

# M.D. UNIVERSITY, ROHTAK

(NAAC Accredited 'A+' Grade)

## SCHEME OF STUDIES AND EXAMINATION B.TECH (FIRE TECHNOLOGY AND SAFETY)

### SEMESTER 5<sup>th</sup> AND 6<sup>th</sup>

### Scheme effective from 2020-21

#### COURSE CODE AND DEFINITIONS:

Course Code	Definitions
L	Lecture
T	Tutorial
P	Practical
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional Core Courses
LC	Laboratory Courses
MC	Mandatory Courses
PT	Practical Training
S	Seminar
TH	Theory
Pr	Practical

#### General Notes:

1. Mandatory courses are non credit courses in which students will be required passing marks in internal assessments.
2. Students will be allowed to use non programmable scientific calculator. However, sharing of calculator will not be permitted in the examination.
3. Students will be permitted to opt for any elective course run by the department. However, the department shall offer those electives for which they have expertise. The choice of the students for any elective shall not be binding for the department to offer, if the department does not have expertise. To run the elective course a minimum of 1/3<sup>rd</sup> students of the class should opt for it.

**Scheme of Studies and Examination**  
**B.TECH (Fire Technology and Safety) – 5<sup>th</sup> Semester**  
**w.e.f. 2020-21**

S N	Category	Course Code	Course Title	Hours per week			Total Contact hrs/week	Credit	Examination Schedule (Marks)				Dura tion of Exam (Hou rs)
				L	T	P			Interna l Assess ment	Ext ern al Ex ami nat ion	Pr	Total	
1	Professional Core Courses	PCC-FT- 301 G	Building Construction & Urban Planning	3	1	0	4	4	25	75		100	3
2	Professional Core Courses	PCC-FT- 303 G	Mechanics of Structure	3	1	0	4	4	25	75		100	3
3	Professional Core Courses	PCC-FT- 305 G	Passive Measures for Fire Safety	3	1	0	4	4	25	75		100	3
4	Professional Elective Courses	_____	Elective-I	3	0	0	3	3	25	75		100	3
5	Professional Elective Courses	_____	Elective -II	3	0	0	3	3	25	75		100	3
6	Professional Core Courses	PCC-FT- 307G	Mechanics of Structure Lab	0	0	2	2	1	25		25	50	3
7	Seminar	PR-FT- 309G	Industrial Seminar-I	0	0	2	2	1	50			50	3
8	Training	PR-FT - 311G	Fire Ground Operation-III	0	0	2	2	1	25		25	50	3
9	Mandatory Course	MC- 315-G	Essence of Indian Traditional Knowledge	2	0	0							3
<b>TOTAL</b>								<b>21</b>				<b>650</b>	

**Note:**

1. Choose any one from Elective-I
2. Choose any one from Elective-II

**Scheme of Studies and Examination**  
**B.TECH (Fire Technology and Safety) – 6<sup>th</sup> Semester**  
**w.e.f. 2020-21**

S N	Category	Course Code	Course Title	Hours per week			Total Contact hrs/week	Credit	Examination Schedule (Marks)				Dura tion of Exam (Hou rs)
				L	T	P			Internal Assess ment	Ext ern al Exa min atio n	Pr	Total	
1	Professional Core Courses	PCC-FT- 302 G	Rescue Equipment and Techniques	3	1	0	4	4	25	75		100	3
2	Professional Core Courses	PCC-FT- 304G	Fire Protection and Salvage Operation	3	0	0	3	3	25	75		100	3
3	Professional Elective Courses	_____	Elective-III	3	0	0	3	3	25	75		100	3
4	Professional Elective Courses	_____	Elective-IV	3	0	0	3	3	25	75		100	3
5	Open Elective Courses	_____	Open Elective-I	3	0	0	3	3	25	75		100	3
6	Open Elective Courses	_____	Open Elective -II	3	0	0	3	3	25	75		100	3
7	Professional Core Courses	PCC-FT- 306 G	Computer Applications and CAD Lab	0	0	2	2	1	25		25	50	3
8	Training	PR-FT- 308 G	Fire Ground Operation-IV (Rescue Operations)	0	0	2	2	1	25		25	50	3
<b>TOTAL</b>								<b>21</b>				<b>700</b>	

**NOTE:**

1. At the end of 6<sup>th</sup> 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 an Industry/ Institute/ Professional Organization/ Research Laboratory/ Training Centre/ other building Occupancy etc. and submit typed report along with a certificate from the organization & its evaluation shall be carried out in the 7<sup>th</sup> Semester.
2. Choose any one from Elective-III
3. Choose any one from Elective-IV
4. Choose any one from Open Elective-I
5. Choose any one from Open Elective-II

**Professional Elective Courses (Third Year)**

<b>Sr. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Total Contact Hrs</b>	<b>Credit</b>
1	PEC-FTEL321	Fire Safety Codes and Standards	3	3
2	PEC-FTEL322	Nuclear Safety and Radioactive Materials	3	3
3	PEC-FTEL323	Fire Risk Calculations	3	3
4	PEC-FTEL324	Salvage Evaluation of Fire Situation	3	3
5	PEC-FTEL325	Special Hazards and Protection	3	3
6	PEC-FTEL326	Building Design and Drawing	3	3
7	PEC-FTEL327	Fire Modeling	3	3
8	PEC-FTEL328	Electrical Systems and Safety in Design	3	3
9	PEC-FTEL329	Safety in Petroleum and Petrochemical Industries	3	3
10	PEC-FTEL330	Design of Pipe, Pressure Vessels and Machine Elements	3	3

**Open Elective Courses (Third Year)**

<b>Sr. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Total Contact Hrs</b>	<b>Credit</b>
1	OEC-FTEL-331	Materials and Metrology	3	3
2	OEC-FTEL-332	Power Plant Engineering	3	3
3	OEC-FTEL-333	Computer Applications, and CAD-CAM	3	3
4	OEC-FTEL-334	Process Instrumentation and Control Engineering	3	3
5	OEC-FTEL-335	Operation Research	3	3
6	OEC-FTEL-336	Industrial Noise and Vibrations	3	3
7	OEC-FTEL-337	Engineering Economics	3	3
8	OEC-FTEL-338	Artificial Intelligence	3	3
9	OEC-FTEL-339	Environmental Engineering and Management	3	3
10	OEC-FTEL-340	Robotics and Robot Applications	3	3

**Note: A Student can not choose the same subject as Professional Elective Courses and Open Elective Courses in Sem V and Sem VI**

Course code	<b>PCC-FT-301 G</b>				
Category	Professional Core Courses				
Course title	<b>Building Construction &amp; Urban Planning</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-V
	3	1	0	4	
<b>Course Outcomes:</b>	After completion of this course, students will be able to: <ul style="list-style-type: none"> <li>Recall the types of occupancies according to National Building Code of India (NBC).</li> <li>Describe building bye laws and provisions of NBC in building construction, prevention and protection in relation to the various type of fire hazards in the buildings.</li> <li>Explain the topography, its importance in urban planning, housing units and building services.</li> <li>Calculate Floor Area Ratio, capacity, number and width of exit as per NBC.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>To be familiar with National Building Code of India.</li> <li>To study various components of buildings, behaviour of building materials under fire fighting conditions.</li> <li>To familiarize with the urban planning, housing units and services.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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**

Provisions of National Building Code of India (NBC), Introduction to building by laws, Classification of building based on occupancy, Classification of types of construction according to Fire Resistance, General exit requirements as per NBC, Planning of location and calculation of capacity, Number and width of exit as per NBC for different types of occupancy, Stairs, sizes layout and various kinds of Stairs in different kind of building, FAR terminology with different modes of construction in stone, timber, steel or RC details.

### **Unit-II**

Walls, Stone, brick masonry walls and their construction, Fire walls and its types, Doors and windows, types and construction.

Roof, Fitched roofs, Various types of roof coverings, Types of roof frame in timber and steel, Roof construction details, Terrace roofs, drainage and water proofing.

Floors, timber floors, steel jointed floors, RCC floors and their modes of construction, floor paving, tiles, flag stones, concrete, terrace for different light and heavy duty uses in buildings.

### **Unit-III**

Behaviour of building materials and elements of structure under fire fighting conditions, Fire hazards, Personnel hazard, Damage hazard, Fire precautions in relation to fire hazard, Grading of occupancies to damage hazard with reference to fire load and fire resistance of elements of structure, Problems of high rise buildings and their safety measures, Behavior of retardant structures under fire.

### **Unit-IV**

Urban Planning, its objectives, Planning surveys, selection of site for urban growth, complexity and its impact on National development, Topography, Types of roads in urban areas, Types of housing

units, Detached, Semidetached, Group Housing, Multi story flats or apartments, Skyscraper, Group Ware Housing, Commercial complexes, layout of housing areas with consideration of site orientation.

Principle of building planning, Significance, Criteria under Indian conditions, Introduction of building services like Water Supply and Drainage, Electrification, Lightening and Staircase Fire Safety, Acoustics of buildings, Ventilation, Air conditioning, Thermal insulation.

