQkj8g?list=PLp6ek2hDcoNCd093zjHjuo4Lu_pIr3rFr	NPTEL (IIT Delhi)
Unit-II	Fire triangles	https://youtu.be/eLeZ2zc2hgI	NPTEL (IIT Madras)
	Flammability and flash point	https://youtu.be/6btv5t8DYXU	NPTEL (IIT Roorkee)
Unit-III	Thermal explosion	https://youtu.be/O_FWY7vlAzs	NPTEL (IIT Madras)
	Runway: explosion at T2 laboratory	https://youtu.be/C561PCq5E1g	NPTEL (IIT Madras)
	Industrial safety integrity	https://youtu.be/jFDWlKayrTc	NPTEL (IIT Kharagpur)
Unit-IV	Nuclear reactor and safety	https://youtu.be/vQ5HrubRYVo?list=PLbMVogVj5nJR6nZje9ewAeZ7lvnoVV1X3	NPTEL (IIT Madras)
	Event tree analysis	https://youtu.be/ikbC5_6qTvs	NPTEL (IIT Kharagpur)

Course Code	**PEC-FT-322A**				
Category	Professional Elective Courses				
Course Title	**Building Design and Drawing**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To develop the understanding of students regarding building drawing, building elements, foundations, doors, windows, staircases, roofs, trusses, and other structural components used in building construction. • To make the students familiar with NBCS–2026 provisions, building bye-laws, FAR, setbacks, architectural composition, planning principles, and building orientation. • To make the students learn building services such as water supply, drainage, electrification, ventilation, lighting, and fire safety services along with fire service layouts and arrangements. • To familiarize the students with the design and preparation of residential, commercial, and institutional building drawings including elevations, sections, ventilation, smoke ventilation, and energy efficient building concepts.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the terminology related to building planning, building elements, services, and fire safety drawings.	Level 1: Remember
CO2	Explain the principles of building planning, building services, fire protection systems, and building design.	Level 2: Understand
CO3	Prepare building and fire service drawings in accordance with applicable standards and functional requirements.	Level 3: Apply
CO4	Analyze building layouts and fire protection provisions to ensure safe and efficient building design.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit–I

Drawing of Building Elements: Drawing of various elements of buildings like footing, open foundation, raft, grillage, pile and well foundation, Drawing of frames of doors, windows, various types of door, window and ventilator, lintels and arches, stairs and staircases, trusses, flooring and roofs.

Unit–II

Building Planning: Provisions of National Building Construction Standards- 2026, Building bye-laws, open areas, setbacks, FAR terminology, Principles of architectural composition (i.e. unity, contrast etc.), Principles of architectural planning and orientation.

Unit–III

Building Services: Water supply, Drainage, Electrification, Ventilation, Lighting and Fire safety services.
Building Fire Services: Layout of water tank compartment, Pump house layout, Main fire pump, Stand by pump and Jockey pump arrangement, Drawings of hydrant post, Hose box, Hose reel, Dry riser, Wet riser and Down comer.

Unit–IV

Design and Drawing of Building: Design and preparation of detailed drawings of various types of building like residential, Commercial and Institutional buildings with elevation and sectional details, Functional requirements of buildings, Ventilation, Smoke ventilation and Energy efficient buildings, Introduction to perspective drawing.

Suggested Readings:

- Building Design and Drawing by Vs Limaye and Ad Pawar, Nirali Prakashan
- Building Drawing: with an integrated approach to built environment by M.G. Shah, C.M. Kale and S.Y. Patki, McGraw-Hill
- Building Services Handbook by Fred Hall & Roger Greeno, Routledge
- Building Construction by B.C. Punmia, Er. Ashok Kumar Jain & Dr. Arun Kumar Jain, Laxmi
- Fire Safety in Buildings by V.K. Jain, New Age International Private Limited

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Design of footing	https://youtu.be/8ATp13mOhvg?si=lCdLVnSfxItfd6W7	NPTEL (IIT Kharagpur)
	Design of Staircases	https://youtu.be/hxakW1miEcM?si=JnL-cIKJ1CF77ggY	NPTEL (IIT Kharagpur)
Unit-II	Introduction to Planning and Scheduling	https://youtu.be/Nto1VbJSQWs?si=mggmAURIE0BN-CoP	NPTEL (IIT Kanpur)
	National Building Code 2016 Part I	https://youtu.be/Dpy40oDxtfw?si=2QRKk3TJkech6Rq5	NPTEL (IIT Madras)
	National Building Code 2016 Part II	https://youtu.be/rVasz5j-2L8?si=T-zA_1DHTT1lv6ia	NPTEL (IIT Madras)
Unit-III	Design of Water Supply System	https://youtu.be/JlKkqI7yqW4?si=Wj7a_oUKZH_9NZnV	NPTEL (IIT Delhi)
	Electrification	https://youtu.be/EC72aSUGqTM?si=IpSaLI91nUn95gLB	NPTEL (IIT Delhi)
	Fire Safety: Urban Planning	https://youtu.be/eAKTwc3_ixE?si=8czptB1wtBCA0yBs	NPTEL (IIT Delhi)
Unit-IV	Perspective Drawing	https://youtu.be/xclQPSp2SQw?si=VvcDZBu8dvUtwwie	NPTEL (IIT Madras)

<table>
<tr><td>Course Code</td><td colspan="5">PEC-FT-324A</td></tr>
<tr><td>Category</td><td colspan="5">Professional Elective Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Industrial Hygiene and Occupational Health</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester -VI</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
• To introduce students to chemical, physical and occupational hazards associated with industrial work environments.
• To develop understanding of industrial ventilation, exposure assessment and occupational hygiene practices for hazard control.
• To familiarize students with occupational diseases, medical surveillance systems and workplace health protection measures.
• To provide knowledge of personal protective equipment, respiratory protection systems and regulatory requirements for occupational safety management.</td></tr>
<tr><td>Assessment</td><td colspan="5">40 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">60 Marks</td></tr>
<tr><td>Total</td><td colspan="5">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the terminology related to industrial hygiene, occupational health, workplace hazards and personal protective equipment.	Level 1: Remember
CO2	Explain the principles of industrial hygiene, occupational health, hazard control, ergonomics and personal protective equipment.	Level 2: Understand
CO3	Apply industrial hygiene practices, hazard control measures, occupational health procedures and personal protective equipment for workplace safety.	Level 3: Apply
CO4	Analyze workplace hazards, occupational health risks and personal protective equipment requirements to recommend appropriate control measures.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Chemical Hazards: Introduction to industrial hygiene, Types of chemical hazards in industry: Dust, Gases, Fumes, Mists, Vapours and smoke. Toxicological properties of chemicals and routes of exposure, Exposure assessment and air sampling techniques, Personal and area monitoring, Threshold limit values (TLV), Permissible exposure limits (PEL) and occupational exposure standards, Effects of key industrial chemicals such as chlorine, Ammonia, and other toxic gases. Storage, Handling and transportation of hazardous chemicals, Chemical safety in process industries.

Industrial Ventilation: Principles of natural and mechanical ventilation, General and local exhaust ventilation systems, Design considerations and control of airborne contaminants.

Unit-II

Physical Hazards: Illumination and lighting standards, Thermal radiation, Ultraviolet and ionizing/non-ionizing radiation, Preventive and control measures.
Noise: Measurement techniques, Noise surveys, Noise dose, Hearing loss mechanisms and noise control methods.
Vibration: Types, Effects on human body, Hand-arm and whole-body vibration, Isolation techniques.
Thermal Stress: Heat balance, Heat stress indices, Heat disorders, Prevention and control measures.
Work physiology: Classification of workload, Human energy expenditure, Work capacity, Job–man alignment, Fatigue and recovery.
Ergonomics: Principles, Human-machine interaction, Posture analysis and methods of reducing musculoskeletal and postural strain in industry.

Unit-III

Occupational Health and Diseases: Concept of occupational health and industrial medical services, Occupational diseases- Silicosis, Asbestosis, Pneumoconiosis, Lead, Nickel, Chromium, Manganese toxicity and their effects, Occupational cancer, Occupational dermatitis and other work-related diseases: Causes, Exposure pathways and prevention strategies, Medical surveillance of workers, Occupational health centre, Health records and reporting systems, Prevention and control of occupational diseases, Occupational hygiene practices and health risk reduction strategies, Occupational disease compensation systems and legal provisions, Fundamentals of first aid and emergency medical response in industries.

Unit-IV

Non Respiratory Personal Protective Equipments: Head protection, Hearing protection, Face and eye protection, Feet protection, Body protection, Selection, Use, Inspection, Care and maintenance of personal protective equipment.
Respiratory Personal Protective Equipments: Classification of respiratory hazards, Types of respirators and breathing apparatus, Selection criteria, Usage procedures and training requirements, Selection of respirators, Care & maintenance of breathing apparatus.
Workplace safety laws and regulatory requirements related to PPE usage, Industrial safety management practices for PPE compliance and occupational risk reduction.

Suggested Readings

- Industrial Safety and Health Management by R.K. Jain, Sunil S. Rao, Khanna Publications.
- Safety Management, 1st Edition by R.K. Mishra, AITBS Publisher India.
- Fundamental of industrial safety and health by KU Mistry, Shyamaraj Global Commerce.
- Industrial Safety Management by Pravin M. Pathak, Jayant P. Khairnar, Notion Press.
- Principles of Industrial Safety Management: Understanding the Ws of Safety at Work by Akhil Kumar Das, PHI Learning
- Industrial Safety Management by Naseer Elahi, Kalpaz Publications.
- Safety Management System And Documentation Training Programme Handbook (Pb 2019) by SV Paul, CBS Publication.
- Safety, Occupational Health and Environmental Management in Construction by S.C. Sharma, Vinit Kumar, Khanna Publishers.
- Industrial Safety and Maintenance Management by M.P. Poonia, S.C. Sharma, P. Sojan Lal, Khanna Publishing House, New Delhi

Course Code	**PEC-FT-326A**				
Category	Professional Elective Courses				
Course Title	**Nuclear Reactors and Safety**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to nuclear reactor fundamentals, radiation principles and nuclear power generation systems. • To develop understanding of nuclear reactor safety principles, event analysis and emergency response strategies in nuclear facilities. • To familiarize students with quality assurance practices, environmental safety considerations and site evaluation criteria for nuclear installations. • To provide knowledge of nuclear safety regulations, licensing procedures and safety review practices followed in nuclear industries.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the principles of nuclear reactors, radiation behaviour, reactor components, quality, environmental safety and nuclear fuel cycle processes.	Level 1: Remember
CO2	Explain nuclear reactor safety principles, radiation protection measures, event analysis methods, emergency response procedures, nuclear safety regulation used in nuclear facilities.	Level 2: Understand
CO3	Apply quality assurance, environmental safety and regulatory concepts for evaluation of nuclear safety practices and reactor operations.	Level 3: Apply
CO4	Analyze nuclear reactor incidents, safety systems and regulatory measures for improving nuclear safety and risk management.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Nuclear Reactor Fundamentals and Radiation: Energy sources, Nuclear Power, Production, Medical and societal applications of radiation, Nuclear fuel cycle, Basic Physics of Nuclear Reactors: Atomic Structure, Isotopes, Radioactivity, Half-life, Basics of fission reaction, Moderation, Criticality, Decay heat, Reactivity and Feedback, Breeding, Nuclear Reactor Types, Components of Nuclear Reactor, Present Reactor Types, Generation IV Concepts, Radiation sources and Protection, Radiation and its units, Natural, background and man-made Radiation, Biological Effects, Exposure limits and protection, Sources of radiation, shielding.

Unit-II

Nuclear Reactor Safety and Event Analysis: Safety Principles, Safety objectives, Defence in depth philosophy, Multiple barriers, Radwaste management, Levels of defence, Redundancy, Diversity Principles, Event analysis, core inventory, Emergency response, Safety Approach, Deterministic approach – Design Basis, Events and Beyond Design Basis Events, Acceptance Criteria, Probabilistic approach – Fault tree, Event tree, Failure rates. History of Events in Nuclear reactors and facilities, INES Scale, TMI, Chernobyl, Fukushima, Windscale, Thorp Reprocessing, Kyshtym, Vandellos, Tokaimura, NRX, David Besse, Enrico Fermi, Narora Fire, Monju and FBTR Sodium Leak, Radiation over exposures in Industry and Medical applications. Analysis of Some Events in NPP, Heat transfer and Fluid flow prediction, validation, Safety set points, Safety actions for events, Spurious opening of Pressurizer valve in a PWR, LOCA analysis Indian, PHWR, Station Blackout without Reactor Trip, FBTR.

Unit-III

Quality and Environmental Safety: Quality Assurance, Quality Assurance Plan, materials, Design, Fabrication, Maintenance, Surveillance, In Service Inspection, Training & Qualification, Quality Audit. Siting of Nuclear plants, Site evaluation Stages, Site Rejection Criteria, Earthquake, Geological criteria, Meteorological considerations, Flooding, Tsunami, Shoreline erosion, chemical explosion, Radiological impact study, Radioactivity path ways to humans, environmental Impact study.

Unit-IV

Nuclear Safety Regulation: Safety Regulation in India, Atomic Energy Regulatory Board, functions, safety Documents, Safety Review of site, design, regulatory inspections, safety review for PFBR, Koodankulam, Regulatory review of operating plants, Licensing stages, licensing of operating personnel, Training simulator, safety up-gradation, Review after TMI Chernobyl, Review after Fukushima, safety review for decommissioning, Safety Review of Radiation Facilities, medical X-ray units, Gamma irradiators, Safety Practices in India.

Suggested Readings:

- Nuclear Reactor Engineering (Principles and Concepts) by G. Vaidyanathan, S. Chand & Company, New Delhi
- Elements of Nuclear Safety by Jacques Libmann, Les Editions de Physique
- Nuclear Power Reactor Safety by E. E. Lewis, John Wiley and Sons, New York
- Nuclear Safety by Gianni Petrangeli, Butterworth-Heinemann
- NPTEL Web Course on Nuclear Reactor Technology by K. S. Rajan
- Radioactive Materials by B. M. Rao, Himalaya Publishing House

Useful Video Links:

Unit No.	Topic	Link	Source
Unit-I	Nuclear power generation	https://youtu.be/oPZrUW9GQRg?si=EK1gh_uKq7FaWxIb	NPTEL (IIT Guwahti)
	Nuclear reactions	https://youtu.be/vQ5HrubRYVo	NPTEL (IIT Madras)
Unit-II	Nuclear reactor and safety	https://youtu.be/vQ5HrubRYVo?si=7x8McU_4HuL7jwjp	NPTEL (IIT Madras)
	Radioactive waste	https://youtu.be/qYDjjJxc4h4	e-pathshala
Unit-III	Nuclear power production cycle	https://youtu.be/jAmrYtcknMc	NPTEL (IIT Madras)
	Nuclear reactor and safety	https://youtu.be/vQ5HrubRYVo?si=0b1pkcjiUcDMjfa_	NPTEL (IIT Madras)
Unit-IV	Radiological protection	https://youtu.be/EzxZCgcLtqk	NPTEL (IIT Madras)
	Safety practices in NPP	https://youtu.be/k2NOPsYw6i0	NPTEL (IIT Madras)

Course Code	**PEC-FT-328A**				
Category	Professional Elective Courses				
Course Title	**Computational Fluid Dynamics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize students with numerical methods and discretization techniques used for solving fluid flow and fire dynamics problems. • To develop understanding of governing equations used in computational fluid dynamics such as continuity, momentum, and energy equations. • To enable students to analyze smoke propagation, heat transfer, ventilation, and fire behavior in buildings using CFD tools. • To develop the ability to interpret CFD simulation results for improving fire safety design and risk assessment in industrial and building environments.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the concepts related to fluid mechanics and heat transfer used in computational fluid dynamics (CFD).	Level 1: Remember
CO2	Understand the principles of numerical methods, turbulence models and CFD applications in fire and smoke movement analysis.	Level 2: Understand
CO3	Apply CFD software and simulation techniques to model fire scenarios, smoke propagation, and heat transfer problems in fire safety engineering.	Level 3: Apply
CO4	Analyze CFD simulation results to evaluate fire behavior, smoke control performance in buildings and industrial facilities.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Introduction: Impact and application of CFD in diverse fields, Governing equation of fluid dynamics, Continuity, Momentum and energy, Generic integral form for governing equations, Initial and boundary conditions, Governing equation for boundary layers, Classification of partial differential equations, Hyperbolic, Parabolic, Elliptic and mixed types, Applications and relevance.

Unit-II

Basic Aspects of Discretization: Discretization techniques, Finite difference, Finite volume and finite element method, Comparison of discretization by the three methods, Introduction to finite differences, Transient one-dimensional and two-dimensional conduction, Explicit, Implicit, Crank-nicolson, ADI scheme, Stability criterion.

Difference Equations: Numerical errors, Grid independence test, Optimum step size.

Unit-III

Grid Generation: General transformation of the equation, Form of the governing equations suitable for CFD, Boundary fitted co-ordinate systems, Elliptic grid generation, Adaptive grid, Modern developments in grid generation.

Unit-IV

Steady One-Dimensional Convection and Diffusion: Central difference, Upwind, Quick, Exponential, False diffusion, Hybrid and power law schemes, Transient one dimensional heat conduction equation.

Representation of the Pressure Gradient Term and Continuity Equation: Staggered grid, Momentum equation, Pressure and velocity correction, Pressure correction equation, Numerical procedure for SIMPLE algorithm, Boundary condition for the pressure correction method, Stream function, Vorticity method, Discussion of case studies.

Suggested Readings:

- An Introduction to Computational Fluid Dynamics by H. Versteeg, W. Malalasekra, The Finite Volume Method (2nd Edition), Prentice Hall. (2007)
- Computational Fluid Dynamics by Sreenivas Jayanti, Springer (2016)
- Introduction to Computational Fluid Dynamics by Pardip Niyogi, S.K. Chakrabarity, M. K. Laha, Person India (2005)
- Computational Fluid Dynamics and Heat Transfer by S.Thanigaiarasu, Techsar Pvt. Ltd. (2020)
- Computational Fluid Dynamics by Young-II Lim, MDPI (2021)

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Governing equation of Fluid Dynamics	https://youtu.be/AZknqweSR9w?si=U5atrcPzCqxjTUtC	NPTEL (IIT Madras)
	Partial Differential Equation	https://youtu.be/W2DvB1R6uJc?si=LCEN4sCr4NHDupdE	NPTEL (IIT Madras)
Unit-II	Finite Differences	https://youtu.be/j-Hpi1zd2fk?si=gxbUs2qurVY4Kso7	NPTEL (IIT Madras)
	Numerical Errors	https://youtu.be/UFg_yhh5nRU?si=wJpzAsoa9y4pzuTo	NPTEL (IIT Madras)
Unit-III	Introduction to Grid Generation	https://youtu.be/LY215hdSFd4?si=fIqpzYPQWiBKfSIS	NPTEL (IIT Kharapur)
	Boundary Fitted Co-ordinate System	https://youtu.be/mHD3pFoUXD0?si=EYJntXxNg2plniHy	NPTEL (IIT Kharapur)
Unit-IV	Steady One Dimensional Convention, upwind	https://youtu.be/UFg_yhh5nRU?si=wJpzAsoa9y4pzuTo	NPTEL (IIT Madras)
	Numerical Procedure for SIMPLE Algorithm	https://youtu.be/S28FrU_xZ24?si=USOrI3XsQ9Pn0mMB	NPTEL (IIT Madras)

Course Code	**OEC-07A**				
Category	Open Elective Courses				
Course Title	**Computer Aided Risk Analytics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to hazard identification, risk assessment techniques and safety management practices used in industrial systems. • To develop understanding of quantitative risk analysis, reliability concepts and computer aided safety analysis tools. • To familiarize students with risk control strategies, human factors engineering and occupational safety practices for industrial environments. • To provide knowledge of accident investigation methods, stochastic safety modelling and advanced applications of computer aided safety engineering.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the terminology related to hazard identification, risk analysis, safety engineering, and computer-aided safety tools.	Level 1: Remember
CO2	Explain the principles of risk assessment, safety engineering, human factors, accident analysis, and computer-aided risk analysis.	Level 2: Understand
CO3	Apply risk assessment techniques, safety engineering principles, and computer-aided tools to industrial safety problems.	Level 3: Apply
CO4	Analyze industrial risks, accident scenarios, and safety performance using quantitative and computer-aided risk analysis techniques.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit–I

Hazard Identification and Risk Assessment: Introduction to hazard, risk and safety, Concepts of hazard identification and risk assessment, Risk perception and risk acceptance criteria, Principles of risk management, Accident causation theories, Hazard monitoring and control techniques, Safety audits and management system audits, Safety checklists and inspection procedures, Material Safety Data Sheets (MSDS), Preliminary hazard analysis, What-if analysis, Event Tree Analysis (ETA), Fault Tree Analysis (FTA), Hazard and Operability Study (HAZOP), Coarse hazard analysis, Human error analysis, Hazard warning systems and plant safety review methods.

Unit–II

Quantitative and Computer Aided Risk Analysis Techniques: Basic concepts of quantitative and qualitative risk analysis, Probability theory and Boolean algebra, Reliability engineering fundamentals, Quantitative Risk Assessment (QRA), Consequence analysis methods, Fire and explosion modelling, Toxic gas dispersion modelling, Thermal radiation and overpressure estimation, Failure Mode and Effect Analysis (FMEA), Criticality analysis, Layer of Protection Analysis (LOPA), Safety Integrity Level (SIL), Principles and applications of computer aided risk analysis software, Introduction to PHAST, SAFETI, EFFECTS, HAZAN and FETI software tools, Applications of modelling and simulation in industrial safety analysis.

Unit–III

Risk Control, Human Factors and Safety Engineering: Risk control and mitigation strategies, Property damage and loss estimation, Human reliability and behavioural safety, Man-machine systems, Job and personal risk factors, Safety standards and guidelines, Selection and training of personnel, Ergonomics and workplace design, Anthropometric considerations, Body posture and body dimension analysis, Adjustment range and posture evaluation, Methods for reducing posture strain, Human-machine interface design, Types of controls and displays, Control-display compatibility, Fatigue, stress and vigilance, Performance enhancement strategies, Occupational health and industrial hygiene practices.

Unit–IV

Accident Analysis, Stochastic Modelling and Advanced Applications: Accident and incident investigation techniques, Collection and analysis of accident data, Legal requirements for accident reporting, Statistical analysis of safety data, Computer applications in accident analysis and prediction, Fire growth and stochastic risk models, Response surface methods, Estimation of untenable conditions during fire, Carbon monoxide exposure and COHb analysis, Reliability index calculations, Emergency planning and disaster management, Risk communication and safety reporting, Applications of artificial intelligence and machine learning in safety engineering, Cyber safety in industrial systems, Case studies of industrial disasters and lessons learned, Recent trends in computer aided risk analysis and safety management systems.

Suggested Readings:

- Guidelines for Hazard Evaluation Procedures by AIChE/CCPS, Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York
- Guidelines for Chemical Process Quantitative Risk Analysis by AIChE/CCPS, Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York
- Loss Prevention in the Process Industries by F. P. Lees, Butterworths, London
- Accident Prevention Manual for Business and Industry, Vol. I by National Safety Council, USA
- Process Safety Analysis – An Introduction by Bob Skelton, Gulf Publishing Company, Houston, Texas
- Safety Analysis: Principles and Practices in Occupational Safety by Lars Harms-Ringdahl, CRC Press
- Safety at Work by John Channing, Routledge Taylor & Francis Group, London and New York
- Risk Analysis in Building Fire Safety Engineering by A. M. Hasofer, V. R. Beck and I. D. Bennetts, Elsevier
- Practical Hazops, Trips and Alarms by David Macdonald, Elsevier

Course Code	**OEC-08A**				
Category	Open Elective Courses				
Course Title	**Health, Safety and Environment**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to the fundamentals of health, safety and environmental management in industrial and engineering workplaces. • To develop understanding of industrial hazards, risk assessment methods and safety management practices for accident prevention. • To familiarize students with environmental protection measures, pollution control techniques and sustainable development practices. • To provide knowledge of occupational health regulations, safety standards and modern HSE management systems used in industries.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the terminology related to health, safety, environment, risk management, and HSE regulations.	Level 1: Remember
CO2	Explain the principles of occupational health, industrial safety, environmental protection, and HSE management systems.	Level 2: Understand
CO3	Apply HSE principles, risk management techniques, and safety regulations to industrial workplaces.	Level 3: Apply
CO4	Analyze workplace hazards, environmental impacts, and HSE management practices to recommend appropriate control measures.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Health, Safety and Environment: Introduction to health, safety and environment, Importance of HSE in engineering industries, Concepts of hazard, risk, accident and incident, Safety terminology and principles, Occupational health and hygiene, Industrial health hazards, Physical, chemical, biological and ergonomic hazards, Occupational diseases and prevention methods, Safety signs and symbols, Personal protective equipment (PPE), Safety culture and safety management systems, Roles and responsibilities of employees and employers, Accident causation theories, Accident investigation and reporting techniques.

