

# UNIVERSITY OF MUMBAI



Revised syllabus (Rev- 2016) from Academic Year 2016 -17

## **Chemical Engineering**

**Second Year** with Effect from **AY 2017-18**

**Third Year** with Effect from **AY 2018-19**

**Final Year** with Effect from **AY 2019-20**

Under

## FACULTY OF TECHNOLOGY

As per **Choice Based Credit and Grading System**

With effect from the AY 2016-17

## **From Coordinator's Desk**

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated 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 Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering 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 not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Credit grading based system was implemented for Second Year of B.E. in Chemical Engineering from the academic year 2017-2018. This system is carried forward for Third Year of B.E. in Chemical Engineering in the academic year 2018-2019 and will be implemented for Fourth Year B.E. in the year 2019-2020 respectively.

**Dr. S. K. Ukarande**

**Co-ordinator,**

**Faculty of Technology,**

**Member - Academic Council**

**University of Mumbai, Mumbai**

## **Preamble to the Revision of Syllabus in Chemical Engineering**

To match the increasing pace of development in all fields including Chemical Engineering and Biotechnology along with use of softwares for process plant and process engineering, there is demand on academicians to upgrade the curriculum in Education. The availability of free software such as Scilab, DW SIM expand the boundaries of learning. Hence, the Undergraduate Curriculum in Chemical Engineering must provide the necessary foundation for a Chemical Engineer to be able to specialize in any area as and when the need and opportunity arise. The Curriculum must integrate knowledge of the basic and advanced sciences with problem solving abilities and inclusion of technological development. 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 along with expansion. 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, a meeting was organized at Thadomal Shahani Engineering College Bandra on 17<sup>th</sup> November 2016 which was attended by Industries experts, heads of the departments and subject faculty of affiliating Institutes. The program objectives and outcomes were thoroughly discussed in this meeting and the core structure of the syllabus was formulated keeping in mind choice based credit and grading system curriculum to be introduced in this revised syllabus for B.E. (Chemical Engineering) for all 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 meetings were held to finalize the detail syllabus in Bharati Vidyapeeth College of Engineering on 13<sup>th</sup> Jan 2017, SS Jondhale College of Engineering on 27<sup>th</sup> Jan 2017, Datta Meghe College of Engineering Airoli on 20<sup>th</sup> February 2017 and 13<sup>th</sup> April 2017 and in D. J. Sanghavi College of Engineering on 17<sup>th</sup> April 2017.

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 responsibilities.
4. To prepare the student in achieving excellence in their career in Indian and Global Market.

**Dr. Kalpana S. Deshmukh,**

**Chairman, Board of Studies in Chemical Engineering (Adhoc),**

**University of Mumbai**

## General Guidelines

### Tutorials

- The number of tutorial batches can be decided based on facilities available in the institution.
- Tutorials can be creative assignments in the form of models, charts, projects, etc.

### Term Work

- Term work will be an evaluation of the tutorial/practical done over the entire semester.
- It is suggested that each tutorial/practical be graded immediately and an average be taken at the end.
- A minimum of eight tutorials/ten practical will form the basis for final evaluation.
- The total 25 marks for term work (except project and seminar) will be awarded as follows:

Tutorial / Practical Journal – 20 marks

Overall Attendance – 05

Further, while calculating marks for attendance, the following guidelines shall be adhered to:

75 % to 80%. – 03 marks

81% to 90% - 04 marks

91% onwards – 05 marks

### Theory Examination

- In general all theory examinations will be of 3 hours duration.
- Question paper will comprise of total six questions, each of 20 Marks.
- Only four questions need to be solved.
- Question one will be compulsory and based on maximum part of the syllabus.

#### Note:

In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus as far as possible.

### Practical Examination:

- Duration for practical examination would be the same as assigned to the respective Lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

## Project and Seminar Guidelines

- Project Groups: Students can form groups with minimum 2 (Two) and not more than 3 (Three)
- The load for projects may be calculated proportional to the number of groups, not exceeding two hours per week.
- The load for projects may be calculated as:  
Sem VII: ½ hr for teacher per group.  
Sem VIII: 1 hr for teacher per group.
- Each teacher should have ideally a maximum of three groups and only in exceptional cases four groups can be allotted to the faculty.
- Seminar topics will be the consensus of the project guide and the students. Each student will work on a unique topic.
- The load for seminar will be calculated as one hour per week irrespective of the number of students
- Students should spend considerable time in applying all the concepts studied, into the project. Hence, eight hours each were allotted in Project A, B and three hours for Seminar to the students.

**B.E. Semester VII (w.e.f 2019-2020)**

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC701	Process Equipment Design. (PED)	4	-	-	4	-	-	4
CHC702	Process Engineering	3	-	1	3	-	1	4
CHC703	Process Dynamics and Control (PDC)	4	-	-	4	-	-	4
CHDE703X	Department Elective III	4	-	-	4	-	-	4
ILO701X	Institute Elective I	3	-	-	3	-	-	3
CHP701	Project A	-	-	8	-	-	3	3
CHS701	Seminar	-	-	3	-	-	3	3
CHL701	PED Lab	-	3	-	-	1.5	-	1.5
CHL702	Chemical Engineering Lab X (PDC)	-	3	-	-	1.5	-	1.5
<b>Total</b>		<b>18</b>	<b>6</b>	<b>12</b>	<b>18</b>	<b>3</b>	<b>7</b>	<b>28</b>

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	Process Equipment Design. (PED)	20	20	20	80	3	-	-	-	100
CHC702	Process Engineering	20	20	20	80	3	25	-	-	125
CHC703	Process Dynamics and Control (PDC)	20	20	20	80	3	-	-	-	100
CHDE703X	Department Elective III	20	20	20	80	3	-	-	-	100
ILO701X	Institute Elective I	20	20	20	80	3	-	-	-	100
CHP701	Project A	-	-	-	-	-	100	-	25	125
CHS701	Seminar	-	-	-	-	-	50	-	-	50
CHL701	PED Lab	-	-	-	-	-	25	-	25	50
CHL702	Chemical Engineering Lab X (PDC)	-	-	-	-	3	25	25	-	50
<b>Total</b>				<b>100</b>	<b>400</b>	<b>-</b>	<b>225</b>	<b>25</b>	<b>50</b>	<b>800</b>

Department Elective III (Sem VII)		
Engineering Stream (Elective Code)	Management Stream (Elective Code)	Technology Stream (Elective Code)
1. Corrosion Engineering (CHDE7031)	1. Industrial organization and Management. (CHDE7032)	1. Petroleum Refining Technology (CHDE7033) 2. Food Technology (CHDE7034)

Institute Level Optional Subject I (Sem VII)		
1. Product Lifecycle Management (ILO7011)	4. Design of Experiments (ILO7014)	7. Disaster Management and Mitigation Measures (ILO7017)
2. Reliability Engineering (ILO7012)	5. Operation Research (ILO7015)	8. Energy Audit and Management (ILO7018)
3. Management Information System (ILO7013)	6. Cyber Security and Laws (ILO7016)	9. Development Engineering (ILO7019)

Course Code	Course/ Subject Name	Credits
<b>CHC701</b>	<b>Process Equipment Design</b>	<b>4</b>

**Prerequisites:**

- Fundamentals of units
- Elementary theory of engineering mechanics,
- Engineering drawing.
- Knowledge of heat transfer, mass transfer, mechanical operations and
- Mechanical equipment design.

**Course Objectives:**

- To understand the basic of design of heat transfer equipments.
- To understand the design of mass transfer equipments.
- To understand the basic of construction and design of high pressure vessels.
- To understand basics of flow diagrams and different equipment inspection methods.

**Course Outcomes:**

Students would be able to

- Design heat exchanger and evaporator.
- Design distillation and absorption columns.
- Design high pressure vessels.
- Explain different flow sheet presentation and equipment inspection methods.

<b>Module</b>	<b>Contents</b>	<b>Contact Hours</b>
<b>1</b>	<b>Heat exchangers</b> Introduction codes and standards for heat exchangers. Material of construction. <ul style="list-style-type: none"> <li>• Design of shell and tube heat exchanger (U-tube and fixed tube) as per IS: 4503, TEMA standards i.e., shell, tube, tube sheets, channel and channel cover, flanged joints.</li> </ul>	<b>8</b>
<b>2</b>	<b>Evaporators</b> <ul style="list-style-type: none"> <li>• Design of standard vertical evaporator with design of calendria and tube, flange evaporator drums and heads.</li> </ul>	<b>6</b>
<b>3</b>	<b>Distillation and Absorption column</b> Basic features of columns, stresses in column shell. <ul style="list-style-type: none"> <li>• Shell thickness determination at various heights, elastic stability under compression stresses, allowable deflection.</li> <li>• Column internals, design of supports for trays.</li> </ul>	<b>10</b>
<b>4</b>	<b>High Pressure Vessels</b> Materials of construction, constructional method of high pressure vessels and stress analysis. <ul style="list-style-type: none"> <li>• Design of mono block and multi layered high pressure vessels (stress distribution diagram).</li> </ul>	<b>8</b>
<b>5</b>	<b>Flow Diagram</b> <ul style="list-style-type: none"> <li>• Symbols of process equipments and their concepts</li> </ul>	<b>8</b>

	<ul style="list-style-type: none"> <li>• Flow sheet representation: <ol style="list-style-type: none"> <li>1. Block diagram</li> <li>2. Process Flow Diagram (PFD)</li> <li>3. Engineering Line Diagram (ELD or PID)</li> <li>4. Utility line Diagram (ULD)</li> <li>5. Plant Layout</li> <li>6. Tank Farm and Plot plan</li> </ol> </li> </ul>	
<b>6</b>	<b>Equipment Inspection</b> <ul style="list-style-type: none"> <li>• Methods of Inspection of Equipments <ol style="list-style-type: none"> <li>1. Radiography</li> <li>2. Ultrasound</li> <li>3. Dye Penetration</li> <li>4. Fatigue assessment test</li> </ol> </li> </ul>	<b>8</b>

### 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.

### References

1. Process Equipment Design- Vessel Design by E. Brownell and Edwin, H. Young. John Wiley, New York 1963.
2. Chemical Engineering volume 6- Design by J.M Coulson, J.F. Richardson and P.K. Sinnot, Pregamovr press, International edition 1989.
3. Introduction to Chemical Equipment Design- Mechanical aspects by B.C. Bhattacharya CBS Publications
4. Process Equipment Design by M.V. Joshi Macmillan India.

Course Code	Course/ Subject Name	Credits
CHC 702	Process Engineering	04

### Prerequisites:

- The students should have knowledge of Heat transfer and Mass Transfer to carry out Mass and Energy balance around process.



- They should be aware about basic principles of economics to evaluate cost and profit of process.
- They should be familiar with process and mechanical design of Process equipments.
- They should be familiar with various types of plant utilities.

