ACADEMIC REGULATIONS

COURSE STRUCTURE AND SYLLABI

FOR

M.TECH.
CHEMICAL ENGINEERING
2012-2013

GAYATRI VIDYA PARISHAD COLLEGE OF ENGINEERING
(AUTONOMOUS)
ACCREDITED BY **NAAC** WITH **A** GRADE WITH A **CGPA** OF **3.47/4.00**
AFFILIATED TO JNTU KAKINADA
MADHURAWADA, VISAKHAPATNAM 530048

Vision

To evolve into and sustain as a Centre of Excellence in Technological Education and Research with a holistic approach.

Mission

To produce high quality engineering graduates with the requisite theoretical and practical knowledge and social awareness to be able to contribute effectively to the progress of the society through their chosen field of endeavor.

To undertake Research & Development, and extension activities in the fields of Science and Engineering in areas of relevance for immediate application as well as for strengthening or establishing fundamental knowledge.

F O R E W O R D

It is three years since the G.V.P College of Engineering has become Autonomous with the appreciation and support of erstwhile JNTU and the fast growing new JNTU-K. The college is progressing well with its programmes and procedures drawing more and more accolades from its sister autonomous colleges and higher authorities. The student community, also could adjust well to the new system without any acrimony.

The College is enriched with the experience of running the Post-graduate programmes under Autonomous stream. It is a moment of pride and achievement that the first Autonomous batch of M.Tech in some branches left the college to the satisfaction of all concerned including firms visited the campus for placements.

Another larger than canvas picture is foreseen for the programmes wherein the college is getting the funds through TEQIP – II for up-scaling the PG education and research under sub- component 1.2. In this connection two new PG Programmes have been introduced in Mechanical, Electrical Engineering.

New set of Boards of Studies, Academic council and Governing Body has further strengthened our hands by endorsing the practices and suggested recommendations.
The encouragement given by the affiliating JNTU-K has left no task insurmountable.

Principal

MEMBERS ON THE BOARD OF STUDIES IN CHEMICAL ENGINEERING

- Prof.B.Srinivas, Head of the Department.

- Prof. K. Krishnaiah, Department of Chemical Engg., IIT-Chennai.
- Prof. P.S.T. Sai, Department of Chemical Engg., IIT-Chennai.
- Prof. V.S.R.K. Prasad, Principal, ANITS, Visakhapatnam.
- Prof. C. Bhaskara Sarma, Principal, GVPCEW, Visakhapatnam.
- Prof. G. Prabhakar, Professor in Chemical Engineering, SVU College of Engg. S.V. University, Tirupati.
- Dr. A. Srinivas Kumar, Addl. Director, NSTL, Visakhapatnam.
- Mr. P. Srikanth Karthik, Process Engineer, Hydro Cracker, HPCL, Vizag Terminal, Visakhapatnam.

All faculty of the department.

ACADEMIC REGULATIONS

(Effective for the students admitted into
first year from the academic year 2012-2013)

The M.Tech Degree of JNTU-KAKINADA shall be recommended to be conferred on candidates who are admitted to the program and fulfill all the requirements for the award of the Degree.

1.0 ELGIBILITY FOR ADMISSION:

Admission to the above program shall be made subject to the eligibility, qualifications and specialization as per the guidelines prescribed by the APSCHE and AICTE from time to time.

2.0 AWARD OF M.TECH. DEGREE:

a. A student shall be declared eligible for the award of the M.Tech. degree, if he pursues a course of study and completes it successfully for not less than two academic years and not more than four academic years.
b. A student, who fails to fulfill all the academic requirements for the award of the Degree within four academic years from the year of his admission, shall forfeit his seat in M.Tech. Course.
c. The duration of each semester will normally be 20 weeks with 5 days a week. A working day shall have 7 periods each of 50minutes.

3.0 COURSES OF STUDY:

M.TECH. COURSES	INTAKE
Chemical Engineering	18
Computer Science and Engineering	18
CAD/CAM	18
Infrastructural Engineering and Management	18
Structural Engineering	18
Power System Control and Automation	18
Embedded Systems & VLSI Design	18
Communications & Signal Processing	18
Software Engineering	18
Power Electronics & Drives	18
Computer Aided Analysis And Design (CAAD)	18

4.0 ATTENDANCE:

The attendance shall be considered subject wise.

a. A candidate shall be deemed to have eligibility to write end semester examinations in a subject if he has put in at least 75% of attendance in that subject.
b. Shortage of attendance up to 10% in any subject (i.e. 65% and above and below 75%) may be condoned by a Committee on genuine and valid reasons on representation by the candidate with supporting evidence.
c. Shortage of attendance below 65% shall in no case be condoned.
d. A student who gets less than 65% attendance in a maximum of two subjects in any semester shall not be permitted to take the end- semester examination in which he/she falls short. His/her registration for those subjects will be treated as cancelled. The student should re-register and repeat those subjects as and when offered next.

e. If a student gets less than 65% attendance in more than two Subjects in any semester he/she shall be detained and has to repeat the entire semester.
f. A stipulated fee shall be payable towards condonation of shortage of attendance.

5.0 EVALUATION:

The Performance of the candidate in each semester shall be evaluated subject-wise, with 100 marks for each theory subject and 100 marks for each practical, on the basis of Internal Evaluation and End Semester Examination.

a. A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.
b. For the theory subjects 60 marks shall be awarded based on the performance in the End Semester Examination, 40 marks shall be awarded based on the Internal Evaluation. One part of the internal evaluation shall be made based on the average of the marks secured in the two Mid–Term Examinations of 30 each conducted one in the middle of the Semester and the other immediately after the completion of instruction. Each mid-term examination shall be conducted for a duration of 120 minutes with 4 questions without any choice. The remaining 10 marks are awarded through an average of continuous evaluation of assignments / seminars / any other method, as notified by the teacher at the beginning of the semester.
c. For Practical subjects, 50 marks shall be awarded based on the performance in the End Semester Examinations, 50 marks

shall be awarded based on the day-to-day performance as Internal marks**.** A candidate has to secure a minimum of 50% in the external examination and has to secure a minimum of 50% on the aggregate to be declared successful.

d. There shall be a seminar presentation during III semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation before the Departmental Committee. The Departmental Committee consists of the Head of the Department, supervisor and two other senior faculty members of the department. For Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% to be declared successful.

e. For Seminar in I, II Semesters in case of the course structure of having 5 Theory + 2 Labs. + 1 Seminar, a student has to deliver a seminar talk in each of the subjects in that semester which shall be evaluated for 10 marks each and average marks allotted shall be considered. A letter grade from A to C corresponding to the marks allotted may be awarded for the two credits so as to keep the existing structure and evaluation undisturbed.

