BHARATI VIDYAPEETH UNIVERSITY,
Pune.

(Established under Section 3 of UGC ACT 1956)

COURSE STRUCTURE AND SYLLABUS

B. Tech. (CHEMICAL) (Sem. V & VI)

COURSE STRUCTURE & SYLLABUS

BHARATI VIDYAPEETH UNIVERSITY, PUNE

B. Tech. (CHEMICAL) (Sem. V & VI)

HIGHLIGHTS

Bharati Vidyapeeth University College of Engineering (BVUCOE) is the largest Engineering College in Maharashtra with an intake of 700 students in each academic year. Imparting quality technical education from undergraduate to doctorate Level, BVUCOE is probably the only Engineering College in India with an accreditation from both NAAC as well as NBA. The faculty at BVUCOE boasts of highly qualified academicians, a quality that is further emphasized by the fact that 15 of them are presently pursuing their Ph.D. degree.

BVUCOE has been ranked 29th amongst the Top 50 Technical Schools of India in survey conducted by DATAQUEST-IDC. We have enjoyed a ranking in this list for the last 4 years. Research is of utmost importance in all our programs. A total of 113 research papers were published in 2007-2008.

Currently we have 12 ongoing research projects. The infrastructure of BVUCOE is state-of-the-art with 62 classrooms, 59 laboratories and a well-stocked library that currently holds 27,130 titles. The college has an international presence with MOUs signed with the North Carolina A&T State University (Greensboro, USA), University of Venice (Italy), Actel Corporation (USA). Corporate interaction is also inculcated in our programs through our association with Oracle India Ltd., Infosys Ltd. and Tata Consultancy Services.

DEPARTMENT OF CHEMICAL ENGINEERING

Department of Chemical Engineering is one of the oldest department in Pune region and known for its very valuable contribution in providing high caliber, outstanding professionals to the industry and R & D establishments.

Being our own university, the department has got freedom to design and adopt the change in the structure and content of the syllabus in consultation with the industrial experts and researchers to suit their requirement. The department of chemical engineering desires its students to excel in the changing trends in the global economy. The salient features of the present course designed are:

- Computer Education with advanced simulation softwares
- Industrial training after VIIth semester for the period of six weeks
- Wide range of advanced elective subjects
- Expert interaction on each subject by the experts from the various fields

The department also conducts a post graduate course in Chemical Engineering. The P. G. students perform their dissertation work in collaboration with National Chemical Laboratories (NCL), Pune.

The Department of Chemical Engineering has following well equipped laboratories:

- Mechanical Operations
- Heat Transfer
- Mass Transfer
- Chemical Reaction Engineering
- Process Dynamics Instrumentation and Control
- Instrumental Analysis
- Software Laboratory – CHEMCAD, MATLAB, FEMLAB, gPROMS, T. K. Solver

The faculty has constantly endeavored to improve the academic standards and pursue the R & D work, publishing the academic research papers in the National and International journals. Some of the faculty members have presented their research papers at various conferences / seminars and workshops. As a result of continuous efforts by the faculty, the department has received the following funds / grants from the AICTE, New Delhi.

- Young Career Award Research Project (10 Lakh)
- Research Promotion Scheme (RPS) Grant (5.75 Lakh)
- MODROB's for various chemical engineering laboratories (12 Lakh)

The department has the state of Art facilities of:

- Gas Chromatography (G. C.)
- High Pressure Liquid Chromatography (HPLC)
- U.V.- Visible Spectrophotometer
- Fluoride ion selective electrode meter

Department plans to provide low priced testing facility for Industry and research laboratories. Students' community actively involved in R & D experimentation can avail the same for affordable rates.

B. Tech. - Chemical Engineering

Semester V

Total Duration : 36 Hrs / Week
Total Marks : 750

Subject Code	Subject	Teaching Scheme (Hrs.) Hrs / Week				Examination Scheme (Marks)				Total (Marks)
		L	T	P	D	Theory	Unit Test	TW & Pr	TW & Or	
K70301	Business organization and Management	04	-	-	-	80	20	-	-	100
K10302	Chemical Engineering Mathematics	04	-	-	-	80	20	-	-	100
K10303	Heat Transfer -II	04	-	04	-	80	20	50	-	150
K10304	Mass Transfer- I	04	-	04	-	80	20	50	-	150
K10305	Chemical Engineering Thermodynamics II	04	02	-	-	80	20	-	25	125
K10306	Chemical Technology	04	-	02	-	80	20	-	25	125
	Total	24	02	10	-	480	120	100	50	750

Teaching Scheme				Examination Scheme				Total
Lectures	Practical	Tutorial	Drawing	Theory	Test	T. W. & Pr	T. W. & Or.	
24	10	02	-	480	120	100	50	750

SemesterVI

Total Duration : 32 Hrs / Week
Total Marks : 750

Subject Code	Subject	Teaching Scheme (Hrs) Hrs / Week				Examination Scheme (Marks)				Total (Marks)
		L	T	P	D	Theory	Unit Test	TW & Pr	TW & Or	
K10307	Mass Transfer - II	04	-	04	-	80	20	50	-	150
K10308	Chemical Reaction Engineering - I	04	-	02	-	80	20	50	-	150
K10309	Process Instrumentation & Instrumental Methods of Analysis	04	-	02	-	80	20	50	-	150
K10310	Computer Programming for Chemical Engineering - II	04	-	02	-	80	20	-	50	150
K10311	Industrial Pollution Control	04	-	02	-	80	20	-	50	150
	Total	20	-	12	-	400	100	150	100	750

Teaching Scheme				Examination Scheme				Total
Lectures	Practical	Tutorial	Drawing	Theory	Test	T. W. & Pr	T. W. & Or.	
20	12	-	-	400	100	150	100	750