**Course Objectives:**

- To provide training to solve problems relevant to the general practice of chemical engineering and design
- To provide experience in the process of original chemical engineering design in the areas of equipment design, process design and plant design through the process of formulating a design solution to a perceived need and then executing the design and evaluating its performance including economic considerations and societal impacts if any, along with other related constraints, and culminating in both written and oral presentation of results.
- To provide students familiarity with professional issues in chemical engineering including ethics, issues related to the global economy and to emerging technologies and fostering of important job related skills such as improved oral and written communications and experience in working in teams at a number of levels.

**Course Outcomes:**

- The graduates are expected to have ability to apply knowledge of mathematics, science and engineering.
- The graduates are expected to have ability to design a system, a component, or a process to meet the desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability and sustainability.
- The graduates are expected to possess ability to function on multi disciplinary teams.
- The graduates are expected to possess ability to identify, formulate and solve engineering problems.
- The graduates are expected to have an understanding of professional and ethical responsibility.
- The graduates are expected to engage themselves in lifelong learning.
- The graduates are expected to possess ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

<b>Module</b>	<b>Contents</b>	<b>Contact Hours</b>
<b>1</b>	<b>Introduction to Process Engineering</b> Chemical Products, Formulation of the Design Problem, Chemical Process Design and Integration, The Hierarchy of Chemical Process, Design and Integration, Continuous and Batch Processes, New Design and Retrofit , Approaches to Chemical Process	<b>06</b>

	Design and Integration, Process Control, Basic concepts regarding PFD, Block diagrams, P and ID Process flow diagram, piping and instrumentation diagram, Importance of safety and environmental aspects.	
<b>2</b>	<b>Process Design of Piping, Fluid moving Devices and Flow Meters</b> (with numerical). Process design of piping, process design of fluid moving devices, Centrifugal pump performance for viscous fluids, Revision of formulae for power requirement for fans, blowers, adiabatic compressor, Process Design for orifice and rotameter, Trouble shooting in fluid flow systems	<b>08</b>
<b>3</b>	<b>Process Design of Distillation Column</b> Selection criteria, equipment selection, distillation column design (multicomponent with numerical), FUG, Lewis Matheson method, Thiele Geddes method, Selection of tray, process design of tray tower, height of packings, Short path distillation, design and working of short path distillation, energy conservation in distillation	<b>08</b>
<b>4</b>	<b>Process Design of Absorbers</b> Selection criteria, design of absorber including multicomponent (with numerical) using shortcut methods	<b>08</b>
<b>5</b>	<b>Reactors:</b> Mass and Energy Balance for reactor, Choice of reactors-Reactor Configuration(Temperature Control, Catalyst Degradation, Gas-Liquid and Liquid-Liquid Reactors, Reactor Configuration, Reactor Configuration for Heterogeneous Solid-Catalyzed Reactions, Reactor Configuration from Optimization of a Superstructure	<b>06</b>
<b>6</b>	<b>Sizing/Costing of Equipments in Flow Sheet:</b> Distillation columns absorbers, pumps, compressors, heat exchangers(with numerical)	<b>08</b>
<b>7</b>	<b>Role and responsibilities:</b> Role and responsibility of process and chemical engineering profession towards society, environment, ethical aspects, safety concerns.	

### Tutorials

- Minimum 8 tutorials should be conducted
- At least one tutorial on each module is expected.
- Tutorial on modules 2 to 6 must include numerical problems.
- One tutorial will be presentation on any process flow sheet demonstrating all the concepts in process engineering.

### Term work

Term work should consist of minimum 8 tutorials from entire syllabus which are to be given at regular intervals batch wise.

Tutorial: 20 marks

Attendance: 05 marks  
Total: 25 marks

### 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

### Text Books

1. Process Engineering and Design: Shuchen B. Thakore, Bharat I Bhatt, Second Ed., McGraw Hill Education(I) Private Limited,2011-[modules 2,3].
2. Robin Smith, Chemical Process Design and Integration, John Wiley and Sons,[ module 1,5]
3. Systematic Methods Of Chemical Process Design, Loren T Biegler, Grossman E.I., West-berg, A.W. Prentice Hall Intl ed., 1997.[module 4,6]
4. Richard M. Felder, Ronald W. Rousseau, Elementary Principles of Chemical Processes, John Wiley & Sons [Module 5].

### References

1. Conceptual Design of Chemical Processes, J.M. Douglas, McGraw Hill International Editions, 1988
2. Chemical Process Equipment: selection & design, Walas, S.M., Butterworth, London,1980
3. Strategy of Process Engineering, John D.F. Rudd& C.C. Watson, Wiley & Sons International, 1968
4. Process Design Principles: synthesis analysis & evaluation, Sieder, W.D., Seader J.D. & Lewin D.R., John Wiley & Sons, 1998.
5. Analysis, Synthesis, and Design of Chemical Processes, Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz, PHI Learning Private Limited, New Delhi, 2011.

Course Code	Course/ Subject Name	Credits
CHC703	Process Dynamics and Control	4

### Prerequisites:

- Linear Algebra
- Differential Equations
- Laplace Transforms

**Course Objectives:**

- To understand dynamic behavior of process systems and equipments.
- To understand frequency response of dynamic systems.
- To understand and analyze stability characteristics of dynamic systems.
- To design controllers.

**Course Outcomes:**

- The student will be able to model dynamical systems
- Will be able to study their responses in Time, Laplace and Frequency domains.
- The student will be able to design stable controllers, for important chemical processes.

<b>Module</b>	<b>Contents</b>	<b>Contact Hours</b>
<b>1</b>	Introduction To Process Control Typical Control Problems A Blending Process Example Control Strategies Hierarchy of Control Activities An Overview of Control System Design	<b>04</b>
<b>2</b>	The Rationale for Dynamic Process Models General Modeling Principles Degrees of Freedom Analysis Typical Dynamic Models	<b>06</b>
<b>3</b>	Transfer Functions of Typical Systems First and Second Order Systems Properties of Transfer Functions Transfer Functions of Systems in Series Time Delay Processes Linearization of Non-linear Systems	<b>06</b>
<b>4</b>	Dynamic Behavior of Processes Standard Process inputs Response of First Order Processes Response of Second Order Processes Response of Integrating Processes	<b>08</b>
<b>5</b>	Development of Empirical Models From Process Data Fitting First and Second Order Models Using Step Tests Development of Discrete Time Dynamic Models Identifying Discrete Time Models From Experimental Data	<b>04</b>
<b>6</b>	Basic Control Modes Features of PID and On-off Control Response of Feedback Control Systems Digital Versions of PID Controllers	<b>04</b>
<b>7</b>	Closed-Loop Transfer Functions Closed-Loop Response	<b>08</b>

	Stability of closed loop systems Frequency Response Stability based on Bode criteria. Gain and Phase Margins	
8	Controller Design and Tuning Performance Criteria On-line controller Tuning Guidelines for common control loops	04
9	Control Strategies at the process unit level Degrees of Freedom Analysis for process control Selection of Controlled, Manipulated, and Measured Variables Selection of Instrumentation Typical Applications	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

### Text 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

### References

1. William L. Luyben; Process Modeling Simulation and Control for Chemical Engineers; 2nd Edition; Mc-Graw Hill Publishing Co.
2. George Stephanopoulos; Chemical Process Control; PHI Learning Pvt. Ltd.
3. Sudheer S Baghade, G.D. Nageshwar, Process Dynamics and Control; PHI learning Pvt. Ltd.
4. Prabir Kumar Sarkar, Advanced Process Dynamics and Control, PHI Learning Eastern Economy Edition.

Course Code	Name of Subject	Credits
CHDE7031	Department Elective III- Corrosion Engineering	04

### Prerequisites:

- Basic knowledge of Chemical Engineering, Physical Chemistry and Electrochemistry, Basic knowledge of Reaction Mechanism, Thermodynamics, Fluid Flow and Chemical Reaction Engineering, Various types of Material and Metals.

**Course Objectives:**

- To understand the needs for Corrosion Education, The Functions and Roles of an Engineer to prevent Corrosion.
- Understanding of basic concepts of Corrosion, Corrosion in different materials, Corrosion Electrochemistry, Corrosion Thermodynamics, Kinetics and Applications.
- To impart the interdisciplinary subject in which Chemical Engineering, Materials Engineering, Electrical Engineering, Civil Engineering and Metallurgy Engineering are involved.
- Understand the Methodology, Methods and Materials to prevent the Corrosion.

**Course Outcomes:**

Upon completion of the course, the student should be able to

- Describe the Chemistry behind the corrosion, process of corrosion, different factors affecting the rate of corrosion.
- Discuss Kinetics and different forms of corrosion and will be able to recognize the corrosion occurring in the different materials.
- Explain techniques of corrosion cells, Corrosion avoidance, corrosion failure and the various factors.
- Students shall understand how to prevent the corrosion, selection of materials for corrosion prevention, how to alter the environment for minimal rate of corrosion, different protection techniques and coating to prevent corrosion.
- Gain knowledge of corrosion by water, boilers feed water, cooling tower water and the scaling indices of water used in many processes. They will also learn about atmospheric corrosion, its tests as well as behavior and resistance to such corrosion.

<b>Module</b>	<b>Contents</b>	<b>Contact Hours</b>
<b>01</b>	<b>The Study of Corrosion</b> -Needs for Corrosion Education, The Functions and Roles of a Corrosion Engineer, The Corrosion Engineer's Education, Strategic Impact and Cost of Corrosion Damage. <b>Corrosion Basics</b> -Why Metals Corrode, Matter Building Blocks, Acidity and Alkalinity (pH), Corrosion as a Chemical Reaction, Corrosion in Acids, Corrosion in Neutral and Alkaline Solutions.	<b>06</b>
<b>02</b>	<b>Corrosion Electrochemistry</b> - Electrochemical Reactions, Anodic Processes, Faraday's Law, Cathodic Processes, Surface Area Effect. <b>Corrosion Thermodynamics</b> -Free Energy, Standard Electrode Potentials, Nernst Equation, Thermodynamic Calculations, Reference Half-Cells (Electrodes), Measuring the Corrosion Potential, Measuring pH, Potential-pH Diagram.	<b>08</b>
<b>03</b>	<b>Corrosion Kinetics and Applications of Electrochemistry to Corrosion</b> -What Is Over potential? Activation Polarization,	<b>06</b>

	Concentration Polarization, Ohmic Drop, Graphical Presentation of Kinetic Data(Evans Diagrams), Examples of Applied Electrochemistry to Corrosion	
<b>04</b>	<b>Eight Forms of Corrosion</b> -Recognizing Corrosion, General or Uniform Attack, Galvanic or Two metal Corrosion, Crevice Corrosion, Pitting, Intergranular, Selective Leaching, Erosion Corrosion, Stress Corrosion, Hydrogen Damage.	<b>08</b>
<b>05</b>	<b>Corrosion Failures, Factors, and Cells</b> - Introduction, Information to Look For, Identifying the Corrosion Factors, Examples of Corrosion Cells, Corrosion Avoidance, Visualizing Corrosion Cells.	<b>06</b>
<b>06</b>	<b>Corrosion Prevention</b> - Materials Selection, Alteration of Environment, Design, Cathodic and Anodic Protection, Coatings.	<b>06</b>
<b>07</b>	<b>Corrosion by Water</b> - Importance of Water, Corrosion and Water Quality and Availability, Types of Water, Cooling Water Systems, Steam Generating Systems, Water Treatment, Scaling Indices. <b>Atmospheric Corrosion</b> - Introduction, Types of Corrosive Atmospheres, Factors Affecting Atmospheric Corrosion, Measurement of Atmospheric Corrosivity Factors, Atmospheric Corrosivity Classification Schemes, Atmospheric Corrosion Tests, Corrosion Behavior and Resistance.	<b>08</b>

### Assessment

#### Internal:

- Assessment consists of an 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 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.