A – Excellent	(average marks $\geq$ 8)
B – Good	(6$\leq$ average marks <8)
C – Satisfactory	(5$\leq$ average marks <6)

If a satisfactory grade is not secured, one has to repeat in the following semester.

f. In case the candidate does not secure the minimum academic requirement in any subject (as specified in 4.0 a, c) he has to reappear for the End Examination in that subject.

A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and he has failed in the end examination. In such a case the candidate must re-register for the subject (s) and secure required minimum attendance. Attendance in the re-registered subject (s) has to be calculated separately to become eligible to write the end- examination in the re-registered subject(s). In the event of re-registration, the internal marks and end examination marks obtained in the previous attempt are nullified.

g. In case the candidates secure less than the required attendance in any subject(s), he shall not be permitted to appear for the End Examination in that subject(s). He shall re-register for the subject(s) when next offered.
h. Laboratory examination for M.Tech subjects must be conducted with two Examiners, one of them being Laboratory Class Teacher and second examiner shall be other than Laboratory Teacher.

6.0 EVALUATION OF PROJECT / DISSERTATION WORK:

Every candidate shall be required to submit the thesis or dissertation after taking up a topic approved by the Departmental Research Committee (DRC).

a. A Departmental Research Committee (DRC) shall be constituted with the Head of the Department as the chairman and two senior faculty as members to oversee the proceedings of the project work from allotment to submission.
b. A Central Research Committee (CRC) shall be constituted with a Senior Professor as chair person, Heads of all the

Departments which are offering the M.Tech programs and two other senior faculty members.

c. Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects (theory and practical subjects.)
d. After satisfying 6.0 c, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the DRC for its approval. Only after obtaining the approval of DRC the student can initiate the Project work
e. If a candidate wishes to change his supervisor or topic of the project he can do so with approval of DRC. However, the Departmental Project Review Committee shall examine whether the change of topic/supervisor leads to a major change in his initial plans of project proposal. If so, his date of registration for the Project work shall start from the date of change of Supervisor or topic as the case may be whichever is earlier.
f. A candidate shall submit and present the status report in two stages at least with a gap of 3 months between them after satisfying 6.0 d.
g. The work on the project shall be initiated in the beginning of the second year and the duration of the project is for two semesters. A candidate shall be permitted to submit his dissertation only after successful completion of all theory and practical subject with the approval of CRC but not earlier than 40 weeks from the date of registration of the project work. For the approval by CRC the candidate shall submit the draft copy of the thesis to the Principal through the concerned Head of the Department and shall make an oral presentation before the CRC.

h. Three copies of the dissertation certified by the supervisor shall be submitted to the College after approval by the CRC.
i. The dissertation shall be adjudicated by one examiner selected by the Principal. For this HOD shall submit in consultation with the supervisor a panel of 5 examiners, who are experienced in that field.
j. If the report of the examiner is not favorable, the candidate shall revise and resubmit the dissertation, in a time frame as prescribed by the CRC. If the report of the examiner is unfavorable again, the dissertation shall be summarily rejected then the candidate shall change the topic of the Project and option shall be given to change the supervisor also.
k. If the report of the examiner is favorable, viva-voce examination shall be conducted by a board consisting of the supervisor, Head of the Department and the examiner who adjudicated the dissertation. The Board shall jointly report candidate's work as:

    A. Excellent
    B. Good
    C. Satisfactory

7.0 AWARD OF DEGREE AND CLASS :

A candidate shall be eligible for the respective degree if he satisfies the minimum academic requirements in every subject and secures satisfactory or higher grade report on his dissertation and viva-voce.

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M.Tech. Degree he shall be placed in one of the following three classes.

% of Marks secured	Class Awarded
70% and above	First Class with Distinction
60% and above but less than 70%	First Class
50% and above but less than 60%	Second Class

The marks in internal evaluation and end examination shall be shown separately in the marks memorandum.

The grade of the dissertation shall also be mentioned in the marks memorandum.

8.0 WITHHOLDING OF RESULTS:

If the candidate has not paid any dues to the college or if any case of indiscipline is pending against him, the result of the candidate will be withheld and he will not be allowed into the next higher semester. The recommendation for the issue of the degree shall be liable to be withheld in such cases.

9.0 TRANSITORY REGULATIONS:

A candidate who has discontinued or has been detained for want of attendance or who has failed after having studied the subject is eligible for admission to the same or equivalent subject(s) as and when subject(s) is/are offered, subject to 6.0 e and 2.0

10.0 GENERAL

1. The academic regulations should be read as a whole for purpose of any interpretation.
2. In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Chairman Academic Council is final.

3. The College may change or amend the academic regulations and syllabus at any time and the changes amendments made shall be applicable to all the students with effect from the date notified by the College.
4. Wherever the word he, him or his occur, it will also include she, hers.

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COURSE STRUCTURE

I SEMESTER:

COURSE CODE	THEORY/LAB	L	P	C
11CH2101	Applied Numerical Methods	4	-	4
11CH2102	Nano Technology	4	-	4
11CH2103	Advanced Transport Phenomena	4	-	4
11CH2104	Advanced Chemical Reaction Engg	4	-	4
	Elective – I	4	-	4
11CH2105	Advanced Bio Process Engineering.			
11CH2106	Advanced Membrane Science			
11CH2107	Chemical Process Safety			
11CH2108	Advanced MATLAB Applications in Chemical Engg - Lab	-	3	2
11CH2109	Simulation of Chemical Engg. Equipment Using PRO-II Lab	-	3	2
11CH21S1	Seminar			2
	Total	**20**	**6**	**26**

II SEMESTER:

COURSE CODE	THEORY/LAB	L	P	C
11CH2110	Multicomponent Mass Transfer	4	-	4
11CH2111	Finite Difference Methods in Heat and Fluid Flow	4	-	4
11CH2112	Advanced Process Control	4	-	4
11CH2113	Optimization Techniques in Chemical Engineering.	4	-	4
	Elective – II	4	-	4
11CH2114	Advanced Chemical Engineering Plant Design			
11CH2115	Advanced Energy Engineering			
11CH2116	Advanced Petroleum Refining Processes			
11CH2117	Analysis of Industrial Pollutants Lab	-	3	2
11CH2118	Computational Fluid Dynamics - Lab	-	3	2
11CH21S2	Seminar			2
	Total	**20**	**6**	**26**

III SEMESTER

COURSE CODE	THEORY/LAB	L	P	C
	Commencement of Project Work			
11CH12S3	SEMINAR	**-**	**-**	**2**

IV SEMESTER

COURSE CODE	THEORY/LAB	L	P	C
11CH2119	PROJECT WORK DISSERTATION / THESIS EXCELLENT/GOOD/SATISFACTORY/ NON-SATISFACTORY	**-**	**-**	**56**

APPLIED NUMERICAL METHODS

Course Code: 11CH2101	**L**	**P**	**C**
	4	**-**	**4**

AIM& OBJECTIVES: This course trains the students in learning and applying the numerical techniques to solve the usual chemical engineering problems.