RULES FOR CONDUCTING TESTS

Mode of the test

- In each semester for each subject three tests shall be conducted. The schedule for the same will be declared at the commencement of academic year in the academic calendar.
- Each test shall carry 20 marks.
- University examination pattern has given weightage of 20 marks for the tests.
- To calculate these marks following procedure is followed:

  i) Out of the three tests conducted during the semester, the marks of only two tests in which the candidate has shown his / her best performance shall be considered, to decide the provisional marks in each subject.

  ii) Average marks obtained in two tests in which students have performed well, shall be considered as provisional marks obtained by the student in the tests.

  iii) If the candidate appears only for two tests conducted during the semester, he / she will not be given benefit of the best performance in the tests.

  iv) If the candidate appears only for one test conducted during the semester, to calculate the marks obtained in the tests it will be considered that the candidate has got 0 (zero) marks in other tests.

  v) The provisional marks obtained by the candidate in class tests should reflect as proportional to theory marks. In cases of disparity of more than 15% it will be scaled down accordingly; These marks will be final marks obtained by the student. No scaling up is permitted.

  vi) If the candidate is absent for theory examination or fails in theory examination his final marks for tests of that subject will not be declared. After the candidate clears the theory, the provisional marks will be finalized as above.

- Paper Pattern for Tests

  i) All questions will be compulsory with weightage as following

Question 1	-	7 marks
Question 2	-	7 marks
Question 3	-	6 Marks

  ii) There will not be any sub-questions.

- For granting the term it is mandatory to appear for all the three tests conducted in each semester.
- Roll numbers allotted to the students shall be the examination numbers for the tests.

SEMESTER - V

K70301: BUSINESS ORGANIZATION AND MANAGEMENT

TEACHING SCHEME
Lectures : 04 Hrs / week

EXAMINATION SCHEME
Theory : 80 Marks
Duration : 03 Hours
Unit Test : 20 Marks

Unit-I (08 Hours)

Management science :

Management, its growth, concepts of administration and management of organization. Definition of management, functions, authority and responsibility.

Unity of command and direction. Decision making in management and management by objectives.

Business organization :

Different forms of organization, their formulation and working. Different organizational structures – line organization, functional organization, and line and staff organization.

Unit-II (08 Hours)

Personnel management:

Manpower planning, sources of recruitment , selection and training of staff. Job evaluation, merit rating, performance appraisal, wage administration and system of wage payment, incentive, motivation. Industrial fatigue. Trade unions , industrial relations.

Unit-III (08 Hours)

Purchase and stores management :

Concepts of quotation, tenders and comparative statement. Inspection and quality control. Inventory, carrying cost and fixed cost of inventory, example of cost of inventory. Stores management, functions of storekeeper Methods of inventory : LIFO, FIFO.

Unit-IV (08 Hours)

Marketing management :

Concepts of selling , marketing . Definition of marketing . Market research and of pricing , penetration , pricing , skimming pricing. Distribution of

product. Advertising and promotion.

Unit-V (08 Hours)

Export and import management :

Concept of international trade, duties , antidumping duty, cost involved in exporting a product, pricing of export product. Government aids for export promotion. Export houses . Export Promotion Council . MODVAT. Patent and patent rights.

Unit-VI (08 Hours)

Management laws :

Concept of control act, offer and acceptance. Types of contract, void contract. Concept of guarantee and warranty. Introduction to MRTP and FERA.

Work study :

Work Measurement, motion and time study, flow process chart, flow diagram, simo chart, string chart , therbligs.

Quality Management :

TQM, quality circles, and ISO systems.

Expert Interaction: (02 Hours)

Lecture(s) by eminent scholar(s) on the topic(s) mentioned in the syllabus.

List of Practical

Minimum number of assignments : 4

- Manpower planning & staffing including management structure for chemical industry. Determination of wages and salaries of staff. Performance appraisal systems.
- Estimation of Capital expenditure requirement for chemical project with the use of cost indices, its sources , choice between debt and equity, working capital requirement & its sources, cash flows and analysis.
- Analysis of financial results of chemical company's balance sheet with respect to profitability & ratio analysis (ROI, EPS, RONW).
- Market research report of chemical compound with respect to total market, existing demand / supply, demand forecasting, product selling strategy.
- International trade analysis of any chemical product with respect to global players,

global capacities, international vis-à-vis domestic prices, import duties, dumping.

- Case study on quality management.

Text Books / References

- George C. S. “Management for Business and Industry,” Prentice Hall Publications
- Koonts and O. Donnell. “Management ”, Mc Graw Hill Publishers
- Shukla M. C. “Business Organization and Management” , S Chand & Co.Ltd
- Khanna. O. P. “Industrial Engineering and Management”, Dhanpat Rai and Sons
- Sherlekar S. A. ”Business Organization and management ”, Himalaya Publishing House

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K10302: CHEMICAL ENGINEERING MATHEMATICS

TEACHING SCHEME
Lectures : 04 Hrs / week

EXAMINATION SCHEME
Theory : 80 Marks
Duration : 03 Hours
Unit Test : 20 Marks

Unit-I (08 Hours)

Special matrices:

Direct method: matrix inversion method, gauss elimination method, gauss Jordon method, LU decomposition, gauss seidel method, cholesky method

Eigen value methods: the power method, the QR method, householder's method, Jacobin method

Unit-II (08 Hours)

Optimization:

Linear programming: simplex method, graphical method

Linear programming case studies on application to chemical Process e.g. reactors, heat exchangers, evaporators etc.