### Textbook/References Book

1. Pierre R. Roberge, Handbook of Corrosion Engineering, McGraw-Hill Publication
2. Mars G. Fontana, Corrosion Engineering, McGraw-Hill Book Company
3. Pierre R. Roberge, Corrosion Engineering Principles and Practice, McGraw-Hill Publication
4. Zaki Ahmad, Principles of Corrosion Engineering and Corrosion Control, Butterworth-Heinemann Publication
5. By Branko N. Popov, Corrosion Engineering: Principles and Solved Problems, Elsevier Publication

<b>Course Code</b>	<b>Name of Subject</b>	<b>Credits</b>
<b>CHDE7032</b>	<b>Department Elective III- Industrial Organization and Management</b>	<b>04</b>

**Prerequisites**

- Communication skills
- Basic Mathematical skills
- Analytical, logical and reasoning skills
- Operations Research



**Course Objectives:**

- To understand basic concepts business, administration and management
- To understand functions of management such as planning, organizing and decision making
- To understand corporate/company governance structures and laws governing industries
- To understand production and quality management
- To understand basics of marketing and sales management
- To understand financial management of companies

**Course Outcomes:**

5. Students will be able to use concepts and knowledge of management to excel in their career
6. Students should be able to prepare detailed plans, organization structures and able to use modern tools for decision making
7. Students should be able to use the knowledge of corporate government structures and government law to upgrade their skills
8. Students should be able to use concepts of production and quality management to improve productivity and quality in manufacturing plants
9. Students should be able to use concepts of marketing and sales to improve profitability of business they will work in future
10. Students should be able to use tools of finance and accounting to keep control and improve profitability of industry they are working in.

<b>Module</b>	<b>Contents</b>	<b>Contact Hours</b>
<b>1</b>	<b>Introduction to business and management</b> Business: Definition, Characteristics, Divisions, Objectives, Management of business Administration, Organization. Management: Definitions, characteristics, nature, principles, Objectives, difference between policies-goals-objectives role of manager and required managerial skills, Difference of relationship between business, administration and management, types of management, Typical management structure, management structure chart for medium scale industry, difference between management and administration, development of management thought:-Taylor, Fayol, Follet, Gilbreth, Gantt (in brief)	<b>5</b>
<b>2</b>	<b>Functions of management:</b> forecasting, planning, organizing, staffing, directing, controlling, coordinating, decision making (brief), <b>Planning:-</b> type of plans, steps in planning, management business objectives ( <b>MBO</b> ) <b>Organization:</b> Concept, definition, importance, characterization, process, principles of healthy organization, organization planning, organizational structure, design of organization	<b>7</b>

	<p>structure, process of organization, organization chart, types of organizations: military, functional, line and staff, committee, matrix; departmentalization, span of management, delegation of authority, decentralization, organizational conflict</p> <p><b>Decision making:</b> importance, types, theories, techniques, decision making process, scientific approach to decision making, guidelines for effective decision making, quantitative methods in decision making, markov analysis. Numericals based on decision making quantitative methods</p>	
<b>3</b>	<p><b>Corporate Management Structures and laws governing industries</b> Industrial ownership: types of company ownership: single ownership, partnership, joint stock company, cooperative ,government companies; organs of company management and their functions(shareholders, board of directors, CEO, managing director, manager, secretary),state regulation of management, company law board, company meetings and resolutions. Companies act</p> <p><b>Industries (Development and Regulation) Act, Contract Law, Indian Sale of Goods Act, Foreign Exchange Management Act, Foreign Exchange Regulation Act , labor laws, factories act, payment of wages act, minimum wages act, workmen’s compensation act, industrial disputes act, employees state insurance act, Union and industrial labor relations :trade unions and industrial relations, types of industrial disputes, settlements of industrial disputes, collective bargaining, handling of grievances and disputes</b></p>	<b>7</b>
<b>4</b>	<p><b>Production and quality management</b> Production system, input -output model, application of microeconomics to industries, productivity and measures to increase productivity. Objectives and activities of production planning and production control, major steps in planning and control: routing, scheduling, dispatching, follow-up and expediting, types of production systems, supervision and functions of supervisor. Definition of quality, dimensions of quality, Deming’s 14 points for management, Juran's quality trilogy, TQM,ISO 9000,ISO14000 Quality control meaning, objectives, benefits, steps, Inspection, cost of quality ,quality control tools for improvement, Quality circles, statistical quality control</p>	<b>6</b>
<b>5</b>	<p><b>Marketing and sales management:</b> Sales management, sales organization, functions of sales department, duties of sales manager, the selling and marketing</p>	<b>6</b>

	concept. Marketing: definition, principle and ,marketing management and its functions, marketing research, pricing policies, sales forecasting, marketing mix, advertising, sales promotion, channels of distribution, pricing, product mix and, international marketing	
<b>6</b>	<b>Financial Management:</b> Definition, difference between finance and accounts, functions of financial management, objectives of financial management, role and scope of financial management Sources of finance, cash management, capitalization. Definitions of assets, liabilities, book keeping, capital and types of capital, discounts, commission, debtor, creditor, turnover. Mechanics of accounting: cash books, sales book, purchase book, debit/credit note, journal, ledger. Financial accounting, accounting equation, balance sheet, income statements, preparation and analysis of financial statements, analysis and interpretation of financial statements, cash flow statements, ratio analysis <b>Management information system: MIS</b> Definition, objectives, functions, Difference between data and information, information as organizational resource, qualities of good information, management information categories, designing information systems, integrated information systems. Numericals	<b>7</b>

### Assessment

#### Internal:

- Assessment consists of an 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 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.

### Textbook/References Book

1. Industrial Engineering and Management-O.P. Khanna, Dhanpat Rai publications (Module 1,2,3,4,5,6)
2. Fundamentals of Business Organization and Management, Y.K. Bhushan, S. Chand (Module 1,2,3)
3. Industrial Organization and Management: Dani, Sabhalok, Parikh, Shahani-Mananprakashan (Module 1,2,3,4)
4. Engineering Management, A.K. Gupta, S.Chand (Module 1,4,5,6)
5. Basic Financial Accounting for Management, Paresh Shah, Oxford press(Module

- 6)
6. Industrial Organization and Management, Basu S.K ,Prentice Hall India Learning Private Limited (1,2,3,4)
  7. NPTEL Course Notes, Managerial Science II(Module 1,2,3,4,5)

<b>Course Code</b>	<b>Course/ Subject Name</b>	<b>Credits</b>
<b>CHDE7033</b>	<b>Department Elective III- Petroleum Refining Technology</b>	<b>4</b>

**Prerequisites:**

- Knowledge about Formation & Origin of petroleum, Composition & testing methods& Basic treatment techniques.

**Course Objectives:**

- To understand Petroleum Refining processes & products, its evaluation & treatment techniques

- To understand various cracking processes & its applications in Chemical industries.

**Course Outcome:**

- Characterize crude petroleum and petroleum refinery
- Fractionate crude petroleum into useful fractions
- Measure important physical properties of petroleum products
- Apply refinery processes to maximize desired petro products
- Use treatment techniques to purify petro products
- Manufacture widely used petrochemicals

Module	Contents	Contact Hours
1	<b>Introduction -Origin ,Formation &amp; Composition of Petroleum:</b> Importance, Origin theory, Reserves in India & world. Exploration of Reserves, Types of crude, (Based on constituents, Sulfur contents & Degree API). Indian crude reserves & production scenario, Indian Petroleum Industry Scenario, Agencies engaged in upstream & downstream petroleum industry (Government & Private).	05
2	<b>Crude Oil Assay:</b> Properties, composition, UOP Characterization factors, Correlation index, Crude distillation curves. Important products test & methods, Gasoline, Kerosene, Diesel.	06
3	<b>Crude Oil Processing &amp; Refining:</b> Separation of well fluid, Dehydration & desalting of crude, Heating of crude, Overall refinery flow diagram, its processes & Products, Low boiling products –LPG, Gasoline, Kerosene & their Specifications. Multi component fractionation of petroleum including pump around & side stripping, ADU & VDU, Blending of gasoline, Corrosion problem.	12
4	<b>Treatment ,Techniques &amp; Product Specifications:</b> Treatment of Gasoline, Kerosene, Lubes & Wax.	08
5	<b>Catalytic Cracking &amp; Thermal Processes:</b> Fluidized bed catalytic cracking, Catalytic reforming, Coking, Hydrogen Processes- Hydro cracking & Hydrodesulphurization, Alkylation Process, Isomerization process, Polymer gasoline.	10
6	<b>Asphalt Technology &amp; Environmental issues:</b> Source of Asphalt, Air blowing of Bitumen, Brief review of Bio refinery, Environmental issues in Petroleum industry, Alternative energy sources (Bio Diesel, Heavy Oil, Shale Oil).	07

**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.

**References**

1. B.K Bhaskara Rao, Modern Petroleum Refining Process.
2. W.L Nelson, Petroleum Refinery Engineering 4th ed, McGraw Hill.
3. Petroleum Chemistry and Refining Edited by James G. Speight, Taylor and Francis .
4. Chemical Process Industries, Austin, G.T Shreves.
5. Encyclopedia of chemical processing and design by John J. McKhetta; Marcel Dekker, Inc.

<b>Course Code</b>	<b>Course/ Subject Name</b>	<b>Credits</b>
<b>CHDE7034</b>	<b>Department Elective III : Food Technology</b>	<b>04</b>

**Prerequisites:**

- Knowledge of Microbiology, Biochemistry, chemical engineering

**Course Objectives:**

- To impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation, food adulteration, food related hazards and safety.