Unit-II

Industrial Safety and Risk Management: Principles of industrial safety, Hazard identification and risk assessment techniques, Job safety analysis, Permit to work system, Machine safety and guarding, Electrical safety, Fire hazards and fire prevention methods, Fire detection and suppression systems, Material handling safety, Construction safety, Confined space safety, Work at height safety, Safety in welding and cutting operations, Chemical handling and storage safety, Emergency preparedness and response planning, Industrial disaster management, First aid and basic life support.

Unit-III

Environmental Protection and Sustainability: Introduction to environmental science and ecology, Environmental pollution and its types, Air pollution, Water pollution, Soil pollution, Noise pollution and thermal pollution, Sources, effects and control measures of pollution, Solid waste management, Hazardous waste management, Biomedical and e-waste management, Environmental impact assessment (EIA), Environmental legislation and standards, Sustainable development, Green technologies, Renewable energy resources, Climate change and global warming, Carbon footprint and energy conservation, Environmental monitoring and auditing.

Unit-IV

Occupational Health, Safety Regulations and Management Practices: Occupational health and safety management systems, Safety audits and inspections, Safety training and awareness programs, Industrial laws and regulations related to health, safety and environment, Factories Act, Environmental Protection Act, Occupational safety standards, ISO 14001 and ISO 45001, Ergonomics and workplace design, Stress management and mental health at workplace, Human factors in industrial safety, Emergency evacuation procedures, Disaster management planning, Public health and community safety, Corporate social responsibility in HSE, Recent trends in industrial health, safety and environmental management.

Suggested Readings:

- Industrial Safety Management by L. M. Deshmukh, Tata McGraw Hill Publishing Company
- Safety Engineering by Dr. D. Udayakumar and Dr. P. Kalyanasundaram, Scitech Publications
- Environmental Engineering by Peavy, Rowe and Tchobanoglous, Tata McGraw Hill
- Occupational Health and Safety Management by Charles D. Reese, CRC Press India
- Health, Safety and Environment Management by R. K. Jain and Sunil S. Rao, Khanna Publishers
- Industrial Safety, Health and Environment Management Systems by R. K. Jain and Sunil S. Rao, Khanna Publishers, New Delhi
- Fundamentals of Environmental Engineering by D. D. Mishra, S. Chand & Company
- Environmental Pollution and Control Engineering by C. S. Rao, New Age International Publishers
- Industrial Safety and Environment by Amit Gupta, University Science Press
- Safety, Health and Environment by Satish Tiwari, Oxford University Press India
- Handbook of Occupational Safety, Health and Environment by K. V. S. Murali Krishna, Universities Press
- Environmental Studies by Benny Joseph, Tata McGraw Hill Education
- Industrial Health and Safety Management by M. P. Poonia and S. C. Sharma, Khanna Publishers
- Fire Prevention and Industrial Safety by R. P. Khandpur, Khanna Publishers
- Safety Management in Industry by N. V. Krishnan, Jaico Publishing House

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA (JHAJJAR)
An Autonomous Institute

'A' GRADE ACCREDITED BY NAAC

Scheme of Studies and Examinations

(Under NEP-2020)

B-SCHEME

Common for B.Tech (Fire Technology and Safety)
and
B.Tech (Fire Technology and Safety- Working Professionals)

Effective from

Academic Session 2026-27 (From 2nd Year onwards)

APPROVED BY AICTE, NEW DELHI AND AFFILIATED TO MDU, ROHTAK

1. DEFINITION OF CREDIT

1	1 Lecture (L) per week	1 Credit
2	1 Tutorial (T) per week	1 Credit
3	1 Practical (P) per week	0.5 Credit
4	2 Practical (Lab) per week	1 Credit

2. RANGE OF CREDIT

A range of credits from 160 to 170 for a student to be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 18-20 credits. These could be acquired through MOOCs.

3. STRUCTURE OF UNDERGRADUATE ENGINEERING PROGRAM (B.TECH)

Sr. No.	Category	Breakup of Credits
1	Basic Science Courses	21
2	Engineering Science Courses	21
3	Professional Core Courses	72
4	Professional Elective Courses (Relevant to chosen specialization/branch)	15
5	Indian Knowledge System	-
6	Open Electives Courses	9
7	Humanities and Social Sciences including Management courses	12
8	Project work, seminar and internship in industry or appropriate work place/ academic and research institutions in India/abroad	17
9	Value Added Courses	03
10	Mandatory Non Credit Courses – Audit Course	(Non-Credit)
	Total Credits	**170***

**Minor variation is allowed as per need of the programme.*

4. COURSE CODE AND DEFINITIONS

Sr. No.	Category	Course Code
1	Basic Science Courses	BSC
2	Engineering Science Courses	ESC
3	Professional Core Courses	PCC
4	Professional Elective Courses (Relevant to chosen specialization/branch)	PEC
5	Indian Knowledge System	IKS
6	Multidisciplinary Open Electives Courses	OEC
7	Humanities and Social Sciences including Management courses	HSMC
8	Laboratory Courses	LC
9	Mandatory Non-Credit Courses (Audit Course)	MC
10	Project	PR
11	Internship/ Practical Training/ Seminar	INT

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA, JHAJJAR (HR.)

Scheme of Studies and Examinations

Common for B.Tech (Fire Technology and Safety) – 3rd Semester

and

B.Tech (Fire Technology and Safety- Working Professionals) – 3rd Semester

w.e.f. 2026-27

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Schedule (Marks)				Exam Duration in H
				L	T	P			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	Basic Science Courses	BSC –FT-201B	Engineering Mathematics-III	3	1	0	4	4	40	60		100	3
2	Professional Core Courses	PCC-FT-203B	Fire Engineering	3	0	0	3	3	30	45		75	3
3	Professional Core Courses	PCC-FT-205B	First Aid and Paramedics	3	0	0	3	3	30	45		75	3
4	Professional Core Courses	PCC-FT-207B	Principles of Safety Management	3	0	0	3	3	30	45		75	3
5	Professional Core Courses	PCC-FT-209B	Fire Appliances and Rescue Equipments	3	0	0	3	3	30	45		75	3
6	Engineering Science Courses	ESC-ME-211B	Heat, Mass Transfer and Thermodynamics	3	0	0	3	3	30	45		75	3
7	Professional Core Courses	LC-PCC-FT-213B	Fire Engineering Lab	0	0	2	2	1	10		15	25	3
8	Professional Core Courses	LC-PCC-FT-215B	First Aid and Paramedics Lab	0	0	2	2	1	10		15	25	3
9	Engineering Science Courses	LC-ESC-FT-217B	Heat, Mass Transfer and Thermodynamics Lab	0	0	2	2	1	10		15	25	3
10	Professional Core Courses	LC-PCC-FT-219B	Fire Ground Operations-III	0	0	2	2	1	10		15	25	3
11	Mandatory Courses	MC-201B	Environmental Science	2	0	0	2	0	20		30	50*	3
							Total Credits	**23**				**575**	

Note:

I. MC-201B is a mandatory non–credit course in which students will be required to obtain passing marks in theory. The marks in this qualifying paper will not be included in determining the percentage of marks obtained for the award of degree. However, these marks will be shown in detailed marks certificate of student.

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA, JHAJJAR (HR.)

Scheme of Studies and Examinations

Common for B.Tech (Fire Technology and Safety) – 4th Semester

and

B.Tech (Fire Technology and Safety- Working Professionals) – 4th Semester

w.e.f. 2026-27

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Schedule (Marks)				Exam Duration in H
				L	T	P			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	Professional Core Courses	PCC-FT-202B	Structural Fire Engineering	3	0	0	3	3	30	45		75	3
2	Professional Core Courses	PCC-FT-204B	Fire Protection	3	0	0	3	3	30	45		75	3
3	Professional Core Courses	PCC-FT-206B	Fluid Mechanics and Fire Service Hydraulics	3	0	0	3	3	30	45		75	3
4	Professional Core Courses	PCC-FT-208B	Industrial Hygiene and Occupational Health	3	0	0	3	3	30	45		75	3
5	Professional Core Courses	PCC-FT-210B	Electric Fire Safety Practice and Standards	3	0	0	3	3	30	45		75	3
6	Professional Elective Courses	Refer Table-I	Professional Elective-I	3	0	0	3	3	30	45		75	3
7	Professional Core Courses	LC-PCC-FT-212B	Structural Fire Engineering Lab	0	0	2	2	1	10		15	25	3
8	Professional Core Courses	LC-PCC-FT-214B	Fire Protection Lab	0	0	2	2	1	10		15	25	3
9	Professional Core Courses	LC-PCC-FT-216B	Fire Service Hydraulics Lab	0	0	2	2	1	10		15	25	3
10	Professional Core Courses	LC-PCC-FT-218B	Industrial Hygiene and Occupational Health Lab	0	0	2	2	1	10		15	25	3
11	Professional Core Courses	LC-PCC-FT-220B	Fire Ground Operations-IV	0	0	2	2	1	10		15	25	3
Total Credits								**23**				**575**	

Notes:

I. At the end of 4th semester each student has to undergo Practical Training based on Fire and Safety/ Fire and Safety Equipments Installation, Care and Maintenance/Fire and Safety Audits/Any Certificate Course related to Fire and Safety (Min Contact Hours must be 30 Hrs) of 4/6 weeks in Fire Service Department/Industry/ Multi-Speciality Hospital/Professional Organization/ Research Laboratory/ Training Centre/ Educational Institute/other building Occupancy having Fire Fighting Installations etc. and submit typed report along with a certificate from the organization & its evaluation shall be carried out in the 5th Semester.

II. **For Working Professionals:** Submit a Training/Project report of their work in their respective company/Organization for the period of summer training/industrial training for evaluation. The evaluation shall be carried out in the 5th Semester.

III. Choose any one from Professional Elective-I

IV. Students can take Massive Open Online Courses (MOOCs) approved by the concerned Chairperson Board of Studies (BoS). The doubt classes will be conducted of 1 hour per week. The students may opt for examinations from the Institute or from the concerned portal.

Table 1 Professional Elective – I

Sr. No.	Code	Subject
1	PEC-FT-222B	Industrial Psychology
2	PEC-FT-224B	Chemical Process Safety
3	PEC-FT-226B	Environmental Engineering and Management
4	PEC-FT-228B	Special Fire Hazards
5	----------	Any one MOOCS/Swayam Course

Course code	**BSC-FT-201B**				
Category	Basics Science Courses				
Course title	**Engineering Mathematics-III**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	1	0	**4**	
Course Objectives	The objectives of this course are • To develop the understanding of students regarding partial differential equations, numerical methods, transform calculus, and statistical techniques used in Fire Engineering analysis. • To familiarize the students with analytical and computational methods for solving differential equations, interpolation problems, numerical integration, and optimization models. • To make the students learn Laplace transform techniques, hypothesis testing procedures, and linear programming methods for mathematical problem solving. • To make the students familiar with the application of mathematical tools and numerical techniques in Fire Engineering and scientific computations.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the concepts related to partial differential equations, numerical methods, Laplace transforms, linear programming, and statistical testing techniques.	Level 1: Remember
CO2	Explain the methods of solving partial differential equations, interpolation problems, numerical integration techniques, Laplace transform problems, and hypothesis testing procedures.	Level 2: Understand
CO3	Solve engineering and scientific problems using partial differential equations, interpolation techniques, numerical integration methods, and numerical solution procedures.	Level 3: Apply
CO4	Apply Laplace transform methods, linear programming techniques, and statistical testing procedures for solving engineering optimization and data analysis problems.	Level 3: Apply

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Partial Differential Equations: First order linear partial differential equations, First order non-linear partial differential equations, Charpit's method, Second order linear partial differential equations and their classifications, Method of separation of variables and its applications to wave equation, One dimensional heat equations and two dimensional heat flow (steady state solutions only)

Unit-II

Numerical Methods: Solution of polynomial and transcendental equations – Bisection method, Regula-Falsi method and Newton-Raphson method, Interpolation using Newton's forward and backward difference formulae, Newton's divided difference and Lagrange's formulae, Numerical integration, Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.

Unit-III

Transform Calculus: Laplace Transforms and its Applications, Laplace transforms of elementary functions, properties of Laplace transforms, existence conditions, transforms of derivatives, transforms of integrals, Multiplication by t^n, Division by t, Evaluation of integrals by Laplace transforms, Laplace transform of unit step function, unit impulse function and periodic function, inverse transforms, convolution theorem, application to linear differential equations.

Unit-IV

Linear Programming: Linear programming problems formulation, solving linear programming problems using (i) Graphical method (ii) Simplex method (iii) Dual simplex method.

Testing of Hypothesis: Testing of hypothesis, Tests of significance for large samples, Student's t-distribution (applications only), Chi-square test of goodness of fit.

Suggested Readings:

- Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publishing Company Limited
- Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers
- Numerical Methods by P. Kandasamy, K. Thilagavathy, K. Gunavathi, S. Chand and Company
- Introductory Methods of Numerical Analysis by S. S. Sastry, PHI Learning.
- A Textbook of Engineering Mathematics by N. P. Bali and Manish Goyal, Laxmi Publications.

Useful Video Links:

Unit No.	Topic	Link	Source
Unit -I	One Dimensional Heat Equation	https://youtu.be/GmIcbqdvIgc?si=4XnsNAbmcXVgE5ur	**IIT Roorkee**
Unit-II	Solution by Separation of Variables	https://youtu.be/W3HXK1Xe4nc?si=aqwoXZcWjcdiWifm	**IIT Kharagpur**
	Bisection Method	https://youtu.be/3FhE9De2__o?si=LM8q56foPk4yBvDb	**IIT Madras**
	Newton-Raphson Method	https://www.youtube.com/watch?v=ZcbFQz_Kwog	**IIT Madras**
	Introduction to numerical differentiation interpolation formula	https://www.youtube.com/watch?v=bnUsBhPLekE	**IIT Roorkee**
	Divided Difference interpolation	https://www.youtube.com/watch?v=DnfC0IUmUe4	**IIT Roorkee**

Unit-III	Laplace Transform	https://www.youtube.com/watch?v=c9NibpoQjDk	**IIT Madras**
	Laplace Transform & its existence	https://www.youtube.com/watch?v=2LyY4t0Gfvs	**IIT Kharagpur**
	Properties of Laplace Transform-Part-1	https://www.youtube.com/watch?v=SN0dcSyoJIE	**IIT Madras**
	Properties of Laplace Transform-Part-2	https://www.youtube.com/watch?v=MV3a-sQqDRc	**IIT Madras**
	Convolution Theorem for Laplace Transfroms	https://www.youtube.com/watch?v=niOMKg9FMO8	**IIT Madras**
Unit-IV	Simplex Method	https://www.youtube.com/watch?v=RcPhmPhjMbc	**IIT Kharagpur**
	Testing of Hypothesis-Basic Concepts	https://www.youtube.com/watch?v=IEP3swFeauE	**IIT Kharagpur**
	Testing of Hypothesis-I	https://www.youtube.com/watch?v=14PQawp_rjk	**IIT Kharagpur**
	Chi-Square Distribution	https://www.youtube.com/watch?v=lQ1ec1nQvKM	**IIT Madras**

<table>
<tr><td>Course Code</td><td colspan="5">PCC-FT-203B</td></tr>
<tr><td>Category</td><td colspan="5">Professional Core Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Fire Engineering</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-III</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
To make the students learn the fundamentals of fire science, combustion behaviour, fire development mechanisms, and the effects of heat and smoke during fire incidents.
To familiarize the students with fire prevention principles, building fire safety requirements, structural fire protection measures, and fire safety standards used in different occupancies.
To develop the understanding of students regarding fire protection systems, fire detection and alarm systems, extinguishing agents, and inspection and maintenance practices for fire safety equipment.
To acquaint the students with industrial fire hazards, explosion phenomena, emergency response procedures, firefighting strategies, rescue operations, and recent developments in fire engineering.</td></tr>
<tr><td>Assessment</td><td colspan="5">30 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">45 Marks</td></tr>
<tr><td>Total</td><td colspan="5">75 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the key terminologies related to fire science, combustion, fire behaviour, fire prevention, fire protection systems, industrial fire hazards and emergency response practices.	Level 1: Remember
CO2	Explain the principles of combustion, fire development, smoke movement, building fire safety, fire protection systems and industrial firefighting practices.	Level 2: Understand
CO3	Apply fire prevention methods, fire safety standards, firefighting techniques, emergency response procedures and fire protection system practices for different fire scenarios.	Level 3: Apply
CO4	Analyze fire behaviour, industrial fire and explosion hazards, smoke movement, fire protection system performance and emergency management strategies for effective fire safety planning.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit–I

Fundamentals of Fire Science and Fire Behaviour: Introduction to fire engineering, Scope and importance of fire engineering, Introduction to NBC, NBCS, IS, NFPA and OISD fire safety standards, Fire, Fire triangle and fire tetrahedron, Classification of fires and combustible materials, Physical and chemical properties of fuels, Flash point, Fire point and Auto-ignition temperature, Fundamentals of combustion, Types of combustion, Ignition and ignition sources, Limits of flammability, Fire causation theories, Electrical fire hazards and electrical safety, Static electricity and lightning protection, Basic stoichiometry of combustion, Fire load and fire severity, Stages of fire development, Fire spread and fire behaviour, Smoke and products of combustion, Smoke production and movement, Smoke density and visibility, Toxicity of smoke and fire gases, Effects of heat and smoke on human body, Principles of fire extinguishment.

Unit–II

Fire Prevention and Building Fire Safety: Principles of fire prevention, Fire hazards and fire risk assessment, Fire safety practices and housekeeping, Electrical fire hazards and electrical safety, Static electricity and lightning protection, Storage and handling of flammable and combustible materials, Classification of buildings based on occupancy as per NBCS, Fire prevention in various occupancies, Fire resistant construction and structural fire protection, Compartmentation and fire barriers, Fire doors and dampers, Means of egress and evacuation requirements, Exit systems, Staircases and refuge areas, Smoke control and pressurization systems, Fire safety audit and inspection procedures.

Unit–III

Fire Protection Systems and Equipment: Active and passive fire protection systems, Water as extinguishing agent, Fire water supply systems, Fire hydrant systems, Hose reels and hose cabinets, Fire pumps, Portable fire extinguishers and extinguishing agents, Foam fire protection systems, Dry chemical powde r systems, CO_2 and clean agent systems, Automatic sprinkler systems, Water spray and deluge systems, Fire detection and alarm systems, Smoke, Heat and Flame detectors, Conventional and addressable fire alarm systems, Public address and emergency communication systems, Selection, Installation, Inspection, testing and maintenance of fire protection systems.

Unit–IV

Industrial Fire Safety and Emergency Response: Industrial fire hazards and process fire safety, Fire and explosion hazards in industries, BLEVE, UVCE and dust explosions, Fire safety in oil and gas Industries, Chemical and petrochemical industries, Power plants and warehouses, Fire safety in storage tanks and pipelines, Grounding and bonding, Incident Command System (ICS), Firefighting organization and strategy, Breathing apparatus and personal protective equipment, Rescue and evacuation techniques,Ventilation, Salvage operation, Ropes, Lines, Ladders, Emergency response planning and disaster management, Post-Fire investigation and reporting, Case studies of major industrial fires and explosions, Recent developments in fire engineering and smart fire safety systems.

Suggested Readings:

- Manual of Firemanship by HMSO
- Fire Safety in Buildings by V K Jain, New Age publishers, New Delhi
- Principles of Fire Safety Engineering by A. K. Das, PHI Publishers.
- Fundamentals of Fire Safety in Building Design by Dr. Than Singh Sharma, Aayush Publications, New Delhi
- Handbook of Fire Technology by R.S.Gupta, Orient Longman Pvt. Ltd., Kolkata
- Manual of Fire Safety by N. Sesha Prakash, CBS Publishers & Distributors Pvt. Ltd.
- National Building Code (NBC) Part-4 Life and Safety (2016- Edition)- Bureau of Indian Standards
- National Building Construction Standards-2026, Part F, Bureau of Indian Standards

- Fire Protection and Prevention: The Essential Handbook by Barendra Mohan Sen, UBS Publishers and Distributors, New Delhi

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Basics of Fire-Part 1	https://youtu.be/eLeZ2zc2hgI?si=VeWVsuhIkwRf-XYd	NPTEL (IIT Madras)
	Basics of Fire-Part 2	https://youtu.be/NzIbiOAJONc?si=7H_mIiQm18vvULrd	NPTEL (IIT Madras)
	Combustion	https://youtu.be/n6HAyxdup_U?si=IMSS2Ye7w01SQQNz	NPTEL (IIT Delhi)
Unit-II	Emergency Scene Management (ESM)	https://youtu.be/uibCRbELVbA?si=z9JrmlCfMjKvDR4g	NPTEL (IIT Kanpur)
	Safety practices for Fire protection	https://youtu.be/-XRu7BSouvY?si=ogFdjHXtUbAbHWly	NPTEL (IIT Madras)
Unit-III	Fire safety: Internal planning, Detection and Suppression	https://youtu.be/e3Orj5XDj2M?si=YghWp5QRE9ECcIKA	NPTEL (IIT Delhi)
	Sprinklers I	https://youtu.be/ZKsqIPM810M?si=5uIMn1w6so-tb7oU	NPTEL (IIT Roorkee)
	Sprinklers II	https://youtu.be/Z82ypLX2gn8?si=bdPqswwPWQ-DB613	NPTEL (IIT Roorkee)
Unit-IV	Fire Safety: Escape and Refuge	https://youtu.be/O6CYQt9vi_Y?si=D-3_DCTnQ3fF6Bxm	NPTEL (IIT Delhi)
	Ventilation	https://youtu.be/K58rDFPGJO0?si=b4r8Lxa3UgPiMnNZ	NPTEL (IIT Delhi)

Course Code	**PCC-FT-205B**				
Category	Professional Core Courses				
Course Title	**First Aid and Paramedics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● To make the students familiar with the fundamentals of first aid, emergency care procedures, cardiopulmonary resuscitation, and basic life support techniques. ● To develop the understanding of students regarding the structure and functions of the human body, types of wounds and injuries, and appropriate first aid management methods. ● To familiarize the students with medical emergencies, environmental injuries, poisoning, bites, burns, and emergency response procedures for different casualty conditions. ● To make the students learn casualty handling methods, ambulance services, accident management procedures, rescue techniques, and disaster response practices.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

Cos	Skills Demonstrated	RBT Level
CO1	Define the terms related to first aid, emergency care, human body systems, wounds, injuries, medical emergencies, casualty handling, accidents and disaster management.	Level 1: Remember
CO2	Explain the concepts of first aid and emergency, human body, injury and wound management, fracture care, medical conditions, causality handling and accidents management.	Level 2: Understand
CO3	Apply first aid and other techniques for managing injuries, wound and medical emergencies, causalities and accidents.	Level 3: Apply
CO4	Analyze emergency situations, injury conditions, accident scenarios, and medical cases to determine appropriate first aid measures, rescue procedures and emergency response actions.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of First Aid and Emergency Care: Introduction to first aid, Principles of first aid, Role and responsibilities of first aider, General rules of first aid, Sequence of actions at emergency scene, First Aid kit and its contents, Vital signs- A, B, C (Airway, Breathing and Circulation) and patient assessment,

Cardiopulmonary Resuscitation (CPR), Artificial respiration, Recovery position, Emergency action procedures, Basic Life Support (BLS), Transportation of casualties, Training and ethics in first aid.

Unit-II

Human Body: Study of the human body and its various systems such as musculoskeletal system, Respiratory system, Circulatory system, Digestive system, Central nervous system etc.
Wounds: Wound, Types, Management, Bleeding and its types, Control of bleeding.
Injuries: Injuries, First Aid for various injuries, Soft tissue injuries, Head injuries, Chest injuries, Eye injuries and blindness, Burn and its types, Rule of Nine, Electrical injuries, Fractures and Dislocations, Sprains and Strains, Bandages and Slings, Immobilization techniques.