UNIT-I: Linear Algebraic Equations: Introduction, Gauss-Elimination, LU Decomposition, Gauss-Jordan Elimination, Gauss-Siedel methods.

UNIT-II: Nonlinear Algebraic Equations: Introduction, single variable successive substitutions (Fixed point method), single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique.

UNIT-III: Eigen values and Eigen vectors: Introduction, Calculation of Largest and smallest Eigen Values and Corresponding Eigen vectors using power method.

UNIT-IV: Regression Analysis: Introduction, least squares curve-fit (linear regression), Newton's forward formulae, Newton's backward formulae.

UNIT-V: Interpolation Polynomial, Lagrangian Interpolation (Unequal Intervals),Pade' approximations, (upto second order both in numerator and denominator)

UNIT-VI: Ordinary Differential Equations-Initial Value Problems (ODE-IVPs): Introduction, explicit and implicit Euler's method, Runge-Kutta fourth order method.

UNIT-VII: Ordinary Differential Equations- Boundary Value Problems (ODE-BVPs): Introduction, Galerkin Finite Element (GFE) Technique, Shooting Techniques.

UNIT-VIII: Advanced methods for Differential Equations:- Introduction, the finite difference technique (method of lines), Orthogonal Collocation, Finite Volume Method.

TEXT BOOKS:

1. Guptha, S.K., "Numerical in Engineering", 1st Edition, Tata McGraw Hill,1998.

REFERENCE BOOKS:

1.Grewal , B.S "Numerical Methods in Engineering & Science". 6th Edition, Khanna Publisher, 2005.

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NANO TECHNOLOGY

Course Code: 11CH2102	**L**	**P**	**C**
	4	**-**	**4**

AIM & OBJECTIVES: This course prepares the students in learning the basics, synthesis and preparation of Nano materials which is turning out to be future of materials.

UNIT I : Nano materials and nano composites: Introduction, surface of nanoparticles, thermal phenomena, surface energy-general considerations, phase transitions, thermodynamics, heat capacity of nanoparticles, Phase transformations of nanoparticles, nanoparticle structure fluctuations.

UNIT II :Gas Phase Synthesis of Nanoparticle: Fundamental considerations, inert gas condensation, physical and chemical vapor synthesis, laser ablation, Microwave plasma process, flame aerosol process, coated particle synthesis of nano particles, sol-gel and Hydrothermal processes, freeze drying attrition, Chemical vapor deposition methods for producing nano particles.

UNIT III:

Properties of nano particles:

a) **Magnetic properties:** super paramagnetic properties, applications, exchange coupled magnetic nano materials.
b) **Optical properties**: quantum confinement, quantum dots and other lumophores, metallic and semiconducting nano particles, special luminescent nano particles, electroluminescence, electro-chromic and photochromic materials, magneto-optic applications.

UNIT IV:

a) **Electrical properties**: electrical conductivity in nano-rods and nanotubes, Photoconductivity of nano-rods, electrical conductivity of nano composites.
b) **Mechanical Properties**: General considerations, influence of grain size, sintering temperature, super plasticity, filled polymer composites, nano fluids and applications of nano fluids.

UNIT V : Carbon Nanotubes: nano rods and nano plates, Layered structures, compounds with layers structures, nano tubes and nano rods from materials other than carbon.

Thin films: Kinetic theory of gasses, concepts vacuum, Thermal evaporation, sputtering, ion implantation concepts in nanomaterial science.

UNIT VI : Characterization of nano-materials: Surface area, X-ray diffraction technique, Electronic diffraction, high resolution scanning electron microscopy, localized chemical analysis, scanning transmission electron microscope, other related techniques.

Nanolithography: Electron beam lithography (EBL), X-ray lithography and Extreme ultraviolet lithography.

UNIT VII : Self-organizing of nanoparticles: Patterning of soft materials by self-organizing examples and applications, Depletion interactions, Surfactants, Hydro phobic forces layering.

Chemical Self-assembly: chemical self-assembly of nano-particulates, designing of self- assembled nano structures and its applications.

UNIT VIII : Nanotechnology for Chemical Engineers: Role of chemical engineers in the development of nano science and technology, Specific applications and need of the hour**.**

Nano technology Impact on Ethics and Society: Merits and demerits.

Applications and future prospects of Nano technology: Energy, medicine, biotechnology, textiles, electronics, food, agricultural industries.

TEXT BOOKS:

1. Vollath, D., "Nano Materils & Intorduction to Synthesis, Properties and Application", Wiley VCH, 2006.

REFERENCE BOOKS:

1. Wang, Z.L., Liu, Y. and Zhang "Handbook of nanophase and nanostructured materials" Vol 1,2,3,4 Academic- Plenum Publisher, 2002.
2. Baysen, E. and Booker, R., "Nano technology", Wiley Cheamtech, 2005.
3. Bandyopadhyay,A.K., "Nano Materials", New Age International Publishers, 2008 .

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ADVANCED TRANSPORT PHENOMENA

Course Code: 11CH2103

L	P	C
4	-	4

AIM & OBJECTIVES: This course prepares the students in formulating the mathematical models for Heat, Mass and Momentum Transfer essential in Chemical Engineering.

UNIT-I: Review of mathematics: Scalars, Vectors, Tensors, divergence, relation between rectangular coordinates and cylindrical coordinates, relation between rectangular coordinates and spherical coordinates, partial derivative, substantial derivative, total derivative, line integral, surface integral, integral theorems, frames of reference (Eularian and Lagrangian).

UNIT-II: The equations of change for isothermal flow: Equations of continuity, equation of motion, the equation of mechanical energy, application of Navier-Stokes equation to solve problems like falling film, flow in a tube, shape and surface of a rotating fluid.

UNIT-III: Velocity distribution with more than one independent variable like flow over a plate set in motion, unsteady flow between plates, and laminar flow over a flat plate.

UNIT-IV: The equations of change for non-isothermal flow: Equations of energy, the energy equation in curvilinear coordinates, use of equations of change to set up steady state heat transfer problems, steady state forced and free convection, flow with viscous dissipation, free convection heat transfer over a vertical plate.

UNIT-V: Temperature distribution with more than one independent variable: heating of a semi infinite slab and finite slab, cooling of a sphere in contact with a fluid, laminar tube flow with constant heat flux at the wall.

UNIT-VI: The equations of change for multi component systems: The equations of continuity for a binary mixture, the equation of continuity of a in curvilinear coordinates, the multicomponent equations of change in terms of the flows, the multi component fluxes in terms of the transport properties, use of equations of change to setup diffusion problems and solve like simultaneous heat and mass transfer, concentration profile in a tubular reactor, catalytic oxidation of CO.