### **References:**

1. Building Construction by Sushil Kumar, (Standard Publishers & Distributors).
2. Town planning by S.C. Rangwala, Charotar Publishing House.
3. National Building Code of India by Bureau of Indian Standards, New Delhi (Latest Edition)
4. Fire Protection Engineering in Building Design by Jane I. Lataille.
5. Fundamentals of Industrial Safety & Health by K.U.Mistry, Siddharth Prakashan.
6. NFPA Manual
7. Introduction to Town Planning by Robert, Mnotype Publishers, latest edition.
8. Urban Growth and Development : A Problem approach by Andrews, Richard B., New York, Simmons Boardman, latest edition.

Course code	<b>PCC-FT-303 G</b>				
Category	Professional Core Courses				
Course title	<b>Mechanics of Structure</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-V
	3	1	0	4	
<b>Course Outcomes:</b>	After completion of this course, students will be able to: <ul style="list-style-type: none"> <li>• Understand the theorems, laws and concepts related to force, friction, lifting machines, moment of inertia and centre of gravity.</li> <li>• Apply the laws, principles, theorems and concepts for solving the various problems related to beams, structures and machines performance.</li> <li>• Distinguish the forces, stresses, structures, lifting machines, beams under various loading conditions.</li> <li>• Determine the influence of forces, friction, loads in structures and beams.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To understand the concepts of stress and strain, truss and frames, friction, center of gravity, shear force and bending moment of beams under different loading conditions.</li> <li>• To enable students to solve practical problems related to friction, lifting machines, shear force and bending moments.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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

**Friction:** Concept of friction, laws of friction, limiting friction and coefficient of friction, sliding friction and rolling friction, inclined plane.

**Simple Lifting Machines:** Concept of machine, mechanical advantage, velocity ratio and efficiency of a machine, their relationship, law of machine, simple machines (lever, wheel and axle, pulleys, jacks, winch crabs only).

#### **Unit-IV**

**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.

**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.

#### **References:**

1. Strength of Materials – G. H. Ryder - Macmillan, India
2. Strength of Materials– Andrew Pytel and Fredinand L. Singer, Addison – Wesley
3. Engineering Mechanics – Irving H. Shames, PHI Publication
4. Engineering Mechanics – Dr. D. S. Kumar, Kataria & Sons
5. Strength of Materials - S. Ramamrutham, Dhanpat Rai Publishing company
6. Mechanics of Materials – B.C. Punamia, Laxmi Publication



Course code	<b>PCC-FT-305 G</b>				
Category	Professional Core Courses				
Course title	<b>Passive Measures for Fire Safety</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-V
	3	1	0	4	
<b>Course Outcomes:</b>	After completion of this course, students will be able to: <ul style="list-style-type: none"> <li>• Understand site planning, protection for explosive, flammable material, fire wall.</li> <li>• Understand the layout of hazardous pipelines, selection of appropriate extinguishing devices, fire doors, escape routes and their planning, smoke extraction etc.</li> <li>• Apply the proper standards and rules in site planning, layout of hazardous pipelines, calculating fire loads etc.</li> <li>• Analyze the suitable extinguishing device after strategic planning, detailed case study for reducing life losses.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To learn about the different passive measures of fire safety.</li> <li>• To study the site planning of various occupancies from the point of view of fire protection and safety.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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**

Planning and construction of building, Site planning by considering the nature of the plant, Building, Equipment and process from the point of safety and fire protection, Protection where Corrosive, Explosive and easily Combustible materials are handled and processed, Fire wall and its types, Barricades etc. Fire Separation, Segregation and Isolation.

### **Unit-II**

Layout of hazardous pipelines, vessels and equipments, Planning of strategic points and Selection of fire extinguishing devices

Fire doors, their resistance rating, Wire glass windows, Prevention of fire through roofs, Vertical cut off's, Exits guards and Guarding, Protection devices for lightening hazards.

### **Unit-III**

Escape route, Escape route plan, Emergency exits, Components, Compartmentation, Smoke extraction system, Fire dampers, Fire rated smoke extraction ducts, Cable ducts, Vertical and horizontal opening, Steel protection and steel staircase enclosure, Fire escape enclosure, Glazing, Fire load and Fire rating.

### **Unit-IV**

Housekeeping and management, Indoor housekeeping and Outdoor housekeeping, 5's of Housekeeping, Inspection and checklists, Housekeeping of specific industries, Detailed analysis of fire case studies, Especially those fires where large number of people were involved.

**References:**

1. Industrial Safety, Health & Environment management System by R.K. Jain & Sunil S. Rao, Khanna Publishers.
2. Fire Safety in Buildings by V.K. Jain, New Age International Publishers
3. Manual of Fire Safety by N Sessa Prakash, CBS Publishers and Distributors
4. Fire Protection and Prevention: The Essential Handbook Volume 1 & 2 by B.M. Sen, UBS Publishers
5. NFPA Manual

Course code	<b>PCC-FT-307 G</b>				
Category	Professional Core Courses				
Course title	<b>Mechanics of Structure Lab</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-V
	0	0	2	1	
Class work	25 Marks				
Practical	25Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

### List of Experiments

1. To draw shear force, bending moment diagrams for a simply supported beam under point and distributed loads.
2. To study the universal testing machine and perform the tensile test on UTM.
3. To perform compression & bending tests on UTM.
4. To perform the shear test on UTM.
5. To study the impact testing machine and perform the impact tests (Izod & Charpy).
6. To study the Brinell hardness testing machine & perform the Brinell hardness test.
7. To study the Rockwell hardness testing machine & perform the Rockwell hardness test.
8. To study the Vickers hardness testing machine & perform the Vickers hardness test.
9. To determine mechanical advantage and efficiency of single and double purchase winch crab.
10. To determine mechanical advantage and efficiency of simple and compound screw jack.

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	<b>PR-FT-309 G</b>				
Category	Seminar				
Course title	<b>Industrial Seminar-I</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-V
	0	0	2	1	
Class work	50 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

**Note:** Industrial Seminar based on the training//project /certificate course/case study done after 4th semester.

Course code	<b>PR-FT-311G</b>				
Category	Training				
Course title	<b>Fire Ground Operation-III</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-V
	0	0	2	1	
Class work	25 Marks				
Practical	25Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

### **List of Experiments**

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 tests
  - Round test
  - String test
  - Extension line test
6. To Perform different Hose tests
  - Suction hose test
  - Delivery hose test
  - Hose reel hose test
7. To study and perform extinguisher drill.
8. To perform foam drill with foam test.
9. To perform four men pump drill with pump test.
10. To perform six men pump drill with pump test.
11. To perform close water pumping drill.
12. To perform open water pumping drill.

At least 8 experiments to be performed from the above list. Other drills and tests can be performed as decided by department (time to time) depending upon the scope of course.

Course code	MC-315G			
Category	Mandatory Course			
Course title	<b>Essence of Indian Traditional Knowledge</b>			
Scheme and credits	L	T	P	Credits
	2	0	0	0

### Course Contents

- Basic structure of Indian knowledge System: अष्टादशविद्या – वेद, उपवेद (आयुर्वेद, धनुर्वेद, गन्धर्ववेद, स्थाप्य आदि) वेदांग (शिक्षा, कल्प, निरुक्त, व्याकरण, ज्योतिष, छंद) उपाङ्ग (धर्मशास्त्र, मीमांसा, पुराण, तर्कशास्त्र)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case studies

### References

1. V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5<sup>th</sup> Edition, 2014
2. Swami Jitatmanand, *Modern Physics and Vedant*, Bharatiya Vidya Bhavan
3. Swami Jitatmanand, *Holistic Science and Vedant*, Bharatiya Vidya Bhavan
4. Fritzo Capra, *Tao of Physics*
5. Fritzo Capra, *The Wave of life*
6. VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam
7. *Yoga Sutra of Patanjali*, Ramakrishna Mission, Kolkata
8. GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakashan, Delhi 2016
9. RN Jha, *Science of Consciousness Psychotherapy and Yoga Practices*, Vidyanidhi Prakashan, Delhi 2016
10. P B Sharma (English translation), *Shodashang Hridayan*

Course code	<b>PCC-FT-302G</b>				
Category	Professional Core Courses				
Course title	<b>Rescue Equipment and Techniques</b>				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	1	0	4	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Define different types of hydraulically and pneumatically operated tools and equipments used in emergency.</li> <li>• Describe small gears, application and working principles, Ladders its constructional features, their types, material and applications, ropes, tools, techniques and equipments and its types, materials and applications.</li> <li>• Examine breathing apparatus, various types of tenders and to calculate the capacity of the BA set in actual rescue operation.</li> <li>• Categorize and select suitable type of tenders, tools, techniques and equipments for different types of emergency situations.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To familiarize with rescue equipments like hydraulic and pneumatic tools, electric power tools, ladders, ropes etc.</li> <li>• To study the various rescue techniques, PPEs, fire fighting vehicles, rescue vehicles and rescue operations.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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

**Hydraulic and Pneumatic Tools:** Hydraulic jack, Hydraulic cutter, Hydraulic expender, Hydraulic combi tools, Air lifting bags.

