Pandit Deendayal Energy University, Gandhinagar

School of Technology

Department of Chemical Engineering

Curriculum

B.Tech - Chemical Engineering

Academic year

2020 - 2024

VISION

To impart quality education in an industry research driven modules to motivate the young chemical engineers for creating knowledge wealth to help generate employability following professional ethics and focus towards a sustainable environment and benefits to the society.

Pandit Deendayal Energy University, Gandhinagar
School of Technology
Department of Chemical Engineering

Mission

- To facilitate the chemical engineering students with the state-of-the-art facilities with focus on skill development, creativity, innovation and enhancing leadership qualities.

- To nurture creative minds thru' mentoring, quality teaching & research for building a value based sustainable society.

- To work in unison with the national and international level academic and industrial partners by venturing into collaborations to tackle problems of bigger interest to society.

- To build an encouraging environment for the young faculties and staff by providing safe work culture, transparency, professional ethics and accountability that will empower them to lead the department in right spirit.

- To inculcate the culture of continuous learning among the faculties by encouraging them to participate in a professional development programs and envisage to address the social, economic and environmental problems.

Pandit Deendayal Energy University, Gandhinagar
School of Technology
Department of Chemical Engineering

Program Education Objectives (PEOs)

- Acquire the fundamental principles of science and chemical engineering with modern experimental and computational skills.

- Ability to handle problems of practical relevance of society while complying with economical, environmental, ethical, and safety factors.

- Demonstrate professional excellence, ethics, soft skills and leadership qualities with life-long learning's.

- Graduates will be active members ready to serve the society locally and internationally

Pandit Deendayal Energy University, Gandhinagar
School of Technology
Department of Chemical Engineering

Programme Outcomes

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified need with appropriate considerations for public health and safety, and the cultural, societal and environmental considerations.

4. **Conduct investigations of complex problems**: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practices.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical practices and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in the team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning of broadest context of technological change.

Pandit Deendayal Energy University, Gandhinagar
School of Technology
Department of Chemical Engineering

PROGRAM SPECIFIC OUTCOMES (PSOs)

1.To analyse and tackle the complex and diverse engineering problems by appropriate experimentation, simulation, data analysis and interpretation, and, provide probable solutions by applying principles of chemical engineering in combination to the fundamental knowledge of basic sciences and mathematics.

2. Competence to incorporate socio-economic considerations in engineering practices, including the concept of sustainable development, into chemical engineering practice.

3. An ability to work together collaboratively in multidisciplinary teams to tackle multifaceted problems and pursue a bright career in chemical engineering and allied areas by demonstrating professional success at different platforms within industry, governmental bodies or academia.

Semester 1

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 1	BSC	20MA101T	Mathematics - I	3	1	0	4	4
	ESC	20CP101T	Programming with C	1	0	0	1	1
	ESC	20CP101P	Programming with C Lab	0	0	2	1	1
	BSC	20CH101T	Engineering Chemistry	3	0	0	3	3
	BSC	20CH101P	Engineering Chemistry Lab	0	0	2	2	1
	ESC	20ME102T	Element of Mechanical Engineering	3	0	0	3	3
	ESC	20ME102P	Element of Mechanical Engineering Lab	0	0	2	2	1
	ESC	20IC101T	Basic Electronics	2	0	0	2	2
	ESC	20IC101P	Basic Electronics Lab	0	0	2	2	1
	ESC	20ME101P	Engineering Graphics Lab	0	0	4	4	2
	HSC	20HS102T	Environmental Studies	3	0	0	3	3
	HSC	16SP101	NCC-I	0	0	2	2	1
		16SP102	NSS-I					
		16SP103	Sports-I					
				15	**1**	**14**	**30**	**23**

20MA101T					MATHEMATICS-I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/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 evaluate problems related to differential and integral calculus of complex functions.
- To be able to obtain area, volume using integral calculus.
- To be able to formulate and solve various engineering problems using the calculus.
- To study the properties of Matrix algebra and apply them to solve system of algebraic equations.

UNIT 1 DIFFERENTIAL CALCULUS AND ITS APPLICATIONS **08 Hrs.**

Partial derivative and its application, - Euler's theorem - Total derivatives - Jacobians – Maxima and Minima of two variables using Lagrange's multipliers. Convergence of infinite series.

UNIT 2 INTEGRAL CALCULUS AND ITS APPLICATIONS **12 Hrs.**

Definition Evaluation of double integral (Cartesian – Polar form) – Change of orders - Change of variables – Evaluation of triple integral, change of variables (Cartesian to spherical – and cylindrical) – Applications, area – volume – center of mass – center of gravity by double and triple integral.

UNIT 3 MATRIX ALGEBRA AND ITS APPLICATIONS **10 Hrs.**

Solution of system of algebraic equation - Rank of a matrix, consistency of system of equation - Characteristic equation of a square matrix- Eigen values and Eigenvectors of a real matrix - Properties of eigen values and eigen vectors - Cayley-Hamilton theorem (without proof) - finding inverse of a matrix - Diagonalisation of a matrix using orthogonal transformation.

UNIT 4 VECTOR CALCULUS **10 Hrs.**

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector Integration – Simple problems on line, surface and volume integrals – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (without proofs) – Simple application involving cubes and rectangular parallelopipeds.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify the use of convergence of infinite series in engineering aspects.
CO2 – Understand the concept of Directional derivative, Irrotational and Solenoidal vector fields.
CO3 – Develop the ability to apply appropriate tool/method to extract the solutions of engineering problems.
CO4 – Analyze the obtained solution in context with theory.
CO5 – Appraise mathematical problems from real to complex domain.
CO6 – Evaluate problems on Green's, Stoke's and Divergence theorems.

TEXT/REFERENCE BOOKS

1. B. S Grewal, Higher Engineering Mathematics, (43rd Edition), Khanna Pub., Delhi (2014).
2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Alpha Science, 3rd Ed., 2007.
3. Erwin Kreyszig, Advanced Engineering mathematics, John Wiley, 10th Ed., 2015.
4. G. Strang, Linear Algebra and its applications, 4th Edition, Cengage Learning, 2005.
5. K. Hoffman and R. A. Kunze, Linear Algebra, Prentice Hall of India, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A: 10 questions 3 marks each	30 Marks (40 min)
Part B: 5 questions 6 marks each	30 Marks (50 min)
Part C: 5 questions 8 marks each	40 Marks (90 min)

20CH101T					Engineering Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	0	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To develop the fundamental understanding about atomic structure and interatomic bonding.
- To provide the knowledge about structural features, synthesis, properties of various categories of materials.
- To develop the skills for phase, microstructural and elemental characterisation of materials.
- To provide the knowledge about the role of chemistry in modern engineering applications.

UNIT 1 Atomic structure and interatomic bonding **12h**

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 H_2, covalent, ionic and metallic bonding, bonding forces and energies, lattice energy and Madelung constant, metallic crystal structure, ceramic crystal structure and influencing factors.

UNIT 2: Chemistry of materials **10 h**

Introduction and classification of materials; structural features, synthesis, properties of metallic (e.g. noble metal), polymeric (e.g. thermoplastic and thermosetting), glass-ceramic (e.g. silicates, metal oxides) carbonaceous materials (e.g. fullerene, carbon nanotube, graphene); Introduction to nanomaterials, surface area to volume ratio and aspect ratio of nanomaterials, quantum confinement, top-down and bottom up chemical/physical approaches for synthesis of nanomaterials.

UNIT 3: Chemistry of Fuels and energy devices **10 h**

Fuels – Classification of fuels; Determination of calorific values of solid fuels by bomb calorimeter – Manufacture of synthetic petrol by Fischer-Tropsch method – Knocking in IC engines – Octane and cetane rating of fuels; Petrol and Diesel Engine, chemistry for alternative source and storage of energy (supercapacitor, fuel cell, battery); role of chemistry on in photo-voltaic devices (solar cell).

UNIT 4: Instrumental methods of chemical analysis **12 h**

Characterization of materials using X-ray diffraction (XRD), thermal Analysis (TGA-DTA-DSC), basics and application of Microwave spectroscopy, FTIR, UV-visible spectroscopy; NMR spectroscopy; Chromatographic techniques (GC, HPLC).

Max. 44 h

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamental concept about atomic structure and interatomic bonding.

CO2 - Acquire knowledge about metallic and ceramic crystal structure.

CO3 - Acquire knowledge about structural features, properties of different classes of materials including nanomaterials.

CO4 - Explain the methodologies for the synthesis of different categories of materials.

CO5 - Develop the skill for phase, microstructural and elemental characterisation of materials.

CO6 - Develop the knowledge on the role of chemistry in various modern engineering applications.

TEXT/REFERENCE BOOKS

1. An Introduction to Materials Science & Engineering, W.D. Callister, John Wiley & Sons (2007).
2. Fundamental of Ceramics, MW Barsoum, IOP publishing (2003).
3. Text book of Nanoscience and Nanotechnology, T. Pradeep, Mc. Graw Hill Education (2003).
4. Textbook of Nanoscience and Nanotechnology, Murty, Shankar, B Raj, Rath, Murday, Springer (2013).
5. Materials Science and Engineering, V. Raghavan, Prentice-Hall of India Private Limited (2003).
6. Principles of Instrumental Analysis, Douglas A. Skoog, Donald M.West, 6th Edition, Cengage (2014)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: 3 Questions from each unit, each carrying 3 marks 36 Marks

Part B/Question: 2 Questions from each unit, each carrying 8 marks 64 Marks

20CH101P					Engineering Chemistry- Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/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 $K_2Cr_2O_7$ 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. **Iodimetry**– 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: 3Hrs**

Part A : Lab Work – Continuous Assessment 50 Marks

Part B : Lab Exam and Viva 50 Marks

20ME102T					Elements of Mechanical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To introduce and define the basics concept of mechanical engineering.
- To familiarize the working principles of IC engines and industrial robotics systems.
- To enable the students to understand the details about the energy systems and its components.
- To demonstrate the various machine elements, materials and its function.
- To help the students acquire knowledge about the various manufacturing process.

UNIT 1 **10 Hrs.**

Introduction to Thermodynamics: Definition and applications, systems and control volumes, thermodynamic properties, thermodynamic systems, state and equilibrium processes and cycles, temperature and Zeroth law of thermodynamics, forms of Energy, energy transfer by work and heat, law of conservation of energy, energy conversion efficiencies.

Properties of Pure substances: Definition, examples and phases, phase change of pure substances, property diagrams and property tables. Solution of Numerical Problems through EES Software.

UNIT 2 **10 Hrs.**

Law of degradation of Energy and Internal Combustion Engines: Limitations of First Law, Thermal Energy reservoirs, heat engines, Refrigerators and Heat pumps, Kelvin Plank and Clausius statement and their equivalence.Introduction, classification and brief description of I.C. engines mechanism, 4-Stroke and 2-Stroke cycles and engines. Otto, Diesel and dual cycles; MEP and air standard efficiencies.

UNIT 3 **10 Hrs.**

Engineering materials and Introduction to Manufacturing Processes: Stresses, strains and material properties.

Conventional manufacturing process: Lathe Machines, CNC machines, drilling machines, universal Milling machines. Non-conventional manufacturing processes: Additive Manufacturing, 3D printing.

UNIT 4 **10 Hrs.**

Introduction to industrial robotics and Introduction to Industry 4.0. Introduction, Industrial and Non-industrial robots, Anatomy and configuration of Industrial Robots, Robot Components, Robot Applications.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Define the "fundamentals' and "terminologies" used in Engineering Thermodynamics.
CO2: Explain the energy conservation principles applicable for ideal gas and pure substance applications
CO3: Analyse the performance of thermodynamic cycles.
CO4: Evaluate the performance of power cycles
CO5: Identify the principles of different machining techniques and material properties.
CO6: Understand the anatomy, applications of robots and introduction to industry 4.0.

TEXT/REFERENCE BOOKS

1. Yunus A. Cengel& Bole, Thermodynamics- Engineering Approach by Tata Mcgraw Hill.
2. Sharma PC. A Textbook of Production Enginerring. S. Chand Publishing.
3. P. K. Nag, Engineering Thermodynamics, Tata Mcgraw Hill, New Delhi.
4. Industrial Robotics, Mikell Groover, McGraw-Hill Education (India) Pvt Limited

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Unit 1 and 2: Two question from each unit (Total 4 question with subparts) 40 Marks
Unit 3 and 4: Two question from each unit (Total 4 question with subparts) 60 Marks

20ME102P					Elements of Mechanical Engineering Lab.		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester LE/Viva	
0	0	2	1	2	25	25	50

COURSE OBJECTIVES

- To Perform experiments and collect experimental data on thermal and mechanical systems to validate theoretical principles.
- To analyse, differentiate and evaluate Law of conservation of energy on thermal systems.
- To evaluate performance of heat engine and heat pumps.
- To calculate and compare the components, application of the conventional manufacturing machines, non-conventional manufacturing machines and industrial robotic systems.
- To demonstrate the working principle of heat engine and additive manufacturing process.

LIST OF EXPERIMENTS

1. To understand and perform fluid property evaluation using property tables and engineering equation solver software.
2. To perform experimental study and verify 1st law of thermodynamics by energy balance of heat exchanger.
3. To evaluate thermodynamic systems using Engineering Equation Solver.
4. To determine Performance of Heat pump and evaluate its coefficient of performance.
5. To understand and demonstrate components and working cycle of Internal Combustion engine.
6. To understand and demonstrate construction and working of conventional manufacturing machine.
7. To understand and demonstrate construction and working of non-conventional manufacturing machine.
8. To study additive manufacturing process applied for 3D printing.
9. To develop a working model of a simple robotic system.

COURSE OUTCOME

On completion of the course, students will be able to

CO1 - Understand and evaluate conservation law of thermodynamics through experimentation.

CO2 - Understand and analyse thermal systems data using engineering equation solver.

CO3 – Measure the coefficient of performance of heat pump.

CO4 - Examine the internal combustion engine components and its working.

CO5 -Demonstrate the various components of convention and non-conventional manufacturing machines and elaborate their applications.

CO6 – Classify the components in industrial robots and develop a simple robotic system.

RESOURCES/TEXT/REFERENCE BOOKS

1. Solar energy by Prof. Sukhatme.
2. Heat transfer by Yungus A. Cengel.
3. Industrial Robotics, Mikell Groover, McGraw-Hill Education (India) Pvt Limited

End Semester Lab Examination

Max. Marks	**Exam Duration: 2 hrs**
Quiz/Experiment	10 Marks
Viva	15 Marks

20IC101T					Basic Electronics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	0	0	100

COURSE OBJECTIVES

- To understand rectification through p-n junction diode and applications of diode
- To learn different configurations and static characteristics of bipolar junction transistor and MOSFET
- To illustrate the OPAMP application in different real life circuits
- To introduce basic concepts of digital electronics

UNIT 1: DIODES AND RECTIFIERS **8 Hrs.**

Review of p-n junction diode, 1-phase half wave, full wave and bridge rectifier using diode. Calculation of average & rms value, PIV, efficiency, transformer utilization factor and ripple for different diode rectifier circuit. Use of Capacitor Filter for ripple reduction, voltage multipliers, Zener diode in load and line regulation.

UNIT 2: BJT, FET AND MOSFET **07 Hrs.**

Working of a BJT, transistor biasing, different transient circuit configuration (CB, CE and CC), static characteristic for BJT, transistor as switch, amplifier, concept of feedback amplifier and oscillator. Classification of FET, static characteristics of FET, FET biasing and load line, MOSFET, static characteristic of MOSFET and biasing

UNIT 3: OPAMP **04Hrs.**

Introduction, Block Diagram and Characteristics of Ideal Op-Amp, Parameters of an Op-Amp, Inverting and Non- Inverting Amplifier, Virtual Ground, Adder, Subtractor, Comparator, Integrator and Differentiator.

