COCHIN UNIVERSITY OF SCIENCE & TECHNOLOGY

SCHEME & SYLLABUS
(I to VIII Semesters)

B. TECH PROGRAMME

in

SAFETY AND FIRE ENGINEERING

(2023Admission onwards)

B.TECH. DEGREE PROGRAMME IN SAFETY AND FIRE ENGINEERING

VISION

To become a Centre of Excellence in Safety and Fire Engineering through advanced research, training and consultancy.

MISSION

To provide quality education and to prepare nationally and internationally competitive undergraduate and postgraduate students for a successful career in safety, occupational health, environmental management and fire protection engineering.

To promote research in the field of safety, occupational health, environmental management and fire protection engineering for improving safety and fire engineering practices.

To encourage students for advanced study and research and to improve the safety standards of the society and the nation at large.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1. Graduates will compete on a global platform to pursue their professional career in Safety and Fire Engineering and allied disciplines.
PEO2. Graduates will pursue higher education and/or engage in continuous up gradation of their professional skills.
PEO3.Graduates will communicate effectively and will demonstrate professional behavior while rking in diverse teams.
PEO4. Graduates will demonstrate high regard for human rights, respect values in diverse cultures, and have concern for society and environment.

PROGRAMME OUTCOMES (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES

PSO 1: Analyze and assess life safety and fire safety of the built environment to design and specify life saving and fire protection systems.
PSO 2: Assess hazards and risks in chemical process and other manufacturing/production industries based on sound safety engineering principles and devise remedial measures and safety management systems.
PSO 3: Assess the occupational health and environmental issues associated with industrial and other activities to design control measures with traditional and modern computational tools based on codes and statutes.
PSO 4: Develop policies, codes, standards and industry practices/guidelines pertaining to safety, fire Protection and occupational safety at National and International level.

Program Articulation Matrix

PEO / **Mission Statements**	**PEO1**	**PEO2**	**PEO3**	**PEO4**
To provide quality education and to prepare nationally and internationally competitive undergraduate and postgraduate students for a successful career in safety, occupational health, environmental management and fire protection engineering.	3	3	2	2
To promote research in the field of safety, occupational health, environmental management and fire protection engineering for improving safety and fire engineering practices.	3	3	2	2
To encourage students for advanced study and research and to improve the safety standards of the society and the nation at large.	3	3	2	2

1-Slightly; 2-Moderately; 3-Substantially

Categories of Courses with the Breakup of Credits

Sl. No	Category of Courses	Credit breakup
1	Humanities and Social Sciences including Management Courses	10
2	Basic Science courses	21
3	Engineering Science Courses including workshop, drawing, basics of electronics/electrical/mechanical/computer etc.,	26
4	Professional Courses	76
5	Professional elective courses relevant to chosen specialization/discipline	18
6	Open subjects-Electives from other technical and /or emerging subjects	6
7	Project work, seminar and internship in industry or elsewhere	13
8	Mandatory courses	(non-credit)
	Total	170

Stream A: Civil Engineering, Mechanical Engineering and Safety and Fire Engineering

SEMESTER I [Stream – A]

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0101A	Calculus	3	1	0	3	50	50	100
23-200-0102A	Engineering Chemistry	3	0	1	3	50	50	100
23-200-0103A	Engineering Graphics	2	0	3	3	50	50	100
23-200-0104A	Basic Civil Engineering	3	1	0	4	50	50	100
23-200-0105A	Basic Mechanical Engineering	3	1	0	4	50	50	100
23-200-0106A	Environmental and Life Sciences	3	0	0	3	50	50	100
23-200-0107A	Civil Engineering Workshop	0	0	3	1	25	25	50
23-200-0108A	Mechanical Engineering Workshop	0	0	3	1	25	25	50
	TOTAL	17	3	10	22			

CA – Continuous Assessment SEE – Semester End Examination

SEMESTER II [Stream A]

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0201A	Computer Programming and Problem Solving	3	1	0	4	50	50	100
23-200-0202A	Engineering Physics	3	0	1	3	50	50	100
23-200-0203A	Engineering Mechanics	3	1	0	4	50	50	100
23-200-0204A	Basic Electrical Engineering	3	0	0	3	50	50	100
23-200-0205A	Basic Electronics Engineering	3	0	0	3	50	50	100
23-200-0206A	Soft Skills Development	2	0	0	2	50	-	50
23-200-0207A	Computer Programming Laboratory	0	0	3	1	25	25	50
23-200-0208A	Basic Electrical and Electronics Engineering Laboratory	0	0	3	1	25	25	50
23-200-0209A	Language Laboratory	0	0	2	1	25	25	50
23-200-0210A	NSS/Nature Conservation Activities/Yoga	0	0	2	0	-	-	-
	TOTAL	17	2	11	22			

SEMESTER III

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0301A*	Linear Algebra & Transform Techniques	3	1	0	3	50	50	100
23-206-0302	Chemical Process Principles	3	1	0	3	50	50	100
23-206-0303	Engineering Fluid Mechanics and Introduction to CFD	3	1	0	3	50	50	100
23-206-0304	Fire Engineering Fundamentals	3	1	0	3	50	50	100
23-206-0305	Occupational Safety and Industrial Hygiene	3	1	0	3	50	50	100
23-206-0306	Principles of Safety Management	3	1	0	3	50	50	100
23-206-0307	Fluid Mechanics and Machinery Laboratory	0	0	3	1	25	25	50
23-206-0308	Industrial Hygiene Laboratory	0	0	3	1	25	25	50
23-206-0309	Internship-1	0	0	0	1	50	-	50
	TOTAL	**18**	**6**	**6**	**21**			

Minor in Safety and Fire Engineering

Code No.	Subject	L H/W	T Hours/ Week	P/D Hours/ Week	C	Marks		Total
						CA	SEE	
23-206-0310	Principles of Health, Safety and Environmental Management (class room)	3			3	50	50	100

*Common for CE, ME and SE branches

Internship-1 of a minimum duration of two weeks (10 working days) after second semester and the evaluation will take place during the III semester. For lateral Entry students a mini project carried out can be considered equivalent to Internship-I

SEMESTER IV

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0401A*	Complex Variables and Partial Differential Equations	3	1	0	3	50	50	100
23-206-0402	Heat Transfer Operations	3	1	0	3	50	50	100
23-206-0403	Strength of Materials	3	1	0	3	50	50	100
23-206-0404	Planning and Design of Fire Protection Systems	3	0	0	3	50	50	100
23-206-0405	Electrical Technology and Safety	3	0	0	3	50	50	100
23-206-0406	Manufacturing Processes	3	0	0	3	50	50	100
23-200-0407**	Universal Human Values	2	1	0	3	25	25	50
23-206-0408	Strength of Materials Laboratory	0	0	3	1	25	25	50
23-206-0409	Electrical Technology Laboratory	0	0	3	1	25	25	50
	TOTAL	**20**	**4**	**6**	**23**			
Minor in Safety and Fire Engineering								
23-206-0410	Fire Protection Engineering (class room)	3			3	50	50	100
23-206-0411#	MOOC I (Broad area: Safety Engineering and Management)				3			100
Honours in Safety and Fire Engineering								
23-206-0412	Soft computing Techniques for Safety Engineering (class room)	3			3	50	50	100
23-206-0413#	MOOC I				3			100

*Common for CE, ME and SE branches

**The evaluation pattern for Universal Human Values will be the same as that for a Laboratory course.

Students should take Massive Open Online Courses (MOOCs) approved by the concerned Division/Board of Studies (BoS)

SEMESTER V

Code No.	Subject	L H/ W	T H/ W	P/D H/ W	C	Marks		Total
						CA	SEE	
23-200-0501A*	Numerical and Statistical Methods	3	1	0	3	50	50	100
23-206-0502	Mass Transfer Operations	3	1	0	3	50	50	100
23-206-0503	Principles of Engineering Design	3	1	0	3	50	50	100
23-206-0504	Structural Fire Safety	3	1	0	3	50	50	100
23-206-0505	Chemical Technology and Reaction Engineering	3	1	0	3	50	50	100
23-206-05**	Professional Elective I (MOOC)	0	0	0	3			100
23-206-0510	Computer Applications in Safety and Fire Engineering Laboratory I	0	0	3	1	25	25	50
23-206-0511	Fire Safety Training	0	0	3	1	25	25	50
23-206-0512	Internship-II	0	0	0	1	50	-	50
	TOTAL	**15**	**5**	**6**	**21**			
Minor in Safety and Fire Engineering								
23-206-0513#	MOOC II (Broad area: Occupational health and Environmental management)				3			100
Honours in Safety and Fire Engineering								
23-206-0514	Research methodology and IPR	3			3	50	50	100
23-206-0515#	MOOC II				3			100

23-206-0506 to 23-206-0509 Professional Elective – I (MOOC)	
Code No.	**Broad Area**
23-206-0506(IE)	Aviation Safety and Safety of Space Missions
23-206-0507	Hazard Control in Manufacturing
23-206-0508	Safety in Fireworks Industry
23-206-0509	Introduction to process plant security

*Common for CE, ME and SE branches

Students should take Massive Open Online Courses (MOOCs) approved by the concerned Division/Board of Studies (BoS)

Internship-II of a minimum duration of four weeks (10 working days) after fourth semester and the evaluation will take place during the V semester.

SEMESTER VI

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-206-0601	Legal Aspects of HSE	3	1	0	3	50	50	100
23-206-0602	IOT based Process Instrumentation and Control	3	1	0	3	50	50	100
23-206-0603	Chemical Process Safety	3	1	0	3	50	50	100
23-206-0604	Life Safety in Building Fire	3	1	0	3	50	50	100
23-206-0605	Environmental Engineering and Management	3	1	0	3	50	50	100
23-206-06**	Professional Elective – II	3	1	0	3	50	50	100
23-206-0610	Computer Applications in Safety and Fire Engineering Laboratory II	0	0	3	1	25	25	50
23-206-0611	Machine Shop	0	0	3	1	25	25	50
	TOTAL	**18**	**6**	**6**	**20**			
Minor in Safety and Fire Engineering								
23-206-0612	Mini Project	-		3	3	100	-	100
23-206-0613#	MOOC II (Broad area: Fire Engineering)				3			
Honours in Safety and Fire Engineering								
23-206-0614#	MOOC III				3			100

23-206-0606 to 23-206-0609 Professional Elective – II	
Code No.	**Subject**
23-206-0606(IE)	Safety in Petroleum and Petrochemical Industries
23-206-0607	Food and Bio-safety
23-206-0608	Fault Detection and Diagnosis
23-206-0609	Explosive Engineering and Safety

Students should take Massive Open Online Courses (MOOCs) approved by the concerned Division/Board of Studies (BoS)

SEMESTER VII

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-206-0701	Hazard Identification and Risk Assessment	3	1	0	3	50	50	100
23-206-0702	Disaster Management	3	1	0	3	50	50	100
23-206-0703	Safety in Construction	3	1	0	3	50	50	100
23-206-07**	Professional Elective – III	3	1	0	3	50	50	100
23-206-07**	Open Elective -I	3	0	0	3	50	50	100
23-206-0712	Chemical and Environmental Engineering Laboratory	0	0	3	1	25	25	50
23-206-0713	Fire Engineering Laboratory	0	0	3	1	25	25	50
23-206-0714	Entrepreneurship Development	0	0	2	1	50	-	50
23-206-0715	Project Phase I	0	0	3	2	50	-	50
23-206-0716	Internship-III	0	0	0	1	50	-	50
	TOTAL	**15**	**4**	**11**	**21**			
Honours in Safety and Fire Engineering								
23-206-0717	Dynamic Risk Analysis (class room)	3			3	50	50	100

23-206-0704 to 23-206-0707 Professional Elective – III	
Code No.	Subject
23-206-0704 (IE)	HSE Aspects of Fertiliser Industry
23-206-0705	Transportation Systems and Safety
23-206-0706	Principles of Industrial Management
23-206-0707	Industrial Ecology

23-206-0708 to 23-206-0711 Open Elective – I	
Code No.	Subject
23-206-0708	Industrial Psychology
23-206-0709	Entrepreneurship and Small Business Enterprises
23-206-0710	Science and Technology of Nano materials
23-206-0711	Energy Management and Conservation

Internship-III of a minimum duration of two weeks (10 working days) after VI semester and the evaluation will take place during the VII semester.

SEMESTER VIII- Regular Track

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-206-08**	Professional Elective IV	3	1	0	3	50	50	100
23-206-08**	Professional Elective V	3	1	0	3	50	50	100
23-206-08**	Professional Elective VI	3	1	0	3	50	50	100
23-206-08**	Open Elective II	3	0	0	3	50	50	100
23-206-0818	Seminar	0	0	3	1	50	-	50
23-206-0819	Project Phase II	0	0	12	6	200	-	200
23-206-0820	Comprehensive Viva Voce	-	-	0	1	-	50	50
	TOTAL	**12**	**3**	**15**	**20**			

SEMESTER VIII- Internship Track

Code No.	Subject	L Hours/ Week	T Hours /Week	P/D Hours / Week	C	Marks		Total
						CA	SEE	
23-206-08**	Professional Elective IV	3	1	0	3	50	50	100
23-206-08**	Elective(Professional /Open)	3	1	0	3	50	50	100
23-206-0818	Seminar			3	1	50	-	50
23-206-0819	Project Phase - II			12	6	200	-	200
23-206-0820	Comprehensive Viva Voce			0	1	-	50	50
23-206-0821	Internship-IV	0	0	0	6	200	-	200
	TOTAL	**6**	**2**	**15**	**20**			

23-206-0801 to 23-20-0804 Professional Elective – IV	
Code No.	Subject
23-206-0801	Advanced Safety Engineering and Management
23-206-0802	Functional Safety Engineering
23-206-0803	Incident Investigation Techniques
23-206-0804	System Safety Engineering

23-206-0805 to 23-20-0808 Professional Elective – V	
Code No.	Subject
23-206-0805	Human Factors Engineering
23-206-0806	Operations Research
23-206-0807	Advanced Fire Dynamics
23-206-0808	Environmental Risk and Impact Assessment

23-206-0809 to 23-20-0812 Professional Elective – VI	
Code No.	Subject
23-206-0809	Introduction to Occupational Epidemiology
23-206-0810	Quality Management Systems and Procedures
23-206-0811	Applications of IOT and AI in safety engineering
23-206-0812	Reliability Engineering

23-206-0813 to 23-206-0816 and 23-200-0817 Open Elective – II	
Code No.	Subject
23-206-0813	Non-destructive Testing Methods
23-206-0814	Automobile engineering and safety
23-206-0815	Safety, Fire and Environmental Management
23-206-0816	History and Philosophy of Science
23-200-0817*	Constitutional Law

*Common to all branches

List of Courses for Minor in Safety and Fire Engineering

Code No.	Subject	L Hour/ week	T Hours/ Week	P/D Hours/ Week	C	Marks		Total Marks	Semester in which offered	Mode of learning
						CA	SEE			
23-206-0310	Principles of Health, Safety and Environmental Management	3			3	50	50	100	III	Class room
23-206-0410	Fire Protection Engineering	3			3	50	50	100	IV	Class room
23-206-0411	MOOC I (Minor) (Broad area: Safety Engineering and Management)				3			100	IV	On-line
23-206-0513	MOOC II (Minor) (Broad Area: Occupational health and Environment Management)				3			100	V	On-line
23-206-0612	Mini Project	-		3	3	100	-	100	VI	
23-206-0613	MOOCIII (Minor) (Broad Area: Fire Engineering)				3			100	VI	On-line

List of Courses for Honours

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total Marks	Semester in which offered	Mode of learning
						CA	SEE			
23-206-0412	Soft computing Techniques for Safety Engineering	3			3	50	50	100	IV	Class room
23-206-0413	MOOC I				3			100	IV	On-line
23-206-0514	Research Methodology and IPR	3			3	50	50	100	V	Class room
23-206-0515	MOOC II				3			100	V	On-line
23-206-0614	MOOC III				3			100	VI	On-line
23-206-0717	Dynamic Risk Analysis	3			3	50	50	100	VII	Class room

Industry based Electives

Industry based Electives are offered in 5th, 6th and 7th Semesters and are listed among the Professional Electives with notation (IE) along with the subject code. A student should opt for at least one Industry based elective during the B.Tech. Programme.

Open Electives:

Open Electives are offered in 7th and 8th Semesters. A student should opt for at least one Open Elective offered by any Division/Department other than their branch of study.

MOOC : Every student shall undergo at least one MOOC of minimum 12 weeks duration during the programme (preferably before the final semester) as per the University Regulations for conducting online courses (MOOC)

SEMESTER VIII Internship Track

- Students who intend to go for internship track should inform the division head concerned before the commencement of 8th semester. The students will be given an option to change the track within 30 days from the commencement of 8th semester.
- Students opting for Internship Track have to do Project-Phase – II and appear for the Comprehensive Viva-Voce.
- The interns may opt for courses recommended by the division from the list of NPTEL/Swayam courses approved by BoS.
- The students opting for divisional courses have to fulfill the requirements of continuous assessment and semester end examination.
- One elective from Open Elective pool is mandatory if they have not completed one mandatory Open Elective in the seventh semester.
- Project-phase –II is the continuation of Project-phase –I completed in the seventh semester.

- The Internship -IV of minimum 6 weeks' duration must be done in an industry approved by either the Placement Cell or the respective Departments based on a valid MOU or other Government organisations approved by the Division.
- The Internship-IV is equivalent to two 3-credit courses of total 200 marks
- The progress of Internship-IV will be evaluated twice during the semester, along with the internal examinations and finally after the completion of the internship.

Evaluation Pattern for Theory and Practical courses

1. Theory courses

Type of Questions for Semester End Examination (SEE)

PART - A (5 x 2 = 10 marks)

Question No. I (a) to (e) –Five short answer questions of 2marks each with at least one question from each of the four modules.

PART - B (4x10 = 40 marks)

Question nos. II and III (from Module I) of 10 marks each with option to answer either II or III. The question may have sub sections (a) and (b)

Question nos. IV and V (from Module II) of 10 marks each with option to answer either IV or V. The question may have sub sections (a) and (b).

Question nos. VI and VII (from Module III) of 10 marks each with option to answer either VI or VII. The question may have sub sections (a) and (b).

Question nos. VIII and IX (from Module IV) of 10 marks each with option to answer either VIII or IX. The question may have sub sections (a) and (b)

The maximum marks that can be awarded for the Semester End Examination (SEE) will be only 50.

2. Practical courses

50% marks is earmarked for Continuous Evaluation, and 50% marks for Semester End Examination. The Semester End Examination to be conducted by a minimum of two examiners.

3. Pass Requirements

A candidate has to obtain a minimum of 50% marks for continuous assessment and semester end examination put together with a minimum of 40% marks in the semester end examination for a pass in theory and laboratory courses.

In the case of theory/laboratory/other courses having only continuous assessment, a candidate has to obtain a minimum of 50% marks in continuous assessment for a pass.

.

23-200-0101A CALCULUS

Course Outcomes:

On completion of this course the student will be able to:

1. Solve ordinary differential equations and linear differential equations of higher orders with constant coefficient and apply them in engineering problems
2. Determine the maxima and minima of multi variable functions.
3. Convert line integrals into surface integrals and surface integrals into volume integrals
4. Illustrate the physical meaning and application of gradient, divergence and curl.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO2
CO1	3	2	2									
CO2	3	2	1									
CO3	3	2										
CO4	3	3	1									

1-Slightly; 2-Moderately; 3-Substantially

Module I

Ordinary differential equations:

First order differential equations - exact differential equations, Bernoulli's equations--Methods of solution and Simple applications.

Linear differential equations of higher orders with constant co-efficient- Methods of solution of these equations. Cauchy's linear differential equations. Simultaneous linear differential equations- Simple applications of linear differential equations in engineering problems –Electrical Circuits, Mechanical Systems.

Module II

Partial differentiation: Partial differentiation-Concept of partial derivative - Chain rule- Total derivative-Euler's theorem for homogeneous functions, Differentials and their applications in errors and approximations, Jacobians - Maxima minima of functions of two variables (Proof of the result not required)-Simple applications.

Co-ordinate systems: Rectangular co-ordinates-Polar co-ordinates-In plane and in Space-Cylindrical polar co-ordinates-Spherical polar co-ordinates.

Module III

Integral calculus:

Application of definite integrals: Area, Volume, Arc length, Surface area.

Multiple integral: Evaluation of double integrals-Change of order of integration. Evaluation of triple integrals-Change of Variables in integrals.

Applications of multiple integrals. Plane Area, Surface area &Volumes of solids

Module IV

Vector calculus: scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of vector point functions, their physical meaning. Evaluation of line integral, surface integral, and volume integrals, Gauss's divergence theorem, Stoke's theorem (No proofs), conservative force fields, scalar potential.

References:

1. Sastry, S.S. Engineering Mathematics: Vol1. (Fourth edition).PHI Learning, New Delhi. (2008).
2. Erwin Kreyzig. Advanced Engineering Mathematics (Tenth edition). John Wiley& Sons, Hoboken, NJ. (2011)
3. Veerarajan, T. Engineering Mathematics. (Third edition). Tata McGraw Hill Publishers, New Delhi. (2011)
4. Grewal, B.S. Higher Engineering Mathematics. (Forty third Edition). Khanna Publishers, New Delhi. (2013).

23-200-0102A ENGINEERING CHEMISTRY

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the basic concepts of chemical thermodynamics, and quantum chemistry.
2. Illustrate the spectroscopic methods in characterizing materials.
3. Develop electro chemical methods to protect different metals from corrosion.
4. Interpret the chemistry of a few important engineering materials and their industrial applications.
5. Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2													
CO2	3	2	3													
CO3	1	1	1													
CO4	1	1	1													
CO5	2	2	3													

1-Slightly; 2-Moderately; 3-Substantially

Module I

Chemical Thermodynamics: Fundamentals. First law of thermodynamics, Molecular interpretation of internal energy, enthalpy and entropy. Heat of reaction. Kirchoff's equations. Dependence on pressure and temperature. Gibbs-Helmholtz equation. Free energy changes and equilibrium constant. Chemical potential and fugacity. Thermodynamics of biochemical reactions.

Phase Rule: Terms involved in phase rule and examples, Application of phase rule to one component water system, Application of phase rule to two-component systems. (Simple eutectic systems).

Module II

Quantum Chemistry: Schrodinger wave equation – significance of Ψ, well behaved functions, Postulates of quantum mechanics, Application of quantum mechanics to simple systems - particle in 1 D box, normalization of wave function, Forms of hydrogen atom wave functions and the plots of these functions to explore their spatial variations, Quantum numbers.

Module III

Spectroscopy: Principles of spectroscopy and selection rules. Electronic spectroscopy, Vibrational and rotational spectroscopy of diatomic molecules. Applications. ^{1}H NMR spectroscopy – Principle - Relation between field strength and frequency - chemical shift - spin-spin splitting - coupling constant - applications of NMR- MRI.

Module IV

Electrochemistry: Cell EMF- its measurement and applications. Nernst Equation and application, relation of e.m.f. with thermodynamic functions (ΔH, ΔF and Δ S). Lead storage battery. Corrosion; causes, effects and its prevention.

Polymers- Classifications- Thermoplastics and thermosetting plastics- A brief account of conducting polymers (polypyrrole and polythiophene) and their applications.

Lubricants- Introduction solid and liquid lubricants- Properties of lubricants-Viscosity index- flash and fire point- cloud and pour point- aniline value.

Refractories: Classifications – Properties of refractories.

Laboratory Experiments to be conducted in the virtual lab mode

List of Experiments (Minimum six experiments shall be conducted)

1. Determination of the partition coefficient of a solute in two immiscible liquids.
2. Phase diagram of two component System (Naphthalene-diphenylamine).
3. Conductometric titration of **S**trong acids with Strong base.
4. Potentiometric titration: Fe^{2+} vs $KMNO_4$.
5. Heat of neutralization.
6. Verification of Beer-Lamberts law.
7. Determination of rate constant of a reaction.
8. Determination of total hardness of water by EDTA method.
9. Determination of COD of water sample.
10. Determination of alkalinity of water.
11. Determination of chloride content of water by Mohr's method.
12. Determination of dissolved oxygen in given water sample.
13. Determination of acidity of water sample.
14. Determination of adsorption of acetic acid by charcoal.
15. Determination of acidity of water sample

References:

1. B. H. Mahan and R. J. Meyers. University Chemistry, 4th Edition, Pearson publishers. (2009).
2. Peter W. Atkins, Julio de Paula, and James Keele. Physical Chemistry, 11th Edition, Oxford publishers. (2018).
3. M. J. Sienko and R. A. Plane. Chemistry: Principles and Applications, 3rd Edition, McGraw-Hill Publishers. (1980).
4. C. N. Banwell. Fundamentals of Molecular Spectroscopy, 5th Edition, McGraw-Hill Publishers. (2013).
5. B.L. Tembe, M.S. Krishnan and Kamaluddin. Engineering Chemistry (NPTEL Web Course).
6. Shashi Chawla. A Text book of Engineering Chemistry. Dhanpat Rai & Co, New Delhi.(2013).

Pattern of Continuous Assessment

Test – I for the theory portions: 15 marks

Test -II for the theory portions: 15 marks

Assignment from the theory portions: 5 marks

Laboratory record and Viva -voce: 10 marks (5 + 5)

Attendance: 5 marks

The students are required to submit the laboratory record.

23-200-0103A ENGINEERING GRAPHICS

Course Outcomes:
On completion of this course, the student will be able to:

1. Visualize and draw orthographic projection of straight lines and planes and solids
2. Understand development of surface of different geometric shapes
3. Construct isometric scale, isometric projections and views.
4. Obtain multiview projections and solid models of objects using CAD tools

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2		1				1	2			3			
CO2	2	3	2		1				1	2			3			
CO3	2	2	2		1				1	2			3			
CO4	2	2	2		1				1	2			3			

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to engineering graphics. Drawing instruments and their use. Familiarisation with current Indian Standard Code of Practice for general engineering drawing, scales and geometric curves.
Introduction to orthographic projections- plane of projection- principles of first angle and third angle projections, projection of points in different quadrants.
Orthographic projection of straight lines parallel to one plane and inclined to the other plane- straight lines inclined to both the planes- true length and inclination of lines with reference planes- traces of lines. Projection of plane laminae of geometrical shapes in oblique positions.

Module II

Projection of polyhedra and solids of revolution- frustum, projection of solids with axis parallel to one plane and parallel or perpendicular to other plane- projection of solids with axis inclined to both the planes- projection of solids on auxiliary planes.
Section of solids by planes inclined to horizontal or vertical planes- true shape of sections.

Module III

Development of surface of cubes, prisms, cylinders, pyramids and cones.
Intersection of surfaces- methods of determining lines of intersection - intersection of prism in prism and cylinder in cylinder.

Module IV

Introduction to isometric projection- isometric scales, isometric views- isometric projections of prisms, pyramids, cylinders, cones and spheres.
Introduction to perspective projections: visual ray method and vanishing point method- perspective of circles- perspective views of prisms and pyramids.

Note: A minimum of two exercises from each module shall be done using suitable drafting software.

References:

1. Bhat, N.D. Engineering Drawing. 54th Edition, Charotar Publishing House, Anand (2023).
2. John, K.C. Engineering Graphics. PHI Learning, New Delhi. (2013).
3. Anilkumar, K.N., Engineering Graphics, 10th Edition, Adhyuth Narayan Publishers (2016).
4. Gill P.S. Geometric Drawing. B.D Kataria & Sons, Ludhiana. (2012)
5. Kulkarni, D.M., Rastogi, A.P. and Sarkar, A.K., Engineering Graphics with AutoCAD, PHI (2009).

Pattern of Question Paper for the Semester End Examination

Two questions of 12.5 mark each from all the four modules. Answer one question from each module.

23-200-0104A BASIC CIVIL ENGINEERING

Course Outcomes

On completion of this course, the student will be able to:

1. Summarize the types, uses and properties of various building materials
2. Explain the different components of building and types of foundations
3. Recognize the fundamental aspects and services in the field of civil engineering
4. Discuss about the surveying techniques and to solve problems related with levelling
5. Prepare site plan based up on the Kerala Panchayath and Municipality Building Rules

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2					1		1				1	2			
CO2	2					1		1				1	2			
CO3	2					1		1				1	2			
CO4	1					1		1				1	2			
CO5	2					1		1				1	2			

1-Slightly; 2-Moderately; 3-Substantially

Module I

Overview of Civil Engineering - Civil Engineering contributions to the welfare of Society – Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering.

Engineering Materials: Cement - varieties and grade of cement and their uses. Steel- types of steel for reinforcement bars, steel structural sections. Brick- varieties, tests on bricks. Aggregates, Concrete, water cement ratio, workability, batching, mixing, transportation, placing, compaction and curing of concrete.

Module II

Construction: Components of a building-Foundation- types of foundations- isolated footing, combined footing, raft, pile & well foundation.

Super structure: Brick masonry, English bond and Flemish bond, Stone masonry-Ashlar masonry- Rubble masonry. Roofing- Steel trusses, roofing for industrial buildings.

Module III

Surveying: Basic Principles of surveying, instruments, methods, and measurements- linear measurements- field works

Levelling: Levelling instruments, reduction of levels by height of collimation method. Introduction to Total Station.

Module IV

Site planning as per Building Rules-Selection of site-Site plan preparation for buildings- general provisions regarding site and building requirements- set back, coverage and Floor Area Ratio as per Kerala Panchayath and Municipal Building Rules.

Basic concepts of Intelligent Buildings and Green Buildings, Roads- Classification of Rural and urban Roads, Sources of Water - Water Supply-Quality of Water-Rain water harvesting.

References:

1. Mamlouk, M. S., and Zaniewski, J. P., Materials for Civil and Construction Engineering, Pearson Publishers (2011).
2. Chudley, R., Construction Technology, Vol. I to IV, Longman Group, England (2011).
3. McKay, W. B. and McKay, J. K., Building Construction, Vol. 1 to 4, Pearson India Education Services (2013).
4. Rangwala, S.C and Dalal, K.B, Building Construction, Charotar Publishing House (2017).
5. Kerala Panchayath and Municipal Building Rules (Latest revision).

23-200-0105A BASIC MECHANICAL ENGINEERING

Course Outcomes:

On completion of this course, the student will be able to:

1. Summarise the role of mechanical engineering, different energy sources, and basic thermodynamic laws
2. Illustrate the principles and types of power generating and power producing devices
3. Explain the working of power transmission systems, electric and hybrid vehicles and modern fuel injection systems.
4. Demonstrate the types and classification of composite and smart materials and joining processes
5. Summarise the machine tools operations and advanced manufacturing systems
6. Explain the concepts of Mechatronics, Robotics, and Automation in IoT

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3					1	2			1		1		2		
CO2	3					1	1			1		1		2		
CO3	3					1	1			1		1		2		
CO4	3					1	1			1		1		2		
CO5	3					1	1			1		1		2		
CO6	3					1	1			1		1		2		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction: Role of Mechanical Engineering in Industries and Society- Emerging Trends and Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.

Introduction to thermodynamic laws, power generating devices: Boilers, Turbines (Steam & Gas), IC engines: Components and Working Principles of two stroke petrol engine and 4-Strokes Petrol and Diesel Engines, Application of IC Engines. (Elementary ideas only no numerical problems).

Introduction to power consuming devices: Refrigerator, types and properties of refrigerants, working of domestic refrigerators, Air-conditioning systems, Windows and Split systems (only elementary ideas, no numerical problems).

Module II

Introduction to power transmission systems: Belts, chain, and Gear drives, types and application, (numerical problems related to simple power calculations only).

Energy: Introduction and applications of Energy sources like Fossil fuels, nuclear fuels, Hydel, Solar, wind, and bio-fuels, Environmental issues like Global warming and Ozone depletion.

Modern fuel injection systems in CI and SI engines: CRDi, MPFI systems, cooling and lubricating systems in two stroke and four stroke engines. (Only elementary ideas with block diagrams).

Insight into Future Mobility: Electric and Hybrid Vehicles, Components of Electric and Hybrid Vehicles. Advantages and disadvantages of EVs and Hybrid vehicles.

Module III

Introduction to engineering materials: composite and smart materials.

Joining Processes: Soldering, Brazing and Welding, Definitions, classification of welding process, Arc welding, Gas welding and types of flames.

Machine Tool Operations: Working Principle of lathe, Lathe operations: Turning, facing, knurling. Working principles of Drilling Machine, drilling operations: drilling, boring, reaming. Working of Milling Machine, Milling operations: plane milling and slot milling.

(No sketches of machine tools, sketches to be used only for explaining the operations).

Introduction to Advanced Manufacturing Systems: Introduction, components of CNC, advantages and applications of CNC, 3D printing.

Module IV

Introduction to Mechatronics and Robotics: open-loop and closed-loop mechatronic systems. Classification based on robotics configuration: polar cylindrical, Cartesian coordinate and spherical. Application, Advantages and disadvantages.

Automation in industry: Definition, types – Fixed, programmable and flexible automation, basic elements with block diagrams, advantages.

Introduction to IOT: Definition and Characteristics, Physical design, protocols, Logical design of IoT, Functional blocks, and communication models.