**Electric Power Tools:** Electric cutter, Electric saw, Chain saw etc.

**Small gears:** Small gears and their types.

**Ladders:** Applications and working principles of Ladders, constructional features, their types, materials and applications.

**Ropes:** Ropes, their types, materials and applications.

### Unit-II

**Rescue Techniques:** Carriers and drags, One rescuers methods, Two rescuers methods, Multi-rescuers methods, Stretcher carry and different types of drags, Different types of knots, hitches and their applications in emergency.

**PPE's-** IS specification with types and testing for protection of head, Eye and face, Hand and arm, Foot and leg, Ear and body, Safety belt and Harness.

### Unit-III

**Fire Fighting and Rescue Vehicles:** Emergency rescue tenders(ERT), Water tender, Foam tender, Multipurpose tender, Hydraulic platforms, Turntable ladder, Canteen van and ambulance.

**Fire Extinguishers:** Introduction, types and applications.

**Rescue Operations:** Rescue by ordinary means, Rescue from fire incidents, Rescue problems & their remedies, Rescue from high rise buildings, Major disasters like earth quake, Flood drought, Tsunami, etc.

#### **Unit-IV**

**Respiratory Equipments:** Respiratory physiology, Composition of air, Breathing, Breathing rate, B.A set- their types, Constructional features, Working principles and applications, Calculation of the capacity and time duration of the B.A. set.

**Gas Masks:** Introduction, their types, Constructional features, Working and applications.

**Respirators and types:** Canister type, Chemical cartridge type, Filter type, Compressed air Line type.

#### **Reference:**

1. Fire Safety in Buildings by V.K. Jain, New Age International Publishers
2. Safety Management by R.K. Mishra- AITBS Publishers.
3. Manual of Fire Safety by N Sessa Prakash, CBS Publishers and Distributors
4. Fire Protection and Prevention: The Essential Handbook Volume 1 & 2 by B.M. Sen, UBS Publishers
5. NFPA Manual
6. National Building Code of India by Bureau of Indian Standards, New Delhi (Latest Edition)



Course code	<b>PCC-FT-304G</b>				
Category	Professional Core Courses				
Course title	<b>Fire Protection and Salvage Operation</b>				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Recall the basic concepts of fire fighting, extinguishing media.</li> <li>• Explain the hose and hose fittings, properties of extinguishing agents and salvage operation.</li> <li>• Apply the principles, IS codes and standards for installation, care inspection and maintenance of portable fire extinguishers.</li> <li>• Classify fire detection systems, alarms.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To learn about various fire fighting equipments.</li> <li>• To evaluate right position for sitting of detector system.</li> <li>• To learn the use of IS codes regarding fire protection.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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

**Hose and Hose fittings:** Detailed study of hoses, coupling, branches, branch holders, nozzles, breaching, adaptors, hose ramp, collecting heads, suction hose fittings, stand pipes, monitors.

**Foam and foam making equipments:** Types of foam, foam making equipments, practical considerations, care and maintenance, Hose reel hose - specifications and installation.

### Unit-II

Extinguishing properties of Water, droplet size, heat absorbing capacity, surface tension, Extinguishing Properties of foam, expansion, concentration, bubble size, burn back resistance etc., Extinguishing properties of DCP, composition, particle size, radiation shielding, chain braking mechanism, Extinguishing Properties of CO<sub>2</sub>, inert gas and extinguishing agent, FM 200, NOVEC 1230.

Description, working principle and operation methods of portable fire extinguishers, care, inspection and maintenance of portable fire extinguishers, performance criteria and testing of different types of fire extinguishers as per relevant Indian standard IS : 2190, extinguishing agents and their installation techniques.

### Unit-III

**Alarm Systems:** Fire alarm system, classification of fire alarm system, components, testing and maintenance of fire alarm system, basic consideration for installation.

**Detectors:** Automatic fire detectors, heat detector, smoke detector, gas sensing fire detector, Radiant energy sensing detectors, detector installation, maintenance and testing.

## Unit-IV

**Salvage:** Introduction, equipments-salvage sheets, other gears, procedure at fire- covering up, removal of water, reduction of water damage, reduction of smoke damage, removal of sheets, laying sawdust, drying off, fatal fires, etc. Procedure after the fire- repair of roofs, securing premises against entry.

### References:

1. Industrial Safety, Health & Environment Management System by R.K. Jain & Sunil S. Rao, Khanna Publishers.
2. Fire Safety in Buildings by V.K. Jain, New Age International Publishers.
3. Manual of Fire Safety by N Sessa Prakash, CBS Publishers and Distributors.
4. Fire Protection and Prevention: The Essential Handbook Volume 1 & 2 by B.M. Sen, UBS Publishers.
5. Manual of Firemanship 6A, HMSO.

Course code	<b>PCC-FT-306G</b>				
Category	Professional Core Courses				
Course title	<b>Computer Applications and CAD Lab</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-VI
	0	0	2	1	
Class work	25 Marks				
Practical	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

### **List of Experiments**

1. To study various commands used in Auto- CAD software.
2. 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.
3. Layout drawing of a building using different layer and line colors indicating all Building details. Name the details using text commands, Make a title Block.
4. To make a Drawing of Line, arc, circle, ellipse, triangle etc.
5. To make a Drawing of a flange.
6. To make a Drawing of a bushing assembly.
7. To make an Isometric dimensioned drawing of a connecting Rod using isometric grid and snap.
8. To make different types of bolts and nuts with internal and external threading in Acme and square threading standards. Save the bolts and nuts as blocks suitable for insertion.
9. To make a quarter sectional isometric view of a cotter joint.
10. To study CNC Machine and perform operations CNC Milling and CNC Lathe.

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	<b>PR-FT-308G</b>				
Category	Training				
Course title	<b>Fire Ground Operation-IV (Rescue Operations)</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-VI
	0	0	2	1	
Class work	25 Marks				
Practical	25 Marks				
Total	50Marks				
Duration of Exam	03 Hours				

### **List of Experiment**

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 perform rescue drill using full body harness.
10. To perform drills on Rescue from well.
11. To perform drills on Rescue from confined space like tunnels.
12. To perform drills on Rescue from building.
13. To perform drills on Rescue from accidents/incident.

At least 8 experiments to be performed from the above list. Other drills and tests can be performed as decided by department (time to time) depending upon the scope of course.

Course code	<b>PEC-FTEL-321</b>				
Category	Professional Elective Courses				
Course title	<b>Fire Safety Codes and Standards</b>				
Scheme and Credits	L	T	P	Credits	Semester----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>Recall basics of various fire fighting equipments and appliances.</li> <li>Explain various IS codes and NFPA codes related to tenders, Hose Couplings, Fire Extinguishers, Ladders, portable and trailer pumps. Examine industrial fire prevention and protection enforcement.</li> <li>Outline codes concerning construction and design of buildings, temporary structures and pandals.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>To familiarize with different IS codes and NFPA manuals.</li> <li>To understand the use of National Building Code of India, IS codes and standards, Building by laws and NFPA manuals.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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 Extinguishers IS:** 940, 6234, 2878, 10204, 2171, 2190, 884, 3844, 636, 903, 944, and 6070.

#### **Unit-II**

**Fire Tenders IS:** 948, 950, 6067, 10460, 4989, 951, 957, 949, and 10993.

#### **Unit-III**

**National Building Code-2016** (Part-4 Life and Safety).

**NFPA:** NFPA 704- Identification of hazard of materials for emergency response (NFPA Diamond), IS: 1024, NFPA 1983- Ropes, NFPA 1932- Ground Ladders.

#### **Unit-IV**

Code of practice for construction of temporary structures and pandals IS: 8758. Municipal bye-laws in relation to fire prevention, Industrial fire prevention and protection enforcement.

#### **References:**

1. Relevant Indian Standards (IS codes)
2. Relevant NFPA standards
3. Delhi Building Bye-Laws by V.K. Puri, A Jba Publication
4. Town Planning by S.C. Rangwala, Charotar Publishing house.
5. NBC, Bureau of Indian Standards.

Course code	<b>PEC-FTEL-322</b>				
Category	Professional Elective Courses				
Course title	<b>Nuclear Safety and Radioactive Materials</b>				
Scheme and Credits	L	T	P	Credits	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Describe radioactivity and its monitoring techniques.</li> <li>• Explain radioactive materials, its handling and storage, its waste, method of disposal, nuclear power stations and possible hazards.</li> <li>• Apply the fire fighting and rescue operation in nuclear power stations and its safety.</li> <li>• Analyze the major incidents/accidents, hazards at Nuclear Power Stations and other areas affected with radioactive materials.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To learn the basic concept of radiation, its effects and its monitoring techniques.</li> <li>• To study various nuclear power stations and safety guidelines.</li> <li>• To evaluate the various hazards, incidents/accidents occurs in nuclear power stations and rescue technique during radiation hazard.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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

**Radiation Terms:** Radioactivity, Alpha, Beta, Gamma Rays, Ionizing Effect, Radiation Exposure, Biological Effects, Radiation Protection Factors, Radioactive Placard and Label Requirement, Fixed site Storage Vessels for Medical Isotopes, Radiation Monitoring Equipment- Geiger- Muller (GM) Counter, Pocket Chamber, Dosimeters, Survey meters, Radiation Detection, Devices.