**Course Outcomes:**

- Knowledge of food essential nutrients and the various causes of food deterioration.
- Identification of appropriate processing, preservation, and packaging method.
- Students should be able to analyze product quality and effect of processing technique on it.
- They should Identify important species of pathogenic microbes and describe factors that affect their growth in various types of food.
- Analysis of food related hazards and HACCP method

<b>Module</b>	<b>Contents</b>	<b>Contact Hours</b>
<b>1.</b>	<b>Food Biochemistry and Food Microbiology:</b> Food Constituents: Carbohydrates, Proteins, Vitamins, Lipids, And Minerals, Flavors, Water, Nutritional & sensory characteristics, Food fortification. Water activity enzymes: Production from microorganisms and application in food processing, Growth of microorganisms and food spoilage, D & Z values, Indian laws regulating Foods and Foods processing	<b>06</b>
<b>2</b>	<b>Ambient Temperature Process:</b> Raw material preparation, Size reduction of solid fibrous foods and in liquid foods., Emulsification and Homogenization ,Theory and equipment , Mixing and Forming, Extraction and expression , Membrane concentration Fermentation : Theory , Types, Equipment Effect on foods	<b>08</b>
<b>3</b>	<b>Thermal Processing:</b> Theory, Equipment, Effect on foods, blanching, extrusion, pasteurization, Heat Sterilization, In-container Ultra high temperature (UHT)/aseptic processes, Microbial spoilage, thermal death time curve.	<b>08</b>
<b>4</b>	<b>Freezing and Refrigeration:</b> Types, Equipments, refrigerants, effects of low temperature on quality, chilling, freezing , freeze drying and freeze concentration	<b>08</b>
<b>5</b>	<b>Food Storage &amp; Packaging:</b> Modified Atmosphere Storage(MAS) , Hurdle Technology, Modified atmosphere packaging(MAP) <b>Food Adulteration &amp; Quality Management:</b> Food Adulteration and food safety. HACCP, GMP, GHP, GLP.	<b>06</b>
<b>6</b>	<b>Food Processing:</b> Manufacturing and processing of food products: Fruit juice processing, Alcoholic beverages, Milk and Milk Products; Milk powder, cheese, Ice cream, Tea coffee, cocoa, Bread , Biscuits , confectionary(hard boiled sweets & chocolates)	<b>08</b>

**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.

### **Text Book**

1. Fellows, P., Food Processing Technology: Principles and Practice , 2nd ed., Woodhead Publishing Ltd., England , 2000.

### **Reference Books**

1. Toledo, R., Fundamentals of Food Process Engineering, 2nd ed., CBS Publishers & Distributors, New Delhi, 1997.
2. Sharma K., et.al., Food Process Engineering, Theory and Laboratory Experiments, John Wiley and Sons Inc., Canada 2000.
3. Pandey and Srivastava , Chemical Process Technology , Vol.2
4. Singh, R.P. & Heldman , D.R., Introduction to Food Engineering, 3rd ed., Academic press, UK 2001.
5. Lelieveld, H.L.M., et.al. Hygiene in Food Processing, Woodhead Publ. Ltd., England 2003.
6. Subbulakshmi G. & Udipi S.A., Food Processing and Preservation, New Age International Pvt. Ltd., India 2001.
7. Valentas, k.J.et.al., Food Processing Operations and scale up, Marcel Dekker, N.Y 1991.
8. Tamb, I.A. and Singh R.P., Food Storage Stability CRC Press 19981.
9. D. G. Rao, Fundamentals of Food Engineering, PHI Learning Pvt. Ltd.

<b>Course Code</b>	<b>Course Name</b>	<b>Credits</b>
<b>ILO7011</b>	<b>Institute Level Optional Subject I- Product Life Cycle Management</b>	<b>03</b>

### **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

<b>Module</b>	<b>Detailed Contents</b>	<b>Contact Hours</b>
<b>01</b>	<b>Introduction to Product Lifecycle Management (PLM):</b> 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 <b>PLM Strategies:</b> Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM.	<b>10</b>
<b>02</b>	<b>Product Design:</b> 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 Product Development (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.	<b>09</b>
<b>03</b>	<b>Product Data Management (PDM):</b> 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.	<b>05</b>
<b>04</b>	<b>Virtual Product Development Tools:</b> 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.	<b>05</b>
<b>05</b>	<b>Integration of Environmental Aspects in Product Design:</b>	<b>05</b>

	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.	
<b>06</b>	<b>Life Cycle Assessment and Life Cycle Cost Analysis:</b> 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.	<b>05</b>

### 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

Course Code	Course Name	Credits
ILO7012	Institute Level Optional Subject I- Reliability Engineering	03

### 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	<b>Probability theory:</b> Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. <b>Probability Distributions:</b> Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. <b>Measures of Dispersion:</b> Mean Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	<b>Reliability Concepts:</b> Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. <b>Failure Data Analysis:</b> Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. <b>Reliability Hazard Models:</b> Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	<b>System Reliability:</b> System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	<b>Reliability Improvement:</b> 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	<b>Maintainability and Availability:</b> 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.	
<b>06</b>	<b>Failure Mode, Effects and Criticality Analysis:</b> Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	<b>05</b>

### 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.

Course Code	Course Name	Credits
ILO7013	Institute Level Optional Subject I- Management Information System	03

### 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: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

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

Course Code	Course Name	Credits
ILO7014	Institute Level Optional Subject I- Design of Experiments	03

**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
<b>01</b>	<b>Introduction</b> 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	<b>06</b>
<b>02</b>	<b>Fitting Regression Models</b> 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	<b>08</b>
<b>03</b>	<b>Two-Level Factorial Designs and Analysis</b> 3.1 The $2^2$ Design 3.2 The $2^3$ Design 3.3 The General $2^k$ 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	<b>07</b>
<b>04</b>	<b>Two-Level Fractional Factorial Designs and Analysis</b> 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	<b>07</b>

	4.6 Fractional Factorial Split-Plot Designs	
<b>05</b>	<b>Conducting Tests</b> 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	<b>07</b>
<b>06</b>	<b>Taguchi Approach</b> 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	<b>04</b>

### 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. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3<sup>rd</sup> 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, 2<sup>nd</sup> 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



Course Code	Course Name	Credits
ILO7015	Institute Level Optional Subject I- Operations Research	03

### 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	<p><b>Introduction to Operations Research:</b> Introduction, Structure of the Mathematical Model, Limitations of Operations Research</p> <p><b>Linear Programming:</b> 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, <b>Duality</b>, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p><b>Transportation Problem:</b> 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.</p> <p><b>Assignment Problem:</b> Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem</p>	14

	<b>Integer Programming Problem:</b> Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
<b>02</b>	<b>Queuing models:</b> queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	<b>05</b>
<b>03</b>	<b>Simulation:</b> 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	<b>05</b>
<b>04</b>	<b>Dynamic programming.</b> Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	<b>05</b>
<b>05</b>	<b>Game Theory.</b> 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.	<b>05</b>
<b>06</b>	<b>Inventory Models:</b> Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	<b>05</b>

### 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
ILO7016	Institute Level Optional Subject I- Cyber Security and Laws	03

**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	<b>Introduction to Cybercrime:</b> 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	<b>Cyber offenses &amp; Cybercrime:</b> 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	<b>Tools and Methods Used in Cyberline</b> 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	<b>The Concept of Cyberspace</b> 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 for Electronic Data Interchange Law Relating to Electronic Banking,	8

	The Need for an Indian Cyber Law	
<b>05</b>	<b>Indian IT Act.</b> Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	<b>6</b>
<b>06</b>	<b>Information Security Standard compliances</b> SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	<b>6</b>

### 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. Kenneth 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
ILO7017	Institute Level Optional Subject I- Disaster Management and Mitigation Measures	03

### 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

	<p>in disaster management.</p> <p>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 to proceed in due course of time, study of flowchart showing the entire process.</p>	
<b>04</b>	<p>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 of casualties, set up of emergency facilities, importance of effective communication 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.</p>	<b>06</b>
<b>05</b>	<p>Financing Relief Measures: Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.</p>	<b>09</b>
<b>06</b>	<p>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 disaster preparedness, 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.</p>	<b>06</b>

## 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 Elsevier 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 level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO7018	Institute Level Optional Subject I- Energy Audit and Management	03

**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
<b>01</b>	<b>Energy Scenario:</b> 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	<b>04</b>
<b>02</b>	<b>Energy Audit Principles:</b> 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)	<b>08</b>
<b>03</b>	<b>Energy Management and Energy Conservation in Electrical</b>	<b>10</b>



	<p><b>System:</b> Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings.</p> <p><b>Energy efficiency measures in lighting system, Lighting control:</b> Occupancy sensors, daylight integration, and use of intelligent controllers.</p> <p>Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.</p>	
<b>04</b>	<p><b>Energy Management and Energy Conservation in Thermal Systems:</b> 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.</p> <p>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.</p>	<b>10</b>
<b>05</b>	<p><b>Energy Performance Assessment:</b> 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.</p>	<b>04</b>
<b>06</b>	<p><b>Energy conservation in Buildings:</b> Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources</p>	<b>03</b>

### 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](http://www.energymanagertraining.com)
9. [www.bee-india.nic.in](http://www.bee-india.nic.in)

Course Code	Course Name	Credits
ILO7019	Institute Level Optional Subject I- Development Engineering	03

**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.	
<b>5</b>	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.	<b>04</b>
<b>6</b>	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education.	<b>04</b>
<b>7</b>	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.	<b>06</b>
<b>8</b>	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	<b>04</b>

## 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 or society 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 (73<sup>rd</sup>GoI, 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

Course Code	Course Name	Credits
<b>CHP701</b>	<b>Project-A</b>	<b>03</b>
<p><b>Guidelines:</b></p> <ul style="list-style-type: none"> <li>• Project groups: Groups can formed with minimum TWO and not more than THREE students per group.</li> <li>• Students should spend considerable time in applying all the concepts studied, into the Project, hence, eight hours each are allotted in project A and B to the students.</li> <li>• Students are advised to take up industrial/ experimental/ simulation and/or optimization based topics for their project.</li> <li>• Students should report their guides with their work on weekly basis.</li> </ul> <p><b>Exam Guidelines</b></p> <p><b>Term Work - 100 Marks:</b></p> <ul style="list-style-type: none"> <li>• Presentation – 50 Marks</li> <li>• Report -50 Marks</li> </ul> <p><b>Oral – 25 Marks</b></p>		

Course Code	Course Name	Credits
<b>CHS701</b>	<b>Seminar</b>	<b>03</b>
<p><b>Guidelines:</b></p> <ul style="list-style-type: none"> <li>• Each student has to present Seminar on the topic which will be the consensus of the project guide and the student, considering the recent development in the field of Chemical Engineering.</li> <li>• The load for seminar will be calculated as one hour per week irrespective of the number of students</li> </ul> <p><b>Exam Guidelines</b></p> <p><b>Term Work - 50 Marks:</b></p> <ul style="list-style-type: none"> <li>• Seminar Presentation – 25 Marks</li> <li>• Report -25 Marks</li> </ul>		

Course Code	Course Name	Credits
CHL701	Process Equipment Design Lab	1.5

### Concept of Lab

The practical shall include Design and Drawing of:

Minimum TEN practicals should be performed

1. Heat Exchangers
2. Short Tube vertical Evaporator
3. Distillation Column
4. High Pressure vessels

With respect to:

- Symbols
- P & I D
- Plot plan and Tank farm
- Plant Layout

### Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

**Total: 25 marks**

Course Code	Course Name	Credits
CHL702	Chemical Engineering Lab X (PDC)	1.5

Minimum of TEN experiments should be performed from the modules of Theory Course Process Dynamics and Control (CHC703)

#### **Term work**

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

**Total: 25 marks**

#### **Practical Examination**

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.