UNIT 4: DIGITAL ELECTRONICS **07Hrs.**

Number system, Binary arithmetic, logic gates and combinational logic, Boolean algebra, DeMorgan's Theorems, Logic minimization and Karnaugh maps, full adder, multiplier, multiplexing, Flip Flops, Introductory Sequential Logic, Counters, Registers

Total 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 –Demonstrate application of different diode in circuits
CO2 – Evaluate zener diode as voltage regulator
CO3- Apply BJT, FET and MOSFET in different circuits
CO4–Understand static characteristics OPAMP
CO5–Illustrate basic concepts and theorem of digital systems
CO6–Build digital circuits using logic gates and flip flops

TEXT/REFERENCE BOOKS

1. Boylestad and Nashlesky, "Electronic Devices and Circuit Theory", PHI
2. N.N. Bhargava, S.C. Gupta, and D.C. Kulshreshtha, "Basic Electronics And Linear Circuits", McGraw Hill Education (India)
3. R. A. Gaikwad, "Operational Amplfier and Linear Integrated Circuits", PHI
4. Morris Mano, "Digital Design", PHI
5. J. Millman, C. Halkias and C. Parikh, "Integrated Electronics", Tata McGraw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc.(10 to 20 marks each)	80 to 60 Marks

20IC101P					Basic Electronics Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	0	0	0	25	25	50

COURSE OBJECTIVES

- To understand the characteristics of PN junction diodes and their applications
- To Observe properties of BJT, FET and MOSFET
- To illustrate the OPAMP application in different real life circuits
- To introduce basic concepts of digital electronics

Experiment Sessions would be simulation based covering but not limited to following topics:

1. To study the simulation tool and its features for analog circuit simulation
2. To study the VI characteristic of silicon and germanium diodes.
3. To study reverse characteristics of zener diode.
4. To study half wave, full wave and bridge rectifiers
5. To study BJT as switch
6. To study common emitter amplifier
7. To study different biasing circuits of BJT
8. To study transfer and drain characteristic of FET and MOSFET
9. To study the simulation of digital circuits
10. To study and verify logic gates
11. To implement X-OR and X-NOR gates using basic gates
12. To study and design adder and subtracter circuits
13. To study and design flip flops
14. To study OPAMP and its properties
15. To study ADC and DAC
16. Design of mini project in a group of 4-5 students

COURSE OUTCOMES

On completion of the course, student will be able to
CO1: Study the fundamentals of electronic components
CO2: Understand the working principle of semiconductor devices
CO3: Apply the analog and digital concept in building real time circuits
CO4: Analyze the behaviour of semiconductor devices, OPAMP, ADC and DAC
CO5: Evaluate different circuit for different device parameters
CO6: Build analog and digital sub-system

TEXT/REFERENCE BOOKS

1. Boylestad and Nashlesky, “Electronic Devices and Circuit Theory”, PHI
2. N.N. Bhargava, S.C. Gupta, and D.C. Kulshreshtha, “Basic Electronics And Linear Circuits”, McGraw Hill Education (India)
3. R. A. Gaikwad, “Operational Amplfier and Linear Integrated Circuits”, PHI
4. Morris Mano, “Digital Design”, PHI
5. J. Millman, C. Halkias and C. Parikh, “Integrated Electronics”, Tata McGraw Hill.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 100 **Exam Duration: 1 Hrs.**

PART A- Laboratory Exam: would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/ implementation/ investigation /solution-development. **50 Marks**

PART B: Viva **50 Marks**

20ME101P					Engineering Graphics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	4	2	4	-	-	-	50	50	100

COURSE OBJECTIVES

- To learn fundamental of engineering drawing and standards used in drawing
- To enable the students with various concepts of projections and standards related to technical drawings.
- To demonstrate and communicate ideas using orthographic (2D) & isometric projection (3D) methods
- To help students to use CAD software to solve engineering problems

UNIT 1 **10 Hrs.**

Introduction to Engineering Graphics – Importance and applications, drawing instruments & accessories, lettering, types of lines, dimensioning methods, basic geometric drawing.
Computer Aided Engineering Drawing: Introduction to CAD, use of softwares in drawing, CAD software user interface, commands, menus and toolbars.

UNIT 2 **14 Hrs.**

Orthographic Projection – Introduction to projection, types of projection, 1st angle and 3rd angle projection, 2D sketch, sketch entities and tools – origin, points, lines, arcs, polygons, fillets and chamfer, trim, extend and offset, projections from pictorial view, orientation of views, sections and sectional views.

UNIT 3 **14 Hrs.**

Isometric Projection - Construction of isometric views from orthographic projections, approach to modelling, moving from 2D to 3D, creating 3D models using CAD features, assembly of components and exploded views.
Projection of Solids - Classification of solids, projections of solids like cylinder, cone, pyramid and prism with its inclination to reference plane, concept of development of lateral surfaces, intersection of solids.

UNIT 4 **14 Hrs.**

Drafting – Drafting standards, drawing views, alignment of drawing views, dimensions and tolerances, symbols, comments and annotations, computer aided drafting, drawing sheet and title block.
Tolerance - Introduction to limits, fits and tolerances, standardized representation of threads, fasteners, welds, bearings and springs, dimensional and geometric tolerances, surface finish symbols.

Total 52 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of engineering graphics and remember the basic rules of dimensioning and labelling.
CO2 - Develop the ability to learn fundamental of CAD software and its use to solve engineering problems.
CO3 - Comprehend the concept of projection and use it to represent the views on reference planes.
CO4 - Apply the technical communication skill for 3-dimensional geometries in the form of 3D models using isometric projection.
CO5 - Analyze the orientation of geometrical bodies with respect to reference planes and evaluate the intricate details of solid using sectioning and development of lateral surfaces.
CO6 - Create drawing sheet by organizing drawing views and applying necessary dimensions and tolerances.

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

20HS102T					ENVIRONMENTAL STUDIES					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To provide the basic understanding of various structural and functional aspects of environmental science and their role in life sustenance
- To identify and analyze different environmental pollution problems, as well as the risks associated with them

UNIT 1 – BIRD'S EYE VIEW TO ENVIRONMENT **10 Hrs.**

Environmental Studies – Its importance and Multidisciplinary nature, Ecosystem and its various types, factors affecting the functioning of an ecosystem, Biodiversity – its importance, threats and conservation, Natural Resources – Forest, Water, Mineral, Energy, Food, Review of State of India's Environment.

UNIT 2 – MULTI-SCALE ENVIRONMENTAL POLLUTION (GLOBAL, REGIONAL AND LOCAL) **12 Hrs.**

Concept of Clean Environment, Introduction to various environmental standards – air, water, soil, noise, heat, Causes and Effects of Air Pollution, Water Pollution, Soil Pollution, Solid Waste (organic and Inorganic) Pollution, Hazardous Waste Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Radioactive Pollution, Pollution across Indian cities – case studies, Introduction to man-made disasters like floods, heat waves, landslides, etc.

UNIT 3 – ENVIRONMENTAL POLLUTION CONTROL STRATEGIES **10 Hrs.**

Case studies of Pollution control strategies, Review of the Central and State Government's policies and mechanisms for managing various natural resources and controlling the various types of pollutions (including Swacch Bharat Abhiyan), Global Initiatives for environmental management,

UNIT 4 – SOCIAL ISSUES AND THE ENVIRONMENT **8 Hrs.**

Concept of sustainability and Sustainable Development, Environmental Sustainability Index, Environmental Ethics, Public awareness and people's participation, Consumerism and Waste products, Introduction to Carbon Footprint & Water Footprint, Green Buildings and Green Business

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Outline the importance of Ecosystem, Biodiversity and the conservation of natural resources
CO2 - Understand the consequences and impact of multi scale environmental pollution
CO3 - Implement the various Pollution controlling strategies across all the frontiers of environment effectively
CO4 - Illustrate an integrative approach to deal with environmental issues with a focus on sustainable development
CO5 - Review the various Global initiatives for environmental management
CO6 - Facilitate the critical thinking skills for environmental Protection

TEXT/REFERENCE BOOKS

1. Bharucha Erach, Textbook for Environmental Studies, UGC New Delhi
2. Principles of Environmental Science, Cunningham W.P. and Cunningham M.A. (2002), Tata McGraw-Hill

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: <Details> <60> Marks
Part B/Question: <Details> <40> Marks

20CP101T					Programming with C					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop a greater understanding of the issues involved in programming language, design and implementation
2. To inculcate functional and logical problem-solving skills through programming.
3. To understand the basic concepts of C programming

UNIT I: BASICS OF C PROGRAMMING **04 Hrs**

Input, Output constructs, different data types, types of Operators, Precedence and associativity of Operators, Control Structure and Loop Structure

UNIT II: ARRAY AND STRINGS **04 Hrs**

1-dimensional, 2-dimensional and 3-dimensional arrays, different types of user defined functions, String operations in form of Character arrays, In-built String functions

UNIT III: POINTERS **04 Hrs**

Basic pointer arithmetic, arrays and String using Pointer, call the functions using Call-by reference property

UNIT IV: FILE HANDLING **02 Hrs**

Open the file in write mode and write the data into it, open the file in read mode and read from the file, Open the file in append mode and append the contents in the file, handle the File operations using seek function.

TOTAL HOURS 14 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand functional and logical problem-solving skills through programming
CO2 - Write, compile and debug programs in C language
CO3 – Use basic and derived data types in C and Operators in C.
CO4 - Design programs involving decision structures, loops, and functions in C.
CO5 - Implement Programs to perform pointer arithmetic and array handling with Pointers.
CO6 - Perform File-handling operations in C.

TEXT/REFERENCE BOOKS

1. E.Balaguruswamy, Programming in ANSI C, McGraw-Hill
2. Jeri R. Hanly and Elli B.Koffman, Problem Solving and Program Design in C.
3. Brain W.Kernighan & Dennis Ritchie, C Programming Language, PHI

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

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

20CP101P					Programming with C - Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- To understand the basic concepts of C programming
- To understand design and implementation issues involved with variable allocation and binding, control flow, types, subroutines, parameter passing
- To develop understanding of Compilation process.

LIST OF PROGRAMS:

Practical list should be prepared based on the content of the subject and following guidelines should be useful.
- Computer Programming covering all constructs of C language.
Following list gives some programming examples. Faculty can prepare their own list in same manner keeping above guidelines and syllabus in mind.

1. Add, subtract, multiply, divide two numbers.
2. Convert hours into minutes, minute to hours.
3. Conversion related programs dollars into Rs. Where 1 $ = 48 Rs. , grams to KG, Kilobytes to Megabytes.
4. Convert Celsius into Fahrenheit. F = (9/5 * C) + 32 and Fahrenheit into Celsius. C = 5/9 * (F –32)
5. Calculate simple and compound interest where I = PRN/100.
6. Calculate area & perimeter of a square, rectangle, circle, triangle.
7. Program to sort N numbers. (Ascending and Descending)
8. Program to calculate string length, reverse the string.
9. Program to check the string and number is palindrome or not.
10. Program to generate sine, cosine, tan series.
11. Program to generate Fibonacci series.
12. Program to calculate factorial using recursion.
13. Program to create a database using array of structures.
14. Programs related to pointers.
15. Programs related to file.

Design based Problems (DP)/Open Ended Problem:

1. Develop a game/Puzzle in C language.
2. Use interrupts to develop programs related to basic operations.

COURSE OUTCOMES

On completion of the course, the students will be able to
CO1 – Understand functional and logical problem-solving skills through programming. CO2 - Write, compile and debug programs in C language.
CO3 – Use basic and derived data types in C and Operators in C.
CO4 - Design programs involving decision structures, loops, and functions in C.
CO5 - Implement Programs to perform pointer arithmetic and array handling with Pointers. CO6 - Perform File-handling operations in C.

TEXT/REFERENCE BOOKS

1. E.Balaguruswamy, Programming in ANSI C, McGraw-Hill
2. Jeri R. Hanly and Elli B.Koffman, Problem Solving and Program Design in C.
3. Brain W.Kernighan & Dennis Ritchie, C Programming Language, PHI

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

COURSE OBJECTIVES

- To develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young citizens
- 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):

Importance and role of youth leadership, Life competencies, Youth development programmes and youth 'shibir', Health, hygiene and sanitation, Youth health, lifestyle, first aid, youth and yoga

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.

Semester 2

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 2	BSC	20MA102T	Mathematics – II	3	1	0	4	4
	ESC	20CP102P	Fundamentals of Python Programming	0	0	2	2	1
	HSC	20HS101P	Communication skills-I	0	0	2	2	1
	BSC	20PH101T	Engineering Physics	3	0	0	3	3
	BSC	20PH101P	Engineering Physics Lab	0	0	2	2	1
	ESC	20EE101T	Element of Electrical Engineering	3	0	0	3	3
	ESC	20EE101P	Element of Electrical Engineering-Lab	0	0	2	2	1
	ESC	20CE101T	Element of Civil Engineering and Mechanics	4	0	0	4	4
	ESC	20CE101P	Element of Civil Engineering and Mechanics Lab	0	0	2	2	1
	ESC	16ME103P	Workshop Practice	0	0	2	2	1
	HSC	16HS109T	Professional Ethics and Human Values	1	0	0	1	1
	TP110	16TP110	Civic services and Social Internship	0	0	0	0	1
	HSC	16SP101	NCC-II	0	0	2	2	1
		16SP102	NSS-II					
		16SP103	Sports-II					
				14	**1**	**12**	**27**	**22**

20MA102T					MATHEMATICS - II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/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 apply the calculus of complex functions to construct analytic functions.
- To be able to compute residues and apply them to evaluate contour integrals.
- To be able to formulate and solve various engineering problems using the methods of solving ODEs.
- To study the properties of Laplace transforms and apply them to solve ODEs.

UNIT 1 COMPLEX DIFFERENTIATION **10 Hrs.**

Limit, Continuity, Differentiability of function of complex variable, Analytic function, Cauchy-Euler equation (in Cartesian and polar coordinates), Harmonic function and its significance, Singularities, Taylor's series, Mapping (translation, rotation and inversion), bilinear transformation, Conformal mapping, Applications of Conformal mapping.

UNIT 2 COMPLEX INTEGRATION AND APPLICATIONS **10 Hrs.**

Definition of a Complex line integral, Contour integrals, Cauchy- Goursat theorem, Cauchy integral theorem, Cauchy Integral formula (CIF), CIF for derivatives, Calculation of residues, Cauchy Residue theorem, Applications of residues to evaluate real definite integrals.

UNIT 3 ORDINARY DIFFERENTIAL EQUATIONS WITH APPLICATIONS **10 Hrs.**

Differential equations of first order and higher degree, Higher order differential equations with constant coefficients, Rules for finding C.F. and P.I., Method of variation of parameters, Cauchy and Legendre's linear equations, Linear differential equations of second order with variable coefficients; Simultaneous linear equations with constant coefficients, Applications of higher order differential equations in solving engineering problems.

UNIT 4 LAPLACE TRANSFORMS **10 Hrs.**

Piecewise continuous functions and exponential functions, Definition, Existence and Properties of Laplace transforms, Heavyside function, Inverse Laplace transform, Properties of inverse Laplace transforms, Convolution theorem, Applications of Laplace Transforms in solving differential equations.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify the use of various special functions in engineering aspects.
CO2 – Illustrate the ability to handle mathematical models, to describe physical phenomena, using suitable techniques.
CO3 – Develop the ability to apply appropriate tool/method to extract the solutions of engineering problems.
CO4 – Analyze the obtained solution in context with theory.
CO5 – Appraise mathematical problems from real to complex domain.
CO6 – Create a mathematical model of engineering interest.