UNIT-VII: Setting up and solving problems like: Diffusion with heterogeneous reaction, gas absorption with chemical reaction, diffusion in a falling film, diffusion and reaction in a spherical catalyst particle.

UNIT-VIII: Turbulent flow: Introduction, fluctuations and time smoothened equations for velocity, time smoothing of equation of change, Reynolds stresses.

NOTE :
Examinations:

- Equations of change should be provided during the examinations or paper setter may give the appropriate equations.

TEXT BOOKS :

1. Bird, R.B., Stewart W.E. and Lightfoot, E.N., "Transport Phenomena". Wiley international Edition, NewYork 2002.

REFERENCE BOOKS:

1. Slattery J.C., "Advanced transport Phenomena", Cambridge series in Chemical Engineering,1999.

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ADVANCED CHEMICAL REACTION ENGINEERING

Course Code: 11CH2104

L	P	C
4	-	4

AIM & OBJECTIVES: Reactor Design and Reactor Modeling plays an important role in Chemical Engineering. This course helps the students in writing and formulating the equation.

UNIT-I: Models for Non-Ideal flow Reactors: Two- parameter models- Real CSTR modeled using bypass and dead space, real CSTR modeled as two CSTR interchange, testing a model and determining its parameters.

UNIT-II: Mixing of fluids: Zero parameter models - Segregation model, and qualitative concept of Maximum Mixedness model.

UNIT-III: Fluid-Particle reactions – Design: Various types of contacting in gas- solid operations; Development of performance equation for frequently met contacting pattern assuming uniform gas composition- Particles of a single size, plug flow of solids, Mixture of particles of different but unchanging sizes, plug flow of solids, Mixed flow of particles of a single unchanging size, Mixed flow of a size mixture of particles of unchanging size. Application to a fluidized bed with entrainment of solid fines.

UNIT-IV: Fluid-Fluid Reactions-design: Factors to consider in selecting a gas liquid contactor, Straight mass Transfer: Plug flow G/Plug flow L – counter current flow in a tower. Mass transfer plus not very slow reaction: Plug flow G/Plug flow L – mass transfer and reaction in a countercurrent tower. Plug flow G/Plug flow L – mass transfer in a concurrent tower.

UNIT-V: Catalysis and catalytic reactors: Design of reactors for gas-solid reactions. Heterogeneous data analysis for reactor design; catalyst deactivation – Types of Deactivation, Moving bed Reactors.

UNIT-VI: External diffusion effects on heterogeneous reactions- External resistance to mass Transfer: Mass transfer coefficient, mass transfer to a single particle, mass transfer limited reactions in packed beds.

UNIT-VII: Diffusion and reaction in porous catalysts- Diffusion and reaction in spherical Catalyst pellets, Internal effectiveness factor, Falsified kinetics, Overall effectiveness factor.

UNIT-VIII: Non- isothermal reactor design- energy balance, non-isothermal adiabatic , CSTR, PFR,Flow, reactors at steady state, equilibrium conversion; multiple steady states- ignition- extinction curve.

TEXT BOOKS:

1. Levenspiel, O., "Chemical Reaction Engineering", 3rd Edition Wiley Eastern University, New Delhi, 2001.

REFERENCE BOOKS:

1. Fogler, H.S.,"Elements of chemical reaction Engineering", 4th Edition. Prentice Hall, New Jersey, 1986.

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ADVANCED BIO PROCESS ENGINEERING

Course Code: 11CH2105

L	P	C
4	-	4

AIM & OBJECTIVES: This course trains the student in Biological process Design from a Chemical Engineering point of view. The various cell products their recovery and enzyme kinetics are taught.

UNIT-I: Introduction to Bioprocess:- Historical development of Bioprocess technology, an overview of traditional and modern application of biotechnology industry, outline of an integrating bioprocess and Unit operation in Bioprocess.

UNIT-II: Enzymes, Enzyme Kinetics, Effects of p^H and temperature, Immobilized Enzymes Technology- Enzyme Immobilization, Industrial processes, Utilization and Regeneration of Cofactors.

UNIT-III: Metabolic Pathways:- Bio energtics, Glucose Metabolism:- Glycolysis, TCA cycle, Overview of Biosynthesis, Anerabic metabolism.

UNIT-IV: Cell Kinetics in Batch Culture and continuous Culture. Stoichiometery of microbial growth and product formation.

UNIT-V: Operating considerations for bioreactors for suspension and immobilized cultures. Modifying Batch and Continuous reactors, Immobilized cell systems, Solid state fermentation.

UNIT-VI: Scale up and its difficulties, Bioreactors Instrumentation and control, Sterilization of process fluids.

UNIT-VII: Types of Bioreactors: Packed bed, Bubble column, Fluidized bed and Trickling Bed. Fermentation technology: Medium

formulation, Design and Operation of a typical Aseptic Aerobic Fermentation Process. Alternative bioreactor Configuration.

UNIT-VIII: Product Recovery Operations: Separation of Insoluble Products, Cell disruption Separation of Soluble products, finishing steps for purifications.

TEXT BOOKS:

1. Nielsen, J., Villadsen J., and Liden G., "Bio Reaction Engineering. Principles " 2nd Edition, Academic Kluwer
2. Schuler M.L. and Kargi, " Bio Process Engineering- Basic concepts" PHI, 2002.

REFERENCE BOOKS:

1.Najapour G.D.' "BioChemical Engineering and BioTechnology", First Edition, Elsevier 2007.

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ADVANCED MEMBRANE SCIENCE

Course Code: 11CH2106	**L**	**P**	**C**
	4	**-**	**4**

AIM & OBJECTIVES: This course explains general aspects and importance of various membrane process and understand the various mechanism involved in membrane based separations.

UNIT-I: Introduction: Separation process, membrane processes, definition of a membrane, classifications membrane processes. Preparation of Synthetic membranes: Types of Membrane materials, phase inversion membranes, preparation technique for immersion precipitation, preparation technique for composite membranes.

UNIT-II: Characterization of membranes; Introduction, membrane characterization, characterization of porous membranes, characterization of non-porous membranes.

UNIT-III: Transport in membranes: introduction, driving forces, non equilibrium thermodynamics, transport through porous, non-porous, and ion exchange membranes.

UNIT-IV: Membrane Processes: Introduction, osmosis, pressure driven membrane processes: Introduction, microfiltration, membranes for microfiltration, industrial applications, ultrafiltration: membranes for ultrafiltration, industrial applications, reverse Osmosis and nanofiltration: membranes for reverse osmosis and nanofiltration, industrial applications.

UNIT-V: Electrically Driven processes: Introduction, electrodialysis, Process parameters, membranes for electrodialysis, applications, Membrane electrolysis, Bioploar membranes, Fuel Cells.