**University of Mumbai**  
**Program Structure for B.E. Chemical Engineering (Revised 2016)**  
**B.E. Semester VIII (w.e.f 2019-2020)**

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC801	Modeling, Simulation & Optimization (MSO)	4	-	-	4	-	-	4
CHC802	Project Engineering & Entrepreneurship Management	3	-	1	3	-	1	4
CHC803	Energy System Design	3	-	1	3	-	1	4
CHDE804X	Department Elective IV	4	-	-	4	-	-	4
ILO802X	Institute Elective II	3	-	-	3	-	-	3
CHP801	Project B	-	-	8	-	-	6	6
CHL801	Chemical Engineering Lab XI (MSO)	-	2	-	-	1	-	1
<b>Total</b>		<b>17</b>	<b>2</b>	<b>10</b>	<b>17</b>	<b>1</b>	<b>8</b>	<b>26</b>

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						
CHC801	Modeling, Simulation & Optimization (MSO)	20	20	20	80	3	-	-	-	100
CHC802	Project Engineering & Entrepreneurship Management	20	20	20	80	3	25	-	-	125
CHC803	Energy System Design	20	20	20	80	3	25	-	-	125
CHDE804X	Department Elective IV	20	20	20	80	3	-	-	-	100
ILO802X	Institute Elective II	20	20	20	80	3	-	-	-	100
CHP801	Project B	-	-	-	-	-	100	-	50	150
CHL801	Chemical Engineering Lab XI (MSO)	-	-	-	-	2	25	25	-	50
<b>Total</b>				<b>100</b>	<b>400</b>	<b>-</b>	<b>175</b>	<b>25</b>	<b>50</b>	<b>750</b>

Department Elective IV (Sem VIII)		
Engineering Stream (Course Code)	Management Stream (Course Code)	Technology Stream (Course Code)
1. Advanced Process Control (CHDE8041)	1.Total Quality Management (CHDE8042)	1. Advanced Separation Technology (CHDE8043) 2. Polymer Technology (CHDE8044)

Institute Level Optional Subject II (Sem VIII)		
1. Project Management (ILO8021)	4. Human Resource Management (ILO8024)	7. IPR and Patenting (ILO8027)
2. Finance Management (ILO8022)	5. Professional Ethics and CSR (ILO8025)	8. Digital Business Management (ILO8028)
3. Entrepreneurship Development and Management (ILO8023)	6. Research Methodology (ILO8026)	9. Environmental Management (ILO8029)

Course Code	Name of Subject	Credits
CHC801	Modelling Simulation and Optimization	04

**Prerequisites:**

- Linear Algebra, Process Calculations, Computer Programming

**Course Objectives:**

- To make students understand writing and solving models of chemical engineering system
- To make students understand writing and solving systems of nonlinear equations for single and multiple units
- To make students understand simulation of complete flowsheets
- To make students understand optimization of single and multiple units

**Course Outcomes:**

- The students will be able to write and solve models of chemical engineering system.
- The students will be able to carry out sequential and equation oriented simulation of complete flowsheets.
- The student will be able to optimize typical chemical processes.

Module	Contents	Contact hrs
01	Modeling Aspects: 1.1 Definition of process model, physical and mathematical modeling, classification of models, model building, classification of mathematical methods 1.2 Mathematical Models of Chemical Engineering Systems: Introduction, uses of mathematical models, scope of coverage, principles of formulation, fundamental laws, continuity equations, energy equations, equation of motion, transport equation, equation of state, equilibrium, kinetics.	08
02	Examples of Mathematical Models of Chemical Engineering Systems: Introduction, series of isothermal, constant-hold up CSTR, CSTR with variable holds up, two heated tanks, gas-phase, pressurized CSTR, non-isothermal CSTR, single-component vaporizer, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup. Degree of Freedom analysis Concept of design and rating problem in context of selection variables after DOF analysis.	10
03	Introduction to Simulation, Sequential and Equation oriented Simulation, Flowsheet topology analysis, Recycle, Partitioning and Tearing of flow sheets. Simulation Examples, Williams Otto Flowsheeting	08

<b>04</b>	Numerical Methods for solving sets of nonlinear equations, Newton's method with Armijo Line search, Successive substitution. Solution for models developed in module 2	<b>08</b>
<b>05</b>	Introduction to Optimization. Unconstrained single and multi variable non-linear optimization. Numerical methods for single and multivariable optimization. Golden section and Newton's method, for Single variable case, and Gradient and Newton's method for multi-variable cases may be considered. Optimization of specific process units such as Heat exchangers, Reactors, Separation equipment etc. can be considered.	<b>16</b>

### 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 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.
- Weightage of marks should be proportional to number of hours assigned to each Module.

### Reference

1. William Y.Luyben, Process Modelling simulation and control for chemical Engineer, Second edition McGraw Hill
2. Thomas Edger, David M. Himmelbleau, Optimization of chemical processes, 2nd Ed., John Wiley
- 3.Lorenz T. Beigler, Ignacio E. Grossman, Arthur W. Wesburg, Systematic Methods of Chemical Process Design, Prentice Hall

Course Code	Course/ Subject	Credits
CHC802	Project Engineering and Entrepreneurship Management	04

**Prerequisites:**

- Communication skills, Mathematical skills, Analytical, logical and reasoning skills

**Course Objectives:**

- To understand basic concepts project management and application of PM to process industries
- To understand project feasibility reports and learn about various clearances required to start an industry
- To learn various project organizations and basics of contracting
- To learn various tools and techniques used in PM and understand role of entrepreneurship in the society for the economic growth.

**Course Outcomes:**

Students will be able to use

- concepts and knowledge of project management to manage projects in process industries
- Students should be able to prepare feasibility reports.
- Students should be able to understand various clearances required to start industry
- Students should be able to prepare project organization charts and contracts
- Students should be able to prepare contracts
- Students should be able to use tools of PM to solve problems and will be motivated to become entrepreneurs

Module	Name of module and contents	Contact Hours
1	<p><b>Concepts of project management:</b>            Definition of project, project management, project types, project life cycle: purpose, inputs, project manager's role and outputs, Tools and techniques in project management, major knowledge areas of project management , Difference between project management and formal management, Role-responsibilities and skills of project manager, project overruns            Project management in process industries: project strategy, project specification, project engineering, detailed design, procurement, construction, commissioning and closure            Case studies : swagraha constructions, Advanced recycling sciences, superclean paperboards, Instron manufacturing company, Ind constructions, Goshe Corporation, accorn, govt of India bridge project Delhi, Jharkhand project</p>	10

2	<p><b>Feasibility report, licensing and clearances</b></p> <p>Feasibility reports: Raw material survey, Market survey and demand study, technical study, location survey, financial survey and types of cost estimates, Estimation of project profitability Industrial license and LOI, Various laws &amp; regulations governing industries, need for clearances and influences on project, List of various clearances.</p> <p>Case studies: Discussion of feasibility report for soap/mustard oil / ready to eat snacks, Decotile corporation, SIRIS pharma Hyderabad, coal fired boilers project, plant on river Yangtze, IC software, temples and towers. Numerical based on cost benefit analysis, profitability, cost estimation</p>	06
3	<p><b>Project organization and contracting</b></p> <p>Project scope, project priorities, development of WBS, Development of process breakdown structure, 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</p> <p>Case study: Hindustan oil company: Hamad petroleum company, corel production systems, Jones and Shephard Accountants, White manufacturing, Hotel pulkeshi international</p>	06
4	<p><b>Tools and techniques in project Management and entrepreneurship:</b></p> <p>Health-safety and environmental guidelines for chemical plants Quality assurance, Hazard analysis, Risk analysis and management, Change Management. Cost benefit analysis, Project execution plan (PEP), Bar charts/GANTT charts, LOB, Networking techniques (PERT/CPM), Productivity budgeting techniques, Value engineering (VE) , ABC and VED Analysis , Economic Order Quantity (EOQ), CAT vs RAT, Time and cost control tools and techniques. Use of Microsoft projects.</p> <p>Entrepreneurship: Definition, Concept of entrepreneur and entrepreneurship, Characteristics, aspects, factors affecting entrepreneurship, Classification and types of entrepreneurship based on business, technology, motivation, growth and stages of development.</p> <p>Case: Prima industries, Rudra offshore, Bhargava oils case, Acme Corporation. Numerical based on topics mentioned above.</p>	08

**Term-work Marks: 25 Marks**

- Assignments : 20 Marks

- Attendance : 05 Marks

A total of 10 tutorials need to be conducted. At least one tutorial on each module is expected. Six tutorials will be based on case studies and 4 tutorials based on numerical

## **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.

## **References**

1. Project Management, Choudhary, S., Tata McGraw Hill(module 1 to 4)
2. Total Project Management, Joy, P. K.,(module 1 and 2)
3. Project Management for process Industries, Gillian Lawson, I chem. E (Module 1 and 4)
4. Project Management Case Studies, Harold Kerzner, Second edition, John Wiley and Sons (for case studies)
5. Project Management Methodology Guidelines, City of Chandler (Module 1)
6. Project Management-The Managerial Process, Clifford Gray, 6th edition, McGraw Hill (module 1, 2, 3)
7. Plant Design and Economics for Chemical Engineers, Klaus D Timmerhaus, 5th edition, McGraw Hill (Module 2 and 4)
8. Theory and problems in financial management, Khan, M.Y.; Jain, P.K.; Second Edition, Tata McGraw Hill (Module 2 and 4)
9. Fundamentals of Financial Management, Vyuptakesh Sharan, Second Edition, Pearson publications(module 2 and 4)
10. Dynamics of entrepreneurial development and management, Vasant Desai (module 4)

<b>Course Code</b>	<b>Course/ Subject Name</b>	<b>Credits</b>
<b>CHC803</b>	<b>Energy System Design</b>	<b>4</b>

**Prerequisites:**

- The students should have knowledge of Heat transfer to carry out Energy balance.
- They should be aware about basic principles of economics to evaluate cost and profit of energy efficient operations/modifications/techniques.
- They should be familiar with various types of plant utilities.
- They should be familiar with basic Industrial systems/operations like, HVAC, Lighting,
- Steam, Refrigeration, etc.