References:

1. Jonathan Wickert and Kemper Lewis. An Introduction to Mechanical Engineering, Third Edition, Cengage Learning (2012).
2. Hazra Choudhry and Nirzar Roy. Elements of Workshop Technology (Vol. 1 and 2), Media Promoters and Publishers Pvt. Ltd. (2010).
3. V. Ganesan. Internal Combustion Engines, 4th edition, Tata McGraw Hill Education (2017).
4. Appu Kuttan K .K. Robotics Volume 1, I K. International Publishing House Pvt Ltd (2013).
5. SRN Reddy, Rachit Thukral and Manasi Mishra. Introduction to Internet of Things: A Practical Approach, ETI Labs (2021).

23-200-0106A ENVIRONMENTAL AND LIFE SCIENCES

Course Outcomes

On completion of this course the student will be able to:

1. Identify the global environmental issues
2. Examine the types of pollution in society along with their sources
3. Elucidate the basic biological concepts via relevant industrial applications and case studies.
4. Evaluate the principles of design and development, for exploring novel bioengineering projects.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2				3	3								2	
CO2	2	2				2	3								3	
CO3	2	2				2	2								1	
CO4	2	2				2	2								1	

1-Slightly; 2-Moderately; 3-Substantially

Module -I

Environment, Ecosystems and Biodiversity: Definition, scope and importance of environment — need for public awareness — concept of an ecosystem — structure and function of an ecosystem — producers, consumers and decomposers — energy flow in the ecosystem — ecological succession — food chains, food webs and ecological pyramids — Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) — Introduction to biodiversity definition: genetic, species and ecosystem diversity — biogeographical classification of India — value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values — Biodiversity at global, national and local levels — India as a mega-diversity nation — hot-spots of biodiversity — threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts — endangered and endemic species of India — conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems — pond, river, hill slopes, etc.

Module -II

Natural Resources: Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people — Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems — Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies — Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies — Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies — Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification — role of an individual in conservation of natural resources. The concept of sustainable development.

Environmental Pollution: Definition — causes, effects and control measures of: (a) Air pollution (b) Water pollution and (c) Soil pollution (d) Noise pollution. Management of e-waste.

Module – III

Biomolecules and their Applications (Qualitative): Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), Lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching).

Nature-Bioinspired Materials and Mechanisms (Qualitative): Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).

Module -IV

Human Organ Systems and Bio Designs (Qualitative): Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease). Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye). Heart as a pump system (architecture, electrical signalling – ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine). Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems). Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis).
Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods.

References:

1. Rajagopalan, R. Environmental Studies: From Crisis to Cure. Oxford University Press, New Delhi, (2015).
2. Erach Bharucha. Textbook of Environmental Studies and Ethics. Universities Press (India), Hyderabad, (2013).
3. Thyagarajan S., Velmurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K. Biology for Engineers, Tata McGraw-Hill, New Delhi, (2012).
4. Arthur T. Johnson. Biology for Engineers, CRC Press, Taylor and Francis, (2019).
5. Sohini Singh and Tanu Allen. Biology for Engineers, Vayu Education of India, New Delhi, (2020).
6. Ibrahim Ozbolat. 3D Bioprinting: Fundamentals, Principles and Applications, Academic Press, (2016).

23-200-0107A CIVIL ENGINEERING WORKSHOP

Course Outcomes:

On completion of this course the students will be able to:

1. Identify various building materials and simple plumbing and sanitary fittings.
2. Construct brick walls using English Bond and Flemish Bond.
3. Set out a building as per a given building plan using surveying instruments.
4. Compute the various quantities of materials required for a building.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1					1	1	1	1		1				
CO2	1						1	1	1			1				
CO3	1						1	1	1	1		1				
CO4	1	1					1	1	1	1		1				

1-Slightly; 2-Moderately; 3-Substantially

Building Materials:

Familiarization of building materials and their testing.

Plumbing:

Introduction to simple plumbing and sanitary fittings.

Masonry:

Construction of English bond and Flemish bond – wall junction – one brick – one and a half brick – and two brick thick.

Surveying:

Surveying and levelling instruments

Setting out of building (single room only) as per the given building plan using surveying instruments Demonstration of Total Station.

Computation of area and/or volume of various features of a building/structure such as door and window size, number of bricks required to construct a wall of a building, diameter of bars used in windows, RCC construction etc. (to create an awareness of measurements and units).

Assignment: *Students shall collect the list of various building materials used for the construction of a building including their market rate.*

23-200-0108A MECHANICAL ENGINEERING WORKSHOP

Course Outcomes:

On completion of this course the student will be able to:

1. Identify and use tools, and make different types of joints used in carpentry, fitting, and sheet metal shop.
2. Compare basic fabrication techniques of different types of welding.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1					2			2					2		
CO2	1					2			2					2		

1-Slightly; 2-Moderately; 3-Substantially

Preliminary exercises for beginners in all the following shops.
Specific models may be designed by the teachers.

1) Fitting Shop
2) Sheet Metal Shop
3) Foundry Shop
4) Welding Shop
5) Carpentry Shop
6) Familiarization of wheel replacement, automobile battery charging, identification of different dashboard indications, IC engine parts, refrigerators, nut, bolts and its specifications.

23-200-0201A COMPUTER PROGRAMMING AND PROBLEM SOLVING

Course Outcomes:

On completion of this course the student will be able to:

1. Elucidate the basic architecture and functionalities of a computer and also recognize the hardware parts.
2. Apply programming constructs of C language to solve real-world problems.
3. Explore user-defined data structures like arrays in implementing solutions to problems like searching and sorting.
4. Explore user-defined data structures like structures, unions and pointers in implementing solutions.
5. Design and Develop Solutions to problems using modular programming constructs using functions.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	3								1	2		
CO2	3	2	2	2	3								2	2		
CO3	2	2	2	2	3								1	2		
CO4	2	2	2	2	3								1	2		
CO5	2	2	2	2	3								1	2		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Basics of Computer and Information Technology: Digital Computer System (CPU, Memory, I/O devices)- Working of a digital computer-Hardware and Software: Definition - Categories of Software, Application of Computers.

Problem Solving Methodology: Problem statement, Analysis, Design a solution, Implement/Coding the solution, Test the solution, Design tools (Algorithm, Flow-chart, Pseudo-code)- Develop algorithms for simple problems.

Programming Languages: Types of programming languages-Compiler–Interpreter-Linker–Loader–Execution of program.

Module II

Basics of C: Character set-Identifier- Keywords- Constants –Data Types- Variables and declaration –Operators and Expressions – Operator precedence and associativity – Expression Evaluation (Simple Examples) - Input and output functions – Simple computational problems involving the above constructs.

Control Statements: Selection, Conditional operator, Iteration (for, while, do-while), Branching (switch, break, continue, goto), Nesting of control statements- Problems using control statements.

Module III

Arrays and Strings: 1D and 2D arrays –Searching (Linear and Binary) - Sorting (Bubble, Selection) – Matrix manipulation programs – Strings and basic operations on strings – Strings functions -Programs on string manipulation.

Functions: Definition – Calling – Declaration – Parameter Passing (by value and by reference) – Recursion – Programs based on functions.

User defined data types: Structure – Union - Enumerated data type - Programs involving structure and union.

Module IV

Pointers: Declaration, Initialization – Operations on pointers- Pointers and arrays – Pointers and Structures- Command line arguments-Dynamic memory allocation — Programs involving the above concepts.

Files: File concept – File pointer – File handling operations (open, close, read, write etc) on sequential and random-access files. Programs on file manipulations using fgetc(), fgets(), fseek().

References:

1. Pradip Dey and Manas Ghosh. Computer Fundamentals and Programming in C, Second Edition, Oxford University Press (2013).
2. Reema Thareja. Computer Fundamentals and Programming in C, Second Edition, Oxford University (2016).
3. Byron Gottfried. Programming with C, Second edition, Tata McGraw-Hill (2006).
4. Brian W. Kernighan and Dennis M. Ritchie. The C Programming Language, Second Edition, PearsonEducation, (2001).
5. E. Balagurusamy. Programming in ANSI C, 8th Edition, Tata McGraw-Hill (2017).
6. Kanetkar Y.Let Us C: Authentic guide to C programming language, 19th Edition, BPB Publications (2022).

23-200-0202A ENGINEERING PHYSICS

Course Outcomes:

On completion of this course the student will be able to:

1. Interpret modern devices and technologies based on lasers and optical fibres.
2. Explain the basic principles of crystal physics
3. Summarise the characteristics and applications superconducting materials nanomaterials and smart materials
4. Illustrate the theory of semiconductors and magnetic materials
5. Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2													
CO2	3	1	1													
CO3	3	2	1													
CO4	2	2	2													
CO5	3	2	2													

1-Slightly; 2-Moderately; 3-Substantially

Module I

Laser-properties-interaction of radiation with matter-absorption, spontaneous and stimulated emission-principle of laser--Einstein coefficients- population inversion- metastable state -Basic components of a laser-construction and working of Ruby laser and He-Ne laser -Applications.

Fibre optics - Basic structure - principle- step-index fibre and graded index fibre- single mode and multimode-Numerical aperture (no derivation) -acceptance angle and acceptance cone-propagation- Applications.

Module II

Crystallography – Space lattice- Basis- Unit cell-Bravais lattices- cubic lattices-sc, bcc, and fcc- Number of atoms per unit cell- Co-ordination number- Atomic radius-Packing factor- Relation between density and crystal lattice constants- Lattice planes and Miller indices-

X-rays- Production, Properties, characteristic and continuous X-rays, Moseley's law; Diffraction of X-rays-Bragg's law (derivation), Bragg's Spectrometer.

Module III

Superconductor-transition temperature-Meissner effect-effect of current- isotope effect- Type 1 and type 2 superconductors –BCS theory (basic idea only)- Applications.

Nanomaterials- nanoparticle, nano ring, nano rod, nanoshells, fullerens- surface occupancy-quantum confinement effect- optical, electrical, magnetic and mechanical properties - Applications.

Smart materials-Liquid crystals, Metallic glasses, Shape memory alloys- optical, electrical magnetic and mechanical properties-applications.

Module IV

Magnetic Materials-Magnetic pole strength, magnetic moment, intensity of magnetization, magnetic field, magnetic induction, magnetic susceptibility, magnetic permeability, classification. Hard and soft-Paramagnetic materials-properties, Diamagnetic materials-properties, Ferromagnetic properties-Antiferromagnetic materials, Ferrimagnetic materials- Applications.

Semiconductor-Properties-Energy band description-effect of temperature-intrinsic, extrinsic semiconductors-n-type and p-type semiconductors-Majority and minority carriers.

Laboratory Experiments to be conducted in the virtual lab mode

List of Experiments (Minimum six experiments shall be conducted)

1. Transmission grating: To find the wavelength of laser beam.
2. Determination of NA of an optical fibre.
3. Laser beam divergence and spot size.
4. Determination of Grain size and lattice parameter using Bragg's X-ray spectrum.
5. Lattice planes from X Y Z intercept.
6. LCR circuits to find the resonance frequency and quality factor.
7. Diode characteristics.
8. Ohms law.
9. LED circuits to find cutting voltage.
10. Determination of Energy band gap of a given semiconductor material.
11. Magnetic field along the axis of a circular coil carrying current.
12. Deflection Magnetometer.

References:

1. S. Mani Naidu, A Text book of Engineering Physics, Pearson. (2010)
2. A.S. Vasudeva, Modern Engineering Physics, S. Chand & Co. (2013)
3. Prabir K. Vasu and Hrishikesh Dhasmana, Engineering Physics, Ane books Pvt. Ltd. (2010)
4. S.O. Pillai and Sivakami, Applied Physics, New Age International (P) Ltd., Second Edition. (2008)
5. G.S. Raghuvanshi, Engineering Physics, Prentice Hall of India. (2008)

Pattern of Continuous Assessment

Test – I for the theory portions: 15 marks
Test -II for the theory portions: 15 marks
Assignment from the theory portions: 5 marks
Laboratory record and Viva-voce: 10 marks (5 + 5)
Attendance: 5 marks

The students are required to submit the laboratory record.

23-200-0203A ENGINEERING MECHANICS

Course Outcomes:

On completion of this course, a student will be able to

1. Explain principles and theorems related to rigid body mechanics
2. Identify the components of a system of forces acting on the rigid body
3. Apply the conditions of equilibrium to various practical problems involving different force System.
4. Choose appropriate theorems, principles or formulae to solve problems of mechanics.
5. Solve problems involving rigid bodies, applying the properties of distributed areas and masses

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3											1			
CO2	2	3											2			
CO3	2	3											1			
CO4	2	3											1			
CO5	2	3											1			

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Mechanics: Definition and classification of mechanics – rigid body (statics and dynamics) and deformable body mechanics.

Forces and Force systems: Force and its characteristics, Principles of statics – concept of resultant and equilibrant, Composition and resolution of forces, force systems.

Coplanar Concurrent force system: Equilibrium of two, three and more than three forces, Moment of a force, Varignon's theorem of moments, Equations of equilibrium, Friction and its effects on bodies, Engineering applications.

Coplanar Parallel force System: Two parallel forces, General case of parallel forces in a plane, Centre of parallel forces, Centre of gravity, Centre of mass, Centroids of curves, areas and volumes – regular and composite, Pappus's theorems, Equilibrium of distributed forces in a plane, Applications of the concept of centroid in engineering practice.

Module II

Moment of Inertia: Concept of moment of inertia and second moment of area, Moment of inertia of regular and composite solids, Second moment of area of regular and irregular surfaces, Polar moment of inertia / second moment of area, Product of inertia, Principal moments of inertia and principal axes, Applications of the concepts in engineering practice.

Coplanar non-concurrent force system: Resultant of a general case of force system in a plane, Equilibrium equations, Applications in engineering practice.

Analysis of Plane trusses and frames: Concept of load carrying mechanism in trusses and frames – internal (axial) forces, two force and multi force members, Analysis of plane trusses by Method of joints and Method of sections, Analysis of Plane frames by Method of members, Applications of trusses and frames in structures.

Module III

Introduction to Dynamics: Definitions, Units, Divisions – Kinematics, Kinetics.

Rectilinear translation: Kinematics of rectilinear motion – displacement, velocity, acceleration, Kinetics – Differential equations of motion, D'Alembert's principle in rectilinear translation and its applications, Motion of a particle due to a constant force, Motion of a particle due to a force proportional to displacement – Simple harmonic motion, Momentum and impulse, Work and energy, Conservation of energy, Collision of two bodies – direct central impact.

Module IV

Curvilinear translation: Kinematics of curvilinear translation – components of displacement, velocity and acceleration, normal and tangential acceleration, Kinetics – Differential equations of motion, Motion of a

projectile – projection on horizontal and inclined surfaces, D'Alembert's principle in curvilinear motion and its applications, Moment of momentum, Work and energy in curvilinear motion.

Rotation of a rigid body: Kinematics of rotation – angular displacement, velocity and acceleration, RPM, Relations of kinematic parameters of linear and angular motions, Kinetics – Equation of motion of a rigid body rotating about a fixed axis, Rotation under the action of a constant moment, Rotation proportional to angular displacement.

References

1. Timoshenko and Young. Engineering mechanics. McGraw Hill Book Company, Singapore. (1956)
2. Beer, F. P. and Johnston, E. R. Mechanics for Engineers (Vol. 1: Statics and Vol.2: Dynamics). Tata McGraw Hill, New Delhi. (2004).
3. Merriam, H. L. and Kraige, L. G. (2003). Engineering Mechanics (Vol. 1: Statics and Vol.2: Dynamics*)*. John Wiley and Sons, Somerset, N.J. (2003)
4. Hibbeller, R.C. Engineering mechanics. Vol. 1: Statics, Vol. 2: Dynamics. (Twelfth edition). Pearson Education Asia Pvt. Ltd., New Delhi (2010).
5. Rajasekaran, S.and Sankarasubramanian, G. Fundamentals of Engineering Mechanics. (Third edition). Vikas Publishing House Pvt. Ltd., New Delhi. (2010)

23-200-0204A BASIC ELECTRICAL ENGINEERING

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the concepts of various energy sources and electric circuits.
2. Apply the basic electrical laws to solve circuits.
3. Discuss the construction and operation of various electrical machines.
4. Identify suitable electrical machine for practical implementation

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	0	1	1	1						2			
CO2	3	3	2	1	1	1	0						1			
CO3	3	2	1	1	1	1	1						2			
CO4	3	2	2	1	0	1	1						2			

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction: Conventional and non-conventional energy resources; General structure of electrical power systems using single line diagram approach. Power Generation: Hydel, Nuclear, Solar & wind power generation (Block Diagram approach).

DC Circuits: Ohm's Law and its limitations. Kirchhoff's Current and Voltage Laws (KCL and KVL), series, parallel, series-parallel circuits. Faradays law, Lenz's law, Induced emf. Simple Numerical.

Module II

A.C. Fundamentals: Equation of AC Voltage and current, waveform, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor. (Only definitions) Voltage and current relationship with phasor diagrams in R, L, and C circuits. Concept of Impedance.
Analysis of R-L, R-C, R-L-C Series circuits. Concepts of active power, reactive power and apparent power. Concept of power factor. (Simple Numerical).
Three Phase Circuits: Generation of Three phase AC quantity, advantages and limitations; star and delta connection, relationship between line and phase quantities (excluding proof).

Module III

DC Machines:
DC Generator: Principle of operation, constructional details, induced emf expression, types of generators. Relation between induced emf and terminal voltage. Simple numerical.
DC Motor: Principle of operation, back emf and its significance. Torque equation, types of motors, characteristics and speed control (armature & field) of DC motors (series & shunt only). Applications of DC motors. Simple numerical.

Module IV

Transformers: Necessity of transformer, principle of operation, Types and construction of single-phase transformers, EMF equation, losses (physical concepts and applications), variation of losses with respect to load. Efficiency and simple numerical.
Three-phase induction Motors: Concept of rotating magnetic field, Principle of operation, constructional features of motor, types – squirrel cage and wound rotor. Slip and its significance. (Qualitative aspects only).

Equipment Safety measures: Working principle of Fuse and Miniature circuit breaker (MCB).
Personal safety measures: Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

References:

1. Cotton, H. Electrical Technology. (Seventh edition). CBS Publishers and Distributors, New Delhi (2005).
2. D. P. Kothari and I. J. Nagrath. Basic Electrical Engineering,4th edition, Tata McGraw Hill (2019).
3. Rajendra Prasad. Fundamentals of Electrical Engineering. Third edition. PHI Learning, New Delhi (2014).
4. D C Kulshreshtha. Basic Electrical Engineering, First Edition, Tata McGraw Hill (2019).

23-200-0205A BASIC ELECTRONICS ENGINEERING

Course Outcomes:

On successful completion of this course the student will be able to:

1. Illustrate the concept of diode in rectifiers, filter circuits and wave shaping,
2. Interpret the functioning of oscillators and operational amplifiers.
3. Explain the principle of embedded systems and sensors
4. Summarise the functioning of a communication system and different modulation technologies.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2				2								2			
CO2	2				2								1			
CO3	2				2								2			
CO4	2				2								2			

1-Slightly; 2-Moderately; 3-Substantially

Module I:

Semi-conductor devices and applications: p-n junction diode - Characteristics and Parameters Half-wave rectifier, Full-wave rectifiers and filters, Voltage regulators, Output resistance and voltage regulation, Voltage multipliers.(Only concepts and working and principle. No mathematical derivations).

Amplifiers – Types of amplifiers, Gain, Input and output resistance, Frequency response, Bandwidth, Phase shift, Negative feedback, multi-stage amplifiers. (Only elementary ideas. Mathematical treatment is not envisaged)

Module II:

Oscillators – Barkhausen criterion, sinusoidal and non-sinusoidal oscillators, Multivibrators, Crystal controlled oscillators (Only qualitative concepts, working principle, waveforms and applications).

Operational amplifiers -Operational amplifier parameters, Operational amplifier characteristics,Operational amplifier configurations, Operational amplifier circuits (Only qualitative concepts, working principle and applications). Elementary concepts of logic gates.

Module III:

Introduction to Embedded Systems – Definition, Embedded systems vs general computing systems, Classification of Embedded Systems, Major application areas of Embedded Systems, Elements of an Embedded System, Core of the Embedded System, Microprocessor vs Microcontroller, RISC vs CISC (Elementary concepts only).

Sensors and Interfacing – Instrumentation and control systems (Elementary concepts only), Working principle and applications of Transducers, Sensors, Actuators, LED, and 7-Segment LED Display.

Module IV:

Communication Schemes – Modern communication system scheme, Information source, And input transducer, Transmitter, Channel or Medium – Hardwired and Soft wired, Noise, Receiver, Multiplexing, Types of communication systems. Types of modulation (only concepts. No mathematical derivations) – AM,FM, Concept of Radio wave propagation (Space, sky). Elementary concepts of satellite, mobile, and fibre optic communication.

References:

1. Mike Tooley. Electronic Circuits, Fundamentals & Applications,4thEdition, Elsevier (2015).
2. K V Shibu. Introduction to Embedded Systems, 2nd Edition, McGraw Hill Education (India) Private Limited (2016).
3. S L Kakani and Priyanka Punglia. Communication Systems, New Age International Publisher, (2017).

23-200-0206A SOFT SKILLS DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to:

CO1: Understand the role and importance of verbal communication.

CO2: Read, comprehend and answer questions based on literary, scientific and technological texts.

CO3: Understand the fundamental grammar.

CO4: Practice words and styles used for formal and informal communication.

CO5: Develop presentation skills through oral, poster and power point.

CO6: Improve communication skills through group discussions and debates.

CO7: Develop self-motivation, raised aspiration, belief in one's own abilities and commitment to achieving one's goal.

CO8: Demonstrate emotional maturity and emotional health.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1								1	1		
CO2	1								1	1		1
CO3	1								1	1		
CO4	1								1	2		1
CO5	1								2	2		1
CO6	1								2	2		1
CO7	1								1	1		1
CO8	1								1	1		1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Role and importance of verbal communication, Everyday active vocabulary, Common words used in transitions, enhancing vocabulary, affixes and changes in pronunciation and grammatical functions, words often confused in pronunciation and usage. Passage comprehension- skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Two types of meaning- literal and contextual. Constructive criticism of speeches and explanations.

Module II

Fundamental grammar, Simple structures, passivizing the active sentences, reported speech, the judicious use of tenses and moods of verbs, forming questions and conversion from questions to statements and vice versa, forming open –ended and close- ended questions. Words and style used for formal and informal communication. Practice converting informal language to formal, the diction and the style of writing. Dealing with the nuances of ambiguous constructions in language. Learning authoritative writing skills, polite writing and good netiquette. Writing for internships and scholarships.

Module III

Kinesics, Proxemics, Haptics, and other areas of non-verbal communication, fighting communication barriers, positive grooming and activities on the same. Different types of interviews, and presentation - oral, poster, ppt. Organizing ideas for group discussions, the difference between GD and debates. Effective listening and seeking to understand others' perspectives. Non-violent negotiation and persuasion, communicating across age groups, cultures or identity groups. Higher order thinking and evaluation, information-seeking, research, and independent learning, synthesis, creativity, problem analysis and problem solving. Decision making, Self-reflection and learning from experience.

Module IV

Developing positive self: Understanding oneself, A realistic awareness of oneself and one's abilities, strengths and potential, Self-esteem, Self-efficacy, steps for improvement. Intra-personal skills – Self-control, emotional regulation and self-discipline, conscientiousness, dutifulness, reliability, truthfulness, honesty and trustworthiness. Goal orientation and initiative. Time management – prioritising work. Interpersonal skills – cross cultural competence and valuing diversity of perspectives, respecting and expressing concern for others. Empathy and ability to notice the effect of one's actions on others, tolerance for disagreement, conflict management and resolution. Civic engagement and social responsibility – Global and local awareness (issues, challenges, priorities). Vision, ability to imagine something new or improved. Social responsibility and willingness to take constructive action.

References:

1. Duck, Steve and David T. Macmahan. Communication in Everyday Life. 3rd Ed. Sage, (2017).
2. Gamble, Kawl Teri and Michael W. Gamble. The Public Speaking Playbook. Sage, (2015).
3. Raman, Meenakshi and Sangeetha Sharma. Technical Communication: Principles and Practice, Oxford University Press, (2015).
4. Coleman, D. Emotional intelligence: Why it can matter more than IQ, Bantam Books, New York (2006).
5. Devadas Menon. Stop sleep walking through life, Yogi Impressions Books Pvt. Ltd, Mumbai (2012).
6. Barun K Mitra. Personality Development and Softskills, Oxford University Press (2012).

ASSESSMENT

1. 'Soft Skills Development' is a practical and activity-oriented course which has continuous assessment for 50 marks based on class room interaction, activities, and assignments. The activities may include 'Just a Minute' (JAM) sessions, group discussion, role play, debate, and extempore speech.

The weightages for the different components shall be as follows:

Class room interaction – 10 marks
Activities – 30 marks
Assignments (from Modules I and II) – 10 marks

2. Semester End Examination is not envisaged.

3. A student should secure a minimum of 50% marks in continuous assessment for a pass in the course.

23-200-0207A COMPUTER PROGRAMMING LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Solve problems efficiently by choosing loops and decision-making statements in C programming.
2. Demonstrate different operations on arrays.
3. Solve problems using functions and recursion.
4. Develop C programs using the concepts of structure, pointers and files.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3												1			
CO2	2												1			
CO3	3												1			
CO4	2												1			

1-Slightly; 2-Moderately; 3-Substantially

Cycle I

Application Packages:

Text Editor

1. To create a word document like an advertisement.

Spread Sheet

2. To create a spread sheet to analyse the marks of the students of a class and also to create appropriate charts.

Presentation Software

3. To create a presentation for the department using Power Point.

C Programming Basics:

4. To write a program to calculate and display areas of rectangle and triangle.

Decision Making:

5. To write a program for electricity bill preparation.
6. To write a program to find the roots of a quadratic equation.
7. To write a simple menu driven calculator program using switch statement.
8. To write a program to find the sum of digits of a given number.

Cycle II

Looping:

9. To write a program to print all the prime numbers of a given range.
10. To write a program to print the sine and cosine series.
11. To write a program to print Pascal's triangle.

Arrays:

12. To write a program to print the sum and average of elements in an array.
13. To write a program to sort the given numbers using bubble sort.
14. To write a program to perform Matrix addition and matrix multiplication.

String:

15. To write a program to perform string manipulation functions like string concatenations, Comparison, find the length and string copy without using library functions.
16. To write a program to arrange names in alphabetical order.

Cycle III

Functions:

17. To write a C program to calculate the mean, variance and standard deviation using functions.
18. To write a C program to perform sequential and binary search using functions.

Recursion:

19. To write a program to print the Fibonacci series using recursive function.

20. To write a program to print the factorial of the given number using recursive function.

Structure:

21. To print the mark sheet of n students using structures.

Pointers:

22. To write a program using pointers to access the elements of an array and count the number of occurrences of the given number in the array.

Files:

23. To write a program to count the number of characters, lines in a file.

References:

1. Pradip Dey and Manas Ghosh, Computer Fundamentals and Programming in C, Second Edition, Oxford University Press, (2013).
2. Smarajit Ghosh, All of C, PHI Learning Pvt. Ltd, (2009).
3. Byron Gottfried, Programming with C, 2 nd edition, Tata McGraw-Hill, (2006).
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second Edition, Pearson Education, (2001).
5. Sukhendu Dey, Debobrata Dutta, Complete Knowledge in C, Narosa PublishingHouse, New Delhi, (2009).

23-200-0208A BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

Course Outcomes:

1. Identify the tools used for electrical wiring, electrical accessories, wires, cables, batteries and standard symbols
2. Develop the connection diagram, identify the suitable accessories and materials necessary for wiring simple lighting circuits for domestic buildings
3. Identify and test various electronic components
4. Draw circuit schematics with EDA tools
5. Assemble and test electronic circuits on boards

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3												1			
CO2	2												1			
CO3	3												1			
CO4	2												1			
CO5	2															

1-Slightly; 2-Moderately; 3-Substantially

List of Exercises / Experiments
(Any 9 exercises to be carried out)

1. a) Demonstrate the precautionary steps adopted in case of Electrical shocks.
b) Identify different types of cables, wires, switches, fuses, fuse carriers, MCB, ELCB and MCCB with ratings.
2. Wiring of simple light circuit for controlling light/ fan point (PVC conduit wiring).
3. Wiring of light/fan circuit using Two-way switches (Staircase wiring).
4. Wiring of Fluorescent lamps and light sockets (6A) with a power circuit for controlling power
Device (16A socket).
5. Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, main switch and Energy meter.
6. a) Identify different types of batteries with their specifications.
b) Demonstrate the Pipe and Plate Earthing Schemes using Charts/Site Visit.
7. Familiarization/Identification of electronic components with specification
(Functionality, type, size, colour coding, package, symbol, cost etc. [Active, Passive, Electrical, Electronic, Electro-mechanical, Wires, Cables, Connectors, Fuses, Switches, Relays, Crystals, Displays, Fasteners, Heat sink etc.).
8. Drawing of electronic circuit diagrams using BIS/IEEE symbols and introduction to EDA tools (such as Dia or XCircuit), Interpret data sheets of discrete components and IC's, Estimation and costing.
9. Familiarization/Application of testing instruments and commonly used tools.[Multimeter, Function generator, Power supply, DSO etc.] [Soldering iron, Desoldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers, Crimping tool, Hot air soldering and de- soldering station etc.].
10. Measurement of input and output parameters of a transistor in CE, CB and CC configuration.
11. Design of a centre tap full wave rectifier circuit.
12. Testing of electronic components [Resistor, Capacitor, Diode, Transistor and JFETusingmultimeter.]
13. Measurement of voltage and current in a series RLC circuit using multimeter.
14. Realization of basic gates.
15. In house substation visit.

23-200-0209A LANGUAGE LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Test pronunciation skills through stress on word accent, intonation, and rhythm.
2. Use English language effectively for writing business letters, resume, minutes of meeting and reports.
3. Use English language effectively to face interviews, group discussions, and public speaking.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1									2	3		2				1
CO2									2	3		2				1
CO3									2	3		2				1

1-Slightly; 2-Moderately; 3-Substantially

The following exercises are prescribed for the **Language Laboratory** sessions:

1. Introduction to the Sounds of English- Vowels, Diphthongs & Consonants.
2. Introduction to Stress and Intonation.
3. Preparing business letters
4. Preparing a resume
5. Conducting a meeting and writing the minutes
6. Writing a report
7. Situational Dialogues / Role Play.
8. Oral Presentations- Prepared and Extempore.
9. 'Just A Minute' Sessions (JAM).
10. Describing Objects / Situations / People.
11. Debate
12. Group discussion

23-200-0210A NSS/NATURE CONSERVATION ACTIVITIES/YOGA

NATIONAL SERVICE SCHEME (NSS)

Course Outcomes:
On completion of this course the student will be able to:

1. Identify the community in which they work
2. Utilise their knowledge in finding practical solution to individual and community problems.

A student enrolling as member of NSS will have to complete 10 hours of training / social service.

NATURE CONSERVATION ACTIVITIES

Course Outcomes:
On completion of this course the student will be able to:

1. Demonstrate the message of sustainable life styles.
2. Explain the importance of green plants in mitigating global environmental problems.
3. Identify suitable waste management practices for the local community.

A student enrolling as member of the Nature Conservation Club will have to complete 10 hours of campus cleaning and greening activities.

YOGA

Course Outcomes:
On completion of this course the student will be able to:

1. Demonstrate the use of yoga for stress management.
2. Illustrate the different yogic postures for physical and mental wellbeing.
3. Identify suitable methods of strengthening physical, emotional, intellectual aspects of “self” based on the principles and practices of Yoga and positive psychology.

23-200-0301A LINEAR ALGEBRA & TRANSFORM TECHNIQUES

Course Outcomes:
On completion of this course the student will be able to:

1. Solve linear system of equations and to determine Eigen values and vectors of a matrix.
2. Exemplify the concept of vector space and sub space.
3. Determine Fourier series expansion of functions and transform.
4. Solve linear differential equation and integral equation using Laplace transform.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1														
CO2	3	1														
CO3	3	3	3													
CO4	3	3	2													

1-Slightly; 2-Moderately; 3-Substantially

Module I.
Linear Algebra 1:Rank of a matrix, solution of linear system of equations- existence, uniqueness, general form-Eigen values and Eigen vectors- properties of Eigen values - Diagonalization of a matrix - Cayley Hamilton theorem (without proof) Verification-Finding inverse and power of a matrix using it-Quadratic form-orthogonal reduction of quadratic form to Canonical form.

Module II
Linear Algebra 2: Vector space-subspace-Linear dependence and independence-Spanning of a subspace- Basis and Dimension. Inner product- Inner product spaces - Orthogonal and Orthonormal basis –Gram- Schmidt Orthogonalization process. Linear Transformation.

Module III
Fourier Analysis: Periodic function, Fourier series, Functions of arbitrary period, Even and odd functions, Half Range Expansion, Harmonic analysis, Complex Fourier Series, Fourier Integrals, Fourier Cosine and Sine Transform, Fourier Transform.