Unit-III

Medical Emergencies and Environmental Injuries: Heart attack and Angina, Stroke and Hypertension, Diabetes mellitus, Hyperglycemia and Hypoglycemia, Seizures and Epilepsy, Fever and Meningitis, Fainting and Shock, Allergy and Anaphylaxis, Headache and Migraine, Earache and Toothache, Abdominal pain, Vomiting and Diarrhea, Poisoning and Toxic Exposure, Snake bite, Dog bite and Insect bite, Drowning and Choking, Unconsciousness, Frostbite and Heat stroke, Childbirth emergencies, Protection of body from extreme weather conditions.

Unit-IV

Casualty Handling and Ambulance Services: Handling and transportation of casualties, Lifting techniques and rescue methods, Stretchers and their types, Ambulance services and patient transportation, Minor illness management**.**
Accident Management: Accidents and their types, Accident reporting and record keeping, Accident investigation procedures, Medical history assessment, Observation of signs and symptoms, Preparation of diagnosis reports, Duties and responsibilities of paramedics, Communication during emergencies, Disaster and mass casualty management, Safety precautions during rescue operations.

Suggested Readings:

- Manual of first aid to the injured by St. John Ambulance Association.
- First aid text book by American National Red Cross
- Manual of First aid instruction by US Bureau of Mines
- Accident First Aid by V.V. Yudenich, Mir Publishers, Moscow

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Basic Life Support (BLS)- Part 1 by NPTEL	https://www.youtube.com/watch?v=LAJJDH5ol4M	NPTEL (IIT Madras)
	Basic Life Support (BLS) - Part 2 by NPTEL	https://www.youtube.com/watch?v=kYZvMk88zx4	NPTEL (IIT Madras)
	CPR	https://www.youtube.com/watch?app=desktop&v=BQNNOh8c8ks	St. John Ambulance
Unit-II	Circulatory System	https://www.youtube.com/watch?v=b0bOclBpyME	NPTEL (IIT Guwahati)
	Muscular System	https://www.youtube.com/watch?v=ijiEeazaotE	NPTEL (IIT Guwahati)
	Respiratory System	https://www.youtube.com/watch?v=974jAldy8JY&t=5s	SWAYAM (IIT Madras)

	Head Injury	https://www.youtube.com/watch?v=a4cIFZx1f2E	St. John Ambulance
Unit-III	Stroke- Signs & Symptoms	https://www.youtube.com/watch?v=PhH9a0kIwmk	St. John Ambulance
	Diabetic Emergency	https://www.youtube.com/watch?v=L06DNMRcy98&t=144s	St. John Ambulance
Unit-IV	How to Treat a Fracture & Fracture Types	https://www.youtube.com/watch?v=2v8vlXgGXwE	St. John Ambulance
	Accident Investigation, Reporting	https://www.youtube.com/watch?v=VhuZ6M7a8N8	NPTEL (IIT Kharagpur)

Course Code	**PCC-FT-207B**				
Category	Professional Core Courses				
Course Title	**Principles of Safety Management**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to the fundamentals of safety management, accident prevention principles and industrial safety practices. • To develop understanding of hazard identification, risk assessment and hazard control techniques used in industries. • To familiarize students with safety training methods, accident investigation procedures and occupational safety management systems. • To provide knowledge of safety auditing, performance evaluation techniques and industrial safety compliance practices.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe safety management, hazards, risks, accidents, safety culture, training, PPEs, safety audits and industrial safety practices.	Level 1: Remember
CO2	Explain hazard identification methods, risk assessment techniques, safety training procedures, accident investigation methods and safety management systems used in industries.	Level 2: Understand
CO3	Apply hazard control measures, permit to work systems, safety training techniques, safety auditing procedures and performance evaluation techniques for industrial safety management.	Level 3: Apply
CO4	Analyze safety performance indicators, human factors, accident causes, audit findings and compliance practices for improvement of industrial safety management systems.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Safety Management: Introduction to safety and safety management, Integration of health safety and environment, safety and productivity, points for consideration of safety, general instructions for safety, objectives and principles of safety management, concepts of hazard, risk and accident, accident causation theories, accident prevention principles, direct and indirect cost of accidents, introduction to PPEs, safety culture and safety climate, roles and responsibilities of management, supervisors, workers and safety professionals in industrial safety management.

Unit-II

Hazard Identification and Risk Control: Hazard Identification and Risk Assessment (HIRA), Job Safety Analysis (JSA), risk assessment techniques, hierarchy of hazard control measures, permit to work systems, contractor safety management, safety in plant operation and maintenance, behaviour-based safety, safety communication and reporting systems, emergency preparedness and response planning.

Unit-III

Safety Training, Investigation and Safety Management Systems: Safety education and training, Elements of training cycle, objectives and methods of safety training, behaviour-oriented training techniques, Safety communication and awareness, causes of preventable injuries, safety awareness programs, accident and incident investigation procedures, root cause analysis, reporting and documentation systems, safety committees and their functions, elements of Safety Management Systems (SMS), overview of ISO 45001 occupational health and safety management systems.

Unit-IV

Safety Auditing and Performance Evaluation: Safety audits and inspection systems, types and procedures of safety audits, responsibilities of audit team, safety surveys and safety observation techniques, safety performance measurement and indicators, frequency rate, severity rate, incidence rate and Safe-T-Score, safety benchmarking and continuous improvement, principles of safety in design and engineered safety, human factors in safety, safety legislation overview and industrial safety compliance practices.

Suggested Readings

- Fundamentals of Industrial Safety & Health by K.U. Mistry, Siddharth Prakashan.
- Industrial Safety Health and Environment management Systems by Jain and Rao, Khanna Publishers
- Safety Management by R.K. Mishra- AITBS Publishers.
- Safety Management in Industry by N.V. Krishnan, Jaico Publishing House, 1997
- Industrial Safety by Ronald P. Blake, Prentice Hall, New Delhi, 1973
- Occupational Safety and Health by David L. Goetsch, Prentice Hall
- Modern Accident Investigation and Analysis by Ted S. Ferry, John Wiley & Sons

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Accident, Accident Investigation	https://youtu.be/VhuZ6M7a8N8?si=AJ0gXnTGKOd9KPFK	NPTEL (IIT Kharagpur)
	Safety Engineering & Accident causing mechanisms	https://youtu.be/91YpCY-1Fy0?si=4L5f1y_NiOLGSm-4	NPTEL (IIT Kharagpur)
	Personal Protective Equipment	https://youtu.be/eLnv6Eb2Pq0?si=cbAkgLUqZ9QEJoWQ	NEPTEL (IIT Delhi)
	Safety Committee Meeting	https://youtu.be/N12BEnI1hCY?si=TdR-4HO58IZsM5mp	NPTEL- IITC
Unit-III	Safety Education	https://youtu.be/v-eltsixu4I?si=2T9UetPJdllhk7YN	NPTEL (IIT Kharagpur)
Unit-IV	Safety Audit	https://youtu.be/HuYIDi0QQm8?si=y_vJEkJHAVaP81WS	NPTEL (IIT Kharagpur)
	Safety Performance Indicators	https://youtu.be/NI89F0ISMog?si=sxTayTaCNV23t7a1	NPTEL (IIT Kharagpur)

Course Code	**PCC-FT-209B**				
Category	Professional Core Courses				
Course Title	**Fire Appliances and Rescue Equipments**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To make the students familiar with different types of fire appliances, firefighting vehicles, fire pumps and associated operational systems used in fire services. • To develop the understanding of students regarding firefighting equipment, rescue tools, ladders, ropes and operational safety procedures used during emergency response. • To familiarize the students with rescue operations, casualty handling methods, incident command systems and personal protective equipment used in fire and rescue services. • To make the students learn about specialized rescue systems, modern firefighting technologies and advanced emergency response equipment used in contemporary fire services.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the terminology related to fire appliances, rescue equipment, personal protective equipment and modern firefighting technologies.	Level 1: Remember
CO2	Explain the principles, functions, and operational features of fire appliances, rescue equipment, personal protective equipment and modern firefighting technologies.	Level 2: Understand
CO3	Apply fire appliances, rescue equipment, personal protective equipment and rescue techniques in emergency response operations.	Level 3: Apply
CO4	Analyze the suitability and performance of fire appliances, rescue systems and modern firefighting technologies for different emergency scenarios.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fire Appliances and Firefighting Vehicles: Introduction to fire appliances, Classification of fire appliances, Functional requirements of fire appliances, Fire tender chassis and vehicle design, Water tender, Foam tender, Multipurpose tender, Crash fire tender, Rescue tender, Hose laying tender and control van, Fire pumps and

priming systems, Midship and PTO pump configurations, Hose reels and hose management systems, Water and foam monitors, Vehicle stability and load distribution, Technical specifications of fire appliances, Preventive maintenance and inspection procedures.

Unit-II

Firefighting Equipment and Rescue Tools: Portable fire extinguishers and their applications, Hydraulic rescue equipment, Hydraulic cutters, Spreaders, Rams and combi tools, Pneumatic rescue equipment, Air lifting bags and jacks, Electric power tools, Electric cutters, Electric saws and chain saws, Portable lighting systems and power sources, Ladders and ladder appliances, Extension ladders, Hook ladders, Turntable ladders and snorkels, Ropes and lines used in fire services, Knots, Hitches and their applications, Testing and safety procedures of rescue equipment.

Unit-III

Rescue Operations: Principles of rescue operations, Search and rescue techniques, Rescue planning and operational safety, Casualty handling methods, One rescuer and two rescuer techniques, Multi rescuer techniques, Stretchers and casualty transportation methods, Rescue from fire incidents and high-rise buildings, Rescue during earthquakes, Floods and other disasters, Incident command system (ICS) in rescue operations,

Personal Protective Equipments: Personal protective equipment (PPE), Safety belts and harnesses, Breathing apparatus and associated equipment, Oxygen breathing apparatus, Compressed air breathing apparatus, BA control systems and cylinder management, Gas masks and respirators, Airline and filter type respirators.

Unit-IV

Specialized Rescue Systems and Modern Firefighting Technologies: SCUBA and water rescue equipment, HAZMAT rescue equipment, Emergency rescue tender (ERT), HAZMAT van and decontamination systems, Robotics in firefighting and rescue operations, Drones in fire and rescue services, Thermal imaging systems, Ultra high pressure systems (UHPS), Compressed air foam systems (CAFS), Communication and monitoring systems in emergency response, Smart fire appliances and sensor networks, Artificial intelligence in fire and rescue operations, Recent developments in firefighting and rescue technologies.

Suggested Readings:

- Fire Safety in Buildings by V.K. Jain, New Age International Publishers
- Safety Management by R.K. Mishra, AITBS Publishers
- Manual of Fire Safety by N Sesha Prakash, CBS Publishers and Distributors
- Fire Protection and Prevention: The Essential Handbook Volume 1 & 2 by B.M. Sen, UBS Publishers
- NFPA Manual
- National Building Construction Standard by Bureau of Indian Standards, New Delhi
- Related IS Codes and Standards

<table>
<tr><td>Course Code</td><td colspan="5">ESC-ME-211B</td></tr>
<tr><td>Category</td><td colspan="5">Engineering Science Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Heat, Mass Transfer and Thermodynamics</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-III</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
● To make the students familiar with the fundamental concepts of thermodynamics and their applications in fire and safety engineering.
● To develop the understanding of students regarding heat transfer mechanisms and their role in fire behavior, thermal insulation and industrial safety applications.
● To familiarize the students with mass transfer, combustion processes, flame characteristics and products of combustion relevant to fire dynamics.
● To make the students learn about explosion phenomena, industrial fire hazards, emergency planning and fire safety practices involving hazardous materials and explosives.</td></tr>
<tr><td>Assessment</td><td colspan="5">30 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">45 Marks</td></tr>
<tr><td>Total</td><td colspan="5">75 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the technical terms of thermal engineering related to fire and safety engineering.	Level 1: Remember
CO2	Explain the fundamental concepts of thermodynamics, heat and mass transfer, and their influence on fire development, flame behavior, combustion, explosion and fire effluents in engineering systems.	Level 2: Understand
CO3	Apply the principles of thermodynamics, heat transfer, combustion, and explosion safety to solve problems in industrial fire safety.	Level 3: Apply
CO4	Analyze fire and explosion hazards, combustion characteristics, thermal behavior of materials, and industrial fire safety measures to evaluate risk control strategies.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Thermodynamics: Basic concepts of thermodynamics, System, Surrounding and boundaries, Types of thermodynamic systems, Thermodynamic properties, State and process, Cyclic process, Reversible and irreversible processes, Work and Heat, Ideal Gas Laws, Equation of state, Specific seat, Zeroth Law of thermodynamics, First Law of thermodynamics, Steady flow energy equation, Enthalpy, Applications of thermodynamics in fire and safety engineering.

Unit-II

Heat Transfer Fundamentals: Introduction to heat transfer, Modes of heat transfer, Thermal conductivity, Heat conduction through plane walls and cylinders, Composite walls, Convection heat transfer, Natural and Forced convection, Radiation heat transfer, Black body and Grey body radiation, Stefan–Boltzmann Law, Heat transfer in fire situations, Thermal insulation and Fire resistant materials, Heat transfer applications in industrial safety.

Unit–III

Mass Transfer and Combustion: Introduction to mass transfer, Diffusion and mass flux, Fick's Law of diffusion, Convective mass transfer, Heat and mass transfer analogy, Fundamentals of combustion, Types of combustion, Combustion of solid, liquid and gaseous fuels, Complete and Incomplete combustion, Stoichiometric combustion, Products of combustion, Smoke and fire effluents, Fire behavior and flame characteristics.

Unit-IV

Explosion and Industrial Fire Safety Applications: Explosion fundamentals, Types of explosions, Fire and explosion hazards in industries, Flammable liquid storage hazards, Major Accident Hazard (MAH) Control, On-Site and Off-Site emergency planning, Petroleum and Explosives Safety Organization (PESO), Fire and explosion prevention measures, Industrial fire safety applications.

Fires Involving Explosives: Introduction, Industrial processes and hazards of explosives, Explosives and fireworks manufacture and filling, Explosive storage, Explosive transport, Causes of fire and methods of protection, Fire extinguishing ball, Jet fire, Pool fire, Boilover, Fire fighting involving explosives in transit, Match manufacture and storage, Material used, Process, Causes of fire and protective measures, Fire fighting.

Suggested Readings:

- Heat and Mass Transfer -3rd edition by PK Nag 2007 Tata McGraw Hill
- Heat and Mass Transfer – revised edition by RK Rajput . S. Chand Publication.
- Heat & Mass transfer 4rd edition by 2014 Yunus A- Cengel Tata McGraw Hill
- Principles of heat transfer by Kreith Thomas Learning 2001
- Fundamental of Heat and Mass Transfer by M. Thirumaleshwar. Pearson.
- Fundamental of Heat and Mass Transfer- 4th edition by C.P.Kothandaraman

Useful Video Links:

Unit No.	Topic	Link	Source
Unit-II	Heat Transfer	https://youtu.be/6Zpf3YpkNCM?si=WhLLog7VWHqqB9q8	NPTEL (IIT Kharagpur)
	Conduction	https://youtu.be/hZBpV_QVJ3Y?si=gkdZn4iSXVXpIvyk	NPTEL (IIT Kharagpur)
	Convection	https://youtu.be/zw884u2pWw0?si=UXn4GVnim-mBMULQ	NPTEL (IIT Kharagpur)

	Radiation	https://youtu.be/TIFGm-QusM4?si=gxeW7TYVqtnnCbHt	NPTEL (IIT Kharagpur)
Unit-III	Combustion	https://youtu.be/Fyq4Q5yWDDU?si=UiglMcNy2y8j5Pvz	NPTEL (IIT Madras)
	Stoichiometric combustion	https://youtu.be/yh1h23fbWtw?si=vxkNdc1J-4UlK5Kt	NPTEL (IIT Madras)
Unit-IV	Explosion	https://youtu.be/19IGLmowQuw?si=EaRFaaiJAikgqlCN	NPTEL (IIT Kharagpur)
	Classification of explosion	https://youtu.be/uwr9a98YJ64?si=xD9qtgX97NJzDtZf	NPTEL (IIT Madras)
	Explosives	https://youtu.be/1_3OOsnjWjo?si=IOwl5pmE7brHZYdr	NPTEL (IIT Kharagpur)
	Nature and properties of explosives	https://youtu.be/i7nE6Pl5uWU?si=cTmdJs1p8Wfc0DvV	NPTEL (IIT Kharagpur)
	Cause of fire and methods of protection	https://youtu.be/PJhjs3gtfEU?si=uBlsCxFZY9eeAlqz	NPTEL (IIT Madras)
	Fire Protection	https://youtu.be/n6HAyxdup_U?si=oxC3ENbX0qMw-Cex https://youtu.be/krnmHKZ87Wg?si=TUKEin4bND_zczdl	NPTEL (IIT Delhi)

Course Code	**LC-PCC-FT-213B**				
Category	Professional Core Courses				
Course Title	**Fire Engineering Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	**1**	
Course Objectives	The objectives of this course are: • To bridge theory and practice by giving students hands-on experience with real-world firefighting equipment, systems, and safety procedures. • To develop practical skills in identifying fire types, selecting appropriate extinguishing agents, and operating fire detection and suppression systems. • To foster critical awareness of fire hazards, structural fire safety, and compliance with national (NBCS) and international (NFPA) fire safety standards. • To prepare students for emergency scenarios by providing training to respond effectively using appropriate firefighting tools and decision-making strategies.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Explain the different types of fires, fire elements, extinguishing agents and their appropriate applications in real-life scenarios.	Level 2: Understand
CO2	Demonstrate the operation and usage of various fire detection, suppression, and firefighting systems including fire extinguishers, hose fittings, sprinkler systems and mobile equipments.	Level 3: Apply
CO3	Analyze the calorific values, flashpoint and fire point of the different fuels.	Level 4: Analyze
CO4	Evaluate structural integrity under fire conditions and interpreting building occupancies and combustion products as per national and international standards.	Level 5: Evaluate

List of Experiments

Sr. No.	**Contents**
1	To determine the flashpoint and fire point of different fuels using Pensky-Marten apparatus.
2	To study different types of fuels and their calorific values.
3	To study different types of fire and its elements.
4	To study different types of extinguishing media- water, foam, dry powder, ABC Powder, CO2, Halon.
5	To study of Modular Automatic Fire Extinguishers, Trolley Mounted fire extinguishers.
6	To study the different causes and phases of fire.
7	To study the fire detection systems.
8	To study the basic fire protection equipments.

9	To study the Mobile firefighting equipments
10	To study different types of sprinkler systems
11	To study the products of combustion.
12	To study different types of occupancies as per National Building Construction Standards (Latest Edition).
13	To study structural integrity under fire using standard methods of NFPA.
14	To study different types of hose fittings and their application.

At least 10 experiments to be studied/performed from the above list and other experiments can be studied/performed depending upon the scope of course as decided by the department.

Course Code	**LC-PCC-FT-215B**				
Category	Professional Core Course				
Course Title	**First Aid and Paramedics Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	**1**	
Course Objectives	The objectives of this course are: • To familiarize students with first aid kits, emergency equipment and basic medical response procedures. • To develop understanding of major human body systems related to first aid and emergency care. • To train students in CPR, bandaging, slings and safe handling and transportation of victims. • To enable students to understand medical emergencies, accident investigation, reporting and record keeping procedures.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Explain the use of first aid equipment, major human body systems, and basic emergency care procedures.	Level 2: Understand
CO2	Demonstrate cardiopulmonary resuscitation (CPR), bandaging, slings, and victim dressing techniques.	Level 3: Apply
CO3	Perform casualty handling, stretcher operations, and victim transportation techniques in emergency situations.	Level 3: Apply
CO4	Analyze medical conditions, accident investigations, reporting procedures, and record keeping for effective emergency response.	Level 4: Analyze

List of Experiments

Sr. No.	**Contents**
1	To study the first aid kit.
2	To study different human systems: Respiratory, Circulation, Nervous, Digestive and Excretory systems.
3	To study and perform different techniques of Respiration (CPR).
4	To study various types of Bandages and Slings.
5	To perform the victim's dressing using various types of bandages by first aid responder.
6	To study maintenance of various charts related to casualties.
7	To study of stretchers and its types.
8	To perform and practice the different methods of handling and transportation of victims.
9	To study different types of medical conditions.
10	To study accidents, investigations, reporting and record keeping.

At least 8 experiments to be studied/performed from the above list and other experiments can be studied/performed depending upon the scope of course as decided by the department.

Course Code	**LC-ESC-FT-217B**				
Category	Engineering Science Courses				
Course Title	**Heat, Mass Transfer and Thermodynamics Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To develop understanding of thermodynamic principles, heat transfer mechanisms, and mass transfer phenomena relevant to industrial and fire safety engineering. • To provide practical knowledge of internal combustion engines, boilers, refrigeration systems, cooling towers, and thermal engineering equipment. • To analyze conduction, convection, radiation, combustion, and diffusion processes through experimental investigations. • To develop the ability to evaluate thermal system performance, energy balance, and industrial fire and explosion hazards using engineering principles and safety practices.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Explain the operating principles of thermodynamic systems, internal combustion engines, boilers, and industrial thermal systems.	Level 2: Understand
CO2	Determine the thermodynamic, heat transfer, and mass transfer characteristics of engineering systems through laboratory experiments.	Level 3: Apply
CO3	Investigate the combustion characteristics and energy performance of thermal systems through experimental studies.	Level 3: Apply
CO4	Analyze industrial fire and explosion hazards to recommend appropriate fire prevention and safety measures.	Level 4: Analyze

List of Experiments

Sr. No.	**Contents**
1	To study the basic thermodynamic properties and verify the ideal gas laws.
2	To determine the specific heat capacity of a given substance.
3	To verify the First Law of Thermodynamics using a steady flow process apparatus.
4	To study the working of 2-stroke petrol and diesel engine.
5	To study the working of 4-stroke petrol and diesel engine.
6	To study low and high pressure boilers and their accessories and mountings.
7	To prepare the heat balance sheet for an internal combustion engine.
8	To determine thermal conductivity of insulating and fire resistant materials.

9	To study heat conduction through composite walls and cylinders.
10	To analyze natural and forced convection heat transfer characteristics.
11	To study radiation heat transfer and verify Stefan–Boltzmann law.
12	To determine diffusion coefficient using Fick's law of diffusion experiment.
13	To study combustion characteristics of solid, liquid, and gaseous fuels under complete and incomplete combustion conditions.
14	To study different types of cooling towers and their industrial safety applications.
15	To study industrial fire and explosion hazards including pool fire, jet fire, boilover, and fire prevention measures.

At least 10 experiments to be studied/performed from the above list and other experiments can be studied/performed depending upon the scope of course as decided by the department.

Course Code	**LC-PCC-FT-219B**				
Category	Professional Core Courses				
Course Title	**Fire Ground Operations -III**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	1	
Course Objectives	The objective of this course are ● To provide foundational knowledge of various fire-fighting tools and equipment including hoses, extinguishers, ropes, and ladders. ● To train students in standard operational techniques such as hose drills, rope handling, extinguisher usage, and ladder operations under simulated conditions. ● To develop students' ability to inspect, test, and maintain the performance and safety of fire-fighting equipment as per standard protocols. ● To instill discipline, coordination, and response skills essential for effective participation in real-life fire emergency operations.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Explain the procedures for hose rolling techniques, rope types, and ladder configurations along with their operational relevance in fire safety.	Level 2: Understand
CO2	Work as an individual and in a group with the capacity to be a leader as well as an effective team member.	Level 3: Apply
CO3	Perform standard hose and extinguisher drills, ladder and rope tests, and demonstrate practical handling and maintenance of fire service equipment.	Level 3: Apply
CO4	Analyze the condition and performance of fire-fighting tools and equipment through standard testing methods and drills to ensure operational readiness.	Level 4: Analyze

List of Experiments

1	To study and perform extinguisher drills.
2	To study fire hose (Deliveryhose, Suction hose), Hose binding, Washing, Storage.
3	To study and perform rolling of hoses (Coil roll, Figure of 8 roll, Flaking roll, Dutch roll).
4	To perform different hose tests (Suction hose test, Delivery hose test, Hose reel hose test)
5	To perform the hose drill (Lifting, Lowering, Carrying, Laying, Connect, Disconnect, Remove the kink, Under running)
6	To study the rope construction and types of ropes (Natural rope (a. Italian hemp, b. Manila, c. Sisal, d. Coir, e. Cotton, f. Jute), Manmade rope (a. Synthetic, b. Nylon, c. Steel, d. Cara mandala))

7	To study and perform rolling of ropes.
8	To study and perform testing of ropes.

Other drills and tests can be performed as decided by department (time to time) depending upon the scope of course.

