Semester III

Fire Codes and Standards

1.1 Course Number: FSE201
1.2 Contact Hours:3-0-0 Credits:9
1.3 Semester-offered: 2nd Year –Odd
1.4 Prerequisite: Basic Science
1.5 Syllabus Committee Members: Ms. Ananya Borah & Dr. Nilambar Bariha

2. Objective:

i) To provide in-depth view of fire/combustion science.
ii) To introduce the concepts of fire protection/suppression engineering principles & systems currently followed in Oil & Gas industrial sector
iii) To brief the legislation requirements-national/international codes/ standards from fire & safety perspective

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Introduction**	FIRE: Definition of Fire, Fire Triangle, Tetrahedron of Fire, Classification of fires, Types of Extinguishing Media of Agent, Principles of Fire Extinguishing Methods Cooling, Starvation, Smothering, Retarding Chain Reaction, Stages of Fire, various Products of combustion.	9
2	**National Building code-Part IV-Fire & Life safety**	Code & Standards in construction & Design of building. Classification of buildings based on occupancy and type of construction according to fire resistance as per NBC; Fire zone; General fire safety requirements applicable to all individual occupancies. General exit requirements as per NBC; Internal staircases; horizontal exits; fire tower; ramps; fire lifts; external fire escape ladders.	9
3	**Specification of fire-fighting equipment**	Overview of Codes and Standards for active & passive fire protection system and materials.	8
4	**International Code & Standards**	International code & standard for Hydraulic platform, Turntable ladder and other Rescue and fire-fighting devices. Code, Standard and specification concerning to safety of fire-fighting personnel i.e., Breathing Apparatus P.P.E., safety gears and other devices.	8
5	**Scaffolding**	Code and Practice for construction of scaffolding. Scaffolding: Types, Parts, Hazards & Control Measures.	8
Total			**42**

4. Reading

4.1 Reference Books and Standards:

1. National Building codes of India- Part IV (2016), Bureau of Indian standards

2. IS 3696-1: Safety code of scaffolds and ladders, Part 1: Scaffolds,BIS, Part 2-Ladders.

3. IS 5896 (Part 3): Code of Practice for Selection, Operation, and Maintenance of Fire Fighting Appliances, Part 3: Turntable Ladder, BIS

4. IS 15105: Design and Installation of Fixed Automatic Sprinkler Fire Extinguishing Systems - Code of Practice,BIS

5. IS 6070: Code of practice for selection, operation and maintenance of trailer fire pumps, portable pumps, water tenders and motor fire engines,BIS

6. Sesha, P., Manual of Fire Safety

7. Jain, V.K., Fire Safety in Buildings

5. Outcome of the Course:

1) Gain knowledge on extinguishment of different kinds of fire & demonstrate the usage of various fire extinguishers.
2) Identify & explain different types of fire protection systems/ installations in oil and gas industry
3) Summarize the fire safety requirements for buildings of different occupancy as per the National Building Code of India.

Unit Operations-I

1.1 Course Number- CE201
1.2 Contact Hours- 3-1-0 Credits: 11
1.3 Semester Offered- 2nd Year Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee members- Dr. Abhimanyu Kar, Dr. Sanat Kumar Singha, Dr Naveen Mani Tripathi, Dr. Karthik Babu NB

2. Objective:

i) To study statics, kinematics and dynamics of fluids.
ii) To understand the characteristics associated with the fluid flow though pipeline systems.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Fluid Statics**	Brief description of various fluid properties, Pressure at a point, Compressible and Incompressible fluid, Measurement of pressure, Manometry, Buoyancy, Archimedes' principle and stability	6
2	**Fluid Kinematics**	Classification of fluid flows – viscous vs inviscid flow, internal vs external flow, compressible vs incompressible flow, laminar vs turbulent flow, natural vs forced flow, steady vs unsteady flow, uniform vs non-uniform flow; Flow patterns – timeline, streamline, path line, streamline	9
3	**Fluid Dynamics**	Fluid flow rate, Conservation of mass, Continuity equation, The Bernoulli's equation and its application	9
4	**Pipe Flow**	Flow regimes in a pipe, Energy loss in pipes through Darcy-Weisbach equation and Hagen-Poiseuille equation, Friction factor, Turbulent flow in pipes, Moody's Diagram	9
5	**Pipeline Systems**	Basic of pipe network system, Minor losses in pipes, Energy and hydraulic grade line, Valves used in pipelines – Flow control valve, Check valve, Pressure relief valve/ Safety valves	6
Total			**39**