Module IV
Laplace Transforms: Gamma functions and Beta function-Definition and properties, Laplace transforms. Inverse Laplace Transform, Shifting theorem, Transform of Derivative and Integrals, Solution of differential equation and integral equation using Laplace transform, Convolution, Unit step function, Second Shifting theorem, Laplace transform of periodic function.

References:

1. Erwin Kreyzig. *Advanced engineering mathematics*. (tenth edition). John Wiley & Sons, Hoboken, N.J (2010).
2. Grewal, B.S. *Higher engineering mathematics*. (forty third edition). Khanna Publishers, New Delhi. (2013).
3. Hsiung,C.Y and Mao, G. Y. *Linear algebra*. World Scientific, New Jersey. (1999).
4. Hoffman, K. and Kunze, R. *Linear algebra*. Prentice Hall of India, New Delhi. (1971).
5. Venkataraman,M.K. *Linear algebra*. The National Publishing Co, Chennai. (1999).

23-206-0302 CHEMICAL PROCESS PRINCIPLES

Course Outcomes

On completion of this course the student will be able to:

1. Exemplify material balance for various unit operations or processes with or without chemical reaction.
2. Solve energy balance on processes with and without reaction and solve heat of combustion problems.
3. Explain the properties of thermodynamic systems and interpret the significance of the laws of thermodynamics.
4. Understand particle size analysis, handling and transportation.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3												1		
CO2	3	3												1		
CO3	3	3												1		
CO4	3	2	1	1										1		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Material balance Introduction to chemical engineering, basic chemical calculations-mole concept, methods of expressing composition-mole fraction, weight fraction, volume fraction, concentration of liquid solutions- molarity, molality, normality, ppm. Ideal gases and gas mixtures- ideal gas law, Amagat's law, Dalton's law, Henry's law, and average molecular weight, density of gases, partial pressure and partial volume calculations. Material balance involving chemical reactions and not involving chemical reactions, simple calculations involving recycle, bypass and purge streams.

Module II

Energy balance Energy balance- heat capacity, specific heat and enthalpy, heat capacity of gases at constant pressure, heat capacity of gaseous mixtures, latent heats, enthalpy changes accompanying chemical reactions- standard heat of formation and standard heat of combustion, standard heat of reaction.

Fuels and combustion: Fuels-Ultimate and proximate analyses. Higher and lower heating values of fuels. Combustion chemistry. Incomplete combustion. Theoretical and excess air. Computations involving flue gas analysis and Orsat analysis. Determination of fuel composition.

Module III

Chemical Engineering Thermodynamics: Chemical thermodynamics, fundamental concepts and definitions- types of thermodynamic systems and properties- closed, open and isolated system- intensive and extensive properties ,path and state functions, first law of thermodynamics, second law of thermodynamics, entropy, change in entropy, Maxwell relations, heat capacity in terms of entropy, equation of state of gases, the principle of corresponding states, compression and expansion of fluids – Joule Thomson expansion. Gibbs free energy change, equilibrium constant, effect of temperature on equilibrium constant.

Module IV

Mechanical Operations

Solids: Properties of solids, screening, screening equipment, effectiveness of screens, sieve analysis, average diameter and specific surface. Size reduction, types of equipment used in the various stages of reductions. Laws of crushing & grinding power requirements. Belt conveyer, bucket conveyer, pneumatic conveyers. Capacity and power requirements of conveyers.

Flow of solids through fluids, terminal settling velocity & hindered settling. Laboratory batch sedimentation, Kynch theory, calculation of area and depth for continuous thickeners.

Filtration: Filtration theory, equipment for filtration, constant pressure and constant rate filtration, filter calculations, optimum cycle time & filter aids.

References:

1. Bhatt, V.I. and Vora, S.M. Stoichiometry. (Fourth edition). Tata McGraw Hill, New Delhi. (2004).
2. Narayanan, K.V. and Lakshmikutty, B. Stoichiometry and process calculations. Prentice-Hall of India Pvt. Ltd, New Delhi. (2006).
3. Narayanan, K.V. A text book of chemical engineering thermodynamics. Prentice Hall of India Pvt Ltd, New Delhi. (2013).
4. Badger, W.L. and Banchero, J.T. Introduction to chemical engineering. Tata McGraw Hill Education, New Delhi. (1997).
5. Christe J. Geankoplis. Transport process and unit operations, Prentice Hall India Pvt Ltd, New Delhi. (1993).

23-206-0303 ENGINEERING FLUID MECHANICS AND INTRODUCTION TO CFD

Course Outcomes:

After the completion of the course the student will be able to

1. Analyse fluid flow behaviour under different operating conditions.
2. Apply equations of motion to flow problems.
3. Estimate the major and minor losses associated with fluid flow in piping networks.
4. Optimize the design and operation of various processes.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3		1									1			2
CO2	3	3		1									1			2
CO3	3	3		1									1			2
CO4	3	2	3	1									1			2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Scope of fluid mechanics – Dimensions and units – Definition of fluid - Fluid properties – density, specific weight, pressure, viscosity, surface tension and capillarity, compressibility – Rheological classification of fluids.

Fluid Statics – Pressure at a point – Basic equation of fluid statics – Hydrostatic equations for incompressible and compressible fluids – Hydrostatic force on a submerged plane and curved surfaces – Buoyancy and equilibrium of floating bodies – Absolute and gauge pressure – Pressure measurement by manometers and pressure gauges.

Module II

Fluid Kinematics and Fluid Dynamics - continuum Lagrangian and Eulerian approaches – Classification of fluid motions – path line, stream line, streak line, stream tube, one, two and three dimensional flow, velocity field – acceleration of fluid particle in a velocity field- Continuity equation (one and three dimensional differential forms) - equation of stream line – stream function – velocity potential function – circulation – flow net – fluid dynamics – equations of motion – Euler's equation along a streamline – Bernoulli's equation – applications – constant head and area meters.

Module III

Incompressible Fluid Flow – Viscous flow – Navier – Stoke's equation (statement only) – Shear stress, pressure gradient relationship – Laminar flow through circular tubes (Hagen Poiseulle's) – Hydraulic and energy gradient – flow through pipes – Darcy-weisbach equation – pipe roughness – friction factor – Moody's diagram – minor losses. Boundary layer flows, boundary layer thickness, and boundary layer separation – drag and lift coefficients.

Pumps: Definition and classification – Centrifugal pump: working principle, velocity triangles, specific speed, efficiency and performance curves – Reciprocating pumps: working principle, indicator diagram and performance curves – cavitation in pumps – NPSH – Priming.Rotary pumps: working principle of gear and vane pumps.

Module IV

Introduction to CFD :The Need for CFD -Applications of CFD -The Strategy of CFD- Discretization Using the Finite-Difference Method- Discretization using The Finite-Volume Method - Assembly of Discrete System and Application of Boundary Conditions- Solution of Discrete

System Grid Convergence -Dealing with Nonlinearity Direct and Iterative Solvers- Iterative Convergence- Numerical Stability - Turbulence modeling.

References:

1. R. K. Bansal, A Textbook of Fluid Mechanics (ninth edition) and Hydraulic Machines, Laxmi Publications (P)LTD, New Delhi.(2010)
2. Kumar, K.L. Engineering fluid Mechanics. (Seventh edition). Eurasia Publishing House (P) Ltd, New Delhi. (1995).
3. McCabe, W.L. Smith J.C. and Harriot, P. Unit operations in chemical engineering. (sixth edition). McGraw-Hill, New York. (2000).
4. dward J. Shaughnessy Jr. Ira M. Katz. and James P. Schaffer. Introduction to fluid mechanics. Oxford University Press, New Delhi. (2005).
5. Som S K, Gautam Biswas and Chakraborty S Introduction to fluid mechanics and fluid machines. (Third edition), McGraw Hill Education, New Delhi. (2017).
6. H. Versteeg W. Malalasekera**,** Introduction to Computational Fluid Dynamics; The Finite Volume Method, PHI,(2007)

23-206-0304 FIRE ENGINEERING FUNDAMENTALS

Course Outcomes

On completion of this course the student will be able to

1. Explain the basic concepts of combustion chemistry and recognize different types of fires.
2. Analyse the fire dynamics in an enclosure.
3. Describe the use and operation of fire service equipment, machineries and accessories.
4. Calculate the water requirement and the pump capacity for fire fighting and recognize the basic fire ground operations.

Course Articulation Matrix

COs	PO1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3	PSO 4
CO1	1	3	3											2	2	
CO2	1	3	3											2	2	
CO3	1	3	3											2	2	
CO4	3	2	2											2	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction - temperature, heat, specific heat, flash point, fire point, ignition, combustion; Ignition - pilot ignition, spontaneous ignition, ignition sources; Types of combustion - rapid, spontaneous, physical explosion, chemical explosion; smoldering combustion; Product of combustion harmful to human - flame, heat, smoke, fire gases; Special kinds of combustion - flash fire, pool fire, deep seated fire, spillover, boil over, dust explosion, BLEVE, VCE; Classification of fire based on material.

Flames – Diffusion flames - Zones of combustion, characteristics of diffusion flames, laminar and turbulent jet flames, flame from natural fires, buoyant plume; Premixed flames-structure, limits of flammability, burning velocity, explosion and expansion ratios, deflagration and detonation, characteristics of premixed flame; Spread of flames over liquid and solid surfaces.

Module II

Introduction to enclosure fire dynamics – General description of fire growth in an enclosure; Stages in enclosure fire development - ignition, growth, flashover, fully developed fire, decay. Heat release rate – introduction, design fire, calorific value, fire load; Factors controlling heat release rate in enclosure fires – burning rate, enclosure effects; Measurement techniques and parameters measured – energy release rate, burning rate, heat of combustion, combustion efficiency; Design fire – background, t-squared fire.

Heat transfer in compartment fires –measurements, modes of heat transfer and basic heat transfer equation, convection and radiative heat transfer in fire- approximate methods for calculating radiation from flame to target. Fire plumes and flame heights - flame characteristics, mean flame height, flame height correlations, turbulent fire plume characteristics, ideal plume, line plume, bounded plume, ceiling jets.

Module III

Use, operation and maintenance of fire service equipment and accessories - Suction and delivery Hose, Hose reel, Hose fittings-coupling, adapters, branches, branch holders, radial branches, collecting heads, stand pipe, monitors, hydrants; Introduction to fire fighting vehicles and appliances- crash tenders, rescue tenders, hose laying tenders, control vans, hydraulic platforms; Ladders - extension ladders, hook ladder, turntable ladders, snorkel; Fire pumps and primers ; Uses

and maintenance of small gear and miscellaneous equipment used during firefighting; Lamps and lighting sets; Ropes and Lines- wire and rope lines used in fire service, use and testing of lines, knots, bends and hitches and general rope work.

Module IV

Fire Hydraulics- path and range of fire stream, types of nozzles and calculation of discharge capacity, nozzle reaction; Pressure loss or gain because of elevation; back pressure; Flow in pipes and fire hoses-hydraulic and energy grade lines, friction loss in pipes, fire hoses and fixtures, parallel and series connection of fire hoses, branching lines; Water relay techniques; Estimation of fire protection water requirements, pump capacity and other parameters relating to fire hydraulics.

Fire ground operations - preplanning, action on arrival and control, methods of rescue, methods of entry. Personnel safety. Control procedure and use of other safety equipment. Ventilation and salvage operations.

References:

1. Ron Hirst Underdowns practical fire precautions, Gower publishing company Ltd., England. (1989).
2. Jain V.K. Fire safety in buildings (2nd edn.). New Age International (P) Ltd., New Delhi. (2010).
3. Andrew L Simon, Fire hydraulics Prentice-Hall Inc., USA. (1983).
4. Bjorn Karlsson and James G. Quintiere, Enclosure Fire Dynamics, CRC Press, USA (2000).
5. Dougal Drysdale An Introduction to Fire Dynamics, (2nd edn.), John Wiley & Sons Ltd., England. (1999)

23-206-0305 OCCUPATIONAL SAFETY AND INDUSTRIAL HYGIENE

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the concept occupational health, toxicology, industrial hygiene
2. Outline the sources for health hazards at workplace.
3. Summarize the occupational hazard control principles and methods.
4. Develop the methods for occupationally safe work environment

Course Articulation Matrix

COs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1			1						3	2	2	
CO2	3	1	2	1			1			1			2	2	3	
CO3	3	1	2	2			1						3	2	3	
CO4	3	1	2	2		2							3	2	3	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Occupational Health- Use of mind body communication to maintain wellness-emotional wellness Occupational Health Hazards –Notifiable occupational diseases and their effects and prevention – Community health- role of occupational health services -Levels of prevention of diseases- illness and healing- degenerative illness. Occupational Safety and Health Management – Functions of Occupational Health Services – Case Studies of health hazards in industry – Ethical Aspects of Occupational Health.

Industrial toxicology – Principles of Toxicology-Fundamentals of Genetic Toxicity, Reproductive Toxicity- Dose response calculation- Human Anatomy and Physiology-Routes of entry of substance to human body-local and systemic and chronic effects, temporary and cumulative effects.

Module II

Industrial Hygiene- Introduction- Role of Industrial Hygienist- Hazard Recognition- Work related heart diseases-occupational dermatoses-hearing loss- work related eye disorders-Physical Hazards-Industrial noise- noise measurement, evaluation, biological effects of noise exposure-noise control methods.

Vibration- description and measurement of vibration. Vibration control methods. Effects of whole-body vibration and hand arm vibration on human body and control measures.

Radiation- Types of radiation- Radiation hazards-Early recognition of radiation hazard-Radiation detection and measurement-Personal monitoring devices-Preventive measures. Ergonomics- Human Body as mechanical system – Assessment of ergonomic hazard – MSDs and Cardiovascular Fatigue –Thermal stress – heat disorders and health effects such as heat exhaustion, hear cramp etc. WBGT index, acclimatization.

Lighting and the work- Purpose of lighting- Sources and kinds of artificial lighting-Principles of good illumination - Advantages of good illumination- Design of lighting installation.

Module III

Chemical Hazards-Mechanism of Breathing & Gaseous Exchange- Recognition and Evaluation of Chemical Hazards –Gases, Vapours, Solvents & Particulate Matter-Threshold Limit Values (TLV)-TLV TWA-TLV STEL-TLV SL-TLV C-Air sampling methods. Techniques and

strategies-Calculating TWA exposures for chemicals. Biological Hazards–Type of microorganisms–Mechanism of infection–Bioaerosols in workplaces–Measurement and Evaluation–Control measure-Biological Exposure Indices (BEI).

Module IV

Personnel Protective Equipment – Non – Respiratory PPEs- Types and Selection – Respiratory PPEs–Types and Selection–Fundamentals of Epidemiology–Measuring Health and Diseases - CausationofEpidemiologicalstudies–Linkingoccupationalandenvironmentalepidemiology– ExposureAssessmentStrategies-Psycho-SocialRiskFactorsandEffects– BiologicalRhythmsandshiftwork

References:

1. Jeanne Mager Stellman (ed*).* Encyclopaedia of occupational health and safety. (Four volumes). (Fourth edition). International Labour Office, Geneva.(1998).
2. The industrial environment - its evaluation and control. DHHS (NIOSH) publication number 74-117, (1973).
3. Clayton, C.D. and Clayton, F. Patty's industrial hygiene and toxicology. Wiley Inderscience, New York. (1981).
4. Gayle Woodside & Dianna Kocurek, Environmental, Safety and Health Engineering, John Wiley & Sons, New York, (1997). :
5. Cantlie, James. First aid to the injured. St John Ambulance Association. (1932).
6. Yudenich,V.V. Accident first aid, Mir Publishers, Moscow. (1986).

23-206-0306 PRINCIPLES OF SAFETY MANAGEMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the concepts of safety and safety equipments and safety organisation
2. Analyse job safety, accidents through accident models, estimate costs
3. Estimate safety performance using various indices
4. Produce different types of permits, reports, and compliance check lists.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2										2	2	
CO2	1	2	1	2										3	2	
CO3	3	2	1	2										2	2	
CO4	3	2	1	2										3	3	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction-Safety -Goals of safety engineering. Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. History of safety movement. Theories of accident causation. Safety organization-objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages

Module II

Accident prevention Methods-Engineering, Education and Enforcement. Safety Education & Training -Importance, Various training methods, Effectiveness of training. Behaviour-based safety. Communication-purpose, barrier to communication. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system-objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.

Module III

Personal protection in the work environment, Types of PPEs, Personal protective equipment-respiratory and non respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Cost of accidents-Computation of Costs-Utility of Cost data. Plant safety inspection, types, inspection procedure. Safety sampling techniques. Job safety analysis (JSA), Safety surveys, and Safety audits, Safety tour Safety Inventory Technique.

Module IV

Accident investigation –Why? When? Where? Who? & How? Basics-Man-Environment & Systems. Process of Investigation –Tools-Data Collection-Handling witnesses-Case study. Accident analysis – Analytical Techniques-System Safety-Change Analysis-MORT-Multi Events Sequencing-TOR.

References:

1. Krishnan, N.V. Safety management in Industry. Jaico Publishing House, New Delhi.(1997).
2. John V. Grimaldi and Rollin H.Simonds Safety management. All India Traveller Book Seller, Delhi.(1989).
3. Ronald P. Blake Industrial safety. Prentice Hall, New Delhi.(1973).
4. Ted S. Ferry Modern accident investigation and analysis, John Wiley & Sons, Hoboken, N.J. (1988).
5. Alan Waring Safety management system. Chapman & Hall, England.(1996).
6. National Safety Council Accident prevention manual for industrial operations. Chicago.(1982).

23-206-0307 FLUID MECHANICS AND MACHINERY LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the principles of fluid flow.
2. Calculate the major and minor losses in fluid flow due to friction and pipe fittings.
3. Determine velocity of fluid flow using flow meters.
4. Select proper machinery for fluid transportation.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1										1	1		
CO2	3	2	1										1	1		
CO3	3	2	1										1	1		
CO4	3	2	3	1									1	1		

1-Slightly; 2-Moderately; 3-Substantially

Experiments

1. Study of pressure gauge, flow meters, and devices used to determine meta centric height and radius of gyration of floating bodies.
2. Determination of terminal settling velocities in a viscous medium.
3. Experimental verification of Bernoulli's theorem.
4. Steady flow through pipes-determination of friction factor and Reynolds number.
5. Determination of the loss coefficients for pipe fittings.
6. Calculation of hydraulic coefficients of mouthpieces, nozzles, and orifices.
7. Determination of the coefficient of discharge and calibration of venturi meter.
8. Determination of the coefficient of discharge and calibration of orifice meter.
9. Determination of performance characteristics of centrifugal pumps at a constant speed.
10. Determination of constant head characteristics of a Pelton turbine.

23-206-0308 INDUSTRIAL HYGIENE LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Classify the different types Personal Protective Equipments (PPEs) used in industries.
2. Identify the methods of monitoring the health parameters related to work environment.
3. Measure and analyse air contaminants, noise, illumination, and thermal comfort.
4. Interpret the different body movements related to ergonomics.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1			3								1	3	
CO2	3	2	3			3	2							1	3	
CO3	3	2	3			3	2							1	3	
CO4	3	1	3			1	1							1	2	

1-Slightly; 2-Moderately; 3-Substantially

List of Experiments:

1. Study of Personal Protective equipment used in industries.
2. Study of occupational diseases with photographic models.
3. Vision testing.
4. Lung function testing.
5. Demonstration of Air sampling equipment.
6. Sampling and estimation of dust using high volume sampler.
7. Sampling and estimation of contaminants using personal sampler.
8. Measurement of Noise.
9. Measurement of illumination.
10. Assessment of thermal comfort.
11. Study of different body movements related to ergonomics.

23-206-0309 INTERNSHIP-1

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organisation of the information gained during the internship.
3. Conceive the pros and cons of working in a real time industrial/incubation/ innovation /entrepreneurship/labenvironment and the wonderful results which could evolve through team-work.
4. Present and defend self-prepared and corrected internship report (with the help of internship guide) of a self-created work to a peer audience.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1							1	1	2	2	1	2	2	2	1	
CO2							1	1	2	2	1	2	2	2	1	
CO3							1	1	2	2	1	2	2	2	1	
CO4							1	1	2	2	1	2	2	2	1	

1-Slightly; 2-Moderately; 3-Substantially

Internship Guidelines

During the summer vacations, after the 2nd Semester, students are required to be involved in Inter/ Intra Institutional Activities viz; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the University; contribution at incubation/ innovation /entrepreneurship cell of the University; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research project within the institutes and Participation in all the activities of Institute's Innovation Council for eg: IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review. Training Certificate from the Inter/ Intra Institutional Activities from the concerned department/lab as mentioned above for the prescribed period shall be submitted at the end of the internship which can be considered as evidence for the the Internship-1.

Guidelines for evaluation:

1.	Regularity and progress of work	10
2.	Work knowledge and Involvement	10
3.	Semester End presentation and oral examination	10
4.	Level of completion of internship	10
5.	Internship Report – Presentation style and content	10
Total		**50** Marks

23-200-0401A COMPLEX VARIABLES AND PARTIAL DIFFERENTIAL EQUATIONS

Course Outcomes:
On completion of this course the student will be able to:

1. Transform a region to another region using conformal mapping
2. Evaluate real integrals using residue theorem
3. Form and solve partial differential equation
4. Determine solution of partial differential equation for vibrating string and heat conduction

Course Articulation Matrix

COs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2		1								1	1	1	
CO2	3	2	2		1								1	1	1	
CO3	3	2	2		1								1	1	1	
CO4	3	2	2		1								1	1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I
Analytic function- Cauchy-Riemann equation (Cartesian and polar)-Harmonic function- construction of analytic function given real or imaginary parts- Conformal mapping of standard elementary function and bilinear transformation.

Module II
Cauchy's integral theorem, Cauchy's integral formula and for derivatives-Taylor's and Laurent's expansion (without proof) - Singularities-Residues-Cauchy's Residues theorem- Contour integration involving unit circle.

Module III
Formation of partial differential equation eliminating arbitrary constants and function—Solution of first order equation-four standard types- Lagrange's equation—Linear homogeneous partial differential equation with constant coefficient.

Module IV
One dimensional wave equation, Alembert's solution and one dimensional heat flow equation—solution by the method of separation of variables- application of Fourier series solution. Solution of Laplace's equation over a rectangular region by the method of separation of variables.

References:

1. Erwin Kreyzig. Advanced engineering mathematics. (Tenth edition). John Wiley & Sons, Hoboken, N.J. (2010)
2. Grewal, B.S. Higher engineering mathematics. (Forty third edition). Khanna Publishers, New Delhi. (2013).

23-206-0402 HEAT TRANSFER OPERATIONS

Course Outcomes

After the completion of the course the student will be able to

1. Identify and distinguish various modes of heat transfer and examine the mechanisms involved
2. Apply appropriate governing equations and analyze conduction heat transfer problems for different geometries under steady state and transient processes
3. Solve forced and natural convection heat transfer problems using empirical equations
4. Explain the concepts behind evaporative heat transfer and solve evaporator problems
5. Analyse the heat transfer processes involved in boiling and condensation

Course Articulation Matrix

COs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2										1	2		
CO2	3	3	3	1									1	2		
CO3	3	2	2										1	2		
CO4	3	3	3	1									1	2		
CO5	3	2	2										1	2		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Modes of heat transfer-Concept of heat conduction ,convection and radiation- Fourier's law of heat conduction - one-dimensional steady state heat conduction equation for flat plate, hollow cylinder, hollow sphere - Heat conduction through a series of resistances- Analogy between flow of heat and flow of electricity. Concept of heat transfer by convection - Individual and overall heat transfer coefficients and the relationship between them. Natural and forced convection Equations for forced convection under laminar and turbulent conditions - Equations for natural convection.

Module II

Heat Exchangers: Parallel and counter flow heat exchangers - Log mean temperature difference - Single pass and multipass heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers effectiveness; number of transfer unit - Chart for different configurations - Fouling factors and Wilson's plot - Design of heat exchangers. Radiation: Concept of thermal radiations– Emissive power- Black body concept- Laws of radiation -concept of grey body - radiation between surfaces.

Module III

Evaporation - Principle of evaporation, types of evaporators-their construction and operation - natural circulation evaporators-Types of evaporators- single effect and multiple effect evaporators, performance, capacity and economy of evaporators, factors affecting the performance ,overall heat transfer coefficient, material and energy balances for single effect evaporator and the calculations on single effect evaporator, numerical problems of practical interest. Multiple effect evaporators - material and energy balance, temperature profile of liquids in the evaporator, enthalpy of solution, Different feeding arrangements in multiple effect evaporators – their merits and demerits.

Module IV

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling.

References:

1. Binay K.Dutta. Heat Transfer principles and applications. Prentice Hall of India, New Delhi.(2001)
2. Kern, D.Q., Process Heat Transfer, McGraw Hill Co. Inc, (1999).
3. McCabe, W.L., J.C. Smith, J.C. and Peter Harriott. Unit operations of chemical engineering. (Seventh edition). McGraw-Hill Education, New York. (2004).

23-206-0403 STRENGTH OF MATERIALS

Course Outcomes

On completion of this course the student will be able to:

1. Explain thefundamentalconceptsofstressandstrainelasticbodiessubjectedtoexternalloads.
2. Apply the concept of stress and strain in solving engineering problems.
3. Explain the behavior of beams under bending and solve engineering problems related to determinate beams.
4. Solve engineering problems related to thin and thick pressure vessels.
5. Solve engineering problems related to circular shafts, helical springs and buckling of columns.

Course Articulation Matrix

COs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2										1			
CO2	3	3	2	1									1			
CO3	3	3	2										1			
CO4	3	3	2	1									1			
CO5	3	3	2	1									1			

1-Slightly; 2-Moderately; 3-Substantially

Module I

Simple Stress and Strain and Principal Stresses-Axial stress and strain, elasticity, Hook's law – stress-strain relationship of ductile and brittle materials, Factor of safety, Lateral Strain, Poisson's ratio -Volumetric strain - Shear stress and shear strain - Elastic constants and their relationships - stresses in composite bars due to axial loading and temperature – Strain energy due to axial load-stresses due to impact and suddenly applied loads.

State of stress at a point - Normal and tangential stresses on a given plane; Principal stresses\and their planes, plane of maximum shear; Mohr's circle of stresses.

Module II

Shear Force and Bending Moment in Beams-Relationship connecting intensity of loading, shearing force and bending moment; Shear force and bending moment diagrams for cantilever, simply supported and overhanging beams subjected to concentrated load and UDL; Maximum bending moment and point of contra flexure.

Theory of simple bending-assumptions and limitations - Derivation of bending formula and its applications to engineering problems

Module III

Deflection of Beams- Differential equation of the elastic curve. Slope and deflection of beams by method of successive integration and Mc Caulauy’s method.

Thin and Thick Walled Structures- Hoop and longitudinal stresses in thin walled cylindrical and spherical shells subjected to internal pressure; Changes in dimension and volume; Thick Cylinders-Lame's equations, shrink fit, compound cylinders, wire wound cylinders.

Module IV

Torsion-Theory of torsion and assumptions; Torsion of solid and hollow circular shafts; Power transmission, strength and stiffness of shafts. Close and open coiled helical springs.

Theory of columns Buckling and stability, buckling of long columns, Euler’s Formula, Long columns with different support conditions.

References:

1. Mechanics of Materials, Enhanced Edition (9th edition), Cengage Learning India Pvt. Ltd. (2022)
2. Subramanian, R. Strength of Materials(3rdedn.) Oxford University Press, NewDelhi.(2016).
3. Egor P Popov Engineering Mechanics of solids (2^{nd} edn.), Pearson Education Pvt. Ltd, Singapore.(2015).
4. Timoshenko S.P and Young, D.N, Elements of Strength of materials (5^{th} ed), D.Van Nostrand Company Inc.,(2003).
5. Ramamurtham,S. Strength of Materials (20^{th} edn.).Dhanpat Rai and Sons.(2020).
6. Bhavikatti, S.S,Strength of materials (5^{th} Edn.) Vikas Publishing House Pvt. Ltd(2020).

23-206-0404 PLANNING AND DESIGN OF FIRE PROTECTION SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the working principle of different types of fire detectors and alarm system and plan and distribute them in buildings of different occupancy.
2. Interpret the concept of fire extinguishment with different extinguishers; the working principle and operation of portable fire extinguishers; and plan and distribute appropriate portable extinguishers in buildings of different occupancy.
3. Design fixed sprinkler system in buildings of different occupancy as per Indian Standard Specifications
4. Interpret appropriate standards for the design and installation of fixed CO_2, DCP and Foam systems and apply these concepts in the design of appropriate fire protection system.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2										3			
CO2	3	2	2										3			1
CO3	3	3	3										3			1
CO4	3	3	3										3			1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Fire detection- Need and importance of automatic fire detection system, principle of detection, classification of detectors; Heat detectors – fixed temperature, rate of rise , thermistor rate of rise and rate compensated type detectors; Smoke detectors- optical and ionization type, photo electric light scattering and light obstruction type detectors; Flame detectors – infra red and ultra violet detectors; Flammable gas detection- Pellistor and laser detectors; Testing of fire detection devices as per relevant Indian standards specifications; Performance characteristics of detectors; Lag time associated with fire detection; Comparison of detectors.

Fire alarm system- classification of alarm system as per National Building Code (NBC); Manually operated system; Automatic alarm system-various components and modules; Addressable and non-addressable system;

Citing of detectors as per relevant Indian standard specifications (BIS); Selection and planning of alarm system as per relevant BIS. General requirements and guidelines for the selection and installation of fire detection and alarm system in buildings of different occupancy classification; Performance and effectiveness of automatic fire detectors.

Module II

Principles of Fire Extinguishments-extinction of premixed flames, diffusion flames and burning metals; fire triangle, fire tetrahedron.

Basic concept of fire fighting with water, carbon dioxide, powders, foams, inert gases, halons; Need for halon replacement and halon substitutes; Extinguishant performance- flame extinguishing concentration, inerting concentration, fire trials.

Description, working principle, method of operation of different types of portable fire extinguishers-water type, foam type, dry powder type, CO_2 type, vapourizing liquid type; Selection and distribution

of portable extinguishers for different occupancy classification as per NBC; Care, inspection, and maintenance of portable extinguishers as per relevant BIS. Performance and effectiveness of portable fire extinguishers.

Module III

Automatic water sprinkler system- requirement and source of water supply, automatic pumps; Sprinkler heads-Quartzoid type, fusible link type, modern types; mounting and protection of sprinkler heads; Sprinkler pipe works-standard and staggered lay out, hangers; Control valves for wet and dry installations; deluge valve; Drenchers; High velocity and medium velocity spray system. Performance and effectiveness of water sprinkler system.

Design of water sprinkler and spray system as per relevant BIS-application to illustrative problems.

Module IV

Fixed fire fighting system using CO_2, Dry chemical powder, and Foam - concept of total flooding and local application, advantages and disadvantages of each system; Basic system components and design principles as per relevant BIS.

Design of fixed foam type fire fighting systems for total flooding and for local application as per relevant BIS -Application to typical hydrocarbon storage tank protection problems.

References:

1. Ron Hirst. Underdowns practical fire precautions, Gower publishing company Ltd., England. (1989).
2. Jain V.K. Fire safety in buildings (2^{nd} edn.). New Age International (P) Ltd., New Delhi. (2010).
3. Barendra Mohan Sen. Fire protection and prevention the essential handbook, UBS publishers and Dist., New Delhi. (2013).
4. Rasbash D., Ramachandran G., Kandola B., Watts, J., Law M., Evaluation o Fire Safety, John Wiley & Sons Ltd., England, (2004).
5. Robert M Gagnon, Design of water based fire protection system, (2^{nd} edn.), Delmar Cegage Learning, USA. (2013).
6. Robert M Gagnon, Design of special hazard and fire alarm systems, (2^{nd} edn.), Thomson Delmar Learning, New York. (2008)
7. Relevant Indian Standard Code of Practices(BIS)

23-206-0405 ELECTRICAL TECHNOLOGY AND SAFETY

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the constructional features and applications of electrical machines
2. Solve numerical problems related to the operation of electrical machines
3. Understand the working principle of various electrical safety equipments
4. Summarise the safety precautions to be taken during installation of plants and equipments

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3										1			
CO2	3	2	3										1			
CO3	3	2	3										1			
CO4	3	1	2										1			

1-Slightly; 2-Moderately; 3-Substantially

Module I

Construction and principle of operation of dc machines, e.m.f equation of a generator, use of interpoles. Characteristics of shunt, series and compound generators – starting and speed control – losses and efficiency, application of motor for industrial drive. Construction and principle of operation of single phase transformers, e.m.f equation, phasor diagrams, equivalent circuit, regulation, losses and efficiency. Instrument transformers CT, PTs,

Module II

Induction Motor; construction and principle of operation, torque slip characteristics, method of starting, applications.

Fundamentals of motors used in EVs , Motor control for BLDC motors , Analyse EVs based on power sources and calculate range of an EV. - Perform motor power and torque calculations to select a motor to build their own EV.