UNIT-VI : Concentration driven membrane processes: gas separation: gas separation in porous and non porous membranes, membranes for gas separation, applications, pervaporation, membranes for pervaporation, applications, dialysis: membranes for dialysis, applications, liquid membranes: aspects, liquid membrane development, choice of the organic solvent and carrier, applications, introduction to membrane reactors.

UNIT-VII : Polarization phenomenon and fouling: Introduction to concentration polarization, turbulence promoters, pressure drop, gel layer model, osmotic pressure model, boundary layer resistance model, concentration polarization in diffusive membrane separations and electro dialysis, membrane fouling, methods to reduce fouling, compaction.

UNIT-VIII : Module and process design: Introduction, plate and frame module, spiral wound module, tubular module, capillary module, hollow fiber module, comparison of module configurations.

TEXT BOOKS:

1. Marcel, M., "Basic Principles of Membrane Technology", 2nd Editon, Springer Publications., 2007
2. Philip,R., and Wanket, C., "Rate- Controlled Separations", Springer, 1994.

REFERENCE BOOKS:

1. Nunes, S.P. Peinemann, K.V., "Membrane Technology in the chemical industry", Wiley-VCH. 2006.
2. Rautanbach and Albrecht R., "Membrane Process", John Wiley & sons, 1989.
3. Crespo, J.G. Bodekes, K.W., "Membrane Processes in separation and Purification", Kluwer Academic Publications, 1986.
4. Geankoplis C.J., "Transport processes and Unit Operations", 3rd Edition, PHI, New Delhi, 2002.

CHEMICAL PROCESS SAFETY

Course Code: 11CH2107

L	P	C
4	-	4

AIM & OBJECTIVES: Chemical Engineering Processes are designed & operated to minimize risk. This course teaches the student the safety aspects of the Chemical Industry.

UNIT-I : Introduction : Importance of process safety with examples of major accidents; which might cover chemical, petroleum & petroleum chemical Industrial.

UNIT-II : Material Hazards : **Flammability**: Flammability Characteristics of Liquid and Vapour, Dependence on Temperature estimation of Flammability, Flammabili diagram, **Toxicity:** Toxicology- How toxicants enter biological organisms, elimation by biological organisms, effect of toxicants on biological organism, Brief Toxilogical study, Threshold limit values, Permissible exposure limits, Reaction Hazards, **Burning Characteristics**: Flash Point, Fire Point Auto ignitions, Temperature LFL, UFL, Flash point determination, Material Properties of Benzene, Methyl alcohol, Ethyl Alcohol, Ethylene Oxide, Caprolactam, Acetone, Acetic Acid, Phenol, Acrylonitrile, Polyprolene, Ploy Vinyl Chloride, Gasoline and Hazards.

UNIT-III : Process Hazards : Temperature & Pressure flow, level deviation on process Hazard , such as explosions, Toxic release, fires, rupture.

UNIT-IV : Ignition Sources : Flames, Hot surfaces, static electricity, and the like Explosions : Confined & Unconfined explosions, BLEVES, Dust Explosions.

UNIT-V : Hazard Analysis : Check – lists, fault trees, cause – consequence diagrams, HAZOP and other methods of study. Dow procedures for safety assessment.

UNIT-VI : Safety Devices : Relief valves and Rupture disks Explosive relief, flare systems.

UNIT-VII : Design to Prevent Fire & Explosions : Inerting, Control of Static Electricity ventilation, explosion proof equipment and instruments, Sprinkler systems, miscellaneous design features for preventing fires and explosions.

UNIT-VIII: Emergency Preparedness and Planning : Typical emergency Plan, On-Site and Off Site Plans, Emergency Control Programme, Individual responsibility during emergency.

TEXT BOOKS:

1. Dainel A.C. and Louvar, J.F., "Chemical process Safety" PHI Series, 2002.

2. Sanders, R.Q., "Chemical process safety", PHI, Elsevier science, 2004 .

REFERENCE BOOKS:

1. Srikanth and Dawande , D., " Chemical Hazards and Safety"., Published by Denette & Co, 2007.

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ADVANCED MATLAB APPLICATIONS IN CHEMICAL ENGINEERING

Course Code: 11CH2108	**L**	**P**	**C**
	-	**3**	**2**

The source code in the form of m file should be attached with the results.

1) Simulation of a boundary value problem: Tubular reactor with axial diffusion.

2) Simulation of a delay differential equation: CSTR with recycle.

3) Control system design for a non-isothermal CSTR.

4) Dynamics of a bioreactor exhibiting multiple steady states.

5) Non linear regression: fitting a catalytic rate model.

6) Dynamics of a binary distillation column.

7) Dynamics of a reactor separator coupled networks.

8) Non Linear regression using Genetic Algorithms.

9) Constrained optimization problem using general MATLAB: Optimization of the dimensions of a fin.

10) Constrained optimization using Genetic Algorithms.

11) Simulation of a catalytic fluidized bed.

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SIMULATION OF CHEMICAL ENGG. EQUIPMENT USING PRO-II LAB

Course Code: 11CH2109

L	P	C
-	3	2

LIST OF EXPERIMENTS:

1) Simulation of a Propane-Propylene splitter distillation column.
2) Simulating distillation column with side trays, multi feed column, interstage heaters and non ideal trays.
3) Absorbers design.
4) Absorbers with reboilers and condensers simulation.
5) Simulation of LLE columns.
6) Simulating interconnected distillation columns.
7) Carrying out case studies in PRO II.
8) Overwriting the databank by regressing VLE obtained from experimental data.
9) Simulating a Pressure Swing Distillation column.
10) Tray sizing.

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MULTI COMPONENT MASS TRANSFER

Course Code: 11CH2110

L	P	C
4	-	4

AIM & OBJECTIVES: This course deals as how to formulate the Mass transport equations for Multi component mixtures. This course also deals with different techniques to solve these highly coupled models.

UNIT-I: The Maxwell-Stefan Relations.
Diffusion in Ideal gas Mixture, Diffusion in Non-ideal Fluids

UNIT-II: Fick's law
Diffusion in Binary Mixture : Fick's first law, The generalized Fick's Law

UNIT-III : Estimation of Diffusion Coefficients
Diffusion coefficients in binary mixture, Estimation of multicomponent Diffusion coefficients.

UNIT-IV : Solution of Multicomponent diffusion problems: The Linearized theory Mathematical preliminaries, Interaction effect, Steady state diffusion , Diffusion in a two bulb diffusion cell, The Loschmidt tube, Multicomponent diffusion in a batch extraction cell, The linearized theory : an appraisal.

UNIT-V : Solution of Multicomponent diffusion problems: Effective diffusivity theory The Effective diffusivity , solution of multicomponent diffusion problems using an effective diffusivity model, Steady state diffusion, The two bulb diffusion cell, The Loschmidt Tube, Diffusion in a batch extraction cell, The Effective diffusivity-Closing remarks.

