GUJARAT TECHNOLOGICAL UNIVERSITY

ENGINEERING ECONOMICS AND MANAGEMENT
SUBJECT CODE: 2140003
B.E. 3rd/4th SEMESTER

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	0	3	70	20	10	0	0	0	100

Content:

Sr. No	Topics	Hrs.	Module Weightage
1.	Introduction to Economics; Definitions, Nature, Scope, Difference between Microeconomics & Macroeconomics Theory of Demand & Supply; meaning, determinants, law of demand, law of supply, equilibrium between demand & supply Elasticity; elasticity of demand, price elasticity, income elasticity, cross elasticity	04	10%
2.	Theory of production; production function, meaning, factors of production (meaning & characteristics of Land, Labour, capital & entrepreneur), Law of variable proportions & law of returns to scale Cost; meaning, short run & long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost. Break even analysis; meaning, explanation, numerical	04	10%
3.	Markets; meaning, types of markets & their characteristics (Perfect Competition, Monopoly, Monopolistic Completion, Oligopoly) National Income; meaning, stock and flow concept, NI at current price, NI at constant price, GNP, GDP, NNP,NDP, Personal income, disposal income.	05	10%
4.	Basic economic problems; Poverty-meaning, absolute & relative poverty, causes, measures to reduce Unemployment: meaning, types, causes, remedies Inflation; meaning, types, causes, measures to control	04	10%
5.	Money; meaning, functions, types, Monetary policy- meaning, objectives, tools, fiscal policy-meaning, objectives, tools Banking; meaning, types, functions, Central Bank- RBI; its functions, concepts; CRR, bank rate, repo rate, reverse repo rate, SLR.	04	10%
6.	Introduction to Management; Definitions, Nature, scope Management & administration, skill, types and roles of managers Management Principles; Scientific principles, Administrative principles, Maslow's Hierarchy of needs theory	04	11%
7.	Functions of Management; Planning, Organizing, Staffing, Directing, Controlling (meaning, nature and importance) Organizational Structures; meaning, principles of organization, types-formal and informal, line, line & staff, matrix, hybrid (explanation with merits and demerits), span of control, departmentalization.	05	11%
8.	Introduction to Marketing management; Marketing Mix, concepts of marketing, demand forecasting and methods, market segmentation Introduction to Finance Management; meaning, scope, sources, functions	05	11%
9.	Introduction to Production Management; definitions, objectives, functions, plant layout-types & factors affecting it, plant location- factors affecting it. Introduction to Human Resource Management; definitions, objectives of manpower planning, process, sources of recruitment, process of selection	05	11%
10.	Corporate Social Responsibility; meaning, importance Business Ethics; meaning, importance.	02	6%

Reference Books:

1. Engineering Economics, R.Paneerselvam, PHI publication
2. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.
3. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning
4. Principles and Practices of Management by L.M.Prasad
5. Principles of Management by Tripathy and Reddy
6. Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publications

Course Outcomes: The course is intended to provide basic understanding of Economics and Management to engineering students with following aspects:

- To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions.
- To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory. The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (05)