**Course Objectives:**

- To provide training to solve problems relevant to the energy conservation.
- To provide students the knowledge in planning conducting energy audit, energy survey, and evaluate energy conservation opportunities.
- To provide knowledge to design and evaluate energy efficient technologies such as heat exchanger networks, multiple effect evaporators, co-generation, etc.

**Course Outcomes:**

- The graduates should able to design an energy system to meet the desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability and sustainability.
- The graduates should able to function on multidisciplinary teams, identify, formulate and solve engineering problems.
- The graduates are expected to have knowledge of professional and ethical responsibility.
- The graduates should able to use the techniques, skills, and modern engineering tools necessary for engineering practice.

<b>Module</b>	<b>Contents</b>	<b>Contact Hours</b>
<b>1</b>	<b>Energy Audit:</b> Energy audit methodology, Types of energy audit, instrumentation used in energy audit, Safety considerations during energy audit, Post audit analysis.	<b>02</b>
<b>2</b>	<b>Energy Efficient Technologies:</b> Energy efficient techniques for lighting system, motors, belt and drives system, fans and pumps system, compressed air system; steam system, refrigeration system.	<b>02</b>
<b>3</b>	<b>Energy Integration in The Process Industries:</b> Temperature Pinch analysis, concept of minimum number of heat exchangers, Heat Exchanger Network design, Threshold approach temperature difference, targeting for number of shells, Area targets, Optimum approach temperature difference	<b>13</b>

<b>4</b>	<b>Heat Integration in Process Units:</b> Heat integration of Multiple effect evaporators (MEE) with background process. Heat integration MEE with and without vapour re-compression: mechanical vapour re-compression, thermal vapour re-compression. Distillation column: heat integration in distillation column – multiple effect distillation, heat pumping, vapour re-compression, Reboiler flashing. Different arrangements of heat integration of columns with background process.	<b>10</b>
<b>5</b>	<b>Co-generation:</b> Definitions, Brayton cycle, Rankine cycle, topping cycle, bottoming cycle, combined cycle. Steam turbine system, gas turbine system, combined gas steam turbine system, diesel engine system. Heat integration and cogeneration.	<b>06</b>
<b>6</b>	<b>Waste Heat Recovery (WHR):</b> Waste heat sources, quality and classification of waste heat and its applications. Benefits of WHR. WHR equipments like recuperators, radiation/convective hybrid recuperator, ceramic recuperator, regenerator, heat wheel, heat pipe, waste heat boiler, economizer, heat pumps.	<b>03</b>
<b>7</b>	<b>Global Energy Scenario:</b> national and international.	Assignment

### Term work

Term work should consist of minimum 8 tutorials from entire syllabus which are to be given at regular intervals batch wise.

Tutorial: 20 marks

Attendance: 05 marks

Total: 25 marks

### 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

### Text Books:

1. Robin Smith, Chemical Process Design and Integration, Wiley India, 2005. [Module: 3, 4, 5, 6]



2. Serth, Robert W., Process Heat Transfer Principles and Applications, Elsevier Science & Technology Books, 2007. [Module: 3]
3. Wayne C. Turner, Steve Doty (Ed.), Energy Management Hand Book, John Wiley and Sons, 2000. [Module: 1, 2, 5, 6]

**References:**

1. Seider W. D., and Seader J. D. and Lewin D. R., Process Design Principles, John Wiley and Sons Inc., 1988.
2. Douglas J. M., Conceptual Design of Chemical Process, McGraw Hill Book Co., 1988.
3. Biegler L. T., Grossman E. I. and Westerberg A. W., .Systematic Methods of Chemical Process Design., Prentice Hall International Ltd., 1997.
4. P K Nag, Power Plant Engineering, The McGraw-Hill Publishing Company Limited.
5. H.M. Robert, J.H. Collins, Handbook of Energy Conservation-Volume 1, CBS Publishers & Distributors.
6. D. P. Kothari, K. C. Singal, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt Ltd, Second Edition.
7. <https://www.beeindia.gov.in>

Course Code	Course/Subject	Credits
CHDE8041	Department Elective IV: Advanced Process Control	4

**Prerequisites:**

- Linear Algebra, Differential Equations, Difference Equations, Laplace Transforms.

**Course Objectives:**

- To understand dynamics of MIMO processes.
- To understand Batch Process Control.
- To understand Model Predictive Control.
- To design digital controllers.

**Course Outcomes:**

- The student will be able to analyze multi-loop and multi-variable control systems.
- The student will be able to design batch controllers.
- The student will be able to design MIMO controllers.
- The student will be able to design Model Predictive Controllers.

Module	Contents	Contact Hours
1.	Advanced SISO Control Strategies: Cascade Control, Time Delay Compensation, Inferential Control, Selective Control/Override Systems, Nonlinear Control Systems, Adaptive control Systems	06
2	Digital Sampling Filtering and Control: Sampling and Signal Reconstruction, Signal Processing and Data Filtering, z-Transform Analysis for Digital Control, Tuning of Digital PID Controllers, Direct Synthesis for Design of Digital Controllers, Minimum Variance Control	06
3	Multiloop and Multivariable Control: Process and Control Loop Interactions, Pairing of Control and Manipulated Variables, Singular Value Analysis, Tuning of Multi-loop PID Control Systems, Decoupling and Multivariable Strategies, Strategies for Reducing Control Loop Interactions	06
4	Model Predictive Control: Overview of Model Predictive Control, Predictions for SISO Models, Predictions for MIMO Models, Model Predictive Control Calculations, Set Point Calculations, Selection of Design and Tuning Parameters, Implementation of MPC	06
5	Batch Process Control: Batch Control Systems, Sequential and Logic Control, Control During The Batch, Run-to-Run Control	06
6	Introduction To Plantwide Control: Plantwide Control Issues, Hypothetical Plant for Plantwide	06

	Control Studies, Internal Feedback of Material and Energy, Interaction of Plant and Control System Design	
<b>7</b>	Plantwide Control System Design: Procedures for the Design of Plant wide Control Systems. A Systematic Procedure for Plantwide Control System Design. Case Study: The Reactor/Flash Unit Plant, Effect of Control Structure on Closed Loop Performance	<b>06</b>
<b>8</b>	Optimal Control: Introduction to Optimal Control, Batch Process Optimisation	<b>06</b>

### 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 need to be solved.
- Question No. 1 should be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all modules .
- Weightage of marks should be proportional to number of hours assigned to each module.

### References

1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, Francis J. Doyle III, Process Dynamics and Control, 3 Ed., John Wiley & Sons (Asia) Pvt. Ltd., New Delhi.
2. William L. Luyben, Process Modeling Simulation and Control For Chemical Engineers, 2 Ed., McGraw Hill Publishing Co.
3. Stephanopoulos, Chemical Process Control, PHI Learning Pvt. Ltd.
4. D Patranabis, Principles of Process Control, McGraw Hill Education
5. Donald R Coughanowr, Stevan E Leblance, Process System Analysis and Control, McGraw Hill Education.

<b>Course Code</b>	<b>Course/Subject</b>	<b>Credits</b>
<b>CHDE8042</b>	<b>Department Elective IV: Total Quality Management</b>	<b>4</b>

**Prerequisites:**

**Course Objectives:**

- To acquaint with the significance and features of TQM philosophy.
- To familiarize with various quality tools and their uses in problem solving.
- To appraise on the modern productivity improvement approaches and their interface with TQM
- To familiarize with various quality standards, quality auditing and certification methodology.
- To give and an insight into the ongoing global trends in quality approach and practices with special forms to the customer relationship

**Course Outcomes:**

Learner will be able to:

- Appreciate the importance of quality and its dimensions in striving for excellence
- Understand the conscious compromise between cost and quality
- Develop competency in the selection in various manufacturing and service functions
- Develop competency in the use of appropriate quality tools in various manufacturing and service functions
- Integrate quality approaches for productivity improvement.
- Acquire knowledge base and develop skills for conducting quality audits

<b>Module</b>	<b>Contents</b>	<b>Contact Hours</b>
<b>01</b>	<b>Introduction:</b> Definition of Quality, principles and dimensions of TQM Quality in manufacturing and service segments. Approach in implementation of TQM, barriers in implementation. Cost of quality prevention, appraisal and failure costs, hidden costs, trade-o between quality and cost.	<b>8</b>
<b>02</b>	<b>Planning for quality and Quality improvement:</b> Planning for quality: Need for quality policies and objective. Significance of top management commitment, strategic planning for quality. Quality improvement: Management of controllable defects, operator controllable defects, sporadic and chronic problems of operator controllable defects, sporadic and chronic problems of quality, Pareto's principle. Bench marking: Definition and significance, data collection for bench marking and its use.	<b>8</b>
<b>03</b>	<b>Customer relations:</b> Customers, user and consumers, product awareness, types of	<b>8</b>

	customers, customer perception and expectations. Quality feedback and redressal. Basic principles of reliability: quality and reliability, Product life cycle, trade-o between maintainability.	
<b>04</b>	<b>Vendor relations:</b> Vendor as a partner, vendor selection, vendor evaluation. Push Pull view of supply chain and cycle view of chain management	<b>8</b>
<b>05</b>	<b>SQC Tool:</b> Histograms, Pie charts, Scatter diagrams, Cause and diagram etc. <b>Statistical Process Control:</b> <b>Process variability:</b> Variables and process variation, measures of accuracy and centering, precision or spread, normal distribution <b>Process Control:</b> Control charts for variables (X-chart, R- chart, -chart) and attributes (np-charts, p-chart, c-charts, U-chart) Process capability: OC curve, acceptance sampling, single and double sampling producer's and consumer's risk.	<b>8</b>
<b>06</b>	<b>Quality System:</b> <b>Quality standards:</b> <ul style="list-style-type: none"> <li>• ISO 9001:2000 Quality management system. ^</li> <li>• ISO 14001:2004 Environmental management system.</li> <li>• ISO 27001:2005 Information security management system.</li> </ul> <b>Quality assurance:</b> Nature of assurance, reports on quality, measuring performance, internal audit, surveillance audit, quality certification methodology and implications <b>Productivity improvement Tools/ Approaches/ Techniques:</b> Principles of Six-Sigma, approaches like JIT, Lean manufacturing zero defect concept, KANBAN, QFD, FMEA, Basics of DOE and Shining concepts of quality. Productivity improvement techniques like 5S, POKAYOKE, SMED, KAIZEN and Concurrent Engineering.	<b>8</b>

Note: Seminar/Case study presentation with report by individual or in groups comprising of not more than three students can be considered.

### 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 need to be solved.
- Question No. 1 should be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all modules .

- Weightage of marks should be proportional to number of hours assigned to each module.