<table>
<tr><td>Course code</td><td colspan="5">MC-201B</td></tr>
<tr><td>Category</td><td colspan="5">Mandatory Courses</td></tr>
<tr><td>Course title</td><td colspan="5">Environmental Science</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-III/IV</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
To create awareness of the multidisciplinary nature and importance of environmental studies, including the sustainable management and conservation of natural resources.
To develop an understanding of ecosystem dynamics, biodiversity, pollution types, and their impacts on environmental and human health.
To foster critical thinking on social, ethical, and legislative aspects of environmental protection, emphasizing the role of individuals and society.
To engage students in practical learning through field work and case studies to apply environmental concepts for sustainable development and responsible citizenship.</td></tr>
<tr><td>Assessment</td><td colspan="5">20 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">30 Marks</td></tr>
<tr><td>Total</td><td colspan="5">50 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe key terminologies of environmental studies, natural resources, ecosystems, pollution, environmental laws and human-environment interactions.	Level 1: Remember
CO2	Explain the relationships among ecosystems, biodiversity, pollution, social issues, environmental ethics and related legislation for sustainable development.	Level 2: Understand
CO3	Apply principles of environmental management, pollution control, disaster management and sustainable practices in real world environmental contexts.	Level 3: Apply
CO4	Analyze environmental issues, population growth impacts, climate change, welfare programs and the role of information technology in promoting public health and environmental sustainability.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 4 parts (Covering all units) of 1.5 marks each and remaining eight questions of 6 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

The Multidisciplinary Nature of Environmental Studies: Definition, Scope and Importance.

Natural Resources: Renewable and Non-Renewable Resources; Natural Resources and Associated Problems.
(a) Forest Resources: Use and Over-Exploitation, Deforestation, Case Studies, Timber Extraction, Mining, Dams and their effects on Forests and Tribal People.
(b) Water Resources: Use and Over-Utilization of Surface and Groundwater, Floods, Drought, Conflicts Over Water, Dams—Benefits and Problems.
(c) Mineral Resources: Use and Exploitation, Environmental Effects of Extracting and Using Mineral Resources, Case Studies.
(d) Food Resources: World Food Problems, Changes caused by Agriculture and Overgrazing, Effects of Modern Agriculture, Fertilizer and Pesticide Problems, Waterlogging, Salinity, Case Studies.
(e) Energy Resources: Growing Energy Needs, Renewable and Non-Renewable Energy Sources, Use of Alternate Energy Sources, Case Studies.
(f) Land Resources: Land as a resource, Land Degradation, Man-Induced Landslides, Soil Erosion and Desertification.
Role of an Individual in Conservation of Natural Resources, Equitable Use of Resources for Sustainable Lifestyles.

Unit-II

Ecosystems: Producers, Consumers and Decomposers, Energy Flow in the Ecosystem, Ecological Succession, Food Chains, Food Webs and Ecological Pyramids Introduction, Types, Characteristic Features, Structure and Function of Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem and Aquatic Ecosystems (Ponds, Streams, Lakes, Rivers, Oceans and Estuaries).
Biodiversity and Its Conservation: Introduction, Definition, Genetic Diversity, Species Diversity and Ecosystem Diversity. Biodiversity at Global, National and Local Levels, India as a Mega-Diversity Nation, Hotspots of Biodiversity.
Values of Biodiversity: Consumptive Use, Productive Use, Social, Ethical, Aesthetic and Option Values.
Threats to Biodiversity: Habitat Loss, Poaching of Wildlife and Man–Wildlife Conflicts, Endangered and Endemic Species of India.
Conservation of Biodiversity: In-situ and Ex-situ Conservation.

Unit-III

Environmental Pollution: Definition, Causes, Effects and Control Measures of Air Pollution, Water Pollution, Soil Pollution, Marine Pollution, Noise Pollution, Thermal Pollution and Nuclear Hazards.
Solid Waste Management: Causes, Effects and Control Measures of Urban and Industrial Wastes, Role of an Individual in Prevention of Pollution, Pollution Case Studies.
Disaster Management: Floods, Earthquakes, Cyclones and Landslides.
Social Issues and the Environment: From Unsustainable to Sustainable Development, Urban Problems Related to Energy, Water Conservation, Rainwater Harvesting, Watershed Management, Resettlement and Rehabilitation of People, Problems and Concerns, Case Studies.
Environmental Ethics: Issues and Possible Solutions, Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust, Case Studies, Wasteland Reclamation, Consumerism and Waste Products.
Environmental Legislation: Environment Protection Act, Air Prevention and Control of Pollution Act, Water Prevention and Control of Pollution Act, Wildlife Protection Act, Forest Conservation Act, Issues Involved in Enforcement of Environmental Legislation, Public Awareness.

Unit-IV

Human Population and the Environment: Population Growth, Variation among Nations, Population Explosion, Family Welfare Programme, Environment and Human Health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and Human Health, Case Studies.

Field Work *(Equivalent to 10 Lecture Hours)*

- Visit to a Local Area to Document Environmental Assets —River, Forest, Grassland, Hill or Mountain.
- Visit to a Local Polluted Site—Urban, Rural, Industrial or Agricultural.
- Study of Common Plants, Insects and Birds.
- Study of Simple Ecosystems—Pond, River, Hills, Slopes, etc.

Suggested Readings:

- Environmental Biology by K.C. Agarwal, Nidi Pub. Ltd., Bikaner
- The Biodiversity of India by Bharucha, MAP in Publishing Pvt.Ltd., Ahmedabad.
- Hazardous Waste Incineration by R.C. Brunner, McGraw Hill Inc.,1989
- Environmental Chemistry by A.K. De, Wiley Eastern Ltd.
- Global Biodiversity Assessment by V.H. Heywood & R.T.Watson, Cambridge University Press, 1995, 1140p.
- Environmental Protection and Laws by H. Jadhav & V.M. Bhosale, Himalaya Pub. House, Delhi, 1995, 284p.
- Matter Hazardous by A.K. Mhaskar, Techno-Science Publications.
- Waste Water Treatment by M.N. Rao & A.K. Datta, Oxford & IBH Publ. Co. Pvt. Ltd., 1987, 345p.
- Environmental Chemistry by B.K. Sharma, Goel Publ. House, Meerut, 2001.
- Survey of the Environment, The Hindu.
- Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II by R.K. Trivedi, Enviro Media.
- Introduction to Air Pollution by R.K. Trivedi & P.K. Goel, Techno-Science Publications.
- Environmental Management by K.D. Wagner, W.B. Saunders Co., Philadelphia, USA, 1998, 499p.
- A Textbook of Environmental Education by Dr. J.P. Yadav, G.V.S. Publishers.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Environment Science: Introduction	https://www.youtube.com/watch?v=5QxxaVfgQ3k
	Natural Resources	https://www.youtube.com/watch?v=CXCT2R1K6Ts
	Ecosystem	https://www.youtube.com/watch?v=1dBU6HB8G6s
Unit-II	Biodiversity and its conservation	https://archive.nptel.ac.in/courses/102/104/102104068/
Unit-III	Sustainable Water Management In Urban Areas	http://digimat.in/nptel/courses/video/127106004/L29.ht
	Environmental Pollution	https://archive.nptel.ac.in/courses/123/105/123105001/
Unit-IV	Population and population growth	https://archive.nptel.ac.in/courses/102/104/102104068/
	National Family Welfare Programme	https://www.youtube.com/watch?v=X5F99L8ZEtc

Course Code	**PCC-FT-202B**				
Category	Professional Core Courses				
Course Title	**Structural Fire Engineering**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objective of this course are • To provide knowledge of building construction, fire safety requirements, and structural fire protection principles. • To develop understanding of fire-resistant construction, means of escape, fire detection systems, and passive fire protection measures in buildings. • To familiarize students with fire behaviour, fire load assessment, compartmentation, and fire safety design of building structures. • To create awareness about national and international standards related to fire safety in buildings and structural fire protection.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the buildings, construction, structural components, and fire safety terminology as per NBCS and IS standards.	Level 1: Remember
CO2	Explain the principles of fire development, building fire behavior, human response, fire detection systems, and compartmentation strategies in fire-safe design.	Level 2: Understand
CO3	Apply national codes and structural safety principles to assess exit planning, stair design, fire-resistant construction techniques, and fire safety systems for safe building designs.	Level 3 : Apply
CO4	Analyze building fire safety, fire severity and structural performance under fire conditions using fire resistance tests, design equations, and material behavior in elevated temperatures.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Building Fire Safety: Classification of building based on occupancy as per National Building Construction Standards (NBCS), Classification of types of construction according to fire resistance as per NBCS,General fire safety requirements applicable to all individual occupancies,fire zones as per NBCS, General exit requirements as per NBCS, Means of escape, Internal staircases, Horizontal exits, Fire tower, Ramps, Fire lifts, External fire escape ladders, Planning of location and calculation of capacity, Number and width of exit

as per NBCS for different types of occupancy, Sizes layout and various kinds of stairs in different kind of building, Egress and containment. Fire hazards in stilt parking, Basement parking and podium parking.

Unit-II

Building Materials: Introduction to the elements of structure, Study of different kinds of components of super-structures, Various common types of buildings with reference to relevant I.S. specifications, Different types of walls, Roofs and floors and their construction methods. Behaviour of elements of structure in a fire, Causes of wall collapse, Criteria for assessing the fire properties of building materials and elements of structure, Standards and guides for passive fire protection.

Unit-III

Fire Protection in Buildings: Fire safety in buildings, Process of fire development, Fire behaviour, Human behaviour, Fire detection and control system, Fire resistance, Fire design time, Fire load, and grading of occupancies by Fire load, Controlling fire spread, Compartmentation, Defend in place theory, Fire severity, Equivalent fire severity, Fire resistance test, Fire resistance of assemblies – Walls, Floors, Beams, Columns, Penetrations, joints, Fire doors, Ducts and glasses, Testing and inspection of fire doors, Firestop system, Material and fire dampers, Building construction for fire safety. Fire safety design of façade, Building integrated and building attached photovoltaic system.

Unit-IV

Structural Design: Design of structures exposed to fire - Structural design at normal temperatures, Loads, Structural design in fire conditions, Design equation, Loads for fire design, Structural analysis for fire design, Material properties in fire, Design of individual members exposed to fire, Design of structural assemblies exposed to fire, Structural Steel Fire Protection.

Concrete Structures: Behaviour of concrete structures in fire, Concrete materials in fire, Spalling of cover concrete, Concrete and steel reinforcing temperatures, Mechanical properties of concrete at elevated temperatures, Design of concrete members exposed to fire - Continuous slabs and beams, Axial restraint. International standards for structural fire protection.

Suggested Readings

- Fire Safety in Buildings by V K Jain, New Age publishers, New Delhi.
- National Building Construction Standards (NBCS)- Part-F (Latest Edition) Bureau Of Indian Standards
- Fundamentals of Fire Safety in Building Design by Dr. Than Singh Sharma, Aayush Publications, New Delhi
- Principles of Fire Safety Standards for Building Construction by M. Ya. Roytman, Amerind Publishing Co. Pvt. Ltd., New Delhi
- Structural Design For Fire Safety by Andrew H. Buchanan & Anthony K. Abu, John Wiley and Sons Ltd., New York, U.S.A.
- Relevant IS & NFPA codes
- Building materials and construction by B. C. Punmia, Laxmi Publications.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	General Exit Requirements as per NBC	https://www.youtube.com/watch?v=O6CYQt9vi_Y	NPTEL (IIT Delhi)
	Stairs, Sizes layout	https://www.youtube.com/watch?v=hxakW1miEcM	NPTEL (IIT Kharagpur)
Unit-II	Roofs and floors construction methods	https://www.youtube.com/watch?v=ptsDs8bcxTI	NPTEL (IIT Delhi)
	Building Construction, Components of Super Structure	https://www.youtube.com/watch?v=X9tNq4kRm9s	Unacademy
Unit-III	Fire detection and control system	https://www.youtube.com/watch?v=vNKXzw6GCHw	NPTEL (Madras)
	Building construction for fire safety	https://www.youtube.com/watch?v=Z15UfahUsG0&t=251s	NPTEL (IIT Delhi)
Unit-IV	Fire resistance	https://www.youtube.com/watch?v=SuepcXmNREU	NPTEL (IIT Delhi)
	Structural Steel Fire Protection	https://www.youtube.com/watch?v=uOegFI_jNEc&t=775s	NPTEL (IIT Delhi)

Course Code	**PCC-FT-204B**				
Category	Professional Core Courses				
Course Title	**Fire Protection**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To provide knowledge of the principles, components and operation of fire detection, alarm and notification systems used in fire protection engineering. • To develop understanding of water-based, water spray, water mist and foam fire suppression systems and their applications in different occupancies and hazards. • To familiarize students with gaseous, chemical and industrial fire protection systems, explosion protection methods and associated safety considerations. • To enable students to learn inspection, testing, maintenance and design considerations of various fire protection systems in accordance with standard engineering practices and codes.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the principles, components, and terminology of fire detection, alarm, and fire protection systems used in fire and safety engineering.	Level 1: Remember
CO2	Explain the working principles, design concepts, and applications of fire detection, water-based, foam, gaseous, and chemical fire protection systems.	Level 2: Understand
CO3	Apply the principles of fire detection and fire protection systems to select appropriate fire safety measures for buildings and industrial occupancies.	Level 3: Apply
CO4	Analyze the performance of fire protection systems and industrial fire and explosion hazards to recommend suitable fire protection strategies.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

UNIT – I

Fire Detection and Alarm Systems: Active and passive fire protection systems, Components of fire detection and alarm systems, heat, smoke, flame and gas detectors, VESDA systems, Notification appliances, Detector selection and spacing concepts, False alarm management, Interconnections and integration, Gas and

vapor detection systems, Electrochemical sensors, Inspection, Testing and maintenance of fire detection and alarm systems.

UNIT – II

Water-Based Fire Protection Systems: Extinguishing mechanism and limitations of water, Automatic sprinkler systems, Principles and types of sprinkler systems, Sprinkler heads and classification, k-factor, Deluge systems, Water supply requirements as per NBC, Fire pumps and pump house arrangements, Terrace tanks and terrace pumps, Overview of fire pump sizing concepts, Standpipe and hose systems, Wet risers, Internal and external hydrants, Zoning in standpipe systems, Hose reels, Inspection, Testing and maintenance of water-based fire protection systems.

UNIT – III

Water Spray, Water Mist and Foam Systems: Water spray systems, Components and applications, Ultra-high-speed water spray systems, Methods of extinguishment, Response time and design considerations, Water mist systems, Methods of generating water mist, Mist classification, Spray characteristics, Applications and limitations, Firefighting foams, Types and properties of foam concentrates, Extinguishing mechanism and limitations of foam, Expansion ratio, Low, Medium and high expansion foam systems, Foam generating equipment, Foam protection systems for storage tanks and industrial hazards, Foam application concepts.

UNIT – IV

Gaseous, Chemical and Industrial Fire Protection Systems: Carbon dioxide fire suppression systems, Extinguishing mechanism and limitations of CO_2, Total flooding and local application systems, Components and safety precautions, Clean agent fire suppression systems, Inert gas and synthetic agents, Extinguishing mechanisms, Design concentration concepts, Pressure relief vents, Applications and limitations, Dry chemical powder, aerosol and wet chemical extinguishing systems, Extinguishing mechanisms, Applications and maintenance, Overview of agent quantity calculations, Industrial fire and explosion hazards, Explosion prevention and protection systems, Deflagration venting and explosion suppression systems, Fire protection considerations in industrial occupancies.

Suggested Readings:

- Industrial Safety, Health & Environment Management System by R.K. Jain & Sunil S. Rao, Khanna Publishers.
- Fire Safety in Buildings by V.K. Jain, New Age International Publishers.
- Fire Protection and Prevention: The Essential Handbook Volume 1 & 2 by B.M. Sen, UBS Publishers.
- Principles of Fire Safety Engineering: Understanding Fire and Fire Protection byAkhil Kumar Das, PHI Learning Private Limited (Prentice Hall India).
- Industrial Safety and Health Management by C. Ray Asfahl and David W. Rieske, Pearson India
- Relevant IS Standards.
- SFPE Handbook of Fire Protection Engineering by Morgan J. Hurley, Society of Fire Protection Engineers (SFPE) / Springer.
- Relevant NFPA Standards.

Course Code	**PCC-FT-206B**				
Category	Professional Core Courses				
Course Title	**Fluid Mechanics and Fire Service Hydraulics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	3	
Course Objectives	The objectives of this course are • To introduce students to the fundamentals of fluid mechanics and hydrostatics relevant to fire protection engineering applications. • To develop understanding of fluid flow principles, fire hydraulics and flow measurement techniques used in firefighting systems. • To familiarize students with the operation, performance and maintenance of fire pumps, priming systems and hydrant systems. • To provide knowledge of sprinkler hydraulics, fire water distribution systems and hydraulic design considerations in fire protection engineering.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the fundamental concepts of fluid mechanics, fire hydraulics, fire pumps, hydrant systems, and sprinkler hydraulics used in fire protection engineering.	Level 1: Remember
CO2	Explain the behaviour of fluids, flow characteristics, hydraulic principles, pump operations and water distribution systems used in firefighting applications.	Level 2: Understand
CO3	Apply the principles of fluid mechanics and fire hydraulics to analyze fire water supply, pumping, hydrant, and sprinkler systems for fire protection.	Level 3: Apply
CO4	Analyze the hydraulic performance of fire water supply, pumping, hydrant, and sprinkler systems to ensure efficient and reliable fire protection.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit – I

Fundamentals of Fluid Mechanics: Units and systems of measurements, Fluid properties: Density, Specific gravity, Viscosity, Surface tension and capillarity, Newtonian and non-Newtonian fluids, Concept of fluid and flow, Ideal and real fluids, Use of water in fire protection services.

Hydrostatics: Pressure, Pressure head, Pascal's law, Hydrostatic pressure distribution, Pressure variation in compressible and incompressible fluids, Effect of external force on pressure in vessels, Fluid pressure measurement using manometers and Bourdon pressure gauges.

Fire water storage concepts, Estimation of capacity of fire water tanks and reservoirs, Time of filling and emptying tanks, Applications of fluid mechanics in fire protection engineering.

Unit – II

Fluid Flow and Fire Hydraulics: Types of fluid flow, Flow rate and continuity equation, Concept of system and control volume, One-dimensional flow analysis, Euler's equation of motion, Bernoulli's equation and its engineering applications, Measurement of fluid flow using venturimeter, Orifice meter and pitot tube, Flow through pipes, Pressure loss in pipes and hoses, Friction loss calculations, Flow through pipes in series and parallel, Impulse-momentum principle and its applications in fire hydraulics, Design and operation of nozzles, Flow through nozzles, Discharge coefficient, Power transmitted through nozzles, Condition for maximum power transmission, Relation between nozzle and hose diameter, Fire stream characteristics and nozzle reaction.

Unit – III

Fire Pumps and Priming Systems: Classification and operation of fire pumps, Centrifugal pumps, Reciprocating pumps, Multistage pumps, Portable and vehicle-mounted fire pumps, Jockey pumps, Pump characteristics and performance curves, Cavitation and priming principles,Net positive suction head (NPSH), Priming devices and systems, Maintenance and testing of fire pumps, Operational safety and troubleshooting of pump systems.

Unit – IV

Hydrant Systems: Hydrant systems and hydrant accessories, Inspection, testing and maintenance of hydrants, Sources of water supply, Fire water distribution systems, Storage tanks, fire flow requirements, Determination of fire flow with reference to fire load and relevant standards, Principles and operational considerations of water relay systems.

Sprinkler System Hydraulics: Fundamentals of sprinkler hydraulics, Hydraulic analysis of sprinkler systems, Flow and pressure relationships in sprinkler systems, Sprinkler discharge characteristics, Pressure balancing in sprinkler systems, Role of pressure reducing valves, Water supply requirements for automatic sprinkler systems, Safety margins and redundancy in sprinkler system design.

Suggested Readings:

- Hydraulics and Fluid Mechanics by P.N. Modi, Dr. S.M. Seth, Rajsons Publications
- Hydraulic Mechanics and Hydraulics Machines by Dr. J. Lal, Metropolitan Book Pvt. Ltd.
- Manual of Firemanship
- Fire Service Hydraulics by Dr. G.C. Mishra, Masood Books
- Fluid Mechanics and Hydraulic Machines by Dr. R. K. Bansal, Laxmi Publications
- Fire Service Hydraulics and Pump Operations by Paul Spurgeon
- Sprinkler Hydraulics by Wass Jr.
- Fire Pumps and Hydraulics by I.E. Ditts and T.M. Harris.
- Fire-Fighting Hydraulics byPurington

Course Code	**PCC-FT-208B**				
Category	Professional Core Courses				
Course Title	**Industrial Hygiene and Occupational Health**				
Scheme and Credits	L	T	P	**Credits**	**Semester -IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to chemical, physical and occupational hazards associated with industrial work environments. • To develop understanding of industrial ventilation, exposure assessment and occupational hygiene practices for hazard control. • To familiarize students with occupational diseases, medical surveillance systems and workplace health protection measures. • To provide knowledge of personal protective equipment, respiratory protection systems and regulatory requirements for occupational safety management.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the concepts related to industrial hygiene, hazards, occupational health and personal protective equipment used in occupational safety engineering.	Level 1: Remember
CO2	Explain the principles of exposure assessment, toxicology of industrial chemicals, ventilation systems, hazards, occupational diseases and PPE systems in industrial environments.	Level 2: Understand
CO3	Apply industrial hygiene principles, exposure control methods, ventilation techniques, ergonomic practices, and PPE selection procedures for managing workplace hazards and occupational risks.	Level 3: Apply
CO4	Analyze different hazards along with occupational health risks, exposure patterns, and control measures for improving workplace safety and health conditions.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Chemical Hazards: Introduction to industrial hygiene, Types of chemical hazards in industry: Dust, Gases, Fumes, Mists, Vapours and smoke. Toxicological properties of chemicals and routes of exposure, Exposure assessment and air sampling techniques, Personal and area monitoring, Threshold limit values (TLV), Permissible exposure limits (PEL) and occupational exposure standards, Effects of key industrial chemicals

such as chlorine, Ammonia, and other toxic gases. Storage, Handling and transportation of hazardous chemicals, Chemical safety in process industries.
Industrial Ventilation: Principles of natural and mechanical ventilation, General and local exhaust ventilation systems, Design considerations and control of airborne contaminants.

Unit-II

Physical Hazards: Illumination and lighting standards, Thermal radiation, Ultraviolet and ionizing/non-ionizing radiation, Preventive and control measures.
Noise: Measurement techniques, Noise surveys, Noise dose, Hearing loss mechanisms and noise control methods.
Vibration: Types, Effects on human body, Hand-arm and whole-body vibration, Isolation techniques.
Thermal Stress: Heat balance, Heat stress indices, Heat disorders, Prevention and control measures.
Work physiology: Classification of workload, Human energy expenditure, Work capacity, Job**–**man alignment, Fatigue and recovery.
Ergonomics: Principles, Human-machine interaction, Posture analysis and methods of reducing musculoskeletal and postural strain in industry.

Unit-III

Occupational Health and Diseases: Concept of occupational health and industrial medical services, Occupational diseases- Silicosis, Asbestosis, Pneumoconiosis, Lead, Nickel, Chromium, Manganese toxicity and their effects, Occupational cancer, Occupational dermatitis and other work-related diseases: Causes, Exposure pathways and prevention strategies, Medical surveillance of workers, Occupational health centre, Health records and reporting systems, Prevention and control of occupational diseases, Occupational hygiene practices and health risk reduction strategies, Occupational disease compensation systems and legal provisions, Fundamentals of first aid and emergency medical response in industries.

Unit-IV

Non Respiratory Personal Protective Equipments: Head protection, Hearing protection, Face and eye protection, Feet protection, Body protection, Selection, Use, Inspection, Care and maintenance of personal protective equipment.
Respiratory Personal Protective Equipments: Classification of respiratory hazards, Types of respirators and breathing apparatus, Selection criteria, Usage procedures and training requirements, Selection of respirators, Care & maintenance of breathing apparatus.
Workplace safety laws and regulatory requirements related to PPE usage, Industrial safety management practices for PPE compliance and occupational risk reduction.