Circuit breakers - SF6, vacuum, air blast. Function of switch gear, circuit breakers principle of operation, arc phenomenon, arc interruption. MCB and ELCB. Faults in power systems – causes – types, SCADA applications.

Module III

Fuses, types and selection of fuses - advantages and disadvantages. Grounding, neutral grounding, solid grounding, resistance grounding, arc suppression coil grounding. Equipment grounding for safety, spark gap, surge protection, lighting arrester, grounding of line structure. Effect of electric and magnetic fields, human safety aspects, effect of current and voltage on human beings. Electrical accident-safety precaution, electric shocks and their prevention. Insulation, FRLS insulation, continuity test. Protective relays, requirement of relay, types of protection, distance relay, differential relay, state relays and digital relay. Transmission line
protection.

Module IV

Safety during installation of plant and equipment. Safe sequences in installation, risk during installation. Safety during testing and commissioning. Test on relays, protection and interlock systems for safety. Hazardous zones, classification of hazardous zones. Intrinsically safe and explosion proof electrical apparatus. Selection of equipments in hazardous area.

Maintenance principle and safety precautions of VFD (Variable-frequency Drive).Electrical fires, hazards of static electricity. Safe procedures for electrical maintenance - Statutory requirements. Safety provisions in Indian Electricity Act & Rules.

References:

1. Cotton, H. Electrical technology. (Seventh edition). CBS Publishers and Distributors, New Delhi. (2005).
2. Kothari, D.P. and Nagrath, I.J. Basic electrical engineering. (Third edition). Tata McGraw Hill Publishing Company Ltd., New Delhi.(2009).
3. National Safety Council. Accident prevention manual for industrial operations. Chicago.(1982).
4. Fordham-Cooper, W. Electrical safety engineering. Elsevier by, Amsterdam.(1998).
5. Rao, S. and Saluja, H.L. Electrical safety, fire Engineering and safety Management, Khanna Publishers, Delhi.(2012).
6. Nagarath I.J. & Kothari D.P, Electric Machines, 3rd edition, Tata McGraw Hill, (2004).
7. John Codick, “Electrical safety hand book”, McGraw Hill Inc., New Delhi, 2000.
8. Per Enge, Nick Enge, Stephen Zoepf, “Electric Vehicle Engineering”, McGraw Hill Inc., New Delhi, 2021

23-206-0406 MANUFACTURING PROCESSES

Course Outcomes:

On completion of this course the student will be able to:

1. Describe the process of production of various engineering materials and also converting the raw material into parts.
2. Classify the various materials and manufacturing process, non-conformities and testing methods.
3. Determine the property modification processes like alloying and heat treatment of metals and the suitable manufacturing process for various applications.
4. Differentiate the various materials, property modification processes and manufacturing process and select suitable ones for specific requirements.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1												1		
CO2	2	1												1		
CO3	2	1												1		
CO4	2	1												1		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Engineering Materials: - Classification, Properties - mechanical, thermal, chemical and technological. Iron and Steel-Processes and Classifications. Non-ferrous metals, processes, properties and use. Heat treatment of steels- purpose and methods. Processes-annealing, normalising, hardening, tempering.

Module II

Welding:-Introduction, weldability, Types of welding, Gas welding, Arc welding - submerged arc, TIG, MIG. Resistance welding, solid state welding, Electron beam welding, Laser beam welding. Oxygen cutting. Heat affected zones, Weld defects, Inspection of welded joints.

Module III

Metal Casting:- Pattern- pattern materials, types of patterns, pattern allowance, Moulding sands- properties and classification. Core and core sands. Moulding process. Special casting methods- die casting, centrifugal casting, investment casting, slush casting. Casting defects and inspection.

Module IV

Metal Forming: - Mechanical working of metals. Hot working, cold working. Methods and process of rolling, forging, and extrusion.

Machining: Metal cutting, Orthogonal and Oblique cutting, Cutting tool materials. Classification of machine tools - lathe, shaper, milling machine, drilling machine and grinding machine. Advanced machining methods- ECM, EDM, USM, AJM.

References:

1. Kalpakjian, S. and Schmid S.R. Manufacturing Engineering and Technology, (Sixth edition). Pearson Education Asia. (2009).
2. Sharma P.C. A Text Book of Production Technology. S. Chand & Co, New Delhi. (2007).
3. Welding Handbook: Vol. I to V. American Welding Society.
4. Hein, Lopper. and Rosenthal. Principles of Metal Casting. (Second edition). McGraw Hill Education (India) Private Limited. (2001).
5. Peter Beeley Foundry Technology. (second edition).Butterworth-Heinemann. (2001).

23-200-0407: UNIVERSAL HUMAN VALUES

Course Outcomes:
At the completion of the course, the students are able to

1. Recognize needs, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity.
2. Understand human being as the co-existence of two realities, self and body and harmony in the individual level.
3. Verify the possibility of ensuring within the naturally acceptable feelings and express those to the others with an expectation of mutual happiness and mutual prosperity.
4. Identify the harmony in society, nature and existence and ensuring them through the effort to fulfil the human goal.
5. Apply the understanding of ethical human conduct to formulate strategies for ethical life and profession.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1			2	2	1	2	2	2	2
CO2			1			2	3	1	3	1	2	2
CO3			1			2	2	3	3	3	2	2
CO4			1			3	3	3	3	3	3	3
CO5			2			3	3	3	3	3	3	3

1-Slightly; 2-Moderately; 3-Substantially

Module I: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education.
Purpose and motivation for the course, recapitulation from Universal Human Values-I.
Self-Exploration–what is it? – Its content and process; 'Natural Acceptance' and experiential Validation- as the process for self-exploration.
Continuous Happiness and Prosperity – A look at basic Human Aspirations.
Right understanding, Relationship and Physical Facility – the basic requirements for the fulfilment of aspirations of every human being with their priority.
Understanding Happiness and Prosperity rightly- A critical appraisal of the current Scenario.
Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human beings as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than arbitrariness in choice based on liking-disliking.

Module II: Understanding Harmony in the Human Being - Harmony in Myself.
Understanding human beings as a co-existence of the sentient 'I' and the material 'Body'.
Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
Understanding the characteristics and activities of 'I' and harmony in 'I'.
Understanding the harmony of I with the Body: Self-regulation (*Sanyam)* and Health; correct appraisal of Physical needs, the meaning of Prosperity in detail.
Programs to ensure Self-regulation (*Sanyam)* and Health.

Include practice sessions to discuss the role others have played in making material goods available to one self, identifying from own life. Differentiate between prosperity and accumulation. Discuss a program for ensuring health vs dealing with a disease.

Module III: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship.

Understanding values in a human-human relationship; the meaning of Justice (nine universal values in relationships) and the program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.

Understanding the meaning of Trust; Difference between intention and competence.

Understanding the meaning of Respect, the difference between respect and differentiation; the other salient values in a relationship.

Understanding the harmony in the society (society being an extension of the family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals.

Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real-life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module IV: Understanding Harmony in Nature and Existence – Whole existence as Coexistence.

Understanding the Harmony in Nature.

Interconnectedness and mutual fulfilment among the four orders of nature – recyclability and self-regulation in nature.

Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.

Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human beings as the cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Implications of the above Holistic Understanding of Harmony on Professional Ethics: Natural acceptance of human values, Definitiveness of Ethical Human Conduct.

Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.

Competence in professional ethics: a. Ability to utilize professional competence for augmenting universal human order, b. Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for the above production systems.

Case studies of typical holistic technologies, management models and production systems.

Strategy for the transition from the present state to Universal Human Order: a. At the level of the individual: as socially and ecologically responsible engineers, technologists and managers, b. At the level of society: as mutually enriching institutions and organizations.

Sum up.

Include practice exercises and case studies to discuss the conduct as an engineer or scientist etc.

Textbook:

1. Human Values and Professional Ethics (3rd revised edition) by R. R. Gaur, R Asthana, G P Bageria, Excel Books, New Delhi, 2022.

References:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 3rd Edition, (2022).
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 5th Edition, (2022).

23-206-0408 STRENGTH OF MATERIALS LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize the basic concept of load and deformation characteristics in elastic bodies subjected to different types of loads.
2. Explain the hardness property and the effect of impact load on ductile materials.
3. Interpret the basic concept of load and deformation characteristics in concrete specimens subjected to compressive load
4. Analyze experimental data and arrive at conclusions.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2										1		1	
CO2	3	2	2										1		1	
CO3	3	3	2										1		1	
CO4	3	3	3										1		1	

1-Slightly; 2-Moderately; 3-Substantially

List of Experiments

1. Torsion test on mild steel specimen
2. Test on open coiled and close coiled helical springs
3. Flexure Test on wood
4. Determination of modulus of elasticity of concrete using cylinder specimen
5. Hardness test on ferrous and non-ferrous materials- Brinnel, Vickers and Rockwell hardness
6. Double shear test on mild steel rod
7. Izod Impact tests
8. Compression test on concrete cubes

23-206-0409 ELECTRICAL TECHNOLOGY LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the laws governing electric circuits
2. Interpret the load and speed characteristics of d.c motors
3. Draw the load and speed characteristics of a.c motors
4. Summarize the functions of protective relays and circuit breakers.

Course Articulation Matrix

COs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3										2			
CO2	3	3	2										2			
CO3	3	3	2										2			
CO4	3	3	2										2			

1-Slightly; 2-Moderately; 3-Substantially

List of experiments

1. Verification of Kirchoff's Laws
2. Verification of Superposition Theorem
3. Study of B.H. Curve on C.R.O
4. Measurement of power in an A.C. circuit by 3 ammeter and 3 voltmeter method
5. Load test on a D.C. series motor
6. Speed characteristics of D.C. shunt motor
7. Regulation of a Transformer
8. Load characteristics of a 3 phase induction motor
9. Study of protective relays and circuit breakers
10. Study of insulation testing and ground testing

23-206-0501A NUMERICAL AND STATISTICAL METHODS

Course Outcomes:

On completion of this course, the student will be able to:

1. Comprehend foundational concepts in numerical analysis, statistical methods, and machine learning, including understanding the importance of numerical methods and statistical techniques in problem-solving.
2. Apply various numerical methods and statistical tests to solve algebraic and transcendental equations, analyze data, and draw inferences about populations and samples.
3. Evaluate and compare the efficiency of numerical techniques in solving engineering problems, demonstrating analytical skills in differentiation, integration, and solving ordinary differential equations.
4. Apply advanced statistical and machine learning techniques using Pandas for data exploration and processing, showcasing proficiency in descriptive statistics, regression analysis, and the implementation of basic machine learning models.

Course Articulation Matrix

COs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2		1								1	1	1	
CO2	3	2	2		1								1	1	1	
CO3	3	2	2		1								1	1	1	
CO4	3	2	2		1								1	1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Fundamentals of Numerical Analysis: Understanding Numerical Methods, Importance in Problem Solving, Error Analysis and Approximations. Numerical solution of algebraic and transcendental equations: Bisection, Newton-Raphson, Secant and Successive Iteration Method.System of Equations: Gauss-Seidel Iteration (Convergence without proof). Interpolation and Approximation: Polynomial, Lagrange, Newton's Forward/Backward/Divided-Difference, and Least Squares.

Module II

Numerical Differentiation at Tabulated Points: Forward, Backward, Central Differences. Numerical Integration: Trapezoidal, Simpson's, Gaussian Quadrature. Ordinary Differential Equations (ODEs): Initial Value Problems- Euler's Method, Runge-Kutta (2nd & 4th Order), Boundary Value Problems- Finite Difference Method (First & Second Order BVPs).

Module III

Statistical Concepts and Tests: Random Variables, Expectation, Mean, Variance. Probability Distributions: Binomial, Poisson, Normal. Statistical Inference: Population, Sample, Sampling Distributions (Mean & Variance). Hypothesis Testing: Level of Significance, Z-Test, Chi-Square Tests (Variance & Goodness of Fit), F-Test.

Module IV

Descriptive Statistics and Regression Analysis. Overview of Descriptive Statistics. Regression Analysis of Numerical Data. Regression Analysis of Categorical Data. Visualization of Data Trends. Basic Concepts of Machine Learning: Introduction to Supervised Learning, Overview of Classification and Regression, Introduction to Unsupervised Learning: Clustering. Utilize Pandas for

data exploration and processing.

The students should be introduced to Computer Algebra Systems (CAS) such as Matlab/Python (utilizing NumPy, SymPy, and SciPy) for both symbolic and numerical calculations. Homework and assignments should be given with the integration of CAS.

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 11th Edition, John Wiley & Sons, (2022).
2. Grewal, B. S., Higher Engineering Mathematics, 45th Edition, Khanna Publishers, (2023).
3. R.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th Edition, New Age International Publishers, (2022).
4. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 10th Edition, Cengage Learning, (2023).
5. Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, 3rd Edition, O'Reilly Media, (2022).
6. Andreas C. Muller, Sarah Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists, 2nd Edition, O'Reilly Media, (2021).

23-206-0502 MASS TRANSFER OPERATIONS

Course Outcomes:

On completion of the course the student will be able to:

1. Analyze fundamentals of mass transfer operations and estimate diffusion coefficients. Summarize interface mass transfer and concepts of mass transfer coefficients
2. Analyse and utilise absorption theory to evaluate absorption equilibrium and kinetic problems, and design absorption columns.
3. Explain boiling point diagrams, relative volatility and differentiate various types of distillation techniques
4. Understand the theory of leaching and design of single stage and multistage Separation processes with an understanding of construction and working of separation equipment.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2										1	2		
CO2	3	3	3										1	2		
CO3	3	3	3										1	2		
CO4	3	3	2										1	2		

1-Slightly; 2-Moderately; 3-Substantially

Module 1

Molecular diffusion - mass fluxes JA and NA - Fick's law - diffusivity and estimation -steady state diffusion of A through stagnant B and equimolar counter diffusion in binary gases, liquids and multi component gas mixtures. Mass transfer coefficients, dimensionless groups - analogy between mass, heat and momentum transfer. Basic concepts and assumptions involved in theories of mass transfer: penetration and surface renewal theories - interphase mass transfer - equilibrium - diffusion between phases - two-film theory – local and overall k-type coefficients.

Module 2

Absorption-Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations. Types of absorbers.

Module 3

Distillation: Introduction to distillation, Vapour-liquid equilibrium, bubble and dew point calculations, Relative volatility, equilibrium curves - application of Raoult's law, Ideal and non - ideal solutions, azeotropes, Batch distillation and equilibrium flash vaporisation, Steam distillation, Differential distillation Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by McCabe - Thiele method, Total reflux, minimum reflux ratio, optimum reflux ratio.

Module 4

Extraction - applications – selectivity, choice of solvent Single-stage and multistage extraction operations - Calculations for immiscible systems. Single-stage and multistage extraction operations - Calculations for partially miscible systems. Types of Extractors Working principles of leaching equipment- Shank's system- thickeners, classifiers and moving bed leaching equipment. Adsorption,

types of adsorption, properties of adsorbents, adsorption isotherm for single gases, vapours and dilute liquid solutions, Adsorption isotherms –Freundlich and Langmuir, Fixed bed adsorption, adsorption wave, rate of adsorption and breakthrough curve. Drying, equilibrium, bound and unbound moisture content, batch drying, rate of drying, mechanism of moisture movement,, classification of industrial dryers for batch and continuous drying.

References:

1. Geankoplis, C. J.(2003).Transport Processes and Separation Process Principles.Prentice Hall.
2. Coulson, J. M., Richardson, J. F., Sinnott, R. K., & Towler, G. (2009). "Chemical Engineering Design." Elsevier.
3. Perry, R. H., Green, D. W., & Maloney, J. O. (2007). "Perry's Chemical Engineers' Handbook." McGraw-Hill Education
4. Treybal, R. E. (1980). "Mass-Transfer Operations." Mc Graw-Hill Education
5. N. Anantharaman and K.M. Meera Sheriffa Begum, Mass Transfer-Theory and Practice, PHI Learning Private Limited (2011) New Delhi.

23-206-0503 PRINCIPLES OF ENGINEERING DESIGN

Course Outcomes:

On completion of this course the student will be able to:

1. Design threaded fasteners and detachable joints.
2. Design non-detachable joints such as riveted and welded joints
3. Design springs and power shafts
4. Design pipe lines, pressure vessels, storage tanks and their supports.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3									1	2	1		
CO2	2	2	3									1	2	1		
CO3	2	2	3									1	2	1		
CO4	2	2	3									1	2	1		

Module I

Introduction to design- steps in design- design factors- practical considerations in design- theories of failure- stress concentration - consideration of creep and thermal stress in design.

Detachable joints- design of screws- thread standards- thread stress- pre-loading of bolts- external load with pre-load -fatigue and shock loading- Types of keys- types of pins- design of cotter and pin joint.

Module II

Riveted Joints-stresses in riveted joints- design of riveted joints subjected to central & eccentric loads- boiler and tank joints - structural joints.

Welded joints-types of welded joints- design of welded joints subjected to axial, torsion and bending loads.

Module III

Springs- stresses in helical spring- deflection of helical compression and extension Spring- springs subjected to fatigue loading- concentric and helical torsion spring - critical frequency of springs- leaf springs- design of automotive leaf springs.

Power Shafting- Design for static loads- combined stresses- design of shaft for strength and deflection- axial load on shaft.

Module IV

Design of cylindrical and spherical pressure vessels for internal and external pressures- design of heads and enclosures- tall vessels- supports for vessels- pipeline design. Design of storage tanks.

References:

1. Budynas, R.G. and Nisbett, K. Shigley's Mechanical Engineering Design. (Tenth edition). Mc Graw Hill Book Co., New York. (2014).
2. Bhandari, V.B. Design of machine elements. Tata McGraw – Hill Education, New Delhi. (2010).
3. Myatt Donald, J. Machine design: an introductory text, McGraw Hill, New York. (1962).
4. Mahajani, V.V. and Umarji, S.B. Joshy's Process equipment design. (Fifth edition). Trinity Press, New Delhi. (2014).
5. Brownell, L. E and Young, E. H. Process equipment design, John Wiley & Sons, New York. (1995).
6. Bhattacharya, B.C. Introduction to chemical equipment design - Mechanical aspects. CBS Publishers and Distributors, New Delhi. (2003).

Codes and Data Hand Books allowed for reference during examinations

1. IS 2825:1969 - Code for unfired pressure vessels
2. Narayana Iyengar B. R, Lingaiah K., Machine Design Data Handbook, Vol. I &II
3. P.S.G., Tech., Machine Design Data Handbook
4. Mahadevan K., Balaveera Reddy K. Design Data Handbook for Mechanical Engineers, 3rd Edition, CBS Publishers & Distributors. (2013).

23-206-0504 STRUCTURAL FIRE SAFETY

Course Outcomes

On completion of this course the student will be able to:

1. Explain the behaviour of compartment fire at the pre-flashover and post-flashover stages and interpret the effect of fire on structural and non-structural materials used for construction.
2. Summarize the method of fire resistance test on structural and nonstructural members; the method of combustibility tests on building materials; and calculate the fire resistance rating of a compartment and design it for a required fire resistance rating.
3. Determine the method of fire protection to structural members made of different materials and their repair methods if damaged due to fire.
4. Implement the design concept of fire walls, fire screens, local barriers and fire doors in selecting them appropriately for a given fire scenario.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2											1			
CO2	3	2	2	1									3		1	
CO3	3	1	2	1									3		1	
CO4	3	2	2	2									3		1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires. Pre-flashover compartment fire- growth period and definition of flashover, conditions necessary for flashover, fuel and ventilation conditions for flashover, factors affecting time to flashover, factors affecting growth. Post flashover compartment fire- regimes of burning, fully developed fire behavior, temperatures achieved in fully developed fire, fire resistance and fire severity, methods of calculating fire resistance, projection of flames from burning compartments, spread of fire from compartments. Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire;

Module II

Effect of temperature on the properties of structural materials- Thermal data for concrete, steel, aluminum, masonry and wood; Mechanical properties of concrete, steel, aluminum, masonry and wood exposed to elevated temperatures (Material data); Constitutive stress-strain models for steel and concrete.; Fire protection of structural members made of steel, RCC and wood.

Fire resistance test on structural elements-standard heating condition, types of furnaces, Indian standard test method, performance criteria, drawbacks to the fire resistance test. Approximate calculation of the fire resistance of a compartment; Method of arriving at the required fire resistance of structural members as per Indian Standard Specifications (BIS).

Module III

Determination of combustibility of materials by fire tube method; Brief description on non-combustibility test as per BIS; Behavior and performance of fabricated fire proof boards-Calcium silicate, Gypsum, Vermiculite, and Perlite boards.

Behavior of non-structural materials on fire- plastics, glass, textile fibers, geopolymers and other house hold materials. Classification of materials based on surface flame spread and their suitability.

Reparability of fire damaged structures- Assessment of fire severity, Assessment of damage to concrete, steel, masonry and timber structures, Assessment of feasibility of repair; Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

Module IV

Fire area- calculation of building fire area, subdivision of fire areas in Industrial, Residential and Public buildings; Fire separation between building-principle of calculation of safe distance.

Design principles of fire resistant walls and ceilings; Fire resistant screens-solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in partitioned fire areas, and in connecting structures;

Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors; Specification, test and performance criteria of Plate, Metal covered and rolling type fire doors as per BIS.

References:

1. Smith, E.E. and Harmathy, T.Z. (Editors), Design of buildings for fire safety. ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A. (1979).
2. Butcher, E. G. and Parnell, A. C. Designing of fire safety. John Wiley and Sons Ltd., New York, U.S.A. (1983).
3. John A. Purkiss Fire safety engineering design of structures (2^{nd}edn.), Butterworth-Heinemann, Oxford, U.K. (2009).
4. Andrew H Buchanan. Structural design for fire safety, John Wiley & Sons Ltd., England. (2001).
5. Dougal Drysdale. An Introduction to Fire Dynamics, (2^{nd}edn.), John Wiley & Sons Ltd., England. (1999).
6. Roytman, M. Ya. Principles of fire safety standards for building construction. Amerind Publishing Co. Pvt. Ltd., New Delhi. (1975).
7. Relevant Indian Standard Code of Practices(BIS)

23-206-0505 CHEMICAL TECHNOLOGY AND REACTION ENGINEERING

Course Outcomes

On completion of this course the student will be able to:

1. Describe the manufacturing methods for heavy chemicals, fertilizers, organic chemicals and polymers.
2. Explain the importance of physical, chemical and physicochemical transformations of the material in process industries.
3. Solve problems using the integral method and differential method of analysis.
4. Compute the volume of Batch, CSTR and PFR reactors using design equations

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	1								2	2	2	
CO2	3	3	2	1	1								2	2	2	
CO3	3	3	3	1	1								3	2	2	
CO4	3	3	3	1	1								3	2	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Inorganic chemical technology: Chlor-alkali industries-soda ash-caustic soda-chlorine-hydrochloric acid. Manufacture of sulphuric acid. Phosphorous industries - phosphoric acid-wet process phosphoric acid, single super phosphate and triple super phosphate. Nitrogenous industries-ammonia, nitric acid, urea, ammonium sulphate, ammonium phosphate.

Module II

Organic chemical technology: Manufacturing processes for pulp and paper, sugar, industrial alcohol by fermentation-absolute alcohol, beers, wines, oils and fats, soaps and detergents, agrochemicals, introduction to polymers, synthetic rubbers- SBR, neoprene, urethane rubbers.

Module III

Classification of reactions, variables affecting rate of reaction, definition of reaction rate. Kinetics of homogeneous reactions – concentration dependent term of a rate equation, temperature dependent term of a rate equation, theories of reaction – collision theory, transition theory, Arrhenius equation. Analysis of experimental reactor data, evaluation of rate equation, integral and differential analysis for constant variable volume system.

Module IV

Ideal reactors- Design for homogeneous systems, batch, stirred tank and tubular flow reactor, design of reactors for multiple reactions, combination reactor system, size comparison of reactors. Elementary ideas of non-ideal reactor performance, residence time distribution curves E, F and C.

References:

1. Gopal Rao, M. and Sittig, M (Eds). Dryden's outlines of chemical technology for the 21st century. (Third edition). Affiliated East West Press, New Delhi. (2010).
2. George T. Austin. Shreve's chemical process industries. (Fifth edition). McGraw- Hill Book Co Inc., New York. (1984).
3. Shukla, S.D. and Pandey, G.N, Text book of Chemical Technology, Vol. I. (1977).
4. Levenspiel, O. Chemical Reaction Engineering, 4th Edition, John Wiley & Sons, 2018.
5. Scott Fogler, H. Elements of chemical reaction engineering. (Fourth edition). Prentice-Hall of India, New Delhi. (2005).
6. Smith J.M. Chemical Engineering Kinetics, (Third edition), McGraw Hill, (1981).

23-206-0506 (IE) AVIATION SAFETY AND SAFETY OF SPACE MISSIONS

Course outcomes:

On completion of this course the student will be able to:

1. Demonstrate knowledge of basic aviation safety principles.
2. Demonstrate knowledge of human factors and crew resource management principles
3. Demonstrate knowledge of safety systems in space missions
4. Demonstrate the importance of protecting the space environment

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2										1	1	1	
CO2	2	3	3										1	1	1	
CO3	2	2	2	1									1	1	1	
CO4	2	2	2	1									1	1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Aviation Safety Program Management: Accident Prevention Concepts – Management Concept and Safety Program Organization - Reporting and Information Systems - Safety Committees Safety Inspections and Audits-Safety Management Systems (SMS).

Flight Safety: Issues Related to Flight Safety - ATC Safety. Ground Safety: Aviation Maintenance Safety- Ground Safety

Module II

Human Factors: Communication – Stress - Situational Awareness – Hazardous Attitudes-Crew Resource Management – Leadership-Teamwork Aircraft Accidents: Accident Investigation Procedures-Accident Causation Models.

Module III

Safety Process, Quality and Reliability - Safety Analyses - Human Ratings - NASA and ISRO Requirement - Failure Tolerance - Design for Minimum Risk - Electrical and Power Systems & Battery Safety - Life Support Systems - Avionics Safety - Propulsion Systems Safety - Structures and Mechanisms Systems Safety - Non-Destructive Evaluation

Module IV

Extra vehicular Activity and Docking Systems Crew Systems (Flight Suits, Seats)– Oxygen Systems-Toxic Environment-Fire-Launch Vehicle Design-Risk to Public Considerations - The Space Environment: Micro Meteoroid and Orbit Debris (MMOD),Space Traffic Management.

References

1. Introduction to Aviation Management by Andreas Wald, Michael Schüffner (2017,Springer)
2. Safety Management Systems in Aviation" by Alan J. Stolzer, Carl D. Halford, John J. Goglia (2008, Routledge)
3. Introduction to System Safety Engineering" by Dennis V. Lindley, Kenneth G. Patton (2000, Wiley)
4. Ferguson, M.D. & Nelson,S., Aviation Safety: A Balanced Industry Approach. Delmar Cengage Learning, 2014.
5. Gary Eugene Musgrave, Axel(Skip) M. Larsen and Tommaso Sgobba (Ed). Safety Design for Space Systems .Butterworth-Heinemann, 2009.
6. IAASS-SSI-1700 Commercial Human-Rated System, SAE Aerospace Standard, Issued 2018-07.

23-206-0507 HAZARD CONTROL IN MANUFACTURING

Course Outcomes

On completion of the course the student will be able to:

1. Describe the various manufacturing processes- hot & cold working of metals, metal cutting, welding & cutting, heat treatment methods, and material handling methods and the equipment and machineries employed in engineering industries.
2. Summarise the various hazards associated with different manufacturing processes, heat treatment methods and material handling methods.
3. Evaluate the various hazards, relate to the hazard control principles and determine the different hazard control measures.
4. Differentiate various hazards identified and suggested hazard control methods.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3										1	1	2	
CO2	3	3	3										1	1	2	
CO3	3	3	3										1	1	2	
CO4	3	3	3										1	1	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction-Classification of Engineering Industry –Manufacturing Processes Hot Working-Foundry operations-furnace and equipment, health hazard, safe methods of operation .Forging operations heat radiation, maintenance of machines, shop equipment and hand tools-safe work practice .Operations in hot and cold rolling mills.

Module II

Machinery safeguard-Point-of-Operation, Principle of machine guarding- breakdown of machine guarding-types of guard sand devices.

Cold Working-Safety in Power Presses, primary and secondary operations-shearing-bending-rolling – drawing. Metal Cutting-safety in turning, boring, Milling, planning and grinding. Maintenance of machine tools-health hazards and prevention.

Module III

Welding and Cutting- Safety Precautions of Gas welding and Arc Welding, Cutting and Finishing. Gas Cylinders and Equipment's. Heat Treatment-Furnaces and Salt baths-operations and maintenance-safety in handling and storage of salts-disposal of effluents-health precautions, exposure to hazardous fumes, source of fumes, ventilation and fume protection.

Module IV

Material Handling- Classification- safety consideration in manual and mechanical handling. Handling assessments and techniques-lifting, carrying, pulling, pushing, palletizing and stocking. MaterialHandlingequipment-operation&maintenance.Maintenanceofcommonelements-wirerope,chains slings, hooks, clamps.

References:

1. National Safety Council, Chicago Accident prevention manual for industrial operations. (1982).
2. Ronald P. Blake. Industrial safety. (3rd edition) Prentice Hall, New Delhi. (2000).
3. Balchin, N.C. Health and Safety in Weldingand Allied process, Jaico Publishers, New Delhi. (2005).
4. Kalpakjian, S and Schmid S.R. Manufacturing Engineering and Technology, (Sixth edition). Pearso Education Asia. (2009)

23-206-0508 SAFETY IN FIRE WORKS INDUSTRY

Course Outcomes:

On completion of the course the students will be able to:

1. Choose the properties of various chemicals used in fire works industry
2. Recall the concepts of earthling and legal requirements
3. Improve the process safety in fire works industry
4. Control the wastes and ensure the human safety in fireworks

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2										2	1		
CO2	3	2	2										2	1		
CO3	3	2	2										2	1		
CO4	3	2	2										2	1		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Properties of fireworks chemicals: Fire properties–potassium nitrate(KNO_3), potassium chlorate ($KClO_3$), barium nitrate ($BaNO_3$), calcium nitrate ($CaNO_3$), Sulphur (S), Phosphorous(P), antimony (Sb), Pyro Aluminum (A1) powder Reactions-metal powders, Borax, ammonia(NH_3) – Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.

Module II

Static charge and dust: Concept-prevention-earthing-copper plates-dress materials-static charge meter lightning, Causes effects-hazards in fireworks factories-lightning arrestor: concept-installation-earth pit-maintenance resistance-legal requirements-case studies.

Dust: size-desirable, non-respirable- biological barriers-hazards-personal protective equipment, pollution prevention.

Module III

Process safety: Safe-quantity, mixing-filling-fuse cutting – fuse fixing – finishing – drying at various stages-packing, storage-hand tools-materials, layout: building - distances- factories act –explosive act and rules–fire prevention and control– risk related fireworks industries. Safe operating procedure during handling of fireworks.

Module IV

Material handling, transportation and user safety: Manual handling – wheel barrows-trucks-cycles-automobiles-fuse handling–handling the mix in the factory-material movement-godown-waste pit.

Packing-magazine-design of vehicles for explosive transports loading into automobiles-transport restrictions-case studies-over head power lines-driver habits-intermediate parking-fire extinguishers-loose chemicals handling and transport. Concepts of wastes– Wastes in fire works-Disposal-Spillages-storage of residues. Risk analysis of inventory.

References:

1. Ronald Lancaster, Roy E.A. Butler, J. Mark Lancaster and Takeo Shimizu, Fireworks Principles and Practice, 4th Edition, Chemical Publishing Company, NewYork, 2006.

2. John Barton, Dust Explosion Prevention and Protection Institution of Chemical Engineers, UK,2002.
3. Michael S.Russell, The Chemistry of Fireworks, Royal Society of Chemistry,UK, 2009.
4. Geoffrey Lunn, "Guide to Dust Explosion Prevention and Protection", Institution of Chemical Engineers, UK, 1992.
5. Proceedings of National conference on Pyro Tech 2013, Petroleum and Explosives Safety Organization (PESO), Ministry of Explosives, GovernmentofIndia,2013.
6. Bill Of ca, Fireworks Safety Manual : A Collection of Essays., HydePark,NewYork,1990

23-206-0509 INTRODUCTION TO PROCESS PLANT SECURITY

Course Outcomes:

On completion of this course the student twill be able to:

1. Assess the security threats to process plants
2. Summarise the essential elements of site security for process industries
3. Appreciate the value of information to the modern organisation
4. Appreciate the difficulties that arise when valuable information needs to be shared

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2			3									3	1		
CO2	1	2	3										3	2		
CO3	3		2	2									3	2		
CO4	1	3	2	2									3	2		

1-Slightly; 2-Moderately; 3-Substantially

Module-I

Security for chemical process industries - Assessments and regulatory environment, methods for assessing security vulnerability, emerging security regulations, government development and industry activities that relate to security for process facilities. Strategies and counter measures – prevention of intentional releases and theft of chemical releases at process facilities.

Security Risk in Process Industries–Ethical, Technical and Economic aspects of security risk.