Unit-III (08 Hours)

Roots of equation:

Secant method, graeffe's method, Muller's method, bairstow's method, Euler's method, modified Euler method, picard method, fourth order range-kutta method, milnes method.

Unit-IV (08 Hours)

Numerical differentiation and integration:

Sterling's formula, LaGrange's formula, gauss Legendre integration method, lobatto integration method, Romberg method, chebyshev method, Laurent's series, caucheys integral formula.

Unit-V (08 Hours)

Statistics:

Introduction to Statistics, application of Statistics, histogram method, measuring centre values by median, mode methods, measuring variation values by standard deviation and Lorenz curve, statistical fallacies. To find

project duration by CPM, PERT method.

Unit-VI (08 Hours)

Modern methods of computation:

Cauchy-Riemann equation, monto Carlo simulation, cubic interpolation, Crank-Nicholson method.

Introduction to MAPLE / MATHEMATICA, ISML.

Expert Interaction: (02 Hours)

Lecture(s) by eminent scholar(s) on the topic(s) mentioned in the syllabus

Text Books/ References

- Chapra S.C., R.P. Canale, "Numerical Methods for Engineers", Tata-McGraw Hill Publications
- Teukolsky S.A., W.H. Press, "Numerical Recipes in 'C' ", Cambridge University press
- Constantinides A., "Applied Numerical Methods with Personal Computer", McGraw Hill publishers
- Dr.S.P.Gupta., "statistical method", sultan-chand and sons
- Abraham I beltzer., "engineering analysis", academic press.
- T.F.Edgar,D.M.Himmblblau., "optimization of chemical processes", Tata-McGraw Hill Publications
- Kendall E. atkinson., " an introduction to numerical analysis", John wiley and sons
- Graham de vahl davis., " numerical methods in engineering and Science", allen and uniwin publicashor
- M.K.Jain, S.R.K. Iyengar,R.K.Jain., "numerical methods for Scientific and engineering computational", new age international Publishers.
- E. Kreyszig., "advanced engineering mathematics", john wiley Publication.

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K10303: HEAT TRANSFER –II

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04 Hrs / week	Theory	: 80 Marks
Practical	: 04 Hrs / week	Duration	: 03 Hours
		Unit Test	: 20 Marks
		T. W. & Pr.	: 50 Marks

Unit-I (08 Hours)

Heat exchangers :

Classification based on construction and type of flow arrangement. Individual and Overall heat transfer coefficient. Fouling factor. LMTD method .Effectiveness- NTU method. Wilson plot .

Design of heat exchangers :

Constructional features of shell and tube heat exchangers . Calculations of double pipe heat exchangers, shell and tube heat exchanger. 2-4 pass tubular exchangers .

Unit –II (08 Hours)

Condensation:

Introduction. Filmwise and dropwise condensation. Film type condensation on a vertical plate. Film condensation on horizontal tubes. Effect of superheated vapors and of noncondensable gases .

Design of condensers :

Condensers .Types. Condenser calculations. Condensation of steam.

Unit-III (08 Hours)

Boiling:

Types of boiling. Pool boiling. Flow boiling. Correlations in pool boiling heat transfer. Pool boiling curve. Forced convection boiling .

Unit-IV (08 Hours)

Evaporators :

Classification of evaporators. Single effect evaporation. Natural circulation evaporator. Forced circulation evaporator. Basket type.

Horizontal tube type. Falling film evaporator. Multiple effect evaporation. Calculation of chemical evaporators. Vapor recompressing technique.

Unit-V (08 Hours)

Drying :

Basic principles of drying. Equilibrium in drying. Types of moisture binding. Rate of drying curve. Mechanism of batch drying and continuous drying. Time requirement for drying. Mechanism of moisture movement in solids.

Design of dryer:

Design principles of dryer.

Unit-VI (08 Hours)

Humidification and dehumidification :

Principles. Vapour-liquid equilibrium. Enthalpy for pure substances. Definitions of humidity terms. Adiabatic saturation temperature. Wet bulb and dry bulb temperatures. Study of humidity charts. Lewis relation. Method of humidification and dehumidification. Cooling towers, spray ponds.

Expert Interaction: (02 Hours)

Lecture(s) by eminent scholar(s) on the topic(s) mentioned in the syllabus.

List of Practical

Term work will consist of the experiments listed below, of which at least eight should be performed in laboratory by the students, along with at least 6 drawing sheets.

- To study temperature distribution and overall heat transfer coefficient, in parallel flow finned tube heat exchanger.
- To study effectiveness and heat transfer rates in counter flow finned tube heat exchanger.
- To study temperature distribution, effectiveness, overall heat transfer coefficient, heat transfer rates in double pipe heat exchanger.
- To study Wilson plot in double pipe heat exchanger.
- To study single effect evaporator.
- To determine overall heat transfer coefficient, effectiveness for shell and tube heat exchanger.
- To determine number of tubes, pressure drop for shell and tube heat exchanger.
- To study rotary dryer operation and efficiency.

- To study humidification and dehumidification process.
- To study filmwise and dropwise condensation for vertical and horizontal plates.

Drawing Sheets

- Symbols in heat exchange equipments
- U-tube heat exchanger.
- Basket type evaporator.
- Reboiler.
- Pneumatic Dryer.
- Flow arrangements in cooling tower.

Text Books/ References

- McCabe, W. L., J. Smith, and Harriot: "Unit operations of chemical engineering," Tata McGraw Hill.
- Kern, D.Q.: "Process heat transfer," Tata McGraw Hill.
- Sukhatme , S. P.: "A text book on heat transfer," Universities Press.
- P. K. Nag,: "Process Heat Transfer," Tata McGraw Hill.
- S. D. Dawande,: "Principles of Heat and Mass Transfer," Central Techno Publications.
- Richardson, J. F., Coulson, J. M.: "Chemical Engineering" Butterworth Heinemann. Volume 1.

