UNIVERSITY OF MUMBAI

Revised Syllabus for the

Bachelor of Engineering

Chemical Engineering

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019-2020)

AC.
Item no.

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Final Year B.E. Chemical Engineering**
2	Eligibility for Admission	**After Passing Third Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2022-2023**

Date:

Dr. S. K. Ukarande
Associate Dean
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Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum is more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the present curriculum, skill-based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for final Year of Engineering from the academic year 2022-23

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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill-based activities and project-based activities. Self-learning opportunities are provided to learners. In the revision process this time, in particular Revised syllabus of 'C ' scheme, wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum, overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preamble to the Revision of Syllabus in Chemical Engineering

Development in all fields including Chemical Engineering along with use of software for process plant and process engineering, there is demand on academician to upgrade the curriculum in Education. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. The Curriculum must integrate knowledge of the basic and advanced sciences with problem solving and creativity abilities.

The Curriculum must be broad enough to cover all areas from design to operation of Process plants. It should be deep enough to enable the learners to carry out research and develop products to meet rapidly changing needs and demands. The major challenge in the current scenario is to ensure quality to the stakeholders. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program.

With these objectives, online meeting was organized on 30th May 2020 which was attended by heads of the departments and subject faculty of affiliating Institutes. The program objectives and outcomes were thoroughly discussed in line with AICTE guidelines and the core structure of the syllabus was formulated keeping in mind choice-based credit and grading system curriculum along with more emphasis on learning outcomes. Thus, Skilled based laboratories and Mini projects are introduced in appropriate semesters. Views from experts and UG teachers were taken into consideration and final Academic and Exam scheme was prepared with the consent of all the members involved. Subject wise online meetings were held by various subject's convenors to finalize the detail syllabus in 2020.

The Program Educational Objectives finalized for the undergraduate program in Chemical Engineering are:

1. To prepare the student for mathematical, scientific and engineering fundamentals
2. To motivate the student to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social and environmental responsibilities.
4. To prepare the student in achieving excellence which will benefit individually and society at large.

Board of Studies in Chemical Engineering

Dr. Parag R Gogte- Chairman
Dr. Kalpana S. Deshmukh - Member
Dr. Sunil J. Kulkarni - Member
Dr. Ramesh S. Bhande - Member
Dr. Shyamala P. Shingare - Member
Dr. Manisha V. Bagal – Member
Dr. Aparna N. Tamaskar– Member

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2022-2023)
Semester VII

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC701	Instrumentation Process Dynamics and Control	3	-	-	3	-	-	3
CHC702	Chemical Engineering Equipment Design	3	-	-	3	-	-	3
CHDO703X	Department Optional Course 3	3	-	-	3	-	-	3
CHDO704X	Department Optional Course 4	3	-	-	3	-	-	3
IOC701X	Institute Optional Course 1	3	-	-	3	-	-	3
CHL701	Instrumentation Process Dynamics and Control Lab	-	3	-	-	1.5	-	1.5
CHL702	Chemical Engineering Equipment Design Lab	-	3	-	-	1.5	-	1.5
CHL703	Hazard and Risk Analysis Lab	-	2	-	-	1	-	1
CHP701	Major Project I	-	6#	-	-	3	-	3
	Total	15	14	-	15	7	-	22

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC701	Instrumentation Process Dynamics and Control	20	20	20	80	3	-	-	-	100
CHC702	Chemical Engineering Equipment Design	20	20	20	80	3	-	-	-	100
CHDO703X	Department Optional Course 3	20	20	20	80	3	-	-	-	100
CHDO704X	Department Optional Course 4	20	20	20	80	3	-	-	-	100
IOC701X	Institute Optional Course 1	20	20	20	80	3	-	-	-	100
CHL701	Instrumentation Process Dynamics and Control Lab	-	-	-	-	3	25	25	-	50
CHL702	Chemical Engineering Equipment Design Lab	-	-	-	-	-	25	-	25	50
CHL703	Hazard and Risk Analysis Lab	-	-	-	-	-	25	-	25	50
CHP701	Major Project I	-	-	-	-	3	25	-	25	50
	Total	-	-	100	400	-	100	25	75	700

Department Optional Course 3 (Sem VII)

Engineering Stream (Elective Code)	Technology Stream (Elective Code)	Management Stream (Elective)
Corrosion Engineering (CHDO7031)	Fundamental of Colloids and Interface Science and Technology (CHDO7032)	Project Management for Chemical Process Industries (CHDO7033)

Department Optional Course 4 (Sem VII)

Engineering Stream (Elective Code)	Technology Stream (Elective Code)	Management Stream (Elective)
Chemical Plant Safety and Hazards (CHDO7041)	Petroleum Refining Technology (CHDO7042)	Operation Research (CHDO7043)

Institute Optional Course 1

Institute Optional Course 1 (Sem VII)		
1. Product Lifecycle Management (IOC7011)	4. Design of Experiments (IOC7014)	7. Disaster Management and Mitigation Measures (IOC7017)
2. Reliability Engineering (IOC7012)	5. Operation Research (IOC7015)	8. Energy Audit and Management (IOC7018)
3. Management Information System (IOC7013)	6. Cyber Security and Laws (IOC7016)	9. Development Engineering (IOC7019)

 # Indicates work load of Learner (Not Faculty), Faculty load for Major Project. semester VII – ½ hour per week per project group

Course Code	Course Name	Credits
CHC701	Instrumentation Process Dynamics and Control	03

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Prerequisites

1. Engineering Physics and Engineering Chemistry.
2. Engineering Mathematics: Linear Algebra, Differential equations and Laplace Transforms
3. Basic laws of Conservations.

Course Objectives

1. To understand basics of process control system and selection of variables for control system design
2. To explain dynamic behavior of processes based on standard process inputs
3. To analyze the characteristics of different measuring instruments
4. To apply the knowledge of closed loop response in selecting different types of control modes based on process requirements.
5. To analyze the stability of closed loop systems based on Bode stability criteria
6. To apply controller performance strategies in designing and tuning controllers.

Detailed Syllabus

Module No	Course Contents	No. of Hours
1	1.1 Introduction to Process Control, Typical Control Problems, A Blending Process Example. 1.2 Control Strategies, the Rationale for Dynamic Process Models, General Modeling Principles. 1.3 Degrees of Freedom Analysis, Selection of Controlled, Manipulated and Measured Variables.	04

2	2.1 Transfer Functions of Typical Systems, First and Second Order Systems, Properties of Transfer Functions and Transfer Functions of Systems in Series. 2.2 Time Delay Processes, Linearization of Non-linear Systems, Dynamic Behavior of Processes, Standard Process inputs, Response of First Order Processes, Response of Second Order Processes, Response of Integrating Processes 2.3 Development of Empirical Models from Process data, fitting First order using Step Tests	12
3	3.1 Introduction Standards and Calibration, Elements of Measuring Systems, Classification of Instruments, Performance Characteristics, Errors in Measurement. 3.2 Measuring Instruments: Flow Measurement, Temperature Measurement, Level Measurement, Pressure Measurement. Control Valve Types, Characteristics and Sizing.	08
4	4.1 Basic Control Modes, Features of PID and On-off Control, Response of Feedback Control Systems, 4.2 Closed-Loop Transfer Functions, Closed-Loop Response	04
5	5.1 Stability of closed loop systems, Frequency Response, 5.2 Stability based on Bode criteria. Gain and Phase Margins	08
6	6.1 Controller Design and Tuning (Zeigler-Nichols controller tuning) 6.2 Performance Criteria, Guidelines for common control loops	03

Course Outcomes

On completion of the course the student will:

1. Develop model of different dynamic systems.
2. Compute system response for various changes in input to the system based on application of Laplace Transform
3. Analyze and select measuring instruments for measuring various process parameters
4. Design controller for controlling output of a specified system
5. Compute stability analysis of a feedback control system based on Frequency response (Bode diagram)
6. Design controller parameters based on Zeigler-Nichols controller tuning method.