Module-II

Site security for process industries–Essential elements–threat analysis, security counter measures, mitigation and emergency response. Specific security measures–information security, cyber security, physical security, policies and procedures, training, mitigation and response, inherently safer processes. Case study.

Module-III

Information Concepts and Processing: Definition of Information, quality and value of information, categories of Information in business organization level of information, storage and retrieval of data, comparison of manual and electronic storage of data, Organization of data as files, Data Extraction, Transformation and Processing, Network Security Fundamentals

Module-IV

Information Security Evolution: Evolution of Encryption Techniques, Historical Perspective of Information Security, Various Encryption and Decryption Techniques, Introduction of Asymmetric and Symmetric Encryption Techniques, Business Continuity Planning and Disaster Planning. Information Technology (Amendment) Act 2008 and its important Sections.

References:

1. Reniers G, Khakzad N, Gelder P V (eds). Security Risk assessment in the Chemical and Process Industry. De Gruyter, 2018.
2. Matt Bishop. Computer Security: Art and Science.Addison-Wesley,2015.
3. ICAI: Technical Guide on Information systems audit. The Institute of Charted Accountants of India, New Delhi, 2009.

23-206-0510 COMPUTER APPLICATIONS IN SAFETY AND FIRE ENGINEERING LABORATORY I

Course Outcomes:

On completion of this course the student will be able to:

1. Create precise 2D drawings and 3D models of parts and assemblies using constructive solid geometry and industry-standard CAD software.
2. Design and draft building fire protection system by Building Information Modelling.
3. Model 3D structures of plant equipment, piping, and utility systems, generate isometric and orthographic views, routes, and renders.
4. Recognize the use of different software for fire modelling

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1		3								3	1	2	
CO2	3	2	1		3								3	1	2	
CO3	3	2	1		3								3	1	2	
CO4	3	3	1		3								3	1	2	

1-Slightly; 2-Moderately; 3-Substantially

List of Experiments

1. Modelling by Constructive Solid Geometry (CSG) using CAD package: Basic drawing and editing, Precision drawing, advanced editing, 2D Geometry, Isometric drawings, Orthographic Projection, Surface modelling, Set up layers of industry standards, Part Modelling, Dimensioning and Tolerancing (D&T), Assembly- Examples from construction, automobile and process industrial machinery, Drafting

2. Application of Building Information Modelling (BIM) software to design of sprinkler system for residential/commercial spaces.

3. Plant Equipment, Piping and Utilities Modelling: P &ID Sketch Up basics,3D structures modelling- Fire protection facilities, Pipe Routing, Isometric and Orthographic view generation, Render generation

4. Fire Modelling using open-source software – zone and field models

23-206-0511 FIRE SAFETY TRAINING

Course Outcomes

On completion of this course the student will be able to:

1. Explain the operation of general rope works related to firefighting and the operation of various firefighting equipments.
2. .
3. Recognize the method of refilling portable cartridge type fire extinguishers.
4. Apply the technique of fighting fire using portable fire extinguishers filled with class A and B extinguishing agents.
5. Explain the method of operation of laying hose line and method of connecting different accessories to the hose line.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1										2	1		
CO2	2	1	1										2	1		
CO3	2	1	1										2	1		
CO4	2	1	1										2	1		

1-Slightly; 2-Moderately; 3-Substantially

List of Experiments:

1. Study and demonstrate different types of knots, bend and hitches used in fire fighting.
2. Study and demonstrate the operation of different firefighting equipment.
3. Study of different fire fighting vehicle.
4. Study on the method of refilling of different portable extinguishers- Water, DCP and Foam based.
5. Fire fighting with different types of portable extinguishers- CO_2, Water, DCP and Foam based.
6. Study of hoses, couplings, landing valves and braches
7. Hose drills (dry) – laying of hose, connecting and disconnecting of hoses, couplings, branches, etc.
8. Table top exercise-scenario based fire fighting.
9. Study of various fire ground operations

23-206-0512 INTERNSHIP-II

Course Outcomes

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organisation of the information gained during the internship.
3. Conceive the pros and cons of working in a real time industrial environment and the wonderful results which could evolve through team-work.
4. Present and defend self-prepared and corrected internship report (with the help of internship guide/industry mentors) of a self-created work to a peer audience.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1							1	1	2	2	1	2	2	2	1	
CO2							1	1	2	2	1	2	2	2	1	
CO3							1	1	2	2	1	2	2	2	1	
CO4							1	1	2	2	1	2	2	2	1	

1-Slightly; 2-Moderately; 3-Substantially

Internship Guidelines

- An internship plan has to be prepared by the interns incorporating the job description/internship duties, name of the project, if any and internship schedule and expected learning outcomes in consultation with industry supervisor/mentor and institute faculty.
- A detailed training report in the prescribed format shall be submitted at the end of the internship.
- Training Certificate from the industry for the prescribed period shall be submitted at the end of the internship.
- The work shall be reviewed and evaluated periodically.
- Orientation of interns, resourse requirement of interns, monitoring of interns progress on a daily basis shall be carried out by the industry offering internship in addition to ensuring safety and welfare of the interns.

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review.

Guidelines for evaluation:

1.	Regularity and progress of work	10
2.	Work knowledge and Involvement	10
3.	Semester End presentation and oral examination	10
4.	Level of completion of internship	10
5.	Internship Report – Presentation style and content	10
Total		**50** Marks

23-206-0601 LEGAL ASPECTS OF HSE

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize important laws on safety, health, welfare, social security, petroleum, explosives and environment for compliance purposes
2. Explain the principles and law points underlying the above provisions of law
3. State the safety provisions of different Acts and Rules and analyse important decided cases
4. Prepare compliance checklists

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		3	1	2		3		2		2					1	2
CO2		3	1	2		2		2		2					1	2
CO3		3	1	2		3		2		2					1	2
CO4		3	1	2		3		2		2					1	2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Occupational Safety, Health and Working Conditions Code, 2020: Provisions related to factories and dock works in major ports – registration, duties of employer, employees, designers, manufacturers, suppliers, importers etc. Notices of accidents, dangerous occurrences and diseases. Roles of NOSHA and SOSHA Boards. Safety committee and safety officers. Health, safety, working conditions and welfare provisions. Inspector-cum-facilitator and other authority for factories and docks. Special provisions relating to employment of women. Approval and licensing of factories, notified factories, dangerous operations, site appraisal committee, compulsory disclosure of information, health recording, emergency standards, permissible limits of exposure. Power to exempt during public emergency, exempting public institutions, schedules, power to make rules and regulations.

Module II

Code on Wages, 2019: Fixation of minimum wages, payment of wages.

Code on Social Security: Definitions, application to ESI and EC – Chapter IV ESI Corporation– principal officers and staff, ESI Fund, all to be insured, contributions, different benefits like sickness, maternity, disablement, medical etc. Chapter VI Maternity benefits in general. Chapter VII – Employees' Compensation: reporting of fatal accidents and serious bodily injuries, employer's liability for compensation for personal injury by accident or occupational disease, amount of compensation, schedules.

Public Liability Insurance Act and Rules- Definitions, amount of relief, environmental relief fund, contribution to relief fund, Advisory Committee, powers of District Collector, extent of liability.

Module III

Explosives Act: Definitions, categories of explosives, general safety provisions, use of explosives, grant of license, notice of accidents, inquiry into ordinary and more serious accidents, and extension of definition to other explosive substances. Briefly, the Explosives Rules, SMPV Rules and Gas Cylinder Rules.

Petroleum Act with important rules - definitions, safety in the import, transport, storage, license, exemption, notice of accidents.

Module IV

Water Act and **Air Act**: Definitions, powers and functions of Boards, prevention and control of pollution, consent administration.

Environment (Protection) Act and Rules: Definitions, powers of central government, power of giving directions, authorities.

MSIHC Rules: Definitions, duties of authorities, notification of major accidents, safety reports, safety audit, on-site & off-site emergency plans, safety information to public.

References:

1. Occupational Safety, Health and Working Conditions Code, 2020
2. Code on Social Security, 2020
3. Code on Wages, 2019
4. Explosives Act and related Rules
5. Petroleum Act and Petroleum Rules
6. Acts related to water, air and environmental pollution and relevant Rules as above

23-206-0602 IOT BASED PROCESS INSTRUMENTATION AND CONTROL

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the measurement principles and techniques of measuring temperature and pressure.
2. Compare the methods for the measurement of flow, level, pH and humidity.
3. Interpret the operation of different types of control system
4. Analyse the stability of a control system

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2		3								2	2	2	
CO2	3	2	2		3								2	2	2	
CO3	3	3	2		3								1	2	2	
CO4	3	3	2		3								1	2	2	

1-Slightly; 2-Moderately; 3-Substantially

Module 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, Pyrometer, Calibration. Pressure and vacuum measurement – Manometers, Measuring element, Absolute pressure measurement, Static accuracy of pressure gauges.

Module 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. Open loop and close loop systems – Transfer function modelling – block diagram representation of mechanical, thermal and liquid level systems

Module III

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 — Gain margin, Phase margin.

Introduction to stability – Definition via impulse response function – Routh-Hurwitz stability criterion – Nyquist stability criterion. Stability analysis using Bode plot

Control system components – error detectors – modulators and demodulators – Hydraulic controllers – Pneumatic controllers – PLC.

Module IV

Introduction to IoT, IoT Sensor, IoT Actuation, IoT Data Acquisition Systems, Analytics for IoT Data, IoT for Process Monitoring, IoT for Advanced Process Control, IoT System Engineering, IoT Project.

References:

1. Patranabis, D. Principles of industrial instrumentation. (Second edition). Tata McGraw-Hill Publishing Company Ltd, New Delhi. (1996*).*
2. Eckman, D. P. Industrial instrumentation. Wiley Eastern Ltd, New Delhi. (1990).
3. George Stephanopolous. Chemical process control: An introduction to theory and practice. Prentice Hall of India Pvt. Ltd. (1990).
4. Coughanowr, C.R. and Koppel, L.M. Process system analysis and control. McGraw Hill, New York. (1998)
5. Katsuhiko Ogata. Modern Control Engineering. Pearson Prentice Hall. (2006)
6. M Gopal. Control Systems *(*3rd Edition) Tata McGraw Hill. (2006).
7. Intelligent Process Monitoring with Industrial IoT" (2022) by Li Da Xu, Taylor & Francis
8. Model Predictive Control over IoT for Process Industries" (2024) by Raghunathan Rengaswamy, Cambridge University Press

23-206-0603 CHEMICAL PROCESS SAFETY

Course Outcomes

On completion of this course the student will be able to:

1. Differentiate inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.
2. Explain the safety aspects of chemical plant operation.
3. Describe the safety precautions to be taken in the storage and handling of gases
4. State the conditions that lead to reaction hazards and measures to prevent them.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2										1	2		
CO2	3	2	2										1	2		
CO3	3	2	2										1	2		
CO4	3	2	2										1	2		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Safety in the design of chemical process plants :-Design principles – Process design development –types of designs, feasibility survey, preliminary design, flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing – inherent safety – engineered safety - safety during startup and shutdown – safety checks in the design of the equipments – reactor safety - safety in erection and commissioning of chemical plants - nondestructive testing methods – pressure and leak testing – emergency safety devices – scrubbers and flares – new concepts in safety design and operation-Pressure vessel testing standards– Inspection techniques for boilers and reaction vessels.

Module II

Safety in the operation of chemical process plants: - Properties of chemicals – Material Safety Data Sheets – the various properties and formats used – methods available for property determination. Operational activities and hazards –standards operating procedures – safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems – effects of pressure, temperature, flow rate and humidity on operations – corrosion and control measures- condition monitoring - control valves – safety valves – pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

Module III

Safety in the storage and handling of chemicals and gases: -Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief – relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation – pipe line transport – safety in chemical laboratories. Safety provisions like level and flow indicators – alarms, trips – protection of stills, columns and towers from lightening – colour coding for pipe lines and cylinders.

Module IV

Chemical reaction hazards: Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self – heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening, Case studies. Stability and sensitivity tests, Classification of materials with explosive potential, Hazard prediction by thermodynamic calculations, Prevention and control of explosions and detonations – diluting a release, purging and inserting, venting, explosion relief, flame arrestors, explosion suppression, Classification of hazardous areas.

References:

1. S. Mannan, Chemical Process Safety: Storage and Transportation, 3rd edition, Butterworth-Heinemann, 2021
2. R.K. Singh, Safety in Process Plant Design,2nd edition, CRC Press, 2017
3. N.V. Krishnan, Safety in Chemical Process Industries, 1st edition, New Age International Publishers, 2018
4. Ralph King and Ron Hirst. King's safety in the process industries. Arnold, London. (1998).
5. Industrial Environment and its Evolution and Control, NIOSH publication. (1973).
6. National Safety Council. Accident prevention manual for industrial operations. Chicago.(1982).
7. Lewis, Richard. J., Sr. Sax's dangerous properties of materials. (Ninth edition). Van Nostrand Reinhold, New York. (1996).

23-206-0604 LIFE SAFETY IN BUILDING FIRE

On completion of this course the students will be able to:

1. Plan and design evacuation route and exits based on the concepts of human behaviour under emergency movement.
2. Explain the effect of heat and toxic gases from fire on human; interpret the mechanism of production of smoke due to fire, its harmful effect and movement within a building, and the control measures to be adopted in buildings.
3. Summarize the fire safety requirements for buildings of different occupancy as per the National Building Code of India and plan, design and distribute various fire safety measures required in buildings of different occupancy type.
4. Explain the method of carrying out fire investigation, arson identification, fire training, fire safety audit and fire risk assessment.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2										3		1	
CO2	3	3	2										3		1	
CO3	3	2	2										3		1	
CO4	3	2	1			2							3		1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Process of emergency evacuation- special features of personnel movement, Parameter characteristics of the movement of people; Evacuation exits and routes- stages of evacuation, importance of different stages of evacuation, planning and design of evacuation routes, passages, and exits; calculation of building evacuation time; Planning of seating arrangements in premises where large number of people gather.

Effect of heat exposure to human body, body burns; Toxicity of smoke- effect of harmful agents preventing escape and causing injury or death - CO, CO_2, HCN, SO_2, NH_3, Nitrogen oxide.

Module II

Production of smoke particles, constituents of smoke, quantity and rate of production of smoke, quality of smoke, smoke density, visibility in smoke, smoke movement in buildings; Smoke control in buildings-natural and mechanical ventilation; Design principles of smoke control using pressurization technique; Principles of smoke and explosion vent design; Introduction to zone modeling of compartment fires- pre-flashover and post-flashover fires. National Building Code (NBC) guidelines for general smoke control in buildings; and smoke, fire and explosion venting requirements in industrial buildings.

Module III

Fire prevention measures in buildings as per NBC- Classification of buildings based on occupancy and type of construction, Fire zone; General fire safety requirements applicable to all individual occupancies.

Life safety measures in buildings as per NBC- General exit requirements; Requirements for different types of exit access and exits-doorway, corridors and passageways, horizontal exits, internal

staircases, exit passageways, external staircases, ramps; Planning of location and calculation of capacity, number and width of exit as per NBC for different occupancy classification; requirements for compartmentation; requirements of fire detection and alarm system in different occupancies; , firefighting shaft, Fireman's lift.
Fire protection measures in buildings as per NBC- requirements for portable and fixed fire fighting installations in buildings of different occupancy.

Module IV
Fire safety requirements as per NBC for special occupancy types- Fire safety requirements applicable to all individual occupancies in addition to the general fire safety requirements; additional fire safety requirements for high rise buildings; Special fire safety requirements for Atriums, Commercial kitchens, and car parking facilities
Planning and installation of fire and life safety requirements in different groups of buildings as per relevant codes and standards -Hotel, Schools & Colleges, Hospitals, Theatres, Shopping malls, etc.; Fire protection in underground structures and in buildings under construction.
Fire training and education- fire drill, fire order, guidelines for fire drill and evacuation procedure for high rise buildings as per NBC; Arson- characteristics, method of controlling; Fire Investigation; Fire safety audits; Fire risk assessment.

References:

1. Roytman, M. Ya. Principles of fire safety standards for building construction. Amerind Publishing Co. Pvt. Ltd., New Delhi. (1975).
2. Butcher, E. G. and Parnell, A. C. Designing of fire safety. John Wiley and Sons Ltd., New York, U.S.A. (1983).
3. Jain, V.K. Fire safety in buildings (2^{nd} edn.). New Age International (P) Ltd., New Delhi. (2010).
4. Barendra Mohan Sen. Fire protection and prevention the essential handbook. UBS Publishers and Dist., New Delhi. (2013).
5. Dougal Drysdale. An Introduction to Fire Dynamics, (2^{nd}edn.), John Wiley & Sons Ltd., England. (1999)
6. Relevant Indian Standard Codes of Practice

23-206-0605 ENVIRONMENTAL ENGINEERING AND MANAGEMENT

Course Outcomes:

On completion of this course the student would be able to:

1. Summarize the most suitable technique for air pollution monitoring and control for a given application.
2. Recognise the type of unit operations and unit processes involved in wastewater treatment plants
3. Explain the techniques for the disposal and management of urban solid wastes and hazardous wastes
4. Exemplify the tools for environmental management in industries.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3		1		1							1	2	
CO2	3	3	3		1		1							1	2	
CO3	3	3	3		1		1							1	2	
CO4	3	3	3		1		1							1	2	

1-Slightly; 2-Moderately; 3-Substantially

Module 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 methods; Biological methods for VOC and odour control.

Module II

Physical, chemical and biological characteristic of waste water; Effects of pollutants on water quality and aquatic life; Physical unit operations in waste water treatment- flow equalization, sedimentation, and flotation; Chemical unit processes in waste water treatment- coagulation and flocculation, chemical precipitation and adsorption; Biological unit processes- kinetics of microbial growth, Aerobic treatment systems: working principle and design parameters of trickling filter, activated sludge process, and rotating biological contactor; Anaerobic treatment systems: mechanism of anaerobic process, low rate and high rate digesters, working principle and applications of anaerobic filters and UASB; Biological nitrification –denitrification; Characteristics and treatment methods for the waste water from fertilizer plants, petroleum refineries, pulp and paper mills and distilleries.

Module 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.

Module 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. The concept of industrial ecology.

References:

1. Rao, C.S. Environmental pollution control engineering. New Age International (P) Ltd Publishers, New Delhi. (2007).
2. Rao, M.N and Dutta, A.K. Wastewater treatment, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi. (1987).
3. Metcalf and Eddy Inc. Wastewater engineering: treatment and reuse. *(*Fourth edition*).* Tata McGraw-Hill Publishing Company Limited, New Delhi. (2003).
4. Canter, L.W. Environmental impact assessment. *(*Second Edition). Irwin / McGraw – Hill,New York. (1996).
5. David, H.F. Liu, I (Ed). Environmental engineer's handbook. *(*Second Edition). Lewis Publishers, New York. (1997).

23-206-0606 (IE) SAFETY IN PETROLEUM AND PETROCHEMICAL INDUSTRIES

Course Outcomes

On completion of this course the student would be able to:

1. Interpret the various processes employed in petroleum refining and petrochemical industries
2. Estimate the firewater requirement for a petroleum refinery and petroleum depots
3. Recognise the hazards involved in on-shore and off-shore drilling and state control measures
4. Describe the various sources of ignition in process industries and the fire prevention systems employed

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1											1	1		
CO2	3	3	2										3	3		
CO3	3	3	2										3	3		
CO4	3	3	2										3	3		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Simplified flow diagrams of a typical refinery – distillation unit, catalytic cracker, reformer, treating unit (hydro forming, gas purification, Sulphur recovery, lubricating oil unit) Simplified flow diagrams of Petrochemical Industry – steam cracking, butadiene extraction, ethane recovery, butyl rubber polymerization.

Module II

Potential fire hazards in petroleum and petrochemical industries (ignition by local sources, spark, flame, hot surface, ignition of oil mists and fumes.). Storage tank farms of petroleum and petrochemical industries – Identification of Hazards, Type of Tanks, Design, Layout, Fire prevention measures including lightning protection. Fire protection arrangements in large tank farms, Design concepts of various fixed fire protection systems like Foam- Water Systems, Halogen & DCP systems. Lock out procedures. Salient features of codes / standards: NFPA, API, OISD, PNGRB and SHELL.

Module III

Fire protection facilities in Oil Refineries, Depots & Terminals- Transportation of petroleum and petrochemical products (safety considerations, statutory considerations). Design and Construction requirements for cross country hydrocarbon pipelines. Liquefied Petroleum Gas (LPG) Bottling Plant Operations. Design Philosophies. Operating Practices- Safety and Fire Protection in bottling plants. Transportation of Bulk Petroleum Products. Storage and Handling of Bulk Liquefied Petroleum Gas.

Module IV

On- Shore and Off- shore drilling. Classification of wells. Drilling method. Rotary drilling. Drilling

equipment. Ground and offshore structures for drilling. Offshore platforms and drilling vessels. Drilling mud – functions, classification and properties. Blow-off, well kicks, Blow out preventer. Shallow gas. Directional drilling. Well killing procedure. Emergency shutdown, Methods of Rescue & Fire Fighting. Petroleum and Natural Gas (Safety in Offshore Operations) Rules, 2008.

References

1. Gopal Rao, M. and Sittig, M (Eds). Dryden's outlines of chemical technology for the 21st century. (third edition). Affiliated East West Press, New Delhi. (2010).
2. Sam Mannan (Editor). Lee's loss prevention in the process industries. (Fourth edition). Butterworth-Heinemann Ltd., UK. (2012).
3. Davorin Matanovic. NedilikaN Gaurina– Medjimurec. and Katarina Simon. (Editors). Risk analysis for prevention of hazardous situations in petroleum and natural gas engineering. Engineering Science Reference, Hershey PA. (2014).
4. Aven, T. and Vinnem, J.E. Risk management with applications from the offshore petroleum industry. Springer-Verlag, U.K. (2007).
5. Fire Protection Hand book NFPA.(2008).
6. OISD Standards published by Oil Industry Safety Directorate.

23-206-0607 FOOD AND BIOSAFETY

Course Outcomes:

On completion of this course the student will be able to:

1. Recognise the food additives and food contaminants and their chemical and toxicological properties
2. Recognise the effects of pests on food and the various methods for controlling them
3. Explain the national and international regulations for bio safety.
4. Interpret the environmental, social and ethical implications of biotech applications

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2										1	1		
CO2	3	2	2			1	1						1	1		
CO3	3	2	2			1	1						1	1		2
CO4	3	2	2			1	1						1	1		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Quality attributes of foods, size and shape, colour and gloss, texture – visual and objectively measurable attributes. Aroma of foods – Introductory ideas, formation and chemistry. Introduction to sensory evaluation of foods and beverages.

Food safety, food additives and food contaminants, their chemical, technological and toxicological aspects, Food laws – development and enforcement. Prevention of Food Adulteration Act and Food Regulations. ISO 9000 series and HACCP. Codex Alimentations protocols for export.

Module II

Principles of food commodity storage, Insect pests – their biology and food preference. Effects of pests on food commodities. Pesticide classification and chemistry. Pesticide formulations. Pesticide appliances. Insect growth regulators, bio pesticides and grain protectants. Fumigants, Sanitation in food processing / handling units. Ballooning techniques. Irradiation and other physical methods of control. Pesticide and health hazards. Safety devices, pesticide residues in foods, residue analysis and decontamination. Concept of organic foods.

Module III

The legal and socio-economic impacts of biotechnology – Public education of the processes of biotechnology involved in generating new forms of life for informed decision making – Biosafety regulation and national and international guidelines. r-DNA guidelines – Challenges for the Indian biotechnological research and industries – Ethical implications of biotechnological products and techniques.

Module IV

Experimental protocol approvals – Levels of containment – Environmental aspects of biotech applications – Use of genetically modified organisms and their resistance in environment – Special procedures for r-DNA based product production – Social and ethical implications of biological weapons – Good safety practices – GLP standards – Lab contaminants – PI, PII, PIII guidelines. Food Safety and Standard regulations.

References

1. Ronald H. Schmidt and Gary E. Rodrick. Food Safety Handbook. 1st edition, Wiley. (2002*).*
2. Norman G. Marriott and Robert B. Gravani. Principles of Food Sanitation. 5th edition. Springer. (2006).
3. Sateesh, M.K. Bioethics and Biosafety. I.K. International Pvt Ltd., New Delhi. (2008).
4. Thomas, J. A. and Fuchs, R.L. Biotechnology and Safety Assessment. (3rd Edition). Academic Press. (2002).
5. https://fssai.gov.in/

23-206-0608 FAULT DETECTION AND DIAGNOSIS

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize the different issues involved in FDD and applications.
2. Explain the design of structured residuals
3. Interpret design of directional structured residuals
4. Summarize advanced level issues and design involved in FDD

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2										1	1		
CO2	2	2	2	2									1	1		
CO3	2	2	2	2									1	1		
CO4	2	2	2	2									1	1		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Fault Detection and Diagnosis: Scope of FDD: - Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances- Different issues involved in FDD- Typical applications.

Analytical Redundancy Concepts: Introduction- Mathematical representation of Fault and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation.

Module II

Design of Structured Residuals: Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of Multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation.

Module III

Design of Directional structured Residuals: Introduction – Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation – Linearly dependent column.

Module IV

Advanced level issues and design involved in FDD: Introduction of Residual generation of parametric fault – Robustness Issues –Statistical Testing of Residual generators – Application of Neural and Fuzzy logic schemes in FDD – Case study.

References:

1. Fault Diagnosis and Fault-Tolerant Control and Guidance for Aerospace Vehicles: From Theory to Application" by Ali Zolghadri, David Henry, M. S. Boucher (2014, Springer)
2. Model-Based Fault Diagnosis in Rotor Systems with Application to Rolling Element Bearings" by Mohamed Haddar, Rafik Neji (2019, Springer)
3. Fault Diagnosis and Fault-Tolerant Control and Guidance for Aerospace Vehicles: From Theory to Application" by Ali Zolghadri, David Henry, M. S. Boucher (2014, Springer
4. Janos J. Gertler. Fault Detection and Diagnosis in engineering systems. (2nd Edition). Marcel Dekker. (1998).
5. Sachin. C. Patwardhan. Fault Detection and Diagnosis in Industrial Process – Lecture Notes, IIT Bombay. (2005).
6. Rami S. Mangoubi. Robust Estimation and Failure detection. Springer-Verlag, London. . (1998).

23-206-0609 EXPLOSIVE ENGINEERING AND SAFETY

Course Outcomes

On completion of this course the student will be able to:

1. Explain the chemistry of explosives and the mechanisms of burning
2. Describe the concepts of shock, detonation and initiation
3. Interpret scaling in design and analysis of explosive devices
4. Summarizetheimportanceofsafetyinexplosivesoperations,storageandtransportation

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2													
CO2	3	2	2										1	1	1	
CO3	3	2	2										1	1	1	
CO4	3	2	2										1	1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Chemistry of Explosives – Chemical reactions – Categories of explosives by chemical type – Use forms of Explosives, Propellants, and Pyrotechnics.

Mechanics of Burning–Burning model–Geometry shape of grains–Calculating the state of the gas–interior ballistics.

Module II

Sound, shock and Detonation–Sound waves–shock waves–Detonation waves Explosive output tests. Initiation and initiators–Initiation theory and criteria–Initiation sensitivity testing Nonelectric initiators–Hot-wire initiators–exploding bridge wire detonators–Slapper detonators.

Module III

Scaling in Design and Analysis – Geometric similarity – Accelerating metal with explosives –Shock waves in air – Shock waves in water – Craters from explosives – Conical – shaped chargers. Off-the-Shelf explosive Devices–Linear explosive products– Mechanical/ explosive devices.

Module IV

Classification, Transportation and Storage of Explosives–Explosives classification–Transportation of explosives– Storage of explosives.

Explosive Facilities and Explosives Operations – Explosive facilities – Explosive operations –Good work practices – Maintenance – Explosive waste – Spills and general cleaning – Explosive handling–Testing and firing of explosives – Licenses, permits and penalties.

References:

1. Chemistry of Explosives" by Jacqueline Akhavan (2009, Royal Society of Chemistry)
2. Explosive Effects and Applications" by Yahya Kheng (2002, Springer)
3. Exp Explosives and Blasting Technique" by D. V. F. Mallik (2005, Universities Press
4. Explosives Engineering" by Paul W. Cooper, Miltos H. V. Papalexandris (1996, Wiley)
5. Paul Cooper and Stanley R. Kurowski. Introduction to the Technology of Explosives. Wiley–VCH, NewYork.(1996)

23-206-0610 COMPUTER APPLICATIONS IN SAFETY AND FIRE ENGINEERING LABORATORY II

Course Outcomes:

On completion of this course the student will be able to:

1. Analyse data in safety and fire engineering using spread sheets and statistical software.
2. Estimate quantitative risk using software packages.
3. Recognize the use of different software in solving safety and fire engineering problems.
4. Construct fuzzy logic systems by defining appropriate membership functions and fuzzy inference system rules using modeling software. Assess systems performance for fire safety classification and prediction applications based on results.
5. Implement and compare artificial neural networks and other machine learning models for analysis of fire related parameters and events using learning software platforms and tools.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3		3				1	1			1		2	
CO2	3	2	3		3				1	1			1		2	
CO3	3	2	3		3				1	1			1		2	
CO4	3	3	3		3				1	1			1		2	
CO5	3	3	3		3				1	1			1		2	

1-Slightly; 2-Moderately; 3-Substantially

List of Experiments

1. Use of spread sheets/packages in computing and graphically representing data in safety and fire engineering.
2. Use of statistical software to Safety Engineering –Regression, ANOVA, Statistical tests of significance,
3. Application of consequence modelling software in quantitative risk assessment (QRA)
4. Construction and cut set Analysis of Fault tree using software.
5. Development of membership functions in fuzzy logic and design of fuzzy inference system (FIS) using software toolbox.
6. Prediction and classification models application using Artificial Neural Net (ANN) software toolbox.
7. Application of some Machine Learning Techniques to Fire and Safety engineering problems: Convolution Neural Networks (CNN), Recurrent Neural Networks (RNN) types- LSTM, Random Forests and Support Vector Machines (SVM).

23-206-0611 MACHINE SHOP

Course Outcomes

On completion of the course the student will be able to:

1. Describe the construction of different machine tools: lathe, milling m/c, drilling m/c, grinding m/c, slotting m/c, shaper.
2. Exemplify the various machining operations that can be performed in the above machine tools.
3. Classify the various work holding devices, cutting tools and measuring instruments employed for machining in the above machine tools and use
4. Determine the various cutting parameters for machining and execute them for machining different components.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2							3	1				1	2	
CO2	2	2							3	1				1	2	
CO3	2	2							3	1				1	2	
CO4	2	2							3	1				1	2	

1-Slightly; 2-Moderately; 3-Substantially

Details of Experiments:

Introduction to Lathe : Spindle drive-work holding devices –types of Lathe tools-tool holders-tool movement-selection of speeds. Feed and depth of cut-use of cutting coolants-Principle of thread cutting-V-threadandsquarethread-threadstandards-cuttingtooltypes-grindingoftools selection of cutting speeds.

Exercises : Exercises involving cylindrical turning, Taper, Turning, Facing, Shoulder turning and curve turning-thread cutting.

Introduction to machine tools like horizontal milling machines, vertical milling machines, slotting and shaping machines ,work holding devices- spindle drives-milling cutters-gear milling-surface slot milling-indexing head-simpleanddifferentialindexing-grindingwheel-specificationandselection-drilling and reaming-capstan and turret lathes-ideas of tool layout.

Exercise: Exercises on lathe-curve turning, multi start thread, drilling and boring, internal thread.

Exercises on milling machines-surface milling and slot and key way milling, straddle milling, machining of spur and helical gears.

Exercises on-Shaper and slotting- marching of plane and bevel surfaces-key way and slot machining, exercises on drilling and reaming, surface grinding and tool grinding.

References:

1. HMT. (1986). Production technology. Mc Graw Hill Education. (1986).
2. Neely. John E. Basic Machine Tool Operations(1st Edition) Prentice Hall. .(1999).
3. Burghardt, Axllered and Anderson. Machine tool operations Part1& Part2. 4th Edition Mc Graw-Hill Book Company.
4. Reddy, Venkart. Workshop Practice Manual, BSP Books.(2014).
5. GoyatS.P.Mechanical Engineering Workshop Practice Laboratory Manual-1, Abhishek Publications, Chandigarh

23-206-0701 HAZARD IDENTIFICATION AND RISK ASSESSMENT

Course outcomes

On completion of this course the student will be able to:

1. Apply suitable tools for the identification of hazards in a process industries
2. Estimate the consequences of fire, explosion and toxic gas release using suitable empirical models and compute the individual and societal risk involved in a process industry.
3. Perform Human error rate prediction in critical scenarios associated with industrial operations
4. Understand the Machine learning principles and apply in relevant domain of safety

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2											2	2	
CO2	2	2	2											3	2	
CO3	2	2	2											2	2	
CO4	1	1	1											1	3	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Hazard and risk, Types of hazards – fire, explosion and toxic gas release. Identification of hazards Inventory analysis, Preliminary hazard analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, The Mond Index, Hazard and Operability study (HAZOP), Fault tree analysis – logic symbols, minimal cut set, logic gates, fault tree quantification. Event tree analysis – notation, event tree construction, advantages and disadvantages of ETA. What If analysis, Failure mode and Effect Analysis (FMEA) – methodology, criticality analysis, corrective action and follow-up. Case studies.

