20MA101T					MATHEMATICS-I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	-	-	100

COURSE OBJECTIVES

- To be able to analyse complex functions.
- To be able to formulate and solve various engineering problems.
- To understand the basic concepts of matrix and its application.
- To study the complex equations and apply them to solve complex functions.

Unit I **Hours: 10**

Systems of Linear Equations and Matrices: Matrix, Some Definitions Associated with Matrices Systems of Linear Equations, Matrices and Elementary Row Operations, The Inverse of a Square Matrix, Matrix Equations, Rank of the Matrix, Applications of Systems of Linear Equations.

Linear Transformation: Linear Transformations, Composition of Linear transformation The Null Space and Range, Isomorphism, Inverse Linear Transformation, Matrix Representation of Linear Transformations, Similarity.

Eigen Value and Eigen Vectors: Eigen value and Eigen Vectors, Diagonalization, Cayley-Hamilton Theorem, Quadratic Form.

Unit II **Hours: 10**

Vector Spaces: Euclidean Vector Space, Vector Spaces, Subspaces, Linear Combination, Span, Linear Dependence and Independence, Basis, Finite Dimensional Vector Space, Basis and Dimension for Solution Space of the Homogeneous Systems, Reduction and Extension of Basis, Coordinate Vector Relative to Basis, Change of Basis, Row Space, Column Space and Null Space, Rank and Nullity

Unit III **Hours: 09**

Inner Product Spaces: Introduction, The Dot Product on Rn and Inner Product Spaces, Orthogonal Basis Orthonormal Bases, Gram-Schmidt Process, Orthogonal Complements, Application: Least Squares Approximation, Orthogonal Projection Diagonalization of Symmetric Matrices, Application: Quadratic Forms

Unit IV **Hours: 10**

Complex Analysis: Complex numbers, Exponential, Trigonometric, De Moiré's Theorem, Roots of a complex number Function of a Complex variable, Analytic function, Cauchy Riemann equations, Laplace Equation, Harmonic Functions, Harmonic Conjugate functions and their Engineering Applications Conformal mapping and its type, Some standard & special conformal mappings, Definition of a Complex line integral, Cauchy's integral theorem, Cauchy's Integral formula, Residue theorem, Calculation of residues, Evaluation of real definite integrals.

MAX <40 Hrs>

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Demonstrate an understanding of matrix and calculus

CO2- Apply the techniques of matrix to evaluate large amount of variables.

CO3- Derive various technique to analyse complex function.

CO4- Apply Theorems to solve complex functions.

CO5- Analyze and evaluate the different structure and process using vector.

CO6- Create an interest to solve various real-world problems with physical significance.

TEXT / REFERENCE BOOKS

1. Higher Engineering Mathematics, by B. S Grewal, Khanna Publication, Delhi
2. Higher Engineering Mathematics Vol. 1 by Dr. K.R.Kachot, Mahajan Publishing House
3. Higher Engineering Mathematics Vol. 2 by Dr. K.R.Kachot, Mahajan Publishing House
4. Complex Variables and Applications, by R. V. Churchill and J. W. Brown (7th Edition), McGraw-Hill.
5. Complex Analysis, by J. M. Howie, Springer-Verlag (2004)
6. Complex Variables-Introduction and Applications, by M. J. Ablowitz and A.S. Fokas, Cambridge University Press, 1998 (Indian Edition).
7. Introduction to Linear Algebra with Application, by Jim Defranza, Daniel Gagliardi, Tata McGraw-Hill
8. Elementary Linear Algebra, Applications version, by Anton and Rorres, Wiley India Edition.
9. Advanced Engineering Mathematics, by Erwin Kreysig, Wiley Publication.
10. Elementary Linear Algebra, by Ron Larson, Cengage Learning.
11. Calculus, Volumes 2, by T. M. Apostol, Wiley Eastern.
12. Linear Algebra and its Applications, by David C. Lay, Pearson Education

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 10 Questions of 2 marks each-No choice **20 Marks**

PART B: 2 Questions from each unit with internal choice, each carrying 16 marks **80 Marks**

21PCM102T					Engineering Graphics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	2	2	3	0	0	0	50	50	100

COURSE OBJECTIVES

- Demonstrate various graphical projections
- Improve analytical skills to understand design blueprints
- Improve skills to prepare designs blueprints for mechanical parts
- Develop skills to plan site layout for petrochemical industries

UNIT I **8 Hrs.**

Introduction to Engineering Graphics: Drawing instruments and accessories, lines and dimensioning. BIS -SP46. Use of plane scales and Representative Fraction. Introduction to Engineering curves and their classification. Introduction to principal planes of projections. Projections of the points. Projections of line and True length of line determination when inclined to two reference planes.

UNIT II **8 Hrs.**

Orthographic Projections: Principle of projection, Principal Planes of projection, Projections from the pictorial view of the object on the principal planes using first angle projection method and third angle projection method. Sectional View: Principle and applications

UNIT III **8 Hrs.**

Isometric Projections and Isometric View or Drawing: Isometric Scale, Conversion of orthographic views into isometric projection, isometric view or drawing.

UNIT IV **8 Hrs.**

Introduction to software: AutoCAD and ProE/Soildworks. Understanding the fundamentals of 3D printing and application in oil and gas industries

Max. 32 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Apply the concept of engineering scales and understand the application of various engineering curves.
CO2: Demonstrate the concept of projection of line for various engineering application.
CO3: Prepare an orthographic and sectional orthographic views of any given object and comprehend the drawings to extract complete information of the object.
CO4: Construct an isometric view and isometric projection of any object from provided orthographic views.
CO5: Create 2D and 3D engineering drawings by using AutoCAD software.
CO6: Demonstrate the understanding of 3D CAD software and 3D printing fundamentals and their application in oil and gas industries.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 2 Hrs.**

Part A: Continuous evaluation	50 Marks
Part B: End semester examination and Viva-voce	50 Marks

TEXT/REFERENCE BOOKS

1. R Hanifan, “Perfecting Engineering and Technical Drawing”, Springer International Publishing Switzerland.
2. Bethune, J. D., “Engineering Design and Graphics with SolidWorks 2019, 1st edition”, Macromedia Press.
3. K Morling, “Geometric and Engineering Drawing”, Elseveir Insights.
4. DM Kulkarni, “Engineering Graphics with AutoCAD”, Easter Economy Edition.
5. Agrawal, B. & Agrawal C. M., “Engineering Drawing”, Tata McGraw Hill Publishers.
6. P.J. Shah, “Engineering Graphics”, S. Chand Publishing.
7. Engineering Drawing, N.D. Butt, Chariot Publication.

21PCM101T					Engineering Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To form a basis for understanding behavior of substances through chemical means for advanced study in engineering aspects
- To understand basic principles theories of electrochemistry and their applications
- To understand the concept of different separation methods and the chemistry involve to our surroundings
- To gain knowledge of different type of reactions and mechanism and to form a basis for understanding behavior of surfaces for advanced study in engineering aspects
- To develop the fundamental knowledge of solid, liquid and gaseous fuels
- To study the principles of nuclear chemistry and their application in different type of instruments for analytical purpose
- Develop an ability to conduct qualitative and quantitative analysis using different analytical instruments and solve problems

UNIT I ELECTROCHEMISTRY, BATTERY AND FUEL CELLS **7 Hrs.**

Specific, equivalent and molecular conductance, their determination, theories of electrolytic conductance, Debye Huckel theory of strong electrolytes, Galvanic cells, Reference electrodes and their potentials. Standard cell standard electrode potential determination of dissociation constants of acids and bases, solubility product, hydrolysis constant hydrogen ion concentration, Complex formation activity of electrolytes etc., theory of acid base indicators, electrolytes etc., theory of acid base indicators, electro-metric titrations. Photochemical reactions, Laws of Photo-chemistry, Batteries Fuel Cells, Hybrid cells and Electric Vehicle.

UNIT II INORGANIC CHEMISTRY **7 Hrs.**

Electrons in atoms, Bohr atomic model, wave mechanical model, introduction to quantum chemistry, wave functions and probability densities, quantum numbers, orbital shapes - s,p,d,f- LCAO-MO of H2, covalent, ionic and metallic bonding, bonding forces and energies, lattice energy and Madelung constant, metallic crystal structure, ceramic crystal structure and influencing factors.

UNIT III SOLID, LIQUID AND GASEOUS FUELS **7 Hrs.**

Solid fuels: wood, charcoal, peat, coal, analysis of coal, ASTM classification, ash, coal and its environment, fluidized bed combustion and coke. Liquid Fuels: Ignition temperature, flash point, fire point and smoke point. Gaseous fuel: Natural gas and its uses, natural gas as a fuel, other carbon based fuel gases, explosion limits. Hydrogen, methods for the preparation of H_2, Transportation and storage of H_2.

UNIT IV NUCLEAR CHEMISTRY **7 Hrs.**

Nuclear fission and fusion, nuclear energy, nuclear reactors, disposal of nuclear waste, radiation measurement and contentment Instrumental methods of analysis: Basic principles and operations, applications, sampling techniques of gas chromatographs, GCMS , FTIR, NMR, HPLC, spectroscopy etc., TGA, DTA, XRD, SEM

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: To understand the concepts of electrode potentials and electro chemical cells through the theories of electrolytic conductance with an aim of achieving underlying electroanalytical techniques

CO2: To apply the fundamental knowledge of reaction chemistry and mechanism in petrochemical industry

CO3: To analyse the fundamental concept of solid, liquid and gaseous fuels aligned with Petroleum Industry

CO4: Introduction to Nuclear chemistry and management and Introduction to various characterization and sampling techniques for analysis of physics and chemistry of substances

CO5: To evaluate the Hydrogen economy

CO6: To understand the introduction to nuclear chemistry and management and Introduction to various characterization and sampling techniques for analysis of physics and chemistry of substances

TEXT/REFERENCE BOOKS

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

21PCM109T					Environmental Studies					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Overall understanding of the natural resources
- Basic understanding of the ecosystem and its diversity
- Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities
- understanding of the environmental impact of developmental activities
- Awareness on the social issues and environmental legislation and global treaties

UNIT I NATURE OF ENVIRONMENTAL STUDIES AND RESOURCES 7 Hrs.

Definition, Scope and Importance, Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects. Role of information Technology in Environment and human health. Natural resources and associated problems. Forest resources, Water resources, Mineral resources, Food resources and Energy resources. Role of an individual in conservation of natural resources.

UNIT II ECOSYSTEMS, BIODIVERSITY AND ITS CONSERVATION 7 Hrs.

Concept of an ecosystem. Structure and function of an ecosystem. Energy flow in the ecosystem, ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems. Definition: genetic, species and ecosystem diversity classification, Value of biodiversity: consumptive use, productive use, social and aesthetic use. Biodiversity at national and local levels. India as a mega-diversity nation Hot-spots of biodiversity. Threats to biodiversity: habitat loss, man-wildlife conflicts - endangered and endemic species of India. Conservation of biodiversity: In-situ and ex-situ measures.

UNIT III ENVIRONMENTAL POLLUTION AND SOLID WASTE MANAGEMENT 7 Hrs.

Definition, cause, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, nuclear hazards. Role of an individual in prevention of pollution - carbon trade - pollution case studies. Sources, classification, effects and control measures of urban and industrial solid wastes. Sanitary landfilling, composting, Incineration. Consumerism and waste products.

UNIT IV SOCIAL ISSUES AND ENVIRONMENTAL MANAGEMENT 7 Hrs.

Urban problems related to energy -water conservation, rain water harvesting - resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental protection act - air (Prevention and control of pollution) act. Water (Prevention and control of pollution) act. Wildlife protection act. Forest conservation ac. Issues involved in enforcement of environmental legislation - Public awareness. Environmental impact assessment and its significance, various stages of EIA, preparation of EMP and EIS. Environmental audit. Ecotourism.

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize the importance of environmental studies and the measure to be taken to overcome global environmental challenges and natural resources and their importance for the sustenance of the life and the need to conserve them

CO2: Able to know the concepts of the ecosystem and its function in the environment and the need for protecting the producers and consumers in various ecosystems and their role in the food web

CO3: Analyse various biodiversity's of India and the threats to biodiversity and conservation practices to protect the biodiversity

CO4: Evaluate various attributes of the pollution and their impacts and measures to reduce or control the pollution along with waste management practices

CO5: Understand social issues both rural and urban environment and the possible means to combat the challenges

CO6: Gain and analyse environmental legislations of India and the first global initiatives towards sustainable development

TEXT/REFERENCE BOOKS

1. Environmental Studies, R. Rajagopalan, 2nd Edition, 2011, Oxford University Press.
2. A Textbook of Environmental Studies, Shaashi Chawla, TMH, New Delhi.
3. Environmental Studies, P.N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani, Pearson Education, Chennai.
4. Text Book of Environmental Studies, Deeshita Dave & P. Udaya Bhaskar, Cengage Learning.
5. Environmental Studies, K.V.S.G. Murali Krishna, VGS Publishers, Vijayawada.
6. Environmental Studies, Benny Joseph, Tata McGraw Hill Co, New Delhi.
7. Environmental Studies, Piyush Malaviya, Pratibha Singh, Anoop singh: Acme Learning, New Delhi.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 3 Questions from each unit, each carrying 3 marks	36 Marks
Part B: 2 Questions from each unit, each carrying 8 marks	64 Marks

21PCM103T					Introduction to Physical Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To provide a broad foundation of fundamentals of thermodynamic
- To provide students with the skills required to succeed in graduate school, the petroleum industry
- To develop the knowledge about the chemical and phase equilibrium of multicomponent system
- To understand the basic concepts of chemical kinetics
- To learn the basic concepts of homogeneous and heterogeneous catalysis
- To understand the basic concepts of different methods of catalyst characterization

UNIT I FUNDAMENTALS OF THERMODYNAMICS **7 Hrs.**

Laws of thermodynamics, definitions of Fundamental thermodynamic quantities, Thermodynamic property relations, Maxwell relations, expansion of ideal gas and changes in thermodynamic properties, cyclic rule, Partial derivatives and Jacobian method; Residual properties; Partial molar properties, Ideal and non-ideal solutions, Standard states definition and choice, Gibbs-Duhem equation, Excess properties of mixtures.

UNIT II PHASE EQUILIBRIA **7 Hrs.**

Phase rule and its applications, vapour-liquid equilibrium, phase diagrams for homogeneous and heterogenous systems and for systems with a miscibility gap; Concept of Azeotropes and its applications to single and multiphase system. liquid-liquid equilibrium, ternary liquid, liquid equilibrium; Activity coefficient composition models, thermodynamic consistency of phase equilibria, application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

UNIT III CHEMICAL KINETICS **7 Hrs.**

Rate of reactions, rate law, order, molecularity, Integrated rate laws: zero order reactions, First, Second and Third order reactions, Rate law for nth order reaction, Pseudo-unimolecular reactions, Half life time: for zero order, 1st order, 2nd order, third order, nth order reactions, Methods of determination of order of a reaction, Factors affecting the rate of a reaction. Homogeneous and Heterogeneous Catalysis, Biocatalysis, Positive catalyst, Negative catalyst, Catalyst promoters, Catalyst poisons, Auto Catalyst, Industrial applications of catalyst, Catalysts in Petroleum Refining, Catalytic converter.

UNIT IV STATISTICAL MECHANICS **7 Hrs.**

Types of statistics, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Translational, Rotational, Vibrational Electronics and Nuclear partition function, Thermodynamics properties in terms of partition function, application of BE statistics to black body radiation, Quantum statistics: Ideal Bose Einstein and Fermi-Dirac gas.

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the fundamental concepts of thermodynamics

CO2 Assess and get acquainted with the concepts of work, power, and heat in thermodynamics; determine work involved with moving boundary systems (graphical and analytical methods)

CO3: Analyse the first and second law of thermodynamics, Carnot cycle and thermodynamic properties of pure substances

CO4: Create the phase diagram of single and multicomponent system

CO5: Analyze the chemical kinetics and its applications to find rate, order and molecularity

CO6: Elucidate the mechanism of catalysis with the help of knowledge of characterization techniques for solving research problem in petrochemical industry

TEXT/REFERENCE BOOKS

1. Atkins, Peter, 'Physical Chemistry', 8th ed New Delhi: Oxford & IBH Publishing House, 2006.
2. Chemical Kinetics, 3rd edition, K. J. Laidler, Pearson India.
3. Physical Chemistry, 9th edition, Peter Atkins, Julio De Paula, Oxford University Press.
4. Essentials of Physical Chemistry, A. Bahl, B.S. Bahl, G.D. Tuli, S Chand Publication.
5. Principle of Physical Chemistry, Puri, Sharma & Pathania, Thomson Press (India) Limited

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

20HS101P					Communication Skills-I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Promote reading habit to enhance vocabulary of graduates
- Promote critical thinking
- Develop communication skills
- Develop writing skills

UNIT I **7 Hrs.**

Overview of English, Writing Program Policies, Writing Tutors, Campus Resources and Internet Addresses.

UNIT II **7 Hrs.**

Introduction to Academic Writing, Arguments, and Analysis.

UNIT III **7 Hrs.**

Reasoning, appropriacy of style and tone, using appropriate format and fluency, inference, analysis, evaluation and creativity, appreciating literary conventions.

UNIT IV **7 Hrs.**

Narrative/ Expository prose models, prose comprehensions, sentence comprehensions.

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Demonstrate the confidence to listen, speak, read and write in English
CO2: Develop the ability to produce something new with the help of inputs
CO3: Recognize the intricacies of learning and understanding to critically analyse
CO4: Analyse the steps involved in preparing reports/critique with the help of collected data
CO5: Demonstrate a multi-dimensional/disciplinary perspective and approach
CO6: Develop skills for better improved and sharpened skills to present, convince and persuade to be an effective and successful professional

TEXT/REFERENCE BOOKS

1. Ene, Estelle, Erik Ellis, and Meg Smith. A Student's Guide to First-Year Composition. 25 ed. Plymouth, MI:Hayden-McNeil, 2004.
2. Hacker, Diana. Rules for Writers. 5thed. Boston: Bedford, 2004.
3. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.
4. Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge, 2011.
5. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011.
6. Dutt P. Kiranmai and Rajeevan Geeta. Basic Communication Skills, Foundation Books: 2013.
7. Means, L. Thomas and Elaine Langlois. English & Communication For Colleges. Cengage Learning, USA: 2007.
8. Redston, Chris & Gillies Cunningham Face2Face (Pre-intermediate Student's Book & Workbook) Cambridge University Press, New Delhi: 2005.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 10 Questions of 2 marks each-No choice 20 Marks
PART B: 2 Questions from each unit with internal choice, each carrying 16 marks 80 Marks

21PCM101P					Engineering Chemistry Practical					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To enhance and develop scientific and analytical skills
- To relate concepts learned in chemistry and engineering to the real-world situations
- To acquire skills to perform laboratory experiments
- To demonstrate safe and proper use of standard chemistry glassware and equipment

List of Experiments

1. **External Indicator**–To determine the strength of given solution of ferrous ammonium sulphate by titrating against standard N/40 K2Cr2O7 using potassium ferricyanide as an external indicator.
2. **Iodometry**– To determine the strength of given copper sulphate solution by titrating against N/20 sodium thiosulphate (hypo) solution.
3. **Iodometry**– To determine the strength of given ascorbic acid by titrating against standard N/10 iodine solution.
4. **Complexometric titration**– To determine the total, permanent and temporary hardness of given water by complexometric titration using standard 0.01M EDTA solution.
5. **pH metric titration**– To determine the strength of given HCl solution using a standard NaOH solution by performing a pH-metric titration.
6. **Conductometric titration**– To determine the strength of given HCl solution using a standard NaOH solution by performing a conductometric titration.
7. **Potentiometric titration**– To determine the strength of given HCl solution potentiometrically.
8. **Chemical kinetics**– To study the kinetics of decomposition of sodium thiosulphate by a mineral acid.
9. **Chloride in Water**– Determination of Chloride in the given water sample by Mohr Method
10. **Polymerization**– To prepare a polymer (Nylon 6,10), identify the functional groups by FT-IR
11. **Spectrophotometry**– To determine the λmax and concentration of given unknown potassium permanganate using UV-Visible Spectroscopy technique

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Apply the concepts learned in chemistry and engineering to the real-world situations.
CO2: Enhanced ability to identify, analyse and interpret the results from the experiments
CO3: Carry out quantitative analysis by instrumental method using conductometer
CO4: Analyse compounds by titrimetric, gravimetric and instrumental methods
CO5: Determine the concentration of unknown solutions by Spectrophotometric method
CO6: Investigate the reaction rate and predict the order and rate constant

TEXT/REFERENCE BOOKS

1. College Practical Chemistry, VK Ahluwalia, S Dhingra, A Gulati, Universities Press.
2. Foundations of Experimental Chemistry, JB Baruah, P Gogoi, PharmaMed Press.
3. A Text Book of Chemistry Practicals Vol I & II, SS Sawhney, M S Jassal, SP Mittal, APH Publishing Corp.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A: Lab Work - Continuous Assessment 50 marks
Part B: Lab Exam and Viva 50 Marks

20PEB111 (Audit)					Gandhian Thoughts					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	0	2	--	--	--	--	--	Pass/Non Pass

COURSE OBJECTIVES

- Demonstrate the biography of Mahatma Gandhi
- Stimulate ethical thinking in graduates
- Produce spiritually strong graduates
- Enhance self-motivation in graduates

UNIT I **7 Hrs.**

Life and Basic Works of Mahatma Gandhi, Sarvodaya

UNIT II **7 Hrs.**

Truth and Non-Violence, Gandhian approach to Science, technology and development.