4. Readings

4.1 Textbooks/ Reference Books:

1) Elger, Donald F., Barbara A. LeBret, Clayton T. Crowe, and John A. Roberson. Engineering fluid mechanics. John Wiley & Sons, 2020.
2) Yunus, A. Cengel. Fluid Mechanics: Fundamentals and Applications (SI Units). Tata McGraw Hill Education Private Limited, 2010.
3) Fox, Robert W., Alan T. McDonald, and John W. Mitchell. Fox and McDonald's introduction to fluid mechanics. John Wiley & Sons, 2020.
4) R.K. Bansal, A textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications.

5. Outcome of the Course:

1) Knowledge of fluid properties, stress, buoyancy and floatation.
2) Classify fluid flow and flow pattern.
3) Understand continuity and Bernoulli equations.
4) Derive Darcy-Weisbach equation and Hagen-Poiseuille equation associated with pipe flow.
5) Calculate friction factor from Moody diagram.
6) Knowledge of minor & major losses and energy & hydraulic grade lines corresponding to pipe flow.
7) Classify flow control valves and safety valves.

Engineering Thermodynamics

1.1 Course Number- ME206
1.2 Contact Hours- 3-0-0 Credits: 9
1.3 Semester Offered- 2nd Year Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee members- Dr. Abhimanyu Kar, Dr. Sanat Kumar Singha, Dr Naveen Mani Tripathi, Dr. Karthik Babu NB

2. Objective:

i) To understand basic concept of thermodynamics and its properties.
ii) To generate the ability to differentiate different forms of energy i.e., heat and work.
iii) To apply first law of thermodynamics to closed and flow systems.
iv) To realize the need of second law of thermodynamics, spontaneity and irreversibility in nature.
v) To learn basic concepts of real gases and working of external and internal combustion engines.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Basic concepts and definition**	Scope and limitations of Thermodynamics, Macroscopic and Microscopic approaches; Definition of System, Surrounding, closed systems, and open system; Properties: (extensive and Intensive), Characteristics of properties (point and path function), and its representation on a property diagram; Units of measurements: Force, Pressure, and Energy.	6
2	**Equilibrium and Zeroth Law**	Equilibrium: Thermal, Mechanical, Chemical, Thermodynamic; Zeroth Law of Thermodynamics and temperature, Measurement of temperature and calibration of Thermometers, the ideal gas temperature scale.	5
3	**Processes and its representation**	Reversible and Irreversible processes; Different types of process and their representations.	2
4	**Work and Heat Transfer**	Definitions and calculations: Work Transfer, Different modes of work, Displacement Work for various processes, Heat Transfer, Specific heat, Latent heat.	4
5	**First Law of Thermodynamics**	Joule's experiment, Introduction of internal energy as a thermodynamics property,	5

		Introduction of enthalpy as a thermodynamic property; Definition of specific heats and their use in calculation of internal energy and enthalpy with emphasis on ideal gases.	
6	**Applications of First Law of Thermodynamics**	Application of First Law to control mass: Work done and heat transfer in various types of elementary processes; Application of First Law to control volumes; Nozzle, Diffuser, Compressor, Turbine, Throttling device, Heat Exchanger. (Only steady flow need be considered).	8
7	**Second Law of Thermodynamics**	Limitations of first law of thermodynamics; Cyclic heat engine; Energy reservoirs; Refrigerator and Heat Pump; Kelvin-Plank statement and Clausius statement of second law; Reversibility and Irreversibility; Carnot Cycle and Carnot Theorems;	5
8	**Entropy**	Clausius' Theorem and Clausius' inequality; Concept of entropy; Entropy and Disorder; Entropy changes in various processes, Entropy Principle and its application,	5
	Total		**40**

4. Readings

4.1 Textbooks:

1. Engineering Thermodynamics by P.K. Nag, Publisher: TMH
2. Basic Engineering Thermodynamics by Rayner Joel, Pearson Education

4.2 Reference Books:

1. Engineering Thermodynamics by Van Wylen and Sontang, John Wiley
2. Engineering Thermodynamics by M. Achuthan, Publisher: PHI
3. Applied Thermodynamics by Eastop and McConkey, Publisher: Pearson
4. Fundamental of Engineering Thermodynamics by E. Rathakrishnan, publisher. PHI
5. Engineering Thermodynamics by Russel and Adebiyi, publisher, Oxford
6. Steam Tables in SI Units by Ramalingam, Scitech.