Assessment

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I).

End Semester Examination (80 marks):

1. Weightage of each module in end semester examination will be proportional to number of respective lectures.
2. Question paper will comprise of total **six questions, each carrying 20 marks.**

3. **Question 1** will be compulsory and should cover **maximum contents of the curriculum.**
4. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
5. Only **Four questions need to be solved.**

Recommended Books

1. Dale E. Seborg, Thomas F. Edga, Duncan A. Mellichamp Francis J. Doyle; Process Dynamics and Control III; Third Edition; John Wiley & Sons (Asia) Pvt Ltd., New Delhi - 110002
2. Donald R. Coughanowr, Steven E. LeBlanc; Process Systems Analysis and Control; Third Edition; Mcgraw-Hill Chemical Engineering series.
3. George Stephanopoulos, Chemical process Control An Introduction to Theory and Practice;; 1st Edition; Prentice Hall;1984
4. Donald P. Eckman; Industrial Instrumentation, Wiley Edition

Reference Books

1. William L. Luyben; Process Modeling Simulation and Control for Chemical Engineers; 2nd Edition; Mc-Graw Hill Publishing Co.
2. Prabir Kumar Sarkar, Advanced Process Dynamics and Control, PHI Learning Eastern Economy Edition.
3. Peter Harriott; Process Control, Tata McGraw-Hill Edition
4. S. K. Singh; Industrial Instrumentation and Control; Second Edition; Tata McGraw-Hill publishing Company Limited, New Delhi.

Semester VII

Course Code	Course Name	Credits
CHC702	Chemical Engineering Equipment Design	03

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory		Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral		Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	
Test-I	Test-II	Average					
20	20	20	80	03 Hrs	--	--	100

Prerequisites

1. Fundamentals of units
2. Elementary theory of engineering mechanics,
3. Engineering drawing.
4. Knowledge of heat transfer and mass transfer
5. Concepts of mechanical operations

Objectives

1. Familiarize with design preliminaries and equipment testing methods.
2. Design of pressure vessels.
3. Design of reaction vessels.
4. Design of heat exchangers.
5. Design of tall columns
6. Understand the concept of storage tank and supports.

Detailed Syllabus

Module No	Course Contents	Contact Hours
1	**Introduction:**	04

	Introduction to Chemical process equipment design. Nature of process equipment, Basic consideration in process equipment design, Standards, codes & their significance, equipment classification & selection, material of construction for chemical process equipment, Design pressure, Design temperature, design stress & design loads, factor of safety, Corrosion Allowance & weld joint efficiency. **Equipment Inspection:** Methods of Inspection of Equipments Radiography Ultrasound Dye Penetration Fatigue assessment test Pressure test	
2	**Pressure vessel :** Type of pressure vessels, code & standard for pressure vessels (IS: 2825:1969). Pressure Vessel Subjected to Internal Pressure. Complete design of cylindrical Pressure vessel as per IS: 2825: 1969. Study, selection & design of various Heads, material of construction of construction, openings/nozzles, Flanged joints. **High Pressure Vessels:** Theories of failure, material of construction, constructional method of high Pressure vessels. Design of multi layered high pressure vessels (stress distribution diagram).	**10**
3	**Reaction vessel :** Introduction, material of construction, Classification of reaction vessels, Heating system. Types of jackets& design of plain jacket. Types of agitators & their application. Components of agitation system. Power requirement of agitators & their applications, system which includes design of shaft based on equivalent bending moment and critical speed. Design of blades & Blade assembly.	**08**
4	**Heat exchangers :** Material of construction, Design of shell and tube heat exchanger (U-tube and fixed tube sheet as per IS: 4503, TEMA standards)includes shell, tube, tube sheets, channel and channel cover, flanged joints. **Evaporators** Design of standard vertical evaporator with design of calendria and tube, flange evaporator drums and heads.	**08**
5	**Tall columns: (**distillation column) Basic features of columns, stresses in column shell. Shell thickness determination at various heights. Study of Type of column internals (plate and packed column) and supports for trays.	**04**
6	**Storage vessels and supports :** Study of Various types of storage vessels and application. Atmospheric vessels, vessels for storing volatile & non-volatile liquids. Storage of gases, Losses in storage vessel. Various types of roofs used for storage vessels. (calculation of variation in thickness with height only) Introduction & classification of support. (Study)	**04**

Course Outcome

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

1. Apply the concept of Chemical Engineering equipment design terminologies and equipment testing methods.
2. Design pressure and high pressure vessel.
3. Design reaction vessel and agitator.
4. Design heat exchanger and evaporator.
5. Design distillation column.
6. Illustrate and explain the concept of storage tank and types of supports

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI).

End Semester Examination (80 marks):

- Weightage of each module in end semester examination will be proportional to number of respective lecture
- Question paper will comprise of total **six questions, each carrying 20marks**
- **Question 1** will be compulsory and should cover **maximum contents of the curriculum.**
- **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
- Only **Four questions need to be solved.**

Recommended Books:

1. Process Equipment Design by M.V. Joshi Macmillan India.
2. Process Equipment Design- Vessel Design by E. Brownell and Edwin, H. Young. John Wiley, New York 1963.

Reference Books:

1. Chemical Engineering volume 6- Design by J.M Coulson, J.F. Richardson and P.K. Sinnot, Pregamovr press, International edition 1989.
2. Chemical Engineering Design, Fifth edition, Ray Sinnott and Cavin Towler, Elsevier, Butterworth-Heinemann publications
3. Introduction to Chemical Equipment Design- Mechanical aspects by B.C. Bhattacharya CBS Publications

Semester VII

Course Code	Course Name	Credits
CHDO7031	Corrosion Engineering (Department Optional)	03

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Prerequisites

1. Knowledge of Physical Chemistry and Electrochemistry
2. .Knowledge of reaction kinetics
3. .Knowledge of material selection.

Objectives

1. To understand corrosion and its related mechanisms and Basic terminologies.
2. Understanding different forms of corrosion and its conditions
3. To understand design aspects for corrosion prevention
4. To Understand the Methodology, Methods and Materials to prevent the Corrosion.
5. To describe the Corrosion Protection techniques, Coatings, Anodic protection, Cathodic Protection and its related topics.
6. To describe and demonstrate the Corrosion monitoring and control methods.