### **References**

1. Juran, J. M., Gryana, F. M., Quality planning and analysis, TMH.
2. Bester Fidd, D. H., et.al., Total quality management, Prentice Hall.
3. Erossbly, Pillip b., Quality is free, Mentor/New Americal Library.
4. Ishikawa, K., What is total quality control? The Japanese way, Prentice Hall
5. Fergenbaum, Armand V., Total quality control.
6. Logothetis, N., Managing for total quality, Prentice Hall
7. Aurora, K. C., Total Quality Management, S. K. Kataria and Sons
8. Haldar, U. K., Total Quality Management, Dhanpatrai and Co.

Course Code	Course/ Subject Name	Credits
CHDE8043	Department Elective IV: Advanced Separation Technology	4

**Prerequisites:**

- Basic knowledge regarding fundamental separation Processes and its application in chemical Industries.

**Course Objectives:**

The students completing this course are expected to understand:

- The various separation principles like adsorption process, the types and designs.
- The supercritical extraction and modern distillation process.
- Introduction to foam fractionation process and application in waste water treatment.
- Liquid chromatography – types and separation of enzymes using it.
- Types of membranes, membrane characterization, membrane material, membrane modules, membrane applications in biotechnology and other industries.

**Course Outcomes:**

- The graduates are expected to have ability to apply knowledge of mathematics, science and engineering.
- The graduates are expected to have ability to design a system, a component, or a process to meet the desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability and sustainability.
- The graduates are expected to possess ability to identify, formulate and solve engineering problems.
- The graduates are expected to possess ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Module	Content	Contact Hours
1.	<b>Adsorption Process:</b> Absorbent such as activated carbon, molecular sieves of various types, activated alumina. Their characteristics and applications. Regeneration & Activation of absorbents. Thermal & pressure swing process. Fixed bed, moving bed, stimulated moving bed and other processing schemes. Design of adsorption process for separation and purification. Industrial examples and related numericals.	8
2.	<b>Super critical extraction and advanced distillation techniques:</b> Working principle, advantages and disadvantages of supercritical solvents over conventional liquid solvents, advantages and disadvantages of supercritical extraction over liquid- liquid extraction. Commercial applications of supercritical extraction. The concept of advanced distillation techniques, advantages and disadvantages and comparison with conventional techniques.	8

3.	<b>Foam Fractionation Process:</b> Foam Formation, coalescence, collapse and drainage phenomena Adsorption properties of foams. Principle of froth flotation,. Application of froth flotation in industries and waste water treatment.	8
4.	<b>Liquid Chromatographic Process:</b> Basic concept of chromatography, phenomena and characterization. Various chromatography options. Typical chromatographic separation systems for preparative chromatography. Applications of chromatography in enzymes and other Industrial separations.	8
5.	<b>Membrane process:</b> Introduction to the membrane process, definition of membrane, importance, process. <b>Characterization of membranes:</b> Characterization of porous membranes, characterization of ionic membranes, characterization of non-ionic membranes. Preparation of synthetic membranes. Preparation of phase inversion membranes. Preparation techniques for immersion precipitation, preparation techniques for composite membranes, influence of various parameters on membrane morphology, preparation of inorganic membranes. Transport process in membrane driving force. Polarization phenomenon and fouling concentration polarization, characteristic flux behavior in pressure driven membrane preparation, various models, membrane fouling, methods to reduce fouling. Modules and process design plate and frame, spiral wound, tubular, capillary, hollow fibre modules and liquid membranes.	10
6	<b>Applications of membranes in industries:</b> Introduction to various applications in the chemical and allied industries. Basics of design and numericals based on reverse osmosis and dialysis techniques	6

### 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 need to be solved.
- Question No. 1 should be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all modules .
- Weightage of marks should be proportional to number of hours assigned to each module.

### References

1. Ruthven, D.M., Principal Adsorption & Adsorption Process, Wiley, 1984.
2. Lemlich, R., Adsorptive Bubble Separation Techniques, Academic Press, 1972.



3. Coulson, Richardson, Chemical Engineering, Vol.3, Pergamon.
4. Terybal, R.E, Mass Transfer Operations, McGraw Hill.
5. Ruthven, Faruqh, Knalbal, Pressure Swing Adsorption, VCH, 1994.
6. Snyder, Kirl, Introduction To Liquid Chromatography, 2 ed., 1979. University of Mumbai Chemical Engineering Rev 2014-15 42
7. Scott RTW, Liquid Chromatography Column Theory, Wiley, 1992.
8. Marcel Mulder, Basic Concepts Of Membrane Technology, Kluwer Academic Publishers (1997).
9. E.J. Hoffman, Membrane Separation Technology, Gulf Professional Publishing.
10. Nath, Membrane Separation Process, Prentice Hall of India.
11. Membrane Handbook - Editors W.S. Winston Ho, K.K. Sirkar, Van Nostrand Reinhold Publication.
12. J. D. Seader and E. J. Henely, Separation Process Principles.
13. C. J. King, Separation Processes.

Course Code	Course/ Subject Name	Credits
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<b>CHDE8044</b>	<b>Department Elective IV: Polymer Technology</b>	<b>04</b>
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**Prerequisites:**

- Chemistry, physics, Chemical reaction engineering

**Course Objectives:**

- To understand thermodynamics of polymer structure.
- To select polymerization reactor for a polymer product.
- To characterize polymers and state polymer additives, blends and composites.

**Course Outcomes:**

At the end of the course students will be able to

- Understand thermodynamics of polymer structure. .
- Student will identify various types of advance material in polymer, ceramics, & composites. Understand the properties of various polymeric, ceramic and metallic materials and their application in various fields.
- Select polymerization reactor for a polymer product
- Characterize polymers and state polymer additives, blends and composites.
- Student will have knowledge of different types of composite material, their properties and application
- After acquiring the knowledge in this subject, students become familiar with various aspects related to polymerization and can apply them for economic evaluation of chemical process and decide its feasibility

<b>Module</b>	<b>Contents</b>	<b>Contact Hours</b>
<b>1</b>	<b>Introduction:</b> Introduction and Classification of Polymers. Thermosets, Factors influencing the polymer properties, Glass Transition Temperature Monomers used for polymer synthesis, Thermoplastics, Linear Branch, Cross Linked Polymers. <b>Addition and Condensation Polymerisation:</b> Mechanism, kinetics, synthesis and reactions.	<b>05</b>
<b>2</b>	<b>Natural Polymers:</b> Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins etc. <b>Polymerization Techniques:</b> Bulk polymerization, Solution polymerization, Emulsion polymerization and Suspension polymerization, Interfacial Polymerization with their merits Comparison of the various processes Advantages and disadvantages.	<b>12</b>
<b>3</b>	<b>Molecular Weight and Molecular Weight Distribution:</b> Molecular Weights, Polydispersity Index, Different Methods of determination of Molecular weight, Effect of Molecular weight on	<b>08</b>

	Engineering Properties of Polymers. <b>Co-Polymerization:</b> Basic concept, Technical significance, steady state assumptions in free radical copolymerization, The copolymer equation, Instantaneous molar composition of copolymer formed; Monomer reactivity ratios; Significance and method of determination, Types of copolymers.	
<b>4</b>	<b>Polymerization Reactor:</b> Polymerization reactors types and mode of operation, Polymerization reactor design, control of polymerization, Post polymerization unit operations and unit processes Polymer Degradation.	<b>06</b>
<b>5</b>	<b>Polymer Processing:</b> High Performance and Specialty Polymers, Polymer additives, compounding. Fillers plasticizers lubricants colourants UV stabilizers, fire retardants, antioxidants, Different moulding methods of polymers. Injection moulding , blow moulding, thermoforming, film blowing etc.	<b>08</b>
<b>6</b>	<b>Manufacturing Processes:</b> Manufacturing of typical polymers with flow-sheet diagrams properties & application: PE, PP, PS, Polyesters, Nylons, ABS, PC, Teflon, Epoxy, Ureaformaldehyde, and poly Urathane. Manufacturing of thermoset polymers such as Phenolic resins	<b>13</b>

### 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.

### References

1. Fried J R, Polymer Science and Technology, Prentice Hall of India Pvt. Ltd., New Delhi, Eastern Economy Edition, 2000.
2. Premamoy Ghosh, Polymer Science and Technology, 3rd Edition, Tata Mc. Graw-Hill Publishing Company, New Delhi, 2010.
3. R. Sinha, Outlines of Polymer Technology: Manufacture of Polymers, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
4. Gowarikar V.R. et.al., Polymer Science Wiley Eastern 1984.

5. Ghosh P, Polymer Science & Technology of Plastics & Rubbers Tata McGraw Hill, 1990.
6. Encyclopedia of Polymer Science & Engineering., Wiley 1988.
7. Rosen S.L. Fundamental Principles of Polymeric materials, 2nd e.d., John Wiley & Sons Inc, 1993
8. Niranjankarak, Fundamentals of Polymers, PHI Learning Pvt. Ltd.

Course Code	Course Name	Credits
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<b>ILO8021</b>	<b>Institute Level Optional Subject II- Project Management</b>	<b>03</b>
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**Objectives;**

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

**Outcomes:**

Learner will be able to...

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

<b>Module</b>	<b>Detailed Contents</b>	<b>Contact Hours</b>
<b>01</b>	<b>Project Management Foundation:</b> Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	<b>5</b>
<b>02</b>	<b>Initiating Projects:</b> How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	<b>6</b>
<b>03</b>	<b>Project Planning and Scheduling:</b> Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	<b>8</b>
<b>04</b>	<b>Planning Projects:</b> Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.	<b>6</b>

	Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	
<b>05</b>	<p><b>5.1 Executing Projects:</b> Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings.</p> <p><b>5.2 Monitoring and Controlling Projects:</b> Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.</p> <p><b>5.3 Project Contracting</b> Project procurement management, contracting and outsourcing,</p>	<b>8</b>
<b>06</b>	<p><b>6.1 Project Leadership and Ethics:</b> Introduction to project leadership, ethics in projects. Multicultural and virtual projects.</p> <p><b>6.2 Closing the Project:</b> Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.</p>	<b>6</b>

### 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. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7<sup>th</sup>Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK<sup>®</sup> Guide), 5<sup>th</sup> Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9th Ed.

Course Code	Course Name	Credits
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ILO8022	Institute Level Optional Subject II- Finance Management	03
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**Objectives:**

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

**Outcomes:**

Learner will be able to...

