UNIVERSITY OF MUMBAI

Revised Syllabus for the

Bachelor of Engineering

Chemical Engineering

Final Year with Effect from AY 2022-23

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

Under

FACULTY OF SCIENCE & TECHNOLOGY

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

AC.
Item no.

UNIVERSITY OF MUMBAI

Syllabus for Approval

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

Date:

Dr. S. K. Ukarande
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Preamble

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

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

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

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

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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

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Preamble to the Revision of Syllabus in Chemical Engineering

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

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

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

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

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

Board of Studies in Chemical Engineering

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

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

Semester VIII

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC801	Modelling Simulation and Optimization	3	-	-	3	-	-	3
CHDO805X	Department Optional Course 5	3	-	-	3	-	-	3
CHDO806X	Department Optional Course 6	3	-	-	3	-	-	3
IO802X	Institute Optional Course 2	3	-	-	3	-	-	3
CHL801	Modelling Simulation and Optimization Lab	-	3	-	-	1.5	-	1.5
CHL802	Software application in Chemical Engineering Lab	-	3	-	-	1.5	-	1.5
CHP801	Major Project II	-	12#	-	-	6	-	6
	Total	12	18	-	12	9	-	21

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	Modelling Simulation and Optimization	20	20	20	80	3	-	-	-	100
CHDO805X	Department Optional Course 5	20	20	20	80	3	-	-	-	100
CHDO806X	Department Optional Course 6	20	20	20	80	3	-	-	-	100
IO802X	Institute Optional Course 2	20	20	20	80	3	-	-	-	100
CHL801	Modelling Simulation and Optimization Lab	-	-	-	-	3	25	25	-	50
CHL802	Software application in Chemical Engineering Lab	-	-	-	-	-	25	-	25	50
CHP801	Major Project II	-	-	-	-	-	50	-	100	150
	Total			80	320	-	100	25	125	650

Department Optional Course 5 (Sem VIII)

Engineering Stream (Course Code)	Technology Stream (Course Code)	Management Stream (Course Code)
Energy System Design (CHDO8051)	Advanced Separation Technology (CHDO8052)	Financial Management (CHDO8053)

Department Optional Course 6 (Sem VIII)

Engineering Stream (Course Code)	Technology Stream (Course Code)	Management Stream (Course Code)
Fuel Cell Electrochemical Engineering (CHDO8061)	1. Biotechnology (CHDO8062) 2. Nanotechnology (CHDO8063)	Chemical Waste Management (CHDO8064)

Institute Optional Course 2 (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)

 # indicates work load of Learner (Not Faculty), Faculty load-for Major Project. semester VIII – 1 hour per week per project group

Semester VIII		
Course Code	**Course Name**	**Credits**
CHC801	**Modelling Simulation and Optimization**	**03**

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

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

Prerequisites

- Linear Algebra, Process Calculations, Computer Programming

Course Objectives

1. To make students understand writing and solving models of chemical engineering system.
2. To make students understand sequential and equation-oriented simulation of complete flow sheets.
3. To make students understand writing and solving systems of nonlinear equations for single and multiple units.
4. To make students understand simulation of complete flow sheets.
5. To make students understand optimization of single and multiple units.
6. To make students understand artificial neural network principles.

Detailed Syllabus

Module No	Contents	Contact Hrs

1	Modeling Aspects: Definition of process model, physical and mathematical modeling, classification of models, model building, classification of mathematical methods 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, equation of state, equilibrium, kinetics.	**06**
2	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.	**08**
3	Artificial Neural Network–Based Models., Applications of ANNs in Chemical Engineering, Advantages of ANN-Based Models. Limitations of ANN-Based Models.	**04**
4	Introduction to Simulation, Sequential and Equation oriented Simulation, Flowsheet topology analysis, Recycle, Partitioning and Tearing of flow sheets. Simulation Examples, Williams Otto Flowsheeting	**08**
5	Numerical Methods for solving sets of nonlinear equations, Newton's method with Armijo Line search, Successive substitution. Solution for models developed in module 2	**08**
6	Introduction to Optimization. Unconstrained single and multi-variable non-linear optimization. Numerical methods for single and multivariable optimization.	**05**

Course Outcomes:

1. The students will be able to write and solve models of chemical engineering system.
2. The students will be able to carry out sequential and equation oriented simulation of complete flow sheets.
3. The student will be able to optimize typical chemical processes.
4. The students will able to solve a process simulation.
5. The students will able to use basics of numerical methods
6. The students will able to understand artificial neural network principles.

Internal Assessment

- 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 20marks.
- 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., JohnWiley
3. Lorenz T. Beigler, Ignacio E. Grossman, Arthur W. Wesburg, Systematic Methods of Chemical Process Design, Prentice Hall
4. Ashok Kumar Verma , Process Modelling and Simulation in Chemical , Biochemical and Environmental Engineering, CRC Press Taylor and Francis Group

Semester VIII

Course Code	Course Name	Credits
CHDO8051	Energy System Design (Departmental Optional Course)	03

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

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

Prerequisites

1. Knowledge of basics of energy.
2. Knowledge of basic concepts of heat transfer.
3. Knowledge of basic concepts of thermodynamics.
4. Knowledge of mass transfer operations like distillation.
5. Knowledge of mathematics.
6. Preliminary knowledge of economics.