Detailed Syllabus

Module No	Course Contents	Contact Hours
1.	**Introduction** Definition of corrosion, Principle of corrosion , Classification of corrosion, Consequences of Corrosion, Functions and role of a corrosion engineer, Corrosion rate expression, What is over potential, Polarization (Activation and Concentration polarization)	**6**
2.	**Environmental factors and corrosion**: Corrosion in water and aqueous solutions, Corrosion in sulphur bearing solutions, Microbiologically induced corrosion, Corrosion in acidic and alkaline process streams.	**5**
3.	**Corrosion Electrochemistry and Thermodynamics** Electrochemical Reaction (Anodic and Cathodic process), Faraday's law, Free Energy, standard electrode potential Nernst equation	**6**
4.	**Galvanic and concentration cell corrosion:** Basic concepts, Experimental measurements, and determination of rates of galvanic corrosion, Concentration cells.	**5**
5.	**Eight forms of corrosion:** Galvanic or two metal corrosion, Crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion, stress corrosion, hydrogen damage	**8**
6.	**Corrosion Prevention:** Design aspects to minimize the corrosion, Material selection, Alteration of environment, Cathodic and anodic protection, coatings	**6**

Course Outcome

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

1. Understand corrosion and its related mechanisms and Basic terminologies.
2. Classify different forms of corrosion and its conditions.
3. To describe the Corrosion Protection techniques, Coatings, Anodic protection, Cathodic Protection.
4. Apply the Methodology, Methods and Materials to prevent the Corrosion
5. The understanding the modern theory principles behind corrosion.
6. To describe and demonstrate the Corrosion monitoring and control methods.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (Approximately 40% but excluding contents covered in Test I).

End Semester Examination (80 marks):

1. Weightage of each module in end semester examination will be proportional to number of respective lecture
2. Question paper will comprise of total six questions, each carrying 20marks
3. Question 1 will be compulsory and should cover maximum contents of the curriculum.
4. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
5. Only Four questions need to be solved.

Recommended Books:

1. M.G. Fontana, Corrosion Engineering, Tata McGraw-Hill (New Delhi), 3rd Ed.
2. H. H. Uhlig: Corrosion and Corrosion Control. An Introduction to Corrosion Science and Engineering. John Wiley and Sons
3. Jones, D.A., Principles and Prevention of Corrosion, Prentice-Hall (1996).
4. Pierre R. Roberge, Corrosion engineering: principles and practice, McGraw-Hill (2008).

.**Reference Books:**

1. G.L.Shvartz and M.M.Kristal, Corrosion of Chemical Apparatus (1959) Chapman Hall Ltd. London.
2. An introduction to Electrochemistry by Samuel Glasstone, Affiliated East West Press Private, Limited.
3. Pierre R. Roberge, Handbook of corrosion engineering, McGraw-Hill (2012). 2nd ed.

Semester VII

Course Code	Course Name	Credits
CHDO7032	Fundamental of Colloids and Interface Science and Technology (Department Optional Course)	03

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	3

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR/ OR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Prerequisites

1. Knowledge of chemistry, physics, physical chemistry and mathematics.
2. Knowledge of fluid mechanics
3. Knowledge of thermodynamics

Course Objectives

The overall aim of this course is to develop a broad background in colloids and interfaces which will enable students to:

1. To study concepts and applications of surface tension, adhesion and capillarity of liquids.
2. To study Intermolecular, nanoscale and interfacial forces in organic, polymeric, biological and aqueous systems.
3. To study Mesoscale phenomenon and its thermodynamics in application of soft matter.
4. To study mechanism of Stability of nanoparticle dispersions.

5. To study nanofluids and its application and working.
6. To study concepts of advanced and functional interfaces.

Detailed Syllabus

Module No	Course Contents	Contact Hours
1	**Surface Tension, Adhesion and capillarity:** Effects of confinement and finite size; Concepts of surface and interfacial energies and tensions; Apolar (van der Waals) and polar (acid-base) components of interfacial tensions. Young-Laplace equation of capillarity; examples of equilibrium surfaces, multiplicity, etc. Stability of equilibrium solutions; Contact angle and Young's equation; Determination of apolar (Van-der Waals) and acid-base components of surface/interfacial tensions. Free energies of adhesion; Kinetics of capillary and confined flows.	**04**
2	**Intermolecular, nanoscle and interfacial forces in organic, polymeric, biological and aqueous systems** Van der Waals, Electrostatic double layer, Acid-base interactions including hydrophobic attraction and hydration pressure.	**08**
3	**Mesoscale thermodynamics** Gibbs treatment of interfaces; concept of excess concentration; variation of interfacial tensions with surfactant concentration**.** **Mesoscale phenomena in soft matter and applications** Adhesion, wetting, nucleation, flotation, patterning of soft material by self-organization and other techniques.	**08**
4	**Stability of nanoparticle dispersions:** DLVO and DLVO like theories and kinetics of coagulation plus general principles of diffusion in a potential field/Brownian movement.	**08**
5	**Nanofluidics:** Stability of thin (< 100 nm) films; self-organization in confined systems; meso-patterning.	**05**
6	**Advanced and Functional Interfaces:** Superhydrophobicity, functional coatings, structural colors, nano-adhesives; nanocomposites.	**06**

Note: Video, Digital, NPTL content can be used for equipment section of each chapter /unit operation.

Course Outcomes

At the end of the course student will be able to:

1. Understand of basic nomenclature, concepts and tools of colloid and interface science and engineering; multi-phase nano-systems; mechanics and thermodynamics on small scales.
2. Understand the differences between the surface and bulk dominated regimes and behavior and exploitation of nano-behavior.
3. To understand and apply Mesoscale phenomenon and its thermodynamics in application of soft matter.
4. To appreciate mechanism of Stability of nanoparticle dispersions.
5. Be aware of nanofluids and its application and mechanism of working.
6. Comprehend concepts of advanced and functional interfaces and its application in chemical industries.

Assessment

Internal

- Assessment consists of average of two tests which should be conducted at proper interval

End Semester Theory Examination

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions to be solved
- Question no.1 will be compulsory and based on entire syllabus where in sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Reference Books:

1. Principles of Colloid and Surface Chemistry, Paul C. Hiemenz, Marcel Dekker, any edition starting with the 2nd edition, 1986.

2. Miller, C. A. and P.Neogi, "Interfacial Phenomena : Equilibrium and Dynamic Effects", 2nd Edn., Marcel Dekker, NY, 2007.