### Unit-II

**Special Nuclear Materials:** Radioactive Pyrophoric Metals- Uranium, Plutonium, Thorium with Fire Extinguishing guide lines.

**Radioactive Material Emergency Response:** Hazard Identification, Action Plan, Zoning, Managing the Incident, Assistance and Termination.

**Radio Active Waste:** Sources and characteristics of radioactive waste and their types, method of disposal, Handling and prevention of radiation emergencies and storage requirements of radioactive materials.

### Unit-III

**Nuclear Power Plant Safety:** Different types of nuclear power plant, Overview and brief description of Pressurized Water Reactor (PWR), Boiling Water Reactor (BWR) and Pressurized Heavy Water Reactor (PHWR-CANDU), Components and equipments, Engineered safety features in each reactors, Nuclear power plant operating states and accident classification as per code of federal regulation, Large break LOCA typical sequence in nuclear power plant.

Fire fighting and rescue operations in the presence of radiation hazard at nuclear power station, Pre plan of Radiation incident.

#### **Unit-IV**

**Dispersion of Radioactivity:** Releases from Nuclear Power Plant, Phenomena of Releases, Diffusion of Radioactive Plume at different heights and temperature condition, Simple Evaluation Techniques, Special Case of Radioactive Iodine release, Biological Absorption and Remedial Plans.

**Major Nuclear Power Plant Accidents:** Case Studies, Causes and sequence of events, Consequences and follow up actions in Three Mile Island unit-2 Accident, Chernobyl Accident, Fukushima Station Accident and Davis Base Accident.

#### **References:**

1. Radioactive Materials, B. M. Rao, Himalaya Publishing House, latest edition
2. J. Misumi, B. Wilpert and R. Miller, Nuclear Safety: A Human Factors Perspective, Taylor & Francis.
3. Principles of Radiation Dosimetry, G. W. White, John Wiley and Sons, New York, latest edition
4. Radioactive Wastes, their Treatment and disposal, J. C. Collins, E. F. N. Spon Ltd., London.
5. Industrial Hygiene and Toxicology, F. A. Patty (Ed), Vols. I and II Interscience, New York
6. Gianni Petrangeli, Nuclear Safety, Elsevier, latest edition
7. John C. Lee and Norman J. McCormick, Risk and Safety Analysis of Nuclear Systems, Wiley, latest edition
8. Joe Varela, Hazardous Materials Handbook for Emergency Response, International Thomson Publishing.

Course code	<b>PEC-FTEL-323</b>				
Category	Professional Elective Courses				
Course title	<b>Fire Risk Calculations</b>				
Scheme and Credits	L	T	P	Credits	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course, students will be able to: <ul style="list-style-type: none"> <li>• Define hazards, risks and their types.</li> <li>• Explain the concept of risk, hazard, explosion and fire.</li> <li>• Apply the different approach and assessment techniques to calculate fire risk.</li> <li>• Analyze the various process in Industries by using HAZOP, FMEA and other techniques.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To learn various aspects of hazard identification.</li> <li>• To familiarize with risk assessment and accident investigation.</li> <li>• To understand the concept of risk assessment and risk reduction in various fields.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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:** Definition, Accepted and imposed risk, Perception and qualification of risk, ALARP, Cost benefit analysis.

**Hazards:** Definition, types of hazards, Fire explosion and toxic gas release, Structure of Hazard Identification and Risk Assessment. Theories of Accident prevention, Principles of accident causation.

#### **Unit-II**

**Basic Quantitative Risk Assessment (QRA):** Principle of QRA, The Logic Tree Approach, Methodologies for Risk Analysis, Event Tree Analysis (ETA).

**Computer aided risk Analysis:** Related techniques and approaches

**Safety in Design and Operation:** Safety assurance in design, safety in operation, maintenance, organizing for safety, Accident investigation and reporting.

#### **Unit-III**

**HAZOP:** Introduction to HAZOP, Conducting a HAZOP study.

**FMEA:** Introduction to FMEA, Methodology of FMEA, criticality analysis, corrective action and follow up.



## Unit-IV

**Explosions and fires:** Vapour Cloud Explosions (VCE), Unconfined Vapour Cloud Explosion (UVCE), confined explosions, dust collector, silos, Physical explosions, BLEVE, Fire extinguishing ball, Jet fire, Pool fire, Boil over. Major Accident Hazard (MAH) control, On-site and Off-site emergency plan.

### References:

1. Industrial Hygiene & Chemical Safety by M.H. Fulekar, I.K. International
2. Lees F.P. Loss Prevention in the Process Industries second edition. Butterworths, London, latest edition.
3. Process safety analysis: An introduction by Bob Skelton.
4. An introduction to Risk Analysis by Robert E, Megill.
5. Safety sharing the experience B P process Safety series
6. Fire Safety Risk Assessment HM government.

Course code	<b>PEC-FTEL-324</b>				
Category	Professional Elective Courses				
Course title	<b>Salvage Evaluation of Fire Situation</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Define salvage operation, fire loss, heat release rate and fire investigation.</li> <li>• Locate various items of equipments necessary in salvage operation.</li> <li>• Demonstrate Salvage operation in different type of occupancies and follow up action and investigation of different type of fire situations.</li> <li>• Analyze case studies of salvage operations performed in different type of occupancies and estimate heat release rate and fire losses.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To learn about salvage operation and its planning stage.</li> <li>• To familiar with various salvage operation equipment and fire investigation.</li> <li>• To evaluate heat release rate and losses in fire and analyze case studies in various occupancies.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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**

**Salvage:** Concept, procedure, considerations, salvage operation during fire and after fire, contract salvage and pure salvage, difficulties during in salvage operations, various equipments necessary in salvage operations.

### **Unit-II**

**Evaluation of fire situations:** Fire loss calculations, Flame temperature measurement, Calculation for heat release rate, Salvage operation in different type of Occupancies like hotel, hospitals, departmental stores and basement godowns etc.

### **Unit-III**

Follow up action and investigation of fire situation such as structural fire, Wild fire and automobile fire etc, Marine salvage operations.

### **Unit-IV**

Case studies of Salvage operations in different type of Occupancy International Salvage convention

### **References:**

1. Manual of Fireman ship, Part 6-A by H.M.S.O.

2. Report and Accounts by Fire Salvage Association of Liverpool limited.
3. The principles and practice of Fire salvage operation by fire salvage association.
4. Loss prevention in process of industries, Vol1, 2 & 3, Frank P. Lees.

Course code	<b>PEC-FTEL-325</b>				
Category	Professional Elective Courses				
Course title	<b>Special Hazards and Protection</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Recall the basic of fire science and thermal engineering.</li> <li>• Describe the basic fire hazards in aircrafts, ships, high rise buildings and nuclear power plants.</li> <li>• Apply the basic fire fighting and evacuation strategies in aviation, marine, high rise buildings and nuclear power plants.</li> <li>• Analyze the level of possible hazards in aviation and marine system, high rise building and nuclear power plant for reducing accidents and improve safety.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To understand the basic working of aviation and marine drive system.</li> <li>• To obtain the basic fire fighting operation technique in aircraft, cargoes, High Rise Building and Nuclear Power Station.</li> <li>• To access the various hazards occurs in aircraft and marine system, High rise building and nuclear power plant.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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**

**Aviation :** Constructional features of an Air Craft, Types of Engines, Basic Fire-Hazards in Aircraft, Nature of Air Crashes, Emergency Landings including belly leading; Access to Fire Service Personnel and Escape of trapped persons problems, Types of Safety Belts, Ejection-Seats; and their methods of release; Rescue and Fires in Air Craft and methods of fire-fighting; Problems of fire-fighting. Hazards in Airport, Protection & Types of Hangers. Categorization of Air-Port, their extinguishing media and determination of the appliances for each category as per International Standard.

### **Unit-II**

**Marine Fire :** The maritime environment, organizational role, vessel types, construction & systems of fire detection & suppression, cargo vessel hazards & safety. Incident strategies & tactics, training & planning, vessel fire incidents, Marine incidents & Rescue operations.

### **Unit-III**

**High rise buildings :** Fundamentals of Fire Safe Building design, Life safety systems for high, rise structures, structural integrity during confinement of fire in building, Alarm signaling in high-rise building, Smoke movement in building, High-rise building with complex occupancy, Basic fire-fighting strategy.

**Evacuation:** Need of Evacuation plans in high rise buildings, Making of Evacuation Plans, types of Evacuation, Procedure of Evacuation.