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K10304: MASS TRANSFER - I

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04 Hrs / week	Theory	: 80 Marks
Practical	: 04 Hrs / week	Duration	: 03 Hours
		Unit Test	: 20 Marks
		T. W. & Pr.	: 50 Marks

Unit -I (08 Hours)

Principles, diffusion mass transfer :

a) General principles of mass transfer. Classification of mass transfer operations. Choice of separation processes. Methods of conducting the mass transfer operations. Design principles.

b) Molecular diffusion in gases and liquids, diffusivities of gases and liquids, types of diffusion. Fick's and Maxwell's law of diffusion. Diffusion in solids. Unsteady state mass transfer.

Unit –II (08 Hours)

Mass transfer Coefficient and Interphase Mass Transfer :

a) Mass transfer coefficients in laminar flow and in turbulent flow. Theories of mass transfer. Mass, heat and momentum transfer. Analogies.

b) Interphase mass transfer. Equilibrium in mass transfer. Two resistance concept. Diffusion between phases. Co-current and counter current processes in steady state. Continuous crosscurrent, counter-current, crosscurrent cascade operations and mass balances.

Unit-III (08 Hours)

Absorption:

Gas absorption: Mechanism of gas absorption. Equilibrium relationships. Application of mass transfer theories in gas absorption. Absorption in wetted wall column. Values of transfer coefficient. Absorption in packed tower and spray tower. Calculation of HETP, HTU & NTU. Calculation of height of packed spray tower.

Absorption in tray towers: Absorption and stripping factors. Tray efficiencies. Calculation of number of trays required for absorption.

Equipments for gas absorption. Systems for gas absorption. Absorption with chemical reactions.

Unit-IV (08 Hours)

Equipment for gas liquid operations :

Gas dispersal : Bubble columns, mechanically agitated vessels, tray towers.

Liquid dispersal : Venturi scrubbers, Wetted wall towers, and spray towers, packed columns.

Unit-V (08 Hours)

Crystallization :

Introduction to the process. Principal rate of crystallization. Mier's supersaturation theory. Population balance and size distribution. Calculations of yield. Mass and enthalpy balances. Equipment used in crystallization.

Unit-VI (08 Hours)

Leaching (Solid Liquid Extraction) :

Introduction to the process. Preparation of solids. Temperature effects. Continuous countercurrent leaching. Ideal stage equilibrium. Operating time. Constant and variable underflow. Number of ideal stages. Stage efficiency. Calculations of single stage and multistage leaching processes.

Expert Interaction: (02 Hours)

Lecture(s) by eminent scholar(s) on the topic(s) mentioned in the syllabus

List of Practical

- To calculate diffusion coefficient in Liquid-Liquid diffusion.
- To calculate diffusion coefficient in still air.
- To determine gas absorption coefficient in tray tower.
- To determine gas absorption coefficient in packed tower.
- To study characteristics of Wetted Wall Column.
- To calculate individual and overall interface mass transfer coefficient.
- To study the crystallization process by air, water cooling and seeding.
- To study agitated batch crystallizer.
- To study batch leaching Operation.

- To study continuous counter current leaching Operation.

Text Books/ References

- Treybal R. E. "Mass Transfer Operation," McGraw Hill Publications
- Coulson J. M. , Richardson. "Chemical engineering," Vol. I and II. Pergamon Press
- King C. J. "Separation Techniques," McGraw Hill Publicatios
- Smith B. D "Design of Equilibrium stage process," McGraw Hill Publiations

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K10305: Chemical Engineering Thermodynamics – II

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04Hrs / week	Theory	: 80 Marks
Tutorial	: 02Hrs / week	Duration	: 03 Hours
		Unit Test	: 20 Marks
		T. W. & Or.	: 25 Marks

Unit -I (08 Hours)

Phase equillibria:

Criteria of phase equilibrium,Criterion of stability, phase equilibria in single and multi component system, phase rule for non-reacting system, Duhem's theorem, equilibrium & stability, VLE, LLE, VLLE, SLE, SVE equilibrium adsorption of gases on solids, phase diagrams for binary solutions (const. P & T equilibria), osmotic equilibrium.

Unit –II (08 Hours)

Vapor-liquid equilibrium (VLE):

VLE in ideal solutions,qualitative behavior, non-ideal solutions, VLE at low pressures, VLE involving high pressures & multicomponent system, liquid phase properties from VLE data, models for the excess Gibb's energy, bubble point & dew point equilibia, consistency test for VLE data, calculation of activity coefficient solute / solvent systems, thermodynamic properties and VLE from equation of state.

Unit-III (08 Hours)

Chemical reaction equilibria:

Reaction stoichiometry, criteria of chemical reaction equilibrium, equilibrium constant, equilibrium constant and standard free energy change, effect of T & P on equilibrium, effect of presence of inert materials, excess of reactants, products on equilibrium, Evaluation of equilibrium constant ,liquid phase reaction.

Unit-IV (08 Hours)

Heterogeneous reaction equilibrium:

Reaction in solutions, equilibria involving pure solids and liquids, pressure of decomposition, simultaneous reactions, phase rule for reacting systems,

Multi reaction equilibria, combined physical & chemical equilibrium.

Unit-V (08 Hours)

Special topics

Thermodynamics of chemical explosions, thermodynamics of electrochemical processes, coupled chemical reactions.

Unit-VI (08 Hours)

Solution Thermodynamics

Liquid phase properties from VLE Data.Models for excess Gibbs Energy.Property changes of mixing.Heat effects of mixing processes.