TEXT/REFERENCE BOOKS

1. R.V. Churchill and J. W. Brown, Complex variables and applications, McGraw-Hill, 7th Ed., 2003
2. J. M. Howie, Complex analysis, Springer-Verlag, 1st Ed., 2003.
3. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Alpha Science, 3rd Ed., 2007.
4. Erwin Kreyszig, Advanced Engineering mathematics, John Wiley, 10th Ed., 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A: 10 questions 3 marks each	30 Marks (40 min)
Part B: 5 questions 6 marks each	30 Marks (50 min)
Part C: 5 questions 8 marks each	40 Marks (90 min)

20HS101P					Communication Skills – I (Semester I/II) (First Year)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	0	2 hours per week	--	--	--	50	50	100

COURSE OBJECTIVES

- Understand of the fundamental elements of communication in English language.
- Know and understand different practices of verbal and non-verbal communication with inputs to improve basic language skills.
- Students are expected to be better equipped in the following areas:
  - **Listening:** Understanding basic content in lectures and common everyday situations
  - **Speaking:** Correct expression in the English language at a basic level
  - **Reading:** Understanding, retaining, and critically analyzing technical/non-technical content
  - **Writing:** Using appropriate vocabulary, grammar, effective paragraph construction, writing in day-to-day scenarios, including digital platforms

UNIT 1 **21 hrs**

Structure of English Language Academic, Research and Technical Vocabulary Phonetics and Accent

UNIT 2 **3 hrs**

Listening Skills Note Taking and Note Making Collective note-taking and note-making on digital platforms

UNIT 3 **3 hrs**

Reading Comprehension Speed Reading

UNIT 4 **1 hrs**

The art of introducing oneself Public speaking and articulation

Max. 30 hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 Confidence to listen, speak, read and write in English

CO2 Being able to produce something new with the help of inputs

CO3 Learning to critically analyze

CO4 Preparing reports/critique with the help of collected data

CO 5 Having a multi-dimensional/disciplinary perspective and approach

CO6 Better improved and sharpened skills to present, convince and persuade to be an effective and successful professional

TEXT/REFERENCE BOOKS

- Harmer, Jeremy. The Practice of English Language Teaching. Harlow: Pearson Longman, 2007.
- Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.
- Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, 2001.
- Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Assessment Tool	Marks	Assignments
Lab Work	50	• Listening and Questionnaire – 15 • Grammar Worksheet – 20 • Short Story/Essay (750 – 1000 words) – 05 • Reading Comprehension – 10
Lab Exam/Viva	50	• Wordsworth – 10 • Narrating a Story along with Self Introduction/Speech – 15 • Reading Aloud – 05 • Vocabulary/Phonetics – 20

Pandit Deendayal Energy University **School of Technology**

20PH101T					Engineering Physics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	Viva	
3	0	2	0	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand basic concepts of quantum mechanics and solve the Schrödinger equation for various cases.
- To understand basics concepts of electric and magnetic properties of solids.
- To develop the fundamental understanding of optoelectronic devices.
- To understand the heat transfer mechanism in solids and fluids.

UNIT 1 Introduction to Quantum Mechanics **12 Hrs.**

Inadequacies in Classical Physics, Wave Nature of Matter, Heisenberg's Uncertainty Principle and its applications, zero point energy, Basic Postulates and Formalism of QM: Energy, Momentum and Hamiltonian Operators. Time-independent Schrodinger Wave Equation for Stationary States. Properties and interpretation of Wave Function. Probability Density and Probability. Conditions for Physical Acceptability of Wave Functions, Application of time-independent Schrödinger equation for various potentials.

UNIT 2 Electronic theory of Solids **10 Hrs.**

Elements of crystallography; lattice vibrations of solids; Bloch Theorem and Origin of energy bands, band structure of conductors, type of semiconductors, Free Electron Theory of metals, Wiede-mann Franz Law, Kronig-Penny model, Hall effect. Magnetism and its origin, magnetization and susceptibility, dia-para-ferro-magnetism. Ferromagnetism, Nano magnets and magneto resistance, hard disk drive storage technology. Phenomenology of Superconductors, Meissner effect, BCS theory - high temperature superconductors.

UNIT 3 OPTICS, LASER AND OPTO-ELECTRONICS **08 Hrs.**

Optics: Introduction, division of amplitude, thin film interference, Applications of interference, Laser: The Einstein coefficients, Spontaneous and stimulated emission, Optical amplification and population inversion, meta stable state, optical resonator, the principle of pumping scheme, laser beam characteristics. Types of LASER, Injection Laser Diode (ILD). Quantum Cascade Laser, Comparison between ILD and QCL. Applications of lasers.

UNIT 4 THERMAL PHYSICS **10 Hrs.**

Laws of thermodynamics-basic concepts, closed and open systems-first law. Heat transfer-thermal expansion of solids and liquids – Conduction in solids – thermal conductivity- Forbe's method, Lees' disc method, conduction through compound media, formation of ice on ponds, thermal insulation and its applications. Thermal Convection - properties of radiant heat, sea and land breeze. Thermal Radiation – emission and absorption radiation, emissive power, black body radiation – Kirchoff's, Stefan's laws, wien's law, Newton's law of cooling.

Max. 40 Hrs.

COURSE OUTCOMES

CO1 – identify and understand the experimental results which require conceptualization of quantum theory.
CO2 – Interpret the solution of Schrödinger equation to obtain physical information about the system.
CO3 - Identify basic concepts in semiconductors, superconductors and magnetism and apply it in engineering applications.
CO4 - To understand concepts of optical interference and LASER, analyse the lasing characteristics to apply in different laser diodes and other applications
CO5 - To understand concepts of thermal physics in terms of laws and modes of heat transfer.
CO6 - To apply knowledge of concepts of engineering physics to solve real world problems.

TEXT/REFERENCE BOOKS

1. N. Zettili, Quantum Mechanics: Concepts and applications, Willey Publications
2. Kittel, Charles. Introduction to Solid State Physics. John Wiley and Sons.
3. W.D. Callister and David Rethwisch, Materials Science & Engineering -An Introduction, 9th edn.,
4. Heat and Thermodynamics BrijLal, N. Subrahmanyam, S. Chand, Limited, 2001.
5. Optics by Ajay Ghatak, Tata macgraw hill publishing.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: 3 Questions from each unit, each carrying 3 marks 36 Marks
Part B/Question: 2 Questions from each unit, each carrying 8 marks 64 Marks

20PH101P					Engineering Physics -Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- To understand the working of various electrical, mechanical and optical instruments in the laboratory.
- To gain practical knowledge in Physics through experiments.
- To understand basics concepts of Physics and be able to apply in performing the experiments.

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.

COURSE OUTCOMES

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

CO1 - Apply and analyze the concepts of electricity and magnetism.
CO2 - Understand the interaction of light waves and its propagation in different media.
CO3 - Demonstrate and implement the phenomenon of resonance
CO4 - Investigate the electrical properties of a given semiconductor device
CO5 - Examine the charge transport mechanism in different conductors
CO6 - Design and analyze the light propagation for communication application using fibre optics

TEXT/REFERENCE BOOKS

1. Ghatak, Optics, 3rd edition, Tata McGraw Hill (2005).
2. Kittel, Knight and Ruderman, Mechanics - Berkeley Physics Course, Vol. 1, Tata McGraw-Hill.
3. Avadhanulu, A text book of engineering Physics, S. Chand & Company, Ltd.
4. Brij Lal, N. Subrahmanyam, Heat and Thermodynamics, S. Chand & Company, Ltd

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Continuous evaluation	50 marks
End semester examination and Viva-voce	50 marks

Pandit Deendayal Energy University					School of Technology					
20EE101T					**Elements of Electrical Engineering**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**Viva**	
3	**0**	**0**	**3**	**3**	**25**	**50**	**25**	**-**	**-**	**100**

COURSE OBJECTIVES

- To impart knowledge on DC and AC circuits.
- To learn construction, working principles and characteristics of transformer and induction machines.
- To introduce students to various means for electrical safety and protection of electrical installations.
- To impart knowledge on electric wiring and illumination for domestic and industrial applications.

UNIT 1: DC CIRCUITS **10 Hrs.**

Electrical circuit elements (R, L and C), voltage and current sources, dependent and independent sources, Ohms Law, temperature co-efficient of resistance, Kirchhoff current and voltage laws, voltage and current divider circuit, Thevenin and Norton Theorems and their equivalents, maximum power transfer and superposition theorems, nodal and mesh analysis, star-delta transformation, Time domain analysis/natural response of first order RL and RC Circuit

UNIT 2: AC CIRCUITS **10 Hrs.**

Generation of AC voltage, representation of sinusoidal waveforms, rms values of different sinusoidal waveforms, Rectangular and Polar representation of phasor, Sinusoid representation in time and frequency domain. of Analysis of single-phase ac series circuits consisting of R, L, C, RL, RC, RLC combinations, instantaneous, average power and reactive power, complex power and power factor. AC parallel circuit and its solution in admittance form, resonance in AC series circuit and parallel circuit. Polyphase circuits, star and delta representation of polyphase circuit, power measurement in polyphase circuit

UNIT 3: TRANSFORMERS AND INDUCTION MACHINES **10 Hrs.**

Magnetic material and its B-H characteristic, Faraday's Law of Electromagnetic Induction Transformers: ideal transformer, emf equation for transformer, working of practical transformer on no-load and load Induction Machine: Types of induction motor, production of rotating magnetic field from 3-phase supply, operation of three phase induction motor, starting and running torque, Torque-slip characteristics of induction motor, Power Stages in IM

UNIT 4: ELECTRICAL INSTALLATION, SAFETY AND PROTECTION **10 Hrs.**

Fuse, MCB, ELCB, MCCB, underground cables. Domestic and Industrial Wiring. Types of lamps, illumination schemes and lumen requirement for domestic and industrial applications, Earthing and it schemes. Electrical safety rules, electric shock and first aid, energy conservation methods, elementary calculation of energy consumptions, tariffs

Max Hrs: 40

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Analyze electrical circuits using network theorems.

CO2 – Compare the behavior of R, L and C and their combinations in AC circuits.

CO3 – Analyze balanced polyphase systems in star and delta configuration

CO4 – Understand the construction, working and basic characteristics of transformer and induction machines

CO5 – Recognize the importance of protective devices and electrical safety measures

CO6 – Carry out domestic and industrial electrification

TEXT/REFERENCE BOOKS

1. J. Bird, "Electrical Circuit Theory and Technology", Routledge, Tailor and Francis Group, Sixth Edition, 2017.
2. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
3. B. L. Theraja, "Electrical Technology", Vol. 1, S. Chand Publication, New Delhi
4. Surjit Singh, "Electrical Estimating and Costing", Dhanpat Rai and Co.

20EE101P					Elements of Electrical Engineering Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To gain practical knowledge on DC and AC circuits
2. To learn operation of electrical instruments and electrical machines
3. To develop skills to implement electric wiring

LIST OF EXPERIMENTS

1. Introduction to elements of electrical engineering laboratory and to study different electrical measuring instruments
2. To validate Ohm's law with linear resistors and find power dissipation in resistor
3. To implement voltage divider and current divider circuit
4. To validate Thevenin and Norton theorem for DC circuit
5. To validate Superposition and Maximum Power Transfer theorem for DC circuit
6. To obtain transient response of RL and RC circuit
7. To evaluate performance of AC series circuit
8. To evaluate performance of AC parallel circuit
9. To analyse resonance condition in AC circuit
10. To establish relation between line and phase quantities in star and delta connected polyphase system
11. To measure power in polyphase system
12. To perform load test on 1-phase transformer
13. To perform load test on 3-phase transformer
14. To obtain current time characteristic for domestic protective devices
15. To carry out domestic electric wirin

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Operate basic electrical measuring instruments
CO2 – Simulate the basic electrical circuits and obtain results based on electrical laws and network theorem
CO3 – Understand the performance of AC circuit with different connection of R, L and C
CO4 – Formulate star and delta configuration of polyphase system and measure power in polyphase system
CO5 – Operate transformer and induction machines and evaluate its performance
CO6 – Understand the basic wiring and operation of protective devices for domestic application

END SEMESTER EXAMINATION PATTERN

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

Part A : Lab Work – Continuous Assessment 50 Marks

Part B : Lab Exam and Viva 50 Marks

20CE101T					Element of Civil Engineering and Solid Mechanics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	-	-	4	4	25	50	25	--	--	100

COURSE OBJECTIVES.

- To introduce and explain the basics scope of engineering.
- To understand different types of force systems and apply them to practical engineering application.
- To develop understanding of the basic concepts related to tensile, compressive and shear stresses in engineering components.
- To discuss the basic principles of torsion in shafts, shear force and bending moment in beams, Deflection in springs, Columns and Struts.

UNIT 1 INTRODUCTION TO CIVIL ENGINEERING & MECHANICS **14 Hrs.**

Basics and scope of Civil Engineering- Introduction to Civil Engineering- Branches of Civil Engineering- Application of Civil Engineering in other domain different types residential of buildings- green building and smart building. Introduction to Engineering Mechanics- Resolution of forces- Varignon's – couples- Lami's theorem-Centroid and Moment of Inertia- Determination of moment of inertia of simple planar laminas like rectangle- triangle- quarter-semi-circle and circle. Theorems of perpendicular and parallel axis-polar moment of inertia- radius of gyration.

UNIT 2. SIMPLE AND COMPOUND STRESSES AND STRAIN **14 Hrs.**

Introduction to stresses and strain – Stress-strain diagram- Elastic constants -relationship between elastic constants and Poisson's ratio – Generalised Hook's law – Strain energy – Deformation of simple and compound bars – thermal stresses. Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress, Theories of failure

UNIT 3 SFD- BMD AND STRESSES IN BEAM **12 Hrs.**

Types of beams- Cantilever, Simply supported, Overhanging: Shear Force and Bending Moment Diagrams Theory of simple bending – bending stress and shear stress in beams. Deflection of beams by Double integration method – Macaulay's method – Area moment theorems for computation of slopes and deflections in beams – Conjugate beam method.

UNIT 4 TORSION AND COLUMNS **12 Hrs.**

Introduction to Torsion – derivation of shear strain – Torsion formula – stresses and deformations in circular and hollow shafts – Stepped shafts – shafts fixed at the both ends – Stresses in helical springs. Theory of columns – Long column and short column – Euler's formula – Rankine's formula - Secant formula - beam column.

Total 52 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 –Describe the basics and scope of civil engineering, role of civil engineer and sub branches of civil engineering.

CO2 -Compute the stress and strain developed due to applied load in any structural member and solve the principal stress & strain at a point of stressed member.

CO3 – Calculate the sheer force & bending moment diagram under various loading & support condition.

CO4 - Analyze bending and shear stresses in the different layers of the beam for various loadings.

CO5 - Determine the torsion equation & pure torsion

CO6 - Explain the loaded structural members for deflection.

TEXT/REFERENCE BOOKS

1. N.H Dubey, Engineering Mechanics-Statics and Dynamics, Tata McGraw Hill Private limited
2. R. S. Khurmi, Engineering Mechanics, S. Chand Publication
3. S.S. Bhavikatti Elements of Civil Engineering (IV Edition) , Vikas Publishing House Pvt. Ltd., New Delhi.
4. Ferdinand P Beer and E Russel Johnson , Mechanics for Engineers (Statics & Dynamics) McGraw Hill book company, New York

END SEMESTER EXAMINATION QUESTION PATTERN

Max. Marks: 100 Exam Duration 3 Hrs.

Part A: 4 Question from unit-1 – 5 Marks Each 20 Marks

Part B: 8 Numerical Questions from unit 2 to unit 4 – 10 Marks Each 80 Marks

20CE101P					Element of Civil Engineering and Solid Mechanics Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	1	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- To conduct standard tests on construction steel under static load.
- To conduct standard tests on metals under impact load
- To conduct standard tests of flexure and compression on wooden items.
- To conduct standard tests of crushing, impact and abrasion on bricks and tiles.