#### **Unit-IV**

**Nuclear Safety** : Radiation and its types, Components of nuclear power plant , Nuclear Reactors, Radiation emergencies, Pre plan of radiation incident, Fire fighting and rescue operations in the presence of radiation hazard, Radiation Safety in Nuclear Power Plants. Nuclear waste management - Radioactive waste, Sources , characteristics and types, Handing of radioactive waste.

#### **References:**

1. Radioactive Materials by B.M. Rao, Himalaya Publishing House
2. Fire Safety in Buildings by V K Jain, New Age publishers, New Delhi
3. National Building Code of India, Bureau of Indian Standards, New Delhi (Latest Edition)
4. Fire protection handbook – NFPA, latest edition

Course code	<b>PEC-FTEL-326</b>				
Category	Professional Elective Courses				
Course title	<b>Building Design and Drawing</b>				
Scheme and Credits	L	T	P	Credits	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Describe various components of building .</li> <li>• Apply National Building Code in building planning.</li> <li>• Judge the necessity of provision of building services like fire safety and thermal insulation etc.</li> <li>• Evaluate and prepare the detailed drawing of various types of buildings.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To understand the different types of building codes, building components.</li> <li>• To understand different modes of supply system inside the building.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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 various types of footing, open foundation, raft, grillage, pile and well foundation, Drawing of frames of doors, window, various types of door, window and ventilator, lintels and arches, stairs and staircase, trusses, flooring, roofs etc.

### Unit-II

**Building Planning** - Provisions of National Building Code, Building bye-laws, open area, setbacks, FAR terminology, principle of architectural composition (unity, contrast, etc), principles of planning, orientation.

**Building Services:** Introduction of Building Services like water supply and drainage, electrification, ventilation and lightening and staircases, fire safety, thermal insulation, acoustics of buildings.

### Unit-III

**Design and Drawing of Building** - Design and preparation of detailed drawings of various types of buildings like residential building, institutional buildings and commercial buildings, detailing of doors, windows, ventilators and staircases etc.

### Unit-IV

**Perspective Drawing** - Elements of perspective drawing involving simple problems, one point and two point perspectives, energy efficient buildings.

### References:

1. Malik & Meo; Building Design and Drawing

2. Shah, Kale & Patki; Building Design and Drawing; TMH
3. Gurucharan Singh & Jgdish Singh Building Planning, Design and Scheduling

Course code	<b>PEC-FTEL-327</b>				
Category	Professional Elective Courses				
Course title	<b>Fire Modeling</b>				
Scheme and Credits	L	T	P	Credits	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Describe basic simulation approaches.</li> <li>• Use the various simulation approaches while designing a building to reduce the effect of fire.</li> <li>• Apply the different models in investigating fire</li> <li>• Analyze various simulation results and simulation models using tables, graphs, web interfaces.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To familiarize with different types simulation and modeling.</li> <li>• To analyze with simulation result using different types of graphs, tables, web interfaces and validation of model.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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

**Simulations:** Basic Model Forms, Basic Simulation Approaches, Handling Stepped and Event-based Time in Simulations, Discrete versus Continuous Modeling, Numerical Techniques, Sources and Propagation of Error.

**Dynamical, Finite State, and Complex Model Simulations:** Graph or Network Transitions Based Simulations, Actor Based Simulations, Mesh Based Simulations, Hybrid Simulations.

**Converting to Parallel and Distributed Simulations:** Partitioning the Data, Partitioning the Algorithms, Handling Inter-partition Dependencies.

**Probability and Statistics for Simulations and Analysis:** Introduction to Queues and Random Noise, Random Variates Generation, Sensitivity Analysis.

### Unit-II

**Simulations Results Analysis and Viewing Tools:** Display Forms: Tables, Graphs, and Multidimensional Visualization, Terminals, X and MS Windows, and Web Interfaces, Validation of Model Results, Index notation, matrix operations, Thermodynamics, equation of state, chemical and phase equilibrium, Droplet mass, momentum, and energy transfer, Taylor series, order of accuracy, Numerical time integration, explicit and implicit methods, Finite difference methods, stability restrictions, Lax equivalence theorem, Derivation of mass, momentum, and energy equations Pressure Poisson equation, projection methods, Scalar transport schemes, Godunov's theorem.



### Unit-III

Time-splitting methods for source terms, Non-dimensional forms of the governing equations, Compressible and low-Mach Number formulations Velocity divergence constraint for low-Mach Number flows, Thermal radiation, discrete ordinates method, Beer's law.

**Turbulence Theory:** vortex dynamics, Kolmogorov, Batchelor, power spectra, 2 DNS, length scale requirements, parallel computing, estimating cost, RANS, turbulence models, statistical correlations, LES, subgrid closures, Itering, energy spectrum, Nyquist limit, aliasing.

### Unit-IV

Turbulent boundary layers, grid design, mesh quality metrics Models for the mean chemical source term (turbulent combustion) Extinction, ignition, under-ventilated combustion, toxic products (CO, soot) Pyrolysis, ame spread, Fire suppression, Model validation and uncertainty quantification (model input and output).

#### References:

1. Introduction to Mathematical Fire Modeling, Second Edition By Marc L.Janssens
2. 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	<b>PEC-FTEL-328</b>				
Category	Professional Elective Courses				
Course title	<b>Electrical Systems and Safety in Design</b>				
Scheme and Credits	L	T	P	Credits	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course, students will be able to: <ul style="list-style-type: none"> <li>Recall the basics of electrical engineering.</li> <li>Describe the terminologies related to electrical fires like electrical equipment failure, protection devices, electric shock etc.</li> <li>Apply the suitable approach to use protection devices for reducing electrical fires and failures.</li> <li>Investigate the different conditions and reasons of electrical fires.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>To learn about fire protection devices.</li> <li>To evaluate reasons behind different Electrical Fires.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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.

### Unit-II

**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 earthing , Methods of improving the earth resistance.

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

### Unit-III

**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.

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

### Unit-IV

**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.

**References:**

1. Electrical Wiring Estimating and Costing by S.L. Uppal, Khanna Publishers.
2. Electricl Fires and Failures by A.A. Hattangadi, TMH Publishers.
3. Electricity Fire Risk by G.S. Hoges.
4. NFPA Manual.
5. J.P. Handbook.

Course code	<b>PEC-FTEL-329</b>				
Category	Professional Elective Courses				
Course title	<b>Safety in Petroleum and Petrochemical Industries</b>				
Scheme and Credits	L	T	P	Credits	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Describe the properties, storage and handling methods of petroleum products.</li> <li>• Explain safety measures for accidents arising during handling and transportation of petroleum product like LPG, CNG, Gasoline, etc.</li> <li>• Apply rules and regulations provided by statutory bodies for safety in petrochemical industries.</li> <li>• Analyze the properties and use of different types of fire-fighting installations like hydrant, mobile water monitors, foam pourer, etc.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To familiarize with different types of petroleum products, their properties and methods of their preparations in industries and OISD.</li> <li>• To know more about the refining process of petroleum like cracking, distillation and safety associated with it.</li> <li>• To understand different types of fire using different petroleum products viz. Gasoline, Naphthalene, LPG, and CNG.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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

**Crude oil :-** Introduction, properties & characteristics, Classification of petroleum & its products, MSDS of crude oil, diesel, gasoline, kerosene, LPG, Natural Gas, Naptha, Ammonia, Benzene, toluene, Acetylene.

**Refining Processes:** Primary Distillation, catalytic cracker, polymerization, reforming, steam cracking, sulphur recovery, Lubricating oil treating. Process units such as desalter, ADU, VDU, FCC, hydrocracker, catalytic reformer etc. Storage tanks & its types. Layout of Refineries, simplified flow diagram of a typical refinery.

### Unit-II

**Fire Protection and Emergency Planning :-** Major fire risks, Use of various media in petroleum & gas fires such as water, foam, DCP. Design criteria for selection of fire water network, fire fighting installations such as hydrant, mobile water monitors, foam pourer, DCP fixed, subsurface injection & steam snuffing systems, Storage tanks protection.

### **Unit-III**

**Fighting Refinery and Petrochemical Fires :** Potential fire hazards, precautionary measures in case of non-ignited releases, oil & gas leaks, Fire fighting facilities for depots, terminals, onshore offshore drilling platforms and pipelines for transportation of petroleum products & gases.

**Fighting Gas Terminal Fires:** Fire fighting in case of BLEVE, LPG hazards, Spillage, vehicle using LPG & CNG as a fuel, Fire fighting facilities at LPG bottling plant, water injection into LPG vessel(water bottoming).

### **Unit-IV**

**Oil Industry Safety Directorate(OISD) :** 105, 116, 117, 244. Petroleum and natural gas regulatory board(PNGRB) drafts. Application of advance technologies used in refineries and petrochemical plants such as SCADA, SAP and various simulation modeling.

Statutory provisions pertaining to refineries, petrochemical plants and gas terminals.