Suggested Readings

- Industrial Safety and Health Management by R.K. Jain, Sunil S. Rao, Khanna Publications.
- Safety Management, 1st Edition by R.K. Mishra, AITBS Publisher India.
- Fundamental of industrial safety and health by KU mistry, Shyamaraj Global Commerce.
- Industrial Safety Management by Pravin M. Pathak, Jayant P. Khairnar, Notion Press.
- Principles of Industrial Safety Management: Understanding the Ws of Safety at Work by Akhil Kumar Das, PHI Learning
- Industrial Safety Managementby NaseerElahi, Kalpaz Publications.
- Safety Management System and Documentation Training Programme Handbook (Pb 2019) by SV Paul, CBS Publication.
- Safety, Occupational Health and Environmental Management in Constructionby S.C.Sharma, Vinit Kumar, Khanna Publishers.
- Industrial Safety and Maintenance Managementby M.P. Poonia, S.C. Sharma, P. Sojan Lal, Khanna Publishing House, New Delhi

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Introduction of Industrial Hygiene	https://youtu.be/lJnLdUFx2gc	NPTEL (IIT Roorkee)
	Toxicological properties and routes of exposure	https://youtu.be/jZvgAUYtS_Y	NPTEL (IIT Roorkee)
	Dose response relationship	https://youtu.be/IxRvsiZkZQ0	NPTEL (IIT Roorkee))
Unit-II	Noise vibration and radiation	https://youtu.be/IxRvsiZkZQ0	NPTEL (IIT Roorkee)
	Heat and stress	https://youtu.be/eIBHwaoG7rM	NPTEL (IIT Guwhati)
Unit-III	Radiation Effects	https://youtu.be/ttfmgTweI-4	NPTEL (IIT Madras)
Unit-IV	Safety Law	https://youtu.be/jFDWlKayrTc?list=PLbRMhDVUMngdXebaRB59KdKwstzuAovua	NPTEL (IIT Kharagpur)

Course Code	**PCC-FT-210B**				
Category	Professional Core Courses				
Course Title	**Electrical Fire Safety Practice and Standards**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to electrical materials, wiring systems, protection devices and electrical safety practices used in industrial and fire safety applications. • To develop understanding of electrical fire hazards, insulation failures, electrical shock phenomena and fire investigation procedures. • To familiarize students with hazardous area classification, explosion proof equipment and statutory safety requirements related to electrical systems. • To provide knowledge of electrical fire prevention, safety management practices and investigation techniques for electrical failures and fires.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the terminology related to electrical systems, protection devices, electrical fires, hazardous zones and fire safety.	Level 1: Remember
CO2	Explain the principles of electrical systems, protection devices, electrical fire mechanisms, shock phenomena, hazardous area classification, and statutory requirements.	Level 2: Understand
CO3	Apply electrical safety principles, protection systems, firefighting procedures, and statutory guidelines to minimize electrical fire and shock hazards.	Level 3: Apply
CO4	Analyze electrical failures, fire incidents, hazardous installations, and management practices to recommend appropriate preventive and control measures.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 09 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Introduction: Conductor, Classification and property of conductors, Semiconductors, Cables, Wires, Wire splicing and termination, Joints, General electrical accessories and insulating materials.

Terminology: Electrical fire, Failure, Defect, Seed defect, Modes and mechanism of failure, Failure rate, Metal fatigue, Elasticity of metals, Creep, Stress, Strain, Elastic and endurance limit.
Wiring System: System of supply, Selection of wiring, Rules and system of wiring, Separation of power and lighting circuit, Necessity of earthing, System of earthing, Rules of earthingand Methods of improving the earth resistance.

Unit-II

Protection Devices: Introduction, Features of good protective device, Relays, Fuses, Circuit breaker, General specification of MCB's, Trip mechanism, ELCB, RCCB.

Electrical Fire: Introduction, Causes of electrical fires, Failure of insulation, Types and causes, Transformer failure, Failure modes, Investigation overheating/ burning of crimped sockets, Failure of plug and socket connectors.

Unit-III

Electrical Shock Phenomenon: Shocks from AC and DC system, Medical analysis of electrical shock, Prevention of shocks, Safety precaution in electrical plant, Safety precaution against contacts shock, Flash shocks and burns.

Electricity and the Fire Service: Introduction, Electrical hazards and safeguards, Firefighting procedure, Fires in generating stations, Fires in transformers, Fires in substations, Fires in cable boxes, Fires in industrial premises, Fires in private dwellings, Fires involving storage batteries, Fires involving electric railways, Fires in motor cars, relevant standards.

Unit-IV

Hazardous Zones: Classification of hazardous zones, intrinsically safe and explosion proof electrical apparatus, Selection of equipment in hazardous area Electrical Fires, Hazards of static electricity, Safety procedures in electrical maintenance, statutory requirements from electrical inspectorate, Introduction to Indian Electricity Act and Rules.

Investigation of failures and fires: Process of investigation, failure investigation: step by step approach, investigation of electrical fire, action plan.

Role of the Management: Materials and Training, preparation of specification, selection of supplier, inspection of material, training of staff, tools and instruments.

Suggested Readings:

- Electrical Wiring Estimating and Costing by S.L. Uppal, Khanna Publishers.
- Electrical Fires and Failures by A.A. Hattangadi, TMH Publishers.
- Electricity Fire Risk by G.S. Hoges.
- NFPA Manual.
- J.P. Handbook.
- Electrical Safety, Fire Safety and Safety Management by S. Rao, Khanna Publishers, Delhi
- Electrical Safety Handbook by John Cadick, TMH publishers, 6th Edition
- Basic Electrical Engineering by C.L.Wadhwa, New Age Publishers

Course Code	**LC-PCC-FT-212B**				
Category	Professional Core Courses				
Course Title	**Structural Fire Engineering Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To provide hands-on practical knowledge of the mechanical and structural properties of construction materials such as steel, concrete, timber and burnt clay bricks under normal and fire-exposed conditions. • To build competency in analyzing material behavior under loading, bending, and elevated temperature conditions for safe structural design and fire safety applications. • To familiarize students with destructive and non-destructive testing techniques for evaluating the performance, durability and integrity of structural materials. • To enhance understanding of fire resistance and fire performance testing of structural components, fire doors and fire stop materials in accordance with relevant national and international standards.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Explain the properties of steel, concrete, timber, and burnt clay bricks using standard laboratory tests.	Level 2: Understand
CO2	Demonstrate testing procedures for tensile strength, compressive strength, strain, moisture content, water absorption, and Young's Modulus.	Level 3: Apply
CO3	Analyze the behavior of structural materials using destructive and non-destructive testing methods.	Level 4: Analyze
CO4	Evaluate the fire resistance and fire performance of structural components and firestop systems as per relevant standards.	Level 5: Evaluate

List of Experiments

Sr. No.	Contents
1	To determine the tensile strength of steel at ambient temperature.
2	To measure the strain in steel using strain gauge.
3	To determine the compressive strength of concrete at ambient temperature.

4	To determine the compressive strength of concrete by Non-Destructive Testing.
5	To determine the moisture content of timber using oven drying methods.
6	To study the fire resistance testing of structural components including fire doors, beams, columns, slabs, and facade systems according to relevant standards.
7	To determine the Young's Modulus of a bar material under non-uniform bending by measuring its deflection.
8	To evaluate the fire performance of firestop and sealing materials according to relevant standards.
9	To determine the water absorption of burnt clay brick.
10	To determine the compressive strength of burnt clay brick.

At least 8 experiments to be performed from the above list and other experiment can be performed depending upon the scope of course as decided by department.

Course Code	**LC-PCC-FT-214B**				
Category	Professional Core Courses				
Course Title	**Fire Protection Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To provide practical knowledge of fire detection, alarm and fire protection systems used in fire safety engineering. • To develop understanding of the operation, inspection, testing and maintenance procedures of fire protection systems and equipment. • To familiarize students with extinguishing agents, foam systems and firefighting equipment used in fire suppression applications. • To provide hands-on exposure to testing procedures, operational demonstrations and maintenance practices as per relevant fire safety standards and codes.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Explain about the components, operation, applications and limitations of fire detection, alarm and fire protection systems used in firefighting.	Level 2: Understand
CO2	Perform operational testing, inspection and maintenance procedures for fire protection systems and portable fire extinguishers as per relevant standards.	Level 3: Apply
CO3	Determine the physical properties, expansion ratio and drainage characteristics of firefighting foam concentrates and foam systems.	Level 4: Analyze
CO4	Assess the performance, applications and maintenance requirements of firefighting agents, foam systems and fire protection equipment.	Level 5: Evaluate

List of Experiments:

Sr. No.	**Contents**
1	To study the components, principle of operation, testing and maintenance of Fire Detection and Alarm Systems.
2	To study the layout, components and basic requirements of Fire Pump House as per relevant standards.
3	To study the components, principle of operation, inspection, testing and maintenance of Fire Hydrant Systems.
4	To study the components, principle of operation and applications of Automatic Sprinkler Systems.
5	To perform operational testing and discharge demonstration of portable fire extinguishers including water, foam and dry chemical powder type extinguishers as per relevant IS standards.
6	To study Passive Fire Protection Systems including fire doors, fire stopping systems and

	compartmentation.
7	To study the extinguishing mechanism, applications and limitations of water as a firefighting agent.
8	To study the extinguishing mechanism, applications and limitations of Dry Chemical Powder extinguishing agents.
9	To determine the physical properties of foam concentrates used for mechanical foam firefighting systems as per relevant IS standards.
10	To determine the expansion ratio and drainage characteristics of mechanical firefighting foam.
11	To study the operation and applications of foam generating equipment and foam protection systems.
12	To conduct inspection, testing and maintenance procedures for fire protection systems as per relevant codes and standards.

Note:At least 10 experiments to be performed from the above list and other experiment can be performed depending upon the scope of course as decided by the department.

Text Books/ Reference Books:

- Industrial Fire Protection Engineering by Robert G. Zalosh.
- NFPA Fire Protection Handbook - National Fire Protection Association.
- SFPE Handbook of Fire Protection Engineering - Society of Fire Protection Engineers.
- Fire Protection Systems by A. Maurice Jones Jr.
- Principles of Fire Protection by Arthur E. Cote and Percy Bugbee.
- National Building Construction Standard Part-F: Fire and Life Safety.
- Relevant Indian Standards related to Fire Detection and Alarm Systems, Hydrant Systems, Sprinkler Systems, Fire Pumps, Fire Extinguishers and Foam Systems.
- Relevant NFPA Standards including NFPA 10, NFPA 11, NFPA 13, NFPA 14, NFPA 20, NFPA 24, NFPA 72 and NFPA 101.
- UL Standards related to Fire Protection Systems and Equipment.
- Manufacturer manuals and technical data sheets related to Fire Detection Systems, Sprinkler Systems, Fire Pumps, Hydrant Systems and Foam Systems.

Course Code	**LC-PCC-FT-216B**				
Category	Professional Core Courses				
Course Title	**Fire Service Hydraulics Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To introduce students to fundamental principles and tools used in hydraulic and fire safety systems. • To develop students ability to conduct experiments and analyze hydraulic performance in fire protection applications. • To familiarize students with essential fire protection components such as hydrants, pumps, and sprinkler systems. • To instill practical skills for evaluating and maintaining fluid dynamics equipment used in fire engineering.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Explain the principles of water supply systems, hydrant types, and the physical properties of water used in fire protection.	Level 2: Understand
CO2	Apply the continuity equation and flow measurement techniques to measure discharge through pipes, nozzles, and firefighting hoses.	Level 3: Apply
CO3	Analyze the impact of free water jets on different surfaces and evaluate flow characteristics through different firefighting equipment.	Level 4: Analyze
CO4	Evaluate the performance, efficiency, and operational reliability of pumps and automatic sprinkler systems used in fire suppression.	Level 5: Evaluate

List of Experiments

Sr. No.	Contents
1	To study pressure measurement devices.
2	To study and identify different types of fire hydrants and their components.
3	To measure force exerted by jet on stationary and moving plates (Impact of jet apparatus).
4	To determine discharge through rectangular and trapezoidal notches.
5	To verify Bernoulli's theorem for flow through pipes.
6	To determine pressure loss in pipes due to friction (Darcy-Weisbach Equation)
7	To determine coefficient of discharge for venturimeter.
8	To determine efficiency of centrifugal pump and plot operational characteristics curve.
9	To determine efficiency of reciprocating pump.
10	To test the activation and spray pattern of a sprinkler head.

Note: At least 8 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

Course Code	**LC-PCC-FT-218B**				
Category	Professional Core Courses				
Course Title	**Industrial Hygiene and Occupational Health Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To provide practical exposure to measurement and monitoring techniques used for assessment of occupational health hazards in workplaces. • To develop understanding of industrial hygiene instruments and methods used for evaluation of physical, chemical and ergonomic hazards. • To familiarize students with occupational health assessment procedures, air monitoring techniques and workplace safety evaluation practices. • To provide hands-on knowledge of personal protective equipment evaluation, workplace ventilation assessment and industrial exposure monitoring techniques.				
Assessment	10 Marks				
End Semester Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Conduct air sampling, dust monitoring, gas detection and ergonomic assessment for identification of occupational health hazards in industries.	Level 3: Apply
CO2	Assess personal protective equipment practices, workplace exposure conditions and control measures for improvement of occupational health and safety.	Level 4: Analyze
CO3	Evaluate noise exposure, lung function, hearing capability, occupational fitness and workplace ventilation conditions using standard assessment techniques.	Level 5: Evaluate
CO4	Measure workplace noise, illumination, heat stress, airborne contaminants and gas concentrations using industrial hygiene instruments and monitoring devices.	Level 5: Evaluate

List of Experiments:

S.No.	**Contents**
1	To measure workplace noise levels using an Integrated Sound Level Meter.
2	To evaluate noise exposure dose using a personal noise dosimeter.
3	To measure illumination levels at workplace using a Lux Meter.
4	To assess thermal comfort and heat stress using WBGT apparatus.

5	To perform lung function testing using a Spirometer.
6	To evaluate hearing capability and hearing loss using a Pure Tone Audiometer.
7	To conduct vision testing for occupational fitness assessment.
8	To conduct air sampling and dust monitoring using a personal air sampling pump.
9	To determine airborne dust concentration using a High Volume Air Sampler.
10	To monitor the presence of toxic gases using portable gas detection instruments.
11	To detect the presence of flammable gases using a combustible gas indicator.
12	To assess ergonomic risk factors associated with body posture and manual material handling activities.
13	To select, use and maintain Personal Protective Equipment used in industries.
14	To assess workplace ventilation effectiveness using airflow measurement devices.
15	To monitor ammonia concentration and evaluate control measures in industrial environments.

Note: At least 10 experiments to be studied/performed from the above list and other experiments can be studied/performed depending upon the scope of course as decided by the department.

<table>
<tr><td>Course Code</td><td colspan="5">LC-PCC-FT-220B</td></tr>
<tr><td>Category</td><td colspan="5">Professional Core Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Fire Ground Operations -IV</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-IV</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
• To familiarize students with essential fire-fighting equipment including hoses, extinguishers, ropes, and ladders used in field operations.
• To train students in correct handling techniques and drills for fire hoses, extinguishers, and ladders following safety protocols.
• To develop practical competence in inspecting, testing, and maintaining the functional readiness of fire-fighting equipment.
• To promote teamwork, coordination, and responsiveness essential for real-time fire emergency handling through structured drills and exercises.</td></tr>
<tr><td>Assessment</td><td colspan="5">10 Marks</td></tr>
<tr><td>End Semester Practical Examination</td><td colspan="5">15 Marks</td></tr>
<tr><td>Total</td><td colspan="5">25 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Explain the operational principles, testing standards, and storage techniques for fire-fighting hoses, hydrant, extinguishers, ladders and ropes.	Level 2: Understand
CO2	Perform hydrant drills, hydrant testing, and fire extinguisher operations for emergency response.	Level 3: Apply
CO3	Demonstrate pump drills and ladder testing procedures using standard firefighting practices.	Level 3: Apply
CO4	Analyze the readiness, safety, and effectiveness of fire-fighting equipment through inspection and standard testing methods.	Level 4: Analyze

List of Experiments

Sr. No.	Contents
1	To study different types of hydrants: Ball type, Sluice valve, Screw down, Pillar and post types of valves.
2	To study different types of hydrant fittings, Types of hydrant gear, Hydrant testing equipment.
3	To perform three men hydrant drill (Add, Remove and replace of hose, Dividing breeching, Collecting breeching.
4	To perform four men hydrant drill (Add, Remove and replace of hose, Dividing breeching, Collecting breeching).
5	To perform hydrant test.
6	To study different types of fire extinguishers, Rating of portable extinguishes for class A, B and C fires. Limitations of portable extinguishers, Operation, Refilling, Testing and maintenance of fire

	extinguishers, Inspection requirement of portable extinguishers.
7	To perform a foam drill.
8	To perform four men pump drill.
9	To perform a six men pump drill.
10	To study different types of ladders and their parts.
11	To perform different ladder tests (Round test, String test, Extension line test).

Other drills and tests can be performed as decided by department (time to time) depending upon the scope of course.

Course Code	**PEC-FT-222B**				
Category	Professional Elective Courses				
Course Title	**Industrial Psychology**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce students to the fundamentals, development and applications of industrial psychology in workplace environments. • To develop understanding of individual behaviour, motivation, job satisfaction and psychological factors influencing work performance. • To familiarize students with employee selection methods, job analysis techniques and fair employment practices used in organizations. • To provide knowledge of performance appraisal, organizational training and career development practices in industrial management.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the concepts, theories, psychological factors and workplace practices associated with industrial psychology and employee behaviour.	Level 1: Remember
CO2	Explain the principles of motivation, job satisfaction, employee selection, job analysis, performance appraisal and organizational training used in workplaces.	Level 2: Understand
CO3	Apply psychological principles and assessment techniques for employee management, performance evaluation and workplace development.	Level 3: Apply
CO4	Analyze individual behaviour, motivational factors, appraisal systems and training practices for improving organizational effectiveness and employee performance.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Introduction to Industrial Psychology: Nature and Development of Industrial/Work Psychology - Historical background, Scientific Management, Time and Motion Study, Hawthorne Studies, World War I & II, Scope &Challenges, Current status.

Unit-II

People at Work: Individual Differences, Personality, Intelligence, Emotional Intelligence, Creativity & Innovation, Perception & Attitudes. Motivation, Expectancy, Equity & Goal Setting Theories,

ModernApproach to Motivation: Employee Predisposition, Expectations, Goals, & Incentives Job Satisfaction- Job Characteristic Theory (Diagnostic Model), Measuring Job Satisfaction Psychometric Testing at Work- Cognitive Abilities.

Unit-III

Managing People at Work-I: Employee Selection- Techniques, Fair Employment Practices, Recruitment, Biographical Information, Interviews, References& Letters of Recommendation. Job Analysis, Types, Newer Developments.

Unit-IV

Managing People at Work-II Performance Assessment: Evaluation & Appraisal- Objective & Subjective Techniques, Bias in Appraisals, Development Plans, Organizational Training,Types of Training, Psychological Issues, Career Development & Planning.

Suggested Readings:

- Introduction to Industrial and Organizational Psychology by Duane P. Schultz & Sydney, Ellen Schultz Pearson Education, New Delhi.
- Industrial Psychology by Michael G. Aamodt, Cengage Learning, Delhi.
- Work Psychology by L. Matthewman, Anabel Rose & Amanda Hetherington, Oxford University Press, New Delhi.
- Work in the 21st Century: An Introduction to Industrial and Organizational Psychology by Frank J. Landy& Jeffrey M. Conte, Wiley India, New Delhi.
- Industrial Psychologyby Ashish Pandey & Atul Kumar Sharma, Global Academic Publishers, New Delhi.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	History and Genesis of Psychology	https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_hs14	NPTEL(IIT Kharagpur)
	Scientific management and time motion study	https://onlinecourses-archive.nptel.ac.in/noc18_me68/preview?utm_source	NPTEL(IIT Roorkee)
Unit-II	Organizational Behaviour (Personality, Attitude and Perception)	https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_mg73	NPTEL(IIT Hyderabad)
Unit-III	Recruitment and Selection	https://www.digimat.in/nptel/courses/video/122105020/122105020.html?utm_source	NPTEL IIT(Kharagpr)
Unit-IV	Performance Evaluation and Career development and Planning	https://www.classcentral.com/course/youtube-core-human-resource-management-i-47643?utm_source	NPTEL(IIT kharagpur)

Course Code	**PEC-FT-224B**				
Category	Professional Elective Courses				
Course Title	**Chemical Process Safety**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To develop the understanding of students regarding foundational understanding of process safety culture, risk perception, and regulatory frameworks in industrial operations. • To make the students familiar with knowledge of toxicology, industrial hygiene, and hazard identification related to chemical exposure. • To train students in preventive strategies for fire, explosion, and chemical reactivity hazards in process industries. • To introduce safety design strategies, relief systems, and real-world case-based learning for effective hazard mitigation.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the terms related to process safety, toxicology, industrial hygiene, fire and explosion, reliefs, safety strategies and hazard mitigation frameworks.	Level 1: Remember
CO2	Explain the fundamentals of risk analysis, fire/explosion prevention, toxicant exposure control, chemical reactivity and process safety strategies.	Level 2: Understand
CO3	Apply process safety principles, industrial hygiene practices, fire and explosion prevention methods, and relief system concepts to industrial processes.	Level 3: Apply
CO4	Analyze process hazards, toxic exposures, fire and explosion risks and safety strategies to recommend appropriate risk control measures.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Introduction: Definition, myths about process safety, Safety culture, Essential features of safety culture, Individual risk, Societal risk and risk populations, Voluntary and involuntary risk, Safety metrics, Safety and accident loss statistics, Risk perception, Risk tolerance/acceptance and risk matrix, Risk management and hazardous substance rules, The CCPS 20 elements of risk-based process safety, Inherently safer design, strategies.

Unit-II

Toxicology: Introduction, Routes & exposure, Entry routes for toxicants and methods for control, Elimination of toxicants from the body, Effects of toxicants on the body, Dose response relationship, Dose response and threshold dose: predictive models and extrapolation, Relative toxicity.

Industrial Hygiene: Regulations and identification, Anticipating and identifying hazardous workplace exposures, Globally harmonized system for safety data sheets, Globally harmonized system for labeling, evaluate the magnitude of exposures and responses, noise, Vibration and radiation, develop and evaluate control techniques to prevent exposures, National Fire Protection Association Diamond.

Unit-III

Concepts to Prevent Fires and Explosions: Inerting and purging, Static electricity, General design methods to prevent fire, Explosion-proof equipment and instruments, Ventilation, Fire extinguishers, Sprinkler systems, I ndustry's fire and explosion protection strategy.

Chemical Reactivity: Key steps in reactivity hazard evaluation, Commitment, Awareness and identification of reactive chemical hazards, controlling reactive hazards.

Unit-IV

Introduction to Reliefs: Relief concepts, Definitions, Type of reliefs and characteristics, Code requirements, Relief system design, Relief installation practices, Relief effluent handling.

Safety Strategies, Procedures and Designs: Process safety strategies, Safe operating procedures, Safe work practices, Designs for process safety, Designs for runaway reactions, Designs and practices for the safe handling of dusts, Case histories and lessons learned.