LIST OF EXPERIMENTS

1. Tension test on mild steel
2. Compression test of ms bar/cost iron
3. Bending test on wooden beam / Steel bars
4. Shear test on steel bar
5. Hardness test
6. Charpy impact test
7. Izod impact test
8. Compression test of on bricks
9. Flexural test on clay roof tiles

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Define the standard tests of mild steel under tension, compression & shear.
CO2 – Compute and use the Charpy impact testing machine to evaluate the performance of metal under impact load.
CO3 – Compute Rockwell hardness testing machine to determine the hardness of metals
CO4 – Illustrate modulus of rupture of timber and steel bar.
CO5 – Determine the compressive and bending strength of clay items.
CO6 – Explain the crushing, impact and abrasion values of bricks.

REFERENCES:

5. S. B. Junarkar and Dr. H. J. Shah, Mechanics of Structures, 27th Revised and Enlarged, Charotar Publication.
6. Beer and Johnston, Mechanics of Materials, McGraw Hill International

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

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

16ME103P					Workshop Practices		
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total Marks**
					Continuous Evaluation	**End Semester**	
-	**-**	**2**	**1**	**2**	**25**	**25**	**50**

COURSE OBJECTIVES

- To impart the machining skills in students
- To develop a skills in precision, safety at work place, team working with right attitude
- To prepare a job by using ability to design and model different prototypes.

Metrology

Semi-Precision tools: Rules and scales, try square. Inside/Outside Calipers, Depth gages etc. Precision Tools: Micrometers, Vernier calipers, Bevel Protractor, Dial indicator, Gage blocks, Surface plates etc.

Carpentry Shop

Timber, Seasoning and Preservation, Plywood and Ply boards, Carpentry Tools, Engineering applications. Different Joints

Bench work and Fitting

Introduction to the familiarization with tools and their uses, Hammers, Hacksaws, choice of blades & sawing techniques, Files with their classification; According to their longitudinal shape & cross section, classification based on cuts; teeth; length of the file, Care of files and hand tool safety rules Vices & their classification, Other hand tools; scribers, chisels, scrapers, center, punch, surface gauge, Universal cribbing block, Trammel, Screw drivers, Drills, Spanners, Pliers, Taps, Dies, Reamers, Screw drivers etc, Fitting Processes : Marking, Chipping, Sawing, Filing, Scrapping, Drilling, Internal Threading (or Trapping), External Threading (or Dieing), Reaming, welding, soldering, brazing

Tin Smithy – Surface development

Shearing and Bending of sheets, Making simple products by Tin Smithy practice.

List of Experiments:

1. Introduction to Workshop and safety.
2. Experiment on measurement of linear, angular and curved dimensions of the object.
3. Fitting job: Detailed drawing of work piece, use of fitting tools and job preparation.
4. Hands on experience on welding, brazing and soldering.
5. Carpentry job: Detailed drawing of work piece, use of carpentry tools and job preparation.
6. Sheet metal job: Detailed drawing of work piece, use of sheet metal working tools and job preparation.
7. Plumbing job: Internal/External threading, piping network using Tees, Elbows, Reducer, Bends etc

COURSE OUTCOMES

CO1: Define fundamentals and principles cutting and enhance the machining skills in students

CO2: Apply principles of machining and develop a skills in dignity of labour, precision, safety at work place, team working and development of right attitude

CO3: Analyse the effect design and model different prototypes in carpentry

CO4: Examine the effect and create and develop ability to design and model different basic prototypes in trade of fitting

CO5: Determine the effect and create and develop ability to design and model different basic prototypes in trade of tin smithy

CO6: Evaluate the performance of different machining and cutting processes such as fitting, carpentry, plumbing etc.

16HS109T					Professional Ethics and Human Value					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	50	25	--	--	100

COURSE OBJECTIVES

- Identify the core values that shape the ethical behaviour of an Engineer
- Awareness on professional ethics and human values
- To know their role in technological development
- To appreciate the rights of others
- Improved communication and learn to work in group
- Learn to understand and discuss on issues of social interest

Unit 1: HUMAN VALUES **[5 hrs]**

Morals, Values and Ethics - Integrity - work Ethic - Service Learning - Civic Virtue - Respect for others - Living peacefully - Caring - Sharing - Honesty - Courage - Valuing time - Co-operation - Commitment - Empathy - Self-Confidence - Character - Spirituality

Unit 2: ENGINEERING ETHICS **[4 hrs]**

Sense of 'Engineering Ethics' - Variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy - Models of Professional Roles & Professionalism - theories about right action - Self-interest - customs and religion - uses of ethical theories.

Unit 3: ENGINEERING AS EXPERIMENTATION **[4 hrs]**

Engineers as responsible experimenters - Research ethics -Codes of ethics - Industrial Standard - Balanced outlook on law - the challenger case study.

Unit 4: SAFETY, RISK AND GLOBAL ISSUES **[5 hrs]**

Safety and risk - assessment of safety and risk - Risk benefit analysis and reducing risk - Threat of Nuclear power - Collegiality and loyalty - respect for authority - Confidentiality - conflicts of interest - professional rights - employees' rights - Intellectual Property rights (IPR) - discrimination. Multinational corporations - Business ethics - Environmental ethics - Role in Technological Development - Weapons development - consulting engineers - engineers as expert witnesses and advisors-Ethics.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Find the core values that shape the ethical behaviour of an Engineer
CO2: Students will get aware of the professional ethics and human values
CO3: Develop and understand their role in technological development
CO4: Simplify to the rights of others
CO5: Perceive improved communication with activities and learning to work in group
CO6: Discuss on issues of social interest and make opinions based on logical reasoning

TEXT/REFERENCE BOOKS

1. A Textbook on Professional Ethics and Human Value by Prof. R. S. Nagaarazan, New Age International Limited Publisher, Chennai. 2006
2. A Text book on Professional Ethics and Human Values by M. Govindarajan, S. Natarajan, V. S. Senthilkumar, PHI Learning Pvt. Ltd., 2013.
3. A Text book on Professional Ethics and Human Values by Dinesh Babu, Firewall Media, 2007

16TP110					Civic Services and Social Internship					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	0	1	21 days	--	--	--	--	--	100

COURSE OBJECTIVES

1. To develop a holistic view of social work and social welfare in the community, with special emphasis on the role of different agencies like Govt. departments and NGOs in human services.
2. To enlighten and sensitize students on various types of problems of the people and their diversified cultural background.
3. To understand the agency as an organization, its structure, functions, activities and sources of funding.
4. To understand and make a commitment to the basic humanistic values and principles of social work practice in a secular democratic society.
5. To develop an understanding of the application of the methods of social work practice in the field.
6. To develop an understanding of the opportunities in working with diverse populations.
7. To develop the self –awareness necessary to assess one's own values, attitudes, feelings, strengths, limitations, and interests and performance.
8. To inspire young technocrats to become change makers

UNIT I: Overview of Civic and Social Service Sector

UNIT II: Understanding of NGO/Civic Body/Government Body Management and their functioning

UNIT III: Study of Individual organizational and government projects and schemes where students are interning

UNIT IV: Field Visits

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Become sensitized workforce of enlightened Engineers and Managers who are socially concerned and willing to positively contribute to the society

CO2 – Acquire desired work habits and attitudes with the sense of social responsibility and think innovatively to find solutions

CO3 – Understand the role of different NGO/civic/government bodies in the service of citizens

CO4 – Imbibe basic humanistic values and principles of social work practice in a secular democratic society

CO5 – To assess one's own values, attitudes, feelings, strengths, limitations, interests and performance through opportunities of working with diverse populations

CO6 – Obtain experiential learning via internship and be sensitive towards issues of modern-day citizenship and democracy

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Part A: NGO evaluation 50 Marks

Part B: Internal faculty 50 Marks

					NCC/NSS/SPORTS-II					
Teaching Scheme					Examination Scheme					
					Theory			Practical		
L	T	P	C	Hrs/Week	MS	ES	IA	LW	*Participation and Attendance	Total Marks
0	0	2	1	2	Continuous Evaluation			--	100	100

COURSE OBJECTIVES

- To develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young citizens
- 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):

Importance and role of youth leadership, Life competencies, Youth development programmes and youth 'shibir', Health, hygiene and sanitation, Youth health, lifestyle, first aid, youth and yoga

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.

Semester 3

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 3	BSC	20MA201T	Maths-III	3	1	0	4	4
	PC	20CH202T	PC-1 (Chemical Process Calculations)	3	0	0	3	3
	PC	20CH201T	PC-2 (Fluid Mechanics)	3	0	0	3	3
	PC Lab	20CH201P	Fluid Mechanics Lab	0	0	2	2	1
	PC	20CH203T	Chemical Engineering Thermodynamics-1	2	0	0	2	2
	PC	20CH204T	PC-3 (Mechanical Unit Operations)	3	0	0	3	3
	PC Lab	20CH204P	Mechanical Unit Operations	0	0	2	2	1
	OE	20CH205T	OE-1 (Nanomaterials)	3	0	0	3	3
		20CH206T	OE-1 (Environmental Engg)	3	0	0	3	3
	HSC	20HS201P	Communication Skills - II	0	0	2	2	1
				17	**1**	**6**	**24**	**21**

20MA201T					MATHEMATICS-III: Chemical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To apply Fourier analysis for solving applications in chemical and allied engineering branches.
- To familiarize students with a variety of engineering problems that can be analyzed by using properties of Fourier transform techniques.
- To provide a broad coverage of various mathematical techniques that are widely used for solving and to get analytical solutions to partial differential equations of first and second order.
- To introduce various applications of partial differential equations in many fields of science and engineering.

UNIT 1 FOURIER SERIES **10Hrs.**

Periodic functions, Odd and even functions, Euler's formulae for Fourier series in an interval of length 2 pi, Change of interval, Dirichlet's conditions, Half range Sine and Cosine series, Complex Fourier series, Parseval's identity and its applications.

UNIT 2 FOURIER TRANSFORM **10 Hrs.**

Fourier integral theorem, Sine and Cosine integrals, Fourier transform, Fourier Sine and Cosine transforms, Properties, Inverse Fourier transform, applications of Fourier transform to problems on 1-d and 2-d heat flow problems.

UNIT 3 PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER **10 Hrs.**

Formation of Partial Differential Equations (PDEs), Solutions of PDEs of first order, Cauchy problem for first order PDEs, Lagrange's method, Charpit and Jacobi methods for solving first order nonlinear PDEs.

UNIT 4 PARTIAL DIFFERENTIAL EQUATIONS OF SECOND ORDER WITH APPLICATIONS **10 Hrs.**

Classification of second order PDEs, Method of separation of variables, Fourier series solutions of one-dimensional wave equation, One dimensional heat equation, Steady state solution of two-dimensional heat equation, Applications of PDEs to string and rod problems, Finite and infinite plate problems and reaction engineering.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify real phenomena as models of partial differential equations.
CO2 – Develop the skills for solving boundary value problems arising in chemical engineering.
CO3 – Apply various analytical methods to obtain solutions to PDEs of first and second order, which occur in science and engineering.
CO4 – Formulate and solve physical problems involving partial derivatives.
CO5 – Apply the techniques learnt to analyze a comprehensive model related to chemical engineering.
CO6 – Demonstrate the ability to use mathematical arguments to describe the real-world problems in science and engineering.

TEXT/REFERENCE BOOKS

1. K. S. Rao: Introduction to Partial Differential Equations, PHI Learning Pvt Ltd, New Delhi, 2010
2. T. Amaranth: An Elementary Course in Partial Differential Equations, Narosa Publishing House, New Delhi.
3. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, American Mathematical Society, 1998.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2017
5. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th Edition, 2016.
6. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd Ed., Narosa Publishing House, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 6 questions 4 marks each	24 Marks (40 min)
Part B: 6 questions 8 marks each	48 Marks (60 min)
Part C: 2 questions 14 marks each	28 Marks (40 min)

20CH202T					Chemical Process Calculations					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- Learn to use the correct unit conversions and dimensions and use them in process calculations
- Synchronize the understanding of stoichiometry and different unit operations & processes
- Handle the material balances for a system with and without reactions and/or with recycle / bypass operations.
- Accustom students to different forms of energy, terminologies of heat and energy and perform energy balances
- To give detail understanding of combustion process and calculations for estimating allied quantities

UNIT 1 BASIC CONCEPTS OF CHEMICAL PROCESSES **10 Hrs.**

Units and dimensions, basic chemical calculations, dimensional consistency, unit processes and unit operations, variables and properties of material in systems, specific properties, mass and energy conservation, equilibrium relations, rate laws, constitutive equations for material behavior, correlations for physical and transport properties.

UNIT 2 MATERIAL BALANCES **15 Hrs.**

Material balance for non-reacting multi-phase systems, material balance for systems with recycle and bypass, material balances on systems with reactions, properties of gases, liquids and solids, ideal and non ideal gas calculations, equations of state, phase equilibria for ideal and real mixtures, humidity and saturation

UNIT 3 ENERGY BALANCES **15 Hrs.**

Terminologies, specific heat capacity, enthalpy, heat of formation, combustion, reaction, solutions, energy balances without reactions, for chemical reactions, isothermal systems, adiabatic systems, simultaneous material and energy balances, unsteady state material and energy balances, introduction to computer aided process calculations, case study

UNIT 4 FUEL AND COMBUSTION **12 Hrs.**

Types of fuels, proximate and ultimate analysis of fuel, combustion theory, heating value of fuels. Calculations involving theoretical and excess air, heat and material balances of combustion processes, analysis of products of combustion calorific value – HCV & LCV. Bomb and Boy's gas calorimeters

COURSE OUTCOMES

CO1 – Recall and choose the correct unit conversions and dimensions for different variables for chemical calculations
CO2 – Relate the stoichiometry in material and energy balances for different unit operations and processes.
CO3 – Solve the material balances of process system with and w/o reactions including recycle / bypass operations.
CO4 – Examine the system and estimate the different forms of energy available and make energy balances
CO5 – Assess the combustion process and decide the air requirement and estimate the heating values of fuel.
CO6 – Elaborate the understanding of a chemical process and build the mass and energy requirements of the process.

TEXT/REFERENCE BOOKS

1. D. M. Himmelblau, J.B Riggs, *Basic Principles and Calculations in Chemical Engineering*, 8th Edition, PHI, 2012
2. B. I. Bhat and S. M. Vora, Stoichiometry, Tata McGraw-Hill, New Delhi.
3. O. A. Hougen, K.M. Watson and R. A. Ragatz, Chemical Process Principles – Part 1, 2nd Ed, John Wiley

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical knowledge and understanding	10-20 Marks
Part B/Question: Problem Solving, Case Studies and Analysis	80-90 Marks

20CH201T					Fluid Mechanics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To develop basic concepts of fluid flow and flow analysis leading to systematic problem solving skills.
- Understand the concept of designing a flow system involving various flow types.
- Design and analysis of fluid transportation devices and systems including agitation and mixing.

UNIT 1 FLUID STATIC AND ITS APPLICATION **10 Hrs.**

Dimensional Analysis: Different methods of dimensional analysis applied to fluid flow problems. Definition and properties of fluid, Types of flow, Hydrostatic equilibrium, relationship between shear stress and pressure gradient, Hagen Poiseuille equation, losses in pipes and fittings.

UNIT 2 BASIC EQUATIONS OF FLUID FLOW **10 Hrs.**

Continuity equation, Bernoulli equation, Euler equation. Equation of motion. Darcy-Weisbach equation for frictional head loss, friction factor, Moody diagram. Velocity profile and boundary layer calculations for turbulent flow.

UNIT 3 TRANSPORTATION OF FLUIDS **10 Hrs.**

Handling of fluids: Pumps, compressors and blowers for handling different fluids, Standards for pumps, compressors and blowers, valves, pipe fittings and their standards, power requirement for flow. Piping layout and economical pipe diameter.

UNIT 4 METERING OF FLUIDS **10 Hrs.**

Flow metering devices: orificemeter, venturimeter, rotameter, pitot tube, anemometer etc. Flow through open channels such as notches, weirs, nozzles. Vacuum producing devices; two phase flow: basic principles and applications

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define principles of fluid mechanics operations

CO2 – Explain the theoretical importance and relevance of fluid flow in chemical process industry

CO3 - Identify and apply the theoretical concept of fluid flow in chemical process industry

CO4 - Comprehend and analyse fluid mechanics problems with the application of conservation principles of mass, energy and the momentum

CO5 - Evaluate fluid mechanics problems with the application of conservation principles of mass, energy, momentum.

CO6 - Design fluid transportation systems such as pumps, compressors and pipe network etc, and choose the fluid transportation devices for process applications

TEXT/REFERENCE BOOKS

1. W. L. McCabe and J. C. Smith, P. Harriot, Unit Operations of Chemical Engineering 7th ed. McGraw Hill 2014.
2. S. Foust, L.A.Wenzel, C.W. Clump, L.B. Andersen. Principles of Unit Operations, 2nd ed. Wiley, NewYork 2008.
3. P N Modi and S M Seth, Hydraulics and fluid Mechanics, 19th Edition, Standard Book House, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Questions 50 Marks

Part B/Question: Analytical Questions 50 Marks

20CH201P					Fluid Mechanics Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Describe how to design experiments, perform experiments, and analyse and interpret the observations yielded.
- To compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows.
- To discuss and practice standard measurement techniques of fluid mechanics and their applications.

List of Experiments:

1. Study of flow regimes by Reynolds's apparatus
2. Study of Bernoulli's equation
3. Determination of Viscosity by efflux time measurement
4. Study of friction factor in close conduits
5. Study of minor losses and determination of equivalent length of pipe fittings
6. Study of venturimeter
7. Study of orifice meter
8. Calibration of rotameter
9. Studies of Pitot tube
10. Characteristics of centrifugal pump
11. Study of friction factor in annular flow
12. Determination of Viscosity by Stokes's Law

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 To relate the theoretical and practical concepts of fluid mechanics used in industry.

CO2 Compare the results of analytical study introduced in lecture to the actual behaviour of real fluid flows and draw correct and sustainable conclusions.

CO3 Develop the ability to work in groups on small design projects that are appropriate to the course.

CO4 Categorize ethical issues associated with decision making and professional conduct.

CO5 Assess the ability to write clear lab reports.

CO6 Take part in successful completion of an experiment as a part of team building exercise and follow ethical practices judiciously.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Practical Work 50 Marks

Part B/Question: Practical and Viva Exam 50 Marks

20CH203T					<Chemical Engineering Thermodynamics-1>					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	2	3	25	50	25	--	--	100

COURSE OBJECTIVES: Students will understand and learn

- Insights necessary to do a preliminary thermodynamic analysis of a process for the purpose of feasibility
- Pure-component, PVT phase behaviour with various Equation of state models for molar volume estimation.
- Partial molar properties, ideal solutions, and excess propertiesincluding vapor pressure, critical point, etc
- Frame works of solution thermodynamics including generating thermodynamics functions.

UNIT 1 1st law and 2nd law of thermodynamics and its application> 9 Hrs.

Scope of thermodynamics, Heat, work and Energy, Reversible process, Equations of Change (dU, dH, dA, dG)the second law of thermodynamics and its application to some familiar processes, concept of entropy,Heat engine, heat pump, Refrigeration and liquification process (qualitative treatment only).

UNIT 2 Volumetric Properties of Pure Fluids and fluid mixtures > 9 Hrs.

Scope of chemical engineering thermodynamics; phase rule, general nature of *PVT behavior* of pure substances, the ideal-gas state, equations of state, mathematical formulations of the *PVT* behavior of fluids, generalized correlations of the *PVT* behavior, cubic equations of state, (RKS and PR EOS), Vapor Pressure of Liquids.

UNIT 3 Thermodynamic Properties of Fluids 9 Hrs.

fundamental property relations from 1st and 2nd law Enthalpy Entropy, internal energy as Functions of T and P, The Gibbs Energy as a Generating Function, r*esidual properties,*Temperature dependence of the Vapor Pressure of Liquids, two phase system, application of various *thermodynamics diagrams and property tables,*

UNIT 4 The Framework of Solution Thermodynamics 9 Hrs.

fundamental property relation, chemical potential, *partial properties*, property relations for the ideal-gas-state mixture, and real-gas mixtures. *fugacity*. Related to the chemical potential, it lends itself to mathematical formulation of both phase- and chemical-reaction-equilibrium problems. *excess properties*, *ideal-solution model*, *standard* mixing process

Max. 36 Hrs.

COURSE OUTCOMES: On completion of the course, student will be able to

CO1 - **choose** and **apply** of laws of Thermodynamics and its application to different processes.

CO2 -**explain** the Pressure-Volume-Temperature relationship and equilibrium condition in pure fluid and fluid mixtures.

CO3 - **Compute** ideal work, lost work, thermal efficiencyand/or thermodynamic efficiencies of processes.

CO4 - **Compute**thermodynamic properties, partial properties of a mixture in the ideal-gas state

CO5–**Analyse** molar volume, compressibility factor, density, using different cubic equation of states and models

CO6 - **Compute** fugacities and fugacity coefficients of pure species from *PVT* data or generalized Correlations.

TEXT/REFERENCE BOOKS

5. <INTRODUCTION TO CHEMICAL ENGINEERING THERMODYNAMICS, 8th Edition by J. M. Smith, H. C. Van Ness, M. M. Abbott, M. T. Swihart: Published by McGraw-Hill Education, 2 Perm Plaza, New York, NY 10121.>
6. < Narayanan, K.V. *A textbook of chemical engineering thermodynamics*, 2/e. New Delhi: PHI learning Pvt. Ltd., 2013Book-

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 Exam Duration: 3 Hrs

Part A/Question: Theoretical knowledge and understanding	10-20 Marks
Part B/Question: Problem Solving, Case Studies and Analysis	80-90 Marks

20CH204T					Mechanical Unit Operations					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To teach importance and applications mechanical unit operations in process industries.
- To teach techniques of solid characterization, size reduction and handling operations
- To teach students about solid-fluid operations including filtration, mixing, agitation and solid transportation.

UNIT 1 Solid characterization – classification and size reduction **15 Hrs.**

Introduction: Unit operations and their role in chemical industries. Properties and handling of particulate solids: Characterization of solid particles, Properties of masses of particles, Classification of solids, sieving and screening equipment's, Mixing of solids. Size reduction: Laws of size reduction, energy relationships in size reduction, power requirement, work index. Methods of size reduction, classification of equipment - crushers, grinders, disintegrators for coarse, intermediate and fine grinders, Ultrafine grinders.

UNIT 2 Solid-Fluid Operations **13 Hrs.**

Gravity settling: Free and Hindered settlings, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation-continuous centrifuges, design of basket centrifuges; Flow through packed bed: Fixed bed and Fluidized bed, Pneumatic conveying; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation.

UNIT 3 Solid Fluid Separation – Filtration **12 Hrs.**

Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipment's -selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT 4 Storage and Transportation of solids **12 Hrs.**

Agitation and mixing of liquids. Storage and Conveying of solids - Bunkers, silos, bins and hoppers. Transportation of solids in bulk: different types of conveyers and their performance characteristics.

<52 hours>

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Choose the techniques of mechanical operations to meet the need of chemical Industries.

CO2 – Ability to select suitable size reduction equipment and solid-solid separation method.

CO3 – Understanding fluid flow through packed and fluidized beds.

CO4 – Able to identify the different types of mixing, agitation and conveying of solids and estimating the power requirement.

CO5 – Determination of the static and dynamic principles of separation for ores in chemical industries.

CO6 – Design of filtration equipment by considering constant and variable pressure governing equations.

TEXT/REFERENCE BOOKS

1. J. M. Coulson and J. F. Richardson, Chemical Engineering, Vol. 2 (Particle Technology And Separation Processes), 5th Edition , Elsevier, 2006

2. W. L. McCabe and J. C. Smith, P. Harriot, Unit Operations of Chemical Engineering 7th ed. McGraw Hill 2014.

3. W. L. Badger and J. T. Banchero, " Introduction to chemical engineering", McGraw-Hill Education, 1st edition, 2001

4. L. A. Wenzel, C. W. Clump, L. Maus, L. B. Andersen, A. S. Foust, " Principles of unit operations", Wiley, 2nd edition, 2008

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: 12 short answer questions of 2 marks each 24 Marks

Part B/Question: 6 long answer questions 76

20CH204P					Mechanical Unit Operations Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- To understand and analyze the complex engineering problem behind working of a mechanical operation equipment
- To investigate the data based upon experiments performed and apply the knowledge of data interpretation, design of experiments and statistical analysis and arrive at a solution.
- To be able to understand the proper engineering practices in a chemical process industry with emphasis upon health, safety, society, environment and sustainable development.

SR. NO.	NAME OF THE EXPERIMENT	No. of Hours
1	Size analysis using a sieve shaker	2
2	Size reduction and characteristics of jaw crusher	2
3	Size reduction and characteristics of roll crusher	2
4	Size reduction and characteristics of ball mill	2
5	Size reduction and characteristics of Hammer mill	2
6	Determination of effectiveness of a screen	2
7	Study of fluidization process and calculation of minimum fluidization	2
8	To determine the Collection efficiency of the cyclone	2
9	To determine the Average specific cake resistance, Filter medium	2
10	To perform the operational characteristics of Top Driven	2
11	To plot the mixing index vs. mixing time curve for Ribbon	2
12	To study the working of Screw Conveyor	2

<24 hours>

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Relate the classical knowledge of basic sciences and mathematical correlations to solve equations based on mechanical unit operations in Laboratory as a part of team.

CO2 – Demonstrate the design and working of mechanical unit operations and appreciate the importance of health, hygiene, safety and sustainable development.

CO3 – Apply data interpretation techniques, plotting graphs based on experiments performed and using design of experiments for data optimization.

CO4 – Take part in successful completion of an experiment as a part of team building exercise and follow ethical practices judiciously.

CO5 – To learn importance of effective communication means both written and oral to write good laboratory observation and reports.

CO6 – Elaborate the importance of difference mechanical unit operations as a lifelong learning exercise in order to comprehend the technological change.

TEXT/REFERENCE BOOKS

1. Mechanical Operations Lab Manual

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination 50 Marks

Practical Examination 50 Marks

20HS201P					Communication Skills – II (Semester – III/IV) (Second Year)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	0	2 hours per week	--	--	--	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 1 **7 hrs**

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

UNIT 2 **7 hrs**

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

UNIT 3 **7 hrs**

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

UNIT 4 **8 hrs**

Group Discussion, Resume Writing, Interview Skills

Max. 30 hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO 1 Apply current technology for effective communication leading to better dissemination of knowledge and expertise.
CO 2 Demonstrate relevant knowledge of communication skills in different settings to cater to different purposes and audiences.
CO 3 A sound understanding of communication theory, practice and application to optimize career opportunities.
CO 4 Dynamic communication skills to build and maintain robust and effective professional relationships.
CO5 Augmented communication skills to prepare and present messages, reports and documents in intent and to integrate different sources of information and knowledge.
CO 6 Monitoring and critical reflection 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.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Assessment Tool	Marks	Assignments
Lab Work	50	• Essay/Journal Writing – 10 • Report Writing – 10 • Creating e-content – 10 • Blog Writing – 10 • Review Writing - 10
Lab Exam/Viva	50	• Mock Interview – 15 • Group Discussion – 15 • Cover Letter/Curriculum - 20

20CH205T					Nanomaterials					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To learn about various kinds of nano-materials and their properties
- To know about the synthesis routes of nano-materials
- To find different characterization techniques for nano-materials
- To choose the different applications in Engineering sciences and allied fields
- To develop new technological routes
- To make aware of role of nanotechnology in day to day activities

UNIT-I-INTRODUCTION TO NANOMATERIALS **10 Hrs**

Definition, Classification, Synthetic routes and general applications. Solid-vapor interface, Surface defects and crystal defects, Effect of surface curvature and solid-liquid interface.

UNIT-II-ZERO DIMENSION NANOPARTICLES **7Hrs**

Size dependent properties, review of some topics related to physics covering free electron model insolids, band gap and band structure in metals and semiconducting nano-materials, energy levels and discretization based on quantum mechanics.Van der Waals interaction, effect of particle geometry, surface charge, zeta potential and electro static stabilization.

UNIT-III-Carbon Nanostructures **7 Hrs**

Structure, preparation of carbon nanotubes, graphene, electrical and mechanical properties and applications.One-Dimension Nanostructures**:** Growth of one-dimensional structures using various processes and selected properties and applications.

UNIT-IV-Two Dimension Nanostructures **10 Hrs**

Various thin film deposition techniques: atomic layer deposition, layer-by-layer deposition,multilayer techniques and mechanisms of nanocomposite coating. Polymers Nanocomposites:Synthesis, processing, properties and applications of polymer-CNT Nano-composites, and polymer-clay nanocomposites.

34 hrs

COURSE OUTCOMES:

On completion of this course, the students will able to

CO1. Define the nano-materials
CO2. Classify the appropriate nano-materials
CO3. Choose various synthesis and processing methods for nano-materials
CO4. Analyze and Identify nano-materials for engineering applications
CO5. Explain the role of nanotechnology in various engineering disciples
CO6. Develop new techniques for the synthesis of nanomaterials

TEXT/REFERENCE BOOKS

1. Dinesh C. Agrawal, Introduction to Nanoscience and Nanomaterials, World Scientific Publishing (2013)
2. GuoZhong Cao, Nanostructures & Nanomaterials, synthesis, properties & applications, Imperial College Press (2008)

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

Part A/Question: Theoretical Questions 50 Marks
Part B/Question: Analytical Questions 50 Marks

20CH206T					Environmental Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the environmental regulations and standards.
- To understand the principles and designing of air pollution control devices.
- To discuss the physical, chemical and biological characteristics of water and wastewater.
- To understand the primary, secondary and tertiary treatment process of water and wastewater.
- To learn about solid waste management and noise pollution control.

UNIT 1 – ENVIRONMENTAL STANDARDS AND AIR POLLUTION CONTROL **10 Hrs.**

Environmental regulations in India, Environmental Standards, GPCB & CPCB norms, Classification of pollutants and their permissible limits, Air pollution control: settling chamber, cyclone separators, dust collector, fabric filters, venturi scrubbers, electrostatic precipitators, wet scrubber, adsorption, absorption, Catalytic reduction eg. SCR.

UNIT 2 – PRELIMINARY AND PRIMARY TREATMENT PROCESSES **10 Hrs.**

Sources of water, Impurities in water, Indian & WHO standards for drinking water, Water borne diseases and their control, Sources of waste water, Physical, chemical and biological characteristics of water and waste water, Preliminary treatment processes: Screens, Skimming process. Primary treatment processes: Sedimentation, Coagulation and flocculation, Sand filtration.

UNIT 3 – SECONDARY AND TERTIARY TREATMENT PROCESSES **10Hrs.**

Primary treatment processes: Activated Sludge Process- design procedures for HRT, F/M ratio, SVI, MLSS, sludge age, Trickling filters and their efficiency: standard, high rate and two-stage, Sludge treatment: sludge digestion process. Tertiary Treatment Processes: Disinfection, Membrane processes, Adsorption and ion exchange, ozonation, Aeration, Softening, fluoridation, Recarbonation, Lime soda softening, Demineralization.

UNIT 4 – SOLID WASTE MANAGEMENT AND NOISE POLLUTION CONTROL **9 Hrs.**

Solid Waste Management: Quantity, Composition and characteristics of solid waste, Methods of solid waste treatment and disposal. Treatment of plastic and e-waste. Noise Pollution: level and standards, Effects and control.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Define environmental regulatory legislations & standards and various types of pollution.

CO2 - Demonstrate different types of waste generated, disposal methods, reduce and monitoring process.

CO3 - Solve design calculations for air pollution control devices.

CO4 - Analyze the properties of water and wastewater.

CO5 - Assess pollution control in air & noise and treatment processes of water, wastewater and solids.

CO6 - Design treatment units involved in water and wastewater.

TEXT/REFERENCE BOOKS

1. C. S. Rao, “Environmental Pollution Control Engineering.
2. H. S. Peavy, "Environmental Engineering", McGraw-Hill, International Ed., New York -1985.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Questions 50 Marks

Part B/Question: Analytical Questions 50 Marks

Semester 4

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 4	PC	20CH207T	Chemical Process Technology	3	0	0	3	3
	PC Lab	20CH207P	Chemical Process Technology Lab	0	0	2	2	1
	PC	20CH208T	Chemical Engineering Thermodynamics-2	2	0	0	2	2
	PC	20CH209T	Elements Heat Transfer	3	0	0	3	3
	PC Lab	20CH209P	Elements Heat Transfer Lab	0	0	2	2	1
	PC	20CH210T	Mass Transfer 1	3	0	0	3	3
	PC Lab	20CH210P	Mass Transfer 1 Lab	0	0	2	2	1
	OE-2	20CH211T	Fundamentals of Colloidal and Interfacial Science	3	0	0	3	3
		20CH212T	Molecular Simulation	3	0	0	3	3
	IND	20IF201T	Industry 4.0	2	0	0	2	2
	IND	20IF201P	Industry 4.0	0	0	2	2	1
	Project	TP210	Industrial Orientation (3 weeks-summer break)	0	0	0	0	1
				16	**0**	**8**	**24**	**21**

Pandit Deendayal Energy University					School of Technology					
20CH207T					**Chemical Process Technology**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	**0**	**0**	**3**	**3**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES

- Provide a broader perspective of manufacturing of various organic and inorganic chemicals
- Introduce the students to understand the processes, flow diagram, various process parameters and equipment utilized
- Ability to identify and solve engineering problems during production
- Bring the understanding of properties, usage and application of chemical intermediate and products at different stages

UNIT 1 INTRODUCTION AND RAW MATERIALS **7 Hrs.**

Brief History of Organic and Inorganic Chemicals, Structure of the Chemical Industry, Raw Materials and Energy (Fossil fuels, biomass, sulphuric acid, nitrogen glass etc.) role of sustainability, National and Global Trends in the Chemical Industry, Raw materials and principles involved in the production of olefins, aromatics and novel developments in technology.

UNIT 2 ORGANIC INDUSTRIES 1 **14 Hrs.**

Important intermediates from olefins and aromatics: derivatives of C_1, C_2, C_3, C_4 olefin compounds, Aromatics, Acetylene, butadiene,Soap and detergent, Biotech Industry (esp. single cell protein, ethanol, etc.)

UNIT 3 ORGANIC INDUSTRIES 2 AND INORGANIC INDUSTRIES 1 **11 Hrs.**

Dyes and intermediate, Paint industry, Pharma industry, Process for biomass conversion, Inorganic Chemicals**:** sulphuric acid (DOSA and DCDA process), Nitric acid, Hydrochloric acid Phosphoric acid and Hydrofluoric acid.Cement manufacturing, Ceramics, Refractory, Potteries

UNIT 4 INORGANIC INDUSTRIES 2 **10 Hrs.**

Nitrogen Industries:Manufacturing of ammonia, Nitrogenous and Mixed fertilizers; Urea, Ammonium sulphate, Ammonium nitrate, Superphosphates and Mixed fertilizers. Chlor–Alkali Industries: Production of Common salt, Caustic soda, Chlorine, Hydrochloric acid, Soda ash and Sodium bicarbonate.

Note: *Brief overview of these organic process industries including raw materials, manufacturing details of important products, properties and applications*

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define and select basic raw materials used for processes carried out in chemical industry
CO2 - Illustrate process flow diagrams/process block diagrams for the manufacture of various chemicals from process description
CO3 - Identify different unit operations and unit processes involved in a process
CO4 - Analyse the technological methods in problem solving in process plant
CO5 - Recognize the importance of process economics in the industry
CO6 - Discuss the impact of the professional engineering solutions for societal benefits

TEXT/REFERENCE BOOKS

1. J A Moulijn, M Makkee, A E. Van Diepen, Chemical Process Technology, Second Edition, Wiley, 2013
2 .I D Mall, Petrochemical Process Technology, Macmillan India Pvt ltd, 2007
3. B K Bhaskararao, A textbook on Petrochemicals, Khanna Publishers, 2007
4.M. Gopala Rao and M Sitting, Dryden's Outlines of Chemical Technology, East-West press, New Delhi, 3rd edition, 1997
5. G T. Austin, Shreve's Chemical process Industries, 5th ed. McGraw Hill, 1984
6. Kirk-Othmer, Encyclopedia of Chemical Technology, 3rd ed., John-Willey, 1981

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: <Question with no choice> <25> Marks

Part B/Question: < Question with internal choice > <75> Marks

Pandit Deendayal Energy University										School of Technology
20CH207P					**Chemical Process Technology Laboratory**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
0	**0**	**2**	**1**	**2**	**-**	**-**	**-**	**50**	**50**	**100**

COURSE OBJECTIVES

- To Provide the practical relevance of the course
- To expose the students to manufacturing and characterization of chemical products
- To develop the analytical skills, lab safety
- To develop the report writing, data interpretation and communication skills

List of Experiments

- To synthesise caustic soda by chemical method.
- To synthesise Anthraquinone from Anthrancene.
- To prepare Phenylazo-2-Napthol
- To prepare hydrated lime from the given calcium carbonate powder.
- To evaluate the saponification value of given oil sample.
- To determine the acid value of given oil samples
- To determine the loss on igniting the cement sample.
- To prepare soap in the laboratory and to carry out its cost analysis.
- To determine the amount of Na_2CO_3 and $NaHCO_3$ in the given mixture of sodium carbonate and sodium bicarbonate.
- Determination of percentage available chlorine in bleaching powder.
- Determination of the Sodium Carbonate in the Washing Soda
- Proximate analysis of Coal

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 - Able to find practical relevance of chemical process technology theory
CO2 - Illustrate the preparation methods of organic compounds involving reactions, separation and purification -techniques
CO3 - Experiment with inorganic compounds involving reactions, separation and purification -techniques
CO4 - Analyze the important compounds
CO5 - Explain the impact of hazardous chemicals on environment
CO6 - Discuss the safety required for the chemical laboratories

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination	25 Marks
Practical Examination	25 Marks

20CH208T					<Chemical Engineering Thermodynamics-II>					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	2	3	25	50	25	--	--	100

COURSE OBJECTIVES: Students will understand and learn

- Pure-component, PVT phase behavior including vapor pressure, critical point, etc
- To solve phase equilibrium data and conditions including bubble point, dew point and flashing>.
- The fundamental concepts of solution thermodynamics including chemical potential, fugacity, activity, partial molar properties, ideal solutions, and excess properties.
- The fundamental principles of chemical reaction equilibria including extent of reaction, equilibrium constant and its temperature-dependence, equilibrium conversion.

UNIT 1 Phase Equilibrium: Introduction **9 Hrs.**

The phase rule and Duhem's theorem, Vapour/liquid equilibrium (VLE): qualitative behavior,P-xy, T-xy and xy diagrams. Low-Pressure VLE. VLE by Raoult's law and/or, *Henry's Law,*bubblepoint, dewpoint, calculations. VLE form K -value. Phase stability, Liquid-liquid equilibrium, Liquid-liquid Liquid-Equilibrium.

9 Hrs.

UNIT 2 ***Thermodynamic Formulations for Vapor/Liquid Equilibrium***

Activity coefficients and excess Gibbs energy of a mixture; Gibbs-Duhem equation, general criterion for phase equilibrium (the gamma/phi formulation of VLE);by modified Raoult's law, Azeotrope and azeotropic calculations. Flash calculations. The extraction of activity coefficients and excess Gibbs energy from experimentallow-pressure VLE data.

9 Hrs.

UNIT 3 VLE data reduction

Correlation for liquid phase activity coefficient, The Redlich/Kister Expansion, Fitting of excess Gibbs energy to models The Margules equations, The van Laar Equation, Local-Composition Models, Wilson Equation, NRTL equation, fitting activity coefficient to VLE data, data reduction**.**Thermodynamic consistency test, VLE by Equation of State.

9 Hrs.

UNIT 4 Chemical Reaction Equilibria

Reaction stoichiometry and extent of reaction, single and multi-reaction coordinate variables, Criteria for chemical reaction equilibrium, The equilibrium constant and its temperature dependence, The relationship between the equilibrium constant and composition, calculation of equilibrium conversions for single and multi-reactions, Multiple reaction equilibrium.

Max. 36 Hrs.

COURSE OUTCOMES: On completion of the course, student will be able to

CO1 - **Identify** dew point and bubble point surfaces, the critical locus, and pure speciesvapor-pressure curves that make up a vapor/liquid phase envelope when presented in a*PTxy*diagram.

CO2 - **Compute** phase equilibrium data and construct P-x-y, T-x-y diagram for ideal vapour-liquid systems.>

CO3 - <**compute** bubble point, dew point, Azeotropeand flash condition in vapour -liquid system>

CO4–**<solve**phase equilibrium using activity coefficient modelsand/or Equation of state models.

CO-5<**Solve** for the equilibrium composition of a mixture of gases undergoing one or morechemical reactions

CO6 - **Estimate** equilibrium conversion in reversible reactions and **solve** problems related to rection equilibria

TEXT/REFERENCE BOOKS

1. INTRODUCTION TO CHEMICAL ENGINEERING THERMODYNAMICS, 8th Edition by J. M. Smith, H. C. Van Ness, M. M. Abbott, M. T. Swihart: Published by McGraw-Hill Education, 2 Perm Plaza, New York, NY 10121.
2. Narayanan, K.V. *A textbook of chemical engineering thermodynamics*, 2/e. New Delhi: PHI learning Pvt. Ltd., 2013Book-

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical knowledge and understanding 10-20 Marks

Part B/Question: Problem Solving, Case Studies and Analysis 80-90 Marks

20CH210T					Mass Transfer 1					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	2	4	5	25	50	25	--	--	100

COURSE OBJECTIVES

- Students will understand fundamental of mass transfer like diffusion, mass transfer theories and mass transfer coefficient.
- Students will learn about steady and unsteady state processes.
- Students will learn about the interphase mass transfer operations.
- Students will understand different methods and conditions for distillation.
- Student will understand the concept of transfer units.

UNIT 1 INTRODUCTION TO MASS TRANSFER OPERATIONS **8Hrs.**

Fick's Law of diffusion, equimolecular counter diffusion in fluids, diffusion in stationary gas, Diffusion through variable cross-sectional area, Diffusion coefficient, Multicomponent diffusion, Diffusivity in solids

UNIT 2 MASS TRANSFER COEFFICIENTS **8 Hrs.**

Introduction to mass transfer coefficient, Correlation for convective mass transfer coefficient, Mass transfer equilibrium, Theories of mass transfer, Local and overall mass transfer coefficients, Steady state co and counter current processes, Material balance, Stage efficiency.

UNIT 3 DISTILLATION **12 Hrs.**

Vapour liquid equilibria, Types of Distillation, Binary systems, Mc-Cabe Thiele and Ponchon Savarit method, Calculations with multiple feeds and withdrawal, Azeotropic and extractive distillation, Multi component distillation concep

UNIT 4 ABSORPTION **12 Hrs.**

Equilibrium solubility of gases, Material balance for transfer of one component, Counter current multistage operations for binary and multi component systems, Continuous contactors, Absorption with chemical reaction, Concept of HTU and NTU, Equipment for Gas–Liquid operations

Max. 40 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define the basic principles of diffusion, mass transfer theories and interphase mass transfer

CO2 - Explain the principles of diffusion and mass transfer operations like distillation, absorption and stripping

CO3 - Apply principles related to diffusion, distillation, absorption and stripping.

CO4 - Analyze the problems related to diffusion, distillation, absorption and stripping

CO5 - Justify the applications of theory learned in industrial practices regarding diffusion, distillation and absorption.

CO6 - Design columns related to diverse mass transfer operations like distillation, absorption and stripping.

TEXT/REFERENCE BOOKS

1. R.E. Treybal, Mass Transfer Operations, 3rd Edition, International Student Edition, McGraw Hill Education
2. W. L. McCabe, J. Smith and P. Harriott - Unit operations of Chemical Engineering, 7th Edition, McGraw-Hill international edition, 2005
3. B. K. Dutta, Principle of Mass Transfer and Separation Processes, Prentice Hall India Learning Private Limited, 2006
4. K. V. Narayanan, Mass Transfer: Theory and Applications, CBS Publishers, 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Question 50 Marks

Part B/Question: Analytical and Numerical Question 50 Marks

20CH210P					Mass Transfer 1 Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- Students will understand fundamental of mass transfer like diffusion, mass transfer theories and mass transfer coefficient.
- Students will learn about steady and unsteady state processes.
- Students will learn about the interphase mass transfer operations.
- Students will understand different methods and conditions for distillation.
- Student will understand the concept of transfer units.

List of Experiments

1. To preform differential distillation experiment and verify the Rayleigh equation
2. To study the absorption of carbon dioxide by aqueous sodium hydroxide solution in a packed bed column.
3. To study solid in air diffusion using a packed bed of spherical particles of naphthalene.
4. To study the steam distillation process using turpentine oil as a feed stock.
5. To determine the diffusion co-efficient of any liquid in air & it's variation with temperature.
6. To study vapor liquid equilibrium using simple distillation.
7. To study bubble cap distillation column.
8. To study the absorption of carbon dioxide by aqueous sodium hydroxide solution in a sieve tray column.
9. To study the absorption of carbon dioxide by aqueous sodium hydroxide solution in a wetted wall tower.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define the basic principles of diffusion, mass transfer theories and interphase mass transfer

CO2 - Explain the principles of diffusion and mass transfer operations like distillation, absorption and stripping

CO3 - Apply principles related to diffusion, distillation, absorption and stripping.

CO4 - Analyze the problems related to diffusion, distillation, absorption and stripping

CO5 - Justify the applications of theory learned in industrial practices regarding diffusion, distillation and absorption.

CO6 - Design columns related to diverse mass transfer operations like distillation, absorption and stripping.

TEXT/REFERENCE BOOKS

1. R.E. Treybal, Mass Transfer Operations, 3rd Edition, International Student Edition, McGraw Hill Education
2. W. L. McCabe, J. Smith and P. Harriott - Unit operations of Chemical Engineering, 7th Edition, McGraw-Hill international edition, 2005
3. B. K. Dutta, Principle of Mass Transfer and Separation Processes, Prentice Hall India Learning Private Limited, 2006
4. K. V. Narayanan, Mass Transfer: Theory and Applications, CBS Publishers, 2005

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

20CH209T					Elements of Heat Transfer					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	2	4	5	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the modes of heat transfer (conduction, convection and radiation) and their application in process industries.
- To understand heat balance equations in heat exchangers.
- To understand heat transfer with phase change
- To understand combined heat transfer, this involves all modes of heat transfer.

UNIT 1 CONDUCTION **12 Hrs.**

Introduction and fundamentals of heat transfer, heat transfer rate, flux, resistances, Conduction through a single homogeneous solid, thermal conductivity of solids, liquids and gases. Conduction through objects in series, Contact resistances, Heat losses and insulation, Concept of critical insulation thickness.

UNIT 2 CONVECTION **12 Hrs.**

Film and overall heat transfer coefficients, Solid-fluid heat transfer, Natural and forced convection, Laminar and turbulent flow heat transfer, Coefficients for scale deposits, concept of L.M.T.D. in heat exchangers with co and counter current flow, Effectiveness, N T U method in finned tube heat exchangers.

UNIT 3 HEAT TRANSFER WITH PHASE CHANGE **9 Hrs.**

Nucleation and boiling, Film wise and drop wise condensation, Condenser design, Fundamentals of pervaporation Unsteady state heat conduction, lumped heat capacity system, transient heat flow in a semi-infinite solid.

UNIT 4 RADIATION **7 Hrs.**

Black and gray body radiations, Plank's law, Stephen-Boltzmann law, View factor, Luminous and non-luminous gases. Combined heat transfer, i.e. conduction, convection and radiation together.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define the basic principles of heat transfer operations, related to different mode of heat transfer.

CO2 - Demonstrate the principles of heat transfer operations involving conduction, convection, radiation including phase change.

CO3 - Apply principles of heat transfer operations involving conduction, convection, radiation including phase change.

CO4 -Analyze the problems related to conduction, convection and radiation involving heat exchanger, evaporators and condensers.

CO5 - Justify the applications of theory learned in industrial practices regarding conduction, convection and radiation involving heat exchanger, evaporators and condensers.

CO6 - Design heat transfer equipments based upon the conditions given in the problem statement.

TEXT/REFERENCE BOOKS

1 .J. M. Coulson and J. F. Richardson, Chemical Engineering Vol. I and II, 6th Edition, Elsevier Press, 2000.

2. W. L. McCabe and J. C. Smith, P. Harriot, Unit Operations of Chemical Engineering, 7th ed. McGraw Hill 2014.

3. D. Q. Kern, "Process Heat Transfer", McGraw Hill, 2014.

4. J. P. Holman and S. Bhattacharyya, "Heat Transfer", McGraw Hill Education, 10th edition, 2011

5. B. K. Dutta, "Heat Transfer: Principles and Applications" PHI Publishers, 2014

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Question	50 Marks
Part B/Question: Analytical and Numerical Question	50 Marks

20CH209P					Elements of Heat Transfer Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To understand the modes of heat transfer (conduction, convection and radiation) and their application in process industries.
- To understand heat balance equations in heat exchangers.
- To understand heat transfer with phase change
- To understand combined heat transfer, this involves all modes of heat transfer.

LIST OF EXPERIMENTS

1. Heat transfer in Natural convection
2. Heat Transfer in Forced Convection
3. Stefan Boltzman constant verification
4. Parallel and counter flow heat exchangers
5. Emissivity apparatus
6. Thermal conductivity of Insulating powder
7. Thermal conductivity of the metal bar
8. Heat transfer by vertical and horizontal heat exchanger in natural convection
9. Plate type heat exchanger
10. Finned tube heat exchanger
11. Heat transfer in agitated vessel
12. Evaporator

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define the basic principles of heat transfer operations, related to different mode of heat transfer.

CO2 - Demonstrate the principles of heat transfer operations involving conduction, convection, radiation including phase change.

CO3 - Apply principles of heat transfer operations involving conduction, convection, radiation including phase change.

CO4 -Analyze the problems related to conduction, convection and radiation involving heat exchanger, evaporators and condensers.

CO5 - Justify the applications of theory learned in industrial practices regarding conduction, convection and radiation involving heat exchanger, evaporators and condensers.

CO6 - Design heat transfer equipments based upon the conditions given in the problem statement.

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1 J. M. Coulson and J. F. Richardson, Chemical Engineering Vol. I and II, 6th Edition, Elsevier Press, 2000.

2. W. L. McCabe and J. C. Smith, P. Harriot, Unit Operations of Chemical Engineering, 7th ed. McGraw Hill 2014.

3. D. Q. Kern, “Process Heat Transfer”, McGraw Hill, 2014.

4. J. P. Holman and S. Bhattacharyya, “Heat Transfer”, McGraw Hill Education, 10th edition, 2011

5. B. K. Dutta, “Heat Transfer: Principles and Applications” PHI Publishers, 2014

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

20CH211T					Fundamentals of Colloidal and Interfacial Science					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3			3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To provide application of Colloids and interface science in various fields.
- To provide understaning of funamental interactions between colloids.
- To provide knowledge of various interface modifying agents and thermodynamic treatment.

UNIT 1 INTRODUCTION **8 Hrs.**

Definition of colloids and small size effects, application in self-cleaning materials, anti-reflective coatings, optical sensors, photonic crystals, surface enhanced Raman-scattering, Foam and Pickering emulsions.

UNIT 2 INTERMOLECULAR AND SURFACE FORCES **12 Hrs.**

Van der Waals forces, Hamakar constant, Lifshitz theory to calculate Hamakar constant, formula of vdW forces for common objects, Electrical double layer, debye screening length.

UNIT 3 CAPILLARY INTERACTION **12 Hrs.**

Surface tension, contact angle, Laplace equation, Kelvin-Laplace equation, Capillary interactions of different kinds between colloidal particles and their role in growing monolayers of colloidal crystals, presence of particles in thin films and their effect on Foam and Pickering emulsion stability.

UNIT 4 THERMODYNAMICS OF INTERFACES **8 Hrs.**

Surfactants, Gibbs' treatment of interfaces, positive and negative surface excess,Langmuir-Blodgette experiment and its implications, critical micelle concentration.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Highlighting various applications of Colloid and Interface Science.
CO2 - Categorizing various types of interactions between colloids
CO3 - Determining conditions for various thermodynamic equilibrium prevailing in the field.
CO4 - Explaining the conditions for stability and instability of colloid systems.
CO5 - Predicting the behavious of particles at interfaces in different conditions.
CO6 - Building a model of any interface phenomena in Surface Evolver.

TEXT/REFERENCE BOOKS

1. Israelachvili, J., Intermolecular and Surface Forces, Academic, Press, 3rd edition, 2011.
2. Hunter, R. J., Foundations of Colloid Science, Vol. I, II Oxford, University Press, 1986.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Problems with multiple questions each carrying 2-3 marks 70-80 Marks
Part B/Question: Problems with multiple questions each carrying 5 marks 20-30 Marks

20CH212T					Molecular Simulation					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	2	3	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To introduce a range of molecular simulation techniques that are used in modelling materials and complex-fluids.
- To demonstrate the predictive capabilities of these methods by considering a set of applications.
- To able to learn efficient programming skills in accordance with the methods and algorithms of molecular modelling

UNIT 1 INTRODUCTION AND OVERVIEW OF MOLECULAR MODELLING CONCEPTS **10 Hrs.**

Electronic, atomic, molecular and mesoscale examples, interaction potentials, Essential principles of statistical mechanics: statistical ensembles, thermodynamic averages, fluctuations, structural quantities, time correlation functions and transport coefficients

UNIT 2 MONTE CARLO SIMULATIONS **10 Hrs.**

Metropolis algorithm in various ensembles, free energy calculations, configuration bias MC, End-bridging Monte Carlo, lattice Monte Carlo simulations, MC Simulations of polymer melts and thin films, grand canonical MC simulations

UNIT 3 MOLECULAR DYNAMICS **10 Hrs.**

Basics of Molecular Dynamics Simulations, Numerical algorithms to solve equation of motion, concept of thermostat and barostat, unconstraint and constrained dynamics, Energy minimization, NVT, NPT and NVE ensemble, Introduction to Brownian dynamics

UNIT 4 APPLICATIONS **10 Hrs.**

Polymers and polyelectrolytes in solutions, adsorption of polymers and surfactants at surfaces/interfaces, transport property calculations (diffusivity, viscosity), Applications of MC and MD techniques for– drug delivery, batteries, CO_2 sequestration Applications of MD and MD in amorphous glassy melts

40 hours

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Recall and relate the basic concepts of molecular modelling and simulations.

CO2 – Outline the application areas in Engineering where concept of molecular modeling can be applied.

CO3 – Choose an appropriate molecular simulation technique and model a material or process

CO4 – Analyse the problem statement and compare solutions obtained from different algorithms of MC and MD.

CO5 – Estimate the properties (structure, dynamics and thermochemical) of a material or complex fluid using computer simulations.

CO6 – Formulate and solve a real life problem statement by conducting thorough literature review of scientific literature.

TEXT/REFERENCE BOOKS

1. Leach AR, Leach AR. Molecular modelling: principles and applications. Pearson education; 2001.
2. Frenkel D, Smit B. Understanding molecular simulation: from algorithms to applications. Elsevier; 2001 Oct 19.
3. Gubbins KE, Quirke N, editors. Molecular simulation and industrial applications: methods, examples, and prospects. Taylor & Francis; 1996.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: 12 short answer questions of 2 marks each 24 Marks

Part B/Question: 6 long answer questions 76 Marks

20IF201T					Industry 4.0					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

- To interpret the core elements and basic technologies of Industry 4.0
- To understand how the core elements and technologies of Industry 4.0 are interconnected
- To develop a holistic approach to improve processes and products with Industry 4.0

UNIT I: INDUSTRY 4.0 – CONCEPTS & TERMINOLOGIES **08 Hrs.**

Industry 4.0, Smart business model, Technology road-map, Sensing & actuation, Communication, Internet of things (IoT), Cyber Physical Systems and Next Generation Sensors, Visualization, Cloud Computing.

UNIT II: SMART WORLD & SUSTAINABLE ENVIRONMENT **08 Hrs.**

Sensors and their integration, Renewable Energy System, Hybrid Energy System, Smart Grid, Smart Metering, Communication Protocols, 5G Technology, Smart Agriculture, Smart Infrastructure, Physiological Sensors, Human Machine Interface.

UNIT III: SMART MANUFACTURING **08 Hrs.**

Automation Systems, Additive Manufacturing, Micro-Electro-Mechanical Systems (MEMS), Smart Factories and Interconnection, Advanced Robotics – Autonomous and Swarm, Self-Propelled Vehicles, Drones–Unmanned Aerial Vehicle (UAV), 3d Printing, Spacecrafts.

UNIT IV: TRANSFORMING TECHNOLOGIES IN BIOENGINEERING **08 Hrs.**

Establishment of Smart Biotechnology Factory, Artificial Intelligence in Bioprocess Technology, 3D Bio Printing for Tissue Engineering, Simulation Tools, RSM and Box Model, Cyber Physical System based Telemedicine, Real Time Biosensors, Bio nanotechnology, biofuel.

Total Hours 32 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Understand the core elements and basic technologies for Industry 4.0
CO2- Apply the different computational techniques and algorithms for realizing Industry 4.0
CO3- Transform the traditional business approach by integrating the data and intelligence
CO4- Develop the traditional industries with intelligent and automated machines
CO5- Utilize data and intelligence for the development of Smart World
CO6- Understand the concept, significance and means to achieve sustainable development

TEXT/REFERENCE BOOKS

1. Ustundag Alp, and Emre Cevikcan, Industry 4.0: Managing the Digital Transformation, Springer,First Edition, 2018
2. Kaushik Kumar, Divya Zindani, and J. Paulo Davim, Digital Manufacturing and Assembly Systems in Industry 4.0., CRC Press, Taylor & Francis First Edition, 2019.
3. Antonella Petrillo, Raffaele Cioffi, and Fabio De Felice, Digital Transformation in Smart Manufacturing., IntechOpen Publisher, First Edition, 2018.
4. J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama and N. Jenkins, Smart Grid: Technology and Applications, John Wiley and Sons Ltd., First Edition, 2012
5. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, First Edition, 2016
6. Ibrahim Garbie, Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessments for Industry 4.0, Springer, First Edition, 2016

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Questions 50 Marks
Part B/Question: Analytical Questions 50 Marks

Pandit Deendayal Energy University **School of Technology**

20IF201P					Industry 4.0 Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To interpret the core elements and basic technologies of Industry 4.0
- To understand how the core elements and technologies of Industry 4.0 are interconnected
- To develop a holistic approach to improve processes and products with Industry 4.0

LIST OF EXPERIMENTS

1. Basic computations using Python programming.
2. Use simulations to understand the performance/behavior of a system by (i) creating a computational environment that mimics the real world, (ii) generating (synthetic) or loading data from sources, and (iii) testing the hypothesis
3. Introduction to MATLAB programming and SIMULINK
4. 3D printing of Airfoil through rapid prototyping 3D printer
5. Dynamic simulation of drone (unmanned air vehicle) through MATLAB/SIMULINK
6. ANSYS simulation of bending of a beam in an earthquake resist-building
7. Introduction to Arduino Embedded platform.
8. Design of line follower autonomous vehicle.
9. Design of smart meter for recording the electricity consumption
10. Design of smart lighting with the help of proximity sensors.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Understand the concept of Industry 4.0 and its significance

CO2- Understand the resource requirements for the implementation of Industry 4.0

CO3- Learn the Simulation Packages for Industry 4.0

CO4 - Explore the concept of Smart Infrastructure through simulation studies

CO5 - Inspect embedded platform applications for Industry 4.0

CO6 - Synthesise the solution for the given Industry 4.0 related problem

TEXT/REFERENCE BOOKS

1. Ustundag Alp, and Emre Cevikcan, Industry 4.0: Managing the Digital Transformation, Springer,First Edition, 2018
2. Kaushik Kumar, Divya Zindani, and J. Paulo Davim, Digital Manufacturing and Assembly Systems in Industry 4.0., CRC Press, Taylor & Francis First Edition, 2019.
3. Antonella Petrillo, Raffaele Cioffi, and Fabio De Felice, Digital Transformation in Smart Manufacturing., IntechOpen Publisher, First Edition, 2018.
4. J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama and N. Jenkins, Smart Grid: Technology and Applications, John Wiley and Sons Ltd., First Edition, 2012

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination 50 Marks

Practical Examination 50 Marks

TP210					Industrial Orientation					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	-	1	-	-	-	-	50	50	100

COURSE OBJECTIVES

- To enable the students to better visualize what they have learned in classroom to the real industrial situations.
- To provide the opportunity during the industrial visit to see large-scale industrial processes and equipments as well as real engineering practices.
- To give opportunity for active/interactive learning experiences in class as well as outside the classroom environment.
- To promote success & growth of individuals and fulfil the current requirements of industry.

CONTENT

Industrial visits offer a great source to gain practical knowledge. Students can observe and learn as to how theoretical concepts are put to into action, thereby aiding their practical learning.
More over students will gain the subject learning outcome by means of pre and post industrial visit survey. This has resulted in enhanced visibility for the students among their learning outcomes and their portfolio.
The visit generally consists of lectures about the company, the site being visited and a range of topics specific to learning outcomes. Students are exposed to real working environment and shown how things are done in an organisation.
It is expected from students to understand and relate the theoretical concepts learned in the classroom with industry. Students are required to prepare good Industrial Orientation report on industries visited and enhance technical as well as communication skills.

COURSE OUTCOMES/LEARNING OUTCOMES

On completion of the course, student will be able to

CO1 - Define the impacts of industrial processes on health, safety, environment and society.

CO2 - Illustrate the processes and products manufactured in the chemical industries.

CO3 - Develop interpersonal skills, communication technique and report writing skills.

CO4 - Classify the industry practices and regulations followed by industries.

CO5 - Prioritize engineering and technological aspects in the chemical industries.

CO6 - Build the bridge between theoretical knowledge and practical learning in a real-life environment.