### **References:**

1. Fire Service Manual (Volume 2) Fire Service Operations - Petrochemical Incidents
2. Manual of Firemanship, Part 6-A by H.M.S.O.
3. Oil Industry Safety Directorate (OISD) Norms & Rules
4. Petroleum & Natural Gas Regulatory Board (PNGRB) drafts
5. Loss prevention in Process of Industries, Vol 1,2, & 3 by Frank P. Lees.
6. NFPA Manuals

Course code	<b>PEC-FTEL-330</b>				
Category	Professional Elective Courses				
Course title	<b>Design of Pipe, Pressure Vessels and Machine Elements</b>				
Scheme and Credits	L	T	P	Credits	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: 1. Recall the basic principles of design. 2. Describe the various types of stresses involved in thick & thin cylinders for safety purpose. 3. Apply the mathematical fundamentals and factor of safety for the design of pressure vessels, pipes and other machine elements. 4. Analyze the various parameters including FOS for designing of pressure vessels pipes and other machine elements.				
<b>Objectives:</b>	1. To understand the designing of pressure vessels, pipes and machine elements like couplings, nuts, bolts etc. 2. To evaluate stresses and other parameters for designing of pressure vessels, pipes and other machine elements for safe working.				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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 Design:** Principle of design, limits, fits and standardization, Theories of failure under static and dynamic loading, Factor of safety, S-N curve for ferrous material and non ferrous material.

### Unit-II

**Piping design:** Introduction to piping Codes and Standards, bends, tees, bellows and valves, types of piping supports and their behaviour, Flow diagram, Piping layout and piping stress analysis, Flexibility factor and stress intensification factor, Design of piping system as per B31.1 piping code.

### Unit-III

**Design of Pressure vessel:** General theory of membrane stresses in vessel under internal pressure and its application to shells (cylindrical, conical and spherical) and end closures. Bending of circular plates and determination of stresses in simply supported and clamped circular plate. Thermal stresses, Stress concentration in plate having circular hole due to bi-axial loading.

Introduction to ASME codes for pressure vessel design, Pressure vessel and related components' design using ASME codes; Supports for short vertical vessels, Stress concentration at a variable thickness transition section in a cylindrical vessel; Design of nozzles.

## Unit-IV

**Design of Transmission Elements:** Spur, helical, bevel and worm gears; belt and chain drives.

**Design of Springs:** Leaf Spring, Helical Spring, Flat Spiral Spring.

**Design of Joints:** Threaded fasteners, pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings, Analysis of clutches and brakes.

### References:

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; latest edition
2. Bhandari, V.B., Design of Machine Elements, Latest Edition, TMH Publishers
3. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, latest edition
4. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, latest edition
5. Spottes, M.F., Design of Machine elements, Prentice-Hall India, latest edition
6. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, latest edition

Course code	<b>OEC-FTEL-331</b>				
Category	Open Elective Courses				
Course title	<b>Materials &amp; Metrology</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Identify crystal structures for various materials and understand the defects in such structures.</li> <li>• Understand the basics of limit, fit and tolerance, material properties of ferrous alloys.</li> <li>• Analyze the various heat treatment processes and various properties of iron and steel.</li> <li>• Evaluate the hardness, tensile strength and creep.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To familiarize with various type of material and their properties.</li> <li>• To Know the various types of defects in materials.</li> <li>• To know various processes used for materials properties modifications.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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:** Introduction to Manufacturing Processes and their Classification.

**Engineering Materials:** General Properties and Applications of Engineering Materials, Mild Steel, Medium Carbon Steel, High Carbon Steel, High Speed Steel and Cast Iron, Effect on material properties by adding the alloying elements, Crystal imperfection.

### Unit-II

**Failures of metals:** Failure analysis, fracture, process of fracture, types of fracture, fatigue, characteristics of fatigue, fatigue limit, mechanism of fatigue, factors affecting fatigue.

**Creep & Corrosion:** Definition and concept, creep curve, mechanism of creep, impact of time and temperature on creep, creep fracture, creep testing and prevention against creep. Corrosion: Mechanism and effect of corrosion, prevention of corrosion.

### Unit-III

**Measurement and Metrology :** Limit, fit ( clearance fit, transition fit and interference fit) and tolerance, allowance, fundamental deviation, principle of gauge (hole and shaft basis), linear measurement (Vernier caliper, Micrometer etc. ) and angular measurement (Bevel protector, Sine bar).

### Unit-IV

**Heat Treatment:** Principles, purpose, classification of heat treatment processes, annealing, normalizing, stress relieving, hardening, tempering, carburizing, nitriding, cyaniding, flame and induction hardening. Allotropic transformation of iron and steel, Properties of austenite, ferrite, pearlite, martensite, iron carbon equilibrium diagram, TTT diagram, concept of tension test, hardness test( BHN, VHN, RHT), impact test( IZOD and CHARPY test), creep test



**References:**

1. Workshop Technology Vol. I &II by Hazra & Chaudhary, Asian Book Comp.
2. Process and Materials of Manufacture by Lindberg, R.A. Prentice Hall of India
3. Principles of Manufacturing Materials and Processes by Campbell, J.S. McGrawHill.
4. Manufacturing Science by Amitabha Ghosh & Ashok Kumar Malik, East-West Press.
5. Elements of Material Science and Engineering by VanVlack, Wesley Pub. Comp.
6. Material Science by Narula, Narula and Gupta. New Age Publishers

Course code	<b>OEC-FTEL-332</b>				
Category	Open Elective Courses				
Course title	<b>Power Plant Engineering</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Recall basics of thermodynamics, power generation cycles, nuclear fission and fusion processes.</li> <li>• Describe conventional and non conventional sources of energy, nuclear power plant, hydro electric power plant.</li> <li>• Explain the principles of operation for different power plants and their economics.</li> <li>• Show energy auditing for the energy consumption of industries.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To provide an overview of power plants and the associated energy conversion issues.</li> <li>• To understand the energy data from industries and carry out energy audit for energy savings.</li> <li>• To understand importance of non conventional sources of energy and their economic utilization.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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:** Types of energy, Energy resources and their availability, Conversion of various forms of energy, Conventional and Non-conventional sources, Need for Non-Conventional Energy based power generation.

**Energy Management:** General Principles of Energy Management, Energy Management Strategy.

**Energy Audit:** Need, Types, Methodology and Approach.

### Unit-II

**Introduction:** Types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants.

**Hydro Electric Power Plants :** Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.

### Unit-III

**Steam Power Plants:** Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator.

**Non-Conventional Energy sources:** Basic principle, site selection of Solar energy power plant, photovoltaic technologies, PV Systems and their components, Wind energy power plant, Bio energy plants, Geothermal energy plants and tidal energy plants.

#### **Unit-IV**

**Nuclear Power Plants:** Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled. Advantages and limitations, nuclear power station, waste disposal. Power Plant Economics: load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, inputoutput put curves, efficiency, heat rate, economic load sharing, Problems.

#### **References:**

1. Power Plant Engineering : P.K. Nag Tata McGraw Hill latest Edition
2. Power Plant Engg. : M.M. El-Wakil McGraw Hill latest edition
3. Non-conventional energy resources- Shobhnath Singh, Pearson.
4. Soni, Gupta, Bhatnagar: Electrical Power Systems – Dhanpat Rai& Sons
5. NEDCAP: Non Conventional Energy Guide Lines
6. G.D. Roy :Non conventional energy sources

Course code	<b>OEC-FTEL-333</b>				
Category	Open Elective Courses				
Course title	<b>Computer Applications and CAD-CAM</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Understand the basics, importance and necessity of Computer Applications and CAD Software.</li> <li>• Explain Transformation, Computer applications, Group Technology, FMS, CAPP.</li> <li>• Demonstrate the knowledge of computer and its applications in design.</li> <li>• Apply the CAD/CAM programming and coding for operation on CNC Machines.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To learn about Computer Aided Design and Computer Added Manufacturing.</li> <li>• To understand the applications of computer, basic concept of transformation, Automation and numerical control.</li> <li>• To make familiarization with Group Technology, FMS and CAPP.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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

**Computer Applications:** Evolution of Computers, Generation of Computers, Classification of Computers Analog Digital and Hybrid Computers, Classification of Computers according to size, Super Computers, Mainframe Computers, Personal Computers (Different Types) and Terminals (Different Types), Characteristics of Computers, Block Diagram of a Digital Computer, types of OS.

MS Windows, and its various elements of application windows title bar, menu bar, maximize and close buttons, borders and corners, scroll bars, windows icon, folder icons, dialog box and its items, starting Microsoft windows, searching the files, copying the files, disk clean up, deleting unnecessary files

### Unit-II

**Introduction:** Introduction to CAD, CAM, CIM, Design Process, Importance and Necessity of CAD, Applications of CAD, Hardware and Software requirement of CAD, Basics of geometric and solid modeling, coordinate systems.

**Transformations:** Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations (No Numericals).

### Unit-III

**Automation and Numerical Control:** Introduction, fixed, programmable and flexible automation, types of NC systems, MCU and other components, NC manual part programming, coordinate systems, G & M codes, Part program for simple parts, computer assisted part programming.