PHYSICAL AND INORGANIC CHEMISTRY

SUBJECT CODE: 2140501

B.E. 4th SEMESTER

Type of Course: Engineering Science

Prerequisite: Zeal to learn the subject

Rationale: It is the basic subject for Chemical Engineering Students

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	4	7	70	20	10	20	10	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**The Phase Rule:** Introduction, Phase, Components, Degree of freedom, Derivation of Gibb's Phase, One component system like water, sulphur systems, two component system, Eutectic systems like silver-lead, zinc-cadmium system	6	**20**
2	**Thermo chemistry:** Introduction, Enthalpy of reaction, Endothermic reaction, Exothermic reaction, ΔH *and* ΔE and numerical. Thermo-chemical equations like heat of reaction, heat of combustion, heat of neutralisation, heat of transition, Hess's Law of constant heat summation and its application, experimental measurement of heat of reaction	7	
3	**Electro Chemistry:** Introduction, half reaction, electrode potential, Nernst's equation, Electro chemical cell, type of electrodes, Reference electrodes, Faraday's Law of Electolysis, buffer solution, buffer capacity, Handerson-Hesselblatch equation for acidic and basic buffer with numerical.	6	**40**
4	**Chemical Kinetics:** Introduction, Reaction rate, Units of rate, Rate laws, Order of a reaction, Zero order reaction, Molecularity of a reaction, Pseudo-order reaction, first order reaction with numerical, second order reaction, third order reaction, units of rate constant .	7	
5	**Metallurgy:** Introduction, general metallurgical operations, metallurgy of Iron,Copper,Aluminium,properties of steel,important mechanical properties of metals	5	
6	**Chemical Bonding :** Introduction, type of chemical bonds-ionic and covalent(polar and non polar),Hydrogen bonding	5	
7	**Nuclear chemistry:** Introduction,radioactivity,type of radiations,dectection and measurement of radioactivity by Cloudchamber,Geiger-Muller counter, scintillation counter, ionisation chamber, film badges, type of radioactive decay, nuclear reaction, Fission &Fusion reactions ,nuclear reactor, breeder reactor and nuclear	6	**40**

	waste disposal.		
8	**Explosives and Propellants:** Introduction, classification, preparation and uses of explosives, blasting fuses , Rocket propellants , characteristics of good propellant , classification and applications of propellant.	6	
9	**Introduction to Instrumental methods:** Introduction, electro analytical methods , conductometry ,applications of conductometry , Potentiometric analysis, Electomagnetic radiation, Molecular spectroscopy, Beer-Lambert's Law, Basic spectroscopy instrumentation, block diagram of Absorption spectrophotometer and Emession spectrophotometer, Infra red spectroscopy, Nuclear Magnetic Ressonance Spectroscopy, Ultra Violet- Visible spectroscopy, Mass spectroscopy, Flame photometry, Chromatography-Liquid chromatography (LC, HPLC), Differential Thermal Analysis (DTA) and their applications	8	

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
18	23	22	07	00

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Essential of Physical Chemistry by Bahl and Tuli., S Chand & Co. Ltd, New Delhi.
2. Inorganic Chemistry by P.L. Soni and Katyal., Sultan Chand & Sons, New Delhi
3. Engineering Chemistry Willey India Publisher
4. Engineering Chemistry by Marry Jane & Shult, Cencage Learning Publisher
5. A Text Book of Engineering Chemistry by Shashi Chawala, Dhanpat Rai and Co.
6. Engineering Chemistry 2e by Prasanth Rath, Cengage Learning

Course Outcomes:

After learning the course the students should be able

1. To build a basic knowledge of the structure of Physical and inorganic chemistry.
2. To analyze scientific concepts and think critically.
3. To review the importance and relevance of chemistry in our everyday life.
4. To be able to utilize the methods of chemical science as a logical means of problem solving

Minimum 4 practical's to be performed and remaining Open-ended Projects / Study Reports / Latest outcomes in technology study **:-**

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Projects / Study Reports / Latest outcomes in technology.
2. Literature survey including patents and research papers of basic chemistry
   - Design based small project **or**
   - Study report based on latest scientific development **or**

- Technology study report/ modeling/ simulation/collection report **or**
- Computer based simulation/ web based application/ analysis presentations of applied science field which may help them in their branches especially in their UDP/IDP projects.

3. These can be done in a group containing maximum Six students in each.
4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
5. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.
6. In the semester student should perform **minimum 4 set of experiments** and complete **one small open ended project** based on engineering applications. This project along with any performed experiment should be **EVALUATED BY EXTERNAL EXAMINER.**

Open Ended Project fields:-

Students are free to select any area of science and technology based on their branches to define projects.

Some suggested projects are listed below:

1. A project on specific eutectic system.
2. A project on kinetics study of some specific process. .
3. Product profile and manufacturing process of Alum, chrome alum explosives, etc.

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Resources which may be helpful for students for Open Ended project work

1) Any literature available in laboratory manual of Physical and Inorganic Chemistry.
2) Vogel's book of inorganic chemistry.
3) World Wide Web.

PRACTICALS(ANY FOUR):

1. To determine the strength of the given Hydrochloric acid by Sodium hydroxide conduct metrically.
2. To Determine the turbidity of given sample in NTU unit by turbidity meter.
3. To study the effect of concentration of reactant on the rate of reaction between sodium Thiosulphate and hydrochloric acid.
4. To study the effect of temperature on the rate of reaction between sodium Thiosulphate and hydrochloric acid.
5. To separate the components of chlorophyll by ascending paper chromatography.
6. To synthesise alum.
7. To synthesise Chrome Alum.