UNIT III **7 Hrs.**

The Constructive work and Human Liberation, Satyagraha and Peace Making.

UNIT IV **7 Hrs.**

Gandhian way of Management and Trusteeship, Gandhian Futurology, Gandhian Life Style, Contemporaries of Mahatma Gandhi

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize the influence of Gandhiji's family background in molding him
CO2: Draw out the various religious influences on life of Gandhi
CO3: Evaluate community life in Gandhi's ashrams and basic idea of satyagraha
CO4: Recognize the involvement of Gandhiji in social movements
CO5: Explain the core Gandhian philosophical ideas and idea of Sarvadharma samabhava
CO6: Recognize Gandhian ideas of satyagraha

TEXT/REFERENCE BOOKS

1. Gandhi, M. K. My experiments with truth.
2. Hingorani, A. T and Hingorani, G. A. (1985) The Encyclopaedia of Gandhian Thoughts.
3. Gupta, A. A. Gandhian Thoughts.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A/B: (Note: the course is AUDIT and grades are Pass/Non Pass based on the (a) attendance, (b) Assignment (c) Viva)

20PEB110 (Audit)					Swami Vivekananda					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	0	2	--	--	--	--	--	Pass/Non Pass

COURSE OBJECTIVES

- Demonstrate the biography of Swami Vivekananda
- Stimulate the humanitarian side of graduates
- Produce psychologically strong graduates
- Enhance self-motivation in graduates

UNIT I LIFE OF YOUNG NAREN **7 Hrs.**

Early years - Young Naren and his friends, At the feet of Sri Ramakrishna, Training of the disciple, As a wandering monk, On the World Stage - Trip to America, The parliament of Religions, Vedanta in America, Experiences in the West, Triumphal Return to India – Calcutta and North India, The Himalayas, At Belur Math, Second visit to The West, To Europe, The Journey's End – Last Days, The passing.

UNIT II INSIGHTS - KARMA, RAJA, JNANA AND BHAKTI YOGA **7 Hrs.**

Karma Yoga - Karma and its effect on character, the secret of work, Duty, Freedom. Raja Yoga – Prana, Control of Psychic Prana, Dharana, Dhyana and Samadhi. Jnana Yoga – Real Nature of man, Maya and Illusion, God in Everything, Realisation, Cosmology, Freedom of the soul. Bhakti Yoga – Need of Guru, Incarnate teachers and incarnations, Om: Word and Wisdom.

UNIT III SWAMIJI'STHOUGTHS AND STORY **7 Hrs.**

On The Ramayana and Mahabharata, Thoughts on the Gita, The story of Prahalada and Jada Bharata, The Great teachers of the World, On Lord Budhha, Christ, Indian Religious Thoughts, Art in India, The Claims of Religion, Concentration and Meditation, Spiritual Research.

UNIT IV MODERN, RATIONAL AND UNIVERSAL TEACHINGS **7 Hrs.**

Divinity of man, Call to the youth of India, Self-confidence, Faith-The source of strength, The power of will, The power of mind, Self-motivation, Education, Religion, Love and purity, Give Up Superstition, True Effort, Be Brave, Service, Way to success, Leader and Organization, Secret of work.

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Summarize the life of Swami Vivekananda and his childhood.
CO2: Describe the contribution of Ramakrishna in Swami Vivekananda's life.
CO3: Summarize the contribution of Swami Vivekananda to world religion of parliament
CO4: Synthesize the teachings of Swami Vivekananda
CO5: Enumerate the contribution of Swami Vivekananda to India and World.
CO6: Practice the teachings of Swami Vivekananda's disciples

TEXT/REFERENCE BOOKS

1. Banhatti, G.S.; Life and Philosophy of Swami Vivekananda; New Delhi: Atlantic Publishers & Dist, 1995.
2. Desh Raj Sirswal; Value Education and Philosophy (A tribute issue to Swami Vivekananda); Milestone Education Review, 2014 Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012.
3. Swami Vivekananda; Living at the Source: Yoga Teachings of Vivekananda; Shambhala Editions, 1993.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A/B: (Note: the course is AUDIT and grades are Pass/Non Pass based on the (a) attendance, (b) Assignment (c) Viva)

16SP101/102/103					NCC/NSS/SPORTS					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	* Continuous Evaluation				--	100

COURSE OBJECTIVES

- To develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young
- To develop youth leadership in the students
- To induce social consciousness among students through various camps and 'Shibir' activities
- To develop skills and physical fitness among students through indoor & outdoor sports, field & track events

National Cadet Corps (NCC)

Introduction to NCC, Aims and objectives, Structure and organization, NCC Song, Incentives, National Integration and Awareness, Drill, saluting, Personality Development & Leadership, Disaster Management, Social Awareness & Community Development, Health & Hygiene, Adventure camps, Environment Awareness and Conservation, Obstacle Training, Armed forces, Map reading, Field Craft & Battle Craft, Introduction to Infantry Weapons & Equipment, Weapon Training (During camps), Participation into Republic and Independence day ceremonial parades.

National Service Scheme (NSS)

Orthographic Projections: Principle of projection, Principal Planes of projection, Projections from the pictorial view of the object on the principal planes using first angle projection method and third angle projection method. Sectional View: Principle and applications

Sports

Importance of sports/games in life, Physical fitness, Introduction to various games and sports, field and track events, Physical training, exercises, running, walking, jogging, Teaching of different sports/games, track & field events , demonstration, practice, skills and correction, Introduction to Yoga & Meditation.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1: Understand the importance of Nation building and individual contribution to the same
CO2: Integrate physical fitness and mental wellbeing
CO3: Discover grassroots challenges of community
CO4: Creating societal impact
CO5: Maintain discipline and team spirit
CO6: Upholding the value of one for all and all for one

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: --**

* All registered students will be evaluated based on his/her attendance during the NCC/NSS/Sports sessions and participation to camps and other activities.

20MA103T					MATHEMATICS-II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	-	-	100

COURSE OBJECTIVES

- Demonstrate the fundamentals and theorems of the course
- Promote critical thinking
- Improve skills to evaluate the solutions of reservoir flow equations.
- Improve mathematical skills for modelling and simulation.

Unit I **Hours: 10**

Infinite Sequences and Series: Introduction of Convergence, Divergence of Sequences and Infinite Series The nth term test for Divergence, Integral Test, Comparison Test, Ratio Test, Root Test, Alternating Series, Absolute convergence, Conditional convergence, Power Series & Radius of convergence Taylor's series, Maclaurin's series, Successive differentiation, Leibnitz theorem (without proof)

Curve Sketching: Concavity Curve sketching, Polar co-ordinates, Relation between Polar and Cartesian Co-ordinates, Graphs in Polar co-ordinates

Indeterminate Forms: Indeterminate form $\left(\frac{0}{0}, \frac{\infty}{\infty}, \infty \times 0, \infty - \infty\right)$, indeterminate form $(0^0, 1^\infty, \infty^\infty)$

Unit II **Hours: 10**

Partial Derivatives: Function of 2-variables, graphs, level curves, Limit, continuity of function of several variables, Partial derivatives and Clairauts' theorem, Tangent plane, Normal line, Linear approximation, Total differential, Chain rule, implicit differentiation, Euler's theorem for homogeneous function, Maximum and minimum values by second derivative test, Lagrange multipliers, Taylor's formula for two variables.

Improper Integrals: Improper integrals of Type- I and Type – II, Convergence and divergence of improper integrals

Unit III **Hours: 10**

Multiple Integrals: Double integrals over rectangles and Fubini's theorem, Properties of double integrals Double integrals over general region, Double integrals in polar co-ordinates, Triple Integrals, Triple integrals in cylindrical coordinates, Triple integrals in spherical co-ordinates, Change of Order of Integration, Jacobian of several variables, Change of variable in multiple integrals.

Application of Integration: Volume by slicing, Volume of solids of revolution by disk method, Volume of solids of revolutions by washer method, Volume by cylindrical shell.

Unit IV **Hours: 09**

Vector Functions: Vector & Scalar Functions and Fields, Derivatives Curve, Arc length, Curvature & Torsion Gradient of Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field,

Vector Calculus: Line Integrals, Path Independence of Line Integrals, Green`s Theorem in the plane, Surface Integrals, Divergence Theorem of Gauss, Stokes`s Theorem.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Understand analytic function of a complex variable and able to apply Cauchy integral theorem and residue theorem to solve contour integrations

CO2- Solve engineering problems using the principles of solution of differential equations.

CO3- To solve partial differential equations

CO4- Apply Laplace transform and its inverse to solve initial value and other related problems.

TEXT / REFERENCE BOOKS

1. Higher Engineering Mathematics Vol. 1 by Dr. K. R. Kachot, Mahajan Publishing House
2. Higher Engineering Mathematics, by B. S Grewal, Khanna Publication, Delhi.
3. Calculus (5th Edition), by James Stewart, Thomson (2003).
4. Higher Engineering Mathematics, by R. K. Jain & S. R. K. Iyernagar
5. Thomas' Calculus, eleventh edition, Pearson.
6. E.Kreyszig, Advanced engineering mathematics (8th Ed.), John Wiley (1999).
7. Advance Engineering Mathematics, by Michael D. Greenberg.
8. Engineering Mathematics, A Programmed Approach, by C. W. Evans, Stanley Thornes Publishers Ltd.
9. Calculus, Volumes 1 and 2, by T. M. Apostol, Wiley Eastern.
10. Calculus, by Robert T. Smith & Ronald B. Minton, McGraw-Hill.
11. Calculus – Single and Multivariable, by Hughes – Hallett et al., John-Wiley and Sons.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 10 Questions of 2 marks each-No choice **20 Marks**

PART B: 2 Questions from each unit with internal choice, each carrying 16 marks **80 Marks**

21PCM104T					Elements of Engineering (Civil & Mechanical)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart basic knowledge on Civil and Mechanical Engineering.
- To explain the materials used for the construction of civilized structures.
- To make understand the fundamentals of construction of structure.
- Enable the students understand wide range of mechanical systems and their practical applications

UNIT I SURVEYING AND CIVIL ENGINEERING MATERIALS 8 Hrs.

Surveying: Objects - types - classification - principles - measurements of distances - angles - levelling - determination of areas - illustrative examples. Civil Engineering Materials: Bricks - stones - sand - cement - concrete - steel sections.

UNIT II BUILDING COMPONENTS AND STRUCTURES 8 Hrs.

Foundations: Types, Bearing capacity - Requirement of good foundations. Superstructure: Brick masonry – stone masonry - beams - columns - lintels - roofing - flooring - plastering - Mechanics - Internal and external forces - stress - strain - elasticity - Types of Bridges and Dams - Basics of interior design and landscaping.

UNIT III BOILERS, COMPRESSORS AND TRANSMISSION SYSTEMS 8 Hrs.

Steam boilers and Reciprocating air compressors: Classification of boilers, essentialities of boilers, selection of different types of boilers, study of boilers, boiler mountings and accessories.

Reciprocating air compressors: uses of compressed air, work done in single stage and twos stage compression, inter cooling and simple problems.

Transmission systems: Belts - Ropes and chain: belt and rope drives, velocity ratio, slip, length of belt , open belt and cross belt drives, ratio of friction tensions, centrifugal tension in a belt, power transmitted by belts and ropes, initial tensions in the belt, simple problems.

UNIT IV INTERNAL COMBUSTION ENGINES 8 Hrs.

Internal combustion engines: classification of IC engines, basic engine components and nomenclature, working principle of engines, Four strokes and two stroke petrol and diesel engines, comparison of CI and SI engines, comparison of four stroke and two stroke engines, simple problems such as indicated power, brake power, friction power, specific fuel consumption, brake thermal efficiency, indicated thermal efficiency and mechanical efficiency.

Max. 32 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Ability to explain the usage of construction material and proper selection of construction materials
CO2: Expose the students to surveying concepts and various civil engineering structures such as buildings, roads, bridges, dams etc.
CO3: Ability to identify the components use in boilers and compressors
CO4: To explain mechanical component suitable for the required power transmission
CO5: Ability to demonstrate working principles of petrol and diesel engine
CO6: Ability to explain the different components of CI and SI engines

TEXT/REFERENCE BOOKS

1. Shanmugam G and Palanichamy M S, “Basic Civil and Mechanical Engineering”, Tata McGraw Hill Publishing Co., New Delhi, 1996.Hacker, Diana. Rules for Writers. 5thed. Boston: Bedford, 2004.
2. Ramamrutham S., “Basic Civil Engineering”, Dhanpat Rai Publishing Co. (P) Ltd. 1999.
3. Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge, 2011.
4. Seetharaman S., “Basic Civil Engineering”, Anuradha Agencies, 2005.
5. Venugopal K. and Prahu Raja V., “Basic Mechanical Engineering”, Anuradha Publishers, Kumbakonam, 2000.
6. Thermal Engineering, Ballaney, P.L., Khanna Publishers, 2003.
7. Elements of Mechanical Engineering, A.R. Asrani, S.M. Bhatt and P.K. Shah, B.S. Publs.
8. Elements of Mechanical Engineering, M.L. Mathur, F.S. Metha & R.P. Tiwari Jain Brothers Publs., 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
PART A: 10 Questions of 2 marks each-No choice	20 Marks
PART B: 5 Questions from each unit with internal choice, each carrying 16 marks	80 Marks

21PCM106T					Engineering Physics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand basic concepts of properties of matter and principle stress and strain
- To develop the fundamental understanding of optoelectronic devices
- To understand the heat transfer mechanism in solids and fluids.
- To get accustomed to the quantum and crystal physics fundamentals

UNIT I PROPERTIES OF MATTER **8 Hrs.**

Elasticity - Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations - twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment - cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders - stress due to bending in beams.

UNIT 2 WAVES AND FIBER OPTICS **8 Hrs.**

Oscillatory motion - forced and damped oscillations: differential equation and its solution - plane progressive waves - wave equation. Lasers: population of energy levels, Einstein's A and B coefficients derivation - resonant cavity, optical amplification (qualitative) - Semiconductor lasers: homojunction and heterojunction - Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index and mode) losses associated with optical fibers - fibre optic sensors: pressure and displacement.

UNIT III THERMAL PHYSICS **8 Hrs.**

Flexural stresses: Theory of simple bending, Assumptions, Derivation of bending equation, Neutral axis, Determination bending stresses, section modulus of rectangular and circular sections (Solid and Hollow), T, I, Angle, Channel sections, Design of simple beam sections.

Deflection of beams: Bending into a circular arc, slope, deflection and radius of curvature, Differential equation for the elastic line of a beam, Double integration and Macaulay's methods, Determination of slope and deflection for cantilever, overhanging and simply supported beams subjected to point loads, U.D.L. Uniformly varying load.

UNIT IV QUANTUM AND CRYSTAL PHYSICS **8 Hrs.**

Black body radiation - Planck's theory (derivation) - Compton effect: theory and experimental verification - wave particle duality - electron diffraction - concept of wave function and its physical significance - Schrödinger's wave equation - time independent and time dependent equations - particle in a one-dimensional rigid box - tunnelling (qualitative) - scanning tunnelling microscope.

Single crystalline, polycrystalline and amorphous materials - single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices - inter- planar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - crystal imperfections: point defects, line defects - Burger vectors, stacking faults - role of imperfections in plastic deformation - growth of single crystals: solution and melt growth techniques.

Max. 32 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Gain knowledge on the basics of properties of matter and its applications

CO2: To understand the concepts of waves and optical devices and their applications in fibre optics

CO3: Interpret the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers

CO4: To understand concepts the advanced physics concepts of quantum theory and its applications in tunneling microscopes
CO5: To understand the basics of crystals, their structures and different crystal growth techniques
CO6: To apply knowledge of concepts of engineering physics to solve real world problems

TEXT/REFERENCE BOOKS

1. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2015.
2. Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012.
4. Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, 2015.
5. Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 2010.
6. Tipler, P.A. & Mosca, G. "Physics for Scientists and Engineers with Modern Physics'. W.H.Freeman, 2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 10 Questions of 2 marks each-No choice	20 Marks
Part B: 5 Questions from each unit with internal choice, each carrying 16 marks	80 Marks

21PCM107T					Introduction to Petroleum and Petrochemical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Demonstrate the unique characteristics of various rocks
- It will help in physical understanding of the petroleum engineering problems and phenomena
- Develop skill to identify petroleum potential of an area
- To introduce the concepts that will enable the transition from science to petrochemical engineering
- Understand and significant role of petrochemical engineers in everyday life and the importance of petrochemical engineering in consideration of environmental and safety aspects in process industries
- To learn the basic knowledge of common unit operations and unit process in major petrochemical industries

UNIT I OIL & GAS EXPLORATION METHODS **7 Hrs.**

Nature of Petroleum- composition & properties; Overview of Petroleum geology & basic rock properties: Source, migration and accumulation of petroleum, Seal and trap; Overview of Petro physical properties of rock and fluid; Overview of drilling operation: Rig Components, Drill String, Casing policy, Drilling fluid and Cementing.

UNIT II RESERVOIR DRIVES & OIL RECOVERY **7 Hrs.**

Fundamentals of reservoir engineering; classification of reservoir flow systems; Darcy's law of fluid flow; Pressure distribution and pressure gradient for linear, radial, compressible, steady state flow; Average permeability calculations for beds in series and beds in parallel for linear and radial reservoir geometry; Brief study of fluid flow through porous media. Production system of crude oil from reservoir to storage and refining; Concept of oil production, gathering, treatment & storage and transportation.

UNIT III INTRODUCTION TO PETROCHEMICAL ENGINEERING **7 Hrs.**

History and Overview of petrochemical industry, Role of Petrochemical Engineer. Major companies in India & abroad. Prospects & Future. Composition of crude oil, Physical properties of oil. Petroleum Materials – Native Materials, Manufactured Materials, Derived Materials.

UNIT IV ROLE OF PETROCHEMICAL ENGINEERS **7 Hrs.**

Introduction, petrochemical engineering in everyday life, Lab scale to plant scale, Versatility of a Chemical/Petrochemical Engineer, Role of petrochemical Engineers in Petroleum refinery, Chemical, Petrochemical, Nanotechnology, Energy and environment. Introduction & Basic concepts of analysis of processes, unit operations, basic laws, units and dimensions. Batch Processing, Transition from batch to continuous processing, Case study: Any chemical industry, Role of basic sciences in petrochemical Engineering (Introduction).

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand petroleum system and storage in rocks
CO2: Apply the knowledge for efficient exploration and exploitation of petroleum
CO3: Analyse the behaviour of crude oil from reservoir to storage and in refinery system
CO4: Demonstrate the role of petrochemical engineers in everyday life and the importance of petrochemical engineering
CO5: Describe various unit operations and unit processes in petrochemical industries
CO6: Analyse the role of petrochemical engineers in environmental and safety aspects in process industries

TEXT/REFERENCE BOOKS

1. Telford, W M, Geldart, L.P., Sheriff, R.E. and Keys, D.E., Applied Geophysics, Oxford and IBH Publishing Co Pvt Ltd.
2. Mukherjee P.K.: A Text Book of Geology
3. B.P. Tissot and D.H. Welte: Petroleum formation and occurrence: a new approach to oil and gas exploration.
4. James G. Speight "The Chemistry and Technology of Petroleum", 4th edition, CD&W Inc. Laramie, Wyoming 2007.
5. Uttam Ray Chaudhuri "Fundamentals of Petroleum and Petrochemical Engineering", CRC Press, 2011.
6. B.K Bhaskar Rao "A textbook on Petrochemicals", 2/e, publishers-Delhi 1998.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

21PCM108T					Organic Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart a comprehensive knowledge of reaction pathways of substitution, addition, elimination and some important named reactions in organic chemistry
- To design synthetic strategies of many important chemicals such as drugs, plastics, food additives, fabrics etc.
- To develop the concept of stereo chemical features of organic molecules that explains many physical and chemical properties on the basis of their spatial orientations
- To provide knowledge about hetero cyclic compounds, properties, design and chemical reactions
- To provide special attention to the organic transformations and synthesis techniques of natural/biological products that motivate students to analyze various research problems
- To impart knowledge on the complicated and diverse structures of biological molecules

UNIT I REACTIONS AND REAGENTS IN ORGANIC CHEMISTRY 10 Hrs.