5. Outcome of the Course:

1) Basic understanding thermodynamics and its applications
2) Understand the basics of Engineering Materials (its applications) and Stress-Strain

3) Basic understanding of boilers, engines and latest automobile technologies.
4) Understand the basics Applied Mechanics, Simple lifting Machines & Power Transmission
5) Understand the basics of Engineering surveying and Smart Infrastructure Development.

Explosions and Industrial Fire Safety

1.1 Course Number: FSE202
1.2 Contact Hours:3-0-0 Credits:9
1.3 Semester-offered: 2nd Year –Odd
1.4 Prerequisite: Fundamentals of Fire and Safety Engineering
1.5 Syllabus Committee Members: Ms. Ananya Borah &Dr. Nilambar Bariha

2. Objective:

i) To provide basic concepts of explosion hazards and its prevention measures.
ii) To provide in-depth knowledge of various processes involved in the engineering industry and the associated hazards.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Introduction to Explosion Characteristics**	Explosion hazards & different case studies, Flammability limits and Theories-Lean limit and Rich limit, LEL & UEL measurement techniques and equipment, Minimum ignition energy, Relation between auto-ignition temperature and flash point, Effect of temperature and pressure on flash point, Classification of flammable materials, Vapour cloud tank explosion.	6
2	**Explosion Prevention and Protection**	Explosion prevention techniques-Ventilation, Separation. Physical barriers. Alternative techniques, Preventing the formation of explosive atmosphere, Explosion protection systems - a. Protection techniques - Containment, Isolation, Suppression, Ventilation for explosion protection system, Explosion protection using inert gases, Flame arrestors and quenching distance.	9
3	**Safety in Welding & Gas Cutting**	Gas welding and oxygen cutting, resistance welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions - safety in generation, distribution and handling of industrial gases- colour coding – flashback arrestor – leak detection- pipe line safety-storage and handling of gas cylinders.	11
4	**Principles of Machine Guarding**	Guarding during maintenance, Zero Mechanical State(ZMS), guarding of hazards-point of operation protective devices, machine guarding, types, fixedguard, interlock guard, automatic guard, trip guard, fixed guard fencing.	7
5	**Safety in cold forming and hot working of metals**	Cold work, power presses, point of operation safeguarding, auxiliary mechanisms, feeding and cutting mechanism, Hot work- safety in forging, hot rolling mill operation, hazards and control measures. Safety in	9

		gas furnace operation, foundry health hazards, work environment, material handling in foundries. Work permit system in cold and hot working areas.	
Total			**42**

4. Reading

4.1 Textbooks/ Reference Books:

1. Nolan, D.P., Handbook of fire and Explosion Protection Engineering Principles for Oil, Gas, Chemical and Related Facilities, 3rd Edition, William Andrew, 2018.
2. Laute, S., Explosion Hazards in the Process Industries, UK ed. Edition, Scitus Academics LLC, 2016.
3. Eckhoff, R.E., Explosion Hazards in the Process Industries, Gulf Professional Publishing Company, 2nd Edition, 2016.
4. Tarafdar, N.K., Tarafdar, K.J., Industrial Safety Management, Assorted Editorial, 2018.
5. Poonia, M.P, Sharma, S.C., Industrial Safety and Maintenance Management, Khanna Book Publishing, 1st Edition, 2019.
6. Deshmukh, L.M., Industrial Safety Management, McGraw Hill Education, 2017.

5. Outcome of the Course:

After completion of this course, the students will be able to

1) Identify hazards associated with various processes used in engineering industry.
2) Formulate the methods of safe operations by effectively controlling the occupational health and safety hazards.
3) Understand and apply safety requirements for safe material handling.