UNIT-VI: Mass Transfer Coefficients:
Definition of Mass Transfer Coefficients, The bootstrap problem and its solution, Interphase Mass Transfer.

UNIT VII: Film Theory –I
The Film model, Film model for binary mass transfer, Exact solutions of the Maxwell Stefen solutions for multicomponent mass transfer in ideal gases.

UNIT-VIII: Film Theory –II
Multicomponent Film model based on the assumption of constant [D] matrix- The linearized theory of Toor, Stewart and Prober. Simplified explicit methods Effective diffusivity methods, multicomponent film model for mass transfer in non-ideal fluid system, Estimation of mass transfer coefficients from empirical correlations.

TEXTBOOK:

1. Krishn. R., and Taylor R., "Multicomponent Mass Transfer" John Wiley 1993.

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FINITE DIFFERENCE METHODS IN HEAT AND FLUID FLOW

Course Code: 11CH2111

L	P	C
4	-	4

AIM & OBJECTIVES: This course helps the student in applying the concept of finite difference methods to heat and fluid flow. Finite difference methods are the easiest to code and helps the student in understanding the various concepts on numerical aspects. This course also teaches the student in grid generation concepts which will help him to solve problems in highly irregular geometries.

UNIT-I : Basic Relations: Classification of Second – order Partial differential Equations, Parabolic systems, Elliptic systems, Hyperbolic systems, Systems of equations, Boundary conditions, Uniqueness of the solution .

Discrete Approximation of Derivatives: Taylor Series formulation, Finite difference operators, Control- Volume Approach, Application of control –Volume Approach, Errors involved in numerical solution.

UNIT-II : One- Dimensional Steady – State Systems: Diffusive systems, Diffusive – Convection system, Diffusive – Convective system with flow.

UNIT-III : One- Dimensional Parabolic systems: Simple Explicit Method, Simple Implicit Method, Crank- Nicolson Method, Combined Method, Three- Time-Level Method, Cylindrical and Spherical Symmetry, A summary of Finite –Difference Schemes.

UNIT-IV: Multidimensional Parabolic Systems : Simple Explicit Method (i) Two Dimensional diffusion (ii) Two-dimensional steady laminar boundary layer flow (iii) One- Dimensional Transient convection- diffusion (iv) Two- Dimensional transient convection-

diffusion, Combined Method (i) Three-dimensional diffusion (ii) One-dimensional transient convection and diffusion, Alternating Direction Implicit(ADI)method,Alternating Direction Explicit(ADE) Method (i) One Dimensional diffusion (ii) Two dimensional diffusion, Modified Upwind Method :Transient Forced convection inside ducts for step change in fluid inlet temperature, Upwind method for free convection over a vertical plate.

UNIT-V : Elliptic systems: Steady –State diffusion, Velocity field for incompressible, Constant property, Two dimensional Flow, Temperature field in incompressible, constant property Two – dimensional Flow.

UNIT-VI : Hyperbolic System: Hyperbolic convection (Wave) equation, Hyperbolic Heat conduction equation, System of Vector equations.

UNIT-VII :. Phase Change Problems: Mathematical formulation of phase change problems, Variable Time step approach for single – phase solidification, Variable Time step approach for two – phase solidification, Enthalpy Methods.

UNIT-VIII : Numerical Grid Generation: Coordinate Transformation relation, Basic ideas in simple transformations, Basic ideas in numerical grid generation and mapping, Boundary value problem of numerical grid generation, Finite difference representation of Boundary value problem of numerical grid generation, Steady state Heat conduction in irregular geometry, Laminar free –convection in irregular enclosures.

TEXTBOOKS:

1. Necati, O.M., "Finite Difference Method in Heat Transfer", CRC Press, 1994.

REFERENCE BOOKS :

1.Anderson, D.A., Tannehill , J.C & Pletcher, R.H., "Computational Fluid Mechanics and Heat Transfer" , McGraw Hill, 1984.

ADVANCED PROCESS CONTROL

Course Code: 11CH2112	**L**	**P**	**C**
	4	**-**	**4**

AIM & OBJECTIVES: This course deals with synthesis and design of advanced controller.

UNIT-I : Review of single input single out put (SISO) systems, Routh stability criteria & Qualitative analysis of Bode and Nyquist stability.

UNIT-II : Internal Model control: Introduction to model based control, practical openloop controller design, generalization of the open-loop control design procedure, model uncertainty and disturbances.

UNIT-III: The IMC structure, IMC design procedure, effect of model uncertainty and disturbances, IMC in context of PID controller.

UNIT-IV: Control-loop Interaction: Introduction, Motivation, the general pairing problem, the relative gain array, properties and application of the RGA.

UNIT-V : Multivariable Right Half Plane (RHP) Zeros and their performance limitations, Design of ideal Decouplers.

UNIT-VI : Model Predictive Control: Model forms of model predictive control, constrained and unconstrained approach, analysis of dynamic matrix control.

UNIT-VII : State space and transfer function representation and their interrelationships.

UNIT-VIII : Sampling and Z-transforms, Open loop and closed loop response.

TEXT BOOKS:

1. Bequette, B.W.,"Process control: Modeling, Design and simulation," PHI, 2003.

2. Stephanopoulos, "Chemical Process Control -An Introduction to theory & Practices" PHI, 2010.

REFERENCE BOOKS:

1. Babatunde, O. and Ray W.H., "Process Dynamics, Modeling and Control"., Oxford University Press, 1994.

2. Seborg, D.E., Edgar, T.F and. Mellichamp, D.A, "Process Dynamics and control," Wiley, 2006.

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OPTIMIZATION TECHNIQUES IN CHEMICAL ENGINEERING

Course Code: 11CH2113	**L**	**P**	**C**
	4	**-**	**4**

AIM & OBJECTIVES: This course is concerned with formulating the optimization problems and solving them. Advanced topics are also treated.

UNIT-I : Introduction to process optimization: Formulation of various process optimization problems and their classification, constrained and unconstrained optimization. Classification of points in the 2D space. Basic concepts of optimization-convex and concave functions, necessary and sufficient conditions for stationary points.

UNIT-II : Linear programming: SIMPLEX algorithm, duality in Linear programming**.**

UNIT-III : Transportation Problem: Solution of Balanced problems using East-West Rule.

UNIT-IV : Unconstrained Optimization: Optimality Criteria, Undiretional search, Powell's Conjugate direction method, Gradient based method: Cauchy's steepest Descent method; Newton's method.

UNIT-V: Constrained Optimization Algorithms: Kuhn-Tucker conditions, Transformation methods: Penalty function method, method of multipliers.

UNIT-VI : Discrete Optimization: Enumeration techniques and Branch and Bound methods to solve discrete optimization problem**.**

UNIT-VII : Genetic Algorithm, Working principles, differences between GAs and traditional methods. Various operations like crossover and mutation**. Simulated annealing**. (Qualitative treatment of GA and SA only).