3. Hiemenz, P. C., and R.Rajgopalan, "Principles of Colloid and Surface Chemistry", 3rd Edn., Marcel Dekker, NY, 1997.

4. Adamson, A. W. and Gast, A., "Physical Chemistry of Surfaces", 6th edition, John Wiley and Sons, 1997.

5. Stokes, R. J. and Evans, D.F., "Fundamentals of Interfacial Engineering", Wiley-VCH, N.Y., 1996.

Semester VII

Course Code	Course Name	Credits
CHDO7033	Project Management for Chemical Process Industries (Departmental Optional Course)	3

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR/OR	OR	
Test-I	Test-II	Average						
20	20	20	80	3 hrs	-	-	-	100

Prerequisites

1.Communication skills
2.Mathematical skills,
3.Analytical, logical and reasoning Skills
4. Economics

Course Objectives

1.To understand basic concepts project management and application of PM to process industries through class teaching and case studies
2.To understand project feasibility reports and
3.To learn about various clearances required to start an industry
4.To learn various project organizations
5.To learn basics of tendering and contracting
6.To learn various tools and techniques used in PM and understand role of entrepreneurship in the society for the economic growth.

Detailed Syllabus

Module no.	Topics	Contact Hours

1	**Concepts of project management:** Definition of project, project management, project types, project life cycle,Definition of project management, Project deliverables and Stakeholder management,Difference between project management and formal/product management, Role-responsibilities and skills of project manager, project overruns. **Case studies** : Superclean paperboards, DEMCO manufacturing , Accorn, Govardhan group	08
2	**Project management in process industries:** Project strategy,Project specification, Project engineering, Detailed design,Procurement, Construction, Commissioning and Closure	03
3	**Feasibility report, licensing and clearances** **Feasibility reports:**Pre feasibility report,Techno economic feasibility report,Detailed project report **Contents of feasibility report**:Raw material survey, Market survey and demand study, technical study, location survey, financial survey. Types of cost estimates, Project selection criteria **Estimation of project profitability:** Payback period, Return on Investment (ROI) ,Net Present Value (NPV) , Internal Rate of Return (IRR), Benefit Cost Ratio (BCR) **Industrial license and LOI**, Various laws & regulations governing industries, Need for clearances and influences on project, List of various clearances. **Case studies:** Coal fired boilers project, Plant on river Yangtze, SIRIS pharma Hyderabad	10
4	**Project organization and contracting** Project scope, Types of WBS, Preparation of WBS, Development of responsibility matrix, development of project communication plan. The traditional management structure, Project management organizational structure: pure project, matrix, task force, Project team- responsibilities of various members. Contracts types, selection criteria,3R of contracting, types of reimbursements and tendering procedure **Case studies:** Hindustan oil company-housing project, Comfort flex, Hamad petroleum company	08
5	**Tools and techniques in project Management:** **Project scheduling and execution**: List of various tools and techniques used in project management, Project execution plan (PEP), Bar charts/GANTT charts, LOB Networking techniques PERT and CPM (critical path, float, total float, AOA and AON diagrams), Material Management- ABC and VED Analysis, Economic Order Quantity (EOQ), CAT vs RAT,	07

	Time and cost control tools and techniques.	
6	**Entrepreneurship:** Definition, Concept of entrepreneur and entrepreneurship, Ccompetencies of entrepreneur, Classification and types of entrepreneurship, Creativity techniques for entrepreneur, Startups- pre requisites, stages, ideas and funding Case study: Any example of startup and entrepreneur	03

Course Outcome

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

1. Understand and apply concepts and knowledge of project management to manage projects in process industries
2. Apply knowledge of engineering and project management to create feasibility reports.
3. Understand how to get various clearances required to start industry by following professional ethics.
4. Prepare project organization charts, work breakdown structure, responsibility matrix, project communication plan etc to facilitate better communication and management of projects
5. To apply their knowledge to prepare tenders and contracts which will satisfy needs of society and environment
6. To use tools of PM [Cost benefit analysis, Project execution plan (PEP), Bar charts/GANTT charts, LOB, Networking techniques (PERT/CPM etc] , to analyze and solve complex problems and will be motivated to become entrepreneurs

Internal Assessment

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (Approximately 40% but excluding contents covered in Test I).

End Semester Theory Examination:

Question paper will comprise of 6 questions, each carrying 20 marks.
Total 4 questions need to be solved.
Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
Remaining questions will be randomly selected from all the modules.

References:

1. Project Management, Choudhary, S., Tata Mc Graw Hill(module 1 to 6)
2. Total Project Management, Joy, P. K.,(module 1 and 3)
3. Project Management for process Industries, Gillian Lawson, I chemE(Module 1 and 2)
4.Project Management Case Studies, Harold Kerzner, Second edition, John Wiley and Sons(for case studies)
5. Project Management-The Managerial Process, Clifford Gray, 6th edition, McGraw Hill (module 1,3,4,5)
6. Plant Design and Economics for Chemical Engineers,Klaus D Timmerhaus,5th edition, McGraw Hill(Module 3 and 5)
7. Theory and problems in financial management, Khan, M.Y.; Jain, P.K.; Second Edition, Tata McGraw Hill (Module 2 and 4)

8.Fundamentals of Financial Management, Vyuptakesh Sharan , Second Edition, Pearson publications(module 2 and 4)
9. Dynamics of entrepreneurial development and management, Vasant Desai (module 6)
10.Project Management Workbook, ICMR India (Module 1,2,3,4,5,6)
11. Entrepreneurship and Startups-Prof Nishant Dubey and Prof Mishra, NITTTR, Bhopal

Semester VII

Course Code	Course Name	Credits
CHDO7041	Chemical Plant Safety and Hazards (Department Optional Course)	03

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Prerequisites

1. Fundamentals of chemical processes.
2. Knowledge of heat transfer, mass transfer and chemical reaction engineering
3. Concepts of mechanical operations.
4. Knowledge of plant operation and maintenance.

Course Objectives

1. To give overview about occupational health, industrial hygiene, accidental prevention techniques to the students.
2. To give the knowledge about fire and explosion.
3. To train the students about Fire and Explosion prevention methods and Reliefs techniques.
4. To make the student aware about safety in process and plant.
5. To train the students about hazard identification and risk assessment.

6. To train the students about safety procedures and design and expert manpower to handle the complex industrial environment.

Detailed Syllabus

Module No	Course Contents	Contact Hours
1	**Introduction:** History and development of safety movement, Safety programs, Need for safety, Engineering ethics, accident and loss statistics, acceptable risk, The nature of accident process, Identifying the causative and initiating factors of Industrial accidents, Accident prevention and control techniques, Plant safety inspections, Major Industrial Disasters (Case Studies) Bhopal disaster (1984), Chernobyl Disaster, Fukushima Daiichi Disaster etc. Case studies. **Industrial Hygiene:** Definition of Industrial Hygiene, Phases of industrial hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, isolation, wet method, local exhaust ventilation, personal hygiene, housekeeping and maintenance, waste disposal, special control measures, Government Regulations, Anticipation and identification, MSDS, Evaluation workers exposure to Volatile toxicants, dust, noise, toxic vapors, Industrial Hygiene : Control	7
2	**Fire and Explosions** Fire: Fire triangle, Classification of fires, Flammability characteristics of liquids and gases, Limiting oxygen concentration, ignition energy, auto ignition, autoxidation, adiabatic compression. Ignition sources, spray and mist. Common causes of industrial fires. Explosion: Detonation, Deflagration, Confined explosion, unconfined explosion, VCE, BLEVE, Problems on energy of chemical explosion.	5
3	**Concept to Prevent Fire and Explosion (Fire and Explosion prevention methods and Introduction to Reliefs) and Introduction to Reliefs** Inerting: vacuum and pressure purging, combined purging, Controlling Static electricity: Bonding and grounding, dip pipes, Explosion-proof equipment instruments, ventilation. Sprinklers systems. Fire-fighting systems: Different types of portable fire extinguishers, their installation, periodic inspection and operation, Replacement of Halon with safer substitutes, Fire hydrant system, Fire monitors, sprinkler system and deluge system, Carbon-dioxide flooding system, Foam Pourer system Relief concept: Principle of pressure system, Pressure, Hazards of steam, Mechanism of Steam explosion, key components and safety features of pressure system, Failure of pressure system, Hazards of overpressure and over temperature in pressure system, location of reliefs and types of relief.	6