Smoke Management System

1.1 Course Number: FSE203
1.2 Contact Hours:3-0-0 Credits: 9
1.3 Semester-offered: 2nd Year –Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee Members: Dr. Nilambar Bariha & Ms. Ananya Borah

2. Objective:

i) To understand about the smoke development, measurements, and its toxic effects in the surrounding.
ii) To understand about the ventilation and its importance in building construction.
iii) To learn about the smoke control reduces the movement of smoke and air circulation in a large structural building.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Smoke Production in Fires**	Smoke measurements, Mass yields/mass fractions/molar yields/molar fractions. Smoke release rate/heat release rate. Visibility through smoke, influence of ventilation on smoke production. Air moving systems and equipment.	8
2	**Principles of Smoke Movement**	Airflow principles, Gas expansion, Buoyancy/stack effect/local heating. Climate design data-Standard Barometric Pressure, Summer and Winter design temperature, design wind conditions.	9
3	**Principles of Smoke Management**	Objectives of smoke management, Passive smoke management methods, Active/mechanically assisted smoke management methods. Opposed air flow Stairwell pressurization, Zoned smoke control Smoke exhaust.	9
4	**Smoke Management for Large Spaces**	Venting requirements, Natural ventilation through roof and wall openings, Mechanical smoke exhaust systems, Complex Smoke Management system.	7
5	**Heating, Ventilation, and Air Conditioning (HVAC) Systems**	HVAC Engineering Equations for Daily Use, HVAC Engineering Fundamentals, Electrical Features of HVAC Systems, Sustainable HVAC Systems.	9
Total			**42**

4. Reading

4.1 Reference Books:

1. Klote, J.H., Milke, J.A., Turnbull, P.G., Kashef, A., Ferreira, M.J., Handbook of Smoke Control Engineering, Amer Society of Heating, Atlanta, 2012.
2. Klote, J.H., Milke, J.A., Principles of Smoke Management, American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc.1791 Tullie Circle, N.E. Atlanta, 1992.
3. Schifiliti, R.P., Design of Detection Systems, SFPE Handbook of Fire Protection Engineering, 3rd Edition, National Fire Protection Association Quincy, Massachusetts, (Society of Fire Protection Engineers, Boston), 2002, Ch. 3-1.
4. Shapiro, J., Standpipe and Hose Systems, Fire Protection Handbook, 17th Edition, ed A.E. Cote (NFPA), Ch. 5-14, 1991.
5. Haines, R.W., Myers, M.E., HVAC Systems Design Handbook, 5th Edition, McGraw Hill, 2009.
6. Khalil, D.E.E, Khalil, E.E. Sprinklers and Smoke Management in Enclosures, 1st Edition CRC Press, 2020.

5. Outcome of the Course:

Students will be able to

1) Learn the fundamentals of smoke control systems and their importance to a facility of fire protection.
2) Evaluate the smoke exhaust calculation and identify the toxic effects on humans.
3) Identify the hazards and effects of personal exposure to occupants to airborne contaminants for eventual risk assessment.

Hazard Identification and Risk Analysis

1.1 Course Number: FSE204
1.2 Contact Hours:3-0-0 Credits:9
1.3 Semester-offered: 2nd Year –Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee Members: Dr. Nilambar Bariha & Ms. Ananya Borah

2. Objective:

i) To understand the occurrence of hazards that are present in the workplace and its awareness.
ii) To learn the concepts of uncertainty, probability, and variability.
iii) To provide in-depth knowledge of safety in the design and operation of process plant.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Hazard, Risk Issues and Hazard Assessment**	Introduction of hazard, hazard monitoring- risk acceptance levels, Risk estimation. Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), human error analysis, hazard operability studies (HAZOP), safety warning systems.	11
2	**Reliability and Fire Risk Assessment**	Component Life, Failure Rate, System Reliability, Probability Models in Fire Protection Engineering: Fault Tree & Event Tree Analysis, Human Error Analysis-Safety Review System-Hazard Warning, Methods-Hazard Warning Analysis- Plant Safety Audit. Introduction, Taxonomy of Methods for Fire Risk Assessment, Schedules, Insurance Rating, Dow's Fire and Explosion Index.	12
3	**Statistics Analysis**	Introduction, Basic concept of statistical analysis, Key parameters of descriptive statistics, Correlation, Regression and Analysis of Variance.	4
4	**Risk Control & Management**	Impact estimation: Property, People, Man and Machine System, Job and Personal Risk Factors-Standards-Selection and Training-Body Size and Posture-Body Dimension (Static/Dynamic)-Adjustment Range- Penalties. Guide Lines for Safe Design and Postures- Evaluation and Methods of Reducing Posture Strain.	8
5	**Risk Analysis Simulation Software for Fire Protection**	Basic Concepts of Risk Analysis, Hazard Assessment Systems - Hazard Operability Studies (HAZOP) - EFFECTS - Hazard Analysis (HAZAN) -Failure Mode and Effect Analysis (FMEA), Layer of Protection Analysis (LOPA)-Safety Integrity Level (SIL)-Basic concepts of Reliability- Software on Risk analysis, ALOHA.	7
Total			**42**