Module II

Consequence modelling: Source models – discharge rate models, flash and evaporation dispersion models. Explosions and fires – vapour cloud explosions, flash fires, BLEVE and fire ball, confined explosions, pool fires, jet fires. Effect models –dose-response functions, probit functions, toxic gas effects, thermal effects, explosion effects – Software application for effect and damage calculations. Individual risk, societal risk, risk estimation

Module III

Presentation and perception of risk, Risk targets, tolerability and acceptability, risk perception, risk reduction methods. ALARP, Presentation of measures of risk – risk contour Software applications in risk analysis such as Aloha, Phast. Case studies – industries and industrial areas. Bow tie analysis, Dynamic Risk analysis.

Introduction to Machine Learning fundamentals: Concepts of machine learning. Empirical risk minimization, Maximum likelihood principles and maximum likelihood estimation. Machine learning and deep learning algorithms for consequence prediction.

Module IV

Applications of Machine learning in Process safety and Asset integrity Management. Machine

Leaning for process Fault detection and diagnosis. Intelligent method for chemical Emission source identification.
Introduction and case studies on Human reliability analysis (HRA): factors leading to human error, characteristics of HRA techniques, Various techniques used human error rate prediction, Technique for Human Error Rate Prediction (THERP).

References:

1. AIChE/CCPS. Guidelines for Hazard Evaluation Procedures. (3rd edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York. (2008).
2. AIChE/CCPS. Guidelines for Chemical Process Quantitative Risk Analysis.(Second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York. (2000).
3. Nicola Paltrinieri and Faisal Khan, Dynamic Risk analysis in Chemical and Petroleum Industries, ICheE (2017).
4. Qingsheng Wang and Changjie Cai, Machine Learning in Chemical safety and health: Fundamentals with applications, (First edition) Wiley (2023).
5. Sam Mannan (Editor). Lee's Loss Prevention in the Process Industries. (Fourth edition). Butterworth-Heinemann Ltd., UK. (2012).
6. Bob Skelton. Process safety analysis: An Introduction, Institution of Chemical Engineers. (1997).
7. ILO, Major hazard control a Practical manual. (1993).

23-206-0702 DISASTER MANAGEMENT

Course Outcomes

On completion of this course the student will be able to

1. Explain Emergencies and controls, with examples of industrial disasters and their consequences.
2. Describe the elements of emergency planning and preparedness.
3. Summarize the causes of natural disasters, mitigation of their effects, rescue, relief an rehabilitation.
4. Explain the disaster management mechanism and capacity building concepts

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1										2	2		
CO2	2	2	1										2	2		
CO3	2	2	1										2	2		
CO4	2	2	1										2	2		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Importance of disaster management– Types of emergencies – major industrial disasters – Causes and consequences of Flixborough, Seveso and Bhopal. Components of a major hazard control system – identification of major hazard control installations – purpose and procedures – safe operation of MH installations – mitigation– reporting. Implementation of major hazard control systems – experts – training – checklists – inspection – evaluation – information to the public – manpower requirements – Sources of information.

Module II

Emergency planning – on-site and off-site emergency plan – need of plan – possible approach – objectives of emergency plan. On-site emergency planning – formulation of the plan and emergency services – Identification of resources – actions and duties – emergency procedure – mock drills. Off-site emergency planning – objectives and elements of off-site plan – role of administrative machinery – role of major hazard works management – role of the local authority.

Requirements of emergency plan as per Indian legislations like Factories Act, Manufacture, Storage and Import of Hazardous Chemicals Rules, Chemical Accidents (Emergency planning, Preparedness and Response) Rules. Emergency planning and preparedness in international standards like ISO 14001, OHSAS 18001 and OSHA's Process Safety Management System,

Module III

Natural Hazards – potentially hazardous natural phenomena – earthquakes – landslides – flooding – cyclones – hazards in arid and semi-arid areas.

Understanding Disaster: Concept of Disaster – Different approaches- Concept of Risk – Levels of Disasters – Disaster Phenomena and Events (Global, national and regional). Hazards and Vulnerabilities: Natural and man-made hazards; response time, frequency and forewarning levels of different hazards – Characteristics and damage potential or natural hazards; hazard assessment – Dimensions of vulnerability factors; vulnerability assessment – Vulnerability and disaster risk – Vulnerabilities to flood and earthquake hazards.

Module IV

Disaster Management Mechanism: Concepts of risk management and crisis managements – Disaster Management Cycle – Response and Recovery – Development, Prevention, Mitigation and Preparedness – Planning for Relief.

Capacity Building: Capacity Building: Concept – Structural and Non-structural Measures Capacity Assessment; Strengthening Capacity for Reducing Risk– Legislative Support at the state and national levels

Planning for disaster management: Strategies for disaster management planning – Steps for formulating a disaster risk reduction plan – Disaster management Act and Policy in India – Organizational structure for disaster management in India. NDMA guidelines.

References:

1. ILO, Geneva. Major Hazard Control – a Practical Manual. (1988).
2. Mrinalini Pandey, Disaster Management, Wiley. (2014).
3. Manual on Disaster Management, National Disaster Management Agency, Govt. of India.
4. T. Bhattacharya. Disaster Science and Management, McGraw Hill Education (India) Pvt Ltd. (2015).
5. N. Pandharinath, CK Rajan Earth and Atmospheric Disasters Management, BS Publications. (2009).
6. National Disaster Management Plan, Ministry of Home affairs, Government of India (http://www.ndma.gov.in/images/policyplan/dmplan/draftndmp.pdf)
7. https://ndma.gov.in/

23-206-0703 SAFETY IN CONSTRUCTION

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize the safety issues at different stages of construction activity.
2. Interpret the safety requirements in various construction operations in framing guidelines to ensure safety at construction site.
3. Interpret the safety requirements in material handling, operation and handling of different tools and vehicles in framing guidelines to ensure safety at construction site.
4. Summarize the legal provisions with respect to the health and welfare of workers at construction site.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1											1	2		
CO2	2	1											1	2		
CO3	2	1											1	2		
CO4	2	1											1	2		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to construction industry and safety issues in construction – Human factors in construction safety management – Roles of various groups and stake-holders in ensuring safety in construction industry – Framing of contract conditions on safety and related matters – Ergonomic risks in construction.

Module II

Safety in the construction of various elements of buildings– Foundations-excavation, piling and other deep foundations; Wall construction; Roof construction; Erection of concrete framed structures; Erection of structural steel work; construction of Temporary Structures; Safety in various construction operation- General safety requirements at work place; Under-pinning & Shoring; Working at height-Use of Ladders and Scaffolds; Tunneling; Blasting; working in confined space; Under-water works; Safety in demolition of buildings; Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety.

Module III

Safety in storage, stacking and handling of common construction materials- Cement, Lime, Masonry units, floor, wall and roof tiles, Aggregates, Timber, steel, Doors, windows and ventilators, Glass sheets, Flammable materials; Safety in the use of construction equipments- hoists and lifts, lifting gears, wire ropes, chain and pulley blocks pneumatic and hydraulic tools, hand held power tools; Safety in the use of construction vehicles/machinery– Movement of people and vehicles, excavators, graders, dozers, mobile and tower cranes, concrete mixers

Different hazards at construction site and their control- Electrical hazard; Fire hazard; Chemical health hazard; Biological health hazard; Physical health hazard; Psychological health hazard.

Module IV

Requirements of habitat for construction workers- site selection, minimum facilities, sanitary facilities, drinking water and first aid facilities

Contract Labour (R&A) Act and Central Rules: Definitions, Registration of Establishments, Licensing of Contractors, Welfare and Health provisions in the Act and the Rules, Penalties, Rules regarding wages. Legal framework regarding construction safety suggested in place of BOCW act.

References:

1. Phil Hughes and Ed Ferret., Introduction to health and safety at work (2nd edn.), Butterworth-Heinemann, UK. (2007),
2. Helen Lingard and Steve Rowlinson., Occupational health and safety in construction project management, Spon Press, Taylor & Francis Group, London. (2005),
3. Vaid, K.N., Construction safety management. National Institute of Construction Management and Research, Mumbai. (1988).
4. Davies, V. J., and Tomasin, K., Construction safety handbook. Thomas Telford Publishing, London. (1996).
5. The Contract Labour (Regulation and Abolition) Central Rules (1971)
6. Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and Central Rules.
7. Relevant Indian standard codes of practice.

23-206-0704 (IE) HSE ASPECTS OF FERTILISER INDUSTRY

Course Outcomes

On completion of this course the student will be able to:

1. Identify engineering problems in fertilizer manufacturing.
2. Suggest measures for occupational health management in fertiliser industry
3. Identify hazards associated with the various activities in fertiliser manufacturing and suggest loss prevention and control measures
4. Summarise the environmental problems in fertiliser industry and identify measures for the prevention and control of these problems.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2										1	1		
CO2	3	2	2										2	2		
CO3	3	2	2										2	2		
CO4	3	2	2										2	2		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Fertiliser an overview, Types of Fertilisers: (Chemical, Organic &Biofertiliser), Nitrogenous fertilisers, Phosphatic & Potassic fertilisers, Complex fertilisers - Major Raw materials for fertiliser manufacture - Brief Manufacturing Processes for Major fertilisers: Urea, Ammonium Sulphate, DAP, SSP, Complex Fertilisers, Organic Fertiliser (Composting), Biofertiliser - Manufacturing process for major intermediates: Ammonia, Nitric Acid, Sulphuric acid, Phosphoric acid.

Module II

Occupational Health problems in fertiliser industries-Measures for preventing the occurrence of occupational health issues - Requirements of ISO 9000, 14000 and OHSAS1800 - Process hazard analysis and risk management - work controls through health protocols-effective occupational health management.

Module III

Safety in Fertiliser industry - Hazards associated with various fertiliser plant operations -Storage, handling and transport of raw materials and intermediates - Reaction Hazards –Measures for loss control in storage, handling and transport. International and Indian standards for the safe storage, handling, and transport of hazardous chemicals. Disaster preparedness and risk reduction in fertiliser industry. Behavioural safety through mind-set change. Management of hazards associated with highly hazardous chemicals-comprehensive management program that integrates technology, procedures and management practices- PSM assurance through asset integrity-Comprehensive "Management of Change" process-Contractor safety management

Module IV

Fertiliser industry - Environmental Challenges: Major Pollutants generated in fertiliser manufacturing processes Pollution Control measures in fertiliser industry. Pollution Prevention strategies in fertiliser industry. Environmental standards applicable to fertiliser industry. Phosphogypsum Challenge. Meeting the challenge of minimizing the pressures on natural

resources, reducing the environmental footprint across the value chain and innovating to meet demands for more environmentally sustainable solutions. Global emission legislation. Climate Change: GHG emissions & reducing the CO_2 footprint.

References:

1. Shishir Sinha, KK Pant and Shailendra Bajpai, Acquisition Ed. JN Govil. Fertilizer Technology I: Synthesis. Stadium Press LLC. 2015.
2. Shishir Sinha, K.K. Pant. Fertilizer Technology-II (Biofertilizers). Stadium Press LLC. 2015.
3. UN Industrial Development Organization, Int'l Fertilizer Development Center. Fertilizer Manual. Springer Science& Business Media, 1998.
4. B. K. Bhaskara Rao, R. K. Jain, Vineet Kumar. Safety in Chemical Plants/Industry and Its Management. Khanna Publishers. 2010

23-206-0705 TRANSPORTATION SYSTEMS AND SAFETY

Course Outcomes

On completion of this course the student will be able to:

1. Explain working of railways and safety aspects in railway operation
2. Recognize basic geometric design features of roads
3. Explain traffic characteristics and prevention of road accidents
4. Summarize the basic layout and facilities of docks and harbours

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2										2			
CO2	3	3	3										2			
CO3	3	3	3										3			
CO4	1	1	1										1			

1-Slightly; 2-Moderately; 3-Substantially

Module I

Railway Engineering: Permanent way. Curves, super-elevation, negative super-elevation, transition curve, grade compensation on curves. Railway operation & control – points and crossings, turn-out. Signaling and interlocking. Centralized traffic control. Railway accidents & safety. Rapid transit railways - types, merits & demerits.

Module II

Highway Engineering: Classification of highways and urban road patterns. Typical cross section of roads. Factors controlling the alignment of roads. Basic geometric design – stopping and overtaking sight distances.

Module III

Traffic Engineering: Traffic characteristics. Various traffic studies and their applications. Traffic signals. Carriage-way markings. Traffic islands. Highway intersections. Principles of highway lighting. Road Accidents – prevention, investigation and reduction.

Module IV

Harbour & Dock Engineering: Water transportation, classification of harbours, accessibility and size, ports, Indian ports. Layout of ports, breakwater, facilities (in brief) for docking, repair, approach, loading and unloading, storing and guiding.

References:

1. Rangwala, S. C. Railway Engineering. Charotar Book Distributors. (2012).
2. Chandra, S. and Agarwal, M. M. Railway Engineering. Oxford University Press. (2007).
3. Khanna, S. K. & Justo, C. E. G. Highway Engineering (9^{th} ed). Nem Chand & Brothers. (2001). (2004).
4. Kadiyali, L. R. Traffic Engineering and Transport Planning. Khanna Publishers, New Delhi.
5. Srinivasan, R. Harbour, Dock and Tunnel Engineering. Charotar Publishing House Pvt. Ltd. (2013).

23-206-0706 PRINCIPLES OF INDUSTRIAL MANAGEMENT

Course Outcomes:

On completion of this course the student will be able to:

1. State the concept of organization and management and define the functions of human resources, operations and project management.
2. Exemplify the different types of organization structures and also summarise the role of human resources, operations and project managers.
3. Determine appropriate organization structures for specific applications and also apply the different tools of human resources, operations and project management.
4. Outline the development of scientific management principles, differentiate the organisation structures and theories of motivation, leadership etc.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1										2	2		
CO2	2	1	1										2	2		
CO3	2	1	1										2	2		
CO4	2	1	1										2	2		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Organisation: Concept of organisation, characteristics of organisation, elements of organisation, organizational structure, organisation charts, Types of organisation- line & staff organisation, functional organisation, project organisation, matrix organization.

Management: Functions, Evolution of management theory, Principles of scientific management.

Module II

Personnel Management: Motivation theories, Leadership theories and models, Recruitment and training, labour turnover, operator training,

Wages and Incentives: feature of wages, time and piece rate, incentive plans, profit sharing. Job evaluation, Merit rating methods-factors of comparison and point rating-defects.

Industrial Relations: industrial disputes, collective bargaining, trade unions, workers' participation in management, labour welfare.

Module III

Production Management: Production System- Functions- Product Design Product Life Cycle. Demand forecasting for operations-components of demand-methods of prediction and forecasting-forecasting models – casual & time series PPC-Functions-Models.

Capacity Planning-Evaluating future capacity-capacity requirement –Aggregate Planning Inventory Control-Objectives-Costs-Models: Basic, Production , Shortage-ABC Analysis.

Module IV

Project Management: Project Appraisal Feasibility Analysis, Market feasibility, technical feasibility, financial feasibility, Economic feasibility, Financial and Economic appraisal of aproject, Social Cost-Benefit Analysis. Network Techniques, PERT, CPM, GANTT charts, GERT, Time cost trade off and crashing procedure.

References:

1. Kootnz, H Principles of Management. Tata McGraw Hill Education. (2004).
2. Buffa, E.S. Modern Production and Operations Management. (Eighth edition). John Wiley and Sons. (2007).
3. Prasanna Chandra. Projects: Planning, Analysis, Selection, Implementation & Review. (7thedn). Tata Mc Graw Hill, New Delhi. (2009).
4. Mart and Telsang., Industrial Engineering and Production management. (3rd edition). S. Chand & Co., New Delhi. .(2014)

23-206-0707 INDUSTRIAL ECOLOGY

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the concept of industrial ecology
2. Summarize the environmental interactions during product use
3. Interpret the methodology of LCA
4. Exemplify metabolic and resource analysis

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2										1		1	
CO2	2	2	2										1		1	
CO3	2	2	2										1		1	
CO4	2	2	2										1		1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Humanity and the Environment - The Industrial Ecology Concept - Technological Change and Evolving Risk.

The Relevance of Biological Ecology to Technology- The Status of Resources - Governments, Laws, and Economics

Module II

Industrial Product & Process Design and Operation - Choosing Materials - Designing for Energy Efficiency.

Product Delivery -Environmental Interactions During Product Use - Design for End of Life.

Module III

An Introduction to Life-Cycle Assessment - The LCA Impact and Interpretation Stages - Streamlining the LCA Process.

Using the Corporate Industrial Ecology Toolbox - Managing Industrial Ecology in the Corporation- Indicators and Metrics - Services Technology and Environment

Module IV

Industrial Ecosystems - Metabolic and Resource Analyses - Systems, Analysis, Models and Scenario Development.

Earth Systems Engineering and Management - The Future of Industrial Ecology.

References:

1. Graedel, T.E. and Allenby, B. R. Industrial Ecology. (2nd edition). Prentice-Hall. (2003).
2. Graedel, T.E. and Allenby, B. R. Industrial Ecology and Sustainable Engineering. Pearson. (2010).
3. Ashby, M.F. 2013. Materials and the Environment: Eco-Informed Material Choice. (2nd Edition) Amsterdam: Elsevier Publishers

23-206-0708 INDUSTRIAL PSYCHOLOGY

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize the nature, scope, and challenges of Industrial Psychology
2. Interpret the psychological factors that influence individual differences in behaviour at work
3. Explain the concepts of motivation and job satisfaction
4. Summarize information required to sustain employability

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1											1	1		
CO2	1	1											1	1		
CO3	1	1											1	1		
CO4	1	1											1	1		

1-Slightly; 2-Moderately; 3-Substantially

Module I

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

Module II

People at Work: Individual Differences: Personality, Intelligence, Emotional Intelligence, Creativity & Innovation, Perception & Attitudes. Motivation- N-Ach, Expectancy, Equity & Goal Setting Theories, Modern Approach to Motivation: Employee Predisposition, Expectations, Goals, & Incentives Job Satisfaction- Job Characteristic Theory (Diagnostic Model), Measuring Job Satisfaction Psychometric Testing at Work- Cognitive Abilities, Personality, Emotional Intelligence.

Module III

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

Module IV

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

References:

1. Schultz, D. & Schultz, S. E. Psychology and Work Today: An Introduction to Industrial and Organizational Psychology. 7th Edition. Pearson Education: New Delhi. (2013).
2. Aamodt, M.G. Industrial Psychology. Cengage Learning: Delhi. (2013).
3. Matthewman, L., Rose, A. & Hetherington, A. Work Psychology. Oxford University Press: India. (2009).
4. Landy, F. J. & Conte, J. M. Work in the 21st Century: An Introduction to Industrial and Organizational Psychology. 2nd Edition. Wiley India: New Delhi. (2010).
5. Schultz, D. & Schultz, S. E. Psychology and Work Today. Pearson Education: New Delhi. (2002).

23-206-0709 ENTREPRENEURSHIP AND SMALL BUSINESS ENTERPRIOSES

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize different types of entrepreneurial ventures
2. Interpret opportunity and risk analysis
3. Summarize the strategies for valuing their own company, and how venture capitalist and angel investors use valuations in negotiating milestones, influence and control
4. Determine correct marketing mix and how to position the company in the market by using analytical tools and explain how organizations operate and their process matrices.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2										1	1		
CO2	2	2	2										1	1		
CO3	2	2	2										1	1		
CO4	2	2	2										1	1		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Market Research: Introduction to Entrepreneurship, Profile of the Entrepreneur, Market Gap /Opportunity Analysis, Market Research Methods, Defining the Focal Market: Market Segmentation, Industry analysing – Research / Competitive Analysis.

Types of Companies and Organizations: Company/ Organization Types, Legal Aspects, Taxation, Government Liaison, Building the Team, Mergers and Acquisitions, import and export nuances.

Module II

Business Finance: Shares and Stakes, Valuation, Finance Creation (Investors / Financers), Revenue Plans and Projections, Financial Ratios, Business Lifecycle, Break Even, Balance Sheets, game theory.

Module III

Marketing: Marketing Basics, Marketing Strategy and Brand Positioning, Plans and Execution Techniques, Marketing Analytics, Online Marketing, Product Life Cycle.

Sales: Understanding Sales, Pitching Techniques, Sales strategies, Inside Sales v/s Outside Sales, RFP.

Module IV

Operations Management and HR: Operational Basics, Process Analysis, Productivity, Quality

Start-ups: Start-up Basics, Terms, Start-up Financing, Start-up Incubation, Getting Listed

References:

1. David Kidder. The Startup Playbook: Secrets of the Fastest-Growing Start-ups from their Founding Entrepreneurs
2. Ed Catmull. Creativity, Inc.: Overcoming the Unseen Forces That Stand in the Way of True Inspiration
3. Bhargava, S. Transformational leadership: Value based management for Indian Organizations (Ed.). New Delhi: Response-Sage. (2003).
4. Hisrich, R. D. & Peters, M. P. Entrepreneurship: Starting, developing, and managing a new enterprise (5th Ed.). New York: McGraw-Hill. (2001).
5. Verma, J. C., & Singh, G. Small business and industry: A handbook for entrepreneurs. New Delhi: Response-Sage. (2002).
6. Prasanna Chandra Financial Management: Theory and Practice, Tata McGraw Hills, 6th Edn. (2004).

23-206-0710 SCIENCE AND TECHNOLOGY OF NANOMATERIALS

Course Outcomes:

On completion of this course the student will be able to:

1. Explain methods of fabricating nanostructures.
2. Relate the unique properties of nonmaterial to the reduce dimensionality of the material.
3. Describe tools for properties of nanostructures.
4. Discuss applications of nonmaterial and implication of health and safety related to nano materials.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2										1	1	1	
CO2	3	2	2										1	1	1	
CO3	3	2	2										1	1	1	
CO4	3	2	2										1	1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction of nanomaterials and nanotechnologies, Features of nanostructures, Background of nanostructures, Techniques of synthesis of nanomaterials, Tools of the nanoscience, Applications of nanomaterials and technologies.

Bonding and structure of the nanomaterials, Predicting the Type of Bonding in a Substance crystal structure, Metallic nanoparticles, Surfaces of Materials, Nanoparticle Size and Properties.

Module II

Mechanical properties of materials, theories relevant to mechanical properties, techniques to study mechanical properties of nanomaterials, adhesion and friction, thermal properties of nanomaterials.

Module III

Electrical properties, Conductivity and Resistivity, Classification of Materials based on Conductivity, magnetic properties, electronic properties of materials, classification of magnetic phenomena.

Module IV

Nano thin films- Fabrication techniques; Tuning electrical, optical, magnetic, thermal and mechanical properties; Applications in microelectronics, sensors, flexible devices, optical coatings. Nanocomposites- Polymer, ceramic and metal matrix nanocomposites; Mechanical, thermal, catalytic, antibacterial enhancements; Applications in packaging, automotive, aerospace, biomedical sectors. New application of nanoparticles in different fields- Synthesis of nanoparticles, nanowires, quantum dots; Characterization methods; Plasmonics, meta-materials, labeling, delivery mechanisms; Case studies in nanomedicine, imaging, diagnostics, therapies

References:

1. Massimiliano Ventra, Stephane Evoy and James R. Heflin (Ed). Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology), Springer US. (2004).
2. Guozhong Cao and Ying Wang. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications (World Scientific Series in Nanoscience and Nanotechnology) (Second edition), World Scientific. (2011).
3. Malkiat S. Johal. Understanding Nanomaterials, CRC Press. (2018).
4. Martin, P. M. (Ed.). (2010). Handbook of deposition technologies for films and coatings: science, applications and technology. William Andrew.
5. Bawa, R., Bawa, S. R., & Mae, C. (2022). Nano structured Polymer Composites for Biomedical Applications. Academic Press.
6. Rawtani, D., & Agrawal, Y. K. (Eds.). (2018). Multifunctional polymer nano composites. CRC Press.
7. Sattler, K. D. (2010). Handbook of nanophysics: nanoparticles and quantum dots. CRC press.

23-206-0711 ENERGY MANAGEMENT AND CONSERVATION

Course Outcomes

On completion of this course the student will be able to:

1. Calculate the efficiency of various thermal utilities and design suitable energy monitoring system to analyze and optimize the energy consumption in an organization.
2. Design suitable systems for heat recovery and co-generation to improve thermal efficiency.
3. Relate energy audit methods learnt to identify the areas deserving tighter control to save energy expenditure.
4. Explain to the employees of the organization about the need and the methods of energy conservation

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2										1	1	1	
CO2	3	2	2										1	1	1	
CO3	3	2	2										1	1	1	
CO4	3	2	2										1	1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, Indian energy scenario, Sectoral energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, Energy security, energy conservation and its importance, energy strategy for the future, Energy Conservation Act 2001 and its features.

Basics of Energy its various forms and conservation: Electricity basics - Direct Current and Alternative Currents, electricity tariff, Thermal Basics-fuels, thermal energy contents of fuel, temperature and pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity and heat transfer.

Module II

Evaluation of thermal performance: calculation of heat loss - heat gain, estimation of annual heating & cooling loads, factors that influence thermal performance, analysis of existing buildings setting up an energy management programme and use management - electricity saving techniques

Energy Management & Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering

Module III

Energy Monitoring and Targeting: Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques - energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS)

Module IV

Energy Efficiency in Thermal Utilities and systems: Energy efficiency in thermal utilities like boilers, pumps and fans, heat exchangers, lighting system, Motors belts and drives, refrigeration system.

Heat Recovery and Co-generation: Heat recovery from ventilation, air co-generation of heat and electricity, heat recovery and bottoming cycles.

References

1. Kenny W.F. Energy Conservation in Process Industry, Academic Press. (2012).
2. Amlan Chakrabarti. Energy Engineering and Management, Prentice Hall India. (2011).
3. Smith C.B. and Parmenter K. Energy Management Principles (Second edition), Elsevier. (2015).
4. Handouts, Bureau of energy efficiency, New Delhi.
5. Turner W. C. and Steve Doty. Energy Management Hand Book (Sixth edition), The Fairmount Press Inc. (2007).

23-206-0712 CHEMICAL AND ENVIRONMENTAL ENGINEERING LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Determine the surface characteristics of solid particles
2. Determine the energy requirements for size reduction equipment
3. Calculate the area required for a continuous thickener
4. Compare the efficiency of different types of distillation
5. Determine the physical, chemical and biological characteristics of water and waste water

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2						1	1	1		2			
CO2	2	3	2						1	1	1		2			
CO3	2	3	2						1	1	1		2			
CO4	2	3	2						1	1	1		2			
CO5	2	3	2						1	1	1		2			

1-Slightly; 2-Moderately; 3-Substantially

List of Experiments:

1. Sieve Analysis – To analyse a given sample using a set of standard sieves and thus to determine the specific surface area, the volume surface mean diameter and the mass mean diameter by differential analysis and cumulative analysis.
2. Verification of the laws of crushing in a Ball mill and calculation of critical speed.
3. Study of the working of Plate and frame filter press.
4. Free settling – To find out the drag coefficient of a falling sphere in a fluid and verification of Stoke's law.
5. Sedimentation – To study batch sedimentation of slurry and to determine the area of the continuous thickener.
6. Heat transfer from steam to air – Determination of overall heat transfer coefficient.
7. Verification of material balance equation and Rayleigh's equation for simple distillation.
8. Steam distillation.
9. Leaching – leaching a mixture of salt and sand.
10. Study of the kinetics of chemical reaction in a batch reactor.
11. Adsorption isotherms.
12. Frequency response of first and second order systems.
13. Determination of pH, turbidity, total hardness, total solids and dissolved oxygen of water samples.
14. Determination of BOD and COD of waste water samples.
15. Jar test for determining the optimum coagulant dose for water treatment.

23-206-0713 FIRE ENGINEERING LABORATORY

Course Outcomes

On completion of this course the students will be able to:

1. Explain the method of determination of flash Point, fire point, pour point and effect of temperature on the viscosity of hydrocarbon liquids
2. Test the quality and hence the acceptability of DCP and AFFF in fighting fire.
3. Test the performance and hence the acceptability of portable fire extinguishers in fighting fire.
4. Explain the effect of temperature on building materials

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1							1	1			2	1		
CO2	1	1							1	1			2	1		
CO3	1	1							1	1			2	1		
CO4	1	1							1	1			2	1		

1-Slightly; 2-Moderately; 3-Substantially

List of Experiments:

1. Determination of flash Point, fire point and pour point of hydrocarbon liquids.
2. Study on the effect of temperature on the viscosity of hydrocarbon liquids using redwood viscometer.
3. Physical tests on Dry Chemical Powder as per relevant Indian standard specifications
4. Physical tests on AFFF as per relevant Indian standard specifications
5. Performance Tests on Portable Fire Extinguishers – AFFF, water and DCP type
6. Determination of flame spread rate of materials
7. Study on the effect of temperature on strength of building materials – Concrete and masonry units.
8. Rebound hammer test on concrete exposed to elevated temperatures.
9. Test of non-combustibility of Building Materials.

23-206-0714 ENTREPRENEURSHIP DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize importance of entrepreneurship opportunities available in the society
2. Summarize the challenges faced by the entrepreneur.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		1	1	1		1	1		2	2	2	2				
CO2			2	2		2	2	1	3	2	2	3				

1-Slightly; 2-Moderately; 3-Substantially

Exercises:

1. To study the types of entrepreneurs and the factors affecting entrepreneurial growth.
2. To make an assessment of the major motives influencing an entrepreneur
3. To make an overview of the various stress management techniques
4. How to identify and select a good business opportunity?
5. Preparation of a techno economic feasibility report for a given project
6. Preparation of a preliminary project report for a given project
7. To identify the various sources of finance and management of working capital
8. Carry out the costing and break-even analysis of a proposed project
9. Preparation of a PERT / CPM chart for the various activities involved in a project
10. To make a study of the various causes and consequences of sickness in small business and identify corrective measures.

References:

1. Roy Rajeev. Entrepreneurship. (Second edition). Oxford University Press, New Delhi. (2011).
2. Gordon, E. and Natarajan, K. Entrepreneurship development. (Fourth edition). Himalaya Publishing House, New Delhi. (2007).
3. Coulter Mary. Entrepreneurship in action. (Second edition). PHI Learning, New Delhi. (2008).
4. Jain, P.C. Handbook for new entrepreneur. Oxford University Press, New Delhi. (2003).
5. Khanka, S.S. Entrepreneurial development. (Fifth edition). S. Chand and Co, New Delhi. (2013).

Note: There will only be continuous evaluation for this course. The evaluation will be based on the performance of the student in the exercises given. A minimum of 50% marks is required for a pass.

23-206-0715 PROJECT PHASE – I

Course Outcomes:

On completion of the Project, the student will be able to:

1. Conduct a comprehensive literature survey to identify and analyze a specific problem statement in Safety and Fire Engineering.
2. Formulate a well-structured project proposal by synthesizing literature insights and engaging with industry experts and academic mentors.
3. Develop a detailed execution plan for Phase II, including resource allocation, timeline, and risk management strategies.
4. Demonstrate technical communication skills through a properly formatted thesis document and professional PowerPoint presentations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO2	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO3	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO4	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1

1–Slightly; 2–Moderately; 3-Substantially

This course aims to equip undergraduate students in Safety and Fire with the essential skills and knowledge required to successfully navigate through the initial phases of a project. Students will learn to conduct a comprehensive literature survey, identify and focus on a specific problem, formulate a project proposal, develop an execution plan for Phase II, and enhance their technical communication skills through thesis preparation and presentation techniques.

Topics to be covered

Introduction to Literature Survey and Problem Identification: Understanding the significance of literature survey in research, Techniques for conducting a thorough literature review, identifying relevant areas of study within Safety and Fire Engineering, and narrowing down to a specific problem statement.

Formulating a Project Proposal: Guidelines for structuring a project proposal, the importance of consultation with industry experts and academic mentors, incorporating insights from the literature survey into the proposal, developing a clear and concise problem statement and objectives

Project Execution Planning: Principles of project management and planning, developing a detailed execution plan for Phase II of the project, identifying resources, timeline, and milestones.

Enhancing Presentation Skills: Understanding the elements of effective presentations, Techniques for engaging and communicating technical information, Hands-on practice sessions on preparing and delivering technical presentations, and Peer feedback and improvement strategies.

Technical Communication: Thesis Preparation- Structure and format of a thesis document, Guidelines for writing thesis chapters- introduction, literature review, methodology, results, discussion, conclusion, Typesetting using Word or LaTeX for professional thesis formatting. Prepare PPTs for technical presentation.

Assessment:

Guidelines for evaluation:		Marks
1	Attendance and Regularity	10

2	Literature Survey and Problem Identification	10
3	Project Proposal	10
4	Project Execution Plan	10
5	Thesis and Presentation Skills Assessment	10
	Total	50

Note: Points (1)-(3) are to be evaluated by the respective project guides and project coordinator based on continuous evaluation. (4)-(5) to be evaluated by the final evaluation team comprising of 3 internal Examiners.