4	**Chemical Reactivity and Safety In Plant Operation And Maintenance** Commitment, Awareness and Identification of reactive chemical hazards, characterization of reactive chemical using calorimeter, controlling reactive hazards. Safe procedures for plant start-up and shut-down, Pipeline colour coding for identification of contents, Safety precautions for working on pipelines, Safety in preventive and emergency maintenance work.	**6**
5	**Hazard Identification and Risk Assessment** Hazard Identification: Hazard identification and risk control approaches and techniques**,** Reactive approach-Incident recall technique (after-the-event approach), Proactive approaches: Critical incident review technique (before-the-event approach), Deductive technique, Inductive technique Process hazards checklists, survey, Hazard and Operability Studies (HAZOP), Maximum Credible Accident Analysis (MCAA)/Quantitative Risk Assessment (QRA), Safety review, Risk assessment: Cause/consequence finding techniques What-if, Fishbone, Why-Why, Root Cause Analysis (RCA), Event tree analysis, Fault tree analysis, Maximum Credible Accident Analysis (MCAA)/Quantitative Risk Assessment (QRA) and LOPA.	**6**
6	**Safety Procedures and Design** Process safety Hierarchy, managing safety, best practices, procedure for safety review and accident investigation, design for process safety, runway reactions, Job safety Analysis (JSA) and investigation of accidents, First aid, Financial costs-direct and indirect, social costs of accidents, Dust explosion, factors of pentagon, causes of dust explosions and controls, handling dusts and Miscellaneous designs for fire and explosions.	**8**

Course Outcome

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

1. give overview about occupational health, industrial hygiene, accidental prevention techniques to the students.
2. Apply the knowledge about fire and explosion.
3. Design and perform Fire and Explosion prevention methods and Reliefs techniques.
4. Implement the knowledge about safety in process and plant.
5. perform hazard identification and risk assessment.
6. prepare safety procedures and design and are expert to handle the complex industrial environment.

Internal Assessment (20 Marks):
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I).

End Semester Examination (80 marks):

1. Weightage of each module in end semester examination will be proportional to number of respective lecture
2. Question paper will comprise of total six questions, each carrying 20 marks
3. Question 1 will be compulsory and should cover maximum contents of the curriculum.
4. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
5. Only Four questions need to be solved.

Recommended Books:

1. Crowl, D. A. and Louvar, J. P.; Chemical Process Safety: Fundamentals with Applications; Prentice Hall, Englewood
2. K. S. N. Raju, Chemical Process Industry Safety, McGraw Hill Education
3. Roy E. Sanders, Chemical Process Safety: Learning from Case Histories, Butterworth-Heinemann publisher
4. H.W. Heinrich, Dan Petersen, and Nestor Roos, McGraw-Hill Book Company, New York / New Delhi
5. A.K.Gupta, Industrial Safety and Environment, McGraw-Hill Book Co. Ltd., New York, N.Y. USA
6. K.T. Kulkarni, Industrial Safety: Concepts and Practices , Pune VidyarthiGrihaPrakashan, 1786, SadashivPeth, Pune
7.Accident Prevention Manual for Industrial Operations (ISBN: 978-08-7-912024-5), National Safety Council USA
8. H.W. Heinrich, Dan Petersen, and Nestor Roos , Industrial Accident Prevention, McGraw-Hill Book Company, New York / New Delhi
9. K.U. Mistry, A Course in Industrial Safety, NKM Publishers, Ahmedabad

Semester VII

Course Code	Course Name	Credits
CHDO7042	Petroleum Refining Technology (Departmental Optional Course)	03

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Prerequisites

Prerequisites:

1. Knowledge about Formation & Origin of petroleum.
2. Composition & testing methods & basic treatment techniques.

Course Objectives

1. To understand Petroleum Refining processes & products, its evaluation & Treatment techniques.
2. To recognize the significance of petroleum refining is to convert crude oil into useful products.
3. The main purpose of refining petroleum is to make the best use petroleum is a fuel.
4. To understand various cracking processes & its applications in Chemical Industries.
5. Describe the overall approach to petroleum refining and categorize refinery processes and Products.
6. Identify the economic and environmental drivers of petroleum refining;

Detailed Syllabus

Module No	Course Contents	Contact Hours

1	**Introduction -Origin ,Formation & Composition of Petroleum: :** Importance, Origin theory, Reserves in India & world. Exploration of Reserves, Types of crude, (Based on constituents, Sulphur contents & Degree API). Indian crude reserves & production scenario, Indian Petroleum Industry Scenario, Agencies engaged in upstream & downstream petroleum industry (Government & Private). Properties, composition, UOP Characterization factors.	04
2	**Crude Oil Assay:** Correlation index, ASTM Distillation, Thermal properties, Crude distillation curves. Important products test & methods, Gasoline, Kerosene, Diesel.	08
3	**Crude Oil Processing & Refining**: Dehydration & desalting of crude, Heating of crude, Overall refinery flow diagram, its processes & Products, Low boiling products –LPG production by absorption and amine techniques ,Gasoline, Kerosene & their Specifications, Arrangement of Tower, ADU & VDU, Blending of gasoline, Corrosion problem	08
4	**Treatment ,Techniques & Product Specifications**: Treatment Techniques • Fraction impurities- physical and chemical • Gasoline Treatment: Cooper Chloride process, Unisol process, Dualayer process, Lead doctoring, Merox sweetening and Sulfuric Acid treatment • Treatment of lubes-Solvent treatment: Phenol extraction, Furfural extraction and Duo-sol • Wax: MEK Dewaxing and Propane Dewaxing	08
5	**Catalytic Cracking & Thermal Processes:** Thermal and catalytic Cracking • Cracking: Reactions, Theory, properties: Visbreaking • Catalytic Cracking: Houdri Fixed bed, Moving bed and Houdri Flow • FCC: Flexi cracking and Ortho Flow • Catalytic Reforming • Coking: Delayed coking, Fluid coking and Flexi coking • Hydro cracking- isomax • Alkylation: Sulfuric Acid and H.F. • Isomerization: ALCl3 Process	08
6.	**Asphalt Technology & Environmental issues:** Asphalt Technology: • Sources: Chemical Structure, Action of heat on asphalt and Types of Asphalt • Air Blowing of Bitumen • Speciality Products 1. Environmental Issues	03

Course Outcome

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

1 Recognize the significance crude petroleum and petroleum refinery.
2 Understand and express the overall objectives of fractionate crude petroleum into useful fractions.
3 Apply important physical properties of petroleum products
4 Analyze refinery processes to maximize desired petro products
5 Students will be able to understand upgradation process.
6 Identify the economic and environmental drivers of petroleum refining.