Expert Interaction: (02 Hours)

Lectures by eminent scholor(s)on the topic(s) mentioned in the syllabus.

Text Books / References

- Smith, J. M.,VanNess H. C., "Introduction to Chemical Engineering Thermodynamics" , McGraw Hill Publication.
- Narayanan, K. V., "Textbook on Chemical Engineering Thermodynamics,"McGraw Hill Publication.
- Stanley I Sandler, "Chemical and Engineering Thermodynamics,"3rd edition .John Wiley and Sons.
- Doubert, T. E., "Chemical Engineering Thermodynamics," McGraw Hill Publication.
- Rao, Y. V. C., "Chemical Engineering Thermodynamics,"
- Glasstone, S., "Thermodynamics for Chemists,"
- Kenneth Denbigh, "Principles of Chemical Equilibrium"
- Kyle, B. G., "Chemical & Process Thermodynamics," Pearson Prentice Hall.

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K10306: CHEMICAL TECHNOLOGY

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04Hrs / week	Theory	: 80 Marks
Practical	: 02Hrs / week	Duration	: 03 Hours
		Unit Test	: 20 Marks
		T. W. & Or.	: 25 Marks

Unit -I (08 Hours)

Historical methods / unit operation and unit process flow diagrams- application, limitations. Economics. Engineering Problems and pollution aspects involved in the process.

Basic concepts of unit operations:

Unit processes. Development of flow diagram. Schematic representation and applications for unit operation and unit processes.

Unit –II (08 Hours)

Chlor-alkali industries:

Manufacture of soda ash, caustic soda and chlorine. Indian Scenario of C.A. industries, Importance of C. A. industry. Chlorination reaction

Unit-III (08 Hours)

Nitrogen Industry:

Role of nitrogen industry in fertilizers, Indian Scenario of Nitrogen Industries, Manufacture of synthetic ammonia, nitric acid. Urea. Manufacture – kinetics involved in the process . Different routes adopted for the production of and most widely used processes : detailed study, limitations, advantages and disadvantages of the process. Nitration reaction .

Unit-IV (08 Hours)

Phosphorous Industry :

Importance. Manufacturing of super phosphate , triple super phosphate, phosphoric acid . NPK fertilizers.

Unit-V (08 Hours)

Coal Chemicals:

Destructive distillation of coal. Types of carbonization and different

products recovered in the process.

Coke oven :

Construction and working . Coke oven chemicals and applications.

Unit-VI (08 Hours)

Petrochemical Industry :

History of production of crude petroleum. Characteristics of refineries . Refinery operation. Pyrolysis. Cracking. Reforming. Polymerization. Alkylation . Hydro-alkylation. Isomerization. Hydrogenation. Oxidation reaction

Pollution aspects – industry wise.

Expert Interaction: (02 Hours)

Lecture(s) by eminent scholar(s) on the topic(s) mentioned in the syllabus

List of Practical

The practical shall include at least (6) assignments from the various units mentioned in the syllabus.

One industrial visit should be arranged to the process industry and students should prepare the report on the same as a part of the term work.

Text Books / References

- Chemical Technology Vol. I, II, III, IV, Chemical Engg. IIT Madras.
- Dryden, "Outlines of Chemical Technology," East-West Press
- Groggins P. "Unit Processes in Organic Synthesis," McGraw Hill Publications.
- Shreeve R. N. "Chemical Process Industries," McGraw Hill Publications.

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

SEMESTER - VI

K10307: MASS TRANSFER - II

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04Hrs / week	Theory	: 80 Marks
Practical	: 04Hrs / week	Duration	: 03 Hours
		Unit Test	: 20 Marks
		T. W. & Pr.	: 50 Marks

Unit -I (08 Hours)

Introduction:

Review of various separation techniques. Selection of the technique of separation, pros and cons of various methods.

Basics of Distillation:

Introduction. Equilibrium of vapor and liquid, relative volatility. Raoult's law. Ideal and Non-ideal behavior study. Azeotropes, positive and negative deviation from ideality. Methods of distillation - simple, flash distillation. Rayleigh's equation. Graphical and analytical method for determination of the compositions.

Introduction to reactive distillation. Azeotropic distillation. Molecular or low pressure distillation. Extractive distillation.

Unit –II (08 Hours)

Rectification:

Continuous rectification for binary systems. Tray towers. McCabe Thiele's method of calculation of number of trays. Method of Ponchon Savarit. Enthalpy concentration diagrams. Tray efficiencies. Concept of reflux, cold reflux, partial and total cold reflux. Effect of feed temperature and q-line equation derivation. Total reflux. Optimum reflux. Fenske Underwood equation. Condenser and reboilers used in distillation. Use of open steam for distillation. Rectification of Azeotropic mixtures.

Unit-III (08 Hours)

Distillation in packed towers :

HETP concept. HTU and NTU calculations.

Distillation column internals :

Types of packing used, regular and random packing. Design of distillation

columns, optimization of height and diameter of the column, material selection, tray design, economic velocities, flooding, loading, coning, dumping, weeping, priming characteristics of the column, design of bubble caps.

Unit-IV (08 Hours)

Liquid-Liquid Extraction :

Introduction. Choice of solvent. Ternary equilibrium. Single stage extraction. Multistage, crosscurrent, countercurrent, extraction, calculations using these methods on triangular and rectangular co-ordinates. Solvent free basis calculations. Nxy diagrams. Material balances.

Continuous countercurrent extraction with reflux. Total reflux, Multistage efficiency.

Unit-V (08 Hours)

Continuous countercurrent extraction in packed columns:

HTU, NTU concepts. Types of extractors used. Stage type and differential extractors.