Suggested Readings:

- Chemical Process Safety: Fundamentals with applications by Crowl and Louvar (2002), New Jersey: Prentice Hall.
- Evaluating Process Safety in the Chemical Industry by Arendt and Lorenzo (2000), New York: CCPS.
- Lees Handbook of Loss Prevention in Chemical Process Industries: hazard identification, assessment and control by Lees F. P. (2005), Butterworths.
- King's safety in the process industries by King et al. (1998), London: Wuerz Publishing Ltd.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Safety and Accident Loss Statistics	https://www.youtube.com/watch?v=dlhXg7KkD0M	NPTEL (IIT Roorkee)
	Risk Management and Hazardous Substance Rules	https://www.youtube.com/watch?v=QYBA9FNoNDw	
Unit-II	Introduction, Routes & Exposure	https://www.youtube.com/watch?v=jZvgAUYtS_Y	
	Dose Response Relationship	https://www.youtube.com/watch?v=jZvgAUYtS_Y	
	Dose Response and Threshold Dose: Predictive models and Extrapolation	https://www.youtube.com/watch?v=_Ut_1L2JlQA	
Unit-III	Designs to prevent Fire and Explosion: Inerting and Purging	https://www.youtube.com/watch?v=PaBDQ-lOGRM	
	Sprinkler Systems	https://www.youtube.com/watch?v=ZKsqIPM810M	
Unit-IV	Introduction to Reliefs	https://www.youtube.com/watch?v=Cs8DQ_9f5qM	
	Type of Reliefs	https://www.youtube.com/watch?v=Q-4601m2zag	

Course Code	**PEC-FT-226B**				
Category	Professional Elective Courses				
Course Title	**Environmental Engineering and Management**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objective of this course are • To develop understanding of air, water, solid, and hazardous waste pollution and control methods. • To familiarize students with environmental monitoring, treatment techniques, and waste management practices. • To develop awareness about environmental management systems, cleaner technologies, and sustainable industrial practices. • To enable students to understand environmental legislation, ISO 14001 EMS, and pollution prevention strategies.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Define the terminology related to pollution control, waste management, and environmental management.	Level 1: Remember
CO2	Explain the principles of pollution control, waste treatment, and environmental management systems.	Level 2: Understand
CO3	Apply pollution control and waste management techniques for environmental protection.	Level 3 : Apply
CO4	Analyze environmental pollution and management practices to recommend sustainable solutions.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 partsof 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Air Pollution: Sources of air pollution, Effects of air pollution, Classification of pollutants, Atmospheric transport of pollutants-Wind profiles, Atmosphere stability, Inversion, Turbulence, Dispersion and diffusion of air pollutants, Gaussian plume dispersion model, Principles and techniques of ambient air and stack emission monitoring, Particulate matter control equipments, Working principles of gravity settlers , cyclones, wet scrubbers, fabric filters and electrostatic precipitators, Gaseous control methods- an overview of absorption, Adsorption and combustion methods; Biological methods for VOC and odor control.

Unit-II

Waste Water: Physical, chemical and biological characteristic of waste water, Effects of pollutants on water quality and aquatic life, Physical unit operations in waste water treatment-Flow equalization, Sedimentation and flotation, Chemical unit processes in waste water treatment-Coagulation and flocculation, Chemical precipitation and adsorption, Biological unit processes: kinetics of microbial growth.
Aerobic Treatment Systems: Working principle and design parameters of trickling filter, Activated sludge process and rotating biological contactor.
Anaerobic Treatment Systems: Mechanism of anaerobic process, Low rate and high rate digesters, Working principle and applications of anaerobic filters and UASB, Biological nitrification: Denitrification, Characteristics and treatment methods forthe waste water from fertilizer plants, petroleum refineries, Pulp and paper mills and distilleries.

Unit-III

Solid Wastes: Environmental, Aesthetic and health risk, Sources, Quantities and composition of solid wastes, Storage, collection and transportation of urban solid waste, Disposal options- Sanitary landfills, Composting and its variations, Anaerobic digestion, Incineration and pyrolysis, Vermicomposting, Recovery alternative, Monitoring of solid wastes.

Hazardous Wastes: Definition and classification, Health and environmental effects, Treatment, Disposal and management of hazardous wastes, Legal frame work for hazardous waste management in India.

Unit-IV

Environmental Management in Industries: Principles and requirements of ISO 14001 EMS, Environmental auditing and auditing for waste minimization, Environmental impact assessment, Prediction and assessment of impacts, Methods of impact analysis, Indian scenario, Public participation in environmental decision making, Strategies for pollution prevention- Recycle and reuse, Cleaner technologies.

Life cycle Assessment: Principle and methodology, Industrial ecology, Clean development mechanism (CDM), Carbon trading.

Suggested Readings

- Environmental Pollution Control Engineering by C.S. Rao, New Age International (P) Ltd.
- Wastewater Treatment by M.N. Rao and A.K. Dutta, Oxford & IBH, Publishing Co. Pvt. Ltd, New Delhi.
- Handbook of solid waste Disposal and Management by Pavani, J. L, New Age International (P) Ltd.
- Waste Water Engineering: Treatment, Disposal, Reuse by Metcalf and Eddy Inc, Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Environmental Impact Assessment by Canter. L.W, Irwin / McGraw – Hill,NewYork.
- Environmental Engineers Handbook by David, H.F. Liu, Lewis Publishers, New York.
- Industrial Safety, Health and Environment Management System by R.K. Jain and S.S. Rao, Khanna Publishers.
- Safety in Chemical Plants/ Industry & its Management by B. K. B.Rao, R .K. Jain, V. Kumar, Khanna Publishers.
- Environmental Health and safety: Principles and Practices by S. Alauddin, C. Bhattacharya, S. Rawat, A. K. Saran, RK Publication.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Introduction of air pollution	https://youtu.be/u142u-wJFwI?list=PLLy_2iUCG87BwOQUbS7WSdMVWHDXByk-w	NPTE (IIT Roorkee)
	Impact of air pollution	https://youtu.be/z4YFkK3Wtsg?list=PLLy_2iUCG87BwOQUbS7WSdMVWHDXByk-w	NPTE (IIT Roorkee)
	Atmospheric stability and lapse rate	https://youtu.be/rQjTM7AVK2k?list=PLLy_2iUCG87BwOQUbS7WSdMVWHDXByk-w	NPTE (IIT Roorkee)
Unit-II	Water and waste water characteristics	https://youtu.be/wI7uvQThX8A	NPTEL (IIT Madras)
	Coagulation and flocculation	https://youtu.be/p2ZtijyhLQE?list=PLLy_2iUCG87A3YUD6wAYrgnhCsYhk72Tw	NPTE (IIT Roorkee)
	USAB Reactor	https://youtu.be/tNq7lZLqCiU	NPTE (IIT Kharagpur)
Unit-III	MSW management	https://youtu.be/cjIacnNRLHE?list=PLwdnzlV3ogoXAap_BHeApkcF7M8nt13hv	NPTE (IIT Guwahati)
	Landfilling	https://youtu.be/19JtBKeENAQ	NPTE (IIT Guwahati)
Unit-IV	EMS	https://youtu.be/BYqLRGawoH0	NPTE (IIT Guwahati)
	EIA	https://youtu.be/_iLdyhgFv1U?list=PLA44FuTLCwbfl50Onai5LZRDw9mAIlzfS	NPTE (IIT Guwahati)

Course Code	**PEC-FT-228B**				
Category	Professional Elective Courses				
Course Title	**Special Fire Hazards**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To provide knowledge of fire hazards, emergency response procedures and preventive measures associated with transportation and railway systems. • To develop understanding of marine, port and aviation fire safety systems, rescue operations and firefighting strategies. • To familiarize students with fire and explosion hazards in industrial occupancies, high-rise buildings and specialized hazardous environments. • To acquaint students with fire safety management, evacuation strategies, firefighting challenges and safety measures related to complex infrastructures and nuclear facilities.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the terminology and standards related to transportation, industrial, building, and nuclear fire safety.	Level 1: Remember
CO2	Explain the fire protection systems, firefighting operations, evacuation procedures and safety management practices used in different hazardous occupancies and infrastructures.	Level 2: Understand
CO3	Apply fire safety principles and emergency response concepts for management of fire and explosion hazards in transportation, industrial, marine, aviation and high-rise building environments.	Level 3: Apply
CO4	Analyze fire risk scenarios, operational challenges and mitigation strategies associated with complex fire emergencies and hazardous installations.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Transportation Safety: Fundamentals of transportation fire safety, Passenger and commercial vehicle fires, Hazardous material transportation, MSDS, HAZCHEM code, Placards and TREM cards, LNG/LPG

transportation hazards, Electric vehicle and lithium-ion battery fire hazards, Emergency response procedures, Preventive measures and case studies.

Trains Safety: Structural features of trains, Railway stations, Tunnels and metro rail systems, Railway fire hazards, Passenger evacuation, Tunnel fire safety, Rescue operations, Emergency response strategies and case studies.

Unit-II

Marine and Port Fire Safety: The maritime environment, Types of vessels, Constructional features of passenger and cargo ships, Fire detection and suppression systems in ships, Cargo hazards and safety measures, Marine firefighting and rescue operations, emergency planning, Preventive measures and strategic management, Fire protection facilities for ports handling hydrocarbons as per OISD-STD-156,Ships and marine technology, Fire extinguishing systems for protection of galley cooking equipment as per IS 17564,Ships and Marine technology windows and side scuttles for fire-resistant constructions as per IS 18280,Shipbuilding testing, Installation and maintenance of marine portable fire appliances- Code of practice as per IS3947, Loading and unloading hazards, Firefighting systems in ports and terminals, Emergency response systems, Preventive measures and case studies.

Unit-III

Aviation Fire Safety: Constructional features of aircraft, Aircraft fire hazards, Air crashes and emergency landings, Rescue operations in aircraft fires, Airport fire hazards, Hangar protection systems, Crash fire tenders and rapid intervention vehicles, Airport categorization and firefighting appliances as per international standards and case studies.

Industrial and High-Rise Fire Safety: Fire safety in iron and steel industries, Petroleum refineries, Fertilizer plants, Pharmaceutical industries, Coal-based industries and thermal power plants, Hydrogen hazards, Bleve, Vapor cloud explosions, Rocket propellants, Industrial emergency response procedures, Preventive measures and case studies.

Unit-IV

Building Fire Safety: Fundamentals of fire-safe building design, Life safety systems for high-rise buildings, Structural fire protection, Alarm and signaling systems, Smoke movement and smoke control systems, Refuge areas, Fire lifts, Façade fire hazards, Evacuation strategies, Firefighting challenges in high-rise buildings and case studies**.**

Nuclear Safety: Radiation and its types, Nuclear reactors, Radiation emergencies, Firefighting and rescue operations in radiation hazard areas, Radiation safety measures, Radioactive waste management, Nuclear accidents, Mitigation measures and strategic management.

Suggested Readings:

- Radioactive Materials by B.M. Rao, Himalaya Publishing House.
- Fire Safety in Buildings by V K Jain, New Age Publishers, New Delhi.
- Indian Buildings Congress Manual of Fire Safety in Buildings by Indian Building Congress, Nabhi Publication
- Industrial Safety, Health and Environment Management Systems by R. K. Jain and Sunil S. Rao,Khanna Publishers
- Handbook on Fire and Life Safety in Buildings by Barendra Mohan Sen, Techno World
- Airport, Aircraft and Aviation Fire Safety by P. K. Sarkar,S. K. Kataria and Sons
- Marine Fire Prevention, Firefighting and Fire Safety by D. K. Gupta,CBS Publishers and Distributors
- Relevant OISD Standard

Annexure AC/ 5.31

~~Annexure 4.6~~

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA (JHAJJAR)

An Autonomous Institute
'A' GRADE ACCREDITED BY NAAC

Scheme of Examinations & Syllabus

For

Minor Degree

in

Sustainable Energy Engineering

Department of Fire Technology and Safety

(Effective from the Session: 2025-26)

APPROVED BY AICTE, NEW DELHI AND AFFILIATED TO MDU, ROHTAK

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA, JHAJJAR (HR.)

Scheme of Studies and Examination

Minor Degree in Sustainable Energy Engineering

w.e.f. 2025-26

Sr. No.	Semester	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Scheme (Marks)				Exam Duration in
				Lecture (L)	Tutorial (T)	Practical (P)			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	III	MFTSE201B	Sustainable Engineering Concepts	3	0	0	3	3	25	50		75	3
2	IV	MFTSE202B	Energy and its Resources	3	0	0	3	3	25	50		75	3
3	IV	MFTSE204B	Sustainable Engineering Lab	0	0	2	2	1	10		15	25	3
4	V	……	Refer Table-I	3	0	0	3	3	25	50		75	3
5	VI	……	Refer Table-II	3	0	0	3	3	25	50		75	3
6	VI	MFTSE302B	Project	0	0	4	4	2	20		30	50	3
7	VII	MFTSE401B	Sustainable Energy Policy	3	0	0	3	3	25	50		75	3
Total Credits								**18**				**450**	

Note: The students have to choose one course from Table-I and one from Table-II. The elective course offered by the department will be mandatory. However, any relevant MOOCs/Swayam Course with the prior approval of Head of Department/Chairperson BOS can be chosen.

Table I Professional Elective – I

Sr. No.	Code	Subject
1	MFTSE301B	Electronics for Energy Engineering
2	MFTSE303B	Climate Change Understanding and Observations
3	MFTSE305B	Energy Storage System for Renewables
4	MFTSE307B	Renewable Energy Technologies
5	MFTSE309B	Hydrogen and Fuel Cell Technology
6	MFTSE311B	Any one MOOCS/Swayam Course

Table II Professional Elective – II

Sr. No.	Code	Subject
1	MFTSE304B	Sustainable Buildings
2	MFTSE306B	Energy Management and Audit
3	MFTSE308B	Energy Conservation and Waste Heat Recovery
4	MFTSE310B	Smart Grid and Energy Systems
5	MFTSE312B	Solar Energy Technologies and System Design
6	MFTSE314B	Any one MOOCS/Swayam Course

Course Code	**MFTSE201B**				
Category	Core Courses				
Course Title	**Sustainable Engineering Concepts**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize the students with the fundamental concepts of sustainability, sustainable development, and their significance in engineering practice. • To develop an understanding of environmental resources, sustainability challenges, environmental impacts, and sustainable engineering approaches. • To make the students learn about life cycle thinking, circular economy principles, and resource-efficient engineering practices. • To enable students to appreciate the role of engineers in addressing environmental, economic, and social dimensions of sustainability through responsible decision-making.				
Assessment	25 Marks				
End Semester Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the fundamental concepts, principles, frameworks and terminology related to sustainability, sustainable development, environmental resources, life cycle thinking, circular economy, and sustainable engineering.	Level 1: Remember
CO2	Explain the interrelationships among environmental, economic and social dimensions of sustainability, resource utilization, environmental impacts, life cycle approaches, and sustainable engineering practices.	Level 2: Understand
CO3	Apply sustainability principles, life cycle thinking, resource efficiency concepts and sustainability assessment approaches to engineering systems and practices.	Level 3: Apply
CO4	Analyze engineering systems, processes, and development practices with respect to sustainability indicators, environmental impacts, resource utilization and circular economy principles to support sustainable decision-making.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Sustainability and Sustainable Development: Introduction to sustainability, Evolution of sustainability concepts, Sustainable development and its importance, Three pillars of sustainability (Environmental, Economic and social dimensions), Sustainable development goals (SDGs), Role of engineers in sustainable development, Resource depletion and environmental challenges,

Population growth, Urbanization and industrialization, Sustainability challenges in developing countries, Water-Energy-Food nexus.

Unit II

Environment, Resources and Sustainable Engineering: Natural resources and their utilization, Renewable and non-renewable resources, Environmental degradation and pollution, Climate change and global warming, Carbon footprint and ecological footprint, Environmental legislation and policies, Principles of green engineering, Sustainable consumption and production, Industrial ecology, Cleaner production technologies, Environmental management systems and ISO 14001 framework.

Unit-III

Life Cycle Thinking and Circular Economy: Introduction to life cycle thinking, Life cycle assessment (LCA), Stages of LCA -Goal and scope definition, Life cycle inventory, Life cycle impact assessment and interpretation, Material flow analysis, Environmental risk assessment, Circular economy principles, Reduce, Reuse, Recycle and recovery strategies, Sustainable materials and green products, Waste minimization and resource efficiency, Case studies on sustainable engineering practices.

Unit-IV

Sustainable Design and Engineering Applications: Sustainable design principles, Design for environment (DfE), Sustainable manufacturing and green technologies, Sustainable buildings and infrastructure, Energy-efficient systems, Renewable energy integration, Sustainable transportation systems, Sustainability indicators and assessment tools, Economic evaluation of sustainable projects, Case studies on sustainable engineering solutions in energy, Construction and industry.

Suggested Readings:

- Sustainable Engineering: Concepts, Design and Case Studies by Allen, D. T. and Shonnard, D. R., Prentice Hall.
- Environmental Engineering: Fundamentals, Sustainability and Design by Mihelcic, J. R. and Zimmerman, J. B., Wiley.
- Introduction to Sustainable Engineering by Bradley, A. S., Adebayo, A. O. and Maria, P., CRC Press.
- Industrial Ecology and Sustainable Engineering by Graedel, T. E. and Allenby, B. R., Pearson.
- Sustainable Solutions: Developing Products and Services for the Future by Martin Charter and Ursula Tischner, Greenleaf Publishing.
- Sustainable Engineering Concepts and Life Cycle Analysis by Brajesh Kumar Dubey, NPTEL Course Material, IIT Kharagpur.
- Sustainable Development in Practice: Case Studies for Engineers and Scientists by Azapagic, A., Perdan, S., and Clift, R., Wiley.
- Sustainable Design: The Science of Sustainability and Green Engineering by Daniel A. Vallero and Chris Brasier, Wiley.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Sustainability and Sustainable Development - Part A	https://youtu.be/oIF9EWyJ2_w?si=grDpXDnGRFk44iZy	NPTEL (IIT Guwahati)
Unit-II	Climate and climate change	https://youtu.be/fB9eBKP3Wm0?si=5i8R5ci5uUH19UOx	NPTEL (IIT Roorkee)

Unit-III	Introduction to Life Cycle Assessment (LCA)	https://youtu.be/j_oIVexNdu0?si=Yg8ogFiUTrr2Hgxl	NPTEL (IIT Roorkee)
Unit-IV	Introduction to Transportation Systems-I	https://youtu.be/IYZA06kRktw?si=c6W5KpRXL7Kp6OwP	NPTEL (IIT Roorkee)

<table>
<tr><td>Course Code</td><td colspan="5">MFTSE202B</td></tr>
<tr><td>Category</td><td colspan="5">Core Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Energy and its Resources</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-IV</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
To familiarize the students with the fundamental concepts of energy, power, energy resources, and the global and national energy scenario.
To develop an understanding of conventional and renewable energy resources, their availability, utilization, and role in meeting future energy demands.
To make the students learn about the environmental impacts of energy systems and the significance of sustainable energy development.
To enable students to appreciate the role of energy resource management and sustainable energy planning in addressing energy and environmental challenges.</td></tr>
<tr><td>Assessment</td><td colspan="5">25 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">50 Marks</td></tr>
<tr><td>Total</td><td colspan="5">75 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, terminology, energy resources, energy systems, environmental aspects, and economic parameters associated with conventional and renewable energy technologies.	Level 1: Remember
CO2	Explain the characteristics, utilization, potential, and limitations of conventional and renewable energy resources along with their significance in the energy sector.	Level 2: Understand
CO3	Apply principles of energy resource assessment, energy efficiency, sustainability concepts, and economic evaluation methods to energy systems and projects.	Level 3: Apply
CO4	Analyze energy resources, energy systems, environmental implications, and economic factors to support informed decision-making for sustainable energy planning and development.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Energy Scenario and Conventional Energy Resources: Introduction to energy and power, Forms of energy and units, Global and Indian energy scenario, Energy demand and supply trends, Energy consumption patterns, Energy security, Classification of energy resources, Conventional energy resources, Coal, Petroleum and natural gas—Origin, Reserves, Extraction, Processing and utilization, Fossil fuel-Based power generation, Energy flow diagrams and energy balance, Resource depletion and future energy challenges.

Unit II

Renewable Energy Resources: Need for renewable energy, Solar energy resource and potential, Wind energy resource assessment, Hydropower resources and applications, Biomass and bioenergy systems, Geothermal energy, Ocean energy (tidal, wave and OTEC), Hydrogen as an energy carrier, Resource assessment methodologies, Renewable energy potential in India, Opportunities and challenges of renewable energy deployment.

Unit-III

Energy, Environment and Sustainability: Environmental impacts of energy production and utilization, Air, Water and soil pollution due to energy systems, Greenhouse gases and global warming, Climate change and energy sector, Carbon footprint and emission factors, Energy efficiency and conservation, Sustainable energy development, Environmental impact assessment of energy projects, International environmental agreements and climate initiatives, Role of renewable energy in sustainable development.

Unit-IV

Energy Economics and Project Evaluation: Principles of energy economics, Energy pricing and energy markets, Energy demand forecasting, Economic evaluation of energy projects, Simple payback period, Discounted cash flow, Net present value (NPV), Internal rate of return (IRR), Benefit-cost ratio, Levelized cost of energy (LCOE), Life cycle costing, Financing of energy projects, Case studies of renewable energy and sustainable energy projects.

Suggested Readings:

- Renewable Energy Resources by Twidell, J. and Weir, T., 4th Edition, Routledge.
- Renewable Energy: Power for a Sustainable Future by Boyle, G.,Oxford University Press.
- Energy and the Environment by Ristinen, R. A., Kraushaar, J. J. and Brack, M. C.,Wiley.
- Solar Energy: Principles of Thermal Collection and Storage by Sukhatme, S. P. and Nayak, J. K.,McGraw Hill.
- Renewable Energy and Sustainability by Khan, I.,Elsevier.
- Renewable Energy Engineering and Technology: Principles and Practice byKishore, V. V. N., Earthscan.
- Financial Evaluation of Renewable Energy Technologies by Kandpal, T. C. and Garg, H. P., Macmillan India.
- Sustainable Energy: Choosing Among Options byTester, J. W. et al.,MIT Press.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Introduction to Fossil Fuels	https://youtu.be/3cYVEFHBF1Q?si=cSgOsG6eSIEwLjYe	NPTEL (IIT Roorkee)
Unit-II	Solar Energy: An overview of thermal applications	https://youtu.be/iZyzvDj6Y3c?si=E6jFQTviJBbVETqa	NPTEL (IIT Guwahati)
Unit-III	Carbon Footprint	https://youtu.be/r1Li7Dh0Xh4?si=HZ7sQ2d9a7WoBGEZ	NPTEL (IIT Kanpur)
Unit-IV	Energy Economics-I	https://youtu.be/XfRtl1DHqgU?si=-KmfNhsQb22PA90a	NPTEL (IIT Roorkee)

Course Code	**MFTSE204B**				
Category	Core Courses				
Course Title	**Sustainable Engineering Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To familiarize the students with experimental techniques and measurement methods used in sustainability assessment and renewable energy systems. • To develop an understanding of sustainability indicators, carbon footprint, ecological footprint, and life cycle assessment methodologies. • To make the students learn about the performance evaluation of renewable energy technologies, including solar, wind, battery, and fuel cell systems. • To enable students to appreciate the practical implementation of sustainable engineering solutions for environmental protection, energy conservation, and sustainable development.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Explain the principles, operating characteristics, assessment procedures, and performance evaluation methods associated with sustainable energy technologies and sustainability indicators.	Level 2: Understand
CO2	Apply standard measurement techniques, assessment methodologies, and performance evaluation procedures for renewable energy systems, energy-efficient technologies, and sustainability studies.	Level 3: Apply
CO3	Analyze experimental data, system performance, energy utilization patterns, sustainability metrics, and environmental impacts to support sustainable engineering decision-making.	Level 4: Analyze
CO4	Evaluate the effectiveness of energy management, renewable energy, and sustainability interventions in achieving resource conservation and environmental protection goals.	Level 5: Evaluate

List of Experiments

Sr. No.	**Contents**
1	Study of sustainable development goals (SDGs) and sustainability indicators.
2	Estimation of carbon footprint of a household/building.
3	Determination of ecological footprint using standard assessment methods.
4	Energy audit of a classroom, Laboratory or Residential building.
5	Measurement of solar radiation using a pyranometer and analysis of solar insolation data.
6	Study of solar photovoltaic (PV) module characteristics (I–V and P–V curves).

7	Determination of efficiency of a solar photovoltaic panel under varying conditions.
8	Performance analysis of solar water heating system. Solar irradiance measurement, PV module testing and thermal system evaluation are common learning outcomes in renewable energy laboratories.
9	Assessment of wind energy potential using an anemometer and wind data analysis.
10	Study of battery charging and discharging characteristics for renewable energy storage.
11	Demonstration and performance analysis of fuel cell systems.
12	Study of hybrid renewable energy systems (solar–battery or solar–wind models). Renewable energy laboratories commonly include wind turbines, Fuel cells, Batteries and hybrid systems for practical training.
13	Energy efficiency analysis of lighting systems (LED, CFL, Incandescent).
14	Life cycle assessment (LCA) of a selected product or engineering system.
15	Comparative study of renewable and conventional energy systems based on environmental impacts.
16	Mini project on sustainable engineering solutions for campus/community applications.

Note:At least 10 experiments to be performed from the above list and other experiment can be performed depending upon the scope of course as decided by the department.