References Books:

1. Laboratory Manual of Engineering Chemistry.By S K. Bhasin & Sudha Rani. Publisher: Dhanpat Rai Publishing Company Ltd.
2. Engineering Chemistry with Laboratory Experiments By M S. Kaurav. Publisher: PHI Learning Pvt. Ltd. New Delhi
3. Vogel's textbook of Quantitative Chemical Analysis.By Arthur I Vogel, Revised by Jefferey et al.Publisher: Addison Wessley Longmann Ltd, England
4. Engineering Chemistry with Laboratory Experiments.By R. P. Mani & Mishra, Cencage Publisher.

Major Equipments:

1. Conductivity meter.

2. NepeheloTurbidity meter.
3. Melting Point Instrument.

List of Open Source Software/learning website:

1. NPTL, World Wide Web, etc.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (05)

CHEMICAL ENGINEERING THERMODYNAMICS – I

SUBJECT CODE: 2140502

B.E. 4th SEMESTER

Type of Course: Engineering Science

Prerequisite: Zeal to learn the subject

Rationale: It is the basic subject for Chemical Engineering Students

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	1	0	4	70	20	10	30	0	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	INTRODUCTION AND FIRST LAW OF THERMODYNAMICS: The scope of thermodynamics, Dimensions and units, Measures of amount or size, Force, temperature, pressure, work, energy, heat, etc. Internal Energy, Enthalpy, The first law of thermodynamics, Energy balance for closed systems, Equilibrium, The Phase rule, The reversible process, Heat capacity, Application of first law of thermodynamics to steady state flow process.	**11**	**40**
2	VOLUMETRIC PROPERTIES OF PURE FLUIDS : PVT behavior of pure substances, Ideal and non-ideal gases, Equation of states, Virial, Cubic, Vanderwaals EOS, Redlich/Kwong (RK) EOS etc., Calculation of constants in terms of Pc, Tc, Vc. Generalized Correlations for gases and liquids.	**10**	
3	HEAT EFFECTS: Sensible heat effects, Temperature dependence of the heat capacity, Latent heats of pure substances, Approximate methods for the estimation of the latent heat of vapourization, Standard heat of reaction, Standard heat of formation, Standard heat of combustion, Temperature Dependence of ΔH^{o}, Heat effects of Industrial Reactions.	**8**	**60**
4	SECOND LAW OF THERMODYNAMICS: Statements of second law of thermodynamics, Heat engines, Thermodynamic Temperature Scales, Concept of entropy. Entropy changes of an Ideal Gas, Third law of thermodynamics.	**7**	
5	THERMODYNAMICS PROPERTIES OF FLUIDS: The fundamental property relations for homogeneous phases, Maxwell's equations, Residual properties, Mathematical relations among thermodynamic properties, Two phase systems, Thermodynamic diagrams.	**6**	
6	THERMODYNAMICS OF FLOW PROCESS: Fundamental equations and relationships flow in pipes, maximum	**6**	

	velocity in pipe flow, nozzles, Single and Multistage compressors and ejectors.		
7	REFRIGERATION AND LIQUEFACTION: Carnot refrigerator, Vapour compression cycle, Absorption refrigeration, Choice of refrigerant, Heat pump, Liquefaction processes.	**6**	

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
18	24	23	5	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. " Introduction to Chemical Engineering Thermodynamics"; J. M. Smith, H. C.Van Ness, M. M. Abbott, The McGraw-Hill Companies, Inc.
2. " Chemical, Biochemical and Engineering Thermodynamics"; S.I. Sandler, Wiley India Edition.
3. "A text book of Chemical Enginnering Thermodynamics"; K. V. Narayanan, Prentice-Hall of India Pvt. Ltd.
4. "Chemical and Process Thermodynamics"; B.G. Kyle, Prentice-Hall Inc.
5. " Introduction to Thermodynamics"; Y.V.C. Rao, 2nd Edition, Wiley Eastern Limited

Course Outcomes:

After learning the course the students should be able

1. Develop a fundamental understanding of the basic principles of chemical engineering thermodynamics and calculations.
2. Examine and select pertinent data, and solve energy transformations problems.
3. Give examples of important application of thermodynamics laws in chemical engineering and biotechnology processes.