References:

1. Jesson, J., Matheson, L., and Lacey, F. M., Doing Your Literature Review: Traditional and Systematic Techniques, Sage Publications Ltd.
2. Machi, L. A., and McEvoy, B. T., The Literature Review: Six Steps to Success, Corwin Press.
3. Friedland, A., and Folt, C., Writing Successful Science Proposals, Yale University Press.
4. Duarte, N., Slide:ology: The Art and Science of Creating Great Presentations, O'Reilly Media.
5. Joyner, R. L., Rouse, W. A., and Glatthorn, A. A., Writing the Winning Thesis or Dissertation: A Step-by-Step Guide, Corwin Pres

23-206-0716 INTERNSHIP-III

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organisation of the information gained during the internship.
3. Conceive the pros and cons of working in a real time industrial environment and the wonderful results which could evolve through team-work.
4. Present and defend self-prepared and corrected internship report (with the help of internship guide/industry mentors) of a self-created work to a peer audience.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1							1	1	2	2	1	2	2	2	1	
CO2							1	1	2	2	1	2	2	2	1	
CO3							1	1	2	2	1	2	2	2	1	
CO4							1	1	2	2	1	2	2	2	1	

1-Slightly; 2-Moderately; 3-Substantially

Internship Guidelines

- An internship plan has to be prepared by the interns incorporating the job description/internship duties, name of the project, if any and internship schedule and expected learning outcomes in consultation with industry supervisor/mentor and institute faculty.
- A detailed training report in the prescribed format shall be submitted at the end of the internship.
- Training Certificate from the industry for the prescribed period shall be submitted at the end of the internship.
- The work shall be reviewed and evaluated periodically.
- Orientation of interns, resourse requirement of interns, monitoring of interns progress on a daily basis shall be carried out by the industry offering internship in addition to ensuring safety and welfare of the interns.

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review.

Guidelines for evaluation:

1.	Regularity and progress of work	10
2.	Work knowledge and Involvement	10
3.	Semester End presentation and oral examination	10
4.	Level of completion of internship	10
5.	Internship Report – Presentation style and content	10
Total		**50** Marks

23-206-0801 ADVANCED SAFETY ENGINEERING AND MANAGEMENT

Course Outcomes

On completion of this course the student will be able to:

1. Describe various methods to improve the safety and reliability of safety systems
2. Solve simple problems related to layer of protection analysis (LOPA) by adding additional independent protection layers (IPL).
3. Explain the concept of behaviour-based-safety and its implementation
4. Interpret the various threats and vulnerability in process industries in order to devise strategies to counter attacks.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1											2		
CO2	2	2	1											2		
CO3	2	2	1											2		
CO4	2	2	1	1										2		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Domino incident investigation – technique, logic diagram, input requirements, output, example. Unavailability analysis of protective systems – technique, logic diagram, input requirements, example. Reliability analysis of automatic control systems - PES safety system development logic diagram system analysis, calculation of fractional dead time, application, strengths and weaknesses. Introduction to MORT analysis, Sneak analysis.

Module II

Layer of Protection Analysis (LOPA) – Overview of relevant standards and guidelines, risk tolerance criteria. Preparation of LOPA – LOPA methodology, the LOPA team. Scenario development – components, inherently safe considerations. Initiating causes / effects – identification, estimation of frequencies. Independent protection layers – IPL criteria, allocation of IPL credit – basic process control systems, operator response, pressure relief device, safety instrumented system, safety instrumented function. Safety integrity level (SIL) assignment, Interpreting LOPA results, risk decisions and making recommendations.

Module III

Security for chemical process industries - Assessments and regulatory environment, methods for assessing security vulnerability, emerging security regulations, government development and industry activities that relate to security for process facilities. Strategies and counter measures – prevention of intentional releases and theft of chemical releases at process facilities.

Site security for process industries – Essential elements – threat analysis, security counter measures, mitigation and emergency response. Specific security measures – information security, cyber security, physical security, policies and procedures, training, mitigation and response, inherently safer processes. Case study.

Module IV

Behaviour- Based Safety (BBS) - Fundamentals of BBS, Observation and feedback process – people-based safety, BBS experience, Checklist for critical behaviour, Outcomes of BBS work, Implementation problems in BBS, Praxis six cell analysis model. Behaviorual safety Observation Process. Manger's role in developing BBS culture. BBS steering committee. Main steps of True BBS approach.

Safety Management Standards. Introduction to other international Safety Management Standards.

References:

1. Centre for Chemical Process Safety. AIChE: Guidelines for Chemical Process Quantitative Risk Analysis, Second edition. (2000).
2. Centre for Chemical Process Safety, AIChE: Layer of Protection Analysis – Simplified Process Risk Assessment. (2001).
3. ACC: Site Security Guidelines for the U.S Chemical Industry American Chemistry Council, Washington DC. (2001).
4. Sam Mannan (Editor). Lee's Loss Prevention in the Process Industries. (Fourth edition). Butterworth-Heinemann Ltd., UK. (2012).
5. Thomas R. Krause. The Behaviour – based safety process: Managing involvement for an injury-Free Culture. (Second edition). John Wiley & Sons. (1996).
6. Kaila, H.L. Behaviour based safety in organisations – a practical guide. IK International, New Delhi. (2010).

23-206-0802 FUNCTIONAL SAFETY ENGINEERING

Course Outcomes

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

1. Explain the basic terminology, standards, and methodologies related to functional safety.
2. Identify hazards and perform risk assessments for safety-critical systems.
3. Design safety systems including emergency shutdown systems and fire & gas detection systems.
4. Understand implementation and verification aspects such as SIL, PHHA, proof testing.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2										1	2	1	
CO2	2	2	3	1		1							1	2	1	
CO3	2	2	2	1		1							1	2	1	
CO4	2	2	2	1		1							1	2	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Functional Safety: Basic terminology and definitions (safety, functional safety, SIS etc.), relevance of functional safety, risk reduction approaches, overview of standards - IEC 61508, IEC 61511.

Risk management-Functional Safety Standards: Process Safety Sector& Machinery Sector-Functional Safety concepts-SIF History- SIF modes of operation: Demand Mode & Continuous Mode- Safety Instrument Function (SIF) allocation-Risk Reduction Factor (RRF)- Safety Integrity Level(SIL) -Hardware Fault Tolerance (HFT)

Module II

Failure modes-Random vs. systematic failures-SIL determination-ALARP-SemiQuantitative: Calibrated Risk graph &LOPA- Tolerable Risk-Target Mitigated Event Likelihood (TMEL)-Dependency-Systematic Integrity llocation of Safety Functions: Safety Integrity Levels (SILs), hardware fault tolerance, safe failure fraction, proof testing for reliability prediction and maintenance.

Module III

Safety Instrumented Systems: Components like sensors, logic solvers and final elements. Safety system architectures like 1oo1, 1oo2 based on reliability requirements.

SIS Design and Engineering: Safety concepts, layers of protection analysis, overview of emergency shutdown systems, trip logics, interlock design.

Module IV

Implementation and Verification: SIL verification methods, hardware checklist, software conformity assessment, system integration, factory acceptance testing, site acceptance testing.

Operations and Maintenance: Bypassing safety functions, human factors, condition monitoring, proof testing procedures, reporting.

References:

1. Safety Instrumented Systems Verification – Practical Probabilistic Calculations, William M. Goble, ISA, 2005.
2. Functional Safety: A Straightforward Guide to Applying IEC 61508 and Related Standards, Jack Whitham, Butterworth-Heinemann, 2016.
3. Safety Instrumented Systems: Design, Analysis, and Justification, Paul Gruhn, Harry L. Cheddie, ISA, 2006.
4. Practical Industrial Safety, Risk Assessment and Shutdown Systems for Industry, Dave Macdonald, Newnes, 2004.
5. Safety Critical Systems Handbook: A Straightforward Guide to Functional Safety, IEC 61508 (2010 Edition) and Related Standards, David J. Smith, Butterworth-Heinemann, 2010.
6. Verification Validation and Testing of Engineered Systems, Avner Engel, Wiley, 2010.
7. IEC 61511: Functional safety - Safety instrumented systems for the process industry sector:
    - Part 1: Framework, definitions, system, hardware and application programming requirements
    - Part 2: Guidelines for the application of IEC 61511-1
    - Part 3: Guidance for the determination of the required safety integrity levels
8. IEC 61508: Functional safety of electrical/electronic/programmable electronic safety-related systems
    - Part 1: General requirements
    - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
    - Part 3: Software requirements

23-206-0803 INCIDENT INVESTIGATION TECHNIQUES

Course Outcomes

After completing this course, students will be able to:

1. Understand the principles and philosophies of incident investigation process.
2. Apply investigation tools like change analysis, barrier analysis etc.
3. Develop effective recommendations based on root causes to prevent recurrence.
4. Analyze human and organizational factors that contribute to incidents.
5. Report and communicate investigation findings effectively to stakeholders.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2										1	1	1	
CO2	2	2	2	1									1	1	1	
CO3	2	2	2	1									1	1	1	
CO4	2	2	2	1									1	1	1	
CO5	2	2	2	1					1	1			1	1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Fundamentals of Incident Investigation: definition, uses and purpose of investigations, investigation process overview, attributes of good investigations. Principles and Guidelines: objectivity, open mindedness, confidentiality, safety perspectives

Module II

Data Collection and Analysis Tools: Change analysis, barrier analysis, Events and Causal Factors Analysis, Time lining of events, 5-why approach. Root Cause Analysis: Fault tree analysis, comparison of causal analysis tools.

Module III

Human Factors in Incidents: Understanding human error - slips, lapses, mistakes & violations; Performance influencing factors and PIF analysis Incident Dynamics and Trajectory Models: Swiss Cheese model, Sequential Timed Events Plotting (STEP)

Module IV

Incident Investigation Program: Developing an investigation protocol, investigation governance, building in-house capacity; Legal perspectives of investigations. Incident Data Analysis: Trends, reporting metrics, risk profiling based on investigations

References:

1. An Introduction to Accident Investigation, Jeff Treasury, EPICO Inc., 2006
2. Investigating Accidents and Incidents, Barry Whittingham, CRC Press 2004
3. Field Guide to Investigation of Accidents, Ted Ferdinand, Det Norske Veritas, 2005
4. Accident/Incident Prevention Techniques, Charles Sennewald, John Tsukayama, AFL Global Inc. 1999
5. Practical Risk Analysis for Safety Management, Donald Watson, NSC Press, 1996
6. Incident Investigation Techniques, Dick Cooper, Dekker, 2009

23-206-0804 SYSTEM SAFETY ENGINEERING

Course Outcome

After completing this course, students will be able to:

1. Explain fundamentals concepts and elements of system safety engineering.
2. Perform hazard analysis and risk assessment at the system level.
3. Implement techniques like FMECA, sneak analysis to identify and control system hazards.
4. Analyze reliability of systems using reliability block diagrams, FTA and reliability predictions.
5. Understand management of functional safety in the system lifecycle.
6. Understand safety verification and validation techniques and continual system safety improvement process.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2										1	1	1	
CO2	2	2	2	1									1	1	1	
CO3	2	2	2	1	1								1	1	1	
CO4	2	2	2	1	1								1	1	1	
CO5	2	2	2	1	1								1	1	1	
CO6	2	2	2	1												

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to System Safety: Basic concepts, definitions, elements and activities; Relation with occupational safety and process safety

Basics of Reliability Engineering: Reliability mathematics, definitions, series and parallel configurations; Failure rates

Module II

System Hazard Analysis: Preliminary Hazard Analysis (PHA), Subsystem Hazard Analysis (SSHA), System Hazard Analysis (SHA); Operating and environment hazard analysis.

Fault Tree Analysis: Gates, minimal cut sets and qualitative evaluation; Reliability evaluation

Module III

Failure Modes Effects and Criticality Analysis (FMECA): Procedure and applications; Comparison with FMEA.

Sneak Circuit Analysis: Overview, design criteria violations, techniques. Reliability Prediction: Parts count methodology, part stress methodology, comparison of prediction techniques

Module IV

Safety Design Concepts and Lifecycle Considerations: Fault tolerance, fail safe design, system safety efforts, Warning systems and safety devices, Human factors and safety, Software safety design.

Safety testing methods, Safety reviews and audits, Safety certification process, Configuration management and change control, Safety data analysis and metrics, Continual system safety improvement process, Safety management systems and culture.

References:

1. System Safety Engineering and Risk Assessment, Nicholas J. Bahr, CRC Press 1997
2. Safety and Reliability Methodology and Applications, Amalendu Mukherjee, Wiley, 2019
3. System Safety for the 21st Century, Harold Roland, Reliabilityweb.com, 2019
4. Integrating Software Assurance into the Software Development Life Cycle (SDLC), John Barnett and Dejan Jovanovic
5. Software Safety and Security: Tools for Analysis and Verification, Christoph Baumann, IGI Global, 2011
6. Functional Safety - An IEC 61508 SIL 3 Compliant Development Process, John Speller, Lulu Publishing, 2017

23-206-0805 HUMAN FACTORS ENGINEERING

Course Outcomes

On completion of this course the student will be able to:

1. Interpret human information processing ability and the parameters influencing it.
2. Exemplify information receptors and visual and auditory displays.
3. Calculate physical work load, and energy consumption for various activities.
4. Design workspace and arrange components in work space.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2			2				1			1	3	2	
CO2	3	3	2			2				1			1	3	2	
CO3	3	3	2			2				1			1	3	2	
CO4	3	3	2			2				1			1	3	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Human factors - objectives and approach. Systems thinking - human –machine systems, characteristics of systems, system reliability. Human beings as information processors- information theory, displaying information, coding of information, characteristics of good coding system, compatibility, types of compatibility, perception, memory, decision making, attention, age and information processing, mental workload and its measurement.

Module II

Process of seeing, visual capabilities, accommodation, visual acuity, contrast sensitivity, factors affecting visual acuity and contrast sensitivity, adaptation, colour discrimination, perception. Design of hard copy and VDT screens. Graphic representations – symbols, objectives and criteria for selection, perceptual principles of symbolic design. Codes – dimension, colour.

Design of dynamic information displays, uses of dynamic information, design of quantitative visual displays, design of qualitative visual displays, design of signal and warning lights, recommendations regarding signal and warning lights, representational displays, head-up displays.

Hearing, nature and measurement of sound, complex sound, anatomy of ear, conversion of sound waves to sensations, masking. Auditory displays, detection of signals, relative discrimination and absolute identification of auditory signals, sound localization, principles of auditory display, tactual displays, substitutes for hearing and seeing, olfactory senses and displays.

Module III

Physical work - muscle physiology, work physiology, measures of physiological strain, physical work load, work efficiency, energy consumption, grades of work, factors affecting energy consumption, controlling energy expenditure, strength and endurance, measurement of strength, factors affecting strength. Manual materials handling– lifting tasks, carrying tasks, pushing tasks, limits of MMH tasks, reducing risks of MMH overexertion.

Motor skills – biomechanics of human motion, types of body movements, range of movements, classes of motor movements, Speed of movements – reaction time, movement time, accuracy of movements.

Human control of systems – compatibility, spatial compatibility, movement compatibility. Supervisory control. Controls devices – functions of control, factors in control design. Principles of hand tool and device design.

Module IV

Workplace design – anthropometry, static dimensions, dynamic dimensions, principles in the application of anthropometric data. Work spaces - work-space envelopes for sitting and standing personnel, out-of-reach and clearance requirements. Design of work surfaces. Science of seating - general principles of seat design. VDT workstations.

Arrangement of components within a physical space – principles of arranging components, methodologies for arranging components, types and uses of various data, link diagrams, general location of various controls and displays within work space, specific arrangements of controls and displays within work space, spacing of control devices. General guidelines in designing individual workplaces.

Understanding MSDs (Musculoskeletal Disorders) Purpose and Objectives of RULA (Rapid Upper Limb Assessment) Purpose and Objectives of REBA(Rapid Entire Body Assessment).

References:

1. Sanders, M.M. and McCormick, E.J. Human factors in engineering & design, (Seventh edition). McGraw-Hill, New York. (1993).
2. Martin Helander. A guide to ergonomics of manufacturing. Tata McGraw Hill, New Delhi. (1996).
3. Bridger, R.S. Introduction to ergonomics. (Third edition). CRC Press. (2008).
4. Mark R. Lehto and James R. Buck. Introduction to human factors and ergonomics for engineers, Lawrence Erlbaum Associates, Taylor & Francis Group, New York.(2008).

23-206-0806 OPERATIONS RESEARCH

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize the importance and value of Operations Research and mathematical modeling to optimally solve a wide variety of engineering and management problems.
2. Formulate Linear Programming models and apply operations research techniques and algorithms to solve LP problems.
3. Understand the concept of duality and conduct post optimal analysis
4. Formulate transportation, assignment problems and drive their optimal solution.
5. Formulate Network models and apply operations research techniques and algorithms to Solve Network problems.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1												1
CO2	3	2	2	2												1
CO3	3	2	2	2												1
CO4	3	2	2	2												1
CO5	3	2	2	2												1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Operations Research: Introduction to OR models, Linear programming - Typical Applications of Linear programming problems, Problem formulation, Graphical and Algebraic method solutions of LPP, Simplex method for LPP. Big-M method, Two Phase simplex method, Degeneracy, Multiple solutions, Unbounded solutions, Infeasible solutions, Sensitivity Analysis: Graphical and algebraic approaches.

Module II

Duality and post-optimal analysis: Dual of an LP, Primal-Dual relationships, Economic interpretation of duality, Dual Simplex method, generalized simplex algorithm, post-optimal analysis, Changes affecting feasibility and changes affecting optimality.

Module III

Transportation model and its variants: Definition, non-traditional transportation models, Transportation algorithm: Determination of the starting solution and iteration computations, Simplex method explanation of method of multipliers, Assignment model: Hungarian method and its simplex explanation.

Module IV

Network models: Scope and definition, Minimal spanning tree algorithm, shortest route problem, maximum flow model, CPM and PERT: Network representation, Critical path computation, construction of the time schedule, LP formulation of CPM, PERT calculations.

References:

1. Hamdy A.Taha, “Operations Research, an introduction”, Eighth Edition, Prentice Hall of India, 2003.
2. Edgar T. F., Himmelblau D.M., Optimization of Chemical Processes, Mc Graw Hill.
3. Miller D.M. and Schmidt J. W., Industrial Engineering and Operations Research, John Wiley and Sons, Singapore, 1990.
4. Shennoy G.V. and Srivastava U.K., “Operation Research for Management”, Wiley Eastern, 1994.
5. Bazara M.J., Jarvis and Sherali H., “Linear Programming and Network Flows”, John Wiley, 1990.
6. Philip D.T. and Ravindran A., “Operations Research”, John Wiley, 1992.
7. Hillier and Liebermann, “Operations Research”, HoldenDay,1986

23-206-0807 ADVANCED FIRE DYNAMICS

Course Outcomes:

After completing this course, students will be able to:

1. Explain fire chemistry, fire plume theory, enclosure fires and combustion toxicity
2. Analyze pre- and post-flashover compartment fire dynamics mathematically
3. Apply empirical correlations for flame height, heat release rate to fire scenarios
4. Predict fire and smoke propagation using models like CFAST, B-RISK
5. Understand explosion phenomena like back draft, smoke explosions

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3									1	1	2	
CO2	3	3	3	3	2								1	1	2	
CO3	3	3	3	3	2								1	1	2	
CO4	3	2	2	3	2								1	1	2	
CO5	3	3	2	3	2								1	1	3	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Fundamentals of Fire Chemistry: Fire tetrahedron, stoichiometry, heat of combustion, ignition, flammability characteristics. Plume Theory: Physical dimensions, entrainment, hot gas layer descent. Pre-flashover Fire Dynamics: Ignition, flame spread theories, plume driven and ventilation-controlled fires. Post-flashover Compartment Fires: Flashover theories, fully developed fires, decay period, travelling fires.

Module II

Introduction to premixed and diffusion fames, thermo chemistry, conservation, equations: ignition and burning rate of liquid and solid fuels flame spread, fire plumes, flame radiation

Module III

Empirical Correlations: flame height, heat release rate, species yields; Applications to warehouse storages.

Fire Modelling: Zone modelling - CFAST, Field modelling - FDS; Model applications and limitations

Module IV

Explosion Phenomenon: Back drafts, smoke explosions; Factors affecting severity

Combustion Toxicity and Assessment: Major products, exposure limits, evaluation methods

References:

1. SFPE Handbook of Fire Protection Engineering, 5th Edition, NFPA 2016
2. Drysdale, D., An Introduction to Fire Dynamics, 3rd Edition, Wiley 2011
3. Fire Dynamics and Modelling - Small Enclosures, Sikanen and Hostikka, Wiley 2020
4. The SFPE Guide to Human Behavior in Fire, Kuligowski et al., SFPE 201
5. Fire Risk Management to Prevent Disaster, Giuseppe Bianchini, Springer 2020
6. Combustion Toxicology, Roger Barrow, Taylor & Francis 1992

23-206-0808 ENVIRONMENTAL RISK AND IMPACT ASSESSMENT

Course outcomes:

On completion of this course the student will be able to:

1. Illustrate the various steps in an environmental impact assessment.
2. Identify the professional standards, including ethical issues, involved in assessing environmental impacts.
3. Examine the legal requirements that affect the scope of an environmental impact assessment.
4. Explain the important role of stakeholders in EIA and the value of working with them.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2			1							1	2	
CO2	3	3	3			2	1	2						1	2	
CO3	3	3	3			2	2							1	2	1
CO4	3	3	3			2	2							1	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA – EIA process- screening –scoping - setting – analysis – mitigation. Cross sectoral issues andtermsofreferenceinEIA– PublicParticipationinEIA-EIAConsultantAccreditation.

Module II

Impact identification and prediction: Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction –Assessment of impacts –air–water–soil – noise–biological—Cumulative Impact Assessment.

Module III

Social impact assessment and EIA documentation: Social impact assessment -Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials. Preparation of EIS.

Module IV

EIA Report preparation- Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans–Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment-Case Studies.

References:

1. Canter,L.W.,EnvironmentalImpactAssessment,McGrawHill,NewYork.1996
2. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Inter science, New Jersey. 2003
3. World Bank–Source book on EIA
4. Marriot, Betty, Environmental Impact Assessment: a Practical Guide, McGraw Hill, 1997.

23-206-0809 INTRODUCTION TO OCCUPATIONAL EPIDEMIOLOGY

Course Outcomes

On completion of this course, students will be able to:

1. Understand basic concepts and principles of epidemiology
2. Apply epidemiologic methods to assess and control workplace hazards
3. Investigate disease outbreaks and analyze occupational exposure data
4. Develop preventive strategies for work-related injuries and illnesses
5. Understand legal and ethical issues related to occupational health
6. Evaluate epidemiologic literature on associations between work factors and health

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2														
CO2	3	3	3			1		1	1				1	2	3	
CO3	3	3	3			1		1	1				1	2	3	
CO4	3	3	3			1		1	1				1	2	3	
CO5	2	2				1		2	1				1	2	3	1
CO6	2	2				1		1	1				1	2	3	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Epidemiology, Definition and scope of epidemiology, Measures of morbidity and mortality, Descriptive epidemiology: person, place and time, Natural history of disease
Observational Epidemiology: Cross-sectional, case-control and cohort studies, Issues in the design and analysis of epidemiologic studies, Confounding, effect modification and bias

Module II

Environmental/Occupational Epidemiology, Unique issues in assessing environmental exposures, Exposure assessment techniques and biomarkers, Risk assessment frameworks and modeling

Module III

Occupational Health Policy and Practice: Occupational safety, health regulations and ethics, Role of occupational epidemiology in PSM, evaluating evidence and making decisions

Module IV

Infectious Diseases, Outbreaks and Surveillance, Transmission, detection and control of workplace outbreaks, Infectious disease epidemiology frameworks, Occupational health and safety surveillance.

References:

1. Friis RH and Sellers TA, “Epidemiology for Public Health Practice”, 5th Ed, Jones & Bartlett Learning, 2014.
2. Checkoway H, Pearce NE and Kriebel D, “Research Methods in Occupational Epidemiology”, 2nd Edition, Oxford University Press, 2004.
3. Levy BS, Wegman DH, Baron SL, Sokas RK, “Occupational and Environmental Health: Recognizing and Preventing Disease and Injury”, 7th Ed, Oxford University Press, 2011.
4. Baker D and Karalliede L, “Occupational Epidemiology”, CRC Press, 2020.
5. Rothman KJ, Greenland S and Lash TL, “Modern Epidemiology”, 3rd Edition, Lippincott Williams & Wilkins, 2008

23-206-0810 QUALITY MANAGEMENT SYSTEMS AND PROCEDURES

Course Outcomes

On completion of this course, students will be able to:

1. Manage and modify quality systems to maintain customer focus.
2. Develop the skills by applying tools of JIT
3. Build the knowledge of implementation of quality in organization
4. Address diverse needs of customers and suppliers.
5. Analyze the current trends in supply chain management

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3											1				
CO2	2	2							1			1				
CO3	2	2							1			1				
CO4	2	2							1			1				
CO5	3	2							1			1				

1-Slightly; 2-Moderately; 3-Substantially

Module I

Quality Management: Introduction to Quality management, principal of Quality Management, Philosophies of various Quality Gurus, Quality planning, leadership theories,
Theories of motivation (Maslow and Herzberg), Fred W. Riggs model of comparative management. Element of Just In Time manufacturing, Advantages, limitations, plant arrangement forflexible plan, planning, control, kanban, just in time logistics, Implementation issues in JIT manufacturing, Inventory management for JIT, Decision making in JIT, leadership theories.

Module II

Quality circle, Human dimension in TOM, Quality Management Tools like Brainstorming, Histogram, check sheet, pareto diagram, Ishikawa Diagram, control chart, scatter diagram, Affinity diagram. Tree diagram, Five S theory. Quality certification, ISO 9000, TPM, Definition and distinctive feature of TPM, Four developmental Stages of TPM Relationship. between TPM. Tero technology and logistics, Maximization equipment effectiveness organization for TPM implementation, communication and control.

Module III

Customers and suppliers-Define internal and external customers, identify their expectations and determine their satisfaction levels, define internal and external suppliers and key elements of relations with them, Customer satisfaction and loyalty, Basic customer service principles, Multiple and diverse customer management.

Module IV

Quality principles for products and processes-Identify basic quality principles related to products (such as features, fitness-for-use, freedom from defects, etc.) and processes (such as monitoring, measuring, continuous improvement, etc.). Quality standards, requirements, and specifications Supply Chain Management Supplier Selection Supplier communications, Supplier Performance, Supplier Improvement, Supplier Certification, Partnerships, and Alliances, Supplier Logistics

References:

1. D. C. Montgomery, Introduction to Statistical Quality Control, John Wiley & Sons,
2. Mitra A., Fundamentals of Quality Control and Improvement, PHI
3. J Evans and W Linsay. The Management and Control of Quality, Thomson.
4. Besterfield, D H et al., Total Quality Management, Pearson Education.
5. D. C.Montgomery, Design and Analysis of Experiments, John Wiley & Sons
6. D. C. Montgomery and GC Runger, Applied Statistics and Probability for Engineers, John Wiley & Sons

23-206-0811 APPLICATIONS OF IOT AND AI IN SAFETY ENGINEERING

Course Outcomes

On completion of this course, students will be able to:

1. Understand the concepts of IoT and its underlying architecture.
2. Apply IoT concepts to real world issues.
3. Understand the Machine learning principles and Artificial Intelligence.
4. Describe important search techniques and their suitable problem domains.
5. Apply the concepts of ML in relevant domain of safety and asset integrity.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3								1	1	1	
CO2	3	3	3	2	3								1	1	1	
CO3	3	3	3	2	3								1	1	1	
CO4	3	3	3	2	3								1	1	1	
CO5	2	2	2	2	2								1	1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Internet of Things Definition Evolution, IoT Architectures, Resource Management, IoT Data Management and Analytics, Communication Protocols, Internet of Things Applications, Security, Privacy, Standardization and Regulatory Limitations.

Module II

Introduction to machine learning, concepts of Machine learning, deterministic setting, stochastic setting, estimation and approximation, empirical risk minimization, general loss functions, maximum likelihood principle, maximum likelihood estimation

Module III

Introduction to Artificial intelligence, Reasoning under uncertainty: Non-Monotonic reasoning – support lists and dependency directed backtracking - Statistical reasoning: Bayes theorem. Bayesian networks. Fuzzy Logic, Semantic Nets, Frames, Neural networks and deep learning, Convolutional neural network.

Module IV

AI-driven solutions for risk assessment, accident prevention, and emergency response. machine learning algorithms for predictive analytics, computer vision for monitoring and detection, and natural language processing for safety communication. AI in industries such as manufacturing, transportation, healthcare, and smart infrastructure.

Fundamental concepts of robotic safety standards, risk assessment methodologies, integration of safety features in robotic systems. challenges and solutions related to human-robot interaction, safety protocols, and emergency response mechanisms.

References:

1. Rajkumar Buyya, Amir Vahid Dastjerdi., Internet of Things, Principles and Paradigms, Morgan Kaufmann.,2016.
2. Zhou, H., The Internet of Things in the Cloud: A Middleware Perspective. CRC Press.,2012.
3. Bahga, A., &Madisetti, V., Internet of things: A hands on approach. VPT., 2014.
4. Elaine Rich and Kevin Knight, Artificial Intelligence, Tata McGraw-Hill, Third Edition, ISBN: 13:978-0-07-008770-5, 2010.
5. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice Hall India Ltd., 2009, ISBN: 81-203-0777-1
6. Stuart Russell and Peter Norvig, Artificial Intelligence – A Modern Approach. 3rd Edition, Prentice Hall, 2009.
7. Qingsheng Wang and Changjie Cai, Machine Learning in Chemical safety and health: Fundamentals with applications, (First edition) Wiley (2023).

23-206-0812 RELIABILITY ENGINEERING

Course Outcomes:

On completion of this course the student will be able to:

1. Recall probability fundamentals and describe different hazard models, simple and complex systems and tools for assessing reliability.
2. Define probability rules & theorems and exemplify standard distribution functions and simple & complex systems and reliability assessing techniques.
3. Compare different hazard models, systems and compute the reliability of complex systems using different tools.
4. Determine reliability, MTTF, MTBF from failure data, implement methods for reliability improvement and differentiate the reliability assessing techniques.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1										1	1	
CO2	3	2	2	1										1	1	
CO3	3	2	2	1										1	1	
CO4	3	2	2	1										1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Reliability: Definition; Probability Concept; Addition of Probabilities; Complimentary Events; Kolmogorov Axioms.

Failure Data Analysis: Introduction, Mean Failure Rate, Mean Time to Failure(MTTF), Mean Time between Failures(MTBF), Graphical Plots, MTTF in terms of Failure Density, MTTF in Integral Form.

Module II

Hazard Models: Introduction, Constant Hazard; Linearly Increasing Hazard, The Weibull Model, Density Function and Distribution Function, Reliability Analysis, Important Distributions and their Choice, Standard Deviation and Variance.

Conditional Probability: Introduction, Multiplication Rule, Independent Events, Vern Diagram, Hazard Rate as conditional probability, Bayes Theorem.

Module III

System Reliability: Series .Parallel and Mixed Configurations, Complex Systems, Logic Diagrams, Markov Models. Reliability Improvement & Repairable Systems: Redundancy ,Element, Unit and standby Redundancy, Optimization; Reliability – cost trade-off, Introduction to Repairable Systems, Instantaneous Repair Rate, MTTR, Reliability and Availability Functions, Important Applications.

Module IV

Fault-Tree Analysis and Other Techniques: Fault-tree Construction, Calculation of Reliability, Tie-set and Minimal Tie-set.

Maintainability and Availability: Introduction, Maintenance Planning, Reliability and Maintainability trade – off.

References:

1. Srinath L.S. Reliability Engineering, Affiliated East-West Press, New Delhi. (2005),
2. Govil A.K. Reliability Engineering, Tata Mc-GrawHill, New Delhi. (1983).
3. Rao S.S. Reliability Engineering, Pearson Education. (2014),
4. Balagurusamy L. Reliability Engineering, Tata Mc-GrawHill, New Delhi. (2002),
5. Kapur K.C and Lamberson L.R., Reliability in Engineering Design, Wiley Publications. (2009).

23-206-0813 NON-DESTRUCTIVE TESTING METHODS

Course Outcomes:

On completion of this course the student will be able to:

1. Classify various nondestructive testing methods.
2. Monitor different metals and alloys by visual inspection method.
3. Explain non-destructive tests like: Liquid penetrant test, Magnetic particle test, Ultrasonic test, X-ray and Gamma ray radiography, Leak Test, and Eddy current test.
4. Detect defects by using relevant NDT methods.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2													
CO2	3	2	2	2										1		
CO3	3	2	2													
CO4	3	2	2	2										1		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction: Fundamentals of introduction to destructive and non-destructive testing. Scope and limitations of NDT, Visual examination methods, Different visual examination aids.