Nucleophilic substitution reaction mechanisms; Free radical reactions, allylic halogenation, auto-oxidation, free radical rearrangements; Electrophilic substitution reaction mechanisms, ESR of aromatic compounds, pyrolytic elimination; Addition reactions involving electrophiles, nucleophiles and free-radicals. Grignard, organozinc and organolithium reagents; Enolates- Aldol, Knoevenagel, Claisen, Perkin and Stobbe reactions; Wagner-Meerwin, Pinacol Pinacolone, PPA cyclization and Fries rearrangement, Wolff and Arndst-Eistert, Hoffmann, Curtius, Schmidt, Lossen, Beckmann reaction; Aldol condensation, Wittig, Prevost, Simmons Smith, Nef reaction, Favorskii, Baeyer-Villiger oxidation.

UNIT II STERO-CHEMISTRY 8 Hrs.

Optical isomerism: concepts, optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiralcenters, Distereoisomers, Relative and absolute configuration: D/L and R/S designations. Threo and erythrodia stereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Stereo selective and stereo specific synthesis. Enantiomeric and diastereomereic excess: definition, determination and control. Examples of selected stereo chemical named reactions and mechanism.

UNIT III HETEROCYCLIC CHEMISTRY, BIOMOLECULES AND CHEMICAL BIOLOGY 10 Hrs.

Preparation, properties and chemical reactions of five membered hetero cyclic compounds (Pyrrole, Furan, Thiophenes). Preparation, properties and chemical reactions of six membered hetero cyclic compounds (Pyridines, Pyrylium salt), Introduction to fused, other heterocyclics: nomenclature, types, reactions and properties of selected heterocyclics (Indoles, benzofurans, pyrazines, quinolines). Classification of Amino acids; Zwitter ion structure and Isoelectric point; Overview of Primary, Secondary, Tertiary and Quaternary structure of Proteins; Determination of Primary structure of peptides; Synthesis of simple peptides by N-protection and C-activating groups; Merrifield solid phase synthesis; Overview of enzyme action, coenzymes and cofactors and their role in biochemical reactions; The beta-lactam antibiotics: Penicillins, and other beta-lactams, Antibiotic Resistance.

UNIT IV UNIT PROCESSES OF ORGANIC SYNTHESIS 8 Hrs.

Principles of a few selected unit processes such as oxidation, reduction, alkylation, halogenations, sulphonation, nitration, esterification and polymerization and important organic products related to the same.

Max. 36 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: To understand the reaction pathways of substitution, addition, elimination and some important named reactions in organic chemistry

CO2: Understand the basic concepts, importance of stereo chemistry

CO3: Enable to illustrate and appraise about the structure, classification, nomenclature and designating the chiral compounds
CO4: Understand the importance of various hetero cyclic compounds and able to design or understand site specific synthesis
CO5: Understand the structural and functional aspects of amino acids, peptides, proteins, enzymes and antibiotics
CO6: Evaluate and apply the concepts of natural product chemistry in real life

TEXT/REFERENCE BOOKS

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

21PCM105T					Elements of Electrical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Learn the basic principles of electrical laws and analysis of networks
- Understand the principle of operation and construction details of dc machines
- Understand the principle of operation and construction details of transformer
- Understand the principle of operation and construction details of alternator and 3-phase induction motor
- Study the operation of PN junction diode, half wave, full wave rectifiers and op-amps
- Learn the operation of PNP and NPN transistors and various amplifiers

UNIT I ELECTRICAL CIRCUITS **7 Hrs.**

Basic definitions - types of network elements - Ohm's Law - Kirchhoff's Laws - inductive networks - capacitive networks - series - parallel circuits - star-delta and delta-star transformations.

UNIT II DC AND AC ROTATING MACHINES **7 Hrs.**

Principle of operation of DC generator - EMF equation - types of DC machines - torque equation - applications - three point starter - speed control methods of DC motor - Swinburne's test. Principle of operation and construction of alternators - types of alternators - principle of operation of synchronous motor - principle of operation of 3-Phase induction motor - slip-torque characteristics - efficiency - applications.

UNIT III TRANSFORMERS **7 Hrs.**

Principle of operation and construction of single phase transformers - EMF equation - Losses - OC & SC tests - efficiency and regulation.

UNIT IV RECTIFIERS, LINEAR ICS AND TRANSISTORS **7 Hrs.**

PN junction diodes - diode applications (half wave and bridge rectifiers). Characteristics of operation amplifiers (OP-AMP) - application of OP-AMPs (inverting, non-inverting, integrator and differentiator). PNP and NPN junction transistor, transistor as an amplifier - transistor amplifier - frequency response of CE amplifier - concepts of feedback amplifier.

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Analyse the various electrical networks
CO2: Understand the operation of dc generators, 3-point starter and conduct the Swinburne's test
CO3: Analyse the performance of transformer
CO4: Explain the operation of 3-phase alternator and 3-phase induction motors
CO5: Analyse the operation of half wave, full wave rectifiers and op-amps.
CO6: Explain the single stage CE amplifier and concept of feedback amplifier

TEXT/REFERENCE BOOKS

1. Electrical Technology, Surinder Pal Bali, Pearson Publications.
2. Electronic Devices and Circuits, R.L. Boylestad and Louis Nashelsky, 9 edition, PEI/PHI 2006.
3. Electrical Circuit Theory and Technology, John Bird, Routledge Taylor & Francis Group.
4. Basic Electrical Engineering, M.S.Naidu and S.Kamakshiah, TMH Publications.
5. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI Publications, 2 edition.
6. Basic Electrical Engineering, Nagsarkar, Sukhija, Oxford Publications, 2 edition.
7. Industrial Electronics, G.K. Mittal, PHI.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 3 Questions from each unit, each carrying 3 marks	36 Marks
Part B: 2 Questions from each unit, each carrying 8 marks	64 Marks

20ME202T					Strength of Materials					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart the knowledge of fundamental concepts of stresses and strains
- To obtain the analytical and graphical solutions of principle stress and strain
- To get acquainted with the theories on flexural stresses and bean deflections
- To get accustomed to the torsional forces in solid and hollow shafts

UNIT I UNIT 1 SIMPLE STRESSES AND STRAINS 8 Hrs.

Elasticity - Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength - torsional stress and deformations - twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment - cantilever: theory and experiment - uniform and non-uniform bending: theory and experiment - I-shaped girders - stress due to bending in beams.

UNIT II PRINCIPAL STRESSES AND STRAINS, SHEAR FORCE AND BENDING MOMENT 10 Hrs.

Principal stresses and strains: Stresses on an inclined section of a bar under axial loading, compound stresses: normal and tangential stresses on an inclined plane for biaxial stresses. Two perpendicular normal stresses accompanied by a state of simple shear, Mohr's circle stresses- Principle stresses and strains- analytical and graphical solutions Shear force and bending moment: Definition of beam, Types of beams, Concept of shear force and bending moment, S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, U.D.L., uniformly varying loads and combination of these loads, Point of contra flexure, Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT III FLEXURAL STRESSES, DEFLECTION OF BEAMS 10 Hrs.

Flexural stresses: Theory of simple bending, Assumptions, Derivation of bending equation, Neutral axis, Determination bending stresses, section modulus of rectangular and circular sections (Solid and Hollow), T, I, Angle, Channel sections, Design of simple beam sections. Deflection of beams: Bending into a circular arc, slope, deflection and radius of curvature, Differential equation for the elastic line of a beam, Double integration and Macaulay's methods, Determination of slope and deflection for cantilever, overhanging and simply supported beams subjected to point loads, U.D.L. Uniformly varying load.

UNIT IV TORSION, COLUMNS & STRUTS 8 Hrs.

Torsion: Torque, Derivation and use of torque equation, Shear stress diagram for solid and hollow circular shafts, Comparison between solid and hollow shaft with regard to their strength and weight, Power transmitted by shaft, Concept of mean and maximum torque. Columns & struts: Buckling and Stability, Columns with Pinned ends, Columns with other support conditions, Limitations of Euler's Formula, Rankine's Formula, Columns with eccentric Axial Loads, Secant formula

Max. 36 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Define the fundamental concepts of stresses and strains in one dimensional and two dimensional states
CO2: Sketch shear force and bending moment diagram for different types of beams with various loading conditions
CO3: Estimate the slope and deflection of beam subjected to various loading conditions
CO4: Interpret the bending and shear stresses in beams of different shapes
CO5: Estimate the power required for the shaft
CO6: Estimate the effective length of columns with different support conditions

TEXT/REFERENCE BOOKS

1. James M Gere, Mechanics of Materials, Cengage publication (2014)
2. Beer and Johnston, Mechanics of Materials, Tata Mc Graw hill (2015)
3. R. C. Hibbeler, Mechanics of Materials, Prentice Hall, Pearson, India (2013)
4. S. S. Ratan, Strength of Materials, Tata Mc Graw hill (2011)
5. R.K.Rajput, Strength of materials, S.Chand & Co, New Delhi (2013)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 8 questions of 2 marks each	16 Marks
Part B: 6 questions of 14 marks each	84 Marks

21PCM106P					Engineering Physics Practical					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Demonstrate the unique characteristics of waves
- Enhance knowledge of graduates on application of physics on petrochemical engineering
- Imbibe skills to develop minor devices for study purpose
- Enhance the skill to develop laser hologram

List of Experiments

1. Introduction to Oscilloscope.
2. Study of Interference using Newton's Ring experiment.
3. Determination of thermal conductivity of different solids.
4. Experiment with solar collector.
5. Experimental to determine linear thermal expansion coefficient of solid bodies.
6. Experiment on reflection of Ultrasonic waves.
7. Experiments with heat pump.
8. Determining Plank's constant and inverse square law.
9. Experiments on diffraction with He-Ne Laser Kit.
10. Study of Hall Effect.
11. Determining semiconductor energy band gap using four probe method.
12. Experiment to study forced oscillations.
13. Study of charging and discharging of capacitive plates.
14. Study of Bio-Savart's Law
15. Experiments on Fiber Optics.
16. Study of Photoconductivity.
17. Determining e/m by Thomson's method.
18. Study of Polarization of light using LASER.
19. Millikan's oil drop experiment.
20. Study of Holography.

** Any 10 experiments will be conducted relevant to theory course.

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Analysis the engineering problems and design the components for the solution
CO2: Developing skills to utilize the different tools for engineering problems
CO3: Analyse the results and correlate with theory and its application in industries
CO4: Design the set-up and utilize for component analysis
CO5: Identifying the problem and creating the solutions for research and development
CO6: Analyse the scientific data and learn to be efficient as individual and a team member

TEXT/REFERENCE BOOKS

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A: Lab Work - Continuous Assessment 50 marks
Part B: Lab Exam and Viva 50 Marks

21PCM108P					Organic Chemistry Practical					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective To understand basic principles theories of electrochemistry and their application
- To provide students with the skills required to succeed in graduate school, the chemical industry or professional school
- To expose the students to a breadth of experimental techniques using modern instrumentation

List of Experiments

1. Estimation of Alcohol
2. Estimation of Aldehydes & Ketones
3. Estimation of Phenol
4. Determination of average molecular weight by viscometer
5. Estimation of amines
6. Estimation of aromatics
7. Qualitative analysis of simple Organic compounds.
8. Hydrolysis of Sucrose.
9. To separate mixture of organic compounds by chromatrotron.
10. To prepare a sample of p-Nitroacetanilide from acetanilide.
11. Purification of organic compounds by crystallization using the following solvents: Water/Alcohol.

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Apply the concepts learned in chemistry and engineering to the real-world situations
CO2: Identify the organic functional groups in a given sample
CO3: Identify, analyze and interpret the results from the experiments
CO4: Synthesize organic compounds with knowledge of organic reactions
CO5: Determine the physico-chemical properties of single and multicomponent systems
CO6: Demonstrate safe and proper use of standard chemistry glassware and equipment

TEXT/REFERENCE BOOKS

1. Dipika Jaspal, Arti Malviya., "Engineering Chemistry: Practical Book, Alpha Science, 2015.
2. Vogel's Textbook of Quantitative chemical analysis, J. Mendham et.al. (Pearson Education).
3. Laboratory Manual on Engineering Chemistry, Sudharani (Dhanpat Rai Publishing Company).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A: Lab Work - Continuous Assessment 50 marks
Part B: Lab Exam and Viva 50 Marks

16SP201/202/203					NCC/NSS/SPORTS					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	*Participation & Attendance	
0	0	2	1	2	* Continuous Evaluation			--	--	100

COURSE OBJECTIVES

- To develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young
- To develop youth leadership in the students
- To induce social consciousness among students through various camps and 'Shibir' activities
- To develop skills and physical fitness among students through indoor & outdoor sports, field & track events

National Cadet Corps (NCC)

Introduction to NCC, Aims and objectives, Structure and organization, NCC Song, Incentives, National Integration and Awareness, Drill, saluting, Personality Development & Leadership, Disaster Management, Social Awareness & Community Development, Health & Hygiene, Adventure camps, Environment Awareness and Conservation, Obstacle Training, Armed forces, Map reading, Field Craft & Battle Craft, Introduction to Infantry Weapons & Equipment, Weapon Training (During camps), Participation into Republic and Independence day ceremonial parades.

National Service Scheme (NSS)

Orthographic Projections: Principle of projection, Principal Planes of projection, Projections from the pictorial view of the object on the principal planes using first angle projection method and third angle projection method. Sectional View: Principle and applications

Sports

Importance of sports/games in life, Physical fitness, Introduction to various games and sports, field and track events, Physical training, exercises, running, walking, jogging, Teaching of different sports/games, track & field events , demonstration, practice, skills and correction, Introduction to Yoga & Meditation.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1: Understand the importance of Nation building and individual contribution to the same
CO2: Integrate physical fitness and mental wellbeing
CO3: Discover grassroots challenges of community
CO4: Creating societal impact
CO5: Maintain discipline and team spirit
CO6: Upholding the value of one for all and all for one

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: --**

* All registered students will be evaluated based on his/her attendance during the NCC/NSS/Sports sessions and participation to camps and other activities.

Teaching Scheme					Numerical Methods (20MA212T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand and acquaint the concept of various numerical methods.
- To develop numerical skills in solving problem of engineering interest.
- To lay foundation of computational techniques for post graduate/specialized studies and research.
- To make familiar the numerical solution techniques for linear/nonlinear ODEs/PDEs.

UNIT I: Interpolation, numerical differentiation and integration 11 Hr.

Finite differences: forward, backward and central differences; Introduction to Interpolation, Newton-Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Stirling's central difference interpolation formula, Lagrange's interpolation formula for unevenly spaced data, Newton's divided difference formula, numerical differentiation; Numerical integration: Newton-Cotes's quadrature formula, trapezoidal rule, Simpson's one-third rule and Simpson's three-eighth rule.

UNIT II: Numerical solution of ordinary differential & simultaneous equations 10 Hr.

Euler's method, modified Euler's method, Runge-Kutta methods of various order and predictor corrector method; Adam's and Milne's method.

Systems of linear equations: Gauss elimination method, pivoting techniques, Thomas algorithm for tri diagonal system; Jacobi, Gauss-Seidel and SOR iteration methods; Conditions for convergence; Systems of nonlinear equations: Fixed point iterations and Newton's method.

UNIT III: Numerical solution of partial differential equations 11 Hr.

Finite difference approximation of partial derivatives, classification of 2^{nd} order PDEs, different type of boundary conditions, solutions of elliptic, parabolic and hyperbolic equations, Crank-Nicholson method, Dirichlet's and Neumann conditions.

UNIT IV: Finite elements methods 10 Hr.

Introduction to finite elements methods: Functionals and base functions; Methods of approximation: Rayleigh-Ritz method, Galerkin method; FEM for one dimensional problems and comparison of FDM and FEM.

Max. 42 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Apply a suitable numerical technique to extract approximate solution to the problem whose solution cannot be obtained by routine methods.
CO2: Analyze the accuracy of numerical methods by estimating error.
CO3: Analyze/interpret the achieved numerical solution of problems by reproducing it in graphical or tabular form.
CO4: Evaluate a polynomial using interpolation/extrapolation from the data generated by an experiment or an empirical formula.

CO5: Evaluate a sufficiently accurate solution of various physical models for petrochemical engineering whose governing equations can be approximated by nonlinear ODEs or PDEs.

CO6: Design/create an appropriate numerical algorithm for various problems of petrochemical engineering.

TEXT/REFERENCE BOOKS

1. Grewal, B.S., "Numerical Methods in Engineering and Science with Programs in C & C++", Khanna Publishers (2010).
2. Sastry, S.S., "Introductory Methods for Numerical Analysis", 4th Edition, Prentice Hall of India (2009).
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Numerical Methods for Scientific and Engineering Computation", New Age International (2007).
4. Erwin K., "Advanced Engineering Mathematics", 9th Edition, Wiley publication (2005).
5. Jain, R.K. and Iyengar, S.R.K., "Advanced Engineering Mathematics", 3rd Edition, Narosa (2002).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Polymer Science (22PCM202T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Analyze fundamental concept along with classification of polymer and explaining the reaction mechanism.
- Evaluate analysis and morphological study with the help of various analytical techniques e.g. XRD, microscopy (optical and electronic as well) TGA, DSC and IR.
- Analyze the glass transition temperature and the factors which affects the glass transition temperature.
- Analyze and justify synthesis and engineering of various types of thermoplastics.
- Explain the rheological characteristic of polymer and plastic along with their polymer processing operation and testing.
- Formulate the concept of a polymer industrial setup.

UNIT I: Fundamentals of polymers & characterization **7 Hr.**

Monomers, functionality, degree of polymerizations, classification of polymers, glass & melting transition, polymerization methods: addition and condensation; their kinetics, metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, block and graft copolymers, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights; Polymer crystallinity; Analysis using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

UNIT II: Polymer synthesis, properties, blends & composites **7 Hr.**

Commodity and general purpose thermoplastics: PE, PP, PS, PVC, Polyesters. Engineering Plastics: Nylon, PC, PBT, PSU, PPO; Thermosetting polymers: PF, UF, epoxy, unsaturated polyester; Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, SBR, nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE; Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, polymer alloys, polymer eutectics, plastic-plastic, rubber-plastic and rubber-rubber blends, FRP, particulate, long and short fibre reinforced composites.

UNIT III: Polymer rheology & technology **7 Hr.**

Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, cross linking and vulcanization; Aspects of polymer rheology, measurements of rheological parameters, different flow equations, dependence of shear modulus on temperature, molecular/segmental deformations at different zones and transitions.

UNIT IV: Polymer processing and testing **7 Hr.**

Compression moulding, transfer moulding, injection moulding, blow moulding, reaction injection moulding, extrusion, pultrusion, calendaring, rotational moulding, thermoforming, rubber processing in two-roll mill and internal mixer; Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact and toughness.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: The fundamental concept of polymer science and technology is required to petrochemical engineering students

CO2: Rheological study and the characterization of polymers with analytical instrument would be useful to solve some complex problem.

CO3: The understanding of glass transition temperature and its determination is useful to design and solve some industrial problem.

CO4: The synthesis of polymers and its reaction mechanism is useful to solve complex problem in petrochemical industry.

CO5: The knowledge of different types of polymer processing operations is useful to formulate a polymer industry

CO6: By formulating the polymer industrial setup the students could become entrepreneur.

TEXT/REFERENCE BOOKS

1. Freid, J.R., "Polymer Science and Technology", 3rd Edition, Prentice Hall (2014).
2. Billmeyer, F.W., "Textbook of Polymer Science", 3rd Edition, Wiley-Interscience (1994).
3. Maiti, S., "Analysis and Characterization of Polymer", Polymer science (2003).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Fluid Mechanics (22PCM203T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Inculcate the importance of fluid statics and dynamics.
- Acquire a sound knowledge on fluid properties and its transport.
- Familiar with various flow measurement and transportation devices.