List of Open Source Software/learning website:

1. Students can refer to video lectures available on the websites including NPTEL.
2. Students can refer to the CDs which are available with some reference books for the solution of problems using softwares. Students can develop their own programs for the solutions of problems.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (05)

PROCESS HEAT TRANSFER

SUBJECT CODE: 2140503

B.E. 4th SEMESTER

Type of course: Chemical Engineering.

Prerequisite: none.

Rationale: The main objective of this subject is to study the basics of heat transfer takes place during the process in industry. This subject provides knowledge regarding to the basic modes and aspects of heat transfer process as well as it also provides an idea about various equipment used for heat transfer

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	3	6	70	20	10	20	10	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Introduction to three modes of heat transfer:** Conduction convection & radiation. General laws of heat transfer.	**03**	**5**
2	**Conduction:** Fourier's law, Thermal Conductivity – its variation with temperature & Pressure and its relationship with electrical conductivity. Heat transfer through composite walls and cylinders. Unsteady state heat transfer through some important shapes. Different types of insulating materials, general properties & application of insulators.	**09**	**16**
3	**Natural convection:** Natural convection from vertical plates & horizontal cylinders. **Forced convection:** In laminar flow - Heat transfer in plate & tubes. In turbulent flow - Empirical equations for individual coefficients: inside tubes, outside tubes, outside bundle of tubes, flow past spheres. Significance of Prandtl No., Nusselt No., Grashof No., Graetz No. & Peclet No. Correction for tube length. Corrections for heating and cooling the fluid. Various analogies between heat & momentum transfer.	**10**	**19**
4	**Radiation:** Radiation laws like Stefan Boltzmann's law, Kirchhoff's law, Wien's law, Plank's law etc. Black body, Grey body. Transmissivity, Absorptivity, Reflectivity, Emissivity of black bodies and gray bodies. Application of thermal radiation: Radiation Transfer between surfaces. Radiation through semi transparent materials.	**08**	**15**
5	**Heat transfer with phase change:** Boiling of liquids, Pool boiling curve, different types of pool boiling, condensation of vapor, film wise & drop wise condensation, weighted LMTD & Overall Heat transfer Coefficient for desuperheating & sub cooling.	**08**	**15**
6	**Evaporation:** Performance of tubular evaporator. Individual & overall Coefficients, Capacity & economy of evaporators. Boiling point elevation, Durhing's rule, Effect of liquid head & friction on pressure	**08**	**15**

	drop, Types of evaporators, Multiple effect evaporators. Vapor recompression, Thermal recompression & mechanical recompression.		
7	**Heat Exchange equipments:** Double pipe heat exchangers. Individual and overall heat transfer coefficient, LMTD, Variable overall Heat transfer coefficient, fouling factors, Shell & tube heat exchangers, LMTD correction factors, Extended surface heat exchangers, Fin efficiency and fin effectiveness	**08**	**15**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
20	15	20	15	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. "Heat Transmission", W. H. McAdams, McGraw Hill, 3rd Edition.
2. "Process Heat Transfer", D. Q. Kern, McGraw Hill.
3. "Unit Operations of Chemical Engineering", McCabe W L, Smith J C, Harriott P, 7th Ed. McGraw Hill, 2005.
4. "Heat Transfer", J. P. Holman, McGraw Hill, Tenth Edition

Course Outcome: After learning the course the students should be able:

1. To build basic knowledge of the heat transfer.
2. To review the practical importance and relevance of energy transfer and its conservation in chemical industry.
3. To utilize the technological methods related to heat transfer in process plant.
4. To study a detailed overview of heat transfer equipment and problems associated at preliminary stage of design.
5. To build a bridge between theoretical and practical concept used in industry.

List of Experiments and Open Ended Projects:

Minimum **5** practicals to be performed and remaining time should be allotted to open-ended projects / study reports / latest outcomes in technology study:-

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Project / Study Report / Latest outcome in technology.
2. Literature survey including patents and research papers of fundamental process

- Design based small project **or**
- Study report based on latest scientific development **or**
- Technology study report/ modeling/ simulation/collection report **or**
- Computer based simulation/ web based application/ analysis presentations of basic concept field which may help them in chemical engineering.