Adsorption:

Adsorption basic principles. Equilibria in adsorption. Single gases and vapors adsorption of liquids. Physical and chemisorption. Methods of adsorption. Langmuir isotherms. Freundlich isotherms. Introduction to pressure swing and temperature swing adsorption.

Equipment :

Continuous contact. Steady state moving bed adsorbers.

Unit-VI (08 Hours)

Ion exchange process. Basic principles and chemical reactions. Techniques and applications. Equilibria and rate of ion exchange. Equipment studies.

Novel techniques :

Membrane separation techniques. Ultrafiltration. Nano-filtration. Reverse osmosis process. Rate based processes such as diffusion coefficient based inert gas generating from air by carbon molecular sieves.

Expert interaction: (02 Hours)

Lecture(s) by eminent scholar(s) on the topic(s) mentioned in the syllabus.

List of Practical

Any eight Practicals to be conducted out of following :

- Simple Distillation
- Total Reflux
- Steam distillation
- Equilibrium diagrams for Liquid -liquid extraction
- Cross current multistage extraction
- Characteristics of spray extraction column
- York Schiebel column
- Ion Exchange
- Bubble cap distillation column
- Sieve tray distillation column
- Vapour liquid equilibria

Text Books/ References

- Treybal R. E., "Mass Transfer Operation," McGraw Hill publication.
- Coulson J. M. Richardson, "Chemical engineering," Vol. I and II., Pergamon Press
- King C.J.,"Separation Techniques," McGraw Hill publication.
- Smith B. D., "Design of Equilibrium stage process," McGraw Hill publication.

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K10308: CHEMICAL REACTION ENGINEERING - I

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04Hrs / week	Theory	: 80 Marks
Practical	: 02Hrs / week	Duration	: 03 Hours
		Unit Test	: 20 Marks
		T. W. & Pr.	: 50 Marks

Unit-I (08 Hours)

Introduction:

Classification of the reactions. Variables affecting the rate of reaction.

Kinetics of homogeneous reactions :

The rate equation. Single and Multiple reactions. Elementary and Non-elementary reactions. Molecularity and Order of Reactions. Rate constant. Representation of elementary and non-elementary reaction. Kinetic models for non-elementary reactions, testing kinetic models. Temperature dependency from Arrhenius law, thermodynamics, collision Theory.

Unit–II (08 Hours)

Interpretation of Batch reactor data:

Constant-volume batch reactor:

a) Integral method of analysis of data

b) Differential method of analysis of data.

Variable-Volume Batch Reactor:

a) Integral method of analysis of data

b) Differential method of analysis of data.

Temperature and reaction rate. The search for the rate equation.

Unit-III (08 Hours)

Reactor Design:

Introduction. Ideal batch reactor. Space-time and Space-velocity. Steady-state mixed flow reactor. Steady-state plug flow reactor.

Unit-IV (08 Hours)

Design for Single Reactions:

Size comparison of single reactors. Multiple reactor systems. Recycle reactor and auto-catalytic reactions.

Unit-V (08 Hours)

Design for Multiple Reactions:

Reactions in Parallel : Qualitative discussion about product distribution. Quantitative treatment of product distribution and of reactor size.

Reactions in Series : Irreversible first order reactions in series. Qualitative discussion about product distribution. Quantitative treatment, plug flow, batch, mixed flow reactor.

Unit-VI (08 Hours)

Temperature and pressure effects:

Single Reactions: Heats of reaction from thermodynamics. Heats of reaction and temperature. Equilibrium constants from thermodynamics. Equilibrium conversion. Optimum temperature progression. Heat effects. Adiabatic operations, non-adiabatic operations.

Multiple Reactions: Product distribution and temperature.

Expert Interaction: (02 Hours)

Lecture (s) by eminent Scholar(s) on the topic(s) mentioned in the syllabus

List of Practical

Term work will consist of the experiments listed below, of which four should be performed in laboratory by the students.

Minimum number of experiments - 4

- To study integral analysis of batch reactor data.
- To study differential analysis of batch reactor data.
- To study Arrhenius parameters.
- To study Plug flow reactor.
- To study half life period.
- Finding rate constant for first or second order system.

Text Books/ References

- Levenspiel Octave, "Chemical Reaction Engineering," Wiley Eastern Publications.
- Smith J. M. , " Chemical Reaction Kinetics", Mc Graw Hill Publications.

- Fogler H.S. , " Elements of Chemical reaction engineering", Prentice Hall Publications.

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K10309: PROCESS INSTRUMENTATION AND INSTRUMENTAL METHODS OF ANALYSIS

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04 Hrs / week	Theory	: 80 Marks
Practical	: 02 Hrs / week	Duration	: 03 Hours
		Unit Test	: 20 Marks
		T. W. & Pr.	: 50 Marks

Unit -I (08 Hours)

Introduction:

Measurement fundamentals: Need & scope of process instrumentation, characteristics of instrumentation, operational modes of instrumentation, accuracy, measurement standards.

Control system fundamentals: Principals, techniques and types (distributed, programmable, stand alone, hydraulic) of control, importance of controls.

Unit –II (08 Hours)

Variable measurement:

Pressure measurement: Direct reading gages, silicon micro machined pressure sensors, thermal conductivity gages and molecular drag gages.

Flow measurement: Positive displacement meters (piston, oval gear, CVH, diapharm) Ultrasonic flow meter, thermal mass flow meter.

Temperature measurement: Biomaterials, thermometers, resistive thermometers, thermistor thermometers, thermocouple, infrared thermometers, pyroelectric thermometers, fibre optics measurement.