UNIT I: Fluid properties and statics **7 Hr.**

Definition of fluid; Properties of fluids: Viscosity, compressibility and bulk modulus; Shear stress in a moving fluid; Difference between liquids and gases, compressible and incompressible fluids; Newtonian and non- Newtonian fluids; Continuum concept of a fluid: Statics of fluid systems, pressure and the variation of pressure due to gravity in a static fluid; Manometers: U-tube, differential and inclined manometers; Force on submerged bodies and centre of pressure.

UNIT II: Kinematics and dynamics of fluid flow **7 Hr.**

Fluid kinematics: Classification and types of flow; Velocity field and acceleration; Continuity equation and its applications; Stream line, streak line, path line, stream function and velocity potential function; Fluid dynamics: Reynolds experiment, laminar and turbulent flows, nature of turbulence and boundary layer; Euler's equation of motion; Bernoulli's theorem; Momentum equations and energy losses in fluid flow.

UNIT III: Dimensional analysis and flow measurement **7 Hr.**

Dimensional analysis: Dimensions of physical quantities, dimensional homogeneity, Buckingham pi theorem, important dimensionless numbers, model analysis (Reynolds, Froude and Mach number); Flow measurement: Application of Bernoulli's equation in pitot tube, venturi meter, orifice meter, rota meter, triangular and rectangular notch, mass flow meters, etc.

UNIT IV: Pumps and compressors **7 Hr.**

Classification of pumps: Characteristic curves, selection criteria; Types of compressors: COP and selection criteria; Compressible fluid flow; Ideal gas relations and energy calculations.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the properties of fluids and its static conditions.
CO2: Illustrate the kinematics and dynamics of fluid flow.
CO3: Apply Euler's and Bernoulli's equation in various flow systems.
CO4: Estimate the energy losses in fluid flow.
CO5: Apply dimensional analysis to predict physical parameters.
CO6: Evaluate the performance characteristics of pumps and compressors.

TEXT/REFERENCE BOOKS

1. Bansal, R.K. "A Textbook of Fluid Mechanics and Hydraulic Machines", 10th Edition, Laxmi Publications (2018).

2. de Nevers, N., “Fluid Mechanics for Chemical Engineers’’, 2nd Edition, McGraw-Hill (1991).
3. Munson, B.R., Okiishi, T.H., Huebsch, W.W. and Rothmayer, A. “Fundamentals of Fluid Mechanics”, 7th Edition, John Wiley Publication, (2012).
4. McCabe, W.L., Smith and Peter Hariott, “Unit Operations of Chemical Engineering”, 7th Edition, McGraw-Hill, New Delhi, (2012).
5. White, F.M., “Fluid Mechanics”, 7th Edition, McGraw-Hill Inc. (2011).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Chemical Process Calculations (22PCM204T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- Develop an ability to apply the knowledge of basic sciences and engineering to solve material and energy balance problems for unit operations and unit processes.
- Understand and correctly implement unit conversions in process calculations.
- Analyze and solve elementary material and energy balances in physical and chemical processes.

UNIT I: Stoichiometric relations and behaviour of ideal gases 12 Hr.

Basis of calculations: Conversion factors, mole concept, chemical calculations and use of molal quantities; Density, specific gravity and specific gravity scales; Composition of solids, liquids and gases; Methods for expressing compositions of mixtures and solutions; Ideal gases, Boyle's law, Charles law, Ideal gas equation, mixtures of ideal gases, Dalton's law, Amagat's law; Average molecular weight; Real gases, critical properties, equations of state and Van-der-Waals equation.

UNIT II: Material balance in unit operations and unit processes 10 Hr.

Basic material balance principles, tie substance and material balance calculations involving unit operations; Process involving recycle, bypass and purge calculations; Limiting and excess reactant, conversion, yield, selectivity and material balance calculations involving chemical reactions.

UNIT III: Vapour pressure and humidity calculations 10 Hr.

Vapour pressure and boiling point; Effect of temperature on vapour pressure, Clapeyron's equation, Clausius-Clapeyron's equation and Antoine equation; Vapour pressure plots; Ideal solutions, Raoult's law, non-ideal solutions and Henry's law; Saturation, humidity, dew point, wet bulb temperature, dry bulb temperature and humidity charts.

UNIT IV: Energy balance and combustion calculations 10 Hr.

Energy balances, heat capacity of gases, liquids and solids, Kopp's rule; Heat of fusion and vaporization, Trouton's rule, Kistyakowsky's equation; Thermochemistry: Heat effects accompanying chemical reactions, standard heat of reaction, combustion and formation; Hess's law of constant heat summation, calculations of theoretical and actual flame temperatures, fuels, calorific value of fuels, air requirements for fuels, Orsat's analysis, combustion calculations, incomplete combustion and thermal efficiency calculations.

Max. 42 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand basics of stioichiometric calculations and make use of the different methods in expressing the composition of mixtures.
CO2: Apply the behaviour of ideal gas equations to bring the relation between temperature and pressure for pure components and solutions.
CO3: Analyze material balance, calculations for steady state unit operation and unit processes.
CO4: Estimate the vapour pressure and solve the heating and cooling problems using humidity concepts.
CO5: Acquaint and analyze energy balances over reactive and non- reactive equipment.
CO6: Apply material and energy balance concepts and perform combustion calculations.

TEXT/REFERENCE BOOKS

1. Hougen O.A., Watson K.M. and Ragatz. R.A., "Chemical Process Principles Part - I: Material and Energy Balance", 2nd Edition, CBS Publishers & Distributors, (2004).
2. Bhatt B.I. and Thakor, S., "Stoichiometry", 6th Edition, Tata McGraw Hill, New Delhi, (2017).
3. Himmelblau D.M. and Rigges J. B., "Basic Principles and Calculations in Chemical Engineering", 8th Edition, Prentice Hall of India, (2011).
4. Earnest J.H. and Harman B., "Chemical Engineering Calculations: Mass and Energy Balances", 1st Edition, McGraw Hill, New Delhi, (1959).
5. Richard M.F. and Ronald W.R., "Elementary Principles of Chemical Processes", 3rd Edition, John Wiley, (2004).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Chemical Engineering Thermodynamics (22PCM205T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To have a clear understanding of chemical engineering thermodynamics.
- To understand the basic laws of thermodynamics, processes cycles and their applications
- To understand the PVT relationship of pure gases and mixtures and their evaluation.
- To understand aspects of solution thermodynamics and mixing rules.
- To understand and predict vapour liquid equilibria based on Gibbs free energy models.
- To study the principles of chemical reaction equilibria and their application.

UNIT I: Thermodynamic law's and processes and their analysis 7 Hr.

Revisiting the laws of thermodynamics, statements of the second law of thermodynamics and their equivalence; Processes and cycles: Carnot's, Otto, Diesel, Rankine and Brayton cycles; Concept of entropy, criterion of irreversibility, calculation of entropy changes; Energy, refrigeration and liquefaction processes.

UNIT II: PVT relationship concepts and calculations 7 Hr.

Properties of pure substances and mixtures, cubic equations of state, Virial equation of state, compressibility factor, acentric factor; Property relationships, residual properties and their evaluation using equation of states.

UNIT III: Solution and equilibrium thermodynamics 7 Hr.

Partial molar properties; Chemical potential, activity and activity coefficients; Fugacity and fugacity coefficients in mixture; Ideal gas mixing models, entropy, enthalpy, free energy and volume change of mixing; Excess property of mixtures: Lewis Randall rule, Raoults law and Henry's law; Criteria for phase equilibrium: Vapour liquid equilibrium, modified Raoult's law and non-ideal mixtures; Excess Gibbs free energy models Margules, Van Laar, NRTL, etc.

UNIT IV: Chemical reaction equilibria 7 Hr.

Equilibrium criteria of chemical reaction, reaction coordinate, equilibrium constant, feasibility of chemical reactions and its relation to Gibbs free energy change; Homogeneous gas phase reaction equilibria: Effect of temperature, pressure, excess reactants and inerts on equilibrium conversion. Homogenous liquid phase reaction equilibria. Heterogeneous reaction equilibria.

Max: 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the concepts of thermodynamic laws and processes.

CO2: Understand and apply the fundamental knowledge of pressure volume temperature relationships.

CO3: Analyse the concept of vapour liquid equilibria.
CO4: Introduce excess properties and Gibbs free energy change during reactions.
CO5: Evaluate the residual properties using equation of state and excess properties of mixtures.
CO6: Understand the reaction coordinate, reaction equilibria and factors influencing it.

TEXT/REFERENCE BOOKS

1. Smith, J.M., Van Ness, H.C. and Abbott, M.M. "Introduction to Chemical Engineering Thermodynamics", 8th Edition, McGraw-Hill India (2019).
2. Halder, G. "Introduction to Chemical Engineering Thermodynamics", PHI Learning Private Limited, New Delhi (2009).
3. Dodge, B.F., "Chemical Engineering Thermodynamics", McGraw-Hill (1944).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Communication Skills – II (20HS201P)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To understand communication and its process and effect on giving and receiving information.
- To learn and apply communication skills in different public and interpersonal contexts.
- To develop analytical, research, and organizational skills through communication skills for a fulfilling career.

UNIT I: **7 Hr.**

- Technical Writing
  - ✓ Report Writing
  - ✓ Creating Lab Journals and Manuals
- Portfolio of Critical Writing and Creative Writing
  - ✓ Essay, Story-writing, etc.

UNIT II: **7 Hr.**

- Summarizing
- Writing Reviews (Books/Articles/Movies/websites)
- Reading Skills (Advanced)

UNIT III: **7 Hr.**

- Digital Literacy
  - ✓ Emails
  - ✓ Creating e-content
  - ✓ Editing and proofreading online
  - ✓ Using grammar and spell check software
  - ✓ Using plagiarism checkers

UNIT IV: **7 Hr.**

- Group Discussion
- Resume Writing
- Interview Skills

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Analyse and apply current technology for effective communication leading to better dissemination of knowledge and expertise.
CO2: Demonstrate relevant knowledge of communication skills in different settings to cater to different purposes and audiences.
CO3: Develop a sound understanding of communication theory, practice and application to optimize career opportunities.
CO4: Evaluate professional relationships and apply dynamic communication skills to build and maintain professional rapport.
CO5: Demonstrate effective communication skills to prepare and present messages, reports and documents in intent and to integrate different sources of information and knowledge.

CO6: Critically reflect on communication skills for the adoption of appropriate strategy required in achieving the desired outcomes.

TEXT/REFERENCE BOOKS

1. Harmer, Jeremy. The Practice of English Language Teaching. Harlow: Pearson Longman, 2007.
2. Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, (2006).
3. Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, (2001).
4. Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, (2002).
5. Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., (2009).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: Lab Work	50 Marks
Part B: Lab Exam/Viva	50 Marks

Teaching Scheme					Fluid Mechanics Practical (22PCM206P)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Demonstrate experiments in fluid mechanics and hydraulic machinery.
- Understand the functioning of various flow measuring devices.
- Discuss the performance characteristics of pumps.

LIST OF EXPERIMENTS

1. Determine the coefficient of discharge in a venturi meter.
2. Determine the coefficient of discharge in an orifice meter.
3. Determine the coefficient of discharge a notch.
4. Determine the coefficient of discharge a rota meter.
5. Verification of Bernoulli's theorem.
6. Determine the Reynolds number for a pipe flow.
7. Determine the kinematic and dynamic viscosity of the given fluid.
8. Determine the efficiency of centrifugal pump.
9. Determine the efficiency of reciprocating pump.
10. Determination of energy losses in pipe fittings.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Evaluate the coefficient of discharge of flow meters.
CO2: Verification of Bernoulli's equation.
CO3: Determine the Reynolds number of fluid flow.
CO4: Analyze the viscosity of fluid.
CO5: Determine the efficiency of pumps.
CO6: Evaluate the energy losses in pipe fittings.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hours**
Part A: Lab Work	50 Marks
Part B: Lab Exam/Viva	50 Marks

Teaching Scheme					Programming Lab (22PCM207P)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To acquire programming skills in core Python.
- To acquire Object Oriented Skills in Python.
- To develop the skill of designing Graphical user Interfaces in Python
- To develop the ability to write database applications in Python

UNIT I: **7 Hr.**

Introduction to Python: The basic elements of Python, Branching programs, Strings and Input, Iteration Functions, Scoping and Abstraction: Functions and Scoping, Specifications, Recursion, Global variables, Modules, Files Testing and Debugging: Testing, Debugging.

UNIT II: **7 Hr.**

Structured Types, Mutability and Higher-order Functions: Tuples, Lists and Mutability, Functions as Objects, Strings, Tuples and Lists, Dictionaries Exceptions and assertions: Handling exceptions, Exceptions as a control flow mechanism, Assertions,

UNIT III: **7 Hr.**

Classes and Object-oriented Programming: Abstract Data Types and Classes, Inheritance, Encapsulation and information hiding,Some Simple Algorithms and Data Structures: Search Algorithms, Sorting Algorithms, Hashtables.

UNIT IV: **7 Hr.**

Plotting and more about Classes: Plotting using PyLab, plotting mortgages and extended examples. Dynamic Programming and fibonacci sequence revisited; Dynamic programming and the 0/1 Knapsack algorithm; Dynamic programming and divide and conquer.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Identify situations where computational methods and computers would be useful
CO2: Given a computational problem, identify and abstract the programming task involved.
CO3: Choose the right data representation formats based on the requirements of the problem
CO4: Use the comparisons and limitations of the various programming constructs and choose the right one for the task in hand.
CO5: Write the program on a computer, edit, compile, debug, correct, recompile and run it
CO6: Identify tasks in which the numerical techniques learned are applicable and apply them to write programs and hence use computers effectively to solve the task.

TEXT/REFERENCE BOOKS

1. David Beazley and Brian K. Jones (2013) Python Cookbook, Third edition.
2. Eric Matthes (2013) Python Crash Course, 2nd Edition: A Hands-On, Project-Based Introduction to Programming

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hr.**

Part A: <Question: <Short Notes, Problems, Numerical>	20 Marks
Part B: 5 <Justification, Criticism, Long answers, Interpretation >	80 Marks

20PEB209					Rural Internship					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	0	2	Internship	-	-	-	50	50	100

COURSE OBJECTIVES

- The Internship aims at exploring the students to the life, culture and issues of rural India.
- The Internship exposes students to the socio-economic aspects of Rural India

Rural Internship

During the Internship student will be associated with rural India, exploring

(a) Rural Society
(b) Rural Life
(c) Rural Culture
(d) Rural Development Issues
(e) Rural Economy

Additionally, it also develops inter-personal skills and allied aspect.

Course outcomes:

On successful completion of the course, the student should be able to

CO-1: Summarize Rural Life of India for creating sense of belongingness for the community
CO-2: Demonstrate leadership qualities and societal responsibility
CO-3: Appraise concepts of rural life and rural society for sustainable development
CO-4: Evaluate skills on participatory methodologies and tools used in rural development.
CO-5: Discover cross-cultural learning on rural and development issues for inter-personal growth.
CO-6: Enable the students to appreciate the importance of agriculture, artisans and rural entrepreneurs in Rural India

TEXT/REFERENCE BOOKS

The Course is self-exploratory

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**
PART A: Evaluation Based on the class performance and field book **50Marks**
PART B: Viva Examination based data collected **50 Marks**

Teaching Scheme					Mechanical Operations (22PCM208T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the fundamentals associated with properties, handling and mixing particulate solids.
- Learn the principles and techniques of size reduction and screening.
- Analyze the principle and applications of filtration.
- Classify the principles and functioning of various solid-fluid operations.

UNIT I: Properties, handling and mixing of particulate solids **7 Hr.**

Characterization of solid particles, properties of particulate masses, storage of solids; Mixing of solids-Types of mixers, mixers for cohesive and free flowing solids; Conveying of solids.

UNIT II: Size reduction & screening **7 Hr.**

Principles of comminution; Size reduction equipment and their selection criteria: Crushers, grinders, ultrafine grinders, cutting machines; Screening: General factors in selecting screening equipment, industrial screening equipment, comparison of ideal and actual screens, screen efficiency.

UNIT III: Filtration **7 Hr.**

Filtration: Principles of filtration, selection criteria of filtration equipment and its operation; Sand filters; Centrifugal filtration: Selection criteria for centrifugal filters; Membrane filtration: Processes and types of membranes, operation conditions, penetration flux, microfiltration, ultra-filtration and reverse osmosis; Advanced filtration techniques.

UNIT IV: Heterogeneous separation process **7 Hr.**

Sedimentation, coagulation and clarification; Principles and working of clarifiers, thickeners sedimentation process; Gravity classifiers, sorting classifiers and thickeners; Principles of cyclones, hydroclones, scrubbers, magnetic and electrostatic separation equipment; Flocculation and froth-flotation techniques.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand and summarize the characterization of particulate solids and equipment for solid operations.
CO2: Classify suitable equipment for size reduction and comminution.
CO3: Apply the knowledge of different screening techniques, equipment and its effectiveness.
CO4: Analyze and design various filtration and membrane processes.
CO5: Select separation equipment for different fluid-solid operations.
CO6: Identify physicochemical and magnetic methods for the separation of heterogeneous mixtures.

TEXT/REFERENCE BOOKS

1. McCabe, W.L., Smith and Peter Hariott, "Unit Operations of Chemical Engineering", 7th Edition, McGrawHill, New Delhi, (2012).

2. Chhabra, R.P. and Basavarai G., “Coulson and Richardson’s Chemical Engineering: Volume 2A, Particulate systems and Particulate Technology”, 6th Edition. Pergamon Press, (2019).
3. Brown, G.G. “Unit Operations”, 3rd Edition, John Wiley & Sons, Inc., New York, (1968).
4. Kulkarni, A.P., Hiremath, R.S., “Mechanical Operations”, 21st Edition. Everest Publishing House, (2020).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Heat Transfer (22PCM209T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the concepts of conduction, convection and radiation.
- Familiar with heat transfer with phase change.
- Understand the design principles of heat exchanger.

UNIT I: Heat transfer by conduction **7 Hr.**

Importance of heat transfer in petrochemical engineering operations; Modes of heat transfer; One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and spheres; Thermal conductivity measurement; Effect of temperature on thermal conductivity; Heat transfer in extended surfaces.

UNIT II: Heat transfer by convection and phase change **7 Hr.**

Mechanism, thermal and velocity boundary layers, boundary layer thickness, relationship between hydrodynamic and thermal boundary layer thickness for flow over flat plates; Estimation of convection and its heat transfer coefficient; Correlation for heat transfer in laminar and turbulent flow; Dimensional analysis; Natural convection under different conditions; Physical significance of Grashoff's and Rayleigh's numbers. Pool boiling: Boiling curve, hysteresis in the boiling curve, nucleate boiling; Condensation: Physical mechanisms, types of condensation, factors affecting condensation.

UNIT III: Heat transfer by radiation **7 Hr.**

Introduction, theories of radiation, electromagnetic spectrum, spectral emissive power, surface emission, total emissive power, emissivity; Radiative properties, emission, irradiation, absorptivity, reflectivity and transmissivity; Concept of black and grey body, radiation intensity, laws of black body radiation, non-black surfaces, radiation between black and grey surfaces.

UNIT IV: Heat exchangers **7 Hr.**

Classification of heat exchangers: Classification according to transfer processes, number of passes, surface compactness, construction features, flow arrangements, heat transfer mechanisms; Shell and tube heat exchanger, fouling, LMTD and its correction factor; Concept of effectiveness: NTU method, definition of effectiveness, effectiveness NTU relations in counter-flow and parallel flow configurations. Double pipe heat exchangers: Construction, various steps for the design.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Identify different modes of heat transfer and understand basic mechanism of conduction.
CO2: Explain heat transfer under different convective regimes.
CO3: Describe various regimes involved in boiling and condensation.
CO4: Predict extent of heat transfer by radiation through black and nonblack bodies.
CO5: Understand the selection of heat exchangers for various applications.
CO6: Evaluate the effectiveness of heat exchangers.

TEXT/REFERENCE BOOKS

1. Kern D.Q., "Process Heat Transfer", McGraw Hill Book Co. (1997).

2. Dutta B.K., “Heat Transfer: Principles and Applications”, Prentice Hall of India (20000.
3. Coulson J.M. and Richardson J.F., “Chemical Engineering Volume 1”, Pergamon Press (1999).
4. Holman J.P., “Heat Transfer”, 10th Edition, McGraw-Hill (2017).
5. Incropera, F.P., DeWitt, D.P., Bergman, T.L. and Lavine, A.S., “Introduction to Heat Transfer”, 5th Edition, John Wiley & Sons (2006).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Hydrogen and C_1 Technologies (22PCM210T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Get a clear idea about the petrochemical Industry, its structure and constitutions.
- Understand the requirements of feedstocks for the production of hydrogen and synthesis gas.
- Study the various processes to produce hydrogen from hydrocarbons.
- Understand C_1 based technologies emphasizing on methanol synthesis
- Understand and evaluate methanol economy and futuristic C_1 technologies.