3. These can be done in a group containing maximum **three** students in each.
4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.

5. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.
6. In the semester student should perform **minimum** 5 set of experiments and complete **one small open ended dedicated project** based on engineering applications. This project along with any performed experiment should be **EVALUATED BY EXTERNAL EXAMINER.**

PRACTICALS (ANY FIVE):

Sr. No.	List of experiments
1.	To determine the thermal conductivity of given metal rod.
2.	To determine the thermal conductivity of the given composite walls.
3	To determine the thermal conductivity of lagging material, by heater input to be heat flow rate through the pipe
4.	To determine heat transfer co-efficient by forced convection.
5.	To determine the emissivity of gray body.
6.	To determine Stephan Boltzmann constant experimentally.
7.	To determine the overall heat transfer co-efficient of shell and tube type heat exchangers.
8.	To determine overall heat transfer co-efficient for finned tube type heat exchangers.
9.	To determine outside and inside heat transfer for parallel plate type heat exchanger.
10.	To study drop & film wise condensation & determine the film co-efficient
11.	To determine the heat flow rate through the lagged pipe and compare it with the heater input for known value of thermal conductivity of lagging material
12.	To study the boiling of liquid by submerged heated surface & determine critical heat flux.

Major Equipments:
Emissivity apparatus, Metal rod apparatus, composite wall apparatus, lagged pipe apparatus, various heat exchange equipments like shell and tube heat exchanger, plate type heat exchanger etc...

Open Ended Project fields:-
Students are free to select any area of science and technology based on chemical engineering applications to define Projects.

Some suggested projects are listed below:

- Preparation of non working models of various heat exchange equipments and its importance.
- Practical importance of different modes of heat transfer and various analogies associated with it.

List of Open Source Software/learning website:
1) Literature available in any laboratory manual of Process heat transfer.
2) NPTEL
4) MIT Open course lecture available on Internet etc…

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the

group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (05)

CHEMICAL ENGINEERING MATHS

SUBJECT CODE: 2140505

B.E. 4th SEMESTER

Type of course: Mathematics in Chemical Engineering

Prerequisite: Engineering Mathematics

Rationale: In chemical engineering, problems arising in heat and mass transfer, fluid mechanics, chemical reaction engineering, thermodynamics, modeling and simulation, etc. involve linear algebra, nonlinear algebraic equations, ordinary differential equations, partial differential equations, etc. The numerical methods give the solution of applied problems when ordinary analytical methods fail. The increasing importance of numerical methods has led to enhanced demand for courses dealing with the techniques of numerical analysis. It is therefore clean training in engineering would be incomplete without an adequate understanding of numerical methods. The students should gain ability which enables them to select the appropriate numerical technique to solve a given engineering problem.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	2	0	5	70	20	10	30	0	20	150

Content:

Sr. No.	Content	Total Hrs	%Weightage
1	**Approximations and Errors:** Types of Errors, Significant figures, Accuracy of Numbers, Precision, Error Propagation, Applications in Chemical Engineering	**4**	**7.5**
2	**Solution of Algebraic and Transcendental Equations:** Basic Properties of Equations, Relations between Roots and Coefficients, Descartes Rule of Sign, Synthetic Division of a Polynomial by a Linear Expression, Bracketing Methods (Bisection, Secant, Method of False Position or Regula Falsi, etc.), Convergence of Iterative Methods, Newton-Raphson Method, Newton-Raphson Method for Non Linear Equations in Two Variables, Algorithms & Computer Programming for all these Methods in Applications of Chemical Engineering	**10**	**18.5**
3	**Solution of Linear Equations:** Mathematical Background, Matrix inversion, Gauss Elimination, Gauss-Jordan Method, Gauss-Seidel Iteration Method, Jacobi's Method, Gauss-Seidel Method, Eigen Value Problem, Algorithms & Computer Programming for all these Methods in Applications of Chemical Engineering	**8**	**15**
4	**Curve Fitting** Method of Least Squares, Fitting a Straight Line and a Polynomial, Fitting a Non-linear Function, Fitting Geometric and Exponential Curves, Fitting a Hyperbola, a Trigonometric Function, etc., Algorithms & Computer	**5**	**9**