4. Reading

4.1 Reference Books:

1. Watts, J.M., John R. Hall, J.R., Fire Risk Analysis, SFPE Handbook of Fire Protection Engineering, National Fire Protection Association Quincy, Massachusetts, (Society of Fire Protection Engineers, Boston), 3rd Edition, 2002.
2. Clement, G.A., Law of Fire Insurance, Nabu Press Primary Source Edition, 2013.
3. AIChE/CCPS, Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York, 2nd Edition 1992.
4. Fire Protection Handbook (Volume 1&2), National Fire Protection Association (NFPA), 20th Edition, 2008.
5. Hasofer, A.M., Beck, V.R., Bennetts, I.D., Risk Analysis in Building Fire Safety Engineering, Butterworth-Heinemann, Elsevier Publication, 1st Edition, 2007.
6. Wells, G., Hazard Identification and Risk Assessment, Institution of Chemical Engineers, 1997.
7. Lees F.P. Loss Prevention in the Process Industries, Butterworths, London, 2nd Edition 1996.

5. Outcome of the Course:

Students will be able to

1) Carryout Risk assessment methods to various Industries and work practices and activity.
2) Create Bow tie diagram, ETA, FTA and FMEA.
3) Understand advantage and disadvantage of various risk analysis techniques.

Unit Operations Laboratory – I

1.1 Course Number: CE201L

1.2 Contact Hours:0-0-2 Credits:2

1.3 Semester-offered: 2nd Year –Odd

1.4 Prerequisite: Diploma level Mathematics and Physics

1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar & Mrs. Sukanya Hazarika

2. Objective:

i) The lab is to provide practical and theoretical experience in a number of important chemical engineering unit operations ensuring a thorough understanding of the principles of unit operation. The course includes experimental execution, data analysis and error analysis, skills development in oral presentation, technical report writing, and team-building.

ii) The experiments are designed to illustrate the principles of fluid and particle mechanics, separation processes.

3. Course Content:

S. No.	List of Experiments
1	To verify the Bernoulli's equation
2	To study the head losses due to various fittings in pipeline
3	To study different types of flow
4	To measure the viscosity of oil using Redwood Viscometer
5	To measure the discharge through Venturi meter, Orifice meter and Rotameter
6	To study the Reciprocating pump characteristics
7	To study the Centrifugal pump characteristics
8	To study the operation of ball mill
9	To study the operation of gyratory sieve shaker
10	To study the working principle of froth flotation cell
11	To study the operation of plate and frame filter press

4. Outcome of the Laboratory:

This lab will give the student a thorough knowledge of fluid and particle mechanics, and separation processes. Understand to analyze experimental data and observed phenomena to write good technical report.

Fire Ground Operations-I

1.1 Course Number: FSE205L
1.2 Contact Hours:0-0-2 Credits:2
1.3 Semester-offered: 2nd Year –Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee Members: Ms. Ananya Borah &Dr. Nilambar Bariha

2. Objective:

i) To familiarize students with the Fire Fighting equipment's.
ii) To understand the selection and operation of different types of extinguishers.

3. Course Content:

S. No.	List of Experiments
1	Classification of Fire and Extinguishing Methods – As Per Indian Standard (Is 15683:2018), British Standards and NFPA 10.
2	Fire Extinguishers- Basic Operations, Types and Color Coding
3	Water Extinguishers- Method of Operation.
4	Carbon Dioxide Fire Extinguishers- Method of Operation.
5	Foam Fire Extinguishers- Method of Operation.
6	Dry Chemical Powder Fire Extinguishers- Method of Operation.
7	Wet Chemical Fire Extinguishers. - Method of Operation.
8	Selection and Maintenance of Fire Extinguishers.
9	Fire Hydrants- Its Types, Working Principle, Components and Color Coding.
10	Fire Hoses- Types, Couplings & Methods of Rolling Fire Hose.
11	Fire Hose Nozzles and Branch Types.
12	Fire Water and Foam Monitors.

4. Outcome of the Laboratory:

On completion of this course, the students will

1) Have the knowledge to select the correct firefighting equipment relative to its contents, capacity and limitations and operate it safely in the event of fire.
2) Will acquire practical knowledge on the usage of various firefighting equipment's.