Unit I: Petrochemical industry its structure and feedstocks 6 Hr.

Natureof petrochemicals: C_1, olefin and aromatic complexes; Petroleum feedstocks for production of hydro-gen and synthesis gas, types of synthesis gas and their applications; Production of hydrogen by elec- trolysis of water and its transportation.

Unit II: Hydrogen production and purification 8 Hr.

Steam reforming of hydrocarbons: Reactions, catalysts and processes; Arrangement of steam re-former: Low temperature and high temperature shift convertors and operating conditions; Auto-ther-mal reforming; Water gas shift reaction, production of hydrogen by partial oxidation, reactions and technology; Purification of hydrogen.

Unit III: Production of C_1 petrochemicals 8 Hr.

Scope of C_1 petrochemicals; Production of carbon mono oxide and its purification; Methane and its purification; Synthesis of Methanol: Chemistry, thermodynamics, kinetics and catalysis; Processes of methanol production; Synthesis of chloro-methanes and production processes; Methanol derivatives: Formaldehyde, MTBE, etc.

Unit IV Modern developments in C_1 technologies 6 Hr.

Methanol economy, general outlook; Fischer-Tropsch synthesis: Its scope, chemistry, catalysis, prod-uct profile and technologies; Methanol to gasoline processes.

Total 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the structure of petrochemical processes.
CO2: Understand and realise the effect of feedstocks on petrochemical processes.
CO3: Analyse the effect of various factors on hydrogen and synthesis gas production.
CO4: Illustrate the importance of C_1 technologies.
CO5: Evaluate the various technologies for methanol and its derivatives.
CO6: Design and apply concepts to the recent developments in C_1 technologies.

TEXT/REFERENCE BOOKS

4. Moulijn, J.., Makkee, M. and Van Diepen, A. “Chemical Process Technology”, 2nd Edition, Wiley, (2013).
5. Chauvel, A. and Lefebvre, G., “Petrochemical Processes I”, Technip, (2001).

6. Olah, G.A. Goeppert, A. and Prakash, G.K.S., “Beyond Oil and Gas: The Methanol Economy”, 3rd Edition, Wiley VCH, (2018).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Mass Transfer – I (22PCM211T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- Learn to evaluate mass transfer rates under laminar and turbulent conditions.
- Learn the principles of adsorption, absorption and distillation operations.
- Provide introduction to physical and thermodynamic principles of mass transfer.
- Learn the design principles of mass transfer equipments.

UNIT I: Introduction to mass transfer **11 Hr.**

Introduction to mass transfer operations; Molecular diffusion in gases, liquids and solids; Diffusivity measurement and prediction; Multi-component diffusion; Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients; NTU and NTP concepts; Stage-wise and differential contractors.

UNIT II: Absorption operations **10 Hr.**

Principles of absorption; Single and multicomponent absorption; Absorption with chemical reaction, equilibrium and material balance; Limiting gas-liquid ratio; Tray tower absorber design: Calculation of number of theoretical stages, tray efficiency, tower diameter; Packed tower absorber: Rate based approach, determination of height of packing using HTU and NTU calculations; Industrial absorbers.

UNIT III: Adsorption operations **10 Hr.**

Adsorption: Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms; Adsorption operations: Stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers; Break through curves.

UNIT IV: Distillation operations **11 Hr.**

Vapour liquid equilibria; Raoult's law; Vapour-liquid equilibrium diagrams for ideal and non-ideal systems; Enthalpy concentration diagrams; Distillation methods: Flash distillation, differential distillation, steam distillation, azeotropic distillation, extractive distillation and multistage continuous rectification; Number of ideal stages by McCabe Thiele method; Total reflux, minimum reflux ratio and optimum reflux ratio; Industrial distillation equipment.

Max. 42 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the mechanisms and functioning of absorption, adsorption and distillation equipment.
CO2: Acquaint with various gas-liquid, vapour-liquid, solid-liquid and liquid-liquid equilibrium.
CO3: Apply correlations for estimating diffusion and mass transfer coefficients.
CO4: Investigate multi-stage equilibrium separation processes.
CO5: Apply diffusive and convective mass transfer equations and correlations.
CO6: Design absorber, adsorber and distillation column.

TEXT/REFERENCE BOOKS

1. Treybal R.E., "Mass Transfer Operations", 3rd Edition. Mcgraw Hill, (1981).

2. McCabe, W.L., Smith, J.C., and Hariott, P., "Unit Operations of Chemical Engineering", 7th Edition, McGrawHill, (2012).
3. Geankoplis C.J. "Transport Processes and Unit Operations", 3rd Edition, Prentice Hall of India, (2002).
4. Coulson and Richardson's, "Chemical Engineering. Vol I & II", Asian Books Pvt Ltd, (1998).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Petroleum Refinery Engineering (22PCM212T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand various petroleum feed stocks and refining processes.
- Explain the different methods for the petrochemical processes and their applications.
- Understand primary and secondary processing techniques.

UNIT I: Petroleum crude and products characterization 6 Hr.

Types of crude, composition and its characteristics; Crude oil properties. Standards and testing of petroleum crude and its products; Specifications and their significance.

UNIT II: Processing of petroleum and treatment techniques 8 Hr.

Pre-treatment of crude: Dehydration and desalting; Distillation: Atmospheric and vacuum; Treatment techniques: Solvent extraction, deasphalting, dewaxing, hydrofining, catalytic dewaxing and clay contact process; Production of lubricating oils; Hydro-treating.

UNIT III: Thermal and catalytic cracking 7 Hr.

Thermal cracking, visbreaking, coking: Processes, operating parameters, feed stock selection and product yields; Fluid catalytic cracking and hydro-cracking: Processes, operating parameters, feed stock selection and product yields.

UNIT IV: Up-gradation of refining products 7 Hr.

Principle, processes, operating parameter and advantages: Reforming, isomerisation, alkylation and polymerization. Asphalt manufacturing and air blowing technology; Bitumen types and their properties; Acid gas removal, desulphurization and other impurities removal techniques.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize diversity of petroleum crude and know their properties.
CO2: Understand various primary crude processing techniques.
CO3: Classify and compare various secondary and their supporting processes.
CO4: Familiar with various refinery processes.
CO5: Analyse the process up-gradation technologies.
CO6: Evaluate various residue processing methods.

TEXT/REFERENCE BOOKS

1. Gary, J.H., Handwerk, G.E. and Kaiser, M.J., "Petroleum Refining: Technology and Economics", 5th Edition, CRC Press (2007).
2. Fahim, M., Al-Sahhaf, T. and Elkilani, A., "Fundamentals of Petroleum Refining", 1st Edition, Elsevier B.V. (2010).
3. Coker, K.A., "Petroleum Refining Design and Applications Handbook", Volume 1, 1st Edition, Wiley-Scrivener Publishers (2018).
4. Meyers, R.A., "Handbook of Petroleum Refining Processes", 4th Edition, McGrawhill Education (2016).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hr.**

Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Chemical Engineering Practical (22PCM213P)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Develop student's ability to investigate and experiment.
- Develop experimental skills.
- Analyze the data and interpret the results.
- Report observations and results in appropriate manner.

LIST OF EXPERIMENTS

I. HEAT TRANSFER EXPERIMENTS

1. Determination of thermal conductivity of solids.
2. Determination of heat transfer by forced convection.
3. To compare overall heat transfer coefficients for parallel flow and counter flow in double pipe heat exchanger.
4. To study the performance of shell and tube heat exchanger and calculate overall heat transfer coefficient.
5. Determination of heat transfer coefficient in laminar flow.
6. Radiation heat transfer.

II. MECHANICAL OPERATION EXPERIMENTS

1. Performance of sieve analysis of a given sample and determination of effectiveness of a screen.
2. Study the performance and characteristics of size reduction equipment.
3. Determine of the collection efficiency of the cyclone separator.
4. Study the performance of plate and frame filter press.
5. Study the performance of batch sedimentation.
6. Study the operational characteristics of batch centrifuge.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Determine the rate of heat transfer by conduction, convection and radiation.
CO2: Estimate the overall heat transfer coefficient of heat exchangers.
CO3: Design and analyze various parameters of heat transfer equipment.
CO4: Analyze the efficiency of various size reduction equipment.
CO5: Evaluate the efficiency of cyclone separator and filter press.
CO6: Analyze sedimentation and centrifugal separation operations.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hr.**

Part A: Lab Work 50 Marks

Part B: Lab Exam/Viva 50 Marks

Teaching Scheme					Petroleum Product Testing Practical (22PCM214P)					
					Examination Scheme					
					Theory			Practical		
L	T	P	C	Hours/Week	MS	ES	IA	LW	LE/Viva	Total Marks
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Gain expertise of handling liquid petroleum products and their analysis.
- Analyze the problems of storage and transportation of petroleum products.
- Identify the design parameters related to petroleum distillation.
- Evaluation of the petroleum product properties.

LIST OF EXPERIMENTS

1. Determination of acid number of fuel samples.
2. Determination of boiling point range of petroleum fraction by ASTM distillation apparatus.
3. Determination of viscosity of a sample by Say Bolt viscometer.
4. Identification of smoke point and luminosity number.
5. Determination of calorific value of solid and liquid fuels by bomb calorimeter.
6. Determination of flash and fire point by Pensky-Martin apparatus.
7. Determination of flash and fire point by Cleveland open cup apparatus.
8. Identification cloud point and pour point of petroleum products.
9. Determination of aniline point.
10. Evaluation of diesel index and cetane number of given samples
11. Study of copper corrosion for a given sample.
12. Determination of the moisture content of the given fuel sample using dean and stark apparatus.
13. Determination of the saponification value of an oil sample.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the experiments related physical characterization.
CO2: Estimate the calorific value of fuels by bomb calorimeter.
CO3: Examine the flash and fire point of diesel and kerosene oil.
CO4: Estimate the aniline point of refinery products to confirm the organic contents.
CO5: Understand the quality assurance issues as per the requirements of industry.
CO6: Assess the characteristics of refinery products by ASTM distillation apparatus.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hr.**

Part A: Lab Work 50 Marks
Part B: Lab Exam/Viva 50 Marks

Teaching Scheme					MATLAB Programing Practical (22PCM215P)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/VIVA	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVE:

- Acquire programming skills in MATLAB.
- Impart knowledge on various syntaxes in MATLAB and development of user defined functions.
- Exposure to algorithms solve engineering problems by computational methods.
- Develop algorithms to solve complex engineering problems.

LIST OF EXPERIMENTS

1. Data representation, error analysis, introduction to MATLAB; Applied MATLAB programming
2. Structured programming and looping.
3. Numerical solution of algebraic and transcendental equations.
4. Interpolation: Newton Gregory forward interpolation and Lagrange's interpolation.
5. Curve fitting: Straight line fit, polynomial curve fit and exponential curve Fit.
6. Numerical integration: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule, Weddle's rule, Romberg's method and double integration.
7. Solution of simultaneous algebraic equations: Gauss elimination method.
8. Numerical solution of ordinary differential equation: Taylor's method, Euler's method, Runge-Kutta method, modified Euler's method; Predictor corrector method: Adam's method and Milne's method.
9. Numerical solution of partial differential equation: Bender-Schmidt method and Crank- Nicholson method.
10. Optimization algorithms and introduction to Simulink.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: Understand various numerical tools in MATLAB and develop an analogy between MATLAB and other programming toolboxes.
CO2: Develop solution to various numerical problems in differentiation, integration and curve fitting.
CO3: Classify and develop solution to initial and boundary value problems applied to petrochemical technology.
CO4: Evaluate solutions to algebraic equations and statistical techniques.
CO5: Formulate mathematical model to complex engineering problems and develop solution algorithms.
CO6: Correlate the fundamental concepts gained to develop efficient solution.

TEXT/REFERENCE BOOKS:

1. Chapra, S., "Applied Numerical Methods with MATLAB for Engineers and Scientists", Edition: 4, McGraw-Hill Education (2017).

2. Pratap, R. “Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers’’, Oxford University Press, (2010).
3. Ahuja, P. “Introduction to Numerical Methods in Chemical Engineering”, PHI Learning Pvt., Edition: 2 (2019).
4. Yang, W.Y., Cao, W., Chung, T. and Morris, J. “Applied Numerical Methods Using MATLAB”, John Wiley & Sons, Inc. (2005).
5. Kreyszig, E. “Advanced Engineering Mathematics”, Edition: 10, Wiley (2015).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: Lab Work	50 Marks
Part B: Lab Exam/Viva	50 Marks

Elective					Pharmaceutical Technologies (22PCM216T)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Gain fundamental knowledge associated with pharmaceutical technologies and product development.
- Develop ideas of various techniques involved in pharmaceutical manufacturing.
- Learn, select and apply appropriate methods, procedures and resources.
- Understand the different dosage forms, manufacturing process, importance of quality control and stages of pharma product development.

UNIT I: Pharmaceutical preparations **6 Hr.**

Classification of Dosage forms I. Solid Dosage: Powders, Tablets, Capsules, and Granules. II. Semi solid Dosage: Creams, Gels, Ointment and Paste. III. Liquid Dosage: Monophasic (Syrups, Elixirs, Mouthwashes, drops), Biphasic liquids: Suspension, Emulsion. IV. Gas Dosage: Aerosols. Different routes of drug administration: Oral, Parenteral, Dermal, Nasal, Ocular, Rectal and their merits & demerits.

UNIT II: Pharmaceutical engineering **7 Hr.**

Principle and theories of various pharmaceutical process
Mixing: Double cone blender, ribbon blender, Sigma blade mixer and planetary mixers; Size reduction: Ball mill, fluid energy mill and Edge runner; Filtration: Frame filter, Meta filter, membrane filters and Seidtz filter; Drying: Tray dryer, drum dryer, spray dryer and fluidized bed dryer.

UNIT III: Pharmaceutical Manufacturing **7 Hr.**

Tablets: Formulation of tablets, Coating: film coating, enteric coating and micro-encapsulation, Quality control of tablets: Physical standards, Disintegration and Dissolution of tablets. Capsules: Hard and soft gelatin capsules, Filling, Storage and Quality control of capsules.

UNIT IV: Pharmaceutical product development **8 Hr.**

Pre-clinical studies: (Safety and Efficacy), Clinical studies (Phase I-IV), CDSCO- Regulatory requirements and approval, Drug distribution cycle.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Gain fundamental knowledge of different pharmaceutical preparations.
CO2: Understand the principles and theories of pharmaceutical techniques.
CO3: Classify and compare various dosage forms and their applications.
CO4: Get acquainted with pharmaceutical manufacturing procedures and its quality control.
CO5: Focus professionally on pharmaceutical product development.

CO6: Design and develop solutions to pharmaceutical manufacturing problems

TEXT/REFERENCE BOOKS

1. Lachman Liebermans., "The Theory and Practice of Industrial Pharmacy", 4th Edition, CBS publisher (2020).
2. Loyd.V.Allen., " Ansel's Pharmaceutical Dosage Form and Drug Delivery System", 11th Edition, Wolters Kluwer India Pvt. Ltd publisher (2018).
3. Subrahmanyam, C.V.S., "Physical pharmaceutics", 3rd Edition, Vallabh Prakashan publisher (2015).
4. Carter, S.J., "Cooper and Gunn's Tutorial pharmacy", 12th Edition, CBS Publishers (2008).
5. Subrahmanyam, C.V.S., "Pharmaceutical engineering Unit operations principles and practices", Vallabh Prakashan publisher (2019).
6. Shivpuje, S.S., Singh, M.C. and Vishwe, P.S., "Pharmaceutics", Volume-1, Technical Publications (2009).
7. Globig, S. and Hunter Jr. W., "Pharmaceutical Technology", 1st Edition, Apple Academic Press (2012).
8. Parthasarathi G, Karin Nyfort-Hansen, Milap C Nahata. A textbook of Clinical Pharmacy Practice-essential concepts and skills, 1st ed. Chennai: Orient Longman Private Limited publisher (2004).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

Teaching Scheme					Elective - Nanotechnology (22PCM217T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the fundamental concept of nanotechnology.
- Design and development of various nanomaterials.
- Apply principle and application of various analytical instruments.
- Understand the various synthesis processes for nanomaterials.
- Acquainted with prospects of nanotechnology in petrochemical industry.

UNIT I: History & background **4 Hr.**

History and origin of nanoscience and technology; Definitions: Nanoscience, nanotechnology and nanomaterials; Nanotechnology timeline: 18^{th}, 19^{th} and 20^{th} century; Evaluation of nanotechnology; Nano and nature.

UNIT II: Fundamentals of nanomaterials **10 Hr.**

Fundamental properties: Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials; Types of nanomaterials (0D, 1D, 2D and 3D) with examples; Relationship between dimension and shape of nanomaterials; Synthesis approaches: Top down and bottom up approach; Metal nanocrystals by reduction, solvo-thermal synthesis, photochemical synthesis, electrochemical synthesis, nanocrystals of semiconductors and other materials by arrested precipitation, thermolysis routes, sono-chemical routes, liquid-liquid interface, hybrid methods and solvated metal atom dispersion; Post-synthetic size-selective processing.

UNIT III: Nanostructured design **6 Hr.**

Functionality of nanostructures and their characteristic evaluation; Size effect in semiconductor nanoparticles: Particle size, shape density, melting point, surface tension, wettability, specific surface area, pore-assembly of nanoparticles, functionalization and self-assembly; Application of nanotechnology in petrochemical industry.

UNIT IV: Characterization techniques **8 Hr.**

Fundamental of optical microscopy; Scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD) and small angle XRD, energy-dispersive X-ray (EDX) spectroscopy, thermal gravimetric analysis (TGA), dynamic light scattering (DLS) analysis and zeta sizer.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the history, background and the nature of the nanotechnology.
CO2: Acquainted with different type of nanostructures and analyze the top down and bottom up approach.
CO3: Explain the functionality of nanostructures and their characteristic evaluation, self-assembly and its applications.
CO4: Analyse the surface modification of nanoparticles by surface functionalization and their application.
CO5: Design of nano-catalysts for petrochemical application.

CO6: Evaluate various nanomaterial characterization techniques applied to petrochemical industry.

TEXT/REFERENCE BOOKS

1. Rao, C.N.R., Muller, A. and Cheetham, A.K. "The Chemistry of Nanomaterials: Synthesis, Properties and Applications" Volume: 2 (2004).
2. Schmidt, G. "Nanoparticles: From Theory to Applications", Edition: 2, Wiley-VCH Verlag (2004).
3. Mansfield, J. "Microscopy and Microanalysis", Volume: 27, Cambridge University Press (2021).
4. Ozin, G.A. and Arsenault, A. "Nanochemistry: A Chemical Approach to Nanomaterials", Royal Society of Chemistry (2005).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM301T					Instrumentation and Process Dynamics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To have a clear idea of Instrumentation and process dynamics
- To understand the basic aspects of process instrumentation and control terminology
- To study the piping and instrumentation diagrams.
- To understand process modelling and dynamics.
- To be able to develop fundamental process models.
- To study the stability and dynamic performance of processes.

Unit I : Meaurement and Instrumentation **6 Hr.**

Sensors and transducers, physical, chemical and biosensors. Pressure, temperature, level, flow, concentration and pH measurements. Measurement errors and accuracy, signal conditioning. Process control terminology; input and output variables, controlled variables, manipulated variables, set point. Measured and unmeasured variables, Block diagram, positive and negative feedback, distributed control system, SCADA, D/A, A/D conversions. Quality control and reliability.

Unit II: **Piping and Instrumentation diagram** **6 Hr.**

Symbols and layout. Basic symbols, instrument lines, Design of piping systems, pipe size selection, economic pipe diameter, valve selection, pump selection, control valves, general controller symbols, failure modes etc.

Unit III: **Process Modelling and dynamics** **7 Hr.**

Process modelling and its necessity, classification of models, development of models from fundamental laws, input-output models. Concept of transfer function, properties of transfer functions, Development of dynamic models for thermometer, thermocouple, dynamics of liquid level, dynamics of non-interacting and interacting systems, forcing functions. Dynamics of more complex systems, first order plus dead time, second order, pure gain and pure capacity process, lead lag system.