Course Code	**MFTSE301B**				
Category	Elective Courses				
Course Title	**Electronics for Energy Engineering**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize the students with the fundamentals of electronic devices and power semiconductor components used in energy conversion and renewable energy systems. • To develop an understanding of power electronic converters, switching principles, and their role in efficient energy conversion and control. • To make the students learn about DC-DC converters, power conditioning techniques, and energy management applications in renewable energy systems. • To enable students to appreciate the role of advanced power electronic technologies in sustainable energy systems, smart grids, electric vehicles, and microgrids.				
Assessment	25 Marks				
End Semester Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the fundamental concepts, characteristics, components, and terminology associated with power electronic devices, converters, photovoltaic systems, energy storage systems and renewable energy integration.	Level 1: Remember
CO2	Explain the operating principles and performance characteristics of power semiconductor devices, power converters, solar power conditioning systems and renewable energy interfaces.	Level 2: Understand
CO3	Apply the principles of power conversion, converter operation, photovoltaic power conditioning, and energy management techniques in renewable energy systems.	Level 3: Apply
CO4	Analyze the performance of power electronic systems, renewable energy interfaces, energy storage technologies, and grid-connected systems with respect to efficiency, control, reliability and power quality.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Electronic Devices and Power Semiconductor Components: Introduction to electronics in sustainable energy systems, Role of electronics in energy conversion and control, Semiconductor fundamentals, Diodes, Power diodes, SCRs, MOSFETs, IGBTs and their characteristics, Switching principles, Power losses and efficiency, Gate drive circuits, Protection of power electronic devices, Introduction to power

electronic systems used in renewable energy applications, Power electronic devices form the basis of renewable energy conversion systems and grid integration technologies.

Unit-II

DC-DC Converters and Energy Conversion: Principles of power conversion, Rectifiers and controlled rectifiers, DC-DC converters Buck, Boost, Buck-Boost and Cuk converters, Operating principles, Circuit configurations and performance characteristics, Converter efficiency, Design considerations, Bidirectional converters for battery charging and energy storage applications, Applications in solar PV and renewable energy systems, DC-DC conversion is central to PV systems, Storage integration and energy management.

Unit-III

Solar Power Electronics and MPPT Techniques: Solar photovoltaic characteristics, PV cell, Module and array configurations, I-V and P-V characteristics, Effect of temperature and irradiance, Maximum power point concept, Maximum power point tracking (MPPT) techniques Perturb & Observe, Incremental conductance and hill climbing methods, Charge controllers Simple, PWM and MPPT controllers, Battery charging systems, Solar inverters Off-grid, Grid-connected and Hybrid inverters, Performance evaluation of solar power conditioning systems, MPPT and inverter technologies are key components in modern photovoltaic systems.

Unit-IV

Power Electronics for Renewable Energy Integration: Power electronic interfaces for wind energy systems, Rectifiers and inverters in wind power generation, Battery management systems (BMS), Microgrids and distributed generation, Grid synchronization and power quality, Smart converters, Electric vehicle charging systems, Vehicle-to-grid (V2G) concept, Monitoring, Protection and control of renewable energy systems, Emerging trends in power electronics for sustainable energy applications, Renewable energy integration increasingly depends on advanced converters, Storage systems and microgrid control technologies.

Suggested Readings:

- Power Electronics: Circuits, Devices and Applications by Rashid, M. H., Pearson Education.
- Fundamentals of Power Electronics by Erickson, R. W. and Maksimovic, D.,Springer.
- Solar Photovoltaics: Fundamentals, Technologies and Applications by Solanki, C. S., PHI Learning.
- Power Electronics for Renewable and Distributed Energy Systems by Chakraborty, S., Simões, M. G. and Kramer, W. E., Springer.
- Grid Converters for Photovoltaic and Wind Power Systems by Teodorescu, R., Liserre, M. and Rodriguez, P.,Wiley-IEEE Press.
- Advanced DC/AC Inverters: Applications in Renewable Energy by Luo, F. L. and Ye, H., CRC Press.
- Modern Power Electronics and AC Drives by Bimal K. Bose, Pearson.
- Power Electronics: Converters, Applications and Design by Mohan, N., Undeland, T. M. and Robbins, W. P.,Wiley.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Types of Semiconductors	https://youtu.be/MovJj2ldIH0?si=1rGAK5CphMrpo6vr	NPTEL (IIT Madras)
Unit-II	DC-DC converters	https://youtu.be/TxgMCGX6ioU?si=3ZjeUfLedoO5MbfR	NPTEL (IISC Bangalore)
Unit-III	Solar Photovoltaics: Principles, Technologies & Materials	https://youtu.be/k-IJ7ulxWe4?si=DVcaHABXQvAyVnic	NPTEL (IIT Kanpur)
Unit-IV	Overview of Electric Vehicles in India	https://youtu.be/3E1SXG7VkQk?si=B5790Dzd1k79gAPO	NPTEL (IIT Madras)

Course Code	**MFTSE302B**				
Course Title	**Project**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	0	0	4	2	
Assessment	20 Marks				
End Semester Practical Examination	30Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

The students expected to take up a project under the guidance of teacher from the college. The Project must be based on Sustainability Engineering/Fire Technology and Safety Engineering problems. The students may be asked to work individually or in a group normally not more than three students in a group (if any large/ big projects occur then strength of student's can be increased as per guide supervision). Viva-voce must be based on the preliminary reports submitted by the students related to the project.

Course Code	**MFTSE303B**				
Category	Elective Courses				
Course Title	**Climate Change Understanding and Observations**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize the students with the fundamental concepts of climate, climate systems and the scientific basis of climate change. • To develop an understanding of climate processes, climate observations and the evidence supporting climate variability and climate change. • To make the students learn about climate drivers, climate modeling approaches and future climate projections used in climate science and planning. • To enable students to appreciate the role of climate science, policy frameworks and international initiatives in addressing climate change challenges.				
Assessment	25 Marks				
End Semester Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the fundamental concepts, terminology, processes, indicators, drivers, models, impacts, adaptation measures, mitigation approaches and policy frameworks related to climate science and climate change.	Level 1: Remember
CO2	Explain the interactions among climate system components, climate variability, climate observations, climate drivers and climate change processes at regional and global scales.	Level 2: Understand
CO3	Apply climate data, climate indicators, climate model outputs, and climate risk concepts for understanding climate variability, impacts and future climate conditions.	Level 3: Apply
CO4	Analyze climate change drivers, observational evidence, projected climate scenarios, climate risks and policy responses to support informed decision-making for sustainable development.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Climate System and Climate Change: Weather and climate, Elements of climate, Earth's climate system Atmosphere, Hydrosphere, Cryosphere, Lithosphere and biosphere, Solar radiation and earth's energy balance, Greenhouse effect, Carbon cycle, Climate forcing mechanisms, Natural climate variability and anthropogenic climate change, Historical evolution of climate science, Climate change terminology and concepts, Understanding climate requires knowledge of earth's energy balance, Atmospheric processes and interactions among earth systems.

Unit II

Climate Observations and Evidence of Climate Change: Climate observation systems, Meteorological stations, Satellites and remote sensing, Climate datasets and indicators, Temperature records, Precipitation trends, Sea level rise, Glacier retreat, Ocean warming, Extreme weather events, Detection and attribution of climate change, Interpretation of observational records, Role of the IPCC in climate assessment, Uncertainties in climate observations, Modern climate science relies on observational evidence and attribution studies to distinguish natural variability from human-induced change.

Unit-III

Climate Variability, Modelling and Future Projections: Climate variability and climate drivers, El Niño and La Niña phenomena, Monsoon variability, Climate feedback mechanisms, Tipping points, Fundamentals of climate modeling, Climate scenarios and emission pathways, Climate projections, Interpretation of climate model outputs, Regional and global climate projections, Uncertainty analysis, Applications of climate models in planning and decision-making, Climate models help understand future climate conditions and evaluate potential impacts of emissions and mitigation pathways.

Unit-IV

Climate Change Impacts, Adaptation and Mitigation: Impacts of climate change on water resources, Agriculture, Ecosystems, Biodiversity, Human health, Energy systems and infrastructure, Climate risks and vulnerabilities, Adaptation strategies and resilience building, Mitigation approaches, Carbon management, Renewable energy and climate action, International climate agreements—UNFCCC, Kyoto Protocol and Paris Agreement, India's climate initiatives and national action plan on climate change (NAPCC), Sustainable development and climate policy, Climate studies increasingly integrate science, Adaptation, Mitigation and policy responses.

Suggested Readings:

- Atmosphere, Weather and Climate by Barry, R. G. and Chorley, R. J., Routledge.
- Introduction to Modern Climate Change by Dessler, A. E., Cambridge University Press.
- Global Warming: Understanding the Forecast by Archer, D., Wiley.
- Climate Change Assessment Reports (AR6 and subsequent reports), IPCC.
- Climate Change: A Very Short Introduction by Maslin, M., Oxford University Press.
- Contemporary Climatology by Henderson-Sellers, A. and Robinson, P. J., Pearson.
- The New Climate War by Mann, M. E., Public Affairs.
- Earth's Climate: Past and Future by Ruddiman, W. F., W.H. Freeman.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Basics of Carbon Cycle	https://youtu.be/dBWwEdoTf7U?si=35SK0NqhsXgyYz7f	NPTEL (IIT Delhi)
Unit-II	Role of the IPCC in climate assessment	https://youtu.be/4qhZyT6guG4?si=4RM5WDkaV3vuttm1	NPTEL (IIT Kharagpur)
Unit-III	Climatic variables of the atmosphere	https://youtu.be/5tVWXsbe-Uk?si=I8DqaublfLCkQo4I	NPTEL (IIT Madras)
Unit-IV	Biodiversity	https://youtu.be/SHxAOoxhKTA?si=gWGkdpXTmV_Xt_1H	NPTEL (IIT Kanpur)

Course Code	**MFTSE304B**				
Category	Electives Courses				
Course Title	**Sustainable Buildings**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize the students with the principles, concepts, and significance of sustainable buildings and sustainable development in the built environment. • To develop an understanding of climate-responsive architecture, passive design strategies and energy-efficient building design practices. • To make the students learn about sustainable construction materials, resource-efficient construction techniques and environmentally responsible building practices. • To enable students to appreciate the role of sustainable building design, construction and operation in reducing environmental impacts and promoting sustainable development.				
Assessment	25 Marks				
End Semester Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the fundamental concepts, principles, terminology, materials, systems, assessment methods and rating frameworks associated with sustainable buildings and green construction practices.	Level 1: Remember
CO2	Explain the relationships among sustainable building design, energy efficiency, resource conservation, indoor environmental quality and environmental performance in the built environment.	Level 2: Understand
CO3	Apply sustainable building design principles, energy conservation measures, resource-efficient practices and building performance assessment approaches to building systems and projects.	Level 3: Apply
CO4	Analyze building designs, construction practices, resource utilization patterns, environmental impacts, and building performance indicators to support sustainable decision-making in the built environment.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Sustainable Buildings: Introduction to sustainable development in the built environment,Concept and objectives of sustainable buildings,Environmental impacts of buildings,Sustainable construction principles,Life cycle approach in buildings,Site selection and sustainable site planning,Climate-responsive architecture,Building orientation,Passive design concepts,Sustainable building design process,Role of sustainable buildings in achieving Sustainable Development Goals (SDGs).

Unit-II

Energy-Efficient Building Design and Building Envelope: Building energy consumption patterns,Heat transfer in buildings,Thermal comfort and indoor environmental quality,Building envelope design,Walls, roofs, windows and insulation materials,Passive solar heating and cooling techniques,Daylighting strategies,Natural ventilation systems,Energy-efficient lighting systems, HVAC systems and energy conservation measures, Energy Conservation Building Code (ECBC) and its provisions.

Unit-III

Sustainable Materials, Water Management and Green Construction: Sustainable construction materials, Embodied energy of building materials, Recycled and eco-friendly materials, Low-carbon construction technologies, Construction waste management, Resource-efficient construction practices.

Water conservation in buildings, Rainwater harvesting, Greywater recycling, Wastewater treatment and reuse, Water-efficient fixtures and appliances, Sustainable landscaping and stormwater management, Green roofs and green walls.

Unit-IV

Green Building Rating Systems and Building Performance Assessment: Green building certification systems, LEED (Leadership in Energy and Environmental Design), GRIHA (Green Rating for Integrated Habitat Assessment), IGBC Green Building Rating System,Net-zero energy buildings,Energy auditing of buildings,Building energy simulation concepts,Building performance assessment,Life cycle cost analysis,Carbon footprint assessment of buildings,Case studies of sustainable buildings in India and abroad.

Suggested Readings:

- Sustainable Construction: Green Building Design and Delivery by Kibert, C.J., Wiley.
- Green Building Through Integrated Design by Yudelson, J., McGraw Hill.
- Sustainable Construction and Building Design by Charles J. Kibert, Wiley.
- Energy Audit of Building Systems: An Engineering Approach by Krarti, M., CRC Press.
- Climate Considerations in Building and Urban Design by Givoni, B., Wiley.
- Sustainable Construction by Halliday, S., Butterworth-Heinemann.
- GRIHA Manual, Green Rating for Integrated Habitat Assessment, TERI.
- ECBC Manual, Energy Conservation Building Code, Bureau of Energy Efficiency (BEE), Government of India.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-II	Introduction to HVAC	https://youtu.be/xMkgzVR1Luo?si=Z0x1-_gMVGGQekF_	NPTEL (IIT Delhi)
Unit-III	Rainwater Harvesting & Roof Catchment System	https://youtu.be/QewEi2U1jLs?si=h3bBGqhtBaI8pLaY	NPTEL (IIT Bombay)
Unit-IV	Energy Audit: Case Studies	https://youtu.be/BrBBneXpIjk?si=KuoZXq7F-oLed_C8	NPTEL (IIT Kanpur)

Course Code	**MFTSE305B**				
Category	Electives Courses				
Course Title	**Energy Storage System for Renewables**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize the students with the fundamentals, characteristics, and significance of energy storage systems in modern energy infrastructure. • To develop an understanding of the role of energy storage technologies in renewable energy integration, grid stability, and energy management. • To make the students learn about electrochemical, mechanical, thermal, and hydrogen-based energy storage technologies and their operating principles. • To enable students to appreciate the techno-economic, environmental, and sustainability aspects of energy storage systems and emerging storage technologies.				
Assessment	25 Marks				
End Semester Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the fundamental concepts, terminology, classifications, characteristics, technologies and applications associated with energy storage systems and renewable energy integration.	Level 1: Remember
CO2	Explain the operating principles, performance characteristics, and functional requirements of electrochemical, mechanical, thermal and hydrogen energy storage systems.	Level 2: Understand
CO3	Apply the principles of energy storage technologies, energy management practices, and system integration approaches to renewable energy, microgrid, smart grid and electric vehicle applications.	Level 3: Apply
CO4	Analyze the performance, reliability, techno-economic feasibility, environmental implications, and integration aspects of energy storage systems for sustainable energy applications.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Energy Storage Systems: Introduction to energy storage,Need for energy storage in renewable energy systems,Energy storage requirements for solar and wind power integration,Energy storage characteristics,Power rating, Energy density, Efficiency, Cycle life, Reliability and safety,Classification of energy storage systems,Grid-scale and distributed energy storage,Applications in renewable energy systems, Electric vehicles and microgrids.

Unit-II

Electrochemical Energy Storage Systems: Principles of electrochemical energy storage,Primary and secondary batteries,Lead-acid batteries,Nickel-cadmium batteries,Nickel-metal hydride batteries,Lithium-ion batteries and advanced lithium battery technologies,Sodium-sulfur batteries,Flow batteries,Battery performance characteristics,Charging and discharging processes,Battery degradation mechanisms,Battery safety considerations.

Unit-III

Mechanical, Thermal and Hydrogen Energy Storage: Mechanical energy storage systems: pumped hydro energy storage, Compressed Air Energy Storage (CAES), Flywheel energy storage systems, Thermal energy storage: Sensible heat storage, Latent heat storage, Phase change materials, Thermochemical storage, Hydrogen energy storage: Hydrogen production, Storage methods, Fuel cells, Hydrogen economy, Comparative analysis of storage technologies for renewable energy integration.

Unit-IV

Energy Storage Applications and System Integration: Battery Management Systems (BMS), Energy management strategies, Hybrid energy storage systems, Integration of storage with solar photovoltaic and wind energy systems, Storage in microgrids and smart grids, Energy storage for electric vehicles, Techno-economic analysis of storage systems, Life cycle assessment, Emerging storage technologies, Case studies on renewable energy storage projects.

Suggested Readings:

- Energy Storage: Systems and Components by Luo, X., Wang, J., Dooner, M., and Clarke, J., Wiley.
- Battery Energy Storage Technology for Sustainable Power Systems by Divya, K. C. and Østergaard, J., Springer.
- Thermal Energy Storage: Systems and Applications by Ibrahim Dincer and Marc A. Rosen, Wiley.
- Energy Storage for Power Systems by A.G. Ter-Gazarian, IET Publications.
- Renewable Energy Conversion, Transmission and Storage by Bent Sørensen, Academic Press.
- Energy Storage by Robert Huggins, Springer.
- Handbook of Batteries by Linden, D. and Reddy, T.B., McGraw Hill.
- PEM Fuel Cells: Theory and Practice by FranoBarbir, Academic Press.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Need for Energy Storage	https://youtu.be/nmqbKCbjArI?si=Ljw4s9NAXBjGb0X3	NPTEL (IIT Kanpur)
Unit-II	Lithium Ion Battery	https://youtu.be/no4vRKvKxcU?si=CIrSjGOVBDohzbuI	NPTEL (IIT Kharagpur)
Unit-III	Fuel cells technologies - Part I	https://youtu.be/Eb7pv0oOf_k?si=alifMYpefoAxEv7Y	NPTEL (IIT Guwahati)

Course Code	**MFTSE306B**				
Category	Electives Courses				
Course Title	**Energy Management and Audit**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize the students with the concepts, principles, and practices of energy management and energy conservation in various sectors. • To develop an understanding of energy resources, energy utilization patterns, energy performance indicators, and benchmarking techniques. • To make the students learn about energy auditing methodologies, audit procedures, measurement techniques, and economic evaluation of energy conservation projects. • To enable students to appreciate the role of energy management, energy auditing, and continuous performance improvement in achieving energy efficiency and sustainable development.				
Assessment	25 Marks				
End Semester Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, terminology, methodologies, standards, indicators, and techniques associated with energy management, energy auditing, energy efficiency, and energy conservation.	Level 1: Remember
CO2	Explain the principles of energy management, energy auditing procedures, energy performance assessment methods, and energy conservation practices in various systems and sectors.	Level 2: Understand
CO3	Apply energy auditing methodologies, energy performance assessment techniques, and energy management principles to identify opportunities for energy conservation and efficiency improvement.	Level 3: Apply
CO4	Analyze energy consumption patterns, energy performance data, audit findings, economic feasibility parameters, and energy management practices to support sustainable energy decision-making.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Energy Management: Energy scenario: Global and Indian perspective,Energy resources and utilization,Energy conservation and its importance,Principles of energy management,Energy

policy and energy planning,Energy management programs,Role and responsibilities of energy managers,Energy accounting and monitoring,Energy Performance Indicators (EnPIs),Benchmarking of energy consumption,Energy efficiency and sustainability.

Unit-II

Energy Audit Methodology: Introduction to energy auditing,Objectives and benefits of energy audits,Types of energy audits—preliminary audit, detailed audit and investment-grade audit,Audit methodology,Audit instruments and measurements,Data collection and analysis,Energy balance and material balance,Identification of energy losses,Preparation of audit reports,Economic evaluation of energy conservation projects,Simple payback period, Net Present Value (NPV), Internal Rate of Return (IRR) and life cycle costing.

Unit-III

Energy Efficiency in Utilities and Building Systems: Energy-efficient electrical systems, Motors and motor efficiency improvement,Transformers and power factor correction,Lighting systems and energy-efficient lighting technologies, HVAC systems and energy conservation,Boilers, Furnaces, Steam systems, Compressed air systems, Pumps and fans,Energy management in buildings, Energy Conservation Building Code (ECBC),Building energy performance assessment.

Unit-IV

Energy Conservation Opportunities and Energy Management Systems: Energy conservation opportunities in industrial, commercialand residential sectors,Waste minimization and resource optimization,Demand-side management,Renewable energy integration,Energy Management Systems (EnMS), ISO 50001 Energy Management Standard,Measurement and Verification (M&V),Carbon footprint reduction strategies,Case studies of successful energy management projects,Role of energy auditing in sustainable development.

Suggested Readings:

- Energy Management by W. R. Murphy and G. McKay, Butterworth-Heinemann.
- Guide to Energy Management by Barney L. Capehart, Wayne C. Turner and William J. Kennedy, CRC Press.
- Energy Efficiency for Engineers and Technologists by Eastop, T. D. and Croft, D. R., Longman.
- Energy Manager and Energy Auditor Guide Books, Bureau of Energy Efficiency (BEE), Volumes I – IV.
- Energy Management by Paul O'Callaghan, McGraw Hill.
- Energy Management Handbook by Wayne C. Turner, Fairmont Press.
- Energy Management Handbook by Doty, S. and Turner, W. C., Fairmont Press.
- Energy Management and Conservation Handbook by Kreith, F. and Goswami, D. Y., CRC Press.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Energy conservation and its importance	https://youtu.be/ubDMIAJydPc?si=jaYVvSx5SMsBLcva	NPTEL (IIT Guwahati)
Unit-II	Introduction to energy auditing	https://youtu.be/BrBBneXpIjk?si=svRS06m15nDLCtI1	NPTEL (IIT Kanpur)
Unit-III	HVAC systems and energy conservation	https://youtu.be/xMkgzVR1Luo?si=iKfek20XGHBzsbJQ	NPTEL (IIT Delhi)
Unit-IV	Carbon footprint	https://youtu.be/r1Li7Dh0Xh4?si=iDr04Ifs_98ok3Wt	NPTEL (IIT Kanpur)

<table>
<tr><td>Course Code</td><td colspan="5">MFTSE307B</td></tr>
<tr><td>Category</td><td colspan="5">Electives Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Renewable Energy Technologies</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-V</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
To familiarize the students with the fundamentals of renewable energy resources, energy transition, and their significance in sustainable development.
To develop an understanding of the principles, technologies, and applications of solar, wind, hydropower, biomass, geothermal, and ocean energy systems.
To make the students learn about renewable energy resource assessment, energy conversion processes, and power generation technologies.
To enable students to appreciate the role of emerging renewable energy technologies, hydrogen energy systems, and policy frameworks in achieving sustainable energy goals.</td></tr>
<tr><td>Assessment</td><td colspan="5">25 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">50 Marks</td></tr>
<tr><td>Total</td><td colspan="5">75 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts, terminology, resources, technologies, systems and applications associated with renewable energy and sustainable energy development.	Level 1: Remember
CO2	Explain the operating principles, resource characteristics, energy conversion processes and performance features of solar, wind, hydropower, biomass, geothermal, and ocean energy systems.	Level 2: Understand
CO3	Apply the principles of renewable energy resource assessment, energy conversion technologies and system integration approaches to renewable energy applications.	Level 3: Apply
CO4	Analyze renewable energy systems, resource potentials, environmental impacts, economic considerations and integration challenges to support sustainable energy planning and decision-making.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Introduction to Renewable Energy and Solar Energy Systems: Global and Indian energy scenario,Need for renewable energy,Renewable and non-renewable energy resources,Sustainability and energy transition,Renewable energy potential in India,Solar radiation fundamentals,Solar geometry,Solar resource assessment,Solar thermal energy systems,Flat plate collectors, Evacuated tube collectors, Concentrating solar collectors,Applications of solar thermal systems,Introduction to solar photovoltaic systems and their applications.

Unit-II

Wind and Hydropower Technologies: Wind energy fundamentals,Wind characteristics and resource assessment,Wind energy conversion systems,Horizontal axis and vertical axis wind turbines, Betz limit, Components and operation of wind power plants,Offshore and onshore wind farms,Environmental aspects of wind energy, Hydropower systems, Hydrological cycle, Classification of hydroelectric plants, Micro, Mini and small hydropower systems,Components of hydropower plants,Pumped storage hydropower,Environmental and social impacts of hydropower development.

Unit-III

Biomass, Geothermal and Ocean Energy Technologies: Biomass resources and characteristics,Biomass conversion technologies,Combustion, Gasification, Pyrolysis, Anaerobic digestion and biogas production, Biofuels and biodiesel, Waste-to-energy technologies, Geothermal energy resources, Geothermal power plants and direct heating applications,Ocean energy technologies including tidal energy, wave energy, Ocean Thermal Energy Conversion (OTEC),Advantages, Limitations and applications of geothermal and ocean energy systems.