Internal Assessment (20 Marks):
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents of syllabus and second test based on remaining contents of syllabus (approximately 40% but excluding contents covered in Test I).
End Semester Examination (80 marks):

- Weightage of each module in end semester examination will be proportional to number of respective lecture
- Question paper will comprise of total **six questions, each carrying 20 marks**
- **Question 1** will be compulsory and should cover **maximum contents of the curriculum.**
- **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
- Only **Four questions need to be solved.**

Reference Books:

1. W.L Nelson, Petroleum Refinery Engineering 4th ed, McGraw Hill.
2. Petroleum Chemistry and Refining Edited by James G. Speight, Taylor and Francis.
3. Chemical Process Industries, Austin, G.T Shrives.
4. Encyclopedia of chemical processing and design by john J. Mc Khetta; Marcel Deckker, Inc.

Recommended Text Books:

1. B.K Bhaskara Rao, Modern Petroleum Refining Process.
2. Petroleum Processing, Principles and Applications, R.J.Hengstebeck, Mc Graw Hill Book Co, 1959.
3. Fundamentals of Petroleum Chemicals Technology, P.Belov.

Semester VII

Course Code	Course Name	Credits
CHDO7043	Operations Research (Departmental Optional Course)	03

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Prerequisites

- Linear Algebra, Computer Programming

Course Objectives:

- Formulate a real-world problem as a mathematical programming model
- to understand Linear Programming and its applications to the models.
- To understand and solve network transportation and assignment models.
- To understand Game theory and its applications.
- To study and solve the Queuing system problems
- Understand the concept of Network flow and inventory control.

Detailed Syllabus

Module No	Contents	Contact Hours
1	**Introduction to Operations Research:** Introduction, Structure of the Mathematical Model, Historical Standpoint, Methodology, Different Phases,	10

	Characteristics, Scope and Application of Operations Research in Chemical Engineering, Limitations of Operations Research. **Linear Programming:** Introduction, Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical method, Simplex Method Penalty Cost Method or Big M-method, Duality, Primal – Dual construction, Dual-Simplex Method, Sensitivity Analysis	
2	**Transportation and Assignment:** Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: MODI method. Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Travelling Salesman Problem	**08**
3	**Queuing Theory:** Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Preliminary examples of M/M/1:∞/FCFA/ **Sequencing:** Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines.	**06**
4	**Inventory Models**: Inventory classification, Different cost associated to Inventory, Economic order quantity, Classic EOQ Model (demand rate uniform, replenishment rate infinite), ABC analysis.	**04**
5	**Decision Analysis and Game Theory:** Decision Making under Certainty, Decision Making under Risk, Decision Under Uncertainty (ONLY NUMERICAL PROBLEMS) **Game Theory:** Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games. (ONLY NUMERICAL PROBLEMS)	**07**
6	**Network Models:** Scope and Definition of Network Models, Minimal Spanning Tree Algorithm, Shortest Route Problem, Maximal Flow Model.	**04**
	Total Hours	**39 hrs**

Course Outcomes:

Learner will be able to…

- Model and solve typical OR problems using the simplex method.
- Understand the relationship between a linear program and its dual and Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems.
- Identify and Solve Queuing System.

- Understand the concept of game and Decision theory and solve problems based on the same.
- Understand the applications of network models and an inventory model and compute important performance measures.

Assessment:

Internal Assessment for 20 marks:
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Semester VII

Course Code	Course Name	Credits
IOC7011	Institute Level Optional Subject I- Product Life Cycle Management	03

Course Hours			Credits Assigned		
Practical	Tutorial	Theory	Practical	Tutorial	Total
-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Outcomes:

Learner will be able to…

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.

- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Contact Hours
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM.	10
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New ProductDevelopment (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process.	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	05
05	**Integration of Environmental Aspects in Product Design:**	05
	Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design.	

06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.	**05**

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Semester VII

Course Code	Course Name	Credits
IOC7012	Institute Level Optional Subject I- Reliability Engineering	03

Course Hours			Credits Assigned		
Practical	Tutorial	Theory	Practical	Tutorial	Total
-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Objectives:

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes:

Learner will be able to…

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Contact Hours

01	**Probability theory:** Probability: Standard definitions andconcepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relationsbetween them and their significance. **Measures of Dispersion:** Mean Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	**08**
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate,Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model.Distribution functions and reliability analysis.	**08**
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	**05**
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	**08**
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and	**05**
	Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	**05**

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Semester VII

Course Code	Course Name	Credits
IOC7013	Institute Level Optional Subject I- Management Information System	03

Course Hours			Credits Assigned		
Practical	Tutorial	Theory	Practical	Tutorial	Total
-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Objectives

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Outcomes Learner will be able to…

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Contact Hours

01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, and Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	**4**
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	**7**
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	**7**
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	**7**
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	**6**
06	Information System within Organization: TransactionProcessing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	**8**

Internal Assessment

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Semester VII

Course Code	Course Name	Credits
IOC7014	Institute Level Optional Subject I- Design of Experiments	03

Course Hours			Credits Assigned		
Practical	Tutorial	Theory	Practical	Tutorial	Total
-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Objectives:

- To understand the issues and principles of Design of Experiments (DOE)
- To list the guidelines for designing experiments
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes:

Learner will be able to…

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action
- Apply the methods taught to real life situations
- Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Contact Hours
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06

02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	**08**
03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	**07**
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs	**07**
	4.6 Fractional Factorial Split-Plot Designs	
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	**07**
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	**04**

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss
6. Phillip J Ross, "Taguchi Technique for Quality Engineering," McGraw Hill
7. Madhav S Phadke, " Quality Engineering using Robust Design," Prentice Hall

SEM VII		
Course Code	**Course Name**	**Credits**
IOC7015	**Institute Level Optional Subject I- Operations Research**	**03**

Course Hours			Credits Assigned		
Practical	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
-	**-**	**03**	**-**	**-**	**03**

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**--**	**--**	**--**	**100**

Objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Outcomes:

Learner will be able to…

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems; solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Contact Hours

01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction,Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian MethodAlgorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	**14**
	Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	**05**
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	**05**
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	**05**
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	**05**
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	**05**

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, Kedar Nath Ram Nath-Meerut.
5. Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
IOC7016	Institute Level Optional Subject I- Cyber Security and Laws	03

Course Hours			Credits Assigned		
Practical	Tutorial	Theory	Practical	Tutorial	Total
-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Objectives:

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Outcomes:

Learner will be able to…

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Contact Hours
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security,Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9