Unit IV: **Process Analysis and Dynamic Performance** **7 Hr.**

Input-output stability, effect of zeros, frequency response and its evaluation for common system. Bode diagrams, Nyquist diagrams, Rouths criterion and root locus method. Elements of control strategies.

Max. 26 Hr.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: Understand the function of basic process instruments
CO2: Generalise the basic control terminology and P&I diagrams
CO3: Demonstrate process models and their classification.
CO4: Analyse various process models.
CO5: Develop the dynamics of complex processes.
CO6: Evaluate the stability of processes.

TEXT / REFERENCE BOOKS:

1. Ogunnake, B, A. and Harmon Ray, W. , Process Dynamics, Modelling and Control, Oxford University press, 1984.
2. Stephanopoulous, G., Chemical Process Control, Prentice-Hall International editions, 1984.
3. Sarkar, P,K., Advanced process dynamics and control, PHI learning private Limited, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM302T				Mass Transfer - II						
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

To study the stage wise mass transfer operations, principles of various stage wise contact processes like extraction, adsorption, drying and crystallization.

UNIT I: **Extraction** **14 Hr.**

Soli- Liquid, Liquid-liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction**.**

UNIT II: Drying **13 Hr.**

Drying: Equilibrium, Definitions, and Drying Conditions - Rate of Batch Drying under constant drying conditions, Mechanisms of batch drying, Drying time Through Circulation Drying. Classification Of Drying Operations: Batch and Continuous Drying Equipment, Material and Energy Balances of Continuous Driers, rate of drying for continuous direct heat driers.

UNIT III: Crystallization **13 Hr.**

Crystallization - Equilibrium, classification of crystallizers, mass and energy balance; kinetics of crystallization – nucleation and growth; design of batch crystallizers; population balance model and design of continuous crystallizers.

UNIT IV: Membrane Separation Process **12 Hr.**

Materials, types and preparation of membranes, membrane characterization, membrane modules, pressure-driven membrane processes for liquid separation, Concentration – Driven processes, Membrane gas separation.

Max. 52 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Describe the theory and derivations of extraction operations.
CO2: Design the various industrial extraction equipment.
CO3: Analyse the moisture by various drying operations
CO4: Determine the materials and energy balance for drying operations.
CO5: Familiar with crystallization operation and its equilibrium stage.
CO6: Understand the different types of membrane processes.

TEXT / REFERENCES BOOKS

1. Treybal, R.E., “Mass Transfer Operations “, 3rd Edn., McGraw-Hill, 1981.

2. Dutta, B.K., “Principles of Mass Transfer and Separation Processes”, Printice Hall of India Pvt Limited, New Delhi.
3. Wankat, P., “Equilibrium Stage Separations”, Prentice Hall, 1993.
4. Geankoplis, C.J., “Transport Processes and Unit Operations”, 4th Edition, Prentice Hall Inc., New Jersey, 2003.
5. Seader, J.D. and E.J. Henley, “Separation Process Principles”, 2nd Ed., John Wiley,2006.
6. McCabe, W.L., Smith, J.C., and Harriot, P., “Unit Operations in Chemical Engineering”, 7th Edn., McGraw-Hill, 2005.
7. King, C. J., “Separation Processes “, 2nd Edn., Tata McGraw-Hill 1980.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM303T					Petrochemical Processes - II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To have a clear idea of the Petrochemical Industry, its structure and constitution.
- To understand the requirements of feedstocks for production of olefins and diolefins
- To study the processes to produce light olefins with emphasis on engineering aspects.
- To learn the commercial utilization of diolefins and higher olefins and their commercial production.
- To understand the upgradation of C4 and C5 cuts.
- To study and understand the Polyolefin technologies and their commercial features

Unit I: **The Structure and feedstocks of Olefin Industry** **8 Hr**.

The nature of olefin production complexes. Petroleum feedstocks for production of primary and higher olefins; their origin and availability. Specifications of Naphtha (long and short), VGO, RCO, role of impurities such as sulfur and metal content and its bearing on processing, purity and yield.

Unit II : **Olefin production and purification** **12 Hr**.

Pyrolysis of hydrocarbons. Bond energies, pyrolysis models, thermodynamic aspects, factors affecting pyrolysis processes, operating variables, severity concept, residence time. Naphtha cracking versus gas cracking, cracking of heavy hydrocarbons, product profiles. Hardware aspects; pyrolysis furnaces, constructional features, SRT heaters, quench, quenching devices, transfer line exchangers etc. Separation and purification of olefins from pyrolysis products, recent developments in olefin production. Pyrolysis gasoline and its utilization, energy considerations. Oligomerization of light olefins, olefin metathesis.

Unit III : **Diolefins and higher olefins.** **9 Hr.**

Dimerization of olefins, paraffin dehydrogenation, UOP pacol process, dehydration of alcohol and other processes. Upgradation of C4 cuts, recovery of butadiene from C4 cuts, separation of mono-olefins from C4 cuts, MTBE and t-butyl alcohol synthesis. Upgradation of C5 cuts and recovery of isoprene. Butadiene production by catalytic dehydrogenation.

Unit IV : **Polyolefin production** **10 Hr.**

Microstructural features of polymers and their effect on properties. Polyolefin types, microstructural classification, polymerization catalysis and mechanism, Polyolefin reactors and processes. Basell spherilene, spheripol and spherizone technology, Chevron Phillips process, high pressure processes, Unipol PE gas phase process etc.

Max. **39 Hr.**

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Visulize the structure of Olefin complexes
CO2: Comprehend and evaluate the effect of feedstocks on olefin production.
CO3: Analyse the effect of various parameters on olefin and diolefin production.
CO4: Visulize the upgradation of C4 and C5 cuts.
CO5: Evaluate the technologies for polyolefin production.
CO6: Focus the current developments in olefin and polyolefin technologies.

TEXT/REFERENCE BOOKS

1. Moulijn, J. A., Makkee, M and Van Diepen, A. E. Chemical Process Technology, Second Edition, Wiley, 2013.
2. Chauvel, A and Lefebvre, G. Petrochemical Processes I, Technip, Paris, 1989
3. Meyers, R A. Handbook of Petrochemical Production Processes, McGraw-Hill, 2005.
4. Asua, J, M. Polymer Reaction Engineering, Blackwell Publishing, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM304T					Design of Petrochemical Process Equipment					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To introduce basic concepts, and design calculations piping system
- To familiarize basic knowledge on design of storage Tanks
- To enumerate different factors considered in design pressure vessels
- To introduce fundamental concepts on mixing and reactor design

UNIT I: Fundamentals of Piping **12 Hr.**

A brief revision covering friction factor, pressure drop for flow of non-compressible and compressible fluids, (Newtonian Fluids), pipe sizing, Pipes and Tube Standards, Types of valve fittings and Valves, selection of fittings, economic velocity of liquid and gas handling. Pipe line networks and their analysis for flow in branches, restriction orifice sizing. Pipe supports, pressure drop calculations for non-Newtonian fluids. Determination of internal and external design pressures, Pipe line design on fluid dynamic parameter. , selection of valves Design of pipeline for natural gas, Pipeline design for transportation of crude oil. Power required in fan, blower and adiabatic compressor.

UNIT II: Storage Tanks **14 Hr.**

Study of various types of storage vessels and applications, Atmospheric vessels, vessels for storing volatile and non-volatile liquids, storage of gases, Losses in storage vessels, Various types of roofs used for storage vessels, Design of cylindrical storage vessels as per IS: 803- design of base plates, shell plates, roof plates, wind girders, curb angles for self-supporting and column supported roofs. Design of rectangular tanks as per IS: 804. Stresses in the shell of a tall vertical vessel, and period of vibration. Vessel supports- introduction and classification of supports, design of skirt supports considering stresses due to dead weight, wind load, seismic load, design of base plate, skirt bearing plate, anchor bolts, bolting chairs and skirt shell plates Design of saddle supports, ring stiffeners.

UNIT III: Pressure Vessels **14 Hr.**

Stresses due to static loads, thermal stresses, stresses caused by bending and wind loads. Thin and thick wall cylinders under internal and external pressure. Thin and thick-walled spherical shells under internal and external pressure, prediction of failure of vessels by maximum normal stress theory and maximum strain theory., different types of heads, design of stiffening rings, design of nozzle, reinforcement pad, gasket, flanges, agitator, design of jackets for heating and cooling.

UNIT IV: Reactor Vessels & Agitators **12 Hr.**

Agitators: a study of various types of agitators, their selection, application, baffling, agitator, shaft diameter calculations, twisting moment, equivalent bending moment, Power requirement calculate ns for agitation systems.

Reaction vessels: classification, heating systems, design of vessels, study and design of various types of jackets like plain, half coil, channel, limpet oil, study and design of internal coil reaction vessels, heat transfer coefficients in coils.

Max. 52 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Estimate pressure loss in pipeline networks
CO2: Select proper pipe and pipe fitting based on pressure loss in pipeline
CO3: Analyse various factors effect selection of storage vessels and suggest thickens and dimensional requirement of storage vessels
CO4: Design pressure vessels based on process and external conditions:
CO5: Calculate power requirements of mixing and agitations equipment
CO6: Analyse various factors to Analyse be considered in the design of reacting vessels

TEXT/REFERENCE BOOKS

(1) Process Equipment Design – M V Joshi & V V Mahajani, 5th Edition, Trinity Press, 2017
(2) Applied Process Design for Chemical and Petrochemical Plants" vol 1, 2 and 3 Ernest E. Ludwig, Gulf Professional Publishing 3 rd Edition , 2001.
(3) Introduction to Process Engineering and Design by S B Thakore and B I Bhatt, Tata McGraw Hill, 1st Edition, 2007
(4) Coulson& Richardson's Chemical Engineering - Vol. 6 by R K Sinnott,CBSPD. 2006
(5) Process equipment design" by L.E. Brownell and E. Young, John Wiley, New York, 1963

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM305T					Gas Processing Technologies					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the various types of gas processing and utilization techniques.
- Identify the parameters and selection criteria for different gas operations.
- Enable to identify different types of processing for gas dehydration and sweetening.
- Develop skills to plan processing required to meet market specification economically.
- Gather comprehensive understanding and information about the C_1 and C_2 gas value chain
- Identify applications of gas in different sectors like Industrial, commercial, residential and electric generation and transportation.

UNIT I: Introduction to C_1 and C_2 gases **6 Hr.**

C_1 and C_2 gas industries. Natural gas and coal bed methane technology and earth science. Global and Indian scenario of gas. Property and its evaluation. Introduction to gas production, gas processing, gas compression, flow measurement, gas transportation: Road, rail and pipeline transport, Liquefied gas and compressed gas (LNG, CNG).

UNIT II: Processing **7 Hr.**

Gas processing; Gas and liquid separation, separation equipment, types of separators, separation principles, separator design, stage separation, low temperature separation and gas cleaning. Gas-water system and dehydration processing: Water content of natural gas, gas hydrates, absorption dehydration, adsorption dehydration. Advanced dehydration processes. Desulfurization processing: removal processes, solid bed sweetening processes and physical and chemical absorption processes. Advanced desulfurization process. Membrane separation processes.

UNIT III: Transportation **7 Hr.**

Introduction to gas usage and city gas distribution, Gas flow in pipelines at high, medium and low pressure, fluid dynamics and thermodynamics, Gas Flow Equations: General flow equation, Panhandle-A equation, Panhandle-B equation, Weymouth equation,, Polyflo equation, Lacey's equation and equation of velocity for gas pipeline. Steel, MDPE Pipelines, Pressure Regulators and Valves. Safety Guidelines, T4S regulations, Impact on environment, Disaster Management Plan.

UNIT IV: Utilization **6 Hr.**

Gas Compression: Positive displacement and centrifugal compressors; fans. Gas utilization as fuels in industrial, commercial, residential, and electric generation; transportation; Utilization in petrochemicals manufacturing.

Max. 26 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize the fundamental of gas processing and its components
CO2: Understand the various influential parameters in gas processing operation.

CO3: Identifies various petrochemicals from C_1 and C_2 and learn their production techniques and examine various associated challenges.
CO4: Understand the gas processing, gas compression, transportation, operation and trouble shooting
CO5: Examine critical issues related to natural gas processing and various associated challenges
CO6: Identify applications of C_1 and C_2 gases in different sectors.

TEXT/REFERENCE BOOKS

(1) Gas Production Engineering, Sanjay Kumar, Gulf Publishing Company, 1987.
(2) Standard Handbook of Petroleum and Natural Gas Engineering. 3rd Edition. William C Lyons, Gary C Plisga. Gulf Professional Publishing, 2015.
(3) Shashi Menon, "Gas Pipeline Hydraulics", Taylor & Francis Group, 2005.
(4) John M Campbell "Gas Conditioning & Processing" Volume 2, Volume 3, Volume 4 published by Campbell Petroleum Series, 1988.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM302P					Mass Transfer Lab.					
Teaching Scheme					Examination Scheme					
					Theory			Practical		Total Marks
L	T	P	C	Hr/Week	MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

Students develop sound working knowledge of various mass transfer equipment.

Week 1: Estimation of diffusivity coefficients for vapor in gas
Week 2: Separation of binary mixture using Simple distillation.
Week 3: Separation of binary mixture using Steam distillation.
Week 4: Separation of binary mixture using packed column distillation
Week 5: Determine the Vapor Liquid Equilibrium.
Week 6: Liquid-liquid extraction
Week 7: Drying characteristics of Vacuum/Tray/Rotary dryer.
Week 8: Mass transfer characteristics of Rotating disc contactor.
Week 9: Estimation of mass/heat transfer coefficient for cooling tower.
Week 10: Evaluation of Mass transfer coefficients for Surface Evaporation.
Week 11: Adsorption studies
Week 12: Leaching studies
Week 13: Demonstration of Gas – Liquid absorption

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Estimate diffusivity coefficients.
CO2: Estimate the separation operation by distillation and its equilibrium.
CO3: Analyze the drying characteristics.
CO4: Understand the working principle of cooling tower and evaporation
CO5: Demonstrate the adsorption and absorption operations.
CO6: Familiar with Extraction and leaching operations.

END-SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hr**

PART A: Evaluation based on the class performance and Laboratory book 50 Marks
PART B: Viva Examination based conducted experiments 50 Marks

22PCM308T					Transport Phenomena					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the concepts of transport phenomena and gains fundamental knowledge in fluid flow, heat transfer and mass transport.
- Identifying and analysing the dynamic models for the fluids by applying transport phenomena basics of multidisciplinary concepts, approximations and constraints.
- Interpreting fluid, energy and mass flow directions by simplifying the generalized equations of change.
- Simplifying complex problems pertaining to petrochemical field.
- Design and development of time average momentum, energy and mass transport linear profiles in turbulent flow patterns.
- Recognize and expertise in using of relations and analogies of all the three transport entities.

UNIT I: Transport phenomena by molecular motion **12 Hr.**

Vectors/Tensors, Newton's law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier's law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick's law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity.

UNIT II: Momentum transport **14 Hr.**

Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems. Equation of continuity, motion, mechanical energy, use of equations of change to solve flow problems, dimensional analysis of equations of change, comparison of laminar and turbulent flows, time-smoothed equation of change, empirical expressions.

UNIT III: Heat transport **12 Hr.**

Shell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical, Equations of change (non-isothermal), equation of motion for forced and free convection, Equation of energy (non-isothermal).

UNIT IV: Mass transport **14 Hr.**

Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical reaction in porous catalyst and the effectiveness factor, equation of continuity for binary mixtures, equation of change to setup diffusion problems for simultaneous heat and mass transfer

Max. 52 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Estimate the transport properties and describe the governing laws and also to examine the dependency of process parameters on each transport property.

CO2: Solve differential equations arising in transport problems by setting up shell momentum balance and recognise initial and boundary conditions.

CO3: Interpret and develop the general equations of change based on conservation of mass and transport entities.

CO4: Simplify the general equations of change for solving momentum flow and mass flow problems.

CO5: Solve a time periodic linear momentum and mass transfer problems.

CO6: Analyse the momentum, heat and mass transport problems involved in processes.

TEXT/REFERENCE BOOKS

(1) R.B. Bird, W.E. Stewart and E.W. Lightfoot, "Transport Phenomena", John Wiley, II Edition 2006.

(2) Robert, S. Brodkey, Harry C. Hershey, "Transport Phenomena A Unified Approach", Brodkey Publishing 2003.

(3) L.S. Sissom and D.R. Pitts, "Elements of Transport Phenomena", McGraw-Hill, New York, 1972.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM309T					City Gas Distribution					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To provide a fundamental understanding of the technical and business aspect of the City Gas Distribution network.
- To provide a fundamental understanding of the technical and business aspect of the City Gas Distribution network.
- To make students confident to implement the knowledge of City Gas Distribution in industry.

UNIT I: Introduction of Natural gas and its Value chain **10 Hr.**

Properties of Natural Gas; Update on Gas Discoveries; Demand – Supply Gap; History of GCD in India; LNG, LPG, and CGD business.

Gas Value Chain**:** Gas Transmission and Distribution System; City Gate Station (CGS); Gas Filtration and Pressure reduction skids; Odorizing unit; Common pressure reduction station (CPRS)/District Regulation Station (DRS); Metering system; Pipeline for CGD network; Steel and PE Pipelines; CNG infrastructure: Mother Station, Online Station, Daughter Station, Daughter Booster Station; SCADA System

UNIT II: Regulatory Framework and Standards for City Gas Distribution **10 Hr.**

Petroleum and Natural Gas Regulatory Board (PNGRB) era; Purpose, role, and functions of PNGRB; Challenges faced by PNGRB; Technical Standards including T4S.

UNIT III: Operation and Maintenance **10 Hr.**

Annual O&M Plan; Steel Pipeline O&M (Cathodic Protection); Maintenance planning.

QHSE: CNG Safety; Emergency Response Plan; Disaster Management Plan; Quality assurance concepts;Inspection and Surveillance; Risk Assessment in CGD Business.

UNIT IV: Business Scenario **9 Hr.**

CGD Business Scenario – India and Abroad; Profile of Major Players; Gas Pricing in CGD; Customer Service Issues in CGD Business; Innovations in CGD; Accelerators and Retarders of CGD business; CaseStudies – India and Abroad

Gas Retailing Business: Introducing Gas Retailing; Terminology used in CGD; Various components of CGD Network; CGD Business Segments; CGD Projects – Status in India; CGD Companies in India; Roleof CNG and PNG in Gas Distribution; CGD Economics

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Summarize City Gas Distribution value chain and Natural Gas system..
CO2: Acquaint and adapt the roles, functions and objectives of PNGRB
CO3: Explain Piped Natural Gas (PNG) distribution system.
CO4: Classify the types of Compressed Natural Gas (CNG) Stations and explain the CNG infrastructure.
CO5: Practice the HSE measures for safety of CGD sector.
CO6: Assess the steps to be taken in financing the CGD measures.

TEXT/REFERENCE BOOKS

1. Natural Gas: A comprehensive study (Anirbid Sircar and Kriti Yadav).
2. City Gas Distribution: An Indian perspective (Anirbid Sircar, Shreya Sahajpal, Umang Modi).
3. City Gas Distribution in India: Demystifying the Opportunity, Growth and Investment Potential(Infra line Energy)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM310T					Petrochemical Process Design					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES:

- To explain the basic concepts of classification and standards of heat exchanges
- To familiarize various components of distillation columns
- To explain the design of columns for separation operations
- To enumerate the basics of reactor design

UNIT I: **Heat Exchanger Equipment** **12 Hr.**

Classification of Heat Exchanger, TEMA Classification; Shell & Tube heat exchangers, Functions of various parts of shell & Tube Heat exchanger, General design method of shell & tube heat exchanger, Criteria of selection among Fixed Tube sheet, U Tube & Floating Head heat exchanger. Tinker's flow model, Air-cooled heat exchangers and air heaters, plate heat exchangers, etc. TEMA classification.

UNIT II: Distillation Systems **14 Hr.**

Introduction, Various types of Distillation columns, Criteria of selection, Distillation column design, Selection of key components for multicomponent distillation, Determination of operating pressure and temperature for a distillation column, Determination of nos. of theoretical stages for multi-component distillation by Fenskey - Underwood-Gilliland's method. Introduction to rigorous methods, elements of distillation sequencing.

UNIT III: Column Design **14 Hr.**

Colum design for Extraction, absorption, distillation, Plate vs packed column; types of packing, packed bed height, prediction of the height of transfer unit, column diameter, wetting rates. Column design for extraction and absorption process. Selection of trays, Calculations for tower diameter & pressure drop of sieve tray tower, Checking of conditions for weeping, down comer flooding, liquid entrainment, etc, tray efficiency, Jet Flooding & down comer Flooding, Different types of weirs & down comers of tray tower, their selection criteria.