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module	Detailed Contents	Contact Hours
01	<p><b>Overview of Indian Financial System:</b> Characteristics, Components and Functions of Financial System.</p> <p><b>Financial Instruments:</b> Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p><b>Financial Markets:</b> Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p><b>Financial Institutions:</b> Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	06
02	<p><b>Concepts of Returns and Risks:</b> Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.</p> <p><b>Time Value of Money:</b> Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.</p>	06
03	<p><b>Overview of Corporate Finance:</b> Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p><b>Financial Ratio Analysis:</b> Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.</p>	09

<b>04</b>	<p><b>Capital Budgeting:</b> Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)</p> <p><b>Working Capital Management:</b> Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity’s Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.</p>	<b>10</b>
<b>05</b>	<p><b>Sources of Finance:</b> Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.</p> <p><b>Capital Structure:</b> Factors Affecting an Entity’s Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure</p>	<b>05</b>
<b>06</b>	<p><b>Dividend Policy:</b> Meaning and Importance of Dividend Policy; Factors Affecting an Entity’s Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon’s Approach, Walter’s Approach, and Modigliani-Miller Approach</p>	<b>03</b>

### 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. Fundamentals of Financial Management, 13<sup>th</sup> Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10<sup>th</sup> Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9<sup>th</sup> Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.



4. Financial Management, 11<sup>th</sup> Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Institute Level Optional Subject II- Entrepreneurship Development and Management	03

**Objectives:**

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

**Outcomes:**

Learner will be able to...

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

Module	Detailed Contents	Contact Hours
01	<b>Overview Of Entrepreneurship:</b> Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	<b>Business Plans And Importance Of Capital To Entrepreneurship:</b> Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur <b>Entrepreneurship And Business Development:</b> Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	<b>Indian Environment for Entrepreneurship:</b> key regulations and legal aspects, MSME Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08

<b>05</b>	<b>Effective Management of Business:</b> Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	<b>08</b>
<b>06</b>	<b>Achieving Success In The Small Business:</b> Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	<b>05</b>

### 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. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGraw Hill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. [www.msme.gov.in](http://www.msme.gov.in)
12. [www.dcmesme.gov.in](http://www.dcmesme.gov.in)
13. [www.msmetraining.gov.in](http://www.msmetraining.gov.in)

Course Code	Course Name	Credits
ILO8024	Institute Level Optional Subject II- Human Resource Management	03

### Objectives:

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

### Outcomes:

Learner will be able to...

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Contact Hours
01	<b>Introduction to HR</b> <ul style="list-style-type: none"> <li>• Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.</li> <li>• Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.</li> </ul>	5
02	<b>Organizational Behavior (OB)</b> <ul style="list-style-type: none"> <li>• Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues</li> <li>• Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness</li> </ul>	7

	<ul style="list-style-type: none"> <li>• Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior.</li> <li>• Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);</li> <li>• Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team.</li> <li>• Case study</li> </ul>	
<b>03</b>	<b>Organizational Structure &amp; Design</b> <ul style="list-style-type: none"> <li>• Structure, size, technology, Environment of organization; Organizational Roles &amp; conflicts: Concept of roles; role dynamics; role conflicts and stress.</li> <li>• Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.</li> <li>• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.</li> </ul>	<b>6</b>
<b>04</b>	<b>Human resource Planning</b> <ul style="list-style-type: none"> <li>• Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.</li> <li>• Performance Appraisal Systems: Traditional &amp; modern methods, Performance Counseling, Career Planning.</li> <li>• Training &amp; Development: Identification of Training Needs, Training Methods</li> </ul>	<b>5</b>
<b>05</b>	<b>Emerging Trends in HR</b> <ul style="list-style-type: none"> <li>• Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes &amp; transformation in HR. Organizational Change, Culture, Environment</li> <li>• Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.</li> </ul>	<b>6</b>
<b>06</b>	<b>HR &amp; MIS</b> Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries <b>Strategic HRM</b> Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals <b>Labor Laws &amp; Industrial Relations</b>	<b>10</b>

	Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	
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### **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. Stephen Robbins, Organizational Behavior, 16<sup>th</sup> Ed, 2013
2. V S P Rao, Human Resource Management, 3<sup>rd</sup> Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6<sup>th</sup> edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15<sup>th</sup> Ed, 2015, Himalaya Publishing, 15<sup>th</sup>edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5<sup>th</sup> Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Institute Level Optional Subject II- Professional Ethics and Corporate Social Responsibility (CSR)	03

**Objectives:**

- To understand professional ethics in business
- To recognize corporate social responsibility

**Outcomes:**

Learner will be able to...

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Contact Hours
01	<b>Professional Ethics and Business:</b> The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	<b>Professional Ethics in the Marketplace:</b> Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy <b>Professional Ethics and the Environment:</b> Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	<b>Professional Ethics of Consumer Protection:</b> Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy <b>Professional Ethics of Job Discrimination:</b> Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	<b>Introduction to Corporate Social Responsibility:</b> Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	<b>Corporate Social Responsibility:</b> Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	<b>Corporate Social Responsibility in Globalizing India:</b> Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of	08

	India, Legal Aspects of Corporate Social Responsibility— Companies Act, 2013.	
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### **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. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.



Course Code	Course Name	Credits
ILO8026	Institute Level Optional Subject II- Research Methodology	03

**Objectives:**

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

**Outcomes:**

Learner will be able to...

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Module	Detailed Contents	Contact Hours
<b>01</b>	<b>Introduction and Basic Research Concepts</b> <b>1.1</b> Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology <b>1.2</b> Need of Research in Business and Social Sciences <b>1.3</b> Objectives of Research <b>1.4</b> Issues and Problems in Research <b>1.5</b> Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	<b>09</b>
<b>02</b>	<b>Types of Research</b> <b>2.1.</b> Basic Research <b>2.2.</b> Applied Research <b>2.3.</b> Descriptive Research <b>2.4.</b> Analytical Research <b>2.5.</b> Empirical Research <b>2.6</b> Qualitative and Quantitative Approaches	<b>07</b>
<b>03</b>	<b>Research Design and Sample Design</b> <b>3.1</b> Research Design – Meaning, Types and Significance <b>3.2</b> Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	<b>07</b>
<b>04</b>	<b>Research Methodology</b> <b>4.1</b> Meaning of Research Methodology <b>4.2.</b> Stages in Scientific Research Process: <b>a.</b> Identification and Selection of Research Problem <b>b.</b> Formulation of Research Problem	<b>08</b>

	<b>c.</b> Review of Literature <b>d.</b> Formulation of Hypothesis <b>e.</b> Formulation of research Design <b>f.</b> Sample Design <b>g.</b> Data Collection <b>h.</b> Data Analysis <b>i.</b> Hypothesis testing and Interpretation of Data <b>j.</b> Preparation of Research Report	
<b>05</b>	<b>Formulating Research Problem</b> <b>5.1</b> Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	<b>04</b>
<b>06</b>	<b>Outcome of Research</b> <b>6.1</b> Preparation of the report on conclusion reached <b>6.2</b> Validity Testing & Ethical Issues <b>6.3</b> Suggestions and Recommendation	<b>04</b>

### 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. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2<sup>nd</sup>ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	Institute Level Optional Subject II- IPR and Patenting	03

#### Objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

#### Outcomes:

Learner will be able to...

- understand Intellectual Property assets
- assist individuals and organizations in capacity building
- work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Contact Hours
01	<b>Introduction to Intellectual Property Rights (IPR):</b> Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. <b>Importance of IPR in Modern Global Economic Environment:</b> Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	<b>Enforcement of Intellectual Property Rights:</b> Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement <b>Indian Scenario of IPR:</b> Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	<b>Emerging Issues in IPR:</b> Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	<b>Basics of Patents:</b> Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	<b>Patent Rules:</b> Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris	08

	convention etc.)	
<b>06</b>	<b>Procedure for Filing a Patent (National and International):</b> Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement <b>Patent databases:</b> Important websites, Searching international databases	<b>07</b>

## 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. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7<sup>th</sup> Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3<sup>rd</sup> Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
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10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi, IPR: Drafting,

- Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
  15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO8028	Institute Level Optional Subject II - Digital Business Management	03

**Objectives:**

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

**Outcomes:**

The learner will be able to .....

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module	Detailed content	Contact Hours
1	<b>Introduction to Digital Business-</b> Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts. Difference between physical economy and digital economy. <b>Drivers of digital business-</b> Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services). Opportunities and Challenges in Digital Business,	09
2	<b>Overview of E-Commerce</b> <b>E-Commerce-</b> Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement. B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals. Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing. EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC.	06
3	<b>Digital Business Support services:</b> ERP as e –business backbone, knowledge Top Apps, Information and referral system <b>Application Development:</b> Building Digital business Applications and Infrastructure	06
4	<b>Managing E-Business-</b> Managing Knowledge, Management skills for e-business, Managing Risks in e –business. Security Threats to e-business -Security Overview, Electronic commerce Threats, Encryption, Cryptography, Public Key and Private Key	06

	Cryptography, Digital signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	
<b>5</b>	<b>E-Business Strategy</b> -E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition(Process of Digital Transformation)	<b>04</b>
<b>6</b>	<b>Materializing e-business: From Idea to Realization</b> -Business plan preparation. <b>Case Studies and presentations</b>	<b>08</b>

### 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. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6<sup>th</sup> Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2<sup>nd</sup> Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2<sup>nd</sup> International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:[10.1787/9789264221796-en](https://doi.org/10.1787/9789264221796-en)OECD Publishing

Course Code	Course Name	Credits
ILO8029	Institute Level Optional Subject II- Environmental Management	03

#### Objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

#### Outcomes:

Learner will be able to...

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Module	Detailed Contents	Contact Hours
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, and The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	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. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3<sup>rd</sup> Ed. Access Publishing.2015

<b>Course Code</b>	<b>Course Name</b>	<b>Credits</b>
<b>CHP801</b>	<b>Project-B</b>	<b>06</b>
<p><b>Guidelines:</b></p> <ul style="list-style-type: none"> <li>• Project groups: Students can form groups with minimum two and not more than 3 (three).</li> <li>• Students should spend considerable time in applying all the concepts studied, into the Project, hence, eight hours each are allotted in project A and B to the students.</li> <li>• Students are advised to take up industrial/ experimental/ simulation and/or optimization based topics for their project</li> <li>• Students should report their guides weekly with work.</li> </ul> <p><b>Exam Guidelines</b></p> <p><b>Term Work - 100 Marks:</b></p> <ul style="list-style-type: none"> <li>• Presentation – 50 Marks</li> <li>• Report -50 Marks</li> </ul> <p><b>Oral – 50 Marks</b></p>		

Course Code	Course Name	Credits
CHL801	Chemical Engineering Lab XI (MSO)	1

### Concept of Experiment:

Students should be able to simulate process models using computer program or mathematical and chemical engineering software such as COCOO/DWSIM/Unisim,/CWSim, /ChemCAD,/Hysys/ Aspen Plus / or any simulator.

Minimum TEN experiments must be performed.

- Simulation of pipe and pump network flows
- Simulation of linear and non linear systems
- Simulation of mass transfer processes like distillation, Absorption
- Simulation of Heat Transfer Process like Shell and tube heat exchanger
- Simulation of chemical reactor like batch, Semibatch, Continuous reactor
- Simulation of Multicomponent flash calculation for ideal and non ideal system
- Simulation of flowsheet calculation (Any chemical manufacturing process)
- Optimisation of chemical processes.

### Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

**Total: 25 marks**

### Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.