UNIT-VIII : Multiobjective optimization (MOO): Different methods to solve MOO like Utility function method and bounded function method. Solving 2D MOO problems graphically, identifying the Pareto set.

TEXT BOOKS:

1.Kalyanmoy D., "Optimization for Engineering Design," Prentice Hall of India, 2005.

2. Edgar, T.F., Himmelblau, D.M., and Lasdon L.S., "Optimization of Chemical Processes," 2nd Ed, McGraw Hill, International edition, Chemical Engineering Series, 2001.

3. Rao, S.S., "Engineering Optimization-Theory & Practice," New Age International Publishers, New Delhi, 1996.

REFERENCE BOOKS:

1. Beveridge G.S. and Schechter, R.S., "Optimization Theory and Practice", Mc Graw Hill, Newyork, 1970.

2. Reklaitis, G.V., Ravindran, A., and Ragsdell, K.M., "Engineering Optimization-Methods and Application", John Wiley, New York, 1983.

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ADVANCED CHEMICAL ENGINEERING PLANT DESIGN

Course Code: 11CH2114

L	P	C
4	-	4

AIM & OBJECTIVES: The Design of equipment constitutes the heart of any Chemical Plant. In this course the student is taught the various design methods for Chemical Engineering equipment.

UNIT-I : Shell and Tube Heat Exchanger Design: 1-2 parallel – counter flow: Shell and Tube Exchanger, Flow arrangements for increased heat recovery, Calculations for Process conditions. Condenser Design: Condensation of single vapor, Condensation of mixed vapor.

UNIT-II : Multiple Effect Chemical Evaporation: Calculations of Chemical Evaporators, Solution of industrial problems: concentration of cane sugar liquors – forward feed, Evaporation of paper pulp waste liquors – backward feed, caustic soda concentration – forced circulation evaporators. Thermo compression: Design of thermo compression sugar evaporator.

UNIT-III: Vaporizers and Reboilers: Vaporizing processes, Reboiler arrangements, Classification of vaporizing exchangers, Heat flux and temperature difference Limitations, Relation between maximum flux and maximum film coefficient, Forced Circulation vaporizing exchangers, Natural Circulation vaporizing exchangers.

UNIT-IV: Towers: Introduction, Contacting Devices, Choice between Packed Columns and Plate columns, Tower Packings, Choice of plate types, Plate calculations, Transfer unit calculations, Column diameter. Packed Towers: Introduction, Type and Size of Packings, Flooding, Pressure Drop, Foam, Holdup, Degree of Wetting, Column Diameter, Height of Packing, Design of a Packed Tower for Distillation, Optimum Design.

UNIT-V: Sieve and Valve Tray Design: Introduction, Sieve Trays: Tower Diameter, Plate Spacing, Entrainment, Weepage, Tray Layout, Hydraulic Parameters, Worksheet for Sieve Tray Design. Valve trays: Flooding and Entrainment, Tray Spacing, Foaming Tray type, Tray diameter and Lay out, Hydraulic Parameters.

UNIT-VI : Mechanical Design: Introduction, The Mechanical Design of Heat Exchangers: General Thicknesses of various components, The Mechanical Design of Columns: Vessel Design, Vessel Supports, Foundations, Manholes and Flanges, Vessel internals, Materials of Construction.

UNIT-VII : Practical Rules of Thumb: Pressure Vessels, Reactor Design Temperature, Drums, Fractionating Towers, Heat Exchangers, Pipelines and Pumps.

UNIT-VIII : Scale up of Process Equipment: Introduction, Basic Principles of Scale-up, Scale-up of Heat Exchange Systems, Scale-up of Chemical Reactors, Scale-up of Liquid Mixing Systems, Scale-up of Fluid Flow systems.

TEXT BOOKS:

1. Kern, D.Q., "Process Heat Transfer", Mc Graw Hill Co., 1997.

2. Backhurst and Harker , "Process Plant Design" Amercian Elservier Pub.Co., Heinmann Chemical Engineering Series, 1973.

3. Joshi, M.V., "Process Equipment Design"McMillan India,1996.

REFERENCE BOOK:

1. Coulson and Richardson, "Chemical Engineering", Volume 6, Pergamon Press, 1983.

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ADVANCED ENERGY ENGINEERING

Course Code: 11CH2115

L	P	C
4	-	4

AIM & OBJECTIVES: Energy crisis has renewed interest in searching for alternate fuels. This course teaches the students the various ways of tapping the energy available.

UNIT-I : Introduction to sources of Energy : Solar Energy, Wind Energy , Bio Mass , Chemical Energy, Magneto hydro dynamics, Geothermal, Ocean Energy, Nuclear Energy. Present usage levels.

UNIT-II : Solar Energy: Solar Radiation and its measurements, solar energy collectors: Flat plate collectors, concentrating collectors, advantages and disadvantages of concentrating collectors over flat plate collectors **Storage of Solar energy techniques**: Thermal storage, Packed Bed Exchanger storage, Latent heat storage, Electrical, Chemical Storage, Mechanical Energy storage, Electromagnetic Energy storage, solar pond.

UNIT-III : Energy from Biomass: Solid, liquid and gaseous biofuels conversion Techniques: Anaerobic digestion, Fermentation, Chemical reduction, Liquefaction, gasification, Hydrogenation and oil extraction. Bio gas generation: Factors affecting biodigestion, for Biomass.

UNIT-IV: Chemical Energy Sources : **Fuel Cell** : Operation of a fuel cell, Classification of fuel cells , Advantages and disadvantages of a fuel cell, conversion efficiency of a fuel cell, Polarization in fuel cells

Hydrogen Energy: Hydrogen production methods: Electrolysis, Thermo-Chemical methods, Fossil Fuel methods, Coal gasification method. Hydrogen Storage Techniques, Advantages of hydrogen as a fuel.

UNIT V : Electrochemical Energy Conversion & Storage: Fundamentals : EMF, reversible cells and irreversible cells, reversible electrodes, relationship between electrical energy and energy content of a cell, free energy changes and emf in cells, relationship between the energy changes accompanying a cell reaction and concentration of the reactants, effect of cell temperature on batteries, derivation of number of electrons involved in a cell reactions, thermodynamic calculation of the capacity of a battery, calculations of energy density of cells, heating effects in batteries, spontaneous reaction in electrochemical cells, pressure development in sealed batteries.

Factors affecting battery performance : Factors affecting battery capacity, voltage level current drain of discharge, types of discharge continuous, intermittent, constant current, constant load, constant power, service life, voltage regulation, changing methods, battery age & storage condition, effect of battery design.

Storage Batteries: Principle design construction, advantage and disadvantages. Primary batteries - Zn-MnO2 system, carbon-zinc and carbon-zinc chlorides performance characteristics and zinc-silver oxide. secondary batteries – lead acid, nickel cadmium, nickel metal hydride, silver oxide zinc system, lithium ion, lithium polymer.