Dye penetrant Testing/ liquid penetrant testing: Principle, procedure, characteristics of penetrant, types of penetrants, penetrant testing materials, fluorescent penetrant testing method– sensitivity, application and limitations

Module II

Magnetic Particle Testing: Important terminologies related to magnetic properties of material, principle, magnetizing technique, procedure, equipment, fluorescent magnetic particle testing method, sensitivity, application and limitations. Ultrasonic Testing: Basic principles of sound propagation, types of sound waves, Principle of UT, methods of UT, their advantages and limitations, Piezoelectric Material, Various types of transducers/probe, Calibration methods, use of standard blocks, technique for normal beam inspection, flaw characterization technique, defects in welded products by UT, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, advantage, limitations acoustic emission testing – principles of AET and techniques.

Module III

Radiographic testing: X-ray and Gamma-Ray radiography, Their principles, methods of generation, Industrial radiography techniques, inspection techniques, applications, limitations, Types of films, screens and penetrometers. Interpretation of radiographs, Safety in industrial radiography.

Module IV

Leak and pressure testing: Definition of leak and types, Principle, Various methods of pressure and leak testing, Application and limitation Eddy current testing: Principle, instrument, techniques, sensitivity, application, limitation. Thermal methods of NDT.

References:

1. Baldev Raj, T. Jayakumar & M. Thavasimuthu. Practical Non-destructive Testing, Norosa Publishing House, New Delhi.
2. Dr. C.G. Krishnadas Nair (Ed). Treaties on Non-destructive testing, Vol. 1, 2 & 3 Edited by, NDT Centre, HAL, Bangalore
3. Warren J. McGonnagle. Non-destructive testing, Gordon Breach Science Publishers Ltd.
4. Krautkramer J. and Herbert Krautkramer, Ultrasonic Testing of Materials, Narosa Publishing House, New Delhi.
5. Hatmshaw R, Non-destructive testing, Leszek Filipezynski, Zdzislaw Pawlowski &Jerzywehr. Ultrasonic Methods of Testing Materials, , Butterworths, London

23-206-0814 AUTOMOBILE ENGINEERING AND SAFETY

Course Outcomes:

On completion of this course the student will be able to:

1. Acquire knowledge of automobile engines, fuels systems.
2. Acquire Knowledge of electrical systems -ignition, lighting, horn, wipers, HVAC and concerned CMV rules.
3. Understand transmission systems-clutch, gearbox, steering, and differential. Chassis-springs, axles and brakes and corresponding CMV rules.
4. Understand lubricating systems and cooling systems and corresponding CMV rules for safety devices.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2														
CO2	3	2														
CO3	2	2														
CO4	2	2														

1-Slightly; 2-Moderately; 3-Substantially

Module I

Types of automobiles. Limiting Dimensions as per Central Motor Vehicles Rules. Engines— Classification, Construction, Materials of engine components. Prototype Testing as per Central Motor Vehicles Rules.

Fuel System— Fuel tank, Fuel filter, Types of Fuel system. Carburettor— Simple and Modern, Fuel injection System. Emission Standards as per CMV Rules.

Module II

Electrical System —Storage Battery Operations and Maintenance. Ignition System—Coil and Magneto Ignition System. Starting System, Lighting System, Horn System — Wind Shield Wiper Motors, Fans, Heaters, Traficators. Automobile air conditioning. Central Motor Vehicles Rules regarding Lighting, Windshields, Wipers.

Module III

Transmission System—Clutches—operation and fault finding of clutches, Fluid Flywheel, Gear Box-types, Steering Systems, Chassis Springs, and Suspension. Differential, Dead and Liv eaxles, Rims, Tyreetc.Brakes— Types, construction and fault finding.CMV Rules—Brakes, Steering & Tyre.

Module IV

Lubrication Systems — Types, Components, Lubricating oil, Cooling system — Details of components, Study of Systems, Types. Miscellaneous —Special gadgets and accessories for fire fighting vehicles. Automobile accidents. CMV Rules regarding Safety devices for drivers, passengers.

References:

1. G.B.S Narang, Autombobile Engineering, Khanna Publishers, Delhi
2. Kripal Singh, Automobile Engineering Vol I & II. Standard Publishers
3. Joseph Heitner Automotive Mechanics-Principles & Practices, CBS Publisher-Delhi
4. P L Kohli, Automotive Electrical Equipments, McGraw Hill Education, New Delhi

23-206-0815 SAFETY, FIRE AND ENVIRONMENTAL MANAGEMENT

Course Outcomes:

On completion of this course, students will be able to:

1. Understand the principles of fire science, combustion and fire dynamics
2. Identify and analyze fire and explosion hazards in the process industries
3. Design safety systems for fire prevention, protection, control and mitigation
4. Conduct fire risk assessments and develop emergency response plans
5. Apply environmental management principles for sustainability
6. Develop systems for monitoring, reporting and compliance

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1									2	1	1	
CO2	3	3	2	2		1							1	2	2	
CO3	3	3	3	2		1							2	2	2	
CO4	3	3	3	3		1							1	1	2	
CO5	3	3	3	2		1	1						1	1	2	1
CO6	3	3	3	3		1	1						1	1	2	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Fire Science and Fire Dynamics: Chemistry and physics of fire, Combustion processes, fire development, Enclosure fires, common equipment fires.

Module II

Fire Protection and Prevention: Active and passive fire protection systems, Detection and alarm systems, emergency isolation, Safe layout, building design, fireproofing Industrial Fire Risk Assessment: Fire load density, ventilation factor calculations. Dow and NFPA fire and explosion indexing, Hazardous area classification.

Module III

Emergency Response Management: Firefighting systems, drills, training ERP development, mock drills, auditing Human behaviour issues, evacuation.

Module IV

Environmental Management: Air, water pollution control technologies Monitoring, impact assessment, Regulatory compliance, ISO 14001

References:

1. Cox, Angus N., “Basic Principles of Combustion”, Academic Press, 2016.
2. NFPA Handbooks. National Fire Protection Association (NFPA).
3. PS Krishnan, “Fundamentals of Fire and Explosion”, EOLSS Publications, 2009.
4. Charles Jennings, Building Energy Management Systems, McGraw Hill, 2011.
5. Cheremisinoff, Nicholas P. “Handbook of Water and Wastewater Treatment Technologies”, Butterworth-Heinemann, 2001.
6. ISO 14001:2015. Environmental Management Systems.

23-200-0816 HISTORY AND PHILOSOPHY OF SCIENCE

Course Outcomes:

On completion of this course the student will be able to:

1. Summarize the central questions and debates facing philosophers of science today,
2. Compare and contrast the predominant philosophical positions on such questions and debates,
3. Explain the importance of such issues by appeal to specific episodes from the history of scientific thought,
4. Exercise an improved ability to think philosophically about today's scientific research and findings.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1					1		1				1				
CO2	1					1		1				1				
CO3	1					1		1				1				
CO4	1					1		1				1				

Module I

The Inductive Method of Francis Bacon - The "Corpuscular" Philosophy(Robert Boyle - The New Star (Tycho Brahe) - The Motion of the Earth (Nicholas Copernicus) - Tradition and Experience (Galileo Galilei) - The Copernican View Vindicated - A Man Ahead of His Time -Johannes Kepler - On Arguments About a Moving Earth (Johannes Kepler). The Explanatory Scope of the Evolutionary Hypothesis (Charles Darwin) - Rationalism and Scientific Method (René Descartes) - Rules for the Discovery of Scientific Truth (René Descartes).

Module II

Catastrophist Geology (Georges Cuvier) - Successful Hypotheses and High Probability (Christiaan Huygens) - Determinism, Ignorance, and Probability (Pierre-Simon Laplace) - The Nature of Scientific Explanation (Antoine Lavoisier) - Space, Time, and Symmetry (Gottfried Wilhelm Leibniz) - The Principle of Least Action (Gottfried Wilhelm Leibniz) - Inductive Methodology (Isaac Newton). Space, Time, and the Elements of Physics (Isaac Newton) - On the Method of Theoretical Physics (Albert Einstein).

Module III

Against Crucial Experiments (Pierre Duhem) - On Observation (N. R. Hanson) - Scientific Explanation(Carl Hempel) - Hypotheses, Data, and Crucial Experiments (John Herschel) - The Nature of Cause and Effect (David Hume) - Human Knowledge: Its Scope and Limits (John Locke) - The Role of Hypotheses in Physical Theor (Henri Poincaré) - Dissolving the Problem of Induction (Peter Strawson) - Against Pure Empiricism (William Whewell) – Science and Non-Science: The Demarcation Problem (Popper, Kuhn, Lakatos, Thagard, Ruse, Laudan).

Module IV

The nature of science and technology in India, Roots of science and technology in India, Science and society, Scientists and society, Science and Faith and the rise of applied sciences.

Science and Technological Developments in Major Areas in India -

Space – Objectives of space programs, Geostationary Satellite Services – INSAT system and INSAT services remote sensing applications, Launch Vehicle Technology

Ocean Development – Objectives of ocean development, Biological and mineral resources, Marine research and capacity building. Defence Research – Spin-off technologies for civilian use
Biotechnology – Applications of biotechnology in medicine, Biocatalysts, Agriculture, Food, Fuel and Fodder, Development of biosensors and animal husbandry.
Energy – Research and development in conservation of energy, India's nuclear energy program, technology spin-offs.

References:

1. Timothy McGrew, Marc Alspector-Kelly, and Fritz Allhoff (eds.) Philosophy of Science: An Historical Anthology, Wiley - Blackwell. (2009).
2. Thomas S. Kuhn The Structure of Scientific Revolutions, 3rd ed. University of Chicago Press, Chicago. (1996).
3. Menon R.V.G. An Introduction to the History and Philosophy of Science, Pearson. (2010),
4. Menon R.V.G. Technology and Society, Pearson. (2011).

23-200-0817 CONSTITUTIONAL LAW*

Course Outcomes

On completion of this course the student will be able to:

1. Configure the preamble and fundamental rights.
2. Actuate the governance and functioning of constitutional functionaries.
3. Describe the functions of legislative bodies.
4. Decipher the judiciary system and its role in governance.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1						3	2	2								2
CO2						3	2	2								2
CO3						2	2	2								2
CO4						2	2	2								2

1-Slightly; 2-Moderately; 3-Substantially

Module I: Introduction

Constitution Law – Constitutional Assembly Debates – Constitution of India – Basic Features of Indian Constitution –Preamble – Structure and Content of Indian Constitution

Module II: Fundamental Rights

Rights–Fundamental Rights–Definition of State–Fundamental Rights under Indian Constitution– Right to Equality–Untouchability–Title–Right to Life Cultural and Educational Rights of Minorities-Enforcement of Fundamental Rights

Module III: Directive Principles of State Policy & Fundamental Duties

DPSP's – Relationship between DPSP and Fundamental Rights – Conversion of DPSP into Fundamental Rights –Role of Judiciary –Judicial Activism– PIL-Fundamental Duties

Module IV: Constitutional Organs

Legislative Organs – Parliament – Lok Sabha, Rajya Sabha - State Legislatures – Executive Organs - President, Vice President, Council of Ministers - Judicial Organs – Supreme Court and High Courts – Other Constitutional Bodies – Election Commission - Comptroller and Auditor General of India, etc.

References:

1. Durga Das Basu, Introduction to the Constitution of India, 24thEdition.Prentice–Hall of India Pvt. Ltd. New Delhi, 2019.
2. D.C. Gupta, Indian Government and Politics, 8thEdition.VikasPublishingHouse,2018.
3. H.M. Sreevai, Constitutional Law of India, 4th edition in 3volumes. Universal Law Publication,2015.

23-206-0818 SEMINAR

Course Outcomes:
On completion of this course, the student will be able to:

1. Identify and familiarize with some of the good publications and journals in their field of study.
2. Acquaint oneself with the preparation of independent reports, name them based on a central theme and write abstracts, main body, conclusions and references identifying their intended meaning and style.
3. Understand effective use of tools of presentation, generate confidence in presenting a report before an, audience and improve their skills in the same.
4. Develop skills like time management, leadership quality and rapport with an audienc

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO2	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO3	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO4	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1

1-Slightly; 2-Moderately; 3-Substantially

Students shall individually prepare and submit a seminar report on a topic of current relevance related to the field of Safety and Fire Engineering. The reference shall include standard journals, conference proceedings, reputed magazines and textbooks and technical reports. The references shall be incorporated in the report following International standards reflecting the state-of-the-art in the topic selected. Each student shall present a seminar for about 30 minutes duration on the selected topic. The report and presentation shall be evaluated by a team of internal experts comprising of 3 teachers based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the seminar report.

23-206-0819 PROJECT PHASE-II

Course Outcomes:
On completion of this course, the student will be able to:

1. Realize various steps involved in conducting a project work, like literature survey, the methodology adopted – field study/survey/experiments / numerical work, analysis of the data to arrive at final results and conclusions, etc.
2. Initiate a habit of proper report writing with all of its major components, proper style of writing and preparation of distinct abstract and carved-out conclusions.
3. Conceive the pros and cons of working in a team and the wonderful results which could evolve through teamwork.
4. Present and defend a self-prepared and corrected report (with the help of a project guide) of a self-created work to a peer audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO2	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO3	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO4	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1

1-Slightly; 2-Moderately; 3-Substantially

Each batch of students shall develop the project designed during the VII semester. The implementation phase shall proceed as follows:

1. A detailed project report in the prescribed format shall be submitted at the end of the semester. All test results and relevant design and engineering documentation shall be included in the report.
2. The work shall be reviewed and evaluated periodically A committee consisting of the Project Coordinator (appointed by the Head of the Department / Division), project guide and at least one senior faculty member will carry out the assessment based on at least one interim review and a final review just before the submission of the project report.

The final evaluation of the project shall include the following.
1. Presentation of the work
2. Oral examination
3. Demonstration of the project against design specifications
4. Quality and content of the project report.

Guidelines for evaluation		Marks
1.	Regularity and progress of work	20
2.	Work knowledge and Involvement	50
3.	Semester End presentation and oral examination	50
4.	Level of completion and demonstration of Functionality / Specifications	50
5.	Project Report – Presentation style and content	30
	Total	200

Note: Points (1) and (2) are to be evaluated by the respective project guide and the project coordinator based on continuous evaluation. (3)- (5) to be evaluated by the final evaluation team.

23-206-0820 COMPREHENSIVE VIVA VOCE

Course Outcomes:
On completion of this course, the student will be able to:

1. Refresh all the subjects covered during the programme
2. Gain good knowledge of theory and practice
3. Develop oral communication skills and a positive attitude
4. Face technical interviews with confidence

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO2	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO3	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO4	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1

1-Slightly; 2-Moderately; 3-Substantially

Each student is required to appear for a comprehensive viva voce examination at the end of the complete coursework. The examination panel shall comprise of a minimum of one internal examiner and one external examiner, both appointed by the University. The examiners shall evaluate the students in terms of their conceptual grasp of the entire course of study and practical/analysis skills in the field.

23-200-0817 INTERNSHIP - IV

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organisation of the information gained during the internship.

3. Conceive the pros and cons of working in a real time industrial environment and the wonderful results which could evolve through team-work.

4. Present and defend self-prepared and corrected internship report (with the help of internship guide/industry mentors) of a self-created work to a peer audience.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO2	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO3	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1
CO4	3	3	3	3	1	-	-	1	-	1	-	1	3	3	1

1–Slightly; 2–Moderately; 3-Substantially

Internship Guidelines

1. An internship plan has to be prepared by the interns incorporating the job description/internship duties, name of the project, if any and internship schedule and expected learning outcomes in consultation with industry supervisor/mentor and institute faculty.
2. A detailed training report in the prescribed format shall be submitted at the end of the internship.
3. Training Certificate from the industry for the prescribed period shall be submitted at the end of the internship.
4. The work shall be reviewed and evaluated periodically.
5. Orientation of interns, resource requirement of interns, monitoring of interns progress on a daily basis shall be carried out by the industry offering internship in addition to ensuring safety and welfare of the interns.

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review.

	Guidelines for evaluation	Marks
1.	Regularity and progress of work	20
2.	Work knowledge and Involvement	50
3.	Semester End presentation and oral examination	50
4.	Level of completion and demonstration of Functionality / Specifications	50
5.	Project Report – Presentation style and content	30
	Total	200

Minor in Safety and Fire Engineering

23-206-0310 PRINCIPLES OF HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT

Course Outcomes:

1. Explain the concepts of safety and safety equipments and safety organisation
2. Analyse job safety, accidents through accident models, estimate costs
3. Estimate safety performance using various indices
4. Produce different types of permits, reports, and compliance check lists.
5. Understand the key concepts and principles of environmental management.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	1	1										2	2	
CO2	1	3	1	1										2	2	1
CO3	3	2	1	1										2	2	1
CO4	3	3	1	1					1	1				3	3	1
CO5	3	3	1	1			3							1	1	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction-Safety -Goals of safety engineering. Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. History of safety movement. Theories of accident causation. Safety organization-objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages

Module II

Accident prevention Methods-Engineering, Education and Enforcement. Safety Education & Training -Importance, Various training methods, Effectiveness of training. Behaviour-based safety. Communication-purpose, barrier to communication. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system-objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.

Module III

Personal protection in the work environment, Types of PPEs, Personal protective equipment-respiratory and non respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Cost of accidents-Computation of Costs-Utility of Cost data. Plant safety inspection, types, inspection procedure. Safety sampling techniques. Job safety analysis (JSA), Safety surveys, and Safety audits, Safety tour Safety Inventory Technique.

Module IV

Introduction to Environmental management. Life cycle assessment and carbon footprint, Air water and soil pollution from industries. Environmental monitoring and impact prediction. Overview of ISO 14001 based environmental management system. Developing EMS policy, Implementation and operation: structure, role, responsibilities, Communication, control and documenting. Moniting measurement auditing and reviews.

References:

1. Krishnan, N.V. Safety management in Industry. Jaico Publishing House, New Delhi. (1997).
2. John V. Grimaldi and Rollin H.Simonds Safety management. All India Traveller Book Seller, Delhi. (1989).
3. Ronald P. Blake Industrial safety. Prentice Hall, New Delhi. (1973).
4. Ted S. Ferry Modern accident investigation and analysis, John Wiley & Sons, Hoboken, N.J. (1988).
5. Alan Waring Safety management system. Chapman & Hall, England. (1996).
6. National Safety Council Accident prevention manual for industrial operations. Chicago. (1982).
7. Joseph C Palmbers, “Environmental Management and systems”, Auerbach publications 2017.

23-206-410 FIRE PROTECTION ENGINEERING

Course outcomes:

1. Explain the basic concepts of combustion chemistry.
2. Explain the working principle of different types of fire detectors and alarm system and plan and distribute them in buildings of different occupancy.
3. Interpret the concept of fire extinguishment with different extinguishers and the working principle and operation of portable fire extinguishers.
4. Plan and Design fixed sprinkler system in buildings of different occupancy as per Indian Standard Specifications
5. Interpret appropriate standards for the design and installation of fixed CO2 and DCP systems as per Indian Standard Specifications.
6. Interpret appropriate standards for the design and installation of fixed foam systems and apply these concepts in the design of typical hydrocarbon storage tank protection.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	3	3									1	2	2	
CO2	3	3	3	2		1						1	3	2	1	
CO3	3	3	3	2		1						1	3	2	1	
CO4	3	3	3	2		1						1	3	2	1	
CO5	3	3	3	2		1						1	3	2	1	
CO6	3	3	2	2		1							3			

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction - temperature, heat, specific heat, flash point, fire point, ignition, combustion; Ignition - pilot ignition, spontaneous ignition, ignition sources; Types of combustion - rapid, spontaneous, physical explosion, chemical explosion; smoldering combustion; Product of combustion harmful to human - flame, heat, smoke, fire gases; Special kinds of combustion - flash fire, pool fire, deep seated fire, spillover, boil over, dust explosion, BLEVE, VCE; Classification of fire based on material.

Flames – Diffusion flames - Zones of combustion, characteristics of diffusion flames, laminar and turbulent jet flames, flame from natural fires, buoyant plume; Premixed flames-structure, limits of flammability, burning velocity, explosion and expansion ratios, deflagration and detonation, characteristics of premixed flame; Spread of flames over liquid and solid surfaces.

Module II

Fire detection- Need and importance of automatic fire detection system, principle of detection, classification of detectors; Heat detectors – fixed temperature, rate of rise , thermistor rate of rise and rate compensated type detectors; Smoke detectors- optical and ionization type, photo electric light scattering and light obstruction type detectors; Flame detectors – infra red and ultra violet detectors; Flammable gas detection- Pellistor and laser detectors; Testing of fire detection devices as per

relevant Indian standards specifications; Performance characteristics of detectors; Lag time associated with fire detection; Comparison of detectors.

Fire alarm system- classification of alarm system as per National Building Code (NBC); Manually operated system; Automatic alarm system-various components and modules; Addressable and non-addressable system;

Module III

Principles of Fire Extinguishments-extinction of premixed flames, diffusion flames and burning metals; fire triangle, fire tetrahedron.Basic concept of firefighting with water, carbon dioxide, powders, foams, inert gases, halons; Need for halon replacement and halon substitutes; Extinguishant performance- flame extinguishing concentration, inerting concentration, fire trials.

Description, working principle, method of operation of different types of portable fire extinguishers-water type, foam type, dry powder type, CO_2 type, vapourizing liquid type; Selection and distribution of portable extinguishers for different occupancy classification as per NBC; Care, inspection, and maintenance of portable extinguishers as per relevant BIS. Performance and effectiveness of portable fire extinguishers.

Module IV

Automatic water sprinkler system- requirement and source of water supply, automatic pumps; Sprinkler heads-Quartzoid type, fusible link type, modern types; mounting and protection of sprinkler heads; Sprinkler pipe works-standard and staggered lay out, hangers; Control valves for wet and dry installations; deluge valve; Drenchers; High velocity and medium velocity spray system. Performance and effectiveness of water sprinkler system.
Design of water sprinkler and spray system as per relevant BIS-application to illustrative problems.

References:

1. Ron Hirst. Underdowns practical fire precautions, Gower publishing company Ltd., England. (1989).
2. Jain V.K. Fire safety in buildings (2nd edn.). New Age International (P) Ltd., New Delhi. (2010).
3. Barendra Mohan Sen. Fire protection and prevention the essential handbook, UBS publishers and Dist., New Delhi. (2013).
4. Rasbash D., Ramachandran G., Kandola B., Watts, J., Law M., Evaluation o Fire Safety, John Wiley & Sons Ltd., England, (2004).
5. Robert M Gagnon, Design of water based fire protection system, (2ndedn.), Delmar Cegage Learning, USA. (2013).
6. Robert M Gagnon, Design of special hazard and fire alarm systems, (2ndedn.), Thomson Delmar Learning, New York. (2008)
7. Relevant Indian Standard Code of Practices(BIS)

23-206-0612 MINIPROJECT

Course Outcomes:

On completion of this course the student will be able to:

1. Students will apply core principles of safety to devise innovative solutions for interdisciplinary challenges.
2. Students will collaborate effectively in diverse teams, integrating ideas from various disciplines to develop a comprehensive project that enhances and ensures safety principles.
3. Students will demonstrate proficiency in project management, including planning, resource allocation, and adaptability, ensuring the successful execution of the mini-project within specified constraints.
4. Students will communicate technical concepts clearly through well-structured reports and presentations, demonstrating their ability to convey the significance, methodology, and andresults of the mini-project.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1			1		1		1	3	3	1	1
CO2	3	3	3	3	1			1		1		1	3	3	1	
CO3	3	3	3	3	1			1		1		1	3	3	1	
CO4	3	3	3	3	1			1		1		1	3	3	1	1

1-Slightly;**2**-Moderately;**3**-Substantially

Assessment Method

1. Project Proposal Evaluation (10%) : Relevance to Safety and Fire Engineering; Clear problem definition and objectives.
2. Mid term Progress Report (20%) : Demonstration of progress compared to the initial proposal ; Identification and resolution of challenges.
3. Prototype/Model (if applicable)(20%):Functional and realistic representation of the design ; Application of Safety and Fire Engineering applications
4. Technical Report (30%) : Clarity of writing and presentation ; Depth o f Information Technology concept applied ; Quality of analysis and results.
5. Final Presentation(20%) : Ability to communicate technical details to a diverse audience ; Handling of questions and feedback.

Honours in Safety and Fire Engineering

23-206-0412 SOFT COMPUTING TECHNIQUES FOR SAFETY ENGINEERING

Course Outcomes:
On completion of this course the student will be able to:

1. Explain the basic principles of soft computing approaches
2. Implement fuzzy logic, neural networks and evolutionary computing algorithms
3. Apply soft computing techniques for modeling and optimization
4. Design fuzzy and neuro-fuzzy systems for real-world applications
5. Compare strengths and weaknesses of soft computing methods

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2										3	
CO2	3	3	3	3	2								1		3	
CO3	3	3	3	2	2								1		3	
CO4	3	2	2	2	2								1		3	
CO5	3	3	3	3	2								1		3	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Soft Computing, Key techniques: Fuzzy logic, neural networks, evolutionary algorithms, Applications and case studies,

Module II

Basic concepts of neural networks, human brain, model of an artificial neuron, neural network architectures. Characteristics of neural Networks, Learning methods Perception models and back propagation algorithms, Self-organizing maps and radial basis functions

.

Module III

Fuzzy Logic Systems, crisp sets and crisp logic, Foundations of fuzzy set theory, representations of fuzzy sets, extension principles, types of operations, fuzzy complements, Fuzzy arithmetic, fuzzy relationships, possibility theory, fuzzy logic, fuzzy quantifiers, fuzzy inference fuzzy rule-based systems, defuzzification, Design of membership functions

Module IV

Introduction to Particle swarm optimization, Ant colony optimization, Integrating fuzzy logic, neural networks and optimization, Design of adaptive neuro-fuzzy systems. Genetic algorithm based back propagation networks, Fuzzy back propagation networks.

References:

1. Zadeh, L.A., “Fuzzy Sets”, Information and Control, Vol. 8, pp. 338-353, 1965.
2. Zurada, J.M., “Introduction to artificial neural systems”, St. Paul: West publishing company, 1992.
3. Goldberg, D. E., “Genetic Algorithms in Search, Optimization and Machine Learning”, Addison-Wesley 1989.
4. Negnevitsky, M., “Artificial Intelligence: A Guide to Intelligent Systems”, Pearson Education, 2005.
5. Pedrycz W., “Fuzzy Modelling: Paradigms and Practice”, Kluwer Academic Publishers, 1996.
6. Passino K.M. and Yurkovich S., “Fuzzy Control”, Addison-Wesley, 1998.
7. George J Klir and Bo Yuan “Fuzzy sets and Fuzzy logic theory and applications” Prentice Hall of India pvt. Ltd. 2008.
8. S. Raja sekaharan, G A. Vijyayalakshmi, Neural networks, fuzzy systems and evolutionary algorithms: Synthesis and applications PHI learning Pvt. Ltd. Delhi 2018.

23-206-0514 RESEARCH METHODOLOGY AND IPR

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the research processes (reading evaluating and developing)
2. Illustrate literature reviews using print and online databases
3. Summarize the important issues and trends within the actual research area
4. Prepare a scientific article within a limited topic but with a quality such that the article could be accepted for presentation in a reputed conference or workshop
5. Create a scientifically sound and reasonable and well documented plan for a Master's project of excellent quality.
6. Compare and contrast the different forms of intellectual property protection in terms of the irkey differences and similarities.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2		2				2	2	3	3	2				
CO2	1	2		2				2	2	3	3	2				
CO3	1	2		2				2	2	3	3	2				
CO4	1	2		2				2		3	3	2				
CO5	1	2		2				2		3	3	2				
CO6	1	2		2				2		3	3	2				

1-Slightly; 2-Moderately; 3-Substantially

Module I

Research process – types of research – problem definition –research problem formulation – identification of variables – constructing hypothesis –literature review – sampling – writing a research proposal – review of basic statistical measures – probability distributions.

Module II

Research design – exploratory research – descriptive and diagnostic research – hypothesis testing – experimental designs – displaying data – writing a research report and presentation – research ethics – plagiarism

Module III

Intellectual property – property theories –InternationalConventionsandTreaties– InternationalOrganisations–objects and functions of WIPO ,WTO -TRIPS. Patents–procedure– provisionaland complete specifications–publication– opposition– examination– grant–term – rights – patent of addition – limitations – transfer – compulsory licensing –infringement– remedies– agents.

ModuleIV

Copyright – where subsists – rights conferred – term of CR – performer's rights –assignment and licensing – compulsory licensing – infringement and remedies –moralrights–internationalCR– CROffice,Board,Societies.Trademarks–essentialsofgoodtrademarks–registration–term– collectivemarks–certification trademarks – assignment and transfer – infringement and remedies –

Appellate Board – passing off. Semiconductor Integrated Circuit Layout Designs –registration – infringement – Appellate Board. Designs – author and proprietor – registration of design – grounds for refusal of registration – term of copyright in registered designs– piracy–remedies. geographical indication (GI) of goods.

References:

1. Ganesan, R, Research Methodology for Engineers, MJP Publishers, 2020.
2. RanjitKumar,ResearchMethodology:A Step-by-Step Guideforbeginners,2nd Edition, Pearson, 2005.
3. Panneerselvam, R, Research Methodology, Eastern Economy Edition, 2004.
4. StuartMelvilleandWayneGoddard,ResearchMethodology:AnintroductionforScience&Engineering students, Juta & Co Ltd, 1996.
5. GopalakrishnanNS,andAgithaTG,Principles ofIntellectualProperty,2nd Edition,Eastern Book Company,2015.
6. BansalKandBansalP,FundamentalsofIntellectualPropertyforEngineers,BSPublications, 2013.
7. DeborahE.Bouchoux,IntellectualProperty:TheLawofTrademarks,Copyrights,Patents,andTradeSecrets,4th Edition, Cengage Learning, 2012.
8. Markel,Mike,TechnicalCommunication.11th Edition,MacMillan,2015
9. Bare Acts on different forms of intellectual properties.

23-206-0717 DYNAMIC RISK ANALYSIS

Course Outcomes:

On completion of this course the student will be able to:

1. Explain concepts and frameworks for dynamic risk analysis
2. Perform hazard identification through dynamic simulations
3. Model escalation scenarios using event trees and Bayesian networks
4. Estimate time-dependent consequences using modeling tools
5. Calculate dynamic risk profiles and tolerability limits
6. Develop risk reduction strategies using dynamic approaches

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2								2	2	2	
CO2	3	3	3	3	2								2	2	2	
CO3	3	3	3	3	2								2	2	2	
CO4	3	3	3	3	2								2	2	2	
CO5	3	3	3	3	2								2	3	2	
CO6	3	3	3	3	2								2	2	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Dynamic Risk Analysis, Limitations of static risk analysis, Concept of dynamic scenarios and escalation, Overview of Risk Analysis. Background and Recent Developments. Overview of dynamic risk assessment frameworks. Dynamic risk assessment approaches.

Module II

Dynamic Hazard Identification and Scenario Development, Simulation of abnormal events, Escalation analysis using DHA, Temporal and causal analysis, Advanced Technique for Dynamic Hazard Identification

Module III

Dynamic Consequence Analysis, Time-varying release rate models, modeling of cascading and escalating scenarios, Case studies: Vapor cloud explosions, BLEVEs. Assessing the Severity of Runaway Reactions.

Proactive Approaches of Dynamic Risk Assessment Based on Indicators. Risk Metrics and Dynamic Risk Visualization.

Module IV

Estimation of Dynamic Risk, Event trees, Bayesian networks and bow-tie diagrams, Risk metrics for dynamic situations, Uncertainty and sensitivity analysis Reactive Approaches of Probability, Update Based on Bayesian Methods

Risk Management, Dynamic risk-based decision making, Early warnings and predictive analytics, Design and control optimizations

References:

1. Nicola paltrinieri and Faisal Khan, Analysis in the chemical and petrochemical industry: Evolution and Interaction with Parallel Disciplines in the Perspective of Industrial Application, Elsevier,2020.
2. Khan, F., Rathnayaka, S. and Ahmed, S., 2015. Methods and models in process safety and risk management: Past, present and future. Process Safety and Environmental Protection, 98, pp.116-147.
3. Khakzad, N., Khan, F. and Amyotte, P., 2013. Dynamic risk analysis using bow-tie approach. Reliability Engineering & System Safety, 104, pp.36-44.
4. Delvosalle, C., Fievez, C., Pipart, A. and Debray, B., 2006. ARAMIS project: A comprehensive methodology for the identification of reference accident scenarios in process industries. Journal of hazardous materials, 130(3), pp.200-219.
5. Pasman, H.J., Jung, S., Prem, K., Rogers, W.J. and Yang, X., 2009. Is risk analysis a useful tool for improving process safety? Journal of loss prevention in the process industries, 22(6), pp.769-777.
6. Khan, F.I. and Abbasi, S.A., 1998. Techniques and methodologies for risk analysis in chemical process industries. Journal of Loss Prevention in the Process Industries, 11(4), pp.261-277.
7. CCPS, Guidelines for Chemical Process Quantitative Risk Analysis. AIChE, New York (2000).