UNIT IV: Reactors **12 Hr.**

Reactor classification, Reactor principle, Space velocity and space-time, Design equation of industrial reactors. Estimation of the number of stages in an adiabatic reactor, Airlift reactor, vapour phase tubular reactor, Design consideration in bubble column and fluidized bed reactor. Design of catalytic reactor systems.

Max. 52 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to;

CO1: Classify various heat exchanging devises
CO2: Design of heat exchangers using Kern and NTU method
CO3: Select various internal components of distillation columns
CO4: Calculate number of equilibrium stages required for separation using distillation
CO5: Design of the plate and packed columns for the mass transfer operations
CO6: Design of chemical Reactors for various Applications

TEXT& REFERENCE BOOKS:

1. Max S. Peters, K.D. Timmerhaus and R.E. West, Plant Design and Economics for Chemical Engineers (5th Ed), McGraw-Hill International Editions (Chemical Engineering Series), New York, USA, 2003.
2. Sinnott R. K, Coulson and Richardson's Chemical Engineering Series, Chemical Engineering Design, Vol. VI, 5th Ed., Butterworth-Heinemann 2018
3. Ernest E.Ludwig Ludwins Applied Process Design for Chemical and Petrochemical Plants, Volume 1,2 and 3
4. S. B. Thakore, B. I. Bhatt, Introduction to Process Engineering and Design, 4th Ed., McGraw Hill education, 2010
5. B. C. Bhattacharya, Introduction to Chemical Equipment Design, CBS Publisher, 2003
6. D. Q. Kern, Process Heat Transfer, McGraw Hill, 1950
7. Stanley M. Walas ,Chemical Process Equipment- Selection and design , Butterworth and Heinemann, 1990

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM311T					Petrochemical Processes III					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To have a clear idea of the Aromatic Industry, its structure and constitution.
- To understand the feedstock requirements for production of primary aromatics and aromatic derivatives
- To study the processes to produce primary aromatics with emphasis on engineering aspects.
- To learn processes for the production of various commercially important petrochemicals.
- To learn the processes for production of aromatic derivatives and monomers.
- To understand the unique aspects of commercial monomers and their polymerization.

Unit I : **The Structure and feedstocks of Aromatic Industry** **9 Hr.**

Petroleum feedstocks for aromatics production; their origin and availability. The nature of aromatic production complexes; refineries, olefin production facilities, coal based processes. Aromatic content in feedstocks. Strategies for aromatic separations.

Unit II : **Aromatic production and purification.** **12 Hr**.

Aromatics from pyrolysis gasoline, its composition and purification, Aromatics from reformates, reforming processes and catalysts, product profiles and separation of aromatics. Separation of xylenes, xylene isomerization, Parex process for p xylene production. Separation of ethylbenzene from xylenes. Styrene production technologies.

Unit III : **Aromatic derivatives and other petrochemicals.** **10 Hr.**

Synthesis of phenol and acetone, phthalic anhydride, maleic anhydride, butanediols, dimethyl terephthalic, substituted benzenes, cyclohexane, hexamethylene diamine, Vinyl monomers; vinyl acetate, ethylene dichloride, acrylonitrile. Napthalene and its derivatives

Unit IV :**Monomer production processes and Polymers** **8 Hr.**

Terephthalic acid and polyethylene terephthalate, caprolactam and nylon 6, vinyl chloride and PVC, Polystyrene synthesis, diisocynates, polyols and synthesis of polyurethanes.

Max. 39 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Comprehend the structure of aromatic production facilities
CO2: Evaluate the effect of feedstocks on aromatic production.
CO3: Analyse the effect of various parameters on aromatic production.
CO4: Study the synthesis of various commercial petrochemicals.
CO5: Study some commercial monomer production processes
CO6: Familiar with the current developments in various aromatic production technologies.

TEXT/REFERENCE BOOKS

1. Moulijn, J. A., Makkee, M and Van Diepen, A. E. Chemical Process Technology, Second Edition, Wiley, 2013.
2. Chauvel, A and Lefebvre, G. Petrochemical Processes II, Technip, Paris, 1989
3. Meyers, R A. Handbook of Petrochemical Production Processes, McGraw-Hill, 2005.
4. Asua, J, M. Polymer Reaction Engineering, Blackwell Publishing, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM312T					Reaction Engineerring					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Exposure to understand of basic principles and terminology in reaction kinetics.
- Develop skills in hazard analysis and able to find out the root cause of an accident.
- To acquaint students towards basic designing of ideal reactors.
- To accustom with the concepts of non-ideality in the reactor systems and studying RTD.
- Provide details on modeling the non-ideality using zero and one parameter models.

UNIT I: Introduction **9 Hr.**

Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis.

UNIT II: Reactor Design **12 Hr.**

Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, Equal sized CSTRs in series and parallel, Equal sized PFRs in series and parallel, size comparison of reactors. Design of reactors for multiple reactions - consecutive, parallel and mixed reactions – factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.

UNIT III: Homogeneous Reactors **10 Hr.**

Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression.

UNIT IV: Residence Time Distribution **8 Hr.**

The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors

Max. 39 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Relate to the basics of kinetics and basic theories to get the underlying mechanisms
CO2: Interpret and evaluate the rate data and get the kinetics parameters.
CO3: Design ideal reactor systems based on experimental data and optimize its performance.
CO4: Select proper reaction mechanism and design reactor by rate data analysis
CO5: Compare the reactor performance with or without internal of external mass transfer limitations
CO6: Design, develop and/or modify reactor systems for specific purpose of real life problems

TEXT/REFERENCE BOOKS

(1) O. Levenspiel," Chemical Reaction Engineering" Willey Eastern, 3rd Ed., 2000 H. S.

(2) Fogler, “Elements of Chemical Reaction Engineering”, 3rd Ed, New Delhi-Prentice Hall, 2001.
(3) J. M. Smith, “Chemical Engineering Kinetics”, 3rd Ed., McGraw- Hill, 1988.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM312P					Reaction Engineering Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hr/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

Students develop sound working knowledge and design different types of reactors.

Week 1: Kinetic studies in a Batch reactor
Week 2: Kinetic studies in a Plug flow reactor
Week 3: Kinetic studies in a CSTR
Week 4: Kinetic studies in a Packed bed reactor
Week 5: Kinetic studies in a PFR followed by a CSTR
Week 6: RTD studies in a PFR
Week 7: RTD studies in a packed bed reactor
Week 8: RTD studies in a CSTR
Week 9: Studies on micellar catalysis
Week 10: Study of temperature dependence of rate constant using CSTR.
Week 11: Kinetic studies in Sono chemical reactor
Week 12: Batch reactive distillation Drying characteristics of Vacuum/Tray/Rotary dryer.
Week 13: Kinetics of photochemical reaction
Week 14: Demonstration of heterogeneous catalytic reaction
Week 15: Demonstration of gas-liquid reaction

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the kinetics of Batch, PFR and CSTR.
CO2: Understand the working principle of Packed and CSTR.
CO3: Gain sound knowledge on sono chemical reactor.
CO4: Demonstrate the drying operations and photo chemical reaction.
CO5: Describe catalysis and catalytic reactions.
CO6: Demonstrate gas liquid reactions.

END-SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hr**

PART A: Evaluation based on the class performance and Laboratory book 50 Marks
PART B: Viva Examination based conducted experiments 50 Marks

22PCM313T					Safety, Health and Environment					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Exposure identify and assess hazards in any stage of process operation to quantify and manage
- Develop skills in hazard analysis and able to find out the root cause of an accident.
- Gain knowledge in devising safety policy and procedures to be adopted to implement total safety in a plant.
- Select, plan and implement health objectives, targets and performance standards
- Recognize and expertise measures of pollution control.

UNIT I: Introduction **9 Hr.**

Need for developing Environment, Health and Safety systems in work places. Status and relationship of Acts, Regulations and Codes of Practice. Role of trade union safety representatives. International initiatives. Ergonomics and work place. Concepts of safety: Hazard classification chemical, physical, mechanical, ergonomics, biological and noise hazards; Hazards from utilities like air, water and steam.

UNIT II: Occupational health and hygiene **11 Hr.**

Definition of the term occupational health and hygiene. Categories of health hazards. Exposure pathways and human responses to hazardous and toxic substances. Advantages and limitations of environmental monitoring and occupational exposure limits. Hierarchy of control measures for occupational health risks. Role of personal protective equipment and the selection criteria. Effects on humans, control methods and reduction strategies for noise, radiation and excessive stress. HAZOP, Job safety analysis; Fault tree analysis; Event tree analysis; Failure modes and effect analysis and relative ranking techniques; Safety audit; Plant inspection; Past accident analysis.

UNIT III: Workplace safety and safety systems **9 Hr.**

Features of the satisfactory design of work premises HVAC, ventilation; Safe installation and use of electrical supplies; Fire safety and first aid provision; Significance of human factors in the establishment and effectiveness of safe systems; Safe systems of work for manual handling operations; Control methods to eliminate or reduce the risks arising from the use of work equipment; Requirements for the safe use of display screen equipment; Procedures and precautionary measures necessary when handling hazardous substances; Contingency arrangements for events of serious and imminent danger.

UNIT IV Environmental Pollution and Control **10 Hr.**

Environmental Hazards, Aspects of air and water pollution, sources, classification characterization and effects of water pollutants, Primary Treatment- equalization, sedimentation, secondary treatment – Activated sludge process, tricking bed, Tertiary Treatment – chlorination, filtration and adsorption, Reverse osmosis. Sources, classification, characterization and effects of air pollutants Gravity Settling Chambers, Venturi scrubbers, Bag Filters, Electrostatic Precipitators. Solid waste management

Max. 39 Hr.

COURSE OUTCOMES

CO1: Identify accident prone areas and adopt methods for reducing accidents following safety precautions.

CO2: adopt safety policy in industry and list out the duties and implement safety targets.

CO3: Create a job safety analysis by applying the concepts of workplace injury prevention, risk management and environmental laws

CO4: Diagnose the cause of environmental pollution and take appropriate control measures to improve the health outcomes

CO5: Develop skills in analysing, sensitizing and managing the community about environmental health issues.

CO6: Select technologies for mitigating pollution

Text Books & References

1. Crowl, Daniel A., and Joseph F. Louvar. Chemical process safety: fundamentals with applications. Pearson Education, 2001.
2. Cheremisinoff, Nicholas P., and Madelyn L. Graffia. Environmental and Health and Safety Management: A Guide to Compliance. William Andrew, 1995.
3. C. S. Rao, Environmental Pollution and Control Engineering, 2nd ed., Wiley, India, 2006
4. S. P. Mahajan, Pollution Control in Processes Industries, TMH, 1985
5. Metcalf and Eddy, Wastewater engineering treatment and reuse, 4th ed., TMH, 2003
6. Gallant, Brian. The Facility Manager's Guide to Environmental Health and Safety. Government Institutes, 2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM313P					Safety, Health and Environment Laboratory					
Teaching Scheme					Examination Scheme					
					Theory			Practical		Total
L	T	P	C	Hr/Week	MS	ES	IA	LW	LE/Viva	Marks
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- Students gain hands on experience on analysis.

Week 1: Determination of pH and turbidity.
Week 2: Determination of Conductivity and TDS (Organic and Inorganic)
Week 3: Determination of Alkalinity/Acidity.
Week 4: Determination of Chlorine.
Week 5: Determination of Iron.
Week 6: Determination of Dissolved Oxygen.
Week 7: Determination of Nitrates.
Week 8: Determination of Optimum Dose of Coagulants.
Week 9: Determination of Chlorine Demand.
Week 10: Determination of Total Phosphorous.
Week 11: Determination of Chemical Oxygen Demand.
Week 12: Determination of Biological Oxygen Demand.

COURSE OUTCOMES

On completion of the course, the student will be able to

CO1: Determine the pH, TDS and conductivity of the organic and inorganic sample.
CO2: Analyze the alkalinity, acidity and chlorine content.
CO3: Describe the analysis of dissolved oxygen and nitrate content.
CO4: Demonstrate the coagulant and chlorine demand equipment.
CO5: Estimate the amount of phosphorous content in the sample.
CO6: Understand to estimate the COD and BOD.

END-SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hr**

PART A: Evaluation based on the class performance and Laboratory book 50 Marks
PART B: Viva Examination based conducted experiments 50 Marks

22PCM314T					Elective - Process Modelling and Simulation					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Enhance the understanding basic concepts in mathematical formulation of a model
- Demonstrate the ability to apply the techniques of modeling and simulation to a range of problem areas (CSTR, Batch Reactor and Distillation etc)
- Impart knowledge on Numerical methods for simulation like iterative solution of algebraic equations, regression methods, numerical integration and interpolation techniques etc.
- Demonstrate an understanding of system modeling through the competent use of Computer Simulation methods for CSTR, Batch Reactor and Distillation unit.

Unit I: Introduction to Mathematical Modelling **6 Hr.**

Mathematical models for Petrochemical engineering systems, introduction to fundamental laws. -Gravity flow tank, Interacting and non-interacting systems.

Unit II: Mathematical Modelling in Heat transfer **7 Hr.**

Heat Transfer through metal rod**,** two heated tanks, single component vaporizer, double pipe heat exchanger, shell and tube heat exchanger.

Unit III: Mathematical Modelling in Mass Transfer **6 Hr.**

Ideal binary distillation column, batch distillation with holdup, mass transfer with chemical reaction, steam distillation, Simulation examples for Binary distillation.

Unit IV: Mathematical Modelling in Reaction Engineering **7 Hr.**

CSTR, PFR, Unsteady State PFR Batch reactor, constant hold-up CSTRs, CSTRs with variable hold-ups, non-isothermal CSTR.

Max. 26 Hr.

COURSE OUTCOMES

On completion of the course, the student will be able to

CO1: Summarise the stages involved in the development of a process model
CO2: Construct and simulate a mathematical model for a simple flow systems
CO3: Construct and simulate mathematical models for Heat exchange equipment's
CO4:-Construct and simulate mathematical models for Mass transfer operations
CO5: Construct mathematical models for CSTR and PFR
CO6: Construct mathematical models Batch reactors

TEXT/REFERENCE BOOKS

1. W. L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, 2nd Ed., McGraw Hill, 1989

2. Upreti, Simant R. Process Modeling and Simulation for Chemical Engineers: Theory and Practice. John Wiley & Sons, 2017
3. Verma, Ashok Kumar. Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering. CRC Press, 2014
4. R. G. E. Franks, Modeling and Simulation in Chemical Engineering, 1stEd., Wiley-Interscience, 1972
5. T.G. Dobre, J. G. Sanchez Marcano, Chemical Engineering: Modeling, Simulation and Similitude, 1stEd., Wiley-VCH., 2007
6. R. G. Rice, D. D. Do, Applied Mathematics and Modeling for Chemical Engineers, 1stEd., John Wiley & Sons, 1995
7. T.F. Edgar and D.M. Himmelblau, Optimization of Chemical Processes, 2ndEd., McGraw-Hill, 2001

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM315T					Elective - Pipeline Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

`COURSE OBJECTIVES

- Fundamental knowledge and understanding of industry terms and acronyms
- Deeper insight between design basis, fluid properties
- Comprehensive understanding of specifications and specialties of various valves
- Fundamental knowledge and understanding of corrosion and its preventions

UNIT I: Introduction **6 Hr.**

Modes and comparison among different modes of transportation of petroleum products, advantages and limitations ofpipelines modes, Introduction to pipeline project, Economics and cost structure of Pipeline project, Economic pipe diameter.

UNIT II: Design Outlines **7 Hr.**

Introduction to outline for Design & construction of onshore-offshore pipelines, Pipeline codes and standards, Overview of O& G field Processes, Types of Onshore/ Offshore Pipelines, Factors affecting pipeline design (External, fluid properties, pipeline parameters and Fluid flow considerations. Loop- lines

UNIT III: Design of Pipelines **7 Hr.**

Hydraulic Analysis, Relevant Pipeline Parameters, Types of fluids, Pressure Loss calculations, Maximum allowable operating Pressure, Pipeline sizing, Diameter sizing, Determination of wall Thickness, Station Spacing, Pumping Power calculations, Design of Gas Pipelines: Factors affecting Gas Pipeline Design, Pressure Loss calculations, Gas pipeline Hydraulic Calculations, as Compression / Power requirement.

UNIT IV: Commissioning and Operation of Pipelines **6 Hr.**

Commissioning of a pipeline. Pipeline Operations, Pigging, integrity assessment by Intelligent pigging instrumentation, Monitoring and Control Through SCADA application, corrosion and control/ Cathodic Protection.

Max. 26 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the basics of pipeline, roles and responsibilities of a pipeline engineer in the oil and gas industry

CO2: Apply pipeline codes, regulations and standards in both offshore and onshore environments

CO3: Attribute pipeline terminology, various components and materials used and the fluid properties that affect pipeline transportation.

CO4: Evaluate forces acting on a pipeline system in operating conditions.

CO5: Analyse the processes involved in the prevention of corrosion and the inspection of pipeline and its components.

CO6: Adapt to various safety issues and practices involved in onshore and offshore pipeline operations

TEXT/REFERENCE BOOKS

1. Alkazraji Duraid, (2008) A quick guide to pipeline engineering WOODHEAD Publishing Limited
2. Vincent, Jecqes (2010) Fundamentals of Pipeline Engineering, Gulf Publishing
3. Antaki, G. A. (2003) Piping and Pipeline Engineering, Marcell Dekker.
4. Modelling of oil and products and gas pipeline transportation by Mikhail V Luric
5. Pipeline Engineering by Henry Liu

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hr.**

Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM316T					**Elective - Artificial Inteligence (AI) in Petrochemical Processes**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hours/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
2	**0**	**0**	**2**	**2**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES

- Identify the problems where AI is required and the different methods available
- Learn Neural Networks
- Gain primary knowledge on data science and
- Explain the components of IoT Architecture and platforms of IoT ecosystem
- Developing IoT Systems using Raspberry Pi and Python

UNIT I: Introduction to Artificial Intelligence **7 Hr.**

AI Problems, Intelligent Agents, Problem Formulation, Basic Problem Solving Methods. Searching: Search strategies, Uniformed Search Strategies, State-Space Search, Bi-Directional Search, BFS, DFS, Heuristic Search Strategies, Local Search Algorithms

UNIT II: Introduction to Neural Networks **6 Hr.**

Characteristics of Neural Networks, Historical Development of Neural Networks Principles, Artificial Neural Networks, Terminology, Models of Neuron, Topology, Basic Learning Laws, , Basic Functional Units

UNIT III: Introduction to Data Science **7 Hr.**

Data, types of data, data quality, issues, data architecture, data quality issues, data architecture. Big Data, big data architecture, big data technologies, requirements. Statistics related to data sciences, clustering, and regression analysis

UNIT IV: Introduction to IoT **6 Hr.**

IoT Basics, Physical and Logical Designs, Elements of IoT - Basic Architecture of an IoT. Application Sensors & Actuators, Edge Networking (WSN), GatewDomain-Specificific IoTs - Home Automation, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and Life Style

Max. 26 Hr.

COURSE OUTCOMES:

At the end of this course students will be able to

CO1: Identify the AI based problems
CO2: Apply techniques to solve the AI problems
CO3: Discuss on Neural Networks
CO4: Understand the components of IoT infrastructure.
CO5: Identify the architecture of IoT and its applications.
CO6: Analyzing data in IoT systems.

TEXT/ REFERENCE BOOKS

1. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
2. Kevin Night and Elaine Rich, Nair B., “Artificial Intelligence (SIE)”, McGraw Hill.
3. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education.
4. G.Luger, W.A. Sttubblefield, “Artificial Intelligence”, Addison-Wesley Longman.
5. N.J.Nilson, “Principles of Artificial Intelligence”, Narosa Publishing House.
6. Pethuru Raj and Anupama C. Raman. The Internet of Things: Enabling technologies, platforms,and use cases. Auerbach Publications,.
7. Internet of Things with Python, Gaston C. Hillar, Packt Open Source
8. Rajkumar Buyya and Amir Vahid Dastjerdi, eds. Internet of Things: Principles and paradigms.Elsevier.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM401T					Process Control					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES:

- Understanding of types of controllers and their selection.
- To learn controller tuning techniques.
- To understand multivariable controllers and their tuning.
- To illustrate various advanced control strategies like feed forward control, cascade control, ratio control, etc and their applications.
- To understand distributed control system and their applications.