Course Objectives

1. Students should know the sources of energy, present status of energy and importance of energy conservation.
2. Students should understand the importance, concepts and methodologies of energy management and audit to improve energy efficiency of industrial operations and conserve the energy.
3. Students should be aware about best energy efficient technologies and practices to be followed in process industries.
4. Students should learn to apply the energy conservation techniques like heat exchanger networking and heat integration in chemical process units.
5. Students should know importance and ways of waste heat recovery and cogeneration.

6. Students should understand various sources of renewable energy sources and their advantages over conventional energy sources.

Detailed Syllabus

Module No	Content	Contact Hours
1	**Energy Scenario:** Classification of Energy sources: Commercial & non-commercial, Primary & Secondary, Renewable & non-renewable; Energy consumption patterns; Indian energy scenario; Sectoral energy consumption; Energy needs of growing economy; Energy intensity on purchasing power parity (PPP) basis; Energy pricing, Energy security; Energy strategy for the future; Energy conservation and its importance	03
2	**Energy Management & Audit:** Definition, Need and Types of Energy Audit; Energy audit methodology; Energy Management (Audit) Approach; Understanding Energy Costs; Benchmarking Energy Performance; Matching energy use to energy requirements; Maximizing system efficiencies; Optimizing the input energy requirements; Fuel and Energy substitution; Instrumentation used in energy audit; Safety considerations during energy audit; Post audit analysis; Minimum one Case study; ECO analysis based on simple payback period.	06
3	**Energy Efficient Technologies:** Energy efficient techniques for lighting system, motors, belt and drives system, fans and pumps system, compressed air system; steam system, refrigeration system.	03
4	**Energy Integration in Process Industries and Process Units:** Temperature Pinch analysis – Temperature interval method & Composite curve method; Design of Heat Exchanger Network (HEN) using Pinch analysis; Design of HEN with minimum number of Heat Exchangers; Breaking Loop and Stream Splitting method for HEN Design; Concept of Threshold approach temperature difference and Optimum approach temperature difference. Heat Integration in Distillation column; Reboiler flashing, Heat pumping, Vapor recompression in distillation column.	12

5	**Waste Heat Recovery (WHR) and Cogeneration:** Waste heat sources; Quality and Classification of waste heat and its applications; Benefits of WHR; WHR Equipments: Recuperators, Radiation/Convective Hybrid Recuperator, Ceramic Recuperator, Regenerator, Heat wheel, Heat pipe, Waste heat boiler, Economizer, Heat pumps. Definition of Cogeneration and few Basic concepts; Types of Thermodynamic cycles as basis for Cogeneration: Brayton cycle, Rankine cycle, Topping cycle, Bottoming cycle, Combined cycle; Types of Cogeneration system: Steam turbine system, Gas turbine system, Diesel engine system, Distributed cogeneration system.	**10**
6	**New and Renewable Energy Sources:** Concept of new and renewable energy; Solar energy; Wind energy; Tidal energy; Geothermal energy; Energy from waste and Biomass.	**05**

Course Outcome

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

1. Understand the present energy status and major steps to be taken to conserve the energy.
2. Know the importance of energy management program, how to carry it and follow the same when they will actual start working in industries.
3. Be aware about best energy efficient practices and will follow the same in future wherever they work.
4. To carry out Heat exchanger networking and learn other heat integration techniques to conserve the energy.
5. Identify sources of waste heat in industry, know the techniques to recover and reuse the waste heat and have knowledge about cogeneration technique.
6. Understand various renewable energy sources, their applications and preference over non-renewable energy sources.

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 marks; 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. 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. Wayne C. Turner, Steve Doty (Ed.), Energy Management Hand Book, John Wiley and Sons, 2000.

Reference Books:

1. Robin Smith, Chemical Process Design and Integration, Wiley India, 2005.
2. Serth, Robert W., Process Heat Transfer Principles and Applications, Elsevier Science & Technology Books, 2007.
3. P K Nag, Power Plant Engineering, The McGraw-Hill Publishing Company Limited.
4. H.M.Robert, J.H.Collins, Handbook of Energy Conservation-Volume 1, CBS Publishers & Distributors.
5. D. P. Kothari, K. C. Singal, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt Ltd, Second Edition.
6. https://www.beeindia.gov.in

Semester VIII

Course Code	Course Name	Credits
CHDO8052	Advanced Separation Technology (Departmental Optional Course)	03

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

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

Prerequisites

1. Mass transfer operations
2. Conventional separation processes

Course Objectives

1 Learn about various adsorbents and to design adsorption column

2 Distinguish the application of supercritical extraction.
3 Familiarize with advanced distillation techniques
4 To have the knowledge of liquid chromatographic process.
5 Distinguish various membranes.
6 Development of specific membrane processes.

Detailed Syllabus

Module No	Course Contents	Contact Hours
1	**Adsorption Process:** Adsorbent such as activated carbon, molecular sieves of various types, activated alumina. Their characteristics and applications. Regeneration & activation of adsorbents. Thermal & pressure swing process. Fixed bed, moving bed, Design of adsorption column for separation and purification. Industrial examples and related numerical.	08
2	**Super critical extraction** 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.	06
3	**Advanced distillation techniques** Molecular, reactive and extractive distillation techniques.	04
4	**Liquid Chromatographic Process:** Basic concept of chromatography, phenomena and characterization. Typical chromatographic separation systems for preparative chromatography. Applications of chromatography in enzymes and other Industrial separations.	07
5	**Membranes:** Introduction to the membrane process, Characterization of membranes: Characterization of porous membranes, characterization of ionic membranes, characterization of non-ionic membranes. Transport process in membrane driving force. Characteristic flux behavior in pressure driven membrane preparation, membrane fouling, methods to reduce fouling. Types of modules: plate and frame, spiral wound, tubular, capillary, hollow fibre modules and liquid membranes.	08
6	**Membrane processes:** Introduction to reverse osmosis, nanofiltration, ultrafiltration, microfiltration, dialysis, membrane distillation. Numericals based on reverse osmosis and dialysis techniques	06

Course Outcomes

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

1 Identify the various adsorbents and to design adsorption column.
2 Choose the separation by supercritical extraction.
3 Choose the appropriate separation techniques
4 Understand the application of chromatography.
5 Select, maintain and design various membrane processes.
6 Assess the various techniques of modern separation processes

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

End Semester Examination (80 marks):

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

Recommended Books:

1. Ruthven, D.M., Principles of Adsorption & Adsorption Processes, A Wiley- Interscience publication, (1984).
2. Coulson and Richardson's, Chemical Engineering, Vol.2,5th ed, Elsevier.
3. Treybal, R.E, Mass Transfer Operations, McGraw Hill.
4. Ruthven,D.M; Farooq,S; Knaebel,K.S, Pressure Swing Adsorption, VCH, (1994).
5. Snyder, L.R; Kirkland,J.J, Introduction to Modern Liquid Chromatography, 2 ed., A Wiley-Interscience publication (1979)
6. Scott R.P.W, Liquid Chromatography for the Analyst, Marcel Dekker,Inc, (1994).
7. Marcel Mulder, Basic Principles of Membrane Technology, Kluwer Academic Publishers (1997).
8. E.J. Hoffman, Membrane Separations Technology, Gulf Professional Publishing. (2003)

9. Kaushik Nath, Membrane Separation Processes, Prentice Hall of India (2008).
10. C. J. King, Separation Processes.2nd ed,2013 McGraw Hill

Reference Books:

1. Membrane Handbook - Editors W.S. Winston Ho, K.K. Sirkar, Van Nostrand Reinhold Publication.
2. J. D. Seader and E. J. Henely, Separation Process Principles.2nd ed,John Wiley & Sons

Semester-VIII

Course Code	Course Name	Credits
CHDO8053	Financial Management (Departmental Optional Course)	03

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

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

Prerequisites

The concepts of basic Mathematics as well as a few concepts of higher mathematics.

Course Objectives

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

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

Detailed Syllabus

Module No	Course Contents	Contact Hours
1.	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Introduction to Financial Accounting** Scope and importance of Financial Accounting. classification of accounts, Preparation of Journal, Ledger , Cash book & Trial balance **Financial Management:** Concept of business finance, Goals & objectives of financial management.	**05**
2.	**Concepts of Returns and Risks:** 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. **Time Value of Money:** 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.	**8**
3.	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Statement:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, **Financial Ratio Analysis:** Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis	**08**
4.	**Capital Budgeting:** 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) **Working Capital Management:** 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.	**09**
5.	**Sources of Finance:**	**03**

	Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Bonds (Types, features & utility).	
6.	**Capital Structure and Dividend Policy:** Factors Affecting an Entity's Capital Structure; Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure ;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	**06**

Course Outcome

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

1. understand and define basic terminology used in finance and accounts •
2. Prepare& appraise Financial Statements and evaluate a company in the light of different measurement systems.
3. Analyze the risk and return of alternative sources of financing.
4. Estimate cash flows from a project, including operating, net working capital, and capital spending.
5. Estimate the required return on projects of differing risk ,to estimate the cash flows from an investment project, calculate the appropriate discount rate, determine the value added from the project, and make a recommendation to accept or reject the project
6. Describe and illustrate the important elements in project finance

Internal Assessment (20 Marks):

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

End Semester Examination (80 marks):

1.Weightage of each module in end semester examination will be proportional to number of respective lectures.

2.Question paper will comprise of total **six questions, each carrying 20marks.**

3.Question 1 will be compulsory and should cover **maximum contents of the curriculum.**

4.Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)

5. Only **Four questions need to be solved.**

Recommended Books:

A Textbook of Financial Cost And Management Accounting, Dr. P. PERIASAMY, HH Publication

Reference Books:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.

2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi

Semester VIII

Course Code	Course Name	Credits
CHDO8061	Fuel Cell Electrochemical Engineering (Departmental Optional Course)	03

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

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

Prerequisites

- Basic knowledge of physics, electrochemistry, electrical properties, thermodynamics, reaction kinetics and transport phenomenon.

Course Objectives

1. To understand the basic elements of electrochemistry which are required for fuel cell.

2. To study different types of fuel cells and their working
3. To analyze performance and operation of fuel cell.
4. To apply thermodynamic principles to fuel cell and related processes.
5. To study Fuel Cell Reaction Kinetics
6. To understand Fuel Cell Charge Transport processes.

Detailed Syllabus

Module No	Course Contents	Contact Hours
1	**Introduction to Electrochemistry**- redox reactions, Revision of concepts of electrochemical cells, Spontaneity of Redox Reaction, Cell Emf Dependency on Changes in Concentration, Nerst equation, Concentration Cells, corrosion, electrodialysis, Quantitative Electrolysis and Faraday's Laws. Introduction to Electrochemical Engineering- Scope and Applications, **Basic Elements of Electrochemistry**- Electric charge, electric current, cathod, anode, chemical kinetics.	4
2	**Fuel cell fundamentals-** Scheme of a proton-conducting fuel cell, Types of Fuel Cells; Design, Proton Exchange Membrane Fuel Cells (PEMFCs), Phosphoric Acid Fuel Cell (PAFC), Solid Acid Fuel Cell (SAFC), High-temperature Fuel Cells, Hydrogen-oxygen Fuel Cell, Comparison of Fuel Cell Types, Efficiency of Leading Fuel Cell Types, Theoretical Maximum Efficiency, Cogeneration, applications, Market and economics. **Fuel cell-** Operation, Fuel cell performance, fuel cell and environment, Hydrogen production and storage. Safety issues and cost expectation and life cycle analysis of fuel cells.	12
3	**Fuel Cell Thermodynamics-** Heat and work potential of a fuel, Relationship between Gibbs Free Energy and Electrical Work, Relationship between Gibbs Free Energy and Reaction Spontaneity, Relationship between Gibbs Free Energy and Voltage, Standard Electrode Potentials: Computing Reversible Voltages, fuel cell efficiency.	7
4	**Fuel Cell Reaction Kinetics-** introduction to electrode kinetics, activation energy and reaction rate, calculating net rate of a reaction, rate of reaction at equilibrium: exchange current density, potential of a reaction at equilibrium: Galvani potential, potential and rate: Butler–Volmer equation, exchange currents and electrocatalysis: how to improve kinetic performance, simplified activation kinetics: tafel equation.	6
5	**Fuel Cell Charge Transport-** charge transport and a voltage loss, characteristics of fuel cell charge transport resistance, physical meaning of conductivity, fuel cell electrolyte classes.	6
6.	**Fuel Cell Mass Transport-** transport in electrode versus flow structure, transport in electrode: diffusive transport, transport in flow structures: convective transport.	4

Course Outcome

On completion of the course the students will be able

1	To apply the concepts of Electrical Potential, Electrical Field, Electrostatic Work, Voltage, Current, Electrochemical Potential, Activation Energy, Electrode & Electrochemical Equilibrium
2	To formulate and calculate relevant transport phenomena such as migration and the characteristics of (diluted) electrolytes. Relate the conversion of matter to the transport of electrical charge.
3	To apply the underlying concepts, methods and application of fuel cell technology.
4	To apply thermodynamic principles to fuel cell processes.
5	To carry out fuel cell kinetics.
6	To understand fuel cell transport processes.

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

End Semester Examination (80 marks):

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

Books

Sr. No	Abbreviations	Name of the book and edition	Authors	publication
TEXT BOOKS				
1	T_1	Electrochemistry and Electrochemical Engineering(Module 1-2)	Lenny Hart	Library Press
2	T2	Fuel Cell Fundamentals(3-6)	Ryan O'hayre, Suk-Won Cha , Whitney G. Colella , Fritz B. Prinz	John Wiley & Sons, Inc
3	T3	Principles of fuel cells(Module 2)	Liu, H	Taylor & Francis, N.Y. (2006).
REFERENCE BOOKS				
1	R1	Fuel Cells and Hydrogen Production- A Volume in the Encyclopedia of Sustainability Science and Technology, Second Edition	Editor-in-Chief Robert A. Meyers. Timothy E. Lipman • Adam Z. Weber Editors	Springer
2	R2	Handbook of Electrochemistry	Cynythia G Zoski	Elsevier 2007

Semester VIII

Course Code	Course Name	Credits
CHDO8062	**Biotechnology (Departmental Optional Course)**	**03**

Course Hours	Credits Assigned

Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

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

Prerequisites

Prerequisites:

1. Knowledge of biology, chemistry, and pharmaceutical sciences in chemical engineering.
2. As biotechnology transforms everything from medicine to agriculture.

Course Objectives

1. At the end of the course the students should understand the basic concept of biotechnology. They should be able to classify micro-organisms, understand cell structure and basic metabolism.
2. Students should be able to understand basic knowledge about biological polymers.
3. Students should be able to understand basic knowledge about enzyme technology.
4. Students should understand role of biotechnology in medical field and industrial genetics.
5. Students should know importance of biotechnology in agricultural, food and beverage industries, environment, energy and chemical industries.
6. Students should understand to how to recover biological products.

Detailed Syllabus

Module No	Course Contents	Contact Hours
1	**Introduction:** Traditional and modern applications of biotechnology. Classification of micro-organisms. Structure of cells, types of cells. Basic metabolism of cells.	03
2	**Biological polymers:** Lipids, Proteins, Amino acids, Nucleic acids, Carbohydrates, Macronutrients and micronutrients. PRODUCTION OF BIOMASS: Production of baker's yeast, starter cultures, algae, mushrooms & single cell proteins from different substrates.	05
3	**Enzyme Technology:** Nomenclature and classification of enzymes. Enzyme kinetics. Microbial growth kinetics. Michaels Menten	08

	Kinetics, Immobilized enzyme kinetics, Immobilization of enzymes. Industrial applications of enzymes.	
4	**Biotechnology in health care and genetics:** Pharmaceuticals and bio-pharmaceuticals, antibiotics, vaccines and monoclonal antibodies, gene therapy. Industrial genetics, protoplast and cell fusion technologies, genetic engineering& protein engineering, Introduction to Bio-informatics. Potential lab biohazards of genetic engineering. Bioethics	08
5	**Applications of biotechnology:** Biotechnology in agriculture, food and beverage industries, chemical industries, environment and energy sectors.	08
6.	**Product recovery operations:** Dialysis, Reverse osmosis, ultrafiltration, microfiltration, chromatography, electrophoresis, Electrodialysis, crystallization and drying.	07

Course Outcome

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

1 The students will be able to demonstrate understanding of modern engineering techniques used in biotechnology
2 Students will have deep knowledge of biological polymers, enzymes, cell and metabolism.
3 The students will be able to utilize engineering skills and high end recent advances in biotechnology
4 The students will be able to examine effectively and demonstrate professional and ethical responsibilities
5 Students will be able to estimate how biotechnology used and helps in agricultural, food and beverage industry, chemical industries, pharmaceutical, environment and energy sectors.
6 Students will be able to improve how biological products are recovered.

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

End Semester Examination (80 marks):
- Weightage of each module in end semester examination will be proportional to number of respective lectures
- Question paper will comprise of total **six questions, each carrying 20 marks**
- **Question 1** will be compulsory and should cover **maximum contents of the curriculum.**
- **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Total only **Four questions need to be solved.**

Reference Books:

1. Shuller M.L. and F. Kargi. 1992. Bioprocess Engineering, Prentice-Hall, Englewood Cliffs, NJ.
2. Bailey. J.E. and Ollis D.F. 1986, Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill, New York.

Recommended Text Books:

1. Kumar H.D., Modern Concepts of Biotechnology, Vikas Publishing House Pvt. Ltd.
2. Gupta P.K., Elements of Biotechnology, Rastogi Publications
3. Inamdar, Biochemical Engineering, Prentice Hall of India.
4. Biotechnology: Food Fermentations Ed. VK Joshi, Ashok Pandey Educational Publishers and Distributors, New Delhi 1999

emester VIII

Course Code	Course Name	Credits
CHDO8063	Nanotechnology (Departmental Optional Course)	03

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

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

Prerequisites

1. Engineering Physics and Engineering Chemistry.
2. Fluid flow operations, Heat Transfer Operations & Thermodynamics
3. Particle Size Measurement

Course Objectives

1. To understand the basic scientific concepts of nanoscience and nanotechnology.
2. To analyse the properties of various nano biomaterials.
3. To study properties of various carbon nanotubes.
4. To be able to characterize various Nanostructures.
5. To be able to estimate the properties values of nanomaterials.
6. To understand applications of nanotechnology in various fields.

Detailed Syllabus

Module No	Course Contents	Contact Hours
1	**Fundamentals of Science behind Nanotechnology**: 1.1 Electron , Atom and Ions, Molecules, Metals, Biosystems, Molecular Recognition, 1.2 Electrical Conduction and Ohms Law, Quantum Mechanics and Quantum Ideas, Optics	**03**
2	**Fullerenes:** 2.1 Combustion Flame Synthesis, Crystal Formation, Sintering, Organic Synthesis Method 2.2 Super Critical Oligomerization, Solar Process, and Electric Arc Process.	**04**
3	**Carbon Nanotubes (CNT):** 3.1 Synthesis of CNT, Electric Arc Discharge Process, 3.2 Laser Ablation Process, CVD 3.3 Physical Properties of CNTs, Morphology of CNT.	**06**
4	**Nano structuring Methods:** 4.1 Vacuum Synthesis, Gas Evaporation Tech, Condensed Phase Synthesis. 4.2 Sol Gel Processing, Polymer Thin Film, Atomic Lithography, Electro deposition, Plasma Compaction.	**12**

	Characterization of Nanostructures: 4.3 Transmission Electron Microscope, Scanning Electron Microscope, 4.4 Microwave Spectroscopy, Raman Microscopy, X ray Diffraction.	
5	**Calculations in Nanotechnology :** 5.1 Particle Size Distribution, Particle Size & Measurement Methods. 5.2 Fluid Particle Dynamics, Particle Collection Mechanisms, Particle Collection Efficiency.	**08**
6	**NanoBiology**: 6.1 Interaction between Biomolecules & Nanoparticle Surface. 6.2 Interactions in the binding of Proteins with Nanoparticles. 6.3 Different Types of Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies, Application.	**06**

Course Outcome

On completion of the course the students will be able to:
1. Understand the essential concepts used in nanotechnology.
2. Identify various types of nanomaterial.
3. Learn various fabrication methods in nanotechnology.
4. Implement characterize methods of nanostructures.
5. Estimate the particle size and its fluid interactions.
6. Determine Interaction of Biomolecules & Nanoparticles.

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

End Semester Examination (80 marks):
- Weightage of each module in end semester examination will be proportional to number of respective lectures
- Question paper will comprise of total **six questions, each carrying 20 marks**
- **Question 1** will be compulsory and should cover **maximum contents of the curriculum.**
- **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
- Only **Four questions need to be solved.**

Recommended Books:
1. Nano-The Essentials, Understanding Nanoscience and Nanotechnology, T. Pradeep
2. Nanotechnology: Basic Calculations for Engineers and Scientists - Louis Theodore, A John Willy & Sons

Reference Books:
1. Nano-structuring Operations in Nanoscale Science and Engineering- Kal Ranganathan Sharma, McGraw-Hill Companies.

2. Nanotechnology: A Gentle Introduction to the Next Big Idea-By Mark Ratner, Daniel Ratner.
3. Introduction to Nanotechnology- Charles P. Poole, Jr. and Frank J. Owens, John Wiley & Sons, 2003.

Semester VIII		
Course Code	**Course Name**	**Credits**
CHDO8064	**Chemical Waste Management (Departmental Optional Course)**	**03**

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

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

Prerequisites

Prerequisites:

- Knowledge of environmental chemistry and fundamentals of environmental engineering.

Course Objectives

1. To assess the activities involved for the proposed and determine the type, nature and estimated volumes of waste to be generated;
2. To identify major pollutant and any potential environmental impacts from the generation of waste at the site;
3. To recommend appropriate waste handling measures / routings in accordance with the current legislative and administrative requirements; and
4. To categorise waste material where practicable (inert material / waste fractions) for disposal considerations i.e. public filling areas / landfill.
5. To ensure the protection of the environment through effective waste management operation.
6. To strive increased self-sufficiency in the management of hazardous waste to minimise the hazardous waste.

Detailed Syllabus

Module No	Course Contents	Contact Hours
1	**Introduction:** Chemical waste management overview. Chemical waste classification, Types of industries and industrial pollution – Characteristics of industrial wastes – Population equivalent – Bioassay studies – effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health. Environmental legislations related to prevention and control of industrial effluents and hazardous wastes.	8
2	**Pollution from major industries:** Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Pharmaceuticals, Sugar, Paper, distilleries, Refineries, fertilizer, thermal power plants – Wastewater reclamation concepts	8

3	**Supporting Industrial Activities and Wastes Generation:** Water treatment and supply systems including soft water, RO water and DM water units, Power systems and captive power units like DG sets and turbines, Boilers and steam systems, Amenities and work environment, Housekeeping, Effluent treatment plants.	6
4	**Waste Handling and Waste Minimization**: Handling, labelling, packaging and disposal procedures for Hazardous chemical waste management. Source reduction, Waste segregation schemes, Waste recycling and reuse, Pre-treatment of wastes; USEPA's waste management hierarchy Multimedia and integrated approaches to waste management, Pollution prevention programs.	6
5	**Waste Treatment and Disposal**: Overview of waste treatment technologies, Domestic wastewater and trade effluent treatment plants, Operation and control of wastewater treatment plants and air pollution control systems, Disposal of treated effluents.	5
6.	**Risk Management**: Chemical emergency response overview, workers safety, contingency plan, Emergency procedures, **Hazardous Management:** State-wise, Status of Hazardous Waste Generation (e-waste) Status of Common Hazardous Waste Treatment, Storage and Capacities, Disposal Facilities.	6

Course Outcome

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

1. Evaluate the subject from the technical, legal and economical points by learning of chemical waste management.
2. Examine the technical points that are required to set up a waste management system.
3. Evaluate recovery, treatment and disposal alternatives according to properties of industrial wastes.
4. Talent to gain knowledge with handling and reduction of waste in a wide perspective
5. Evaluate recovery, treatment and disposal alternatives according to properties of industrial waste
6. Ability to identify hazardous waste and environmental problems, understand, and solve their effects on universal and social scales

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

End Semester Examination (80 marks):

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

Sr. No	Abbreviations	Name of the book and edition	Authors	publication
TEXT BOOKS				
1	T_1	Handbook of Chemical and Biological waste management	Cavallini S., Cerutti F	CBRN Centres of Excellence,EU
REFERENCE BOOKS				
1	R_1	Waste Water treatment, disposal and Reuse	Metcalf et al.	Tata McGraw-Hill publishing company Limited.
2	R_2	Pollution control in process industries	Mahajan S.P	Tata McGraw-Hill publishing company Limited.
3	R_3	Solid and Hazardous Waste Management	By (author) Daniel Dela Torre	Publisher Arcler Education Inc

Course Code	Course Name	Credits

IOC8021	Institute Level Optional Subject II- Project Management	03

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

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

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

Module	Detailed Contents	Contact Hours
01	**Project Management Foundation:** 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).	5
02	**Initiating Projects:** 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.	6

03	**Project Planning and Scheduling:** 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).	**8**
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.	**6**
	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	
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	**8**
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** 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.	**6**

Assessment

Internal

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

End Semester theory examination

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

module

References

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th 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
IOC8022	Institute Level Optional Subject II- Finance Management	03

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

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

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	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06

02	**Concepts of Returns and Risks:** 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-securityPortfolio. **Time Value of Money:** 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.	**06**
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** 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.	**09**
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, PaybackPeriod, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** 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.	**10**
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** 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	**05**
06	**Dividend Policy:** 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	**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. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
IOC8023	Institute Level Optional Subject II- Entrepreneurship Development and Management	03

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

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

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	**Overview Of Entrepreneurship:** 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	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing aswell as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting aNew Business, Buying an Existing Business, New ProductDevelopment, 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	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED 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**
05	**Effective Management of Business:** 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	**08**
06	**Achieving Success In The Small Business:** 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	**05**

Assessment

Internal

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

End Semester theory examination

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

References

1. 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
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
IOC8024	Institute Level Optional Subject II- Human Resource Management	03

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

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

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 & differentaspects 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	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM,Managing ethical issues.	**5**
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness	**7**
	• Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • 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. • Case study	
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	**6**
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	**5**

05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • 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.	**6**
06	**HR & MIS** 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 **Strategic HRM** 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 **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	**10**

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, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
IOC8025	Institute Level Optional Subject II- Professional Ethics and Corporat Social Responsibility (CSR)	03

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

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

Objectives:

- To understand professional ethics in business
- To recognized 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	**Professional Ethics and Business:** 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	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06

04	**Introduction to Corporate Social Responsibility:** 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	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibilityand Public-Private Partnership (PPP) in India	**08**
06	**Corporate Social Responsibility in Globalizing India:** 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.	

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
IOC8026	Institute Level Optional Subject II- Research Methodology	03

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

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

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
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	**Types of Research** **2.1.** Basic Research **2.2.** Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5.** Empirical Research **2.6** Qualitative and Quantitative Approaches	07

03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem	**08**
	c. Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f.** Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment

Internal

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

End Semester theory examination

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

References

1. 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, (2nd ed), Singapore, Pearson Education

Course Code	Course Name	Credits
IOC8027	Institute Level Optional Subject II- IPR and Patenting	03

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

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

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	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:** 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	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	**05**
04	**Basics of Patents:** 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	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	**08**
06	**Procedure for Filing a Patent (National and International):** 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 **Patent databases:** Important websites, Searching international databases	**07**

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, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd 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
9. M Ashok Kumar and mohdIqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
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
IOC8028	Institute Level Optional Subject II - Digital Business Management	03

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

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

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	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts. Difference between physical economy and digital economy. **Drivers of digital business-** 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	**Overview of E-Commerce** **E-Commerce-** 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.ther 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 Affiliatemarketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC.	**06**
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	**06**
4	**Managing E-Business**-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	
5	**E-Business Strategy**-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)	**04**
6	**Materializing e-business: From Idea to Realization**-Business plan preparation. **Case Studies and presentations**	**08**

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, 6th 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, 2nd 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 2nd 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-enOECD Publishing

Course Code	Course Name	Credits
IOC8029	Institute Level Optional Subject II- Environmental Management	03

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

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

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, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

SEMESTER VIII

Course Code	Course Name	Credits
CHL801	Modelling simulation and Optimization Lab	1.5

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

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

Prerequisites

- Linear Algebra, Process Calculations, Computer Programming

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,/CW sim,/ChemCAD,/Hysys/ Aspen Plus / or any simulator.

Course Objectives

1. To study the types of various mathematical models of engineering processes;
2. To provide an overview of the possibilities of process simulation as a tool for computer systems analysis, which minimizes risks and costs in experimentation.
3. To familiarize students with the techniques of modeling of engineering processes and of the developed model optimization;
4. To introduce students to different commercial software to simulate the chemical processes from the design stage to the control and optimization;
5. To provide the background needed by the chemical engineers to carry out computer-aided analyses of large-scale chemical processes.
6. Demonstrate the ability to use a process simulation

Minimum TEN experiments must be performed.

- Simulation of pipe and pump network flows
- Simulation of linear and nonlinear systems
- Simulation of mass transfer process - distillation
- Simulation of mass transfer process- Absorption
- Simulation of Heat Transfer Process like Shell and tube heat exchanger
- Simulation of chemical reactor like batch, Semi batch, Continuous reactor
- Simulation of Multicomponent flash calculation for ideal and nonideal system

- Simulation of flowsheet calculation (Any chemical manufacturing process)
- Optimization of chemical processes.
- Experiments based on computer program or mathematical and chemical engineering software

Course outcomes

1. Students will learn different types of simulation techniques.

2. Students will apply simulation techniques to solve complex system issues and to select feasible, solutions

3.Student will able to calculate the different physicochemical and thermodynamic properties chemicals;

4.Students will able to understand and analyse simulation of various separation process

5.Students will able to apply optimization parameter in distillation process

6.Students will learn to simulate the models for the purpose of optimum control by using software.

Term work

Term work shall be evaluated based on performance in practical. Practical Journal: 20 marks

Attendance: 05marks

Total: 25marks

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.

Semester VIII

Course Code	Course Name	Credits
CHL802	Skilled based lab: Software application in Chemical Engineering Lab	1.5

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

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

Prerequisites:

1. The students should have knowledge of design of unit operation & unit process
2. The students should have knowledge of Mathematics & to solve differential equations
3. They should be aware about basic principles of linear algebra & computer programing
4. The students should have knowledge of Transport phenomenon
5. The students should be aware about selection of Thermodynamic packages

Course Objectives:-

1. To make students understand advantages of software application in chemical engineering.
2. To make students identify and use the software for optimization of the processes in chemical industries.
3. To make students understand writing and solving design problem of chemical engineering System.
4. To make students to design Mass & Heat transfer Equipment's by using various chemical engineering software.
5. To make students understand Material and energy balance through simulation of complete flow sheet of chemical plant.
6. To make students to optimize the process parameters by using chemical engineering software.

List of Experiments (minimum eight)

Experiment No.	Details of Experiment	Lab Hours
1	Simulation of Pipe Network (Pressure drop, Friction factor Head Losses, Pump Power, NPSH)	3
2	Simulation of Heat Transfer Equipment's (Heater and Cooler ,Double Pipe or Shell and Tube Heat exchangers, Plate Type Heat Exchanger)	3

3	Simulation of Chemical Reactors (Plug Flow or Continuous Stirred Tank Reactor, Bubble Column Reactor)	3
4	Simulation of distillation Column (Separation of Butanol and Water system)	3
5	Simulation of Pressure Swing Azeotropic Distillation (Methanol and Acetone)	3
6	Simulation of Advanced Divded Distillation Column (Benzene-Toluene-Xylene)	3
7	Simulation of Thermodynamic cycles (Rankin cycle or Vapor Compression Cycle ,Vapor Absorption cycle)	3
8	Simulation of Extractive Distillation (MethylCycloHexane/Toluene)	3
9	Simulation of Absorption and Desorption Column	3
10	Simulation of any hydrogenation process	3

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

Course Outcomes:

1. Students will become aware of application of software in chemical engineering.
2. Students will be able to identify and use the software for optimization of the processes in chemical industries.
3. The students will be able to design unit operation and unit process by using chemical engineering software .
4. The student will be able to do the material and energy balance of chemical plant
5. The student will be able to optimize typical chemical processes.
6. The students will be able to solve the trouble shooting problem in chemical plants by using various chemical engineering software's.

Assessment:
Term Work (25 marks)
Distribution of marks will be as follows:
Laboratory work: 20 marks
Attendance: 05 marks
End Semester Orals (25 marks)
Orals on experiments done in the laboratory

Reference Book

1. William Y.Luyben, Process Modelling simulation and control for chemical Engineer, Second edition McGraw Hill.
2. Process Engineering and Design: Shuchen B. Thakore, Bharat I Bhatt, Second Ed., McGraw Hill Education (I) Private Limited, 2011.
Source http://www.chemsep.org/
https://pubs.acs.org/doi/10.1021/acs.iecr.6b04939

Semester VIII

Course Code	Course Name	Credits
CHP801	Major Project II	06

Course Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	12#	-	-	06	-	06

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	50	-	100	150

 # indicates work load of Learner (Not Faculty), for Major Project; Faculty load: semester VIII – 1 hour per week per project group

Prerequisites

1. Detail knowledge of applied chemistry, unit operations, reaction engineering, heat transfer.
2. Basics of process engineering and economics.
3. Basics of mathematics, process equipment design.
4. Fundamentals of modeling and simulation and related software.

Objectives

1.To demonstrate a sound technical knowledge of the selected project topic which should be focused on solutions to industrial, societal and environmental problems with the application of sustainable technology.
2. To undertake problem formulation and solution.
3. To develop flowsheet and PID diagram for manufacturing projects as applicable.
4. To design engineering solutions to complex problems utilizing a systems approach.
5. To design and carry out experimental runs and validate the results.
6. To communicate the findings with engineers and the community at large in written and oral form.

Outcomes

After the completion of project work., Students will be able to
1. Demonstrate a sound technical knowledge of the selected project topic related to industrial, societal and environmental problems with the application of sustainable technology.
2. Carry out problem formulation and solution.
3. Develop flowsheet and PID diagram for manufacturing projects as applicable.
4. Design and perform experiments and analyze results for research project. In case of manufacturing project, develop complete flow sheet and PID diagram.

5. Apply knowledge of the chemical engineering subjects for interpretation and analysis of experimental results and formulate a model and use suitable software for comparing results and optimize the parameters as and when required.
6. Write research article, project report and present the findings before experts and society at large.

Guidelines:

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

Exam Guidelines

Term Work – 50 Marks:

- Presentation – 20 Marks
- Project Report -30 Marks
- Oral – 100 Marks