03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	**6**
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework forElectronic Data Interchange Law Relating to Electronic Banking,	**8**
	The Need for an Indian Cyber Law	
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and itsAmendments	**6**
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	**6**

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in

9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
IOC7017	Institute Level Optional Subject I- Disaster Management and Mitigation Measures	03

Course Hours			Credits Assigned		
Practical	Tutorial	Theory	Practical	Tutorial	Total
-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Objectives:

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Outcomes:

Learner will be able to…

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structures associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Contact Hours
01	Introduction: Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03

02	Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	**09**
03	Disaster Management, Policy and Administration: Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift	**06**
	in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how toproceed in due course of time, study of flowchart showing the entire process.	
04	Institutional Framework for Disaster Management in India: Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management ofcasualties, set up of emergency facilities, importance of effectivecommunication amongst different agencies in such situations. Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	**06**
05	Financing Relief Measures: Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related tofinance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past onthe occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	**09**
06	Preventive and Mitigation Measures: Pre-disaster, during disaster and post-disaster measures in some events in general structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication Non Structural Mitigation: Community based disasterpreparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	**06**

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep, Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P. Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International leveland updated information available on authentic web sites)

Course Code	Course Name	Credits
IOC7018	Institute Level Optional Subject I- Energy Audit and Management	03

Course Hours			Credits Assigned		
Practical	Tutorial	Theory	Practical	Tutorial	Total
-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Objectives:

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes:

Learner will be able to…

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Contact Hours
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy Balance	04

02	**Energy Audit Principles:** 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. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	**08**
03	**Energy Management and Energy Conservation in Electrical**	**10**
	System: Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	**10**
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	**04**
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	**03**

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B. Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
IOC7019	Institute Level Optional Subject I- Development Engineering	03

Course Hours			Credits Assigned		
Practical	Tutorial	Theory	Practical	Tutorial	Total
-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Pre-requisite:

- Interest in societal development.

Course Objective:

- To understand the characteristics of rural Society and the Scope and Nature and Constraints of rural Development.
- To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
- The objective of the course is an exploration of human values, which go into making a ‘good’ human being, a ‘good’ professional, a ‘good’ society and a ‘good life’. The context is the work life and the personal life of modern Indian professionals.
- To understand the Nature and Type of Human Values relevant to Planning Institutions.

Course Outcome:

- Students will be able to apply knowledge for Rural Development.
- Students will be able to apply knowledge for Management Issues.
- Students will be able to apply knowledge for Initiatives and Strategies
- Students will be able to develop acumen for higher education and research.
- Students will master the art of working in group of different nature.
- Students will develop confidence to take up rural project activities independently.

Module	Contents	Contact Hours
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development.	04

2	Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	**04**
3	Post-Independence rural Development BalwantRai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	**04**
4	Rural Development Initiatives in Five Year Plans Five Year	**06**
	Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
5	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
6	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education.	**04**
7	Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	**06**
8	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Recommendation

Students can take any one or two live projects beneficial to rural population orsociety at large.

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rdGoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Semester VII

Course Code	Course Name	Credits
CHL701	Instrumentation Process Dynamics and Control Lab	1.5

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	3	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR/OR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	25	--	50

Prerequisites

1. Basics of unit operations.
2. Engineering Physics, Engineering Chemistry and Engineering Mathematics (Linear Algebra, Differential equations and Laplace Transforms)
3. Basic laws of Conservations
4. Knowledge of safety and precautions to be taken in laboratories.

Lab Objectives

1. To understand dynamic behavior of process systems and equipments.
2. To analyze the characteristics of different types control valves.
3. To calibrate various measuring devices
4. To operate closed-loop control system
5. To understand the effect of controller parameters in the response of dynamic systems
6. To optimize the controller parameters in controller tuning process

List of Suggested Experiments

- Dynamic Response of First order system (Thermometer) to step input
- Dynamic Response of First order system (Liquid Level) to impulse input
- Dynamic Response of Non-Interacting system to step input
- Dynamic Response of Interacting system to step input
- Calibration of Measuring Devices.
- Dynamic Response of second order system (Manometer) to step input

- Inherent Characteristics of Control Valves
- Effective Characteristics of Control Valves
- Closed loop control system
- Open loop control system
- Tuning of control system
- Development of Empirical Model from Process Data
- Note: Virtual platforms can be used for better understanding of concepts (Virtual platform should be used for at least one Experiment).

Lab Outcome

On completion of the course the student will:

1. Analyze the dynamic behavior of a system for various inputs
2. Determine the characteristic parameters of a system
3. Analyze the characteristics of control valves
4. Develop Empirical Model from Process Data
5. Analyze various measuring devices
6. Tune the controller parameter

Term work

Term work should be evaluated based on performance in practical.

Practical journal:	20 marks
Attendance:	05 marks
Total:	25 marks

Practical Examination

- Duration for practical examination will be same as assigned to respective lab per week
- A student will become eligible for practical examination after completing 8 out of 10 experiments

Semester VII

Course Code	Course Name	Credits
CHL702	Chemical Engineering Equipment Design Lab	1.5

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR/OR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Prerequisites

1. Fundamentals of units
2. Elementary theory of engineering mechanics,
3. Engineering drawing.
4. Knowledge of Heat and Mass transfer operations
5. Concepts of Mechanical operations

Course Objectives

1. To understand the basic of design and Construction of Pressure Vessels.
2. To understand the basic of design and Construction of High-Pressure Vessels
3. To understand the basic of construction and design of Reaction vessel and Agitator
4. To understand the basic of design and Construction of Heat transfer equipment
5. To understand the basic of design and Construction of Mass Transfer equipments.
6. To understand the basic of construction of Storage Vessel and Supports to vessel

List of Experiments (minimum eight)

Experiment no.	Details of Experiment	Lab Hours
1	Pressure Vessel	3
2	High Pressure Vessel	3
3	Reaction Vessel	3
4	Agitators	3
5	Heat Exchangers	3
6	Evaporator	3
7	Distillation Column	3
8	Storage Vessel	3
9	Supports to vessels	3

10	Autocad / PID	3

Course Outcome

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

1. Design and pictorially represent Pressure vessel.
2. Design and pictorially represent High pressure vessel.
3. Design and pictorially represent Reaction vessel and Agitator
4. Design and draw internals of Heat exchanger and Evaporator.
5. Design and represent pictorially distillation column.
6. Sketch the internals of storage tank and types of supports

Assessment:

Term Work (25 marks)

Distribution of marks will be as follows:

- Laboratory work: 15 marks
- Assignments: 05
- Attendance: 05
- **Total Marks : 25**

End Semester Practical/ Oral Examination/ (25 marks)

Oral Examination will be based on experiments performed in the laboratory

Recommended Books:

1.Process Equipment Design by M.V. Joshi Macmillan India.
2.Process Equipment Design- Vessel Design by E. Brownell and Edwin, H. Young. John Wiley, New York 1963.