**Group Technology:** Part families, part classification and coding, production flow analysis, Machine cell design, Advantages of GT.

### Unit-IV

**Flexible Manufacturing Systems:** Introduction, FMS components, types of FMS, FMS layouts, planning for FMS, advantages and applications.

**Computer Aided Process Planning:** Conventional process planning, types of CAPP, Steps in variant process planning, planning for CAPP.

#### References:

1. CAD/ CAM by Groover and Zimmer, Prantice Hall.
2. CAD/ CAM Theory and Practice by Zeid, McGraw Hill
3. Numerical Control and Computer Aided Manufacturing by Kundra, Rao & Tiwari, TMH.
4. CAD/CAM ( Principles, Practice & Manufacturing Management ) by Chirs Mc Mohan & Jimmie Browne, Published by Addison- Wesley.

Course code	<b>OEC-FTEL-334</b>				
Category	Open Elective Courses				
Course title	<b>Process Instrumentation and Control Engineering</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to : <ul style="list-style-type: none"> <li>• Recall fundamentals of measurement, define error, precision and accuracy.</li> <li>• Describe various flow, temperature, humidity and pressure measuring instruments,</li> <li>• Explain various feedback and response instruments viz. Open loop, close loop, time response system etc.</li> <li>• Analyze various measuring, feedback and response instruments used in process control.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To study the flow measuring instrument.</li> <li>• To know the open loop, closed loop and response system.</li> <li>• To analyze instrumentation and control system.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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

**Elements of measurement :** Fundamental standards, Quality of measurement, Meaning of measurement, Errors in measuring instruments, Precision and accuracy, Calibration principle, Static and dynamic characteristics of measuring instruments.

**Measurement of temperature:** Bimetallic and pressure thermometers, Thermocouples, Resistance thermometers, Pyrometry, Calibration. Pressure and vacuum measurement -Manometers, Measuring element, Absolute pressure measurement, Static accuracy of pressure gauges.

### Unit-II

**Flow measurement:** Orifice installation, Pitot tube, Area flow meters, Open channel meters. Level measurement - Direct method, Measurement of level in open and pressure vessels, Measurement of pH and humidity. Recording Instruments, Indicating and signaling instruments, Signal transmission and codes.

### Unit-III

Open loop and Close loop systems - Transfer function, block diagram representation of mechanical, thermal and liquid level systems.

Transient response analysis, Time response of first and second order system for impulse and step inputs, Effect of damping factors on transient response, Characteristics of proportional, integral, derivative, PI, PD and PID controllers, Frequency response method of analysis, polar plot, Bode Plot.

## Unit-IV

Introduction to stability, Definition via impulse response function, Routh-Hurwitz stability criterion, Nyquist stability criterion, Control system components, error detectors, modulators and demodulators, Hydraulic controllers, Pneumatic controllers, PLC.

Introduction to computer control in chemical process industry, Comparison between discrete data, digital and analogue control systems.

### References:

1. D Patranabis, Principles of Industrial Instrumentation, Second Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi, latest edition
2. George Stephanopolous, Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall of India Pvt. Ltd, latest edition
3. Eckman D P, Industrial Instrumentation, Wiley Eastern Ltd, New Delhi, latest edition
4. Ogata, K., Modern Control Engineering, Prentice Hall, latest edition
5. Benjamin C. Kuo., Digital Control Systems, Oxford University Press, latest edition
6. Stefani R.T, Shahian B, Savant J.C and Hostetter G. H, Design of Feedback Control Systems, Oxford University Press, latest edition

Course code	<b>OEC-FTEL-335</b>				
Category	Open Elective Courses				
Course title	<b>Operation Research</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Identify operational research model from the verbal discussion of real system.</li> <li>• Describe operation research and its applications.</li> <li>• Apply the mathematical tools and simulation models that are needed to solve optimization problem.</li> <li>• Analyze the result and proposed recommendations in language understandable to decision making process in management engineering.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To familiarize students with the basic concepts, models and statements of the operations research theory.</li> <li>• To evaluate the optimum cost in various operations research models.</li> <li>• To analyze various decision making process in certainty, uncertainty and risk environment.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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, Role of operations research in decision-making, applications in industry. Concept on O.R. model building, Types & methods.

**Linear Programming (LP):** Programming definition, formulation, solution- graphical, simplex Gauss-Jordan reduction process in simplex methods, BIG-M methods computational, problems.

### Unit-II

**Deterministic Model:** Transportation model-balanced & unbalanced, north west rule, Vogel's Method, least cost or matrix minimal, Stepping stone method, MODI methods, degeneracy, assignment, traveling salesman, problems.

**Advanced Topic of LP:** Duality, PRIMALDUAL relations-its solution, shadow price, economic interpretation, dual-simplex, post optimality & sensitivity analysis, problems.

### Unit-III

**Waiting Line Models:** Introduction, queue parameters, M/M/1 queue, performance of queuing systems, applications in industries, problems.

**Project Line Models:** Network diagram, event, activity, defects in network, PERT & CPM, float in network, variance and probability of completion time, project cost- direct, indirect, total, optimal project cost by crashing of network, resources leveling in project, problems.



## Unit-IV

**Simulation:** Introduction, design of simulation, models & experiments, model validation, process generation, time flow mechanism, Monte Carlo methods- its applications in industries, problems.

**Decision Theory:** Decision process, SIMON model types of decision making environment- certainty, risk, uncertainty, decision making with utilities, problems.

### References:

1. Operation Research by TAHA, PHI, New Delhi.
2. Principle of Operations Research by Ackoff, Churchman, Arnoff, Oxford IBH, Delhi.
3. Operation Research by Gupta & Sharma, National Publishers, New Delhi.
4. Quantitative Techniques by Vohra, TMH, New Delhi
5. Principles of operation Research (with Applications to Managerial Decisions) by H.M.Wagner, Prentice Hall of India, New Delhi.
6. Operation Research by Sharma, Gupta, Wiley Eastern, New Delhi.

Course code	<b>OEC-FTEL-336</b>				
Category	Open Elective Courses				
Course title	<b>Industrial Noise and Vibrations</b>				
Scheme and Credits	L	T	P	Credits	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to : <ul style="list-style-type: none"> <li>• Explain the merits and demerits of vibrations, sound and noise happened in industries.</li> <li>• Calculate the natural frequency and other response of a system/machine operating under vibratory conditions.</li> <li>• Apply the different methods and techniques to reduce vibrations, noise and sound up to accepted level.</li> <li>• Analyze the mathematical model of a linear vibratory system to determine its response.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To learn the importance of vibrations, sound and noise in context of an industry.</li> <li>• To write the differential equation of motion of vibratory systems having single or multiple degree of freedom.</li> <li>• To understand the basic concepts, techniques and laws that can be used for reduction of vibrations, sound and noise up to accepted level.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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 Vibrations:** Introduction, Causes, Effects, Merits and Demerits , Types of Vibrations, SHM, Addition of harmonic motions, Beats Phenomenon, Work done by harmonic force on harmonic motion, Harmonic series.

**Undamped Free Vibration:** Equations of motion, Natural frequency, Newton's Method, D'Alemberts Principle, Energy method, Rayleigh's method, Simple pendulum, Compound pendulum, Floating and immersed body.

### Unit-II

**Damping:** Introduction, Equation of motion, Critical damping, Underdamping, Overdamping, Logarithmic decrement, Types of Damping, Viscous damping, Coulomb damping, Hysteresis damping, Slip damping.

**Forced Vibrations:** Introduction, Equation of motion with harmonic force, Excitation due to unbalance, rotating and reciprocating unbalance, Transmissibility, Whirling of Shaft.

### Unit-III

**Multi Degrees of Freedom System:** Introduction, Equation of Motion, Influence coefficients, Dunkerley's method, Rayleigh's method, Holzer's method, Matrix method, Matrix Iteration method, Stodola's method.

**Vibrations Control:** Vibrations measuring Instruments, Vibration isolation, Frequency measuring instruments, Vibration absorbers, Centrifugal vibration absorber, Torsional vibration absorber, Vibration dampers, Lanchester damper, Houdaille damper.

### Unit-IV

**Noise:** Introduction, Nature and types of noise, Non Auditory effect of noise, Auditory effects of noise, Noise Standards and limits, Noise Measurement, Hazardous noise explosion, Day Night Noise Level, Noise Sources and control.

**Sound:** Sound level, Subjective response to sound frequency , human response to sound, Sound pressure human response, Decibel Scale, Relation among sound power, Sound intensity & sound pressure level, Octave band analysis.

#### References:

1. Mechanical Vibration & Noise by A.G. Ambekar, PHP Publication
2. Mechanical Vibration by G.K. Grover, Nen Chand & Bros.
3. Theory of Vibrations with Applications by W.T. Thomson, Pearson Publication
4. Mechanical Vibrations by J.K. Narwal, VEI Publications
5. Mechanical Vibrations by S.S. Rao, Pearson Publications
6. Vibrations and Noise for Engineers by Kewal Pujara, Dhanpat Rai & Co.