Neutron flux measurement: Ion chamber neutron detectors, in-core neutron detectors, gas filled detectors, Geiger-Muller detector.

Unit-III (08 Hours)

Spatial Variable measurement:

Displacement measurement: Piezoelectric transducers & sensors, laser interferometer, time of flight displacement sensor, synchro displacement sensors, nano-scale scanning probe microscopy.

Level measurement: Displacers, ultrasonic, microwaves, laser light.

Volume measurement: Air-water plethysmography, indicator dilution methods

Neutron flux measurement: Hydrometers, column type densitometer, refractometer & index of refraction densitometer.

Unit-IV (08 Hours)

Instrumental methods for chemical analysis:

Absorption methods: Filter photometer, Rapid Scan Spectrophotometer and Abridged spectrophotometer.

Spectroscopy methods: Emission Spectroscopy, Ion Spectroscopy, NMR.

Electrochemical methods: Potentiometry, Polarography, Coulometry, Conductimetry.

Chromatographic methods: Gas chromatography, HPLC, Mass spectrometry.

Chemical application of all these methods.

Unit-V (08 Hours)

Process dynamics:

Introduction, tools of dynamics analysis, ideal forcing function, input output model, transfer function models, state space models, proportion of transfer function, poles & zeros of transfer function with qualitative response, dynamic behavior of pure integrater, pure gain, first order & second order systems (with or without dead time), physical example of these systems.

Unit-VI (08 Hours)

Control theory basics:

The control loops, process control terms,componants of control loops, basic control action i.e. on-off,P,I,D,PI,PD,PID for 1st order process control loops and 2^{nd} order response.

Introduction to feedback control:

Pressure control loops, flow control loops, level control loops, temperature control loops for batch reactor, CSTR & heat exchanger.

Expert Interaction: (02 Hours)

Lecture(s) by eminent person(s) in the field, on any of the six syllabus Units

List of Practical

The term work shall consist of the following

- On-off controller
- Calibration of bimetallic thermometer.
- Manometer tuning
- Calibration of RTD.
- Gas chromatography.
- PH meter analysis.
- Spectrophotometer.
- HPLC.

Text Books/ References

- Galen ewing, "Instrumental methods of chemical analysis", Tata-McGraw Hill Publications.
- Webster, JG, "Measurement Instrumentation & Sensors Handbook" CRC Press.
- G McMillan, "Engineer Manual - Process Industrial Instruments and Control Handbook", Tata-McGraw Hill Publications.
- Instrumentation and Control - Fundamentals Handbook - Volume 1 of 2, US department of energy, Washington.
- Instrumentation and Control - Process Control Fundamentals, PA Control System.

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K10310: COMPUTER PROGRAMMING FOR CHEMICAL ENGINEERING - II

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04 Hrs / week	Theory	: 80 Marks
Practical	: 02 Hrs / week	Duration	: 03 Hours
		Unit Test	: 20 Marks
		T. W. & Or.	: 50 Marks

Unit-I (08 Hours)

Introduction to HTML. Modifying an HTML headings. Breaking a page into paragraphs. Generating list.

Unit–II (08 Hours)

Designing web pages. Adding graphics / images. Hyperlinks. Tables. Frames. Style sheets. Applying dynamic effects to the page. Working with forms in a web page

Unit-III (08 Hours)

What is Dynamic HTML. DHTML object model. Events. Handing text attributes. Dynamically changing style. Dynamically changing content. Dynamically altering the placement of elements

Unit-IV (08 Hours)

Introduction to Visual Basic and event driven programming. Character sets, constant, variables and Data Types. Programming constructs on Visual Basic. Loop statements.

Unit-V (08 Hours)

Important Visual Basic controls like Label, Text box, command button, frame, option button, check box, list box, combo box and Timer. Working with menus, toolbars, status bars. Scope of variables and procedures. Data controls. Creating MDI applications.

Unit-VI (08 Hours)

Application of Visual Basic for chemical Engineering: various calculations and solutions in chemical Engineering.

Expert Interaction: (02 Hours)

Lecture(s) by eminent person(s) in the field, on any of the six syllabus Units.

List of Practical

Minimum number of practicals : 6

Writing a program in HTML, DHTML and VB. Unsolved problems should be given to write a program. Term work should be submitted based on the practicals performed . The oral examination shall be based on the term work

Text Books/ References

- Holzschlag M. E. "Using HTML - 4" Eastern Economy Publication
- Holzner S. "HTML Black Book," Dream Tech Press
- "HTML Complete," BPB Publications
- Gurewich. "Learn VB In 21 Days," San's Publications
- Cornell " Visual Basic 6 from the ground " Tata McGraw Hill Publishers
- Hollis " Visual Basic 6 : Design, specification & Objects" (with CD), Longman Publications
- Ivan Bayross "Web Enabled Commercial Application Development Using HTML, DHTML, JavaScript, Perl CGI", PBP Publications.

Syllabus for Unit Test

Unit Test 1	Unit I & IV
Unit Test 2	Unit II & V
Unit Test 3	Unit III & VI

K10311: INDUSTRIAL POLLUTION CONTROL

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04 Hrs / week	Theory	: 80 Marks
Practical	: 02 Hrs / week	Duration	: 03 Hours
		Unit Test	: 20 Marks
		T. W. & Or	: 50 Marks

Unit -I (08 Hours)

Introduction, Man and environment, Types of pollution, pollution control aspects. Environmental legislation, Air pollution control act, physical, chemical, & Biological characteristics of industrial waste water, Indian standards for disposal of industrial effluents.

Unit –II (08 Hours)

Waste water sampling and analysis:

Measurement of physical characteristics, Measurement of D.O., B.O.D., C.O.D., Th.OD, Toxicity, Colour, estimation of inorganic substances.