UNIT I: I**ntroduction of Controller** **7 Hr.**

Review of Controller selection and design for feedback control loops. Feedback controllers, actions, types, reset windup. Tuning of feedback controllers, tuning controllers for integrating processes, synthesis of feedback controllers, tuning rules. Controller design issues, Analysis of typical control loops.

UNIT II: Controller Design **6 Hr.**

Multi variable process control, Interaction analysis and multiple single loop design, relative gain array, loop pairing, design and tuning of multivariable controller. Multivariable controller trouble shooting.

UNIT III: Advanced Control Strategy **6 Hr.**

Advanced control strategies, feed forward, cascade, advanced supervisory, model predictive control, multivariable control, introduction to digital control principles, microprocessor-based control.

UNIT IV: Application of Control Systems **7 Hr.**

Control loop hardware and troubleshooting. Aspects of distributed control systems, programmable logic controllers, fieldbus technology. Actuator systems, Sensor systems. Troubleshooting control loops.

Max 26 Hr.

COURSE OUTCOMES

On completion of the course, the student will be able to

CO1: Select controllers based on system requirements.
CO2: Develop capability to tune based on process response
CO3: Analyse multi loop and multivariable control strategies
CO4: Understand distributed and digital control
CO5: Apply advanced control strategies to implement in operating decisions
CO6: Utilise process control hardware effectively

TEXT BOOK (S) & REFERENCE BOOKS

1. D. R. Coughnowr, Process System Analysis and Control, 3rd Ed., McGraw-Hill Inc., 2013.
2. W. B. Bequette, Process Control: Modeling, Design and Simulation, Prentice Hall, 1998.
3. G. Stephanopoulos, Chemical Process Control: An Introduction to Theory & Practice, PHI, 1983.
4. D.Seborg, T.F. Edgar Duncan, A. Mellichamp, Process Dynamics and Control,3rd Ed., John Wiley & Sons, Inc, 2010.
5. B.Roffel, B.Betlem, Process Dynamics and Control: Modeling for Control & Prediction, John Wiley & Sons, 2006.

END SEMESTER EXAMINATION QUESTION PATTERN

Max. Marks: 100 **Exam Duration: 3Hrs**

Part A/Question: Four questions from each unit 40 Marks

Part B/Question: Four questions from each unit 60 Marks

22PCM402T					Catalytic Reaction Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Classification and characterization of solid catalysts.
- Develop rate expressions for solid catalysed reactions.
- To understand the influence of heat and mass transfer on reaction rates within solid catalysts.
- Understand the concepts of Thiele modulus and effectiveness factors in solid catalysed reaction.
- Design of solid catalysed reactors.

UNIT I Principles of Catalysis **10 Hr.**

Fundamental principles, components of industrial catalysts, catalyst activity, selectivity, catalyst preparation, catalyst storage etc. Catalyst Deactivation: Mechanistic approach, phenomenological approach.

UNIT II Physical properties of catalyst **9 Hr.**

Surface area, pore volume, pore size distribution, solid density, particle density, bulk density, void volume, Catalyst promoters & inhibitors, Catalyst accelerators & poisons.

UNIT III Kinetics of Solid catalyzed reactions **10 Hr.**

Development of kinetic rate expression using Langmuir Hinshelwood Hougen Watson Models, Eli – Rideal mechanism combined effect of chemical and physical kinetics, pore diffusion effects, Thiele modulus, effectiveness factors, inter phase and intra phase temperature gradient, parametric estimation and parametric sensitivity, steady state multiplicity.

UNIT-IV Reactor Design **10 Hr.**

Design of fixed bed and fluidized bed catalytic reactors. Design considerations for multiphase reactors such as Trickle bed reactors, Slurry reactors, Bubble columns, Packed beds etc.

Max. 39 Hr.

COURSE OUTCOMES

On completion of the course, the student will be able to

CO1: Familiarize various types of solid catalysts used industrially.
CO2: Understand important characterization techniques used.
CO3: select the proper catalyst and able to accelerate its life by various techniques.
CO4: Develop rate laws for heterogeneous reactions.
CO5: Estimate the effects of diffusion, mass transfer effect on catalysis.
CO6: Design solid-catalyzed reactors.

TEXT/REFERENCE BOOKS

1. M.V. Twigg, 'Catalyst Handbook', Manson Publishing, 1996
2. Ronald W. Missen, Charles A. Mims, Bradley A. Saville. Introduction to chemical reaction engineering and kinetics ohn Wiley & Sons,, 1999
3. J.M. Smith, Chemical Reaction Kinetics, 3rd Ed. McGraw Hill, Inc, 1981.
4. J.J. Carberry, Chemical and Catalytic Reaction Engineering, McGraw Hill, Inc, 1976.
5. H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Ed., PHI, 2005.
6. C.H. Bartholomew and R.J. Farrauto, 'Fundamentals of Industrial Catalytic Processes', Wiley Interscience, 2006
7. C.N. Satterfield, 'Heterogeneous Catalysis in Industrial Practice 2nd Ed, McGraw-Hill 1999

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM403T					Economics, Utilities and legal aspects of petrochemical Process Plants					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		TotalMarks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To introduce concepts of cash flow and sources of investment and estimation of capital investment.
- To elaborate components of total product cost and to explain total product cost estimation.
- To illustrate depreciation calculation and profitability analysis of investments.
- To explain the various process utilities requirements and construction working of utility equipment and optimum usage of utilities.
- To familiarize laws and regulations related to process Industries.

Unit I: Cost Estimation **10 Hr.**

Cost estimation: Cash flow and cumulative factors affecting estimation of investment and production cost, breakeven point and its significance, total capital investment, fixed and working capital investment & their estimations, type of estimates, cost indexes, method for estimating capital investment. Simple and compound interest.
Estimation of total product cost: manufacturing cost, general expenses, Manufacturing cost: direct production cost, fixed charges, plant overhead cost.

UNIT II: Depreciation **10 Hr.**

Types of depreciation, Method for determining depreciation: straight line method, decline balance method, sum of the year digit method, shrinking fund method etc., single unit and group depreciation, adjustment of depreciation account, evaluation of depreciation methods.
Profitability, alternative investments and replacement: Methods for profitability evaluation, Evaluation of Break Even Point, % rate of return, Practical factors in alternative investment and replacement Studies

UNIT III: Process Utilities **10 Hr.**

Process auxiliaries and Process utilities: Piping design, layout, and supports for piping insulations. Pipe fittings, types of valves, selection of valves, process control and instrumentation control system design. Process water, boiler feed water, water treatment, waste treatment and disposal, steam, oil heating system, chilling plant, compressed air and vacuum.

Unit IV: Legal Aspects **9 Hr.**

International laws on take – back laws, extended responsibility, and Ecolabeling, Examples from pharmaceuticals, foods, cosmetics, packaging, computers, polymers, automobiles and electronics industry. Industrial Case Studies.

Max. 39 Hr.

COURSE OUTCOMES

On completion of the course, the student will be able to

CO1 : Estimate fixed capital working capital and Total Capital investments required for industrial establishments

CO2 : Calculate total product cost from manufacturing expenses and overhead costs of manufacturing

CO3 : Interpret depreciation charges for various equipment's using allowable methods of depreciation

CO4 : Chose alternative equipment's and process by profitability analysis

CO5 : Utilize effectively process utilities and auxiliary equipment's effectively

CO6 : Adapt industrial regulations and laws effectively for the betterment of society

TEXT/REFERENCE BOOKS:

1. Peters, Max S., and Klaus D. Timmerhaus. *Plant Design and Economics for Chemical engineers*. McGraw-Hill International, 2018.
2. Broughton, Jack, ed. Process Utility Systems: Introduction to Design, Operation, And Maintenance. IChemE, 1994.
3. Higgins, Rosalyn. Problems And Process: International Law and How We use It. Oxford University Press, 1995.
4. Towler, Gavin, and Ray Sinnott. *Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design*. Butterworth-Heinemann, 2021.
5. Couper, James R., W. Roy Penney, James R. Fair, and Stanley M. Walas. *Chemical Process Equipment: Selection and Design*. Gulf professional publishing, 2005.
6. Silla, Harry. *Chemical Process Engineering: Design and Economics*. CRC Press, 2003.
7. F.C. Vibrandt and C.E. Dryden, "Chemical Engineering Plant Design", McGraw Hill, Volume 5
8. Roger Hunt and Ed Bausbacher, Process Plant layout and Piping Design, Prentice-Hall Inc, 1990
9. S.K. Shukla, "Enviro Hazards and Techno Legal Aspects", Shashi Publications, Jaipur, 1993.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM404T					Petrochemical Process Synthesis and Intensification					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the basic concepts of process synthesis.
- Enumerate the importance of product life cycle assessment.
- To familiarise the various concepts and techniques of process scheduling.
- To work out heat exchanger network design using pinch analysis.
- To elaborate process integration in petrochemical processes plants.

UNIT I: Basic concepts of process synthesis **10 Hr.**

Basic concept in process synthesis. The synthesis step, Structure and synthesis of process flow diagrams. Product life cycles. Understanding process conditions.

UNIT II: Process synthesis and analysis **10 Hr.**

Design and scheduling of batch processes, Gantt charts, transfer policies, sizing of vessels, inventories. Optimal design and scheduling of multiproduct batch plant

UNIT III: Process integration Tools **9 Hr.**

Synthesis of heat exchanger networks. Pinch technology, Heat and power integration.

UNIT IV: Process intensification using integration tools **10 Hr.**

Synthesis of distillation sequences, energy conservation in distillation, heat integration techniques in distillation. MILP model for distillation sequences.

Max. 39 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Comprehend concepts of Process synthesis.
CO2: Enumerate synthesis of process flow sheet.
CO3: Design and optimization of batch process.
CO4: Analyses heat exchanger networks.
CO5: Comprehend Pinch Technologies.
CO6: Optimize distillation sequences for energy economy.

TEXT/REFERENCE BOOKS:

1. Smith, Robin. Chemical Process: Design and Integration. John Wiley & Sons, 2005.
2. Biegler, Lorenz T., Ignacio E. Grossmann, and Arthur W. Westerberg. "Systematic Methods for Chemical Process Design." 1997.
3. W.D. Seider, J.D. Seader, D.R. Lewin, 'Product and Process Design Principles', 2nd Ed, Wiley 2004.
4. Majozi, Thokozani. Batch Chemical Process Integration: Analysis, Synthesis and Optimization. Springer Science & Business Media, 2010.
5. Ulrich, Gael D. A Guide to Chemical Engineering Process Design And Economics. New York: Wiley, 1984.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A: 10 Questions each carrying 5 marks 50 Marks
Part B: 5 Questions each carrying 10 marks 50 Marks

22PCM405P					Software lab for Petrochemical Engineers					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To introduce basic knowledge of flow sheeting and application of commercial simulators.
- To introduce various programs and simulator usage.
- To demonstrate usage of process equipment in simulators.
- To introduce spread sheet drawing in simulators to solve material and energy balance calculations.
- Introduction to basic modelling and simulation and related technologies.

The following experiments will be conducted using
/C++/Simulink/MATLAB/UNISIM/Simulink/CAD/ASPEN HYSIS

- Estimation of physical property, critical temperature, enthalpy and Gibb's free energy in aspen plus/UNISIM.
- Drawing of T-x, y and P-x, y diagram using python program.
- Regression, Vapor-Liquid equilibrium data, Flash separation, dew point, bubble point in java program.
- Performing mass and energy balance calculation in a flow sheet using UNISIM/Aspen Hysis
- Heat exchanger design, thermal analysis and simulation of heat exchanger in UNISIM/Aspen Plus
- Process Simulation of batch, CSTR and PFR in UNISIM/Aspen plus
- Design and simulation for distillation and absorption unit etc. in UNISIM/Aspen plus
- Process simulators in real industrial scale processes. (Examples: Simulation of cumene production process, Ammonia synthesis, manufacture of vinyl chloride monomer, hydro-dealkylation, etc.) in UNISIM/Aspen plus

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Create input file for given raw data by appropriate pseudo-cut, thermodynamic model selection for hydrocarbon & sour applications.
CO2: Simulate a process plant using a basic process flow diagram/ scheme by building a simulation flow chat/ environment and converging model.
CO3: Use appropriate information in distillation applications a given product specification.
CO4: Write programs and execute to estimate physical properties of petrochemical systems.
CO5: Carry out detailed thermal sizing or rating of shell & tube heat exchangers specifications and guidelines from converged simulation.
CO6: Generate heat & material balance of the streams with required physical & chemical properties from converged simulation.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A: Evaluation based on the lab class performance and laboratory book 50 Marks
Part B: Viva Examination based conducted experiments 50 Marks

22PCM406T					Transportation and Marketing of Petrochemical Products					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES:

- Learn how to develop and implement strategies for profits-maximization in dynamic retailing environments
- Understand how to monitoring performance of products
- Be able to forecast future sales quantities
- Grasp the procedures for managing day-to-day operations of networks of retailers and resellers.

UNIT I: Transportation **6 Hr.**

Transportation of petroleum & petroleum products. Transportation modes. Storage methods. Basics of pipeline construction, operation and protection. Pump and compressor stations. Instrumentation and control.

Unit II: Storage **7 Hr.**

Metering and measurements of oil and gas. Indian and Global supply scenario of petroleum and petroleum products. Product quality control. Storage of petroleum products in fixed installations. Standards and regulations. Types of storage tanks. Underground storage of natural gas. Bulk distribution and handling- domestic, commercial and industrial.

UNIT III: Basic concepts of marketing management **6 Hr.**

Marketing mix, Consumers & Resellers behaviour, Demand forecasting & Demand management, Channel management, Market research Product life cycle, Product development, Product launching.

UNIT IV: Marketing in Petroleum Sector **7 Hr.**

Dynamics of Energy Market, Product mix, understanding customers/ Potential customers, Distribution network, Marketing location management, Transport models/ modes with comparative analysis, Reseller network, Government & Industry regulatory norms influencing petroleum product marketing, Lateral marketing initiatives/ strategies in oil industry in Pool APM scenario. BPRE (Business Person Re-engineers) aligned towards strategic marketing initiatives in oil industry, Integrated marketing in petroleum sector.

Max. 26 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the storage and transportation methods.

CO2: Measure the petroleum products and quality assurance.

CO3: Understand the major problems affecting the storage and distribution of petroleum products.

CO4: Analyse the production and demand.

CO5: Coordinate the various marketing environment variables and interpret them for designing marketing strategy.

CO6: Demonstrate analytical skills in identification and resolution of problems pertaining to marketing management.

TEXT/REFERENCE BOOKS:

1. Abdel-Aal, Hussein K., and Mohammed A. Alsahlawi, Petroleum Economics and Engineering. CRC Press, 2013.
2. Speight, James G. An Introduction to Petroleum Technology, Economics, and Politics. John Wiley & Sons, 2011.
3. Gary, James H., et al. Petroleum Refining: Technology and Economics. CRC press, 2007.
4. Mokhatab, Saeid, William A. Poe, and John Mak. Handbook of Natural gas Transmission and Processing: Principles and Practices. Gulf professional publishing, 2018.
5. Couper, James Riley. Process Engineering Economics. CRC press, 2003.
6. Galbe, Mats, et al. "Process Engineering Economics of Bioethanol Production. “Biofuels” 2007, 303-327.
7. Masseron, Jean. Petroleum Economics. Editions Technip, 1990.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM407T					Pollution Control in Petrochemical Industries					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES:

- Characterization and classification of different types of wastes are discussed along with existing norms for waste disposal.
- Treatment methods of specific pollutant arising out of industrial process are explained.
- Introduces various concepts of water efficiency and waste minimization in industrial sectors.

UNIT I: **Introduction** **6 Hr.**

Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population growth, Pollution of air, Water and soil. Air pollution sources and effects: Classification and properties of air pollutants, Emission sources, Behaviour and fate of air pollutants, Effect of air pollution.

Unit II: Aspects of Air Pollutant Dispersion **7 Hr.**

Temperature lapse rates and stability, Wind velocity and turbulence, Plume behaviour, Dispersion of air pollutants, Estimation of plume rise. Air pollution sampling and measurement: Types of pollutant sampling and measurement, ambient air sampling, Stack sampling, Analysis of air pollutants.

UNIT III: Control of specific gaseous pollutants **6 Hr.**

Control of sulphur dioxide emissions, Control of nitrogen oxides, Carbon monoxide control, Control of hydrocarbons and mobile sources. Water pollution: Water resources, Origin of wastewater, types of water pollutants and their effects.

UNIT IV : Waste water sampling analysis and treatment **7 Hr.**

Sampling, Methods of analysis, Determination of organic matter, Determination of inorganic substances, Physical characteristics, Bacteriological measurement, Basic processes of water treatment, Primary treatment, Secondary treatment, advanced wastewater treatment, Recovery of materials from process effluents.

Max. 26 Hr.

COURSE OUTCOMES

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

CO1: Understand the different types of industrial pollution.
CO2: Realize the environmental impact of industrial pollution.
CO3: Analyse an industrial activity and identify the environmental problems.
CO4: Plan the strategies to control and reduce pollution.
CO5: Select the most appropriate technique to control and treat industrial pollution.
CO6: Analyse the characteristics of pollution.

TEXT/ REFERENCE BOOKS:

1. Peavy, H.S., Rowe, D.R., and Tchobanoglous, G. Environmental Engineering, McGraw Hill International, 1985.
2. Metcalf & Eddy, Wastewater Engineering, Tata McGraw-Hill Education Private Limited, 2009.
3. Masters, G.M., Introduction to Environmental Engineering and Science, Prentice Hall off India, 2008.
4. Rao, C.S., Environmental Pollution Control Engineering, Wiley Eastern, 2010.
5. De Nevers, N., Air Pollution Control Engineering, McGraw-Hill, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

22PCM408T					Optimization Techniques					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Gain knowledge on the methodology of how to specify the '3' components of optimization problems.
- Understand the concept of optimization by giving examples of different types of problems that may be encountered in chemical engineering.
- Provide with basic mathematical concepts of optimization.
- Learn the modelling skills necessary to describe and formulate optimization problems.
- Provide with the skills necessary to solve and interpret optimization problems in Engineering.
- Enhance the skills related to optimization in chemical engineering, open ended problem solving, critical thinking and lifelong learning.

Unit –I: Introduction to Optimization **6 Hr.**

Introduction: Design Vector –Design Constraints, constraint surface, Objective function, Objective function surfaces, classification of optimization problems, optimization techniques, and solution of optimization Problems using MATLAB. Critical optimization Techniques, Single variable optimization, multi-variable optimization with no constraints- Multivariable optimization with equality constraints and inequality constraints.

UNIT-II: Linear programming **7 Hr.**

Simplex method: Applications of linear programming -Standard form of a linear programming problem -Geometry of linear programming problems -Definitions and theorems -Solution of a system of linear Simultaneous equations -Pivotal reduction of a general system of equations -Motivation of the simplex method -Simplex algorithm - Two phases of the simplex method-MATLAB solution of LP problems.

UNIT-III: Nonlinear Programming **7 Hr.**

One dimensional minimization methods: Unrestricted search- Interval halving method -Fibonacci method -Golden section method, etc., unconstrained optimization Techniques - Direct search methods, Indirect Search (descent) methods; constrained optimization techniques.

UNIT- IV: **Geometric and Dynamic Programming** **6 Hr.**

Geometric programming, Dynamic programming, Modern methods of optimization. Application of optimization in fluid flow, heat transfer, and mass transfer problems.

Max. 26 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 : Analyse the optimization criterion for solving problems.
CO2: Apply different methods of optimization and to suggest a technique for specific problem.
CO3: Utilize simplex method for linear optimization problems.
CO4: Solve linear and nonlinear model problems.
CO5: Make use of optimization solve the industrial problems of relevance with petrochemical industry.
CO6: Estimate Optimum Values using advanced optimization techniques like Genetic algorithms and dynamic programming.

TEXT/REFERENCE BOOKS:

1. Dutta, Suman. *Optimization in chemical engineering*. Cambridge University Press, 2016.
2. F. Edgar and Himmelblau D, Optimization of chemical processes Mc-Graw. Hill.2001.
3. Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, PHI-2009.
4. Singaresu S. Rao Engineering Optimization: Theory and Practice, 4th Edition, John Wiley & Sons, 2009.
5. Ashok Belegundu, Tirupathi R. Chandrupatla, Optimization Concepts and Applications in Engineering, Cambridge University Press, 2011.
6. Andreas Antoniou, Wu- shing Lu Practical Optimization: Algorithms and Engineering Applications, Springer, 2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks