University of Mumbai

No. AAMS_UGS/ICC/2022-23/ 126

CIRCULAR :-

Attention of the Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office circular No.UG/146 of 2016-17 dated 9th November, 2016 relating to the revised syllabus of Master of Engineering (Chemical Engineering) (Sem.– I to IV) (CBCS) .

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Chemical Engineering at its meeting held on 04th May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 vide item No. 6.38 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.38 (R) and that in accordance therewith, the revised syllabus of M.E.(Chemical Engineering) (Sem.– I to IV) (CBCS) (REV-2022 Scheme) has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

(Dr. Shailendra Deolankar)
I/c Registrar

MUMBAI – 400 032
20th October, 2022

To

The Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology.

A.C/6.38(R)/11/07/2022

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No. AAMS_UGS/ICC/ 2022-23/ 126

20th October, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Chemical Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Desktop/Circular of Engineering/Priya

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC – 11 July, 2022

Item No. – 6.38 (R)

University of Mumbai

Revised Syllabus for

M.E

Chemical Engineering

(Sem. - I to IV)

(Choice Based Credit System)

(With effect from the academic year 2022-23)

University of Mumbai

O: _____ Title of Course	M.E (Chemical Engineering)
O: _____ Eligibility	Passing Bachler of Engineering as per the Ordinance 0.6264
R: _____ Passing Marks	45%
No. of years/Semesters:	2 Years/ 4 Semesters
Level:	P.G. / ~~U.G./ Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	~~New~~ / Revised
To be implemented from Academic Year:	With effect from Academic Year: 2022-23

Dr. Parag R Gogate
Chairman
of Ad-hoc Board of Studies in
Chemical Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and
Technology

Dr Anuradha Majumdar
Dean,
Faculty of Science and
Technology

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 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 68, 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 are made mandatory across all disciplines of engineering in first and second semester 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 Master of Engineering from the academic year 2022-23

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

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 68, 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.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble to the Revision of Syllabus in Chemical Engineering

Development in all fields including Chemical Engineering along with use of soft wares 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 post-graduation from the program.

With these objectives, online meeting was organized on 7th February 2022 which was attended by heads of the departments and subject faculty of affiliating Institutes. An online meeting was organized on 15th February 2022 with the faculty of MGMCET, Kamothe, Navi Mumbai, teaching the post graduate courses.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 are introduced in appropriate semesters. Views from experts and PG teachers were taken into consideration and final Academic and Exam scheme was prepared with the consent of all the members involved.
The Program Educational Objectives finalized for the Postgraduate program in Chemical Engineering are:

1. To prepare the student for advancements in mathematical, scientific, engineering excellency and research.
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 Tamaskar – Member

SEMESTER I

Course Code	CourseName	TeachingScheme(ContactHours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHC101	Advanced Momentum Transfer	3	--	--	3	--	--	3
CHC102	Advanced Chemical Reaction Engineering	3		--	3		--	3
CHPE101X	ProgramElective 1	3	--	--	3	--	--	3
CHPE102X	ProgramElective 2	3	--	--	3	--	--	3
CHIE101X	InstituteElective1	3	--	--	3	--	--	3
CHL101	ProgramLab-I	--	2	--	--	1	--	1
CHSBL101	Skill Based Lab-I	--	4[$]	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract /Oral	Total
		InternalAssessment			End Sem.Exam	Exam. Duration (inHrs)			
		Test-1	Test-2	Avg					
CHC101	Advanced Momentum Transfer	20	20	20	80	3	--	--	100
CHC102	Advanced Chemical Reaction Engineering	20	20	20	80	3	--	--	100
CHPE101X	ProgramElective 1	20	20	20	80	3	--	--	100
CHPE102X	ProgramElective 2	20	20	20	80	3	--	--	100
CHIE101X	InstituteElective1	20	20	20	80	3	--	--	100
CHL101	ProgramLab-I	--	--	--	--	--	25	25	50
CHSBL101	Skill Based Lab-I	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	--	**75**	**75**	**650**

Program Elective 1 (Semester I)

Advanced Heat Transfer (CHPE1011)	Advanced Thermodynamics (CHPE1012)	Process Intensification in Chemical Plants (CHPE1013)

Program Elective 2 (Semester I)

Corrosion in Industries and its Control (CHPE1021)	Industrial Solid Waste Management (CHPE1022)	Bio Process Engineering(CHPE1023)

Institute Elective 1 (Semester I)

ProductLifecycleManagement (CHIE1011)	ReliabilityEngineering (CHIE1012)	Management Information System (CHIE1013)
Design of Experiments (CHIE1014)	Operation Research (CHIE1015)	Cyber Security and Laws (CHIE1016)
Disaster Management and Mitigation Measures (CHIE1017)	Energy Audit and Management (CHIE1018)	

SEMESTER II

Course Code	CourseName	TeachingScheme(ContactHours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHC201	Advanced Mass Transfer	3	--	--	3	--	--	3
CHC202	Advanced Process Control And Dynamics	3		--	3		--	3
CHPE201X	ProgramElective 3	3	--	--	3	--	--	3
CHPE202X	ProgramElective 4	3	--	--	3	--	--	3
CHIE201X	InstituteElective2	3	--	--	3	--	--	3
CHL201	ProgramLab-II	--	2	--	--	1	--	1
CHSBL201	SkillBasedLab-II	--	4[$]	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract /Oral	Total
		InternalAssessment			End Sem. Exam	Exam. Duration (inHrs)			
		Test-1	Test-2	Avg					
CHC201	Advanced Mass Transfer	20	20	20	80	3	--	--	100
CHC202	Advanced Process Control And Dynamics	20	20	20	80	3	--	--	100
CHPE201X	ProgramElective 3	20	20	20	80	3	--	--	100
CHPE202X	ProgramElective 4	20	20	20	80	3	--	--	100
CHIE201X	InstituteElective2	20	20	20	80	3	--	--	100
CHL201	ProgramLab-II	--	--	--	--	--	25	25	50
CHSBL201	SkillBasedLab-II	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	**--**	**75**	**75**	**650**

Program Elective 3 (Semester II)

Advanced Computer Aided Design (CHPE2011)	Heterogeneous Catalysis and Reactor Design (CHPE2012)	Advanced Downstream Processes (CHPE2013)

Program Elective 4 (Semester II)

Industrial Safety and Hazard Control (CHPE2021)	Green Chemistry and Engineering (CHPE2022)	Industrial Pollution Control and Prevention (CHPE2023)

Institute Elective 2 (Semester II)

Project Management (CHIE2011)	Finance Management (CHIE2012)	Entrepreneurship Development and Management (CHIE2013)
Human Resource Management (CHIE2014)	Professional Ethics and CSR (CHIE2015)	Digital Business Management (CHIE2016)
Environmental Management (CHIE2017)		

Note 1: Skill Based Lab- I and II are focused on the learning through experience. SBL shall facilitate the learnerto acquire the fundamentals of practical engineering in his or her specialization in a project-orientedenvironment. The learning through skill based labs can be useful in facilitating their research work andhenceusefulin earlycompletionoftheirdissertation work.

SEMESTER III

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHMP301	MajorProject: Dissertation-I	--	20	--	--	10	--	10
Total		**00**	**20**	**00**	**00**	**10**	**--**	**10**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract/ Oral	Total
		InternalAssessment			End Sem. Exam	Exam.Duration(inHrs)			
		Test-1	Test-2	Avg					
CHMP301	MajorProject: Dissertation-I	--	--	--	--	--	100	--	100
Total		**--**	**--**	**--**	**--**	**--**	**100**	**--**	**100**

OnlineCreditCourses

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHOCC301	OnlineCreditCourse-I	--	--	--	--	--	--	3
CHOCC302	OnlineCreditCourse-II	--	--	--	--	--	--	3
Total		**--**	**--**	**--**	**00**	**00**	**00**	**06**

Note 2: It is mandatory to complete the Online Credit Courses (OCC) available on NPTEL / Swayam /MOOC orsimilarplatformapprovedbyUoM.Thesetwocoursesshallbecompletedinanysemesterlorllorlll,butnot later end of the Semester III.University shall make a provision that credits earned with OCC- I andOCC-IIshallbeaccountedinthethirdsemestergrade-sheetwithactualnamesofcourses.Thelearnershallbeallowedtotakeupthesecoursesfromhisorherinstituteororganisation/industrywherehis/hermajorprojectis carried out.Thestudentsshallcompletethecoursesandshallqualifytheexamconducted bytherespective authorities/ instructor from the platform. The fees for any such courses and the correspondingexaminationshallbebornebythe learner.

OnlineCreditCourse –I

Thelearnershalloptforthecourseinthedomainof ResearchMethodology**or**Research&PublicationEthics orIPR. Theopted courseshall be of3creditsof equivalentnumber of weeks.

OnlineCreditCourse–II

ThelearnershalloptforthecourserecommendedbyFacultyAdvisor/ProjectSupervisorfromtheinstitute.Theopted course shallbe of 3creditsofequivalentnumberof weeks.

SEMESTER IV

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHMP401	Major Project :Dissertation-II	--	32	--	--	16	--	16
Total		**--**	**32**	**--**	**--**	**16**	**--**	**16**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract/ Oral	Total
		InternalAssessment			End Sem. Exam	Exam. Duration (inHrs)			
		Test-1	Test-2	Avg					
CHMP401	MajorProject: Dissertation-II	--	--	--	--	--	100	100	200
Total		**--**	**--**	**--**	**--**	--	**100**	**100**	**200**

Total Credits:68

Note3: TheDissertation-IIsubmissionshallnotbepermittedtillthelearnercompletesalltherequirementsME course.

Note4: Thecontact hoursforthecalculationofloadofthe teacherforMajorProjectareasfollows:MajorProjectDissertation IandII-02 Hour/ week/student

Semester I		
Course Code	**Course Name**	**Credits**
CHC101	**Advanced Momentum Transfer**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Physics course involving fluids, Basic concepts of viscosity, stress and strain in fluids.
2. Basic fluid flow course involving equation of continuity, motion and related laminar flow problems.
3. Dimensional Analysis (Buckingham PI theorem), Types of flows, Fluid Statics.

Course Objectives

1. To understand the analogous mechanism of momentum Transport for steady and unsteady flow.
2. To perform momentum balance for a given system at macroscopic and microscopic scale
3. To solve the governing equations to obtain velocity profiles.
4. To model the momentum transport under turbulent conditions
5. To study the mechanism of fluidization and flow through Jet and nozzle.
6. To learn the flow dynamics of compressible fluids.

Detailed Syllabus

Module No.	Course Contents	No.ofHours
1	**Shear stress in laminar flow:** Newtonian and non-Newtonian fluids; Rheological models; theories of transport properties of gases and liquids; effect of pressure and temperature.	**08**

	One dimensional momentum transport in laminar flow (shell balance): General method of shell balance approach to momentum transfer problems; momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids in pipes, planes, slits and annulus; Fluid flow of two immiscible fluids.	
2	**Turbulent flow:** basics, Reynolds average Navier-Stokes equations, closure problem, and Boussinesque hypothesis, Prandtl mixing length theory, turbulence models, energy spectrum, turbulent boundary layer, and universal velocity profile.	**05**
3	**Compressible fluids:** Flow through variable area- conduits, Flow of gas through a nozzle or orifice (isothermal flow, non isothermal flow), Flow in a pipe (Energy balance for flow of ideal gas, isothermal flow of an ideal gas in a horizontal pipe, Flow with fixed upstream pressure and variable downstream pressure, Non- isothermal flow of an ideal gas in a horizontal pipe, Adiabatic flow of an ideal gas in a horizontal pipe).	**08**
4	**Fluid flow in closed Conduits:** Friction factors for fully developed laminar, turbulent and transition flow in circular conduits; Friction factors for flow in the entrance to a circular conduit; Friction factors for packed columns.	**03**
5	**Macroscopic momentum balances:** The macroscopic mass, momentum and mechanical energy balances; Use of macroscopic balances for steady-state problems; Use of macroscopic balances for unsteady-state problems.	**05**
6	**Gas-liquid and solid-liquid fluidized beds:** Characteristics of particles, Principle of fluidization and mapping of various regimes, Two phase theory of fluidization, Bubbles in fluidized bed, Entrainment and Elutriation, Fast fluidized bed, Mixing, segregation and gas dispersion, Heat and mass transfer in fluidized bed, Solid-liquid fluidized bed and three phase fluidized bed, Design of fluidized bed reactors.	**10**

Course Outcomes

On completion of the course the students will:

1. Describe origin and importance of Reynolds stresses and estimate values based on simple concepts. Concept of eddy motion scales of turbulence
2. Write Bernoulli's equation and solve simple problems related to flow in pipes, orifice venturi meters, weir, pitot tubes, etc.
3. Calculatefriction factor and pressure drop for fluid flow in closed conduits.
4. Calculate minimum fluidization velocity, terminal setting velocity, velocity void age relationships for fluidized beds. Settling velocities under hindered setting conditions.
5. Have knowledge of flow behaviour of compressible fluids.
6. Calculate momentum and mechanical energy balances

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination..
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four question need to be solved.

Reference Books:

1. Transport Phenomena, R. B. Bird, W. E. Stewart and E.N. Lightfoot, John Wiley, 1960
2. Transport Phenomena – A Unified Approach, R.S. Brodkey and H.C. Hershey, McGraw Hill, 1988
3. Momentum, Heat and Mass transfer, C.O. Bennet and J.E. Myers, McGraw Hill, 1993

Semester I		
Course Code	**Course Name**	**Credits**
CHC102	Advanced Chemical Reaction Engineering	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Rate equation of homogeneous and heterogeneous reactions
2. Basic knowledge of different method of analysis of kinetic data.
3. Design equations of batch, semibatch, recycle and flow reactors

Course Objectives

1. To acquire knowledge of non-ideal reactors
2. To study the residence time distribution (RTD) in PFR and CSTR
3. Tostudyrate equations for fluid solid reactions.
4. Tounderstand the concept of heterogeneous reactions.
5. To understand the concept of catalytic reactions.
6. Tostudy different catalytic reactors.

Detailed Syllabus

Module No.	Course Contents	No. ofHours
1	RTD for Chemical Reactors General characteristics, Measurement of RTD characteristics, RTD in ideal Reactors, Zero Parameter Models, Segregation Model	**06**

2	Analysis of Non- Ideal reactors Basic Data, one parameter Models, The tank in the series Models, The dispersion model, two parameter model, Testing the model and determining its parameters, Other models of the non ideal reactors using the CSTR's and PFR's using the RTD	**06**
3	Rate equation for Fluid- Solid reactions Rate of the absorption, desorption, surface reaction, synthesizing rate law, mechanism and rate limiting steps, design of the reactors for the gas solid reactions, heterogeneous data analysis for the reactor designs, catalysts deactivation, moving bed reactors	**06**
4	External diffusion effects on the Heterogeneous Reactions Binary diffusion, External resistance to Mass Transfer, The shrinking core model	**06**
5	Diffusion and Reaction in Porous Catalysts Diffusion and Reactions in spherical catalyst pellets, Internal effectiveness factor, Overall effectiveness factor, Estimation of diffusion and reaction limited regimes, mass transfer and reaction in packed bed, The determination of limiting situation from reaction data	**08**
6	Design of Heterogeneous Catalytic Reactors Isothermal and adiabatic fixed bed reactors, Non- Isothermal, Non- adiabatic fixed bed reactors, slurry reactors, trickle bed reactors	**07**

Course Outcomes

On completion of the course the students will:

1. apply knowledge of RTD in design of chemical reactors.
2. analyze and design different non ideal reactors.
3. able to predict which controlling mechanism offer resistance to overall reaction rate.
4. analyze the external diffusion effects on the heterogeneous reactions.
5. able to determine the different properties of catalyst
6. analyze and design heterogeneous catalytic reactors.

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasste stor assignmentonlive problemsorcourseproject.

EndSemesterTheoryExamination:

Someguidelinesfor settingupthequestionpaper:

- Minimum80%syllabusshouldbecovered inquestionpapersofendsemester examination.
- Weightage ofeachmodulewillbeproportional to numberofrespectivelecturehoursasmentionedinthesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequal marks

- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3thenpart(b)willb e fromanymoduleotherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. "Chemical Reaction Engineering" by Octave Levenspiel
2. **"**Chemical Engineering Kinetics**" by** J M Smith
3. "Elements of Chemical Reaction Engineering" by H. Scott Fogler

Semester I (Program Elective I)		
Course Code	**Course Name**	**Credits**
CHPE1011	**Advanced Heat Transfer**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Engineering Mathematics.
2. Fluid Flow.
3. Basic Course on Heat Transfer.
4. Transport Phenomena.

Course Objectives

1. To understand the fundamentals of heat transfer and its applications.
2. To analyze heat transfer in Newtonian and Non-Newtonian fluids.
3. To study heat transfer in industrial process equipment.
4. To familiarize with the design heat transfer equipment such as condensers, reboilers and evaporators.
5. To understand the mechanisms of heat transfer in packed, fluidized and moving bed reactors.
6. To study the design of furnaces and the fundamentals of electrical heating.

Detailed Syllabus

Module No.	Course Contents	No. of Hours
1	**Overview of Heat Transfer and its Industrial Applications** Introduction and importance of the subject. Relevance of subject in industrial environment. Modes of heat transfer. Dissipation of energy in industry. Concept of flow patterns and its uses in industry.	**04**
2	**Heat Transfer in Newtonian and Non-Newtonian Fluids** Analogy between momentum and heat transfer. Comparative study of	**09**

	Newtonian and Non- Newtonian fluid in relation to heat transfer. Newtonian and Non- Newtonian heat transfer in circular tubes, coils and other configurations. Non- Newtonian fluid heat transfer in PFR, CSTR and concept of vibrating / oscillating heat transfer.	
3	**Heat Transfer in Industrial Process Equipment** Detailed study of Air-Cooled Condensers. Regenerators and Heat Transfer in Agitated Vessels.	**06**
4	**Design of Heat Transfer Equipment** Design aspects of Condensers, Reboilers and Evaporators.	**08**
5	**Applications of Heat Transfer in Fluidization Engineering** Mechanisms of heat transfer in packed, fluidized and moving bed reactors, heat transfer in dilute phase transport.	**05**
6	**Heat Transfer in Furnaces and Electrical Heating** Heat transfer in furnaces, design methods for furnaces, pipe still, thermo siphoning and other industries. Electrical heating.	**07**

Course Outcomes

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

1. outline the industrial applications of heat transfer.
2. compare heat transfer in Newtonian and Non-Newtonian fluids.
3. analyze heat transfer in industrial process equipment.
4. design heat transfer equipment such as condensers, reboilers and evaporators.
5. predict heat transfer coefficients in packed, fluidized and moving bed reactors.
6. apply the design methods for furnaces and explain electrical heating.

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six questions.
- All questions carry equal marks.
- Questions will be mixed in nature (for example supposed 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.

Reference Books:

1. Fluid Dynamics and Heat Transfer, J.G. Knudsen and D.L. Katz, McGraw-Hill, 1958.
2. Process Heat Transfer, G.F. Hewitt, G.L. Shires and T.R. Bott, CRC Press, 1994.

3. Fluidization, M. Leva, McGraw-Hill, 1959.
4. Fluidization, J.F. Davidson, R. Clift, D. Harrison, Second Edition, Academic Press, 1985.
5. Fluidization Engineering, D. Kunii and O. Levenspiel, Second Edition, Butterworth-Heinemann, 1991.
6. Non- Newtonian Flow and Heat Transfer, A.H.P. Skelland, Wiley, 1967.
7. Non-Newtonian Flow and Applied Rheology : Engineering Applications, R.P. Chhabra and J.F. Richardson, Second Edition, Elsevier Science, 2008.
8. Heat Transfer to Non-Newtonian Fluids : Fundamentals and Analytical Expressions, A. Shenoy, Wiley-VCH, 2018.
9. Advanced Heat Transfer, G.F. Naterer, Third Edition, CRC Press, 2022.

Semester I (Program Elective I)		
Course Code	**Course Name**	**Credits**
CHPE1012	**AdvancedThermodynamics**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Basic course in mathematics and thermodynamics
2. Physical Chemistry, kinetic theory of gases,
3. Ideal gas law, vapor pressure and Raoult's law.

Course Objectives

1. Tolearnadvancedtopicsofclassicalthermodynamics withemphasisonbasicconcepts,laws,and thermodynamicrelationships
2. To compute thermodynamic properties from volumetric data.
3. Toestimate fugacities in gas mixtures based on various cubical equation of states.
4. Toanalyze various thermodynamic properties in liquid mixtures.
5. Toestimate fugacities in liquid mixtures based on variousModelsandTheoriesofSolutions
6. Toanalyze phase equilibrium involving solids

Detailed Syllabus

Module No.	Course Contents	No.ofHours
1	**ClassicalThermodynamicsofPhaseEquilibria:** Gibbs-Duhemequation,chemicalpotential,fugacityandactivitycoefficient.PartialMolarProperties.	**04**
2	**ThermodynamicProperties fromVolumetricData:** ThermodynamicpropertieswithindependentvariablesP&T,fugacityofacomponentinamixtureatmoderatepressures,thermodynamicpropertieswithindependentvariablesVand	**06**

	T,fugacityofcomponentinamixtureaccordingtoVanderWaalsequation.	
3	**FugacitiesinGasmixtures:** Lewisfugacityrule,EquationofState,Virialequationsofstate,Extensiontomixtures,fugacitiesfromvirialequation,calculationofvirialcoefficientsfrom potentialfunctions,third virialcoefficients,Virialcoefficientsfromcorrespondingstatescorrelation,fugacitiesfromgeneralizedchartsforpurecomponents,fugacitiesfroman empiricalequationofstate.	**08**
4	**Thermodynamic Properties inLiquidmixtures:** ExcessfunctionsandfundamentalrelationsofExcessfunction,activityandactivitycoefficient, activity coefficients from excess functions in binary mixtures, application of GibbsDuhum equation , testing of equilibrium data, Wohl's expansion for excess Gibbs energy,equations of Van der Waal, Wilson and Renon equations,Margules equations, Van Laarequation,UNIQUACandUNIFACmethodsforestimationofactivitycoefficient. Thermodynamiccriteriaofmiscibility.Azeotropesandtheirexistence.	**08**
5	**FugacitiesinLiquidMixtures- ModelsandTheoriesofSolutions:** TheoryofVanlaar,Scatchard – Hildelrandtheory, LattictheoryWilson'sempiricalextension oftheFlory–Huggin'sequation,twoliquidtheory,chemicaltheory	**06**
6	**Mixture phase equilibrium involving solids:** Solubility of solid in liquid and supercritical fluid, Solid Liquid Equilibrium,Partitioning of solid between two liquid phases, distribution coefficient, Freezingpoint depression of solvent due to presence of solute, freezing point of liquid mixturesin presence of solid.	**07**

Course Outcomes

On completion of the course the students will:

1. analyze various thermodynamic properties and their correlations.
2. compute thermodynamic properties of individual species in a mixture.
3. evaluate fugacities in gas mixtures based on various cubical equation of states.
4. estimate activity and activity coefficient in liquid mixtures.
5. evaluate fugacities in liquid mixtures using variousModelsandTheoriesofSolutions.
6. analyze phase equilibrium in the presence of solid.

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclassteston assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecovered inquestionpapersofendsemester examination.

- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus**.**
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequal marks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3thenpart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. J. M. Smith & H. C. Van Ness, "Introduction to Chemical Engineering Thermodynamics"
2. Stanley I. Sandler, "Chemical, Biochemical and Engineering Thermodynamics"
3. Savein Stolen, Tor Grande, Neil Allan, "Chemical Thermodynamics of Materials"
4. K.V.Narayanan," Chemical Engineering Thermodynamics"
5. Kenneth Denbigh, "Principles of Chemical Equilibrium"
6. Y. V. C. Rao, "Chemical Engineering thermodynamics"
7. B. F. Dodge, "Chemical Engineering Thermodynamics"
8. T. E. Daubert, " Chemical Engineering Thermodynamics"
9. Glasstone S., "Thermodynamics for Chemists"
10. B. G. Kyle, "Chemical and Process Thermodynamics

Semester I (Program Elective I)		
Course Code	**Course Name**	**Credits**
CHPE1013	**ProcessIntensificationInChemicalPlants**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

- BasicsofUnitChemicalEngineering

Course Objectives

1. TounderstandtheconceptofProcessIntensification.
2. To provide an understanding of basic operating principles of a variety of intensified process equipments
3. Toprovideknowledgeofapplicationofintensificationtechniquestoarangeof processes
4. To understand scale up issues in the chemical process.
5. To gain the scientific background, techniques and applications of intensification in the process industries
6. To Identify and solve process challenges using intensification technologies.

Detailed Syllabus

Module No.	Course Contents	No. ofHours
1	**Philosophyandprinciplesofprocessintensification(PI):** Introduction,philosophyandopportunitiesofPI,TypesofPIequipments,Equipmentsand methods. Micro Process Technology in process intensification: Introduction to microprocess technology, Process Intensification by Microreactors, Hydrodynamics and transport in microchannel based microreactor	**07**
2	**Highgravityinchemicalprocessing**: Historicaldevelopment,Fundamentals,mechanicaldesign,applications,scale-upandcommercialuse,future,Thespinningdisc reactor. Process intensification in extraction: Introduction and Principles, Supercritical extraction for process intensification,	**07**

3	**Multifunctionalheatexchanger:** Introduction,Compactheatexchangertechnology,Singlephaseflow,Heattransferandmasstransfer,applications.	**06**
4	**Micro reactiontechnology:** Microtechnology,effectofminiaturization,microfabrication,implementation.	**05**
5	**Structuredcatalysisandreactors:** Introduction,overviewofstructuredreactors,Gasphasereactions,multiphasereactions.	**05**
6	**Enhanced fields:** Energy based intensifications, Sono-chemistry, Basics of cavitation, Cavitation Reactors, Flow over a rotating surface, Hydrodynamic cavitation applications, Cavitation reactor design, Nusselt-flow model and mass transfer, The Rotating Electrolytic Cell, Microwaves, Electrostatic fields, Sono-crystallization, Reactive separations, Supercritical fluids. Process intensification by membrane: Introduction to membrane and its principles, Membrane engineering in process intensification	**09**

Course Outcomes

On completion of the course the students will:

1. understand the necessity of Process Intensification
2. applyprocessintensificationinindustrialprocesses
3. implementmethodologiesforprocessintensification
4. understandscaleupissuesinthechemicalprocess
5. knowthescientificbackground,techniquesandapplicationsofintensificationintheprocessindustries
6. be able to identifyandsolveprocesschallengesusingintensificationtechnologies

Assessment

Internal:
Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclassteston assignmentonlive problemsorcourseproject.

EndSemesterTheoryExamination:
Someguidelinesfor settingupthequestionpaper:

- Minimum80%syllabusshouldbecovered inquestionpapersofendsemester examination.
- Weightage ofeachmodulewillbeproportional to numberof respectivelecturehoursasmentionedinthesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequal marks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3thenpart(b) willbe fromanymoduleotherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. Reengineeringthechemicalprocessingplant,Andrejstankiewiez,JacobA.,Moulin,MarcelDekkerInc.NewYork,Basel.
2. Compactbrazedplateheatexchanger.J.M.,Navarro,A.,Bailly,Elsvier,Paris.1994.

3. Compactheatexchanger fortheprocessindustry.R.K.,Shah,BegellHouse,1997.
4. Microreactors,EhrfeldW.,HesselV., Lowe,H.,Weinheim:Willey-VCH,2000.
5. Conceptualdesignofchemicalprocesses.J.M.,Douglas,McGraw-Hill,NewYork
6. Reay D., Ramshaw C., Harvey A., Process Intensification, Butterworth Heinemann, 2008.

Semester I (Program Elective II)

Course Code	Course Name	Credits
CHPE1021	Corrosion in industry and its control	03

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

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

Prerequisites

1. MaterialscienceandEngineering
2. Advancedmaterials

Course Objectives

1. Tounderstandtheknowledge ofcorrosionpreventionmethodsfordesigningprocessindustries.
2. To study design aspect for corrosion prevention
3. To design cathodic and anodic protection systems
4. To study corrosion in engineering materials
5. To study corrosion inspection and monitoring
6. To study corrosion and Control methods in industrial environment.

Detailed Syllabus

Module No.	Course Contents	No.ofHours
1	Introduction:Theeconomicsaspectsofcorrosion.Casestudies.Someexamplesofcatastrophiccorrosionfailures.	04
2	Design aspectstominimizethecorrosion,Temporarycorrosionpreventionmethodsanduseofinhibitorsinindustry.	05

3	Design of cathodic and anodic protection systems. Selection of the material for sacrificialanodes– anodesforimpressedcurrentmethodsofprotection.Corrosioninpipelines,internalandexternal protectionofpipeline**.**	**08**
4	Corrosion of Stainless Steel, Plastics and Elastomers Principal engineering materials forequipment,Corrosioncontrolusingtheexoticmaterials.Fabricationofspecialalloys,Stainless Steel, less common metals, composite materials. Welding techniques and corrosion behaviorof weldmetals,PlasticsandCorrosionofPlasticsand Elastomers**.**	**08**
5	Corrosioninspection,instrumentationandmonitoring,Corrosiontesting.UseofDSAin electrochemicalindustries,ElectrochemicalMachining,Chemicalcleaningofequipment.	**07**
6	Corrosion and Control methods for water supply systems, cooling systems heavy watersystems, underground and marine environments, Biological corrosion. Corrosion nuclearreactorsandboilers.Corrosionofreinforcement'sconcretestructure.Corrosioncontrolin IndustrialEnvironments.	**07**

Course Outcomes

On completion of the course the students will:

1. have knowledge of economicsaspectsofcorrosion
2. have knowledge of design aspectstominimizethecorrosion
3. design of cathodic and anodic protection systems
4. acquire the knowledge of corrosion in different materials
5. apply the knowledge of Corrosioninspection,instrumentationandmonitoring
6. acquire the knowledge of Corrosion and Control methods in IndustrialEnvironments

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasstestor assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecoveredinquestionpapersofend semesterexamination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequalmarks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3thenpart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. M.G.Fontana,CorrosionEngineering,TataMcGraw- Hill(NewDelhi),3rdEd.
2. G.L.ShvartzandM.M.Kristal,CorrosionofChemicalApparatus(1959)ChapmanHallLtd.London

Semester I (Program Elective II)		
Course Code	**Course Name**	**Credits**
CHPE1022	**Industrial Solid Waste 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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Management and engineering for waste disposal.
2. Waste treatment cycles.
3. Basics of unit operations.

Course Objectives

1. To identify key sources, typical qualities generated, composition and properties of solid and hazardous wastes.
2. To identify waste disposal or transformation techniques (landfill).
3. To recognize the relevant, regulations that apply for facilities used for disposal and destruction of waste.
4. To identify and design solid and hazardous waste landfills including closure, post closure and rehab uses.
5. To estimate typical waste disposal costs.
6. To identify recycling and reuse option (composting, source separation and reuse of shredded tyres, recycled glass, fly ash).

Detailed Syllabus

Module No.	Course Contents	Contact Hours
	Introduction: Introduction of solid waste. Classification of solid waste. Importance of solid waste	

1	disposal, engineering principles and management.	06
2	Sources, quantities generated and physicochemical properties of MSW and hazardous waste. Solid waste management pyramid, key technologies for SWM. (Collection, transformation, landfills, composting).	08
3	Types of landfills, basic geotechnical considerations, earthen liners for waste disposal. Clay mineralogy, factors controlling hydraulic conductivity, methods to measure K in the lab and field, compatibility of liner materials to chemicals in leachate.	06
4	Containment and liquid transport in soil liners for RCRA liners (Advection and diffusion). Geosynthesis for waste disposal. Overview, geomembrane leakage, transport and structural stability. Geosynthetic clay liners (GCLS).	06
5	Design of leachate, Collection system for landfills, Use of gravel and GDLs. Operational aspects of MSW landfills (daily cover , leachate disposal , GW monitoring)MSW toenergy (production of biogas).	07
6	System landfill gas collection and leachate recirculation system design. Landfill final cap design and water balance (demonstration of HELP Model) modelling. Review problems.	06

Course Outcomes

On completion of the course the students will:

1. understand engineering principles and management regarding solid waste disposal.
2. understand physicochemical properties of MSW and hazardous waste.
3. determine different factors related to waste disposal.
4. understand different waste disposal techniques.
5. manage economical and environmental regulations for municipal, commercial and industrial solid waste in India and all over the world.
6. apply the knowledge of environmental engineering to convert industrial solid waste into usable energy at minimum operating cost.

Assessment

Internal:

Assessment consists of two tests out of which; one should be a compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.

- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- All question carry equal marks
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four question need to be solved.

Reference Books:

1. Integrated solid waste management by Tehobanoglous/Thusen/Vigil publisher McGraw Hill.
2. Hazardous waste management, 2nd Edition MD LaGrega, PL Buckingham and J.C.Evans McGraw Hill publisher.

Semester I (Program Elective II)		
Course Code	**Course Name**	**Credits**
CHPE1023	**Bioprocess Engineering**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Applicationofunitoperationsinmicrobes.
2. Alternateofchemicalreactionstobioreactionsfromcostandqualitypointofview
3. Alternateofsyntheticproductsbynaturalproducts

Course Objectives

1. Toestablishthereactionkinetics modelforalltypesofchemicalreactionthroughbioroute.
2. Toreplacethechemicalcatalystbybio-catalysttoreducethe costofproduction.
3. Tostudythecellstructure,typeofcells,self-fractionationofcentrifugation.
4. To study designaspectsofbio-reactorversuschemicalreactor.
5. To analyze Effectofaerationand agitationduringthecourseofprocesses.
6. To understand Celldoctrineandbiophysics study.

Detailed Syllabus

Module No.	Course Contents	No.ofHours
1	**Introduction:** DefinitionofBPEanditsimportancetochemicalengineers,industrialoperationsetc.Whatisbioprocess engineer,bio-technologyand bio-processengineering.Bioprocess regulationconstraints.HistoryofPencillin.Howbiologistsandengineersworktogether.	**05**

2	**BasicconceptofBiology:** Anengineer'sprospective,anoverviewofbiologicalbasics,biophysicsandcelldoctrine. The structure of all, pro-caryotic cells, Eucaryotic cells, self fractionation,example:analysisofparticlemotioninanycentrifugation.Importantcelltypes, bacteria yeast , moles , algae and protozoa , animal and plant cells, cell constructionand cellnutrients.	**06**
3	**Chemicalsoflife:** Lipid, fatty acids and related lipids, fats soluble vitamins steroids and other liquids,sugars and poly sacchraides. D glucose and the mono saccharides. Disaccharides topoly saccharides, cellulose and starch, amino acids and proteins. Amino acids buildingblocksandpolypeptides.	**06**
4	**Kineticsofenzymecatalysed reaction:** The enzyme substrate complex and enzyme action. Simple enzyme kinetics with oneand two substrate. Michaelis- Menten kinetics evaluation of parameters in Michaelis-Menten equation. Kinetics for reversible reaction, two substrate reactions and cofactoractivation. Determination of elementary step rate constant, other patterns of substrateconcentratedependence,modulationand regulationofenzymaticactivity,other influences on enzyme activities , effect of pH and temperature on enzyme and itskinetics.Enzyme deactivation	**07**
5	**Metabolicstoichiometryandenergetics:** Thermodynamics principles, metabolic reaction coupling, ATP and NAD carboncatabolism,differentpathways.Respirationcyclesandchains.Biosynthesisofsmallmoleculeandmacromolecule,transportacrosscellmembrane.	**08**
6	Kineticsofsubstrateutilization,productformationandbiomassproductionincell culture.Idealreactorsfor kineticsmeasurement,ieidealbatchCSTR,CSTRin series, FEDbackplugflow,kineticsofbalancedgrowth,transientgrowthkinetics,productformationkinetics.Structured kineticmodule,productformationkinetics	**07**

Course Outcomes

On completion of the course the students will:

1. have knowledge of bioprocess engineer,bio-technologyand bio-processengineering
2. have knowledge of basic structure of cell and classification of microorganism
3. acquire the knowledge of basic chemicals of life.
4. explain the kinetics of enzyme catalysed reaction in free and immobilized states. They will also able to organise the production of microbial enzymes and operate variables affecting the production process.
5. acquire the knowledge of Thermodynamics principles, metabolic reaction coupling, ATP and NAD carboncatabolism,differentpathways
6. design and analyse bioreactor and design parameters.

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclassteston assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecoveredinquestionpapersofend semesterexamination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequalmarks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3the npart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. Biochemical Engineering Fundamentals by James E Bailey and David F Ollis. Edition 2nd .Tata McGrawHill.
2. BioprocessEngineeringBasic conceptsbyMichael LShuler andFikretKargi.Edition2nd.PHILearningPrivate Limited.

Semester I (Institute Elective I)		
Course Code	**Course Name**	**Credits**
CHIE1011	**Product Lifecycle 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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. TofamiliarizethestudentswiththeneedbenefitsandcomponentsofPLM
2. ToacquaintstudentswithProductDataManagement&PLMstrategies
3. TogiveinsightsintonewproductdevelopmentprogramandguidelinesfordesigninganddevelopingaproductTofamiliarizethestudentswithVirtualProductDevelopment

.Detailed Syllabus

Module No.	Course Contents	No.ofHours
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM),Need for PLM,Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment,PLMParadigm,Importance&BenefitsofPLM,WidespreadImpactofPLM,FocusandApplication,A PLMProject,Startingthe PLMInitiative,PLMApplications **PLMStrategies:**Industrialstrategies,Strategyelements,itsidentification,selectionandimplementation,DevelopingPLMVisionand PLMStrategy, Changemanagement forPLM.	**10**
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization andDecompositioninProductDesign,TypologiesofDesignProcessModels,ReferenceModel,Product Design in the Context of the Product Development Process, Relation with the DevelopmentProcess Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution inProductDesign,ConcurrentEngineering,CharacteristicFeaturesofConcurrentEngineering,ConcurrentEngineeringandLifeCycleApproach,NewProductDevelopment(NPD)andStrategies,ProductConfigurationandVariantManagement,TheDesignforXSystem,ObjectiveProperties and Design for X Tools, Choice of Design for X Tools and Their Use in the DesignProcess.	**09**

03	**ProductDataManagement(PDM):**ProductandProductData,PDMsystemsandimportance, ComponentsofPDM,ReasonforimplementingaPDMsystem,financialjustificationofPDM,barrierstoPDM implementation.	**05**
04	**VirtualProductDevelopmentTools:**Forcomponents,machines,andmanufacturingplants,3DCADsystemsandrealisticrenderingtechniques,Digitalmock-up,Modelbuilding,Modelanalysis,ModelingandsimulationsinProductDesign,Examples/Casestudies.	**05**
05	**IntegrationofEnvironmentalAspectsinProductDesign:**SustainableDevelopment,DesignforEnvironment,NeedforLifeCycleEnvironmentalStrategies,UsefulLifeExtensionStrategies,End-of-LifeStrategies,IntroductionofEnvironmentalStrategiesintotheDesignProcess,LifeCycleEnvironmentalStrategiesandConsiderationsfor ProductDesign.	**05**
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life CycleAssessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life CycleAssessment,CostAnalysisandtheLifeCycleApproach,GeneralFrameworkforLCCA, EvolutionofModelsforProductLifeCycleCostAnalysis.	**05**

Course Outcomes

On completion of the course the students will:

1. GainknowledgeaboutphasesofPLM,PLMstrategiesandmethodologyforPLMfeasibilitystudyandPDMimplementation.
2. Illustrate variousapproachesandtechniquesfordesigninganddevelopingproducts.
3. Applyproductengineeringguidelines/thumbrulesindesigningproductsformoulding,machining,sheet metalworkingetc.
4. Acquireknowledgeinapplyingvirtualproductdevelopmenttoolsforcomponents,machiningandmanufacturingplant.

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- All question carry equal marks
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four question need to be solved.

Reference Books:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer- Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle

approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Semester I (Institute Elective I)		
Course Code	**Course Name**	**Credits**
CHIE1012	**Reliability Engineering**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. Tofamiliarizethestudentswithvariousaspectsofprobabilitytheory
2. Toacquaintthestudentswith reliabilityanditsconcepts
3. Tointroducethestudentstomethodsofestimatingthesystemreliabilityofsimpleandcomplexsystems
4. TounderstandthevariousaspectsofMaintainability,AvailabilityandFMEAprocedure

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**Probabilitytheory:**Probability:Standarddefinitionsandconcepts;ConditionalProbability,Baye'sTheorem. **ProbabilityDistributions:**CentraltendencyandDispersion;Binomial,Normal,Poisson,Weibull,Exponential,relationsbetweenthemandtheirsignificance. **MeasuresofDispersion:**MeanMedian,Mode,Range,MeanDeviation,StandardDeviation,Variance,SkewnessandKurtosis.	**08**
02	**ReliabilityConcepts:**Reliabilitydefinitions,ImportanceofReliability,QualityAssuranceandReliability,BathTubCurve. **FailureDataAnalysis:**Hazardrate,failuredensity,FailureRate,MeanTimeToFailure(MTTF), MTBF,ReliabilityFunctions. **ReliabilityHazardModels:**ConstantFailureRate,Linearlyincreasing,TimeDependentFailure Rate, WeibullModel. Distributionfunctionsandreliabilityanalysis.	**08**
03	**SystemReliability:**SystemConfigurations:Series,parallel,mixedconfiguration,koutofn structure,Complexsystems.	**05**
04	**ReliabilityImprovement:**RedundancyTechniques:Elementredundancy,Unitredundancy,Standbyredundancies.Markovanalysis.System Reliability Analysis – Enumeration method, Cut-set method, SuccessPath method, Decompositionmethod.	**08**

05	**Maintainabilityand Availability:**System downtime, Design for Maintainability: Maintenancerequirements,Designmethods:FaultIsolationandself-diagnostics,PartsstandardizationandInterchangeability,ModularizationandAccessibility,RepairVsReplacement.Availability–qualitativeaspects.	**05**
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticalityanalysis,FMECA examples.Faulttree construction, basic symbols, development of functionalreliabilityblockdiagram, Fau1ttree analysisandEventtreeAnalysis	**05**

Course Outcomes

On completion of the course the students will:

1. UnderstandandapplytheconceptofProbabilityto engineeringproblems
2. Applyvariousreliabilityconceptsto calculatedifferentreliabilityparameters
3. Estimatethesystemreliabilityofsimpleandcomplexsystems
4. CarryoutaFailureModeEffectandCriticalityAnalysis

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- All question carry equal marks
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four question need to be solved.

References Books:

1. L.S.Srinath,"ReliabilityEngineering",AffiliatedEast-WastPress(P)Ltd.,1985.
2. CharlesE.Ebeling,"ReliabilityandMaintainabilityEngineering",TataMcGrawHill.
3. B.S.Dhillion,C.Singh,"EngineeringReliability",JohnWiley&Sons,1980.
4. P.D.T.Conor,"PracticalReliabilityEngg.", JohnWiley&Sons,1985.
5. K.C.Kapur,L.R.Lamberson,"ReliabilityinEngineeringDesign",JohnWiley&Sons.
6. MurrayR.Spiegel, "ProbabilityandStatistics",TataMcGraw-HillPublishingCo. Ltd.

Semester I (Institute Elective I)		
Course Code	**Course Name**	**Credits**
CHIE1013	**Management Information System**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. ThecourseisblendofManagementandTechnical field.
2. Discusstherolesplayedbyinformationtechnologyintoday'sbusinessanddefinevarioustechnologyarchitecturesonwhichinformationsystemsarebuilt
3. Defineandanalyzetypicalfunctionalinformationsystemsandidentifyhowthey meettheneedsofthefirmto deliverefficiencyandcompetitive advantage
4. Identifythebasicstepsinsystemsdevelopment

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	IntroductionToInformationSystems(IS):ComputerBasedInformationSystems,ImpactofITonorganizations,andImportanceofIStoSociety.OrganizationalStrategy,CompetitiveAdvantagesandIS.	**4**
02	DataandKnowledgeManagement:DatabaseApproach,BigData,DatawarehouseandDataMarts,KnowledgeManagement. Businessintelligence(BI):ManagersandDecisionMaking,BIforDataanalysisandPresentingResults	**7**
03	EthicalissuesandPrivacy:InformationSecurity.ThreattoIS,andSecurityControls	**7**
04	SocialComputing(SC):Web2.0and3.0,SCinbusiness-shopping,Marketing,Operationaland AnalyticCRM,E-businessandE-commerce–B2BB2C.Mobilecommerce.	**7**
05	ComputerNetworksWiredandWirelesstechnology,Pervasivecomputing,Cloudcomputingmodel.	**6**
06	InformationSystemwithinOrganization:TransactionProcessingSystems,FunctionalAreaInformationSystem, ERPandERPsupportofBusinessProcess. AcquiringInformationSystemsandApplications:VariousSystemdevelopmentlifecyclemodels.	**8**

Course Outcomes

On completion of the course the students will:

1. ExplainhowinformationsystemsTransformBusiness
2. Identifytheimpactinformationsystems haveonanorganization
3. DescribeITinfrastructureand itscomponentsanditscurrenttrends
4. Understandtheprincipaltoolsandtechnologiesforaccessinginformationfromdatabasestoimprovebusiness performance anddecisionmaking
5. Identifythetypesofsystemsusedforenterprise-wideknowledgemanagementandhow theyprovidevalueforbusinesses

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- All question carry equal marks
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four question need to be solved.

References Books:

1. KellyRainer,BradPrince, ManagementInformationSystems,Wiley
2. K.C.LaudonandJ.P.Laudon, ManagementInformationSystems:ManagingtheDigitalFirm,10th Ed.,PrenticeHall, 2007.
3. D.Boddy,A.Boonstra,ManagingInformationSystems:StrategyandOrganization,PrenticeHall,2008

Semester I (Institute Elective I)		
Course Code	**Course Name**	**Credits**
CHIE1014	**Design of Experiments**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. TounderstandtheissuesandprinciplesofDesignofExperiments(DOE)
2. Tolisttheguidelinesfordesigningexperiments
3. Tobecomefamiliarwithmethodologiesthatcanbeusedinconjunctionwithexperimentaldesignsforrobustnessandoptimization

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**Introduction** 1.1 StrategyofExperimentation 1.2 TypicalApplicationsofExperimentalDesign 1.3 GuidelinesforDesigningExperiments 1.4 ResponseSurfaceMethodology	**06**
02	**FittingRegressionModels** 2.1 Linear RegressionModels 2.2 EstimationoftheParametersinLinearRegressionModels 2.3 HypothesisTestinginMultipleRegression 2.4 ConfidenceIntervalsinMultipleRegression 2.5 Predictionofnewresponseobservation 2.6 Regressionmodeldiagnostics 2.7 Testingforlackoffit	**08**

03	**Two-LevelFactorial Designs andAnalysis** 3.1 The2^2Design 3.2 The2^3Design 3.3 TheGeneral2^kDesign 3.4 ASingleReplicate ofthe2^kDesign 3.5 TheAdditionofCenterPointstothe2^kDesign, 3.6 Blockinginthe2^kFactorialDesign 3.7 Split-PlotDesigns	**07**
04	**Two-LevelFractionalFactorialDesigns andAnalysis** 4.1 TheOne-HalfFractionofthe2^kDesign 4.2 TheOne-QuarterFractionofthe2^kDesign 4.3 TheGeneral2^{k-p}FractionalFactorialDesign 4.4 ResolutionIIIDesigns 4.5 ResolutionIVandVDesigns 4.6 FractionalFactorialSplit-PlotDesigns	**07**
05	**ConductingTests** 5.1 TestingLogistics 5.2 Statisticalaspectsof conductingtests 5.3 Characteristicsofgoodandbaddatasets 5.4 Exampleexperiments 5.5 AttributeVsVariabledatasets	**07**
06	**Taguchi Approach** 6.1 CrossedArrayDesignsandSignal-to-NoiseRatios 6.2 AnalysisMethods 6.3 Robustdesignexamples	**04**

Course Outcomes

On completion of the course the students will:

1. Plandatacollection,toturndataintoinformationandtomakedecisionsthatleadtoappropriateaction
2. Applythemethodstaughtto reallifesituations
3. Plan,analyze,andinterprettheresultsofexperiments

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- All question carry equal marks
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

- Only Four question need to be solved.

References Books:

1. RaymondH.Mayers,DouglasC.Montgomery,ChristineM.Anderson-Cook,ResponseSurfaceMethodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley &Sons,NewYork, 2001
2. D.C.Montgomery,DesignandAnalysisof Experiments,5thedition,JohnWiley&Sons,NewYork,2001
3. GeorgeEPBox,JStuartHunter,WilliamGHunter,StaticsforExperimenters:Design,InnovationandDiscovery,2nd Ed. Wiley
4. WJDimond,PeacticalExperimentDesignsforEngineersandScintists,JohnWileyandSonsInc.ISBN:0-471-39054-2
5. DesignandAnalysisofExperiments(SpringertextinStatistics),Springer byA.M.Dean,andD.T.Voss
6. PhillipJRoss,"TaguchiTechnique forQualityEngineering,"McGraw Hill
7. MadhavSPhadke, "QualityEngineeringusingRobustDesign,"PrenticeHall

Semester I (Institute Elective I)		
Course Code	**Course Name**	**Credits**
CHIE1015	**Operation Research**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. Formulateareal-worldproblemasa mathematicalprogrammingmodel.
2. Understandthemathematicaltoolsthatareneededtosolveoptimizationproblems.
3. Usemathematicalsoftwareto solvetheproposedmodels.

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**IntroductiontoOperationsResearch**:Introduction,,StructureoftheMathematicalModel,LimitationsofOperationsResearch **LinearProgramming**:Introduction,LinearProgrammingProblem,RequirementsofLPP,MathematicalFormulationofLPP,Graphical method,Simplex MethodPenaltyCostMethodorBigM-method, TwoPhaseMethod,Revisedsimplexmetho **Duality**,Primal–Dualconstruction,SymmetricandAsymmetricDual,WeakDualityTheorem,ComplimentarySlackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis**TransportationProblem**:Formulation,solution,unbalancedTransportationproblem.Findingbasicfeasiblesolutions–Northwestcornerrule,leastcostmethodandVogel'sapproximationmethod.Optimalitytest:the steppingstonemethod andMODImethod. **AssignmentProblem**:Introduction,MathematicalFormulationoftheProblem,HungarianMethodAlgorithm,ProcessingofnJobsThroughTwoMachinesandmMachines,GraphicalMethod of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem**IntegerProgrammingProblem**: Introduction,TypesofIntegerProgrammingProblems,Gomory'scuttingplaneAlgorithm,BranchandBoundTechnique.Introductionto Decompositionalgorithms.	**14**

02	**Queuingmodels**:queuingsystemsandstructures,singleserverandmulti-servermodels,Poissoninput,exponentialservice,constantrateservice,finiteandinfinitepopulation	**05**
03	**Simulation**:Introduction,MethodologyofSimulation,BasicConcepts,SimulationProcedure,ApplicationofSimulation Monte-CarloMethod: Introduction,Monte-CarloSimulation,ApplicationsofSimulation,AdvantagesofSimulation,LimitationsofSimulation	**05**
04	**Dynamicprogramming**.Characteristicsofdynamicprogramming.DynamicprogrammingapproachforPriorityManagementemploymentsmoothening,capitalbudgeting,StageCoach/ShortestPath, cargoloadingandReliabilityproblems.	**05**
05	**GameTheory**.Competitivegames,rectangulargame,saddlepoint,minimax(maximin)methodofoptimalstrategies,valueofthegame.Solutionofgameswithsaddlepoints,dominanceprinciple.Rectangular gameswithoutsaddlepoint–mixed strategyfor2 X2 games.	**05**
06	**InventoryModels**:ClassicalEOQModels,EOQModelwithPriceBreaks,EOQwithShortage, ProbabilisticEOQModel,	**05**

Course Outcomes

On completion of the course the students will:

1. Understandthetheoreticalworkingsofthesimplexmethod,therelationshipbetweenalinearprogramanditsdual, includingstrongdualityandcomplementaryslackness.
2. Performsensitivityanalysistodeterminethedirectionandmagnitudeofchangeofamodel'soptimalsolutionasthe data change.
3. Solvespecializedlinearprogrammingproblemslikethetransportationandassignmentproblems,solvenetwork modelsliketheshortestpath,minimumspanningtree,andmaximumflowproblems.
4. Understandtheapplications ofintegerprogramming and aqueuingmodelandcomputeimportantperformancemeasures

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- All question carry equal marks
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four question need to be solved.

References Books:

1. Taha,H.A."OperationsResearch -AnIntroduction",PrenticeHall,(7thEdition),2002.
2. Ravindran,A,Phillips,D.TandSolberg,J.J."OperationsResearch:PrinciplesandPractice",JohnWilleyand Sons, 2ndEdition, 2009.
3. Hiller,F.S.and Liebermann,G.J."Introductionto OperationsResearch",TataMcGrawHill,2002.

4. OperationsResearch,S.D.Sharma, KedarNathRamNath-Meerut.
5. OperationsResearch,KantiSwarup,P.K.GuptaandManMohan,SultanChand&Sons.

Semester I (Institute Elective I)		
Course Code	**Course Name**	**Credits**
CHIE1016	**Cyber Security and Laws**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

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

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**IntroductiontoCybercrime:**Cybercrimedefinitionandoriginsoftheworld,Cybercrimeandinformation security,Classificationsofcybercrime,Cybercrimeandthe IndianITA2000,AglobalPerspectiveoncybercrimes.	**4**
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking,Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobileand WirelessDevices, TrendsinMobility,CreditCard Fraudsin Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, RegistrySettings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones,MobileDevices:Security ImplicationsforOrganizations,OrganizationalMeasuresforHandling Mobile,Devices-RelatedSecurityIssues,OrganizationalSecurityPoliciesandMeasuresinMobileComputing Era,Laptops	**9**
03	**ToolsandMethodsUsedinCyberline** Phishing, Password Cracking, Keyloggers and Spywares,Virus and Worms, Steganography,DoS andDDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks,Phishing,IdentityTheft(ID Theft)	**6**

04	**TheConceptofCyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,TheIntellectual Property Aspect in Cyber Law The Evidence Aspect in Cyber Law ,The Criminal Aspect in Cyber Law,Global Trends inCyber Law , Legal Framework for Electronic Data InterchangeLaw Relating to ElectronicBanking, TheNeedfor anIndianCyberLaw	**8**
05	**IndianITAct.** CyberCrimeandCriminalJustice:Penalties,AdjudicationandAppealsUndertheITAct,2000,IT Act.2008anditsAmendments	**6**
06	**InformationSecurityStandardcompliances** SOX,GLBA,HIPAA,ISO,FISMA,NERC,PCI.	**6**

Course Outcomes

On completion of the course the students will:

1. Understandtheconceptofcybercrimeanditseffectonoutsideworld
2. Interpretand applyITlawin variouslegalissues
3. Distinguishdifferentaspectsofcyberlaw
4. ApplyInformationSecurity Standardscomplianceduringsoftwaredesignanddevelopment

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- All question carry equal marks
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four question need to be solved.

References Books:

1. NinaGodbole,SunitBelapure,*CyberSecurity*,WileyIndia,NewDelhi
2. TheIndianCyberLawbySureshT.Vishwanathan; BharatLawHouseNewDelhi
3. TheInformationtechnology Act,2000;BareAct-ProfessionalBookPublishers,NewDelhi.
4. CyberLaw&CyberCrimes ByAdvocatePrashantMali;SnowWhitePublications,Mumbai
5. NinaGodbole,*InformationSystemsSecurity*,WileyIndia,NewDelhi
6. KennetchJ.Knapp,*CyberSecurity*&*GlobalInformationAssurance* InformationSciencePublishing.
7. WilliamStallings,*CryptographyandNetworkSecurity*,PearsonPublication
8. Websitesformoreinformationisavailableon: TheInformationTechnologyACT,2008-TIFR:https://www.tifrh.res.in
9. Websiteformoreinformation,ACompliancePrimerforITprofessional:https://www.sans.org/reading-

room/whitepapers/compliance/compliance-primer-professionals-33538

Semester I (Institute Elective I)		
Course Code	**Course Name**	**Credits**
CHIE1017	**Disaster Management and Mitigation Measures**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

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

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**Introduction:** DefinitionofDisaster,hazard,globalandIndianscenario,generalperspective,importanceofstudyinhumanlife,Directandindirecteffectsofdisasters,longtermeffectsofdisasters.Introductiontoglobalwarmingandclimate change.	**03**
02	**NaturalDisasterandManmadedisasters:** Natural Disaster: Meaning and nature of natural disaster,Flood, Flash flood, drought, cloudburst,Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow,Cyclone, Storm,StormSurge, climatechange, globalwarming,sea levelrise,ozone depletionManmadeDisasters:Chemical,Industrial,NuclearandFireHazards.Roleofgrowingpopulationandsubsequentindustrialization,urbanizationandchanginglifestyleofhumanbeingsinfrequentoccurrencesof manmade disasters.	**09**

03	**DisasterManagement,PolicyandAdministration:** Disaster management: meaning, concept, importance, objective of disaster management policy,disasterrisksinIndia,Paradigmshiftindisastermanagement.Policy and administration: Importance and principles of disaster management policies, commandand co-ordination of in disaster management, rescue operations-how to start with and how toproceed induecourse oftime,studyofflowchartshowingtheentire process.	**06**
04	**InstitutionalFrameworkforDisasterManagementinIndia:** Importanceofpublicawareness,Preparationandexecutionofemergencymanagementprogramme. Scope and responsibilities of National Institute of Disaster Management (NIDM)and National disaster management authority (NDMA) in India. Methods and measures to avoiddisasters, Management of casualties, set up of emergency facilities, importance of effectivecommunicationamongstdifferentagenciesinsuchsituations. Use of Internet and softwares for effective disaster management. Applications of GIS, RemotesensingandGPSinthisregard.	**06**
05	**FinancingReliefMeasures:** Ways to raise finance for relief expenditure, role of government agencies and NGO's in thisprocess, Legal aspects related to finance raising as well as overall management of disasters.Various NGO's and the works they have carried out in the past on the occurrence of variousdisasters,Waystoapproachtheseteams.Internationalreliefaidagenciesandtheirrolein extremeevents.	**09**
06	**PreventiveandMitigationMeasures:** Pre-disaster, during disaster and post-disaster measures in some events in general structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	**06**

Course Outcomes

On completion of the course the students will:

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

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- All question carry equal marks
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four question need to be solved.

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References Books:

1. DisasterManagement'byHarshK.Gupta,UniversitiesPressPublications.
2. 'DisasterManagement:AnAppraisalofInstitutionalMechanismsinIndia'byO.S.Dagur,publishedbyCentrefor landwarfare studies, NewDelhi, 2011.
3. 'IntroductiontoInternationalDisasterManagement'byDamonCopolla,ButterworthHeinemannElseveirPublications.
4. 'DisasterManagementHandbook'byJackPinkowski,CRCPressTaylorandFrancisgroup.
5. 'Disaster management &rehabilitation'byRajdeep,Dasgupta,MittalPublications,NewDelhi.
6. 'NaturalHazards andDisasterManagement,VulnerabilityandMitigation– RBSingh,RawatPublications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.(LearnersareexpectedtoreferreportspublishedatnationalandInternationallevelandupdatedinformationavailableonauthenticwebsites)

Semester I (Institute Elective I)		
Course Code	**Course Name**	**Credits**
CHIE1018	**Energy Audit 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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. Tounderstandtheimportance energysecurityforsustainabledevelopmentandthefundamentalsofenergyconservation.
2. Tointroduceperformanceevaluationcriteriaofvariouselectricalandthermalinstallations tofacilitatetheenergy management
3. Torelatethedatacollectedduringperformanceevaluationofsystemsforidentificationofenergysavingo pportunities.

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**EnergyScenario:** PresentEnergyScenario,EnergyPricing,EnergySectorReforms,EnergySecurity,EnergyConse rvationanditsImportance,EnergyConservationAct-2001anditsFeatures.BasicsofEnergyanditsvariousforms,MaterialandEnergybalance	**04**
02	**EnergyAuditPrinciples:** Definition,Energyaudit-need,Typesofenergyaudit,Energymanagement(audit)approach-understandingenergycosts,Benchmarking,Energyperformance,Matchingenergyusetorequir ement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel andenergysubstitution.Elementsofmonitoring&targeting;EnergyauditInstruments;Dataandi nformation-analysis.Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internalrateofreturn(IRR)	**08**
03	**EnergyManagementandEnergyConservationinElectricalSystem:** Electricitybilling,Electricalloadmanagementandmaximumdemand Control;Powerfactorimpr ovement,Energyefficientequipmentsand appliances, starratings. **Energyefficiencymeasuresinlightingsystem,Lightingcontrol:**Occupancysensors,daylight integration,anduse ofintelligentcontrollers.Energyconservationopportunities in:waterpumps,industrialdrives,inductionmotors,motorretrofitting,softstarters,variable speeddrives.	**10**

04	**EnergyManagementandEnergyConservationinThermalSystems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system,Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flashsteamrecoverysystem.General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation-typesandapplication.HVACsystem:Coefficientofperformance,Capacity,factorsaffectingRefrigerationandAir Conditioningsystemperformanceandsavingsopportunities.	**10**
05	**EnergyPerformanceAssessment:** On sitePerformanceevaluation techniques,Casestudiesbasedon:Motorsandvariablespeeddrive,pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method,FinancialAnalysis.	**04**
06	**EnergyconservationinBuildings:** EnergyConservationBuildingCodes(ECBC):GreenBuilding,LEEDrating,ApplicationofNon-ConventionalandRenewableEnergySources	**03**

Course Outcomes

On completion of the course the students will:

1. Toidentifyanddescribepresentstateofenergysecurityanditsimportance.
2. Toidentifyanddescribethebasicprinciplesandmethodologiesadoptedinenergyauditofan utility.
3. Todescribetheenergyperformanceevaluationofsomecommonelectricalinstallationsandidentifytheenergysavingopportunities.
4. Todescribetheenergyperformanceevaluationofsomecommonthermalinstallationsandidentifytheenergysavingopportunities
5. Toanalyzethedatacollectedduringperformanceevaluationandrecommendenergysavingmeasures

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- All question carry equal marks
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four question need to be solved.

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References Books:

1. HandbookofElectricalInstallationPractice,GeofryStokes,BlackwellScience
2. Designingwithlight:LightingHandbook,ByAnilValia, LightingSystem
3. EnergyManagementHandbook,ByW.C.Turner,JohnWileyand Sons

4. HandbookonEnergyAuditsand Management,editedbyA.K.Tyagi,TataEnergyResearchInstitute(TERI).
5. EnergyManagementPrinciples,C.B.Smith,PergamonPress
6. EnergyConservationGuidebook,DaleR.Patrick,S.Fardo,RayE.Richardson,Fairmont Press
7. HandbookofEnergyAudits, AlbertThumann,W.J.Younger,T.Niehus,CRCPress
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Semester I		
Course Code	**Course Name**	**Credits**
CHL101	**Program Lab-I**	**01**

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

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

Prerequisites

4. Basic knowledge of reaction kinetics
5. Basic knowledge of RTD studies in flow reactor.
6. Basic knowledge of Dimensional Analysis Types of flows, Fluid Statics.
7. Basic knowledge of involving equation of continuity, motion and related laminar flow

Course Objectives

1. To understand the concept of residence time distribution in reactor design
2. To study catalytic heterogeneous reaction
3. To study the design semibatch reactor
4. To Design of fluidized bed reactors
5. To studyanalogous mechanism of momentum Transport for steady and unsteady flow
6. To design of stirred tank and different types of mixing equipment

Detailed Syllabus

Program Lab-I should have six experiments based on the courses Advanced Momentum Transfer and Advanced Chemical Reaction Engineering.

Course Outcomes

On completion of the course the students will:

1. able to study the residence time distribution in flow reactors
2. analyze kinetic data obtain from semi batch reactor

3. able to study the heterogeneous reactions.
4. obtain Friction factors for fully developed laminar, turbulent and transition flow in circular conduits
5. calculate momentum and mechanical energy balances
6. calculate minimum fluidization velocity, terminal setting velocity, velocity void age relationships for fluidized beds. Settling velocities under hindered setting conditions.

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Assessment

Laboratory

Weightage for Laboratory should be 40% in Final Assessment of Laboratory Term Work.

Term work
Term work shall be evaluated based on performance in practical.
Practical Journal: 20 marks
Attendance: 05 marks
Total: 25 marks

End Semester Examination

Practical/Oral examination is to be conducted by pair of internal and external examiners

Semester I		
Course Code	**Course Name**	**Credits**
CHSBL101	**Skill Based Lab-I**	**02**

Course Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
-	**04**	**-**	**-**	**02**	**-**	**02**

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						
-	-	-	-	-	50	50	-	100

Prerequisites

1. Basic knowledge Sample Analytical equipment.
2. Practical knowledge of basic engineering subjects like reaction engineering ,fluid dynamics
3. Basic knowledge of basic engineering subjects like reaction engineering ,fluid dynamics
4. Basic knowledge of modeling and simulation

Course Objectives

1. To learn Operation of Analytical Instruments
2. To learn simulation and optimisation of advanced reaction engineering
3. To understand Linear and non linear regression
4. To learn Error analysis methods
5. To learn simulation and optimisation of advanced fluid dynamics
6. To learn the use of process software's used in chemical industries.

Detailed Syllabus

Skill Based Lab-I is focused on the learning through experience. SBL shall facilitate the learner to acquire the fundamentals of practical engineering in his or her specialization in a project-oriented environment. The learning through skill based labs can be useful in facilitating their research work and hence useful in early completion of their dissertation work.

Course Outcomes

On completion of the course the students will:

1. acquire the knowledge to select and use of advanced analytical instruments

2. perform simulation and optimisation of advanced reaction engineering
3. understand the Linear and non linear regression
4. perform simulation and optimisation of advanced fluid dynamics
5. learn error analysis methods.
6. learn the use of process software's used in chemical industries

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Assessment

Laboratory

Weightage for Laboratory should be 40% in Final Assessment of Laboratory Term Work.

Practical/Oral examination is to be conducted by pair of internal and external examiner.

SEMESTER II

Course Code	CourseName	TeachingScheme(ContactHours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHC201	Advanced Mass Transfer	3	--	--	3	--	--	3
CHC202	Advanced Process Control And Dynamics	3		--	3		--	3
CHPE201X	ProgramElective 3	3	--	--	3	--	--	3
CHPE202X	ProgramElective 4	3	--	--	3	--	--	3
CHIE201X	InstituteElective2	3	--	--	3	--	--	3
CHL201	ProgramLab-II	--	2	--	--	1	--	1
CHSBL201	SkillBasedLab-II	--	4[$]	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract /Oral	Total
		InternalAssessment			End Sem. Exam	Exam. Duration (inHrs)			
		Test-1	Test-2	Avg					
CHC201	Advanced Mass Transfer	20	20	20	80	3	--	--	100
CHC202	Advanced Process Control And Dynamics	20	20	20	80	3	--	--	100
CHPE201X	ProgramElective 3	20	20	20	80	3	--	--	100
CHPE202X	ProgramElective 4	20	20	20	80	3	--	--	100
CHIE201X	InstituteElective2	20	20	20	80	3	--	--	100
CHL201	ProgramLab-II	--	--	--	--	--	25	25	50
CHSBL201	SkillBasedLab-II	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	**--**	**75**	**75**	**650**

Program Elective 3 (Semester II)

Advanced Computer Aided Design (CHPE2011)	Heterogeneous Catalysis and Reactor Design (CHPE2012)	Advanced Downstream Processes (CHPE2013)

Program Elective 4 (Semester II)

Industrial Safety and Hazard Control (CHPE2021)	Green Chemistry and Engineering (CHPE2022)	Industrial Pollution Control and Prevention (CHPE2023)

Institute Elective 2 (Semester II)

Project Management (CHIE2011)	Finance Management (CHIE2012)	Entrepreneurship Development and Management (CHIE2013)

Human Resource Management (CHIE2014)	Professional Ethics and CSR (CHIE2015)	Digital Business Management (CHIE2016)
Environmental Management (CHIE2017)		

Semester II		
Course Code	**Course Name**	**Credits**
CHC201	**Advanced Mass Transfer**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Knowledgeofchemistry,physics,physicalchemistryand mathematics.
2. KnowledgeofDiffusion, Film and penetration theories.
3. KnowledgeofDistillation,AdvanceTopicsindistillation.
4. Knowledgeofmembraneseparationprocess.

Course Objectives

1. Togiveinsightofmasstransferbasicprincipleand masstransfer mechanisms
2. To study the need for reactive separation process
3. Tounderstand designof reactive distillationequipments
4. Tounderstand design ofliquid- liquid extractionequipments
5. Tounderstand design of reactive absorptionequipments
6. Togiveinsightofmembraneseparationprocess.

Detailed Syllabus

Module No.	Course Contents	No. ofHours
1.	Characterization of Separation processes: Inherent Separation Factors: Equilibration Processes, Inherent Separation Factors: Rate-governed Processes. Simple equilibrium processes: Equilibrium Calculations, Checking Phase Conditions for a Mixture.	**05**
2.	Multistage separation processes: Increasing Product Purity, Reducing Consumption of Separating Agent, Co-current, Crosscurrent, and Countercurrent Flow.	**04**
3.	Reactive Distillation: Definition, introduction to reactive distillation process. Thermodynamic and kinetic effects on the feasible products of RD: introduction, Azeotropes, azeotropes, kinetics azeotropes in reactive membrane separation, Equilibrium theory and nonlinear waves for reaction separation process. Reactive	**09**

	stripping in structured catalytic reactors: introduction, hydrodynamics, Reactive experiments, comparison of different internals.	
4.	Liquid-liquid extraction; stage wise calculations for multicomponent with multiple feed stream using reflux and mixed solvents. Liquid-liquid extraction with chemical reaction	**07**
5.	Reactive Absorption: introduction, reactive absorption equipment, modeling concept, model parameters, case studies. Reactive Extraction: introductions, phase equilibria, reactive mass transfer, hydrodynamics.	**07**
6.	Membrane Separation Techniques - Basic Equation for membrane separation for permeable& semi permeable membrane, Membrane types & their selection criteria, Technology basedMembraneseparationlikeMicrofiltration,Ultrafiltration,ReverseOsmosis,Nanofiltration.	**07**

Course Outcomes

On completion of the course the students will:

1. understand the concept of separation factor and separating agent
2. be able to compare multi-stage operations. designdistillationcolumn
3. understand the need for reactive separation process
4. categorize reactive separation processes
5. be able to do sizing of equipment for liquid-liquid extraction, gas absorption
6. understandmembraneseparationprocessesprincipleandworking

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclassteston assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecovered inquestionpapersofendsemester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus**.**
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequal marks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3thenpart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. King C. J., Separation Processes, Tata McGraw Hill Book Company, 2nd Ed., New Delhi, 1983.
2. ChemicalEngineeringHandbook7theditionbyR. H. Perry&GreenD.
3. MassTransferOperation3rdEditionbyR. E. Treybal
4. Principles of Mass Transfer and Separation Processes, B.K. Dutta
5. Chemical Engineering, Volume 2, J.M. Coulson, J.F. Richardson
6. Transport Processes and Unit Operations, C.J. Geankoplis
7. Transport Processes and Separation Process Principles, C.J. Geankoplis
8. Kulprathipanja, Reactive Separation Processes, Taylor and Francis, 2002.
9. Luyben W. L. and Cheng-Ching Yu, Reactive Distillation Design and Control, John Wiley and Sons, 2008.

Semester II		
Course Code	**Course Name**	**Credits**
CHC202	**AdvancedProcessControlandDynamics**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. MathematicscourseinvolvingLaplaceTransformanditsapplicationinsolvingmathematicalequations.
2. Basic course in Linear Open-Loop systems (Response of first and higher-order systems, interacting, non-interacting systemsandtransportationlag).
3. LinearClosed-LoopSystems(Thecontrolsystem,finalcontrolelement,Blockdiagramdevelopmentofachemical-reactor control system, Transient response of control system, stability, Root-Locus), Frequencyresponse.

Course Objectives

1. To acquire knowledge of designing complex control systems
2. To analyze controller design for processes with difficult dynamics
3. Tostudycontrollertuningusingapproximateprocessmodels.
4. Tofamiliarizethedesign of multi-loop and multivariable controlsystems.
5. To analyze dynamicsofdiscretetimesystems.
6. Tounderstandtheprinciplesofmodelpredictivecontroland designofdigitalcontrollers

Detailed Syllabus

Module No.	Course Contents	No.ofHours
1	**Design of complex control structures :**Process with significant disturbance, cascadecontrol, feed forward control, feedback augmented feed forward control, ratio control, processeswithmultipleoutputscontrolledbyasingleinput(Overridecontrollers,Auctioneeringcontrol),Processwithsingleoutputcontrolledwithmultipleinput(Splitrangecontrol, multipleinputforimproveddynamics),antiresetwindup.	**05**
2	**Controllerdesignforprocesseswithdifficultdynamics**: Characteristicsofdifficultprocessdynamics,nonminimumphasesystem,Timedelaysystem,timedelaycompensation, inverseresponsesystem,inverseresponsecompensation,openloopunstablesystems.	**06**
3	**Controllerdesign for non linear systems**: Nonlinear controller design philosophies, linearizationandclassicalapproach,adaptivecontrolprinciples(Scheduledadaptivecontrol, modelreferenceadaptivecontrol,selftuningadaptivecontrol),variabletransformations.	**05**
4	**Multivariable Regulatory Control Systems:** Nature of multivariable systems, multivariableprocess model, multivariable transfer functions and open loop dynamic analysis, interactionanalysis and loop pairing, relative gain array, loop pairing using RGA, loop paring for nonlinearsystems,looppairingfornonsquaresystems,controllerdesignprocedure,Decoupling,feasibilityofsteadystatedecouplerdesign,steadystatedecouplingbysingularvalue decomposition.	**07**
5	**Sampled Data Systems:** Sampling and conditioning of continuous signals, signal conditioning,continuous signal reconstruction, mathematical description of discrete–time system, theoreticalmodelingofdiscretetimesystems. **Discretetimesystemanalysis:** Basicconceptsofz–transforms,invertingz–transforms,Pulsetransferfunctions,characteristicsofopen-looppulse transferfunctions,blockdiagramanalysisofsampleddatasystems,stability.	**08**
6	**Design of digital controllers:** The digital controller and its design, discrete PID controller fromthe continuous domain, other digital controller based on continuous domain strategies, digitalControllers based on discrete domain strategies. **Model Predictive Control:** General principlesof model predictive control, Model algorithmic control, commercial model predictive controlschemes,academicandothercontributions,nonlinearmodelpredictivecontrol,closing remarks.	**08**

Course Outcomes

On completion of the course the students will:

1. apply knowledge of process modeling to design complex control structures.
2. design Controllers for processes with difficult dynamics.
3. tune controllers for different controlling processes.
4. analyze and design multi-loop and multivariable control systems.
5. illustrate sampled Data Systems.

6. design digital controllers and analyze Model Predictive control system.

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclassteston assignmentonlive problemsorcourseproject.

EndSemesterTheoryExamination:

Someguidelinesfor settingupthequestionpaper:

- Minimum80%syllabusshouldbecovered inquestionpapersofendsemester examination.
- Weightage ofeachmodulewillbeproportional to numberofrespectivelecturehoursasmentionedinthesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequal marks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3thenpart(b)willbe fromanymoduleotherthanmodule 3)
- Fourquestionneedtobesolved.

Reference Books:

1. "ProcessDynamics,Modeling,andControl"byBabatunde A.Ogunnaike,W.HarmonRay.
2. "ChemicalProcessControl"byGeorgeStephanopoulos.
3. "ProcessControl"byThomasE.Marlin.

Semester II (Program Elective III)		
Course Code	**Course Name**	**Credits**
CHPE2011	**Advanced Computer Aided Design**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Thermodynamics.
2. Unit Operations.
3. Process Equipment Design.
4. Computer Programming.
5. Modelling and Simulation.

Course Objectives

1. To estimate the physical and thermodynamic properties of process fluids.
2. To study the design of chemical process equipment.
3. To familiarize with the basic structure and components of CAD software.
4. To understand the importance and applications of CAD in the field of Chemical Engineering.
5. To utilize computational software for the design and simulation of chemical process equipment.
6. To design chemical process flow sheets with the help of CAD software.

Detailed Syllabus

Module No.	Course Contents	No. of Hours
1	**Physical and Thermodynamic Properties of Liquids and Gases** Introduction, Estimation of Physical and Thermodynamic Properties of Liquids and Gases, Diffusion Coefficients (Diffusivities), Compressibility Z-Factor of Natural Gases.	**06**

2	**Sizing of Vertical and Horizontal Separators** Introduction, Sizing of Vertical and Horizontal Separators, Sizing of Partly Filled Vessels and Tanks.	**06**
3	**Design of Cyclone Separators and Gas Dryers** Cyclone Separator Design, Methods for Gas Dehydration, Gas Dryer (Dehydration) Design.	**06**
4	**Mass Transfer Equipment Design** Determination of Plates in Fractionating Columns by the Smoker Equations for Binary Mixtures, Multicomponent Distribution and Estimation of Minimum Trays in Distillation Columns.	**06**
5	**Introduction to Computer Software Packages used for Chemical Process Design** Types and Characteristics of various Computer Software Packages used for Chemical Process Equipment Design and Flow Sheet Synthesis such as Aspen / Aspen Plus / ChemCad / Hysis (UniSim) / DWSIM.	**04**
6	**Application of Computer Software Packages and Use of Computer Programs for Chemical Process Design** Case studies involving the application of Computer Software Packages such as Aspen /Aspen Plus / ChemCad / Hysis (UniSim) / DWSIM and the use of Computer Programs for Design of Chemical Process Equipment and Process Flow Sheet Synthesis.	**11**

Course Outcomes

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

1. compute the physical and thermodynamic properties of process fluids.
2. calculate the size of Vertical and Horizontal Separators.
3. design Cyclone Separators and Gas Dryers.
4. apply Chemical Engineering Principles in the Design of Mass Transfer Equipment.
5. identify and evaluate various Computer Software Packages for Chemical Process Design.
6. utilize Computer Software Packages and Computer Programs for Design and Simulation of Chemical Process Equipment and Flow Sheet Synthesis.

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six questions.
- All questions carry equal marks.

- Questions will be mixed in nature (for example supposed 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.

Reference Books :

1. Coulson and Richardson's Chemical Engineering Vol.6 – Design, R.K. Sinnott (Ed.) Butterworth- Heinemann, New Delhi, 2000.
2. Process Modeling, Simulation and Control for Chemical Engineers, W. Luyben, Second Edition, McGraw-Hill, 1990.
3. Process Modeling and Simulation, R.W. Gaikwad and Dr. Dhirendra, Third Edition, Bennet and Co., 2010.
4. Process Simulation and Control using Aspen, A.K. Jana, Prentice Hall of India.
5. Fortran Programs for Chemical Process Design, Analysis and Simulation, A. Kayode Coker, Gulf Publishing Co., 1995.
6. Introduction to Chemical Engineering Computing, B.A. Finlayson, Second Edition, John Wiley and Sons, 2012.
7. Chemical Process Design: Computer-Aided Case Studies, A.C. Dimian and C.S. Bildea, Wiley-VCH, 2008.

Semester II (Program Elective III)		
Course Code	**Course Name**	**Credits**
CHPE2012	Heterogeneous Catalysis and Reactor Design	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Rate equation of homogeneous and heterogeneous reactions
2. Basic knowledge of different method of analysis of kinetic data.
3. Design equations of batch, semibatch, recycle and flow reactors

Course Objectives

1. To acquire knowledge of heterogeneous reactions
2. To study the design equations of solid catalyst batch and flow reactors
3. TostudyControlling Resistances and the Rate Equation.
4. Tounderstand the design of solid catalysed reactor.
5. To understand the concept of modeling of different types of solid catalysed reactors.
6. Tounderstandtheconcept of deactivation of catalyst.

Detailed Syllabus

Module No.	Course Contents	No. ofHours
1	Heterogeneous Reactions-Introduction, Contacting Patterns for Two-Phase Systems, solid catalysed reactions, Representation of the action of a catalyst. The Spectrum of Kinetic Regimes, The rate equation for surface kinetics.	**05**

2	Performance equations for reactors containing porous catalyst particles, (Batch reactor, Plug flow reactor and Continuous stirred tank reactor). Experimental methods for finding rates, Comparison of Experimental Reactors. Laboratory Reactors for Accurate Kinetic Data such as Berty Reactor, Carberry Reactor.	**06**
3	Determining Controlling Resistances and the Rate Equation, Product distribution in multiple reactions, Numericals	**05**
4	Reactor Design: The Packed Bed Catalytic Reactor, Staged Adiabatic Packed Bed Reactors, Staged Mixed Flow Reactors, Staged Packed Beds with Recycle. Design of single adiabatic packed bed system, Design of a two adiabatic packed bed system.	**08**
5	Reactors with Suspended Solid Catalyst, Fluidized Reactors of Various Types, background information about suspended solids reactors, The bubbling fluidized bed - BFB, The K-L model for BFB, Application to Catalytic Reactions, First-Order Catalytic Reaction in a BFB, The circulating fluidized bed – CFB, The Fast Fluidized Bed	**08**
6	Deactivating Catalysts – Mechanisms of catalyst deactivation, The rate and performance equations, Performance Equations in the Regime of Strong Diffusional Resistance, Interpreting kinetic data in the presence of pore diffusion resistance and deactivation, Deactivation in a packed bed reactor.	**07**

Course Outcomes

On completion of the course the students will:

1. apply knowledge of reaction stoichiometry to reactor design.
2. apply design equations of batch and flow reactors to reactor design.
3. able to predict which controlling mechanism offer resistance to overall reaction rate.
4. analyze and design different types of catalytic reactors.
5. illustrate bubbling fluidized bed and circulating fluidized bed reactor.
6. apply knowledge of deactivation of catalyst.

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasste stor assignmentonlive problemsorcourseproject.

EndSemesterTheoryExamination:

Someguidelinesfor settingupthequestionpaper:

- Minimum80%syllabusshouldbecovered inquestionpapersofendsemester examination.
- Weightage ofeachmodulewillbeproportional to numberofrespectivelecturehoursasmentionedinthesyllabus.
- Questionpaperwillcompriseoftotalsixquestion

- Allquestioncarryequal marks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3thenpart(b)willb e fromanymoduleotherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. "Chemical Reaction Engineering" by Octave Levenspiel
2. **"**Chemical Engineering Kinetics**" by** J M Smith
3. "Elements of Chemical Reaction Engineering" by H. Scott Gogler

Semester II (Program Elective III)		
Course Code	**Course Name**	**Credits**
CHPE2013	**AdvancedDownstream Processes**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Basic knowledge of Chemical Engineering unit operations.
2. Different separation processes involved in Chemical Engineering
3. Physical Chemistry, kinetic theory of gases
4. Basic knowledge of Process calculations.

Course Objectives

1. Tounderstand the unit processes involved in downstream processing.
2. To acquire knowledge of various advanced downstream processes in Petrochemical industry
3. Tostudy advances in distillation process.
4. Toanalyze energy conseravtion in different separation processes.
5. Tounderstand separation synthesis algorithm
6. Tostudy application of Ion – Exchange techniques in different aspects.

Detailed Syllabus

Module No.	Course Contents	No.ofHours
1	**Introduction:** Introduction to Downstream processes theory, applications in chemical separation for Gas-Liquid system, Gas-Solid system. Super critical fluids extraction in food, pharmaceutical, environmental and petroleum applications, water treatment, desalination, Bio separation, dialysis, industrial dialysis.Chromatographic separations specifically Simulated Moving Bed Chromatography for the separation of Racemic Mixtures.	**05**

2	**Downstream Processes in Petrochemical Industry**: Cryogenic distillation for refinery, petrochemical off gases, natural gases, gas recovery-Olefin, Helium, Nitrogen, Desulfurization - coal, flue gases.	**09**
3	**Advanced Distillation Processes:**Azeotropic & extractive distillation - residue curve maps, homogeneous azeotropic distillation, pressure swing distillation, Column sequences, heterogeneous azeotropic distillation.	**10**
4	**Energy conservation in separation processes:**Energy balance, molecular sieves - zeolites, adsorption, catalytic properties, manufacturing processes, hydrogel process, application, New trends.	**08**
5	**Non-Ideal Mixtures:** Separations process synthesis for nonazeotropic mixtures, non ideal liquid mixtures, separation synthesis algorithm.	**04**
6	**Ion Exchange:** manufacture of resins, physical & chemical properties, capacity, selectivity, application, regeneration, equipment, catalysis use	**03**

Course Outcomes

On completion of the course the students will:

1. have knowledge of downstream processes involved in various aspects in Chemical industry
2. analyze the application of downstream processes in Petrochemical Industry
3. analyze advanced distillation processes.
4. evaluate energy consumption in different separation processes
5. deal with separation process synthesis for non –ideal mixtures.
6. analyze Ion – Exchange techniques in separation processes.

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasste stor assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecovered inquestionpapersofendsemester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus**.**
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequal marks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3thenpart(b)willb e fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. Perry's "Chemical Engg. Handbook": McGraw Hill Pub.
2. Douglas J.M., "Conceptual Design of Chemical Processes", McGraw Hill
3. Liu Y.A., "Recent Developments in Chemical Process & Plant Design", John Wiley & Sons Inc.
4. Timmerhaus K.D., "Cryogenic Process Engg.", Plenum Press
5. Othmer Kirk "Encyclopedia of Separation Technology, Vol I & II", Wiley Inter science

Semester II (Program Elective IV)		
Course Code	**Course Name**	**Credits**
CHPE2021	**Industrial Safety and Hazard Control**	**03**

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

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

Prerequisites

1. Knowledge of Unit Operations (Heat and Mass Transfer); Basic Chemical Kinetics.
2. General awareness about socio-Industrial culture

Course Objectives

1. To develop awareness about the control measures for Industrial safety and hazards

2. To study various aspects of safety during industrial operations

3. To understand potential hazards of chemical industries.

4. To be acquainted with various rules and regulations related to safety hazards management.

5. To gain knowledge of various treatment and disposal of Hazardous Wastes

6. To gain knowledge of various Safety Management

Detailed Syllabus

Module No.	Course Contents	No.of Hours
1	**Introduction:** Aspects of Industrial safety, Importance of safety at working places, List of legislations in Chemical industries. The hazardous Wastes (Management and handling) rules, 1989 (2000).	**05**
2	**Chemical Plant Safety: Chemical plant** – Fire, Explosion, toxicity, process and corrosion hazards, Plant inspection – check list, Safety audit (IS-14489: 1998), Electrical equipment hazardous area classification, Area classification for instruments, Color codification for identification of pipe lines (IS2379), Indian Standard on safety and health, ILO conventions and recommendations on occupational safety and health.	**08**

3	**Safety Management:** The safety management function, Line verses staff authority, Industrial and organized safety, Safety responsibility and accountability, The practice of safety management: The significance of risk acceptability, limitations on standard remedies, safety authority. The problems of holding management's concern: management view of cost, safety and efficiency.	**06**
4	**Hazardous Waste Management:** Fundamentals: working definitions, Historical routes, Regulatory initiatives, Classifications, generation, contaminated sites, future endeavors; Legal frame work: Environmental law, Federal hazardous waste Regulations under RCRA, International perspectives.	**06**
5	**Process Fundamentals:** A Little chemistry, Physical chemical properties, Energy and mass balance, Reactions and Reactors, Contaminants release, Transportation of contaminants in sub surface; Toxicity: Exposure and toxic effects.	**08**
6	**Treatment and Disposal of Hazardous Wastes**: Physical- chemical processes, Biological processes, Stabilization and solidification of waste, Thermal methods-combustion regulations gases and vapors, liquid injection incinerators, solid waste incinerators, storage and feed system, Flue gas temperature reduction,, Air pollution control, Instrumentation, continuous emission monitor, Land disposal/land fill operations.	**06**

Course Outcomes

On completion of the course, the students will:

1. be well aware of various aspects of industrial safety i.e. safe mode of operating chemical plants, consequences of unsafe operations.
2. have knowledge of potential hazards of various chemicals.
3. be able to deal with hazardous waste management.
4. have knowledge of various methods of disposing hazardous waste.
5. be accustomed with Safety Management
6. have knowledge of treatment and disposal of Hazardous Wastes

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination..
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four question need to be solved.

Reference

1. "Safety Legislations in Chemical Industries" by S. S. Manakar, Published by Mrs. Jyoti S Manakar, New Panvel

2. " Safety Management" by John V. Grimaldi, Rollin H. Simonds; 5th Edition, Published by All India traveler Book Seller, Krishan Nagar, Delhi- 110051.

3. "Hazardous Waste Management" by Michael D. LaGrega, Phillips L. Bukingham, Jeffrey C. Evans and Environmental Resource Management, McGraw- Hill International Edition.

Semester II (Program Elective IV)		
Course Code	**Course Name**	**Credits**
CHPE2022	**Green Chemistry and Engineering**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. Engineering Chemistry, Chemical Technology
2. Students should know basic chemistry pertaining to chemical reactions, chemical formula etc.

Course Objectives

1. To understand the principles of Green Chemistry and Engineering.
2. To outline the engineering applications of Green Chemistry and Engineering..
3. To familiarize the process of Green Engineering.
4. To understand the development of environmentally friendly processes.
5. Tostudy the selection of suitable material for the manufacture of industrially important products with minimal formation of waste.
6. To understand methodology for the green process.

Detailed Syllabus

Module No.	Course Contets	No.ofHours
1	**Principles of Green Chemistry and Engineering** Concept of E Factors and Atom Economy, Principles of Green Chemistry, Waste Minimization, Reduction of Material Use and Energy Requirement, Reduction of Risk and Hazard.	**06**

2	**Green Chemistry and Catalysis** Solid Acids and Bases as Catalysts, Catalytic Reductions and Oxidations, Biocatalysis, Phase Transfer Catalysis	**06**
3	**Novel Reaction Media for Green Chemistry and Catalysis** Choice of Solvent, Alternative Reaction Media and Multiphasic systems, Supercritical Fluids including Supercritical Carbon Dioxide, Ionic Liquids.	**08**
4	**Chemicals from Renewable Raw Materials** Application of Green Chemistry and Engineering in Manufacture of Industrially ImportantChemicals such as Ethanol, Lactic Acid, 1,3-Propanediol, Ascorbic Acid, Biodiesel and Green Polymers.	**09**
5	**Process Intensification for Green Processes** Spinning Disc Reactors, Microreactors, Intensified Cross-corrugated Multifunctional Membrane, Applications of Ultrasound, Microwaves and Photochemistry for Environmentally Benign Processes, Electrochemistry and Sustainability, Fuel Cells.	**08**
6	**Life-Cycle Assessment for More Sustainable Products and Processes** Life-Cycle Assessment (LCA) Methodology, Applications of LCA.	**02**

Course Outcomes

On completion of the course the students will:

1. apply the principles of Green Chemistry and Engineering to Chemical and Biochemical Processes.
2. understand the phase transfer catalysis process.
3. determine alternative reactions for green chemistry & catalysis.
4. identify industrial based applications of Green Chemistry and Engineering.
5. design and develop processes which are environmentally friendly.
6. produce the desired product with minimal formation of waste.

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper:

- Minimum 80% syllabus should be covered in question papers of end semester examination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus**.**
- Question paper will comprise of total six question
- All question carry equal marks
- Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

- Only Four question need to be solved.

Reference Books:

1. Handbook of Green Chemistry and Technology, James Clark and Duncan Macquarrie, Blackwell Science Ltd., 2002.
2. Green Chemistry and Catalysis, Roger Sheldon, Isabel Arends and Ulf Hanefeld, Wiley-VCH Verlag GmbH and Co., 2007.

Semester II (Program Elective IV)		
Course Code	**Course Name**	**Credits**
CHPE2023	**Industrial Pollution Control and Prevention**	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Prerequisites

1. EnvironmentalEngineeringandatmosphericpollution.
2. Advancedmethodofwastetreatment.
3. StudyandminimizationofIndustrialpollutionanditscontrol

Course Objectives

1. To understand theprocessofindustrialpollution.
2. Todesignthewaterandairpollutionequipment
3. Toestablishthewastetreatmentprocessesasaproductiveoperatingplant
4. To analyze effectwaterpollutiononhumanhealthandestablishthestandardnorms
5. To analyze effectwaterpollutiononhumanhealthandestablishthestandardnorms
6. To study and analyse pollution control and prevention in specific industries.

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
1	**Introduction:** Introduction and concept of industrial pollution, what is industrial pollution, how many typesof pollution occur in industry explain by industrial examples, why it is important to preventpollution.Differentact forwaterandairpollutiontogetherwithnoiseandnuclearpollution	06
2	**Measurementofindustrialpollution:** Detailsofwaterandairpollutioncreatedbydifferentindustries,variousmethodformeasurement of water and air pollution in a given industrial sample. Define COD, BOD, DO,TSS,TDS,MLVSS,VSSetc.Determinationofindustrialpollutionnormswiththeirpractical aspects.	05
3	**Watertreatment**: Introduction,coagulation, softening, reactors mixing and flocculation, sedimentation, filtration,adsorption,waterplantwastemanagement,numericalproblemsbasedonindustrial wastewatertreatment.	06
4	**Waterqualitymanagement and water treatment :** Water pollution and their sources in different industries, discharge norms of industrial wastewater,viz.towaterbodies.Zerodischargenormsfordifferentindustriesi.e.petroleum, fertilizer,sugar,polymeretc.Recycleofwastewaterinindustryanditsapplicationin preventionofpollution. Wastewatermicrobiology,characteristicsofindustrialwastewater,applicationsofunitoperationsinprimarysecondaryandtertiarytreatment.Advancedmethodswastewatertreatmentbasedondifferentunitoperations.Designofdifferentequipmentsusedforphysical chemicalandbiologicaltreatmentofindustrialwastewater.	10
5	**Airpollution:** Fundamentalsofphysicalandchemicalairpollution,airpollutantsandtheirthresholdlimit,effectofairpollutioninenvironmentultimatelyonhumanhealth,removalofmercury, ammonia,urea,particulate matters,SO_2oxideonnitrogenorganic vaporfromeffluentgases.	06
6	**Pollutioncontrolprocessesandtheireconomics:** Pollution control in selective process industries, pollution control in chemical industries fromgaseous considerations, advanced processes which can made the treatment plan a productiveplant. Pollution control and its prevention in pulp and paper industry. Pollution control andpreventioninmiscellaneousprocessindustries.Detailedeconomicsofpreventionpollution fromdifferentindustry	06

Course Outcomes

On completion of the course the students will:

1. understandthedifferenttypesofwastesgeneratedinanindustry,theireffectsonlivingandnon-livingthings.
2. understandenvironmentalregulatorylegislationsandstandardsandclimatechanges.
3. understandaboutthequantificationandanalysisofwastewaterandtreatment.

4. understandthedifferentunitoperationsandunitprocessesinvolvedinconversion ofhighlypollutedwaterto potable standards.
5. understandaboutanalysisandquantification ofhazardousandnonhazardoussolidwastewastes,treatmentand disposal.
6. have the knowledge of pollution control processes in specific industries.

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasste stor assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecoveredinquestionpapersofend semesterexamination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequalmarks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3 thenpart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. Airpollution"byRKBhatia,
2. "Pollutioncontrolinprocessindustry"bySP Mahajan.
3. "Introductiontoenvironmentalengineering"byDavidACornwellandMackenzie LDavis

Semester II (Institute Elective II)		
Course Code	**Course Name**	**Credits**
CHIE2011	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. Tofamiliarizethestudentswiththeuseofastructuredmethodology/approachforeachandeveryuniqueproject undertaken,including utilizingprojectmanagementconcepts,toolsand techniques.
2. Toappraisethestudentswiththeprojectmanagementlifecycleandmakethemknowledgeableaboutthevariousphasesfromprojectinitiationthroughclosure.

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**ProjectManagementFoundation:** Definitionofaproject,ProjectVsOperations,Necessityofprojectmanagement,Tripleconstraints,Projectlifecycles(typical& atypical)Projectphasesandstagegateprocess.Roleofprojectmanager.Negotiationsandresolvingconflicts.Projectmanagementinvariousorganizationstructures.PMknowledgeareasasper ProjectManagementInstitute(PMI).	**5**
02	**InitiatingProjects:** Howtogetaprojectstarted,Selectingprojectstrategically,Projectselectionmodels(Numeric/ScoringModelsandNon-numericmodels),Projectportfolioprocess,Projectsponsorandcreatingcharter; Project proposal.Effective project team, Stagesofteamdevelopment&growth(forming,storming,norming&performing),teamdynamics.	**6**
03	**ProjectPlanningandScheduling:** WorkBreakdownstructure(WBS)andlinearresponsibilitychart,Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down andbottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart.IntroductiontoProjectManagementInformationSystem(PMIS).	**8**

04	**PlanningProjects:** Crashingprojecttime,Resourceloadingandleveling,Goldratt'scriticalchain,ProjectStakeholdersandCommunicationplan.RiskManagementinprojects:Riskmanagementplanning,Riskidentificationandriskregister.Qualitativeandquantitativeriskassessment,Probabilityandimpactmatrix.Riskresponsestrategiesforpositiveandnegativerisks	**6**
05	**5.1 ExecutingProjects:** Planningmonitoringandcontrollingcycle.Informationneedsandreporting,engagingwithallstakeholdersofthe projects.Teammanagement,communicationandprojectmeetings. **5.2 MonitoringandControllingProjects:** Earned Value Management techniques for measuring value of work completed; Using milestonesformeasurement;changerequestsand scope creep.Projectaudit. **5.3 ProjectContracting** Projectprocurementmanagement,contractingandoutsourcing,	**8**
06	**6.1 ProjectLeadershipandEthics:** Introductiontoprojectleadership,ethicsinproject s.Multiculturalandvirtualprojects. **6.2 ClosingtheProject:** Customeracceptance;Reasonsofprojecttermination,Varioustypesof projectterminations (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**

Course Outcomes

On completion of the course the students will:

1. Applyselectioncriteriaandselectanappropriateprojectfromdifferentoptions.
2. Write workbreakdownstructureforaprojectanddevelopaschedulebasedonit.
3. Identifyopportunitiesand threatsto theprojectand decideanapproachto dealwiththemstrategically.
4. UseEarnedvaluetechniqueanddetermine&predictstatusoftheproject.
5. Capturelessonslearnedduringprojectphasesanddocumentthemforfuturereference

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasstestor assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecoveredinquestionpapersofend semesterexamination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequalmarks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3 thenpart(b)willbe fromanymodule otherthanmodule 3)

- OnlyFourquestionneedtobesolved.

Reference Books:

1. JackMeredith&SamuelMantel,ProjectManagement:Amanagerialapproach,WileyIndia,7th Ed.
2. AGuidetotheProjectManagementBodyofKnowledge(PMBOK® Guide),5th Ed,ProjectManagement InstitutePA, USA
3. GidoClements,ProjectManagement,CengageLearning.
4. Gopalan,ProjectManagement,,WileyIndia
5. DennisLock,ProjectManagement,GowerPublishingEngland,9thEd.

Semester II (Institute Elective II)		
Course Code	**Course Name**	**Credits**
CHIE2012	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. OverviewofIndianfinancialsystem,instrumentsand market
2. Basicconceptsofvalueofmoney,returnsandrisks,corporatefinance, workingcapitalanditsmanagement
3. Knowledgeaboutsourcesoffinance,capitalstructure,dividendpolicy

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of FinancialSystem. **FinancialInstruments:**Meaning,CharacteristicsandClassificationofBasicFinancialInstruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, andTreasuryBills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — CapitalMarket,MoneyMarket andForeignCurrencyMarket **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions —CommercialBanks, Investment-MerchantBanksand StockExchanges	**06**
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of aSingle Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Riskofa Single Securityanda 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 Compoundingand ContinuousDiscounting.	**06**

03	**Overviewof Corporate Finance:**Objectives of Corporate Finance; Functions of CorporateFinance—InvestmentDecision,FinancingDecision,and DividendDecision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and LossAccount,andCash Flow Statement;Purposeof FinancialRatioAnalysis;Liquidity Ratios;Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios;LimitationsofRatioAnalysis.	**09**
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital BudgetingDecisions;InvestmentAppraisalCriterion—AccountingRateofReturn,PaybackPeriod,Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return(IRR),andModifiedInternalRate ofReturn(MIRR) **WorkingCapitalManagement:**ConceptsofMeaningWorkingCapital;ImportanceofWorkingCapitalManagement;FactorsAffectinganEntity'sWorkingCapitalNeeds;Estimationof Working Capital Requirements; Management of Inventories; Management of Receivables; andManagementofCashandMarketable Securities.	**10**
05	**SourcesofFinance:**Long Term Sources—Equity, Debt, and Hybrids; MezzanineFinance;SourcesofShortTermFinance—TradeCredit,BankFinance,CommercialPaper;ProjectFinance. **CapitalStructure:**FactorsAffectinganEntity'sCapitalStructure;OverviewofCapitalStructureTheoriesandApproaches—NetIncomeApproach,NetOperatingIncomeApproach;Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure andCorporateValue; Conceptof OptimalCapitalStructure	**05**
06	**DividendPolicy:**MeaningandImportanceofDividendPolicy;FactorsAffectinganEntity'sDividendDecision;OverviewofDividendPolicyTheoriesandApproaches—Gordon'sApproach,Walter'sApproach,andModigliani-MillerApproach	**03**

Course Outcomes

On completion of the course the students will:

1. UnderstandIndianfinancesystemandcorporatefinance
2. Takeinvestment,financeaswellasdividenddecisions

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasstestor assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecoveredinquestionpapersofend semesterexamination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequalmarks

- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3 thenpart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. FundamentalsofFinancialManagement,13th Edition(2015)byEugeneF. BrighamandJoelF.Houston;Publisher:Cengage Publications, NewDelhi.
2. AnalysisforFinancialManagement,10th Edition(2013)byRobertC.Higgins;Publishers: McGrawHillEducation,NewDelhi.
3. IndianFinancialSystem,9th Edition(2015)byM.Y.Khan; Publisher:McGrawHillEducation,NewDelhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & CompanyLimited,NewDelhi

Semester II (Institute Elective II)		
Course Code	**Course Name**	**Credits**
CHIE2013	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. Toacquaintwithentrepreneurshipand managementofbusiness
2. UnderstandIndianenvironmentforentrepreneurship
3. IdeaofEDP, MSME

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship,History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy,FunctionsofanEntrepreneur,Entrepreneurship andFormsofBusinessOwnershipRole of Money and Capital Markets in Entrepreneurial Development: Contribution of GovernmentAgenciesinSourcinginformationfor Entrepreneurship	**04**
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and MarketingPlans, Management and Personnel, Start-up Costs and Financing as well as Projected FinancialStatements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capitaland itsImportance tothe Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an ExistingBusiness,NewProductDevelopment,BusinessGrowthandtheEntrepreneurLawandit sRelevancetoBusinessOperations	**09**
03	Women'sEntrepreneurship Development,Social entrepreneurship-roleand need,EDPcell,roleofsustainabilityandsustainabledevelopmentforSMEs,casestudies,exercise s	**05**

04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilitiesof various government organisations, departments, banks etc., Role of State governments in termsofinfrastructuredevelopmentsandsupportetc.,Publicprivatepartnerships,NationalSkill developmentMission,CreditGuarantee Fund,PMEGP,discussions,groupexercisesetc	**08**
05	**EffectiveManagementofBusiness:**Issuesandproblemsfacedbymicroandsmallenterprisesan deffectivemanagementofMandSenterprises(riskmanagement,creditavailability,technologyi nnovation,supplychainmanagement,linkagewithlargeindustries),exercises,e-Marketing	**08**
06	**AchievingSuccessInTheSmallBusiness:**Stagesofthesmallbusinesslifecycle,fourtypesoffir m-levelgrowthstrategies, Options– harvestingorclosingsmallbusinessCriticalSuccessfactorsofsmallbusiness	05

Course Outcomes

On completion of the course the students will:

1. Understandtheconceptofbusinessplanandownerships
2. Interpretkeyregulationsandlegalaspectsofentrepreneurshipin India
3. Understandgovernmentpoliciesforentrepreneurs

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasste stor assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecoveredinquestionpapersofend semesterexamination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequalmarks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3 thenpart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. PoornimaCharantimath,Entrepreneurshipdevelopment-SmallBusinessEnterprise,Pearson
2. EducationRobertDHisrich,MichaelPPeters,DeanAShapherd,Entrepreneurship,latestedition,TheM cGrawHillCompany
3. DrTNChhabra,EntrepreneurshipDevelopment,SunIndiaPublications,NewDelhi
4. DrCNPrasad,SmallandMediumEnterprisesinGlobalPerspective, NewcenturyPublications,NewDelhi
5. VasantDesai,Entrepreneurialdevelopmentandmanagement,HimalayaPublishingHouse

6. Maddhurima Lall,ShikahSahai,Entrepreneurship,ExcelBooks
7. RashmiBansal,STAYhungrySTAYfoolish,CIIE,IIMAhmedabad
8. LawandPracticerelatingtoMicro,SmallandMediumenterprises,TaxmannPublicationLtd.
9. Kurakto,Entrepreneurship-PrinciplesandPractices,ThomsonPublication
10. LaghuUdyogSamachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Semester II (Institute Elective II)		
Course Code	**Course Name**	**Credits**
CHIE2014	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. Tointroducethestudentswithbasicconcepts,techniquesandpracticesofthehumanresourcemanagement.
2. ToprovideopportunityoflearningHumanresourcemanagement(HRM)processes,relatedwiththefunctions,andchallengesintheemergingperspective oftoday'sorganizations.
3. Tofamiliarizethestudentsaboutthelatestdevelopments,trends&differentaspectsofHRM.
4. Toacquaintthestudentwiththeimportanceofinter-personal&inter-groupbehavioralskillsinanorganizationalsettingrequiredforfuturestable engineers,leadersandmanagers.

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**IntroductiontoHR** HumanResourceManagement- Concept,ScopeandImportance,InterdisciplinaryApproachRelationshipwithotherSciences,CompetenciesofHRManager, HRMfunctions. Humanresourcedevelopment(HRD):changingroleofHRM–HumanresourcePlanning, Technologicalchange,Restructuringandrightsizing,Empowerment,TQM,Managingethicalissues.	**5**

02	**OrganizationalBehavior(OB)** IntroductiontoOBOrigin,NatureandScopeofOrganizationalBehavior,RelevancetoOrganizational EffectivenessandContemporaryissues Personality: Meaning and Determinants of Personality, Personality development, Personality Types,AssessmentofPersonalityTraitsfor IncreasingSelfAwareness Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude andBehavior. Motivation:TheoriesofMotivationandtheirApplicationsforBehavioralChange(Maslow,Herzberg,McGregor); GroupBehaviorandGroupDynamics: Workgroups formal andinformalgroups andstages ofgroup development. Team Effectiveness: High performing teams, Team Roles, cross functional andself-directed team. Casestudy	**7**
03	**OrganizationalStructure&Design** Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Conceptofroles;role dynamics;role conflictsand stress. Leadership:Conceptsandskillsofleadership,Leadershipandmanagerialroles,Leadershipstyles and contemporaryissuesinleadership. PowerandPolitics:Sourcesandusesofpower;Politicsat workplace,Tacticsandstrategies.	**6**
04	**HumanresourcePlanning** RecruitmentandSelectionprocess,Job-enrichment,Empowerment-Job-Satisfaction,employeemorale. PerformanceAppraisalSystems:Traditional&modernmethods,PerformanceCounseling,Career Planning. Training&Development:IdentificationofTrainingNeeds,TrainingMethods	**5**
05	**EmergingTrendsinHR** Organizationaldevelopment;BusinessProcessRe-engineering(BPR),BPRasatoolfororganizational development , managing processes & transformation in HR. Organizational Change,Culture, Environment Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity atwork**,** Causes of diversity, managing diversity with special reference to handicapped, women andageingpeople, intracompanyculturaldifference inemployeemotivation.	**6**
06	**HR&MIS** Need,purpose,objectiveandroleofinformationsysteminHR,ApplicationsinHRDinvariousindustries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries**StrategicHRM** Role of Strategic HRM in the modern business world, Concept of Strategy,Strategic ManagementProcess, Approaches to Strategic Decision Making;Strategic Intent – Corporate Mission, Vision,ObjectivesandGoals **LaborLaws&IndustrialRelations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial DisputesAct, Trade UnionsAct,Shops andEstablishmentsAct	**10**

Course Outcomes

On completion of the course the students will:

1. Understandtheconcepts, aspects,techniquesandpracticesofthe humanresource management.
2. UnderstandtheHumanresourcemanagement(HRM)processes,functions,changesandchallengesintoday'semergingorganizational perspective.
3. GainknowledgeaboutthelatestdevelopmentsandtrendsinHRM.
4. Applytheknowledgeofbehavioralskillslearntandintegrateitwithininterpersonalandintergroupenvironmentemergingasfuturestable engineersandmanagers.

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasste stor assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecoveredinquestionpapersofend semesterexamination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequalmarks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3 thenpart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. StephenRobbins,OrganizationalBehavior,16th Ed,2013
2. VSP Rao,HumanResourceManagement,3rd Ed,2010,Excelpublishing
3. Aswathapa,Humanresourcemanagement:Text &cases,6th edition,2011
4. C.B.MamoriaandSVGankar,DynamicsofIndustrialRelationsinIndia,15th Ed,2015,HimalayaPublish ing,15th edition, 2015
5. P.SubbaRao,EssentialsofHumanResourcemanagementandIndustrialrelations,5th Ed,2013,Himalaya Publishing
6. LaurieMullins,Management&OrganizationalBehavior,LatestEd,2016,PearsonPublications

Semester II (Institute Elective II)		
Course Code	**Course Name**	**Credits**
CHIE2015	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. Tounderstandprofessionalethicsinbusiness
2. Torecognizedcorporatesocialresponsibility

.Detailed Syllabus

Module No.	Course Contents	No.of Hours
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business;MoralResponsibilityandBlame;Utilitarianism:WeighingSocialCostsandBenefits ;RightsandDutiesofBusiness	**04**
02	**ProfessionalEthicsintheMarketplace:**PerfectCompetition;MonopolyCompetition;OligopolisticCompetition;OligopoliesandPublicPolicy **ProfessionalEthicsandtheEnvironment:**DimensionsofPollutionandResourceDepletion; EthicsofPollutionControl;EthicsofConservingDepletable Resources	**08**
03	**Professional Ethics ofConsumerProtection:**Markets and Consumer Protection; ContractView of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; ConsumerPrivacy **ProfessionalEthicsofJobDiscrimination:**NatureofJobDiscrimination;ExtentofDiscrimination;ReservationofJobs.	**06**
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottomline, Human resources,Risk management, Supplier relations; Criticisms and concerns— Natureofbusiness;Motives;Misdirection.TrajectoryofCorporateSocialResponsibilityinIndia	**05**
05	**CorporateSocialResponsibility:** ArticulationofGandhianTrusteeship CorporateSocialResponsibilityandSmallandMediumEnterprises(SMEs)inIndia,Corporate SocialResponsibilityand Public-Private Partnership (PPP) inIndia	**08**

06	**CorporateSocialResponsibilityinGlobalizingIndia:**CorporateSocialResponsibilityVoluntaryGuidelines,2009issuedbytheMinistryofCorporateAffairs,GovernmentofIndia,LegalAspectsofCorporateSocialResponsibility—CompaniesAct,2013.	**08**

Course Outcomes

On completion of the course the students will:

1. Understandrightsanddutiesofbusiness
2. Distinguishdifferentaspectsofcorporatesocialresponsibility
3. Demonstrateprofessionalethics
4. Understandlegalaspectsofcorporatesocialresponsibility

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasstestor assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecoveredinquestionpapersofend semesterexamination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequalmarks
- QuestionswillbemixedinnatureforexamplesupposedQ.2haspart(a)frommodule3 thenpart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

1. BusinessEthics:TextsandCasesfromtheIndianPerspective(2013)byAnandaDasGupta;Publisher:Springer.
2. CorporateSocialResponsibility:ReadingsandCasesinaGlobalContext(2007)byAndrewCrane,DirkMatten,Laura Spence;Publisher:Routledge.
3. BusinessEthics:ConceptsandCases,7thEdition(2011)byManuelG.Velasquez;Publisher:Pearson,NewDelhi.
4. CorporateSocialResponsibilityinIndia(2015)byBidyutChakrabarty,Routledge,NewDelhi.

Semester II (Institute Elective II)		
Course Code	**Course Name**	**Credits**
CHIE2016	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. Tofamiliarizewithdigitalbusinessconcept
2. ToacquaintwithE-commerce
3. TogiveinsightsintoE-businessanditsstrategies

.Detailed Syllabus

Module	Detailedcontent	ContactHours
1	**IntroductiontoDigitalBusiness-** Introduction,Backgroundandcurrentstatus,E-marketplaces,structures,mechanisms,economicsand impacts. Differencebetweenphysicaleconomyand digitaleconomy. **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media,BYOD, and Internet of Things (digitally intelligent machines/services). Opportunities andChallengesinDigitalBusiness,	**09**
2	**OverviewofE-Commerce** **E-Commerce-**Meaning,Retailingine-commerce-productsandservices,consumerbehavior,marketresearchandadvertisement.B2B-E-commerce-sellingandbuyinginprivatee-markets,publicB2Bexchangesandsupportservices,e-supplychains,Collaborative Commerce, Intra business EC and Corporate portals. ther E-C models andapplications,innovativeECSystem-FromE-governmentandlearningtoC2C,mobilecommerceandpervasivecomputing.ECStrategy andImplementation-ECstrategyandglobal EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commercebusiness,Launchingasuccessfulonlinebusinessand ECproject,Legal,Ethicsand SocietalimpactsofEC.	**06**

3	**DigitalBusinessSupportservices**:ERPase–businessbackbone,knowledgeTopeApps,Informationandreferral system **ApplicationDevelopment:**BuildingDigitalbusinessApplicationsandInfrastructure	**06**
4	**Managing E-Business**-Managing Knowledge,Management skills for e-business, ManagingRisksine–business.SecurityThreatstoe-business-SecurityOverview,Electroniccommerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography,Digitalsignatures,DigitalCertificates,Security Protocolsover PublicNetworks:HTTP,SSL,FirewallasSecurityControl,PublicKeyInfrastructure(PKI)forSecurity,Prominent CryptographicApplications	**06**
5	**E-BusinessStrategy**-E-businessStrategicformulation-AnalysisofCompany'sInternalandexternalenvironment,Selectionofstrategy,E-businessstrategyintoAction,challengesandE-Transition(ProcessofDigitalTransformation)	**04**
6	**Materializinge-business:FromIdeato Realization**-Businessplanpreparation. **CaseStudiesandpresentations**	**08**

Course Outcomes

On completion of the course the students will:

1. Identifydriversofdigitalbusiness
2. IllustratevariousapproachesandtechniquesforE-businessandmanagement
3. PrepareE-businessplan

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasste stor assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecoveredinquestionpapersofend semesterexamination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequalmarks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3 thenpart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

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

Semester II (Institute Elective II)		
Course Code	**Course Name**	**Credits**
CHIE2017	**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	OR	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**3 Hours**	**-**	**-**	**-**	**100**

Course Objectives

1. Understandandidentifyenvironmentalissuesrelevanttoindiaandglobalconcerns
2. Learnconceptsofecology
3. Familiariseenvironmentrelatedlegislations

.Detailed Syllabus

Module	Detailedcontent	ContactHours
01	IntroductionandDefinitionofEnvironment:SignificanceofEnvironmentManagementforcontemporarymanagers, Careeropportunities. EnvironmentalissuesrelevanttoIndia,SustainableDevelopment,andTheEnergyscenario.	**10**
02	GlobalEnvironmentalconcernsGlobalWarming,AcidRain,OzoneDepletion,HazardousWastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters,Atomic/Biomedicalhazards,etc.	**06**
03	ConceptsofEcology:Ecosystemsandinterdependencebetweenlivingorganisms,habitats,limitingfactors,carryingcapacity,foodchain,etc.	**05**
04	ScopeofEnvironmentManagement,Role&functionsofGovernmentasaplanningandregulatingagency.EnvironmentQualityManagementandCorporateEnvironmentalResponsibility	**10**
05	TotalQualityEnvironmental Management,ISO-14000,EMScertification.	**05**
06	GeneraloverviewofmajorlegislationslikeEnvironmentProtectionAct,Air(P&CP)Act,Water(P &CP)Act, WildlifeProtectionAct,ForestAct,FactoriesAct,etc.	**03**

Course Outcomes

On completion of the course the students will:

1. Understandtheconceptofenvironmentalmanagement
2. Understandecosystemandinterdependence,foodchainetc.

3. Understandandinterpretenvironmentrelatedlegislations

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstestandtheotheriseitheraclasste stor assignmentonlive problemsor courseproject.

EndSemesterTheoryExamination:

Someguidelinesforsettingupthequestionpaper:

- Minimum80%syllabusshouldbecoveredinquestionpapersofend semesterexamination.
- Weightage of each module will be proportional to number of respective lecture hours as mentioned in thesyllabus.
- Questionpaperwillcompriseoftotalsixquestion
- Allquestioncarryequalmarks
- Questionswillbemixedinnature(forexamplesupposedQ.2haspart(a)frommodule3 thenpart(b)willbe fromanymodule otherthanmodule 3)
- OnlyFourquestionneedtobesolved.

Reference Books:

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, MajidHussain, 3rd Ed. Access Publishing.2015

Semester II		
Course Code	**Course Name**	**Credits**
CHL201	**Program Lab-II**	**01**

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

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

Prerequisites

1. Basic knowledge of all mass transfer operations
2. Practical knowledge of distillation, absorption, adsorption, extraction, leaching, humidification, drying and crystallization
3. Basic knowledge of process modeling, dynamics and control
4. Practical knowledge of process dynamics and feedback control system

Course Objectives

1. To understand basic Equation for membrane separation for membrane

2. To study Experiment on reactive distillation

3. To understand multistage cross current operation in liquid liquid extraction experimentally

4. Toanalyze cascade, feed forward and ratio control systems

5. Toacquire knowledge of tuning PID control system

6. Toanalyze multi variable control systems

Detailed Syllabus

Program Lab-II should have six experiments based on the courses Advanced Mass Transfer and Advanced Process Controland Dynamics

Course Outcomes

On completion of the course the students will:

1. validate basic Equation for membrane separation for membrane

2. understand reactive distillation operation

3. be able to perform multistage cross current operation in liquid liquid extraction and compare with single stage operation
4. obtain quick control response based on application of advanced control strategies.
5. tune the control parameters for fine system response.
6. achieve pairing of input and output variables in MIMO systems.

Assessment

Laboratory

Weightage for Laboratory should be 40% in Final Assessment of Laboratory Term Work.

Term work
Term work shall be evaluated based on performance in practical.
Practical Journal: 20 marks
Attendance: 05 marks
Total: 25 marks

End Semester Examination

Practical/Oral examination is to be conducted by pair of internal and external examiners

Semester II		
Course Code	**Course Name**	**Credits**
CHSBL201	**Skill Based Lab-II**	**02**

Course Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
-	**04**	**-**	**-**	**02**	**-**	**02**

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						
-	-	-	-	-	50	50	-	100

Prerequisites

1. Basic knowledge Sample Analytical equipment.
2. Practical knowledge of major wastewater analytical test categories.
3. Basic knowledge of process modeling, dynamics and control.
4. Practical knowledge of waste water treatment.

Course Objectives

1. To learn Operation of Analytical Instruments
2. To study Multi component distillation separation and other unit operations using process simulators
3. To understand Linear and non linear regression
4. To learn Error analysis methods
5. To understand Waste Water Analysis
6. To study Development of HEN, Column series

Detailed Syllabus

Skill Based Lab-II is focused on the learning through experience. SBL shall facilitate the learner to acquire the fundamentals of practical engineering in his or her specialization in a project-oriented environment. The learning through skill based labs can be useful in facilitating their research work and hence useful in early completion of their dissertation work.

Course Outcomes

On completion of the course the students will:

1. select the required instruments for sample analysis
2. apply the knowledge of chromatography to Separates the constituents from a complex mixture
3. understand the effects of different constituents in a process outcome and analyse the performance of various on-line and/or off-line instruments and equipment by simulation
4. perform experimental analysis for different offline test TDS, dissolve oxygen etc.
5. learn basic concepts of waste management
6. carryout and determine treatment efficiency of various water treatment processes

Assessment

Laboratory

Weightage for Laboratory should be 40% in Final Assessment of Laboratory Term Work.

Practical/Oral examination is to be conducted by pair of internal and external examiner.

SEMESTER III

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHMP301	MajorProject: Dissertation-I	--	20	--	--	10	--	10
Total		**00**	**20**	**00**	**00**	**10**	**--**	**10**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract/ Oral	Total
		InternalAssessment			End Sem. Exam	Exam.Duration(inHrs)			
		Test-1	Test-2	Avg					
CHMP301	MajorProject: Dissertation-I	--	--	--	--	--	100	--	100
Total		**--**	**--**	**--**	**--**	--	**100**	**--**	**100**

Semester III

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHMP301	MajorProject: Dissertation-I	--	20	--	--	10	--	10
Total		**00**	**20**	**00**	**00**	**10**	**--**	**10**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract/ Oral	Total
		InternalAssessment			End Sem. Exam	Exam.Duration(inHrs)			
		Test-1	Test-2	Avg					
CHMP301	MajorProject: Dissertation-I	--	--	--	--	--	100	--	100
Total		**--**	**--**	**--**	**--**	--	**100**	**--**	**100**

Course Objectives

1. To investigate the research problems.
2. To acquire critique knowledge from research studies.
3. To identify and formulate the Dissertation Topic with novelty.
4. To compare the related research works in the similar field.
5. To write the literature review scientifically.
6. To develop methodology for the Dissertation topic.

Guidelines for Dissertation-I

Students should do literature survey and identify the problem for Dissertation and finalize in consultationwithGuide/Supervisor.Studentsshouldusemultipleliteraturesandunderstandtheproblem.Studentsshould attemptsolutiontotheproblembyanalytical/simulation/experimentalmethods.Thesolutiontobevalidatedwithproperjustificationandcompilethereportinstandardformat.

Course Outcomes

On completion of the course the students will:

1. acquire knowledge of various research problems.
2. do critical analysis of upcoming research problems.
3. formulate the Dissertation topic with novelty.
4. do critical analysis of research works in the similar field.
5. have a skill of writing literature review scientifically.

6. finalize the methodology for the Dissertation topic

GuidelinesforAssessmentofDissertation-I.

Dissertation-Ishouldbeassessedbasedonfollowingpoints

- QualityofLiteraturesurveyandNoveltyintheproblem
- ClarityofProblemdefinitionandFeasibilityofproblemsolution
- Relevancetothespecialization
- Clarity of objective and scope Dissertation-I should be assessed through a presentation by a panel ofInternalexaminersandexternalexaminerappointedbytheHeadoftheDepartment/Instituteofrespective Programme.

SEMESTER IV

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHMP401	Major Project :Dissertation-II	--	32	--	--	16	--	16
Total		**--**	**32**	**--**	**--**	**16**	**--**	**16**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract/ Oral	Total
		InternalAssessment			End Sem. Exam	Exam. Duration (inHrs)			
		Test-1	Test-2	Avg					
CHMP401	MajorProject: Dissertation-II	--	--	--	--	--	100	100	200
Total		**--**	**--**	**--**	**--**	--	**100**	**100**	**200**

Semester IV

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHMP401	Major Project :Dissertation-II	--	32	--	--	16	--	16
Total		**--**	**32**	**--**	**--**	**16**	**--**	**16**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract/ Oral	Total
		InternalAssessment			End Sem. Exam	Exam. Duration (inHrs)			
		Test-1	Test-2	Avg					
CHMP401	MajorProject: Dissertation-II	--	--	--	--	--	100	100	200
Total		**--**	**--**	**--**	**--**	**--**	**100**	**100**	**200**

Course Objectives

1. To implement the methods/techniques identified for research project.
2. To demonstrate the ability to independently perform primary research activities.
3. To analyze and interpret the results obtained.
4. To develp the ability to compare the results obtained with literature.
5. To demonstrate the original contribution to knowledge.
6. To create a research report.

Guidelines for Dissertation-II

Students should implement the methods/techniques identified in dissertation I. Students should perform primary research activities (experiments, numerical modelling, etc.) on a significant open-ended problem. They should analyze, interpret and compare the result obtained from work and explain thorough and advanced knowledge of research topic in written form by writing a dissertation.

Course Outcomes

On completion of the course the students will:

1. implement the suitable methods/techniques
2. demonstrate the ability to independently perform primary research activities.
3. analyze and interpret the results obtained.
4. compare the results obtained with literature.
5. demonstrate the original contribution to knowledge.
6. elucidate in-depth and advanced knowledge of research topic in written form by writing a dissertation.

GuidelinesforAssessmentofDissertationII

DissertationIIshouldbeassessedbasedonfollowingpoints:

- QualityofLiteraturesurveyand Noveltyin theproblem
- ClarityofProblemdefinitionandFeasibilityofproblemsolution
- Relevancetothespecializationorcurrent Research/ Industrialtrends
- Clarityofobjectiveandscope

- Qualityofworkattemptedorlearnercontribution
- Validationofresults
- QualityofWrittenandOralPresentation

Studentsshouldpublishatleastonepaperbasedontheworkinreferred National/Internationalconference/Journal ofrepute.

DissertationIIshouldbeassessedbyinternalandExternalExaminersappointedbytheUniversityofMumbai.