Unit-IV

Renewable Energy Integration and Emerging Technologies: Energy storage requirements for renewable energy systems, Integration of renewable energy with electrical grids, Hybrid renewable energy systems, Distributed generation and microgrids, Hydrogen energy and fuel cells,Smart renewable energy systems,Economics of renewable energy projects,Environmental impacts and life cycle assessment of renewable technologies, Policies, Incentives and future trends in renewable energy development.

Suggested Readings:

- Renewable Energy Resources by Twidell, J. and Weir, T., 4th Edition, Routledge.
- Renewable Energy: Power for a Sustainable Future by Boyle, G., Oxford University Press.
- Renewable Energy Engineering and Technology: Principles and Practice by Kishore, V. V. N., Earthscan.
- Solar Energy by Sukhatme, S. P. and Nayak, J. K., McGraw Hill Education.
- Solar Energy: Fundamentals and Applications by Garg, H. P. and Prakash, S., McGraw Hill.
- Renewable Energy: Technology, Economics and Environment by Kaltschmitt, M., Streicher, W., and Wiese, A., Springer.
- Renewable Energy and Sustainability by Khan, I., Elsevier.
- Non-Conventional Energy Sources by Rai, G. D., Khanna Publishers.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Solar Radiation	https://youtu.be/-I5O_kRzc3E?si=TKboTWIIZ7IBvnzx	NPTEL (IIT Kanpur)
Unit-II	Hydrological cycle	https://youtu.be/MBGBiBNeU6M?si=RGe1Xi8K9Md9iDzg	NPTEL (IIT Kanpur)
Unit-III	Characteristics and properties of biomass	https://youtu.be/L3AEXdvtIkk?si=14qNfh1Vb1Ev6HeT	NPTEL (IIT Guwahati)
Unit-IV	Fuel cells technologies - Part I	https://youtu.be/Eb7pv0oOf_k?si=yzgg_aByuCym-f1o	NPTEL (IIT Guwahati)

Course Code	**MFTSE308B**				
Category	Electives Courses				
Course Title	**Energy Conservation and Waste Heat Recovery**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize the students with the principles, significance, and practices of energy conservation in industrial and building sectors. • To develop an understanding of energy utilization patterns, energy efficiency measures, and energy conservation opportunities in various energy systems. • To make the students learn about energy conservation technologies and performance improvement techniques used in industrial utilities and electrical systems. • To enable students to appreciate the role of energy conservation, waste heat recovery, and emerging technologies in enhancing energy efficiency and reducing environmental impacts.				
Assessment	25 Marks				
End Semester Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the fundamental concepts, terminology, principles, technologies, performance indicators, and economic parameters related to energy conservation and waste heat recovery systems.	Level 1: Remember
CO2	Explain the principles of energy conservation, energy-efficient utility systems, waste heat recovery technologies, and their role in improving energy performance and sustainability.	Level 2: Understand
CO3	Apply energy conservation principles, efficiency improvement techniques, and waste heat recovery approaches to industrial utilities, electrical systems, and process operations.	Level 3: Apply
CO4	Analyze energy utilization patterns, system losses, waste heat recovery opportunities, economic performance indicators, and environmental impacts to support energy-efficient and sustainable decision-making.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Energy Conservation: Energy scenario and energy utilization, Need for energy conservation, Principles of energy conservation, Energy efficiency and energy intensity, Energy conservation opportunities in industries and buildings, Energy performance indicators, Energy losses and their reduction, Energy conservation legislation and policies, Role of Bureau of Energy Efficiency (BEE), Perform, Achieve and Trade (PAT) scheme, Sustainable energy utilization and carbon emission reduction.

Unit-II

Energy Conservation in Industrial Utilities: Energy conservation in boilers and steam systems, Boiler efficiency improvement techniques, Steam distribution and condensate recovery, Energy-efficient furnaces and kilns, Compressed air systems and energy-saving measures, Pumps, Fans, Blowers and motors, Electrical energy conservation, Lighting system efficiency, Power factor improvement, Variable Frequency Drives (VFDs), Energy-efficient industrial practices and case studies.

Unit-III

Waste Heat Recovery Technologies: Introduction to waste heat and its sources, Classification of waste heat, Waste heat potential in industrial systems, Waste heat recovery principles, Heat exchangers and recuperators, Regenerators, Economizers, Waste heat boilers, Heat pipes, Thermal wheels, Thermoelectric generators, Organic Rankine Cycle (ORC), Cogeneration and Combined Heat and Power (CHP) systems, Selection criteria for waste heat recovery systems.

Unit-IV

Applications, Economic Analysis and Emerging Technologies: Waste heat recovery applications in cement, Steel, Glass, Chemical, Refinery, Power generation and process industries, District heating systems, Waste-to-energy concepts, Economic evaluation of energy conservation projects, Payback period, Net Present Value (NPV), Internal Rate of Return (IRR), Life cycle costing, Environmental benefits of waste heat recovery, Carbon footprint reduction, Emerging energy conservation technologies, Industrial case studies and best practices.

Suggested Readings:

- Energy Management and Conservation Handbook by Kreith, F. and Goswami, D. Y., CRC Press.
- Energy Efficiency for Engineers and Technologists by Eastop, T. D. and Croft, D. R., Longman Scientific & Technical.
- Energy Management Principles by Smith, C. B., Pergamon Press.
- Energy Manager and Energy Auditor Guide Books by Bureau of Energy Efficiency (BEE), Volumes I–IV.
- Handbook of Energy Audits by Thumann by A. and Younger, W. J., Fairmont Press.
- Heat Recovery Systems by Reay, D., McMichael, A., and Klemes, J., CRC Press.
- Energy Management Handbook by Turner, W. C. and Doty, S., Fairmont Press.
- Industrial Boilers and Heat Recovery Steam Generators by Ganapathy, V., CRC Press.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Energy scenario	https://youtu.be/19ruvTD65v8?si=ym_Bi3b1GHPYfo4c	NPTEL (IIT Guwahati)
Unit-III	Introduction to waste heat recovery (Contd.)2	https://youtu.be/UvYJzvK_8aE?si=eB_94s2lutWHhjyQ	NPTEL (IIT Kharagpur)
Unit-IV	Carbon Footprint	https://youtu.be/r1Li7Dh0Xh4?si=b-VJcp5ZNsJrrJQz	NPTEL (IIT Kanpur)

Course Code	**MFTSE309B**				
Category	Electives Courses				
Course Title	**Hydrogen and Fuel Cell Technology**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize the students with the fundamentals of hydrogen energy, hydrogen economy, and the role of hydrogen in sustainable energy systems. • To develop an understanding of hydrogen production, storage, transportation, and distribution technologies used in modern energy applications. • To make the students learn about various fuel cell technologies, their operating principles, performance characteristics, and applications. • To enable students to appreciate the role of hydrogen energy systems, fuel cells, and emerging technologies in achieving decarbonization and carbon-neutral energy transitions.				
Assessment	25 Marks				
End Semester Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the fundamental concepts, terminology, technologies, components, processes and applications associated with hydrogen energy systems, hydrogen storage and fuel cell technologies.	Level 1: Remember
CO2	Explain the principles of hydrogen production, storage, transportation, fuel cell operation and energy conversion processes in hydrogen-based energy systems	Level 2: Understand
CO3	Apply the principles of hydrogen production, storage technologies, fuel cell systems and renewable hydrogen integration to energy and transportation applications.	Level 3: Apply
CO4	Analyze hydrogen systems, fuel cell technologies, economic feasibility, environmental impacts, commercialization challenges and policy frameworks to support sustainable energy decision-making.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Hydrogen Energy Fundamentals: Introduction to hydrogen energy, Hydrogen as an energy carrier, Role of hydrogen in sustainable development, Global and Indian hydrogen scenario, Properties of hydrogen, Advantages and limitations of hydrogen energy, Hydrogen economy concept, Energy transition and decarbonization, Applications of hydrogen in transportation, Power generation, Industry and residential sectors, Future prospects of hydrogen technologies.

Unit-II

Hydrogen Production and Storage Technologies: Hydrogen production methods, Steam methane reforming, Coal gasification, Partial oxidation, Water electrolysis, Alkaline electrolysis, PEM electrolysis, Solid oxide electrolysis, Biomass-based hydrogen production, Biological hydrogen production methods, Green, Blue, Grey, and turquoise hydrogen. Hydrogen storage methods, Compressed gas storage, Liquid hydrogen storage, Cryogenic storage, Metal hydrides, Chemical hydrides, Adsorption-based storage, Hydrogen transportation and distribution systems, Safety aspects in hydrogen handling and storage.

Unit-III

Fuel Cell Technologies: Introduction to fuel cells, Principles of operation, Thermodynamics and electrochemistry of fuel cells, Fuel cell efficiency and performance parameters, Polarization characteristics.
Types of fuel cells: Proton Exchange Membrane Fuel Cell (PEMFC), Alkaline Fuel Cell (AFC), Phosphoric Acid Fuel Cell (PAFC), Molten Carbonate Fuel Cell (MCFC), Solid Oxide Fuel Cell (SOFC), Direct Methanol Fuel Cell (DMFC), Fuel cell components, Fuel processing systems, Balance of plant, Performance evaluation and degradation mechanisms.

Unit-IV

Applications, Economics and Future Trends: Hydrogen-fuel cell integrated systems, Renewable hydrogen systems, Fuel cells for transportation, Stationary power generation, Portable power applications, Hydrogen-powered vehicles, Hydrogen refueling infrastructure, Fuel cell hybrid systems. Economic analysis of hydrogen energy systems, Life cycle assessment, Environmental benefits, Carbon neutrality and net-zero targets, Hydrogen policies and missions, National Green Hydrogen Mission (India),Challenges and opportunities in hydrogen commercialization, Emerging developments in hydrogen and fuel cell technologies.

Suggested Readings:

- PEM Fuel Cells: Theory and Practice by Barbir, F., Academic Press.
- Hydrogen Science and Engineering: Materials, Processes, Systems and Technology by Stolten, D. and Emonts, B., Wiley-VCH.
- Recent Trends in Fuel Cell Science and Technology by Basu, S., Springer.
- Hydrogen and Fuel Cells: Emerging Technologies and Applications by Sorensen, B., Academic Press.
- Fuel Cell Fundamentals by O'Hayre, R., Cha, S., Colella, W., and Prinz, F., Wiley.
- Fuel Cell Systems Explained by Larminie, J. and Dicks, A., Wiley.
- Hydrogen Energy Systems: Production and Utilization of Hydrogen and Future Aspects by Dincer, I. and Acar, C., Elsevier.
- The Hydrogen Economy by Rifkin, J., Tarcher Publications.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Hydrogen energy	https://youtu.be/nXW1C1sJ8L8?si=ztmUkp-LnQrvvPLc	NPTEL (IIT Guwahati)
Unit-II	Electrolysis of Water for Hydrogen Production	https://youtu.be/689dqOXqfJo?si=JhrzBthH7xeFCo5M	NPTEL (IIT Bombay)
Unit-III	Fuel cells technologies - Part I	https://youtu.be/Eb7pv0oOf_k?si=9nAJYW3MGHCevZB6	NPTEL (IIT Guwahati)
Unit-IV	India's stand on Carbon Neutrality	https://youtu.be/F9OaRcPM-lE?si=cC6m2SWdTfBRkjxp	NPTEL (IIT Madras)

<table>
<tr><td>Course Code</td><td colspan="6">MFTSE310B</td></tr>
<tr><td>Category</td><td colspan="6">Elective Courses</td></tr>
<tr><td>Course Title</td><td colspan="6">Smart Grid and Energy Systems</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VI</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="6">The objectives of this course are
To familiarize the students with the fundamentals of electrical power systems, smart grid technologies, and their role in modern energy systems.
To develop an understanding of smart grid architecture, components, standards, and challenges associated with conventional and intelligent power networks.
To make the students learn about renewable energy integration, distributed generation, and energy storage technologies in smart grid environments.
To enable students to appreciate the role of smart grids, microgrids, energy storage, electric vehicles, and emerging technologies in achieving sustainable and resilient energy systems.</td></tr>
<tr><td>Assessment</td><td colspan="6">25 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="6">50 Marks</td></tr>
<tr><td>Total</td><td colspan="6">75 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="6">03 Hours</td></tr>
</table>

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, terminology, architectures, components, technologies, standards, and applications associated with power systems, smart grids, renewable energy integration, and smart energy systems.	Level 1: Remember
CO2	Explain the principles, functions, and operational characteristics of smart grids, distributed generation systems, renewable energy integration approaches, energy storage technologies, and microgrids.	Level 2: Understand
CO3	Apply the principles of renewable energy integration, demand management, energy storage utilization, communication technologies, and microgrid operation to smart energy systems.	Level 3: Apply
CO4	Analyze the performance, reliability, operational challenges, communication requirements, security aspects, and sustainability impacts of smart grids and future energy systems.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Power Systems and Smart Grids: Introduction to electrical power systems, Generation, Transmission, Distribution and utilization of electrical energy, Challenges of conventional power grids, Need for smart grids, Evolution of smart grid concept, Characteristics and benefits of smart

grids, Smart grid architecture, Smart grid components, Stakeholders in smart grid systems, Smart grid standards and policies.

Unit II

Renewable Energy Integration in Smart Grids: Solar photovoltaic systems, Wind energy systems, Biomass-based power generation, Distributed generation concepts, Grid integration challenges of renewable energy systems, Intermittency and variability of renewable resources, Forecasting techniques, Power quality issues, Grid codes and standards for renewable energy integration, Virtual power plants.

Unit-III

Smart Metering and Demand Side Management: Advanced Metering Infrastructure (AMI), Smart meters and their functions, Real-time monitoring and control, Demand response programs, Demand-side management techniques, Load forecasting, Peak load management, Energy efficiency measures, Consumer participation in smart grids, Smart homes and smart buildings.

Energy Storage Systems and Microgrids: Role of energy storage in smart grids, Battery energy storage systems, Lithium-ion batteries, Flow batteries, Supercapacitors, Hydrogen energy storage, Pumped hydro storage, Microgrid concepts and architecture, Grid-connected and islanded operation, Microgrid control strategies, Resilience and reliability enhancement.

Unit-IV

Communication Technologies and Future Smart Energy Systems: Communication requirements in smart grids, Wired and wireless communication technologies, Internet of Things (IoT) in energy systems, Supervisory control and data acquisition (SCADA), Cyber security issues in smart grids, Artificial intelligence and machine learning applications in energy management, Electric vehicle integration, Smart cities and future energy systems.

Suggested Readings:

- Smart Grids: Infrastructure, Technology and Solutions by Stuart Borlase, CRC Press.
- Smart Grid: Technology and Applications by Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu and Akihiko Yokoyama, Wiley.
- Design of Smart Power Grid Renewable Energy Systems by Ali Keyhani, Wiley-IEEE Press.
- The Smart Grid: Enabling Energy Efficiency and Demand Response by Clark W. Gellings, CRC Press.
- Smart Grid: Fundamentals of Design and Analysis by James Momoh, Wiley-IEEE Press.
- Microgrids and Active Distribution Networks by S. Chowdhury and S. P. Chowdhury, IET Publications.
- Smart Grid: Integrating Renewable, Distributed and Efficient Energy by Fereidoon P. Sioshansi, Academic Press.
- Energy Technology by O.P. Gupta, Khanna Publishing House.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Introduction to electrical power systems	https://youtu.be/3TR_DS_7z2w?si=OTlyX7s6K2qEHA6D	NPTEL (IIT Kharagpur)
Unit-II	Biomass-based power generation	https://youtu.be/KSN9whMllAk?si=UxlMglteO9ZvAk_7	NPTEL (IIT Guwahati)
Unit-III	Lithium-ion batteries	https://youtu.be/no4vRKvKxcU?si=h0oXn6GVej9sDL84	NPTEL (IIT Kharagpur)
Unit-IV	Internet of Things (IoT) in energy systems	https://youtu.be/WUYAjxnwjU4?si=p70L9m51s9iHGUPq	NPTEL (IIT Kharagpur)

Course Code	**MFTSE312B**				
Category	Electives Courses				
Course Title	**Solar Energy Technologies and System Design**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize the students with the fundamentals of solar energy, solar radiation principles, and solar resource assessment techniques. • To develop an understanding of photovoltaic and solar thermal energy conversion technologies and their applications. • To make the students learn about solar photovoltaic components, performance characteristics, and factors influencing the efficiency of solar energy systems. • To enable students to appreciate the role of solar energy technologies and emerging innovations in achieving sustainable and clean energy development.				
Assessment	25 Marks				
End Semester Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the fundamental concepts, terminology, principles, technologies, components, and applications associated with solar energy systems and solar energy conversion processes.	Level 1: Remember
CO2	Explain the principles of solar radiation, photovoltaic energy conversion, solar thermal energy conversion, system components, and factors affecting solar energy system performance.	Level 2: Understand
CO3	Apply the principles of solar energy conversion, system sizing, component selection, and performance assessment to photovoltaic and solar thermal energy systems.	Level 3: Apply
CO4	Analyze the technical performance, energy yield, economic feasibility, reliability, environmental benefits, and sustainability aspects of solar energy systems for effective decision-making.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Solar Energy: Solar energy and its importance, Structure of the sun, Solar spectrum, Solar constant, Extraterrestrial and terrestrial solar radiation, Solar radiation measurement, Beam, Diffuse and global radiation, Solar angles, Sun-path diagrams, Solar energy potential assessment, Solar radiation data for India.

Unit-II

Solar Photovoltaic Technologies: Principles of photovoltaic energy conversion, Semiconductor fundamentals, Photovoltaic effect, Solar cell materials, Crystalline silicon, Thin-film and emerging solar cells, Solar cell characteristics, I–V and P–V curves, Efficiency and performance parameters, Photovoltaic modules and arrays, Factors affecting PV performance.

Unit-III

Solar Thermal Energy Technologies: Fundamentals of solar thermal energy conversion, Flat plate collectors, Evacuated tube collectors, Concentrating solar collectors, Solar water heating systems, Solar air heaters, Solar cookers, Solar dryers, Concentrated Solar Power (CSP) systems, Thermal energy storage for solar applications.

Unit-IV

Solar Energy System Design and Applications: Load assessment and energy demand estimation, Sizing of photovoltaic systems, Battery sizing and selection, Inverter selection, Stand-alone, Grid-connected and hybrid solar systems, System layout and installation considerations, Solar pumping systems, Rooftop solar systems, Building-Integrated, Photovoltaics(BIPV).

Performance Evaluation, Economics and Emerging Technologies: Performance analysis of solar energy systems, Energy yield assessment, Losses in solar systems, Reliability and maintenance, Economic evaluation of solar projects, Life cycle cost analysis, Payback period, Levelized Cost of Energy (LCOE),Environmental benefits, Floating solar PV, Agrivoltaics, Bifacial modules, Smart solar energy systems.

Suggested Readings:

- Solar Energy: Principles of Thermal Collection and Storage by S. P. Sukhatme and J. K. Nayak, McGraw Hill.
- Solar Photovoltaics: Fundamentals, Technologies and Applications by C. S. Solanki, PHI Learning.
- Solar Energy: Fundamentals and Applications by H. P. Garg and S. Prakash, McGraw Hill.
- Fundamentals of Renewable Energy Sources by G. N. Tiwari and M. K. Ghosal, Narosa Publishing House.
- Renewable Energy Resources by John Twidell and Tony Weir, Routledge.
- Photovoltaic Systems Engineering by Roger A. Messenger and Jerry Ventre, CRC Press.
- Renewable and Efficient Electric Power Systems by Gilbert M. Masters, Wiley.
- Energy Technology by O. P. Gupta, Khanna Publishing House.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Solar angles	https://youtu.be/zHYjuF48Tlc?si=O1376PmmyNJb3rWJ	NPTEL (IIT Guwahati)
Unit-II	Semiconductor fundamentals	https://youtu.be/q7VIITSysMs?si=Ag-GYQs6-wqHFx4S	NPTEL (IIT Guwahati)
Unit-III	Concentrated Solar Power (CSP) systems	https://youtu.be/boATMyQowDQ?si=XeoNUh3tDdgEihpn	NPTEL (IIT Madras)
Unit-IV	Photovoltaics	https://youtu.be/UVN1-SMyEDs?si=Et5p7Bt2_5q-4FC8	NPTEL (IIT Kanpur)

Course Code	**MFTSE401B**				
Category	Electives Courses				
Course Title	**Sustainable Energy Policy**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VII**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To familiarize the students with the fundamental concepts of sustainable energy policy, energy governance and their role in sustainable development. • To develop an understanding of energy security, energy access, environmental protection and policy frameworks supporting sustainable energy systems. • To make the students learn about renewable energy policies, energy efficiency regulations and policy instruments that promote sustainable energy adoption. • To enable students to appreciate the role of policy interventions, regulatory mechanisms and institutional frameworks in achieving sustainable and low-carbon energy futures.				
Assessment	25 Marks				
End Semester Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the fundamental concepts, terminology, principles, policy instruments, regulatory frameworks and governance mechanisms associated with sustainable energy systems and energy policy.	Level 1: Remember
CO2	Explain the relationships among sustainable development, energy security, renewable energy promotion, energy efficiency, climate change mitigation,and energy governance frameworks.	Level 2: Understand
CO3	Apply policy principles, regulatory approaches, sustainability concepts and energy governance frameworks to issues related to renewable energy deployment, energy efficiency, and climate action.	Level 3: Apply
CO4	Analyze energy policies, climate regulations, governance structures, market mechanisms and emerging energy trends to support informed decision-making in sustainable energy planning and management.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2 marks each from all units and remaining 8 questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Fundamentals of Sustainable Energy Policy: Energy and sustainable development, Principles of sustainability, Energy security, Energy access and environmental protection, Role of government in energy planning, Policy-making process, Stakeholders in energy policy, Energy governance, Sustainable Development Goals (SDGs) and energy sector

Unit-II

Renewable Energy and Energy Efficiency Policies: Policies promoting renewable energy technologies, Renewable Purchase Obligations (RPOs),Feed-in tariffs, Renewable Energy Certificates (RECs),Net metering, rooftop solar policies, Energy conservation policies, Energy efficiency standards and labeling, Demand-side management programs, Energy efficiency regulations.

Unit-III

Solar Thermal Energy Technologies: Fundamentals of solar thermal energy conversion, Flat plate collectors, Evacuated tube collectors, Concentrating solar collectors, Solar water heating systems, Solar air heaters, Solar cookers, Solar dryers, Concentrated Solar Power (CSP) systems, Thermal energy storage for solar applications.

Unit-IV

Climate Change and Sustainable Energy Regulations: Energy and climate change linkages, Greenhouse gas emissions from the energy sector, International climate agreements including United Nations Framework Convention on Climate Change, Kyoto Protocol and Paris Agreement, Carbon pricing mechanisms, Carbon taxes, Emissions trading systems, Nationally Determined Contributions (NDCs), India's climate commitments and energy transition strategies.

Emerging Trends and Future Energy Policy Challenges: Energy transition pathways, Smart grids, Distributed energy resources, Electric mobility policies, Hydrogen economy and green hydrogen initiatives, Energy justice and equity, Financing sustainable energy projects, Public-private partnerships, Policy challenges in renewable energy integration, Future outlook of sustainable energy governance.

Suggested Readings:

- Energy Economics: Concepts, Issues, Markets and Governance by Subhes C. Bhattacharyya, Springer.
- The Governance of Energy Megaprojects by Benjamin K. Sovacool, Edward Elgar Publishing.
- Renewable Energy and Sustainable Futures by D. Elliott, Palgrave Macmillan.
- Energy Technology by O. P. Gupta, Khanna Publishing House.
- Sustainable Energy Policy, CRC Press.
- Energy Policy, Routledge.
- Handbook of Energy Policy, Edward Elgar Publishing.
- International Energy Agency reports and policy outlook publications.
- Publications of the Ministry of New and Renewable Energy.

Useful Video Links

Unit No.	Topic	Link	Source
Unit-I	Principles of sustainability	https://www.youtube.com/watch?v=EGVQmNAoIFY	NPTEL (IIT Kharagpur)
Unit-III	Fundamentals of solar thermal energy conversion	https://www.youtube.com/watch?v=mpHZWYpKDJg	NPTEL (IIT Kharagpur)
Unit-IV	Kyoto Protocol	https://youtu.be/97r4704L84s?si=RrgODYsigBksWe5r	NPTEL (IIT Bengaluru)