UNIT-VI: Batteries : Nickel-Based batteries : Nickel/cadmium, nickel/iron, nickel/zinc, nickel/metal hydride, nickel/hydrogen – thermodynamics, kinetic effects, self-discharge, heat effects. Electrode preparation, electrolyte, separator, battery design, parameters influence gas evolution, Electrochemical behaviour, heat and temperature problems, recycling. **Lithium batteries :** Lithium ion, lithium polymer battery, principle,positive and negative materials, electrolyte, separator, reaction mechanism, performance characteristics, manufacturing process, safety, charging techniques. **Maintenance free lead acid batteries:** Concept of maintenance free batteries, thermodynamic parameters, current flow, kinetic parameters, heat effects, lead corrosion, water decomposition,

self discharge, secondary reactions, internal oxygen cycle, separator, container, value design, manufacturing process, bipolar lab, recycling.

Super capacitors: Similarities and differences between super capacitors and batteries for storing electrical energy, double layer at capacitor electrode interface, electrochemical capacitors based on pseudo capacitance, Technology development.

UNIT-VII : Wind Energy : Basic principles of Wind Energy Wind Power calculations, Site selection considerations, Basic components of a Wind Energy conversion system.
Ocean Energy : Ocean Thermal Electric conversion (OTEC), Methods of ocean thermal electric power generation: Claude cycle or open cycle OTEC and Closed or Anderson OTEC.
Energy from Tides: Basic Principles of Tidal Power, Components of Tidal Power Plants.

UNIT-VIII : Magneto Hydro Dynamics(MHD) Power generation , Principles of MHD Power generation. **Nuclear Energy**: Principles of light water Reactors, Pressurized Water Reactors, Boiling Water Reactors, Liquid Metal Fast Breeder Reactors.

TEXTS BOOKS :

1. Culp, A, " Principles of Energy Conversion" MCGraw Hill, 1979.
2. Rai, G.D., " Energy Sourses" , Khanna Publishers, 2008.
3. Barak, "Electrochemical Power sources", I.E.E. series Peter Peregrinus Ltd. Steverage,U.K 1980, reprint 1997.

REFERENCE BOOKS :

1. Linden D and Thomas B.R, "Hand Book on Batteries and Fuel Cell", 3rd Edition. McGraw Hill Book Co.,New York, 2002.
2. Gabano, J.P. "Lithium Batteries", Academic Press, London, 1983.
3. Berndt, D., "Maintenance Free Batteries", 3rd Edition, John Wiley & Sons Inc., New York Chichester – Toronto Brishbane – Singapore, 2003

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ADVANCED PETROLEUM REFINERY PROCESSES

Course Code: 11CH2116

L	P	C
4	-	4

AIM & OBJECTIVES: Refinery operations constitute the major applications of Chemical Engineering. This course prepares the student in Recent Advances in Refining operation.

UNIT-I : Past , Present Scenario in Petroleum refining and Petrochemicals in India and the world. Effect of petroleum products on environment and their control.

UNIT-II : Origin of petroleum, composition of petroleum and petroleum products. Characterization of petroleum and products and distillation of petroleum products and its relation to composition.

UNIT-III: Catalytic cracking, Fluid catalytic cracking, Hydro cracking, process chemistry, Technology and catalysts.

UNIT-IV: Catalytic reforming, Alkylation and isomerization processes, Chemistry technology and catalysts. Hydro treating science and technology.

UNIT-V : Thermal Cracking; vis breaking delayed coking, flexing coking effect, various parameters temperature, residence, time C/H ratio on yields of products from various feed stocks, Formation of coke during pyrolysis simple models for coke formation during thermal crackin.

UNIT-VI : Future Fuels: Alternative fuels biofuels, Fuel Cell science and Technology.

UNIT-VII : Hydrogen production and use in the refinery and hydro management. Steam reforming partial oxidation processes for producing hydrogen.

UNIT-VIII : Details of thermal cracking to produce light olefins from various feed stock for petro chemical production. Recent trends in production & Use of Polymers such as LDPE, HDPE.

TEXT BOOKS:

1. Baskara Rao, B.K., "Modern Petroleum Refining Processes", 4th Edition, Oxford & IBH Pub. Co. Pvt.Ltd. 2002.
2. Baskara Rao, B.K., "A Text on Petrochemicals", Khanna Publishers,2002..
3. Nelson, W.L. "Petroleum Refinery Engineering", McGraw Hill, New York 1961.
4. Hengstebeck R.J., "Petroleum Refining", McGraw Hill, New York ,1959.

REFERENCE BOOKS:

1. Steiner H, "Introduction to petroleum Chemical Industry", Pergamon, London, 1961.
2. Sern, . V.Y, "Gas phase oxidation", Pergamon, London, 1964.
3. Waddams, A.L., "Chemicals from Petroleum", 4th Revised Ed, John MurrayPub., 1978.
4. KNIEL, WINTER & STOCK "Ethylene Derivatives", Marcell O Dekker Publishers.
5. Sinha, NK., "Petroleum Refining and Petrochemical", Umesh Pub.2003.
6. Sharma,Fuels and Petroleum Processing ,. Goel Pub. House, 1998.

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ANALYSIS OF INDUSTRIAL POLLUTANTS LAB

Course Code: 11CH2117	**L**	**P**	**C**
		-	**3**	**2**

1) Estimating the pH of water using pH meter.

2) Estimating BOD of wastewater.

3) Estimating COD of wastewater.

4) Estimation of Dissolved Oxygen.

5) Determination of Total Hardness.

6) Determination of Chloride ions.

7) Determination of Copper.

8) Determination of Fe^{+2} and Fe^{+3} .

9) Preparation of Broth, Agar slant and Agar Plates.

10) Preparation of Pure Culture using Streak Plate Techniques.

11) Aseptic transfer of pure culture.

12) Preparation of pure culture using Spread plate techniques.

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COMPUTATIONAL FLUID DYNAMICS LAB (USING NISA CFD SOFTWARE)

11CH2118	**L**	**P**	**C**
	-	**3**	**2**

All simulation results should be validated with correlations available. The student is expected to attach the simulation predictions and the literature results when he presents the record.

1) Natural convection over a sphere.

2) Mixed convection over a sphere.

3) Forced convection over a sphere.

4) Forced convection over two cylinders in tandem arrangement.

5) Calculation of Nusselt number for staggered and in line arrangement of shell and tube heat exchanger.

6) Turbulent flow in a circular pipe: generating the friction coefficient versus Reynolds number.

7) Calculation of forces over a bent pipe.

8) Calculation of flow and heat transfer in a lid driven cavity.

9) Wall effect on a sphere in a cylindrical tube.

10) Flow of a power law non Newtonian fluid over an elliptic cylinder.