Unit-III (08 Hours)

Physical Unit Operations :

Screening Grit removal, flow equalization, Mixing & Flocculation, Sedimentation, Floatation, Types of Aeration, removal of VOCS.

Unit-IV (08 Hours)

Fundamentals of Biological Treatment :

Role of M.O. in waste water treatment Activated sludge process, Modifications of A.S.P, Stabilization pond. Aerobic- anaerobic lagoons, Advanced waste water treatment methods, sludge treatment and disposal. Solid waste management.

Unit-V (08 Hours)

Air Pollution Sources & Effects :

Classification and Properties of air pollutants, Emission sources, Photochemical smog, Acid rains, Effect of air pollution on man & vegetation.

Unit-VI (08 Hours)

Air pollution control methods & equipments, Dry collectors, Settling Chambers, Tray chambers, Cyclone separator, Fabric filter, E.S.P wet scrubber, Spray tower, venture scrubbers. Control of gaseous pollutants by absorption and adsorption, Combustion, Removal of SO_x and NO_x.

Expert Interaction: (02 Hours)

Lecture(s) by eminent person(s) in the field, on any of the six syllabus Units.

List of Practical

- Determination of pH, color, and turbidity of a given waste water sample.
- Inorganic characterization of waste water sample.
- Measurement of D. O. of waste water sample.
- Measurement of C. O. D. of waste water sample.
- Estimation of B. O. D. of waste water sample.
- Study of flocculation technique for a given waste water sample.
- Study of froth flotation technique for a given waste water sample.
- Study of sedimentation method for the treatment of waste water.
- Characterization of dairy waste- A report.
- Characterization of domestic sewage - A report.

Text Books/ References

- Theodore L & Bhomlore A.J. "Air Pollution Control Equipments."
- Coulson J. M. Richerdson J.F. Vol.6.Tata Mc Graw-Hill.
- Rao M.N. & H.V.N. Rao. "Air Pollution Mc Graw-Hill.
- S.P. Mahajan "Pollution Controls in process industries." Tata Mc Graw-Hill.
- C.S.Rao, "Environmental Pollution control Engg." Willey Estern Ltd.
- Noel de Nevers, "Air Pollution control Engg." Mc Graw-Hill, Inc, Publication.

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

RULES REGARDING ATKT, CONTINUOUS ASSESSMENT and AWARD of CLASS

A. T. K. T.

- A candidate who is granted term for B.Tech. Semester-I will be allowed to keep term for his / her B.Tech. Semester-II examination even if he / she appears and fails or does not appear at B.Tech. Semester-I examination.
- A candidate who is granted term for B. Tech. Semester - III will be allowed to keep term for his / her B.Tech. Semester-IV examination even if he / she appears and fails or does not appear at B.Tech. Semester-III examination.
- A candidate who is granted term for B.Tech. Semester-V will be allowed to keep term for his / her B.Tech. Semester-VI examination if he / she appear and fails or does not appear at B.Tech. Semester-V examination.
- A candidate who is granted term for B.Tech. Semester-VII will be allowed to keep term for his / her B.Tech. Semester-VIII examination if he / she appears and fails or does not appear at B.Tech. Semester-VII examination.
- A student shall be allowed to keep term for the B.Tech. Semester-III course if he / she has a backlog of not more than 3 Heads of passing out of total number of Heads of passing in theory examination at B.Tch. Semester-I & II taken together.
- A student shall be allowed to keep term for the B.Tech. Semester-V of respective course if he / she has no backlog of B.Tech Semester-I & II and he / she has a backlog of not more than 3 Heads of passing in theory examination and not more than 3 heads of passing in termwork and practical examination or termwork and oral examination.
- A student shall be allowed to keep term for the B.Tech. Semester-VII course if he / she has no backlog of B.Tech. Semester-III & IV and he / she has a backlog of not more than 3 Heads of passing in theory examination and not more than 3 Heads of passing in termwork and practical examination or termwork and oral examination.

CONTINUOUS ASSESSMENT

- In respect of Term work at B.Tech. Semester-I & II, B.Tech. Semester-III & IV and B.Tech. Semester-V & VI, target date shall be fixed for the completion of each job, project experiment or assignment as prescribed in the syllabus and the same shall be collected on the target date and assessed immediately at an affiliated college by at least one pair of the concerned teachers for the subject and the marks shall be submitted at the end of each term to the Principal of the college.

• Termwork and performance of Practical / Oral examination shall be assessed on the basis of the depth of understanding of the principles involved, correctness of results and not on ornamental or colorful presentation.

• For B.Tech. Semester-VII & VIII, termwork assessment will be done by external and internal examiners jointly during the examination schedule declared by the university. The record of continuous assessment shall be made available to the examiners during Term work and practical and Term work and oral examinations. Examiner shall use this record for overall assessment of the performance of the student. Every practical / termwork assignment shall be assessed on the scale of 20 marks and weightage of 20 marks shall be distributed as follows:

Sr. No.	Activity	Marks
1	Timely Submission	04
2	Presentation	06
3	Understanding	10

Marks obtained out of 20 for all assignments together will be converted on scale of marks assigned to term work of respective subject in the structure of the course.

CLASS

• The class should be awarded to the student on the basis of aggregate marks obtained together in both the semesters of the respective year by him. The award of class shall be as follows.

A	Aggregate 66% or more marks	First Class with Distinction
B	Aggregate 60% or more marks but less than 66%	First Class
C	Aggregate 55% or more marks but less than 60%	Higher Second Class
D	Aggregate 50% or more marks but less than 55%	Second Class
E	Aggregate 40% or more marks but less than 50%	Pass Class