	Programming of Curve Fitting Methods		
5	**Finite Differences & Interpolation:** Finite Differences: Forward, Backward and Divided Differences Table, Central Differences, Newton's Forward, Backward and Divided Differences Interpolation Formula, Interpolation Polynomials, Lagrange Interpolation Formula, Inverse Interpolation, Algorithms & Computer Programming for all these Methods in Applications of Chemical Engineering	**5**	**9**
6	**Numerical Differentiation & Integration:** Differentiation Formula based on Tabulator at Equal and Unequal Intervals, Newton-Cotes Integration Formulas, Trapezoidal Rule and Simpson's 1/3 and 3/8 Rule, Algorithms & Computer Programming for all these Methods in Applications of Chemical Engineering	**8**	**15**
7	**Ordinary Differential Equations :** Taylor's Series and Euler's Method, Modifications and Improvements in Euler's Method, Runge-Kutta 2^{nd} Order & 4^{th} Order Methods, Milne's Predictor-Corrector Methods, Boundary Value Problems, Algorithms & Computer Programming for all these Methods in Applications of Chemical Engineering	**9**	**17**
8	**Partial Differential Equations:** Parabolic, Hyperbolic, Elliptic (Explicit method-finite difference), Applications in Chemical Engineering	**5**	**9**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
7	21	35	7	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. S C Chapra and R P Canale, Numerical Methods for Engineers, McGraw Hill International Edition.
2. John H Mathews, Numerical Methods for mathematics & science, 2^{nd} Edition, Prentice Hall.
3. Pushpavanam S, Mathematical Methods in Chemical Engineering, Prentice Hall of India.
4. N W Loney, Apllied Mathematical Methods for Chemical Engineers, CRC Press.
5. R G Rice, D D Do, Applied Mathematics and Modeling for Chemical Engineers, Wiley.
6. A Varma, M Morbidelli, Mathematical Methods in Chemical Engineering, Oxford University Press.
7. V G Jenson, G V Jeffreys, Mathematical Methods in Chemical Engineering, Elsevier.
8. Mickley, Reid, Sherwood, Apllied Mathematics in Chemical Engineering, Tata McGraw Hill.
9. S K Gupta, Numerical Methods for Engineers, New Academic Science.
10. M K Jain, S R K Iyengar and R K Jain, Numerical Methods for Scientific and Engineering Computation, Wiley Eastern.
11. S S Shastry, Introductory Methods of Numerical Analysis, Prentice Hall of India.
12. B S Grewal, Numerical Methods in Engineering & Science, Khanna Publishers.
13. Kenneth J Beers, Numerical methods for chemical engineering, Cambridge University Press.

Course Outcome:

After learning the course the students should be able to:

- Understand the basic algorithms for solution of and be able to solve non-linear equations.
- Understand the basic algorithms for solution of and be able to solve linear algebraic equations.
- Be proficient in manipulation of logarithmic, exponential, and other non-linear functions in order to linearize and to regress non-linear expressions.
- Understand the basic algorithms for fitting curves to data.
- Understand the basic algorithms for solution of and be able to solve numerical integration problems.
- Understand the basic algorithms for solution of and be able to solve problems in ordinary differential equations.
- Be familiar with a variety of numerical methods for solving partial differential equations.
- Be proficient in the use of programming language such as C or FORTRAN and use of software such as Excel Spreadsheets, Polymath, Matlab or Scilab, etc. to solve the types of problems listed above.
- Deal comfortably when encountering and solving the types of problems listed above.
- Be able to apply the techniques learnt in this subject to the solution of a comprehensive design problem.

List of Open Source Software/learning website:

- Students can refer to video lectures available on the websites including NPTEL lecture series. http://nptel.iitm.ac.in
- Students can refer to the CDs available with some reference books for the solution of problems using softwares/spreadsheets. Students can develop their own programs/spreadsheets for the solution of problems.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (05)

CHEMICAL PROCESS INDUSTRIES –II

SUBJECT CODE: 2140506

B.E. 4th SEMESTER

Type of course: Chemical Engineering.

Prerequisite: Basic Concept of Chemistry.