Reference Books:

1.Chemical Engineering volume 6- Design by J.M Coulson, J.F. Richardson and P.K. Sinnot, Pregamovr press, International edition 1989.
2.Chemical Engineering Design, Fifth edition, Ray Sinnott and Cavin Towler, Elseveir, Butterworth-Heinemann publications
3. Introduction to Chemical Equipment Design- Mechanical aspects by B.C. Bhattacharya CBS Publications

Semester VII

Course Code	Course Name	Credits
CHL703	Hazard and Risk analysis Lab	01

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR/OR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Prerequisites

Knowledge of Physics, Chemistry, Mathematics, Process Calculations, Process Equipment Design, Process Engineering, Heat and Mass transfer, Thermodynamics, Chemical Reaction Engineering, Fluid flow and Process Safety.

Course Objectives

1. To give the knowledge about fire and explosion.
2. To train the students about Fire and Explosion prevention methods and Reliefs techniques.
3. To make the student aware about safety in process and plant.
4. To train the students about hazard identification and risk assessment.
5. To train the students about safety procedures and design and expert manpower to handle the complex industrial environment.
6. to use RAST and CHEF tools to analyze industrial accidents, hazards and risk.

List of Experiments (minimum eight)

Download RAST and CHEF tools from AIChE Website. It is available for FREE. This is readymade template which can be used in MS Excel/Libre office Calc. Enable Macros before using it. Also download **A Tutorial for the Risk Analysis Screening Tool (RAST) and CHEF.**

A total of 5 case studies need to be solved by using RAST-CHEF.

Download 5 case studies available on AIChE website. Complete Hazard Identification and Risk Analysis (HIRA) study for following cases:

1. Chlorine Rail Car
2. CAI and Arnel-Confined Space Explosion
3. BP Texas City-Refinery explosion and fire
4. Phillips Petroleum Company-Explosion and Fire

5. T2 Industries-Runaway Reaction and Explosion

Case study data is not fully provided for below cases. Find the relevant data from internet and enter the values. As most of these case studies are reported **AFTER** accidents and you are going to do a risk analysis **BEFORE** accident, anticipate **MORE** scenarios. The students will have to imagine more accident prone scenarios in following case studies and not only the reported ones.

6. A Massive Fire, BLEVEs, and $5 Million Damages after a Mechanic Improperly Removes a Valve Actuator-102-106, Roy E. Sanders
7. An Eight-Inch Elbow Ruptures from Internal Corrosion and A Blast Results in Worldwide Feed stocks Disruptions and An Eight-Inch Line Ruptures in Mexico City and over 500 People Die-120-121,Roy E. Sanders
8. Flixborough, England,23-25,Crowl, D. A.
9. Seveso, Italy,26-27
10. A Well-Intended Change Yields a Storage Tank Collapse, 32-36, Roy E. Sanders
11. A Severe Pump Explosion Surprises Employees, 168-170

A total of 3 practical's need to be performed from below experiments

1. Flash point
2. Fire point
3. Fire Extinguishers
4. Flammability limits of gases
5. Industrial Safety Awareness (Lecture by Industry Person/ Visit to Industry)
6. Safety Audit Format
7. Electrical Safety Awareness (Expert lecture by Electrical Background Person)

Course Outcome

At the end of the course students will be

1. able to apply the knowledge of mathematics, science, engineering fundamentals for identifying causative and initiating factors of accidents.
2. able to carry out Hazard and Risk analysis by using principles of sciences and engineering.
3. able to develop fire and explosion index and chemical exposure index by analyzing and interpreting of available data.
4. able to use IT tools such as RAST-CHEF to understand and evaluate situations causing industrial fire, explosions and evaluate risk.
5. able to prepare scenario list- guidance and maximum allowable response time for particular chemical plant/equipment
6. Students should be able to prepare Risk Assessment Matrix and Risk summery for particular plant to avoid accidents, for betterment of environment, society and communicate it with higher authorities

Assessment:

Term Work (25 marks)

Distribution of marks will be as follows:

Laboratory Work and Journal : 20 marks

Attendance	: 05 marks
Total Marks	: 25 Marks

End Semester Practical Examination/orals (25 marks)

Practical Oral Examination will be based on experiments performed in the laboratory.

Reference Books

1. Incidents that define process safety; Centre for Chemical Process Safety, AIChE,Wiley
2. More incidents that define process safety; Centre for Chemical Process Safety,AIChE,Wiley,2020
3. Chemical Process Safety Learning from Case Histories; 3rd Edition; Roy E. Sanders; Elsevier Butterworth–Heinemann 2005
4. Chemical Process Safety: Fundamentals with Applications; Crowl, D. A. and Louvar, J. P.; Prentice Hall, Englewood
5. Chemical Process Industry Safety; K. S. N. Raju, McGraw Hill Education
6. Avoiding Greenhouse Gas Emissions The Essential Role of Chemicals 17 Case Studies; International Council of Chemical Associations.

Semester VII

Course Code	Course Name	Credits
CHP701	Major Project I	03

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
	6#	-		3	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

 # Workload of learner, not faculty for project I. faculty load : semester VII – ½ hour per week per project group

Prerequisites

1. Detail knowledge of applied chemistry.
2. Fundamentals of unit operations.
3. Mass and energy balance calculations
4. Knowledge of chemical engineering economics [Demand supply analysis, rate of interests, profitability methods, depreciation methods]
5. Report writing, feasibility studies.

Objectives

1. To be able to identify advanced topic in chemical engineering based on the technology, its application, and its future potential. (problem identification)
2.To demonstrate a sound technical knowledge of the selected project topic which should be focused on solutions to industrial, societal, and environmental problems with the application of sustainable technology.
3. To carry out market study on the product and find demand supply gap for manufacturing projects.
4. To carry out thorough literature survey on the selected topic and identify research gaps for research projects.
5. To carry out profitability analysis for the selected product and technical/economic feasibility study.
6. To communicate the literature review, proposed work at various platforms for further suggestions, improvement.

Outcomes

After the completion of this project work., Students will be able to

1. Identify advanced topic in chemical engineering based on the technology, its application, and its future potential.
2. Demonstrate a sound technical knowledge of the selected project topic focused on solutions to industrial, societal, and environmental problems with the application of sustainable technology.
3. Carry out market study on the product and find demand supply gap for manufacturing projects.
4. Carry out thorough literature survey on the selected topic and identify research gaps for research projects.
5. Carry out profitability analysis for the selected product.
6. Communicate the literature review, proposed work at various platforms for further suggestions, improvement.

Guidelines:

- Project groups: Groups can be formed with minimum TWO and not more than FOUR students per group.
- Students should spend considerable time in applying all the concepts studied.
- Students are advised to take up industrial/ experimental/ simulation and/or optimization-based topics for their project.
- Students should report their guides with their work on weekly basis.
- For Project oral, external examiners, preferably from industrial background should be appointed.
- For term work marks, punctuality of the students, timely submission of the weekly progress report should be considered along with presentation before guide and departmental expert panel at the end of semester and record of the same should be maintained.

Exam Guidelines

Term Work – 25 Marks:
[• Presentation – 10 Marks
• Report -15 Marks]
Oral – 25 Marks