Course code	<b>OEC-FTEL-337</b>				
Category	Open Elective Courses				
Course title	<b>Engineering Economics</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Define the basic terminologies of economics.</li> <li>• Describe the basics laws of economics and their practical applications in various situations.</li> <li>• Determine the relationship between demand and supply, their effect on cost.</li> <li>• Discuss the different features of market, GST, VAT, GATT etc.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To understand laws of economics and their practical application in market.</li> <li>• To evaluate the market according to the highest profit.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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**

Definitions of Economics, Nature of Economic problems, Production possibility curve Economic laws and their nature. Relation between Science, Engineering, Technology and Economics.

Concepts and measurement of utility, Law of Diminishing Marginal Utility, Law of equi-marginal utility, its practical applications and importance.

### **Unit-II**

Demand: Meaning, Individual and Market demand schedule, Law of demand, shape of demand curve, Elasticity of demand, measurement of elasticity of demand, factors effecting elasticity of demand, practical importance & applications of the concept of elasticity of demand. Meaning of production and factors of production; Law of variable proportions, Returns to scale, Internal and External economics and diseconomies of scale.

### **Unit-III**

Cost: Fixed cost, variable cost, average cost, marginal cost, money cost, real cost opportunity cost. Shape of average cost, marginal cost, total cost etc. in short run and long run. Meaning of Market, Types of Market, Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets).

## Unit-IV

Supply and Law of Supply, Role of Demand & Supply in Price Determination and effect of changes in demand and supply on prices. Nature and characteristics of Indian economy (brief and elementary introduction), Privatization - meaning, merits and demerits, Globalisation of Indian economy - merits and demerits, Elementary Concepts of GST, VAT, GATT & TRIPS agreement.

### References:

1. Principles of Economics: P.N. Chopra (Kalyani Publishers).
2. Modern Economic Theory – K.K. Dewett (S.Chand)
3. A Text Book of Economic Theory Stonier and Hague (Longman's Landon)
4. Micro Economic Theory – M.L. Jhingan (S.Chand)
5. Micro Economic Theory - H.L. Ahuja (S.Chand)
6. Modern Micro Economics : S.K. Mishra (Pragati Publications)
7. Economic Theory - A.B.N. Kulkarni & A.B. Kalkundrikar (R.Chand & Co.)
8. Indian Economy: Rudar Dutt & K.P.M. Sundhram

Course code	<b>OEC-FTEL-338</b>				
Category	Open Elective Courses				
Course title	<b>Artificial Intelligence</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to : <ul style="list-style-type: none"> <li>• Describe artificial intelligence and neural network.</li> <li>• Understand expert system life cycle and fuzzy logic.</li> <li>• Apply the concepts of artificial intelligence using prolog.</li> <li>• Analyze the problem as a state space, graph, heuristics and game based techniques to solve them.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.</li> <li>• To investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.</li> <li>• To explore the current scope, potential, limitations and implications of intelligent system.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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

**Foundational issues in intelligent systems:** Foundation and history of AI, AI problems and techniques, AI programming languages, Introduction to LISP and PROLOG, problem spaces and searches, blind search strategies, Breadth first- Depth first- heuristic search techniques Hill climbing, best first- A \* algorithm AO\* algorithm, game tree, Min max algorithms, game playing, alpha beta pruning.

### Unit-II

Knowledge representation issues, predicate logic- logic programming, semantic nets, frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems.

### Unit-III

Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and Dempster shafer theory, Heuristic methods, symbolic reasoning under uncertainty, Statistical reasoning, Fuzzy reasoning, Temporal reasoning, Non monotonic reasoning.

## Unit-IV

Planning, planning in situational calculus, representation for planning, partial order planning algorithm, learning from examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms, Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems.

### References:

1. Artificial Intelligence: A Modern Approach,. Russell & Norvig. Prentice Hall.
2. Artificial Intelligence, Elain Rich and Kevin Knight, TMH.
3. Artificial Intelligence-A modern approach, Staurt Russel and peter norvig, PHI.
4. Artificial intelligence, Patrick Henry Winston: Addition Wesley latest edition

Course code	<b>OEC-FTEL-339</b>				
Category	Open Elective Courses				
Course title	<b>Environmental Engineering and Management</b>				
<b>Scheme and Credits</b>	L	T	P	<b>Credits</b>	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Understand the impact of humans on environment and environment on humans.</li> <li>• Identify and value the effect of the pollutants on the environment, atmosphere, water and soil.</li> <li>• Apply strategies to control, reduce and monitor pollution.</li> <li>• Select the most appropriate techniques for the treatment of water, waste water, solid waste and contaminated air.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To reduce the various types of pollution from our daily life.</li> <li>• To make our environmental management system effective.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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 equipment working principles of gravity settlers, cyclones, wet scrubbers, fabric filters and electrostatic precipitators, Gaseous control methods- an overview of absorption, adsorption and combustion method, Biological methods for VOC and odour control.

### **Unit-II**

**Waste water:** Physical, chemical and biological characteristic, Effects of pollutants on water quality and aquatic life, Physical unit operations in waste water treatment, flow equalization, sedimentation, and flotation, 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.



### 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, Vermi composting, 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 description of the environmental setting, 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, concept of Industrial ecology, Clean development mechanism (CDM) - carbon trading.

### References:

- 1.Environmental Pollution Control Engineering by C.S. Rao, New Age International (P) Ltd Publishers, latest edition.
2. Wastewater Treatment by M.N. Rao and A.K. Dutta, Oxford & IBH, Publishing Co. Pvt. Ltd, New Delhi, latest edition.
3. Handbook of solid waste Disposal and Management by Pavani, J. L
4. Waste Water Engineering: Treatment, Disposal, Reuse by Metcalf and Eddy Inc.
5. Environmental Impact Assessment by Canter. L.W
6. Environmental Engineers Handbook (latest Ed.) by Liu,

Course code	<b>OEC-FTEL-340</b>				
Category	Open Elective Courses				
Course title	<b>Robotics And Robot Applications</b>				
Scheme and Credits	L	T	P	Credits	Semester-----
	3	0	0	3	
<b>Course Outcomes:</b>	After completion of this course students will be able to: <ul style="list-style-type: none"> <li>• Define the basic concept of industrial robotics and the main components of robotics technologies.</li> <li>• Describe the robot drive system, various robot end effectors, various sensors used in robotics.</li> <li>• Explain the implementation of modern tools like robots in industries and artificial intelligence.</li> <li>• Analyze the various movements of robots and design the robot program.</li> </ul>				
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>• To study different types of sensors in robotics.</li> <li>• To know about the control system and components of robotics.</li> <li>• To Mess up artificial intelligence with robotics for their future scopes.</li> </ul>				
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts of 2.5 marks each from all units and remaining eight questions of 15 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 Robotics/Fundamentals of Robot Technology, Programming and Applications:**

Introduction-Automation and Robotics, brief history of Robotics, the Robotics Market and the Future Prospects, Robot Anatomy, Work Volume, Robot Drive Systems, Control Systems, Precision of Movement, End Effectors, Robotic Sensors, Robot Programming and Work Cell Control, Robot Application

**Control Systems and Components :** Basic control systems concepts and models, Controllers, Control System Analysis, Robot Sensors and Actuators, Velocity Sensors, Actuators, Power Transmissions Systems

### Unit-II

**Robot End Effectors:** Types of End Effectors, Mechanical Grippers, Other Types of Grippers, Tools as End Effectors, Robot/End Effectors Interface, Considerations in Gripper Selection and Design

**Sensors in Robotics:** Transducers and Sensors, Sensors in Robotics, Tactile Sensors, Proximity and Range Sensors, Miscellaneous Sensors and Sensor Based System, Uses of Sensors in Robotics

### Unit-III

**Artificial Intelligence:** Introduction, Goals of All Research, All Techniques, All and Robotics, Robotic Paradigms

**Material Transfer and Machine Loading/Unloading:** General Considerations in Robot Material Handling, Material Transfer Applications, Machine Loading and Unloading, Spot Welding, Continuous Arc Welding, Spray Coating, Other Processing Operations using Robots

## Unit-IV

**Robotics Technology of the Future and Future Applications:** Robot Intelligence, Advanced Sensor Capabilities, Tele-presence and Related Technologies, Mechanical Design Features, Mobility, Locomotion and Navigation, The Universal Hand, Systems Integration and Networking, Characteristics of Future Robot Tasks, Future Manufacturing Applications of Robots, Hazardous and Inaccessible Non-Manufacturing Environments, Service Industry and Similar Applications.

### References:

1. Industrial Robotic Technology – Programming and Applications by M.P. Groover et. Al., McGrawhill
2. Robotics for Engineers by Y. Koren, McGrawhill
3. Robots Modeling Control and Applications with Software by P.G. Ranky and C.Y. Ho, Springer Verlag Berlin