Rationale: The main objective of this subject is to study the basics of chemical processes take place in chemical industries and allied industries such as pharmaceuticals, dyes, etc. This subject provides knowledge regarding to the basic aspects of manufacturing of various chemicals.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Dyes and Intermediates**: Classification of dyes according to constitution and application, various dyes such as Azo dyes, Anthroquione dyes, Triamyl dyes, dispersed dyes, Miscellaneous dyes such as azine, oxazines, thiazines, thiazoles, nitro dyes etc. Various dye intermediates and its manufacturing based on unit processes, Manufacturing Processes of Chrome blue black, H-acid, Koch acid, Vinyl sulphone, Wet dyes, Nitro benzene, Aniline, etc..	**14**	26
2	**Drugs and Pharmaceuticals**: Classification of various drugs and pharmaceuticals, Introduction of Antibiotics such as penicillin, streptomycin, erythromycin, Introduction of vitamins, Manufacturing processes of Aspirin, Vitamin-C, Insulin, Ascorbic acid, Barbital & Phenol Barbital.	**14**	26
3	**Sugar, Paints, Pigments**: Manufacturing of Sugar, Paints, different types of pigments such as white, blue, red, yellow, green, brown, etc. Varnishes, Industrial Coatings, printing inks, Polishes etc.	**14**	26
4	**Fermentation industries** : Industrial alcohol, absolute alcohol, beers, wines and liquors, Manufacturing of Butyl alcohol & Citric acid by Fermentation	**12**	22

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
20	20	20	10	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Shreve's Chemical Process Industries", George T. Austin, McGraw Hill Publication, 5th edition
2. "DRYDENS outlines of chemical technology for the 21st century", M Gopalarao & Marshal Sitting, pub East-West Press, 3rd edition

Course Outcome: After learning the course the students should be able:

1. To build a basic knowledge of the process carried out in chemical industry.
2. To review the practical importance and relevance of process takes place in chemical industry.
3. To be able to utilize the technological methods in problem solving in process plant.
4. To study about the salient features of the processes.
5. To build a bridge between theoretical and practical concepts used in industry.

List of Experiments and Open Ended Projects:

Minimum **5** practicals to be performed and remaining time should be allotted to open-ended projects / study reports / latest outcomes in technology study:-

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Project / Study Report / Latest outcome in technology.
2. Literature survey including patents and research papers of fundamental process
   - Design based small project **or**
   - Study report based on latest scientific development **or**
   - Technology study report/ modeling/ simulation/collection report **or**
   - Computer based simulation/ web based application/ analysis presentations of basic concept field which may help them in chemical engineering.
3. These can be done in a group containing maximum **three** students in each.
4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
5. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.
6. In the semester student should perform **minimum** 5 set of experiments and complete **one small open ended dedicated project** based on engineering applications. This project along with any performed experiment should be **EVALUATED BY EXTERNAL EXAMINER.**

PRACTICALS (ANY FIVE):

1.	To synthesis aspirin from salicylic acid.
2.	To determine % of vitamin – C in the given tablet.
3	Estimation of sulphamethoxazole in the given sample.
4.	Preparation of phenyl azo – β – Naphthol from aniline.
5.	Preparation of nitro benzene from benzene.
6.	To prepare mordant yellow dye.
7.	Preparation of fast green o dye. (dinitroso resorcinol)
8.	Preparation of disperse dye.
9.	To estimate the amount of diazepam in the given solution by non – aqueous titration method.
10.	Estimation of Cephalaxin in the given sample.

11.	Estimation of benzyl penicillin in the given sample.
12.	To study Alcohol Fermentation by *Saccharomyces cereviceae* (Baker's Yeast).
13.	Fermentative production of citric acid using the fungi *Aspergillus niger*.

Major Equipments:
Muffle Furnace, Laboratory Oven etc...

Open Ended Project fields:-
Students are free to select any area of science and technology based on chemical engineering applications to define Projects.

Some suggested projects are listed below:

- Preparation of various dyes and intermediate at laboratory scale and carry out its cost analysis.
- Pharmaceutical Product profile and its manufacturing process like aspirin, Cephalaxin, etc…

List of Open Source Software/learning website:
1) Literature available in any laboratory manual of Chemical Process Industries.
2) NPTEL
4) MIT Open course lecture available on Internet etc…

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