Semester 5

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 5	PC	20CH301T	PC-8 (Mass Transfer II)	3	0	0	3	3
	PC Lab	20CH301P	Mass Transfer II Lab	0	0	2	2	1
	PC	20CH302T	PC-9 (Chemical Reaction Engineering I)	3	0	0	3	3
	PC Lab	20CH302P	Chemical Reaction Engineering I Lab	0	0	2	2	1
	PC	20CH303T	PC-10 (Process Equipment Design)	3	0	0	3	3
	PC Lab	20CH303P	Process Equipment Design Lab	0	0	2	2	1
	CE	20CH304T	CE-1(Petroleum Refining and Petrochemicals)	3	0	0	3	3
	CE	20CH305T	CE-1(Material Science and Engineering)	3	0	0	3	3
	CE	20CH306T	CE-2(Fuel and Energy Technology)	3	0	0	3	3
	CE	20CH307T	CE-2 (Sustainability and Green Chemistry)	3	0	0	3	3
	OE	20CH308T	OE-3(Waste management/	3	0	0	3	3
	OE	20CH309T	OE-3 (Safety and Risk Analysis)	3	0	0	3	3
	HSC	20CH307T	Communication Skills - III	0	0	2	2	1
				18	**0**	**8**	**26**	**22**

20CH301T					Mass transfer 2					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Student will understand the principle of liquid-liquid and solid-liquid operations.
- Able to understand the principle of pressure and temperature swing adsorption.
- Student will understand the importance of humidification and dehumidification for cooling purpose in industries.
- Students will learn the principle and importance of drying and crystallization operation.
- Students will learn how to quantify, formulate and solve engineering problems involving extraction, adsorption, humidification, dehumidification and drying

UNIT 1 EXTRACTION **13 Hrs.**

Introduction to liquid-liquid extraction, liquid-liquid equilibrium, types of co-ordinate systems, solvent selection, stage wise extraction, liquid-liquid extraction equipment, selection of extractors, Principle and theory of solid liquid extraction, types of operations, single and multistage operations.

UNIT 2 ADSORPTION **9 Hrs.**

Introduction, Adsorption isotherm, heat of adsorption, Selection of adsorbent, batch adsorption, Rate of adsorption in fixed beds, Adsorption Equipment, Adsorption dynamics, Regeneration of adsorbent, Thermal and pressure swing adsorption

UNIT 3 HUMIDIFICATION AND DEHUMIDIFICATION **9 Hrs.**

Terminology and definitions, Psychometric charts and measurement of humidity, Classification of cooling tower, Cooling tower calculations, evaporative cooling, types of cooling tower and dehumidification methods.

UNIT 4 Drying and Crystallization **9 Hrs.**

Drying: Drying equilibrium and rate of drying, calculation of drying time, drying operation batch and continuous, types of dryers and selection criteria. Crystallization: Solid-liquid phase equlibrium, nucleation and crystal growth, principles of super saturation, types of industrial crystallizers.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1-Define the basic principles of mass transfer operations like extraction, adsorption, humidification, dehumidification and drying.

CO2 - Explain the principles of mass transfer operations like extraction, adsorption, humidification, dehumidification and drying.

CO3 - Apply principles related to extraction, adsorption, humidification, dehumidification and drying.

CO4 - Analyze the problems related to extraction, adsorption, humidification, dehumidification and drying.

CO5 -Justify the applications of theory learned in industrial practices regarding extraction, adsorption, humidification, and dehumidification and drying.

CO6 - Design mass transfer equipments based upon the conditions given in the problem statement.

TEXT/REFERENCE BOOKS

1. R.E. Treybal, Mass Transfer Operations, 3rd Edition, International Student Edition, McGraw Hill Education
2. W. L. McCabe, J. Smith and P. Harriott - Unit operations of Chemical Engineering, 7th Edition, McGraw-Hill international edition, 2005
3. B. K. Dutta, Principle of Mass Transfer and Separation Processes, Prentice Hall India Learning Private Limited, 2006
4. K. V. Narayanan, Mass Transfer: Theory and Applications, CBS Publishers, 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Question 50 Marks

Part B/Question: Analytical and Numerical Question 50 Marks

20CH301P					Mass transfer 2 Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Student will understand the principle of liquid-liquid and solid-liquid operations.
- Able to understand the principle of pressure and temperature swing adsorption.
- Student will understand the importance of humidification and dehumidification for cooling purpose in industries.
- Students will learn the principle and importance of drying and crystallization operation.
- Students will learn how to quantify, formulate and solve engineering problems involving extraction, adsorption, humidification, dehumidification and drying

List of Experiments

1. To study the effect of phase ratio on extraction of acetic acid (dispersed phase) by ethyl acetate (continuous phase).
2. To find out the number of stages required for extraction of acetic acid (dispersed phase) by ethyl acetate (continuous phase).
3. To determine the effect of time on extraction efficiency and find out the optimum time for maximum percentage extraction.
4. To study solid liquid extraction in batch process and hence find out the effect of solvent temperature on the percentage recovery of oil from oil seeds.
5. To study the batch adsorption of acetic acid by activated carbon and then test the validity of certain adsorption isotherm.
6. To determine the yield of benzoic acid crystal.
7. To Find Out The Critical Moisture Content Of A Given Material & Find Out Its Equation For Constant And Falling Rate Period
8. Study of forced draft cooling tower.
9. To study and verify the Freundlich's Adsorption Isotherm Adsorbing Oxalic Acid on Charcoal
10. To prepare the ternary diagram for a system of three liquid one pair partially soluble system.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 -Define the basic principles of mass transfer operations like extraction, adsorption, humidification, dehumidification and drying.

CO2 - Explain the principles of mass transfer operations like extraction, adsorption, humidification, dehumidification and drying.

CO3 - Apply principles related to extraction, adsorption, humidification, dehumidification and drying.

CO4 - Analyze the problems related to extraction, adsorption, humidification, dehumidification and drying.

CO5 -Justify the applications of theory learned in industrial practices regarding extraction, adsorption, humidification, and dehumidification and drying.

CO6 - Design mass transfer equipments based upon the conditions given in the problem statement.

TEXT/REFERENCE BOOKS

1. R.E. Treybal, Mass Transfer Operations, 3rd Edition, International Student Edition, McGraw Hill Education
2. W. L. McCabe, J. Smith and P. Harriott - Unit operations of Chemical Engineering, 7th Edition, McGraw-Hill international edition, 2005
3. B. K. Dutta, Principle of Mass Transfer and Separation Processes, Prentice Hall India Learning Private Limited, 2006
4. K. V. Narayanan, Mass Transfer: Theory and Applications, CBS Publishers, 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

20CH302T					Chemical Reaction Engineering 1					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	0	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To provide understanding of basic principles and terminology in reaction kinetics
- To acquaint students towards basic designing of ideal reactors
- To allow students to analysis the rate data and thereby find the kinetics parameters of interest
- To illustrate concept of reactor sequencing, and evaluate the performance of ideal reactors

UNIT 1 BASICS OF KINETICS **08 Hrs.**

Mole balances, kinetics of homogeneous reactions – rate of reaction, type of reactions, reaction mechanism, temperature and concentration dependent term of a rate equation, searching for a reaction mechanism, rate law and stoichiometry, approach to reactor sizing and design.

UNIT 2 ANALYSIS OF RATE DATA **12 Hrs.**

Collection and analysis of rate data, integral and differential method of analysis of data, batch reactor data, variable and constant volume system, method of initial rates, method of half-life, differential reactors, least square analysis.

UNIT 3 ISOTHERMAL REACTOR DESIGN **10 Hrs.**

Ideal reactors: batch reactors, semi-batch reactors, continuous-flow reactors, recycle reactors conversion and reactor sizing, design equations, applications of the design equations for continuous-flow reactors, introduction to micro reactors, membrane reactors and bioreactors

UNIT 4 REACTOR SEQUENCING **10 Hrs.**

Reactors in series, reactors for parallel reactions, maximizing desired product in parallel reactions, maximizing desired product in series reactions, temperature and pressure effect in single and multiple reactions, adiabatic reactor design.

Max. 40Hrs.

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 – Select proper design equations and perform reactor sizing for ideal reactors
CO4 – Examine the suitable combinations of ideal reactors for optimal performance
CO5 – Decide the reactor sequencing for single and multiple reactions towards desired products
CO6 – Design ideal reactor systems based on experimental data and optimize its performance

TEXT/REFERENCE BOOKS

1. H. S. Fogler, “Elements of Chemical Reaction Engineering”, 3rd Ed, New Delhi-Prentice Hall, 2001
2. O. Levenspiel,” Chemical Reaction Engineering” Willey Eastern, 3rd Ed., 2000
3. J. M. Smith, “Chemical Engineering Kinetics”, 3rd Ed., McGraw- Hill, 1988

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical knowledge and understanding	20-30 Marks
Part B/Question: Problem Solving, Design and Analysis	70-80 Marks

20CH302P					Chemical Reaction Engineering 1 Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Experimentation with different ideal reactors for a homogeneous liquid phase reactions to determine kinetics
- To find the kinetic parameter using Arrhenius theory by experimentation with different ideal reactors
- Find the application of combination of ideal reactors and the change in performance with the ideal reactors

LIST OF EXPERIMENTS

1. To study a non-catalytic homogeneous liquid phase reaction in an ambient CSTR
2. To study a non-catalytic homogeneous liquid phase reaction in an ambient straight tube PFR
3. To study a non-catalytic homogeneous liquid phase reaction in an ambient semi Batch reactor
4. To study a non-catalytic homogeneous liquid phase reaction in an ambient three Cascaded CSTR
5. Evaluating kinetic parameters (k_0 and E) for a saponification reaction in an Batch Reactor
6. Evaluating kinetic parameters (k_0 and E) for a saponification reaction in an Coiled PFR
7. Evaluating kinetic parameters (k_0 and E) for a saponification reaction in an CSTR
8. To study a non-catalytic homogeneous liquid phase reaction in an ambient combined flow reactor (CSTR+PFR)

COURSE OUTCOMES

CO1 – Relate to the basics of kinetics and application of the same in practical
CO2 – Interpret and evaluate the rate data and get the kinetics parameters for different reactors
CO3 – Apply proper rate equations and compare the performance of different ideal reactors
CO4 – Examine the combinations of ideal reactors and analyze the theoretical findings
CO5 – Decide the reactor sequencing so as to optimize the volume or conversion for given combinations of reactors
CO6 – Develop an ability to work in group, learn report making, and improve soft skills in representing the findings

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Practical Performance, Report Submission and Pre Viva 50 Marks
Part B/Question: Written Exam and Practical Viva 50 Marks

20CH303T					Process equipment design					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

- To know about the basics of chemical process equipment design
- To understand the sizing fundamentals of piping and fluid moving equipment
- To know the fundamentals of heat transfer equipment design
- To understand the design of mass transfer equipment
- To analyze the design criteria in pressure vessels
- To understand the basics of optimization of size of equipment

UNIT-I FUNDAMENTALS OF EQUIPMENT DESIGN **10 Hrs.**

Process design of piping, fluid moving devices, determination of internal and external design pressures, Power required in fan, blower and adiabatic compressor, process design of heat exchangers: design temperature, shell & tube heat exchangers, design method of shell & tube heat exchanger, U tube & floating head heat exchanger, condensers.

UNIT 2 DESIGN OF DISTILLATION COLUMNS **10 Hrs.**

Process design of batch distillation & batch distillation with rectification, process design of distillation column, criteria of selection, selection of equipment for distillation, distillation column design, selection of key components for multicomponent distillation, checking of conditions for weeping, flooding, liquid entrainment, their selection criteria.

UNIT-III- DESIGN OF ABSORPTION SYSTEMS **10 Hrs.**

Process design of absorbers, criteria for selection among different types of absorption equipment, process design of spray tower type absorber, venture scrubber, falling film absorber, process design of packed tower type absorber, selection of packing, determination of tower diameter & pressure drop, process design & selection criteria of liquid distributors, re-distributors & packing support.

UNIT-IV-MECHANICAL DESIGN OF PRESSURE VESSELS **10 Hrs.**

Mechanical design of pressure vessels, stresses developed in the vessel, shell subjected to internal and external pressures, different types of heads, design of stiffening rings, design of nozzle, reinforcement pad, gasket, flanges, agitator, design of jackets for heating and cooling, design of storage tanks (including shell, bottom plate, roof, roof column, girders, rafters, roof curb angle, dyke wall).

Max. 40Hrs.

COURSE OUTCOMES:

On completion of this course, the students will able to

CO1. Define the basics of chemical process equipment design

CO2. Explain the sizing calculations of pipes, heat transfer and mass transfer equipment

CO3. Apply the fundamental understanding the complexity of the design

CO4. Analyze critically the design criteria for the optimum design

CO5. Recommend the international standards, fabrication and testing methods

CO6. Design the various equipments used in chemical process industries

TEXT/REFERENCE BOOKS

1.Introduction to Process Engineering and Design by S B Thakore and B I Bhatt, Tata McGraw Hill, 1st Edition, 2007.

2.Coulson& Richardson's Chemical Engineering - Vol. 6 by R K Sinnott,Asian Book Pvt. Ltd. (publisher)

3.Illustrated Process Equipment Design by S B Thakore, Second edition.

4.Process Equipment Design – M V Joshi & V V Mahajani, Third edition

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Questions 50 Marks

Part B/Question: Analytical Questions 50 Marks

20CH303P					Process equipment design lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- To know about the basics of computer aided process calculations
- To understand the importance of computer aided calculations in process design
- To find the optimal conditions of a process
- To understand the fundamentals of equipment internals
- To develop the process flow diagram
- To understand the process flow sheet using P&IDs

LIST OF EXPERMENTS

A.Process calculations (using computer aided softwares)

1. Introduction to Aspen Plus and understanding of unit operations models in Aspen Plus
2. Process calculations for mixing streams using a mixer
3. Process calculations of pumping system for liquid streams
4. Process calculations of compressor/blower system
4. Process calculation on heat exchangers
5. Process calculation for distillation operation using McCabe and Thiele method
6. Short-cut and rigorous approaches for water-methanol separation using distillation
7. Process calculation on absorption of acetic acid using water solvent

B.Process drawing (using a drawing book)

1. Drawing of various valves with internals
2. Drawing of different pumps with internals
3. Drawing of heat exchangers with internals
4. Drawing of evaporators with internals
5. Drawing of mass transfer columns with internals
6. Drawing of process instrumentation symbols and P&IDs

COURSE OUTCOMES

On completion of this course, the students will able to

CO1. Recall the basics of computer aided software used in process calculations
CO2. Explain the methodology used in the design calculations
CO3. Apply the knowledge gained for the optimization of a process variables
CO4. Analyze critically for the optimum design
CO5. Recommend the various internals needed in a chemical process
CO6. Design and develop the process flow diagrams

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

20CH304T					Petroleum Refining and Petrochemicals					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To develop the fundamental understanding on various Units involved in petroleum refinery
- To understand the operation and importance of various conversion processes employed in refinery
- To discuss the various characterization techniques and testing methods of different petroleum fractions
- To understand the manufacturing processes & applications of widely used petrochemicals

UNIT 1 – EVALUATION AND CHARACTERISATION OF CRUDE OIL AND PETROLEUM PRODUCTS 8 Hrs.

Origin and occurrence, status of Indian petroleum industries, Pretreatment of crude oil for refining, Petroleum Processing data-Evaluation of petroleum, Thermal Properties of petroleum fractions, Characterization of crude oil and product specification.

UNIT 2 – PRETREATMENT AND FRACTIONATION OF CRUDE OIL 10 Hrs.

Dehydration and desalting of crudes, Fractionation of petroleum, Heating of crude-Pipe still heaters, Distillation of Petroleum- Crude distillation and Vacuum Distillation, Treatment techniques-Impurities in fraction, Treatment of Gas, Gasoline, Kerosene etc, Production and treatment of LPG, LNG Technology

UNIT 3 – THERMAL AND CATALYTIC PROCESSES FOR PRODUCT UPGRADATION 14 Hrs.

Thermal and catalytic processes: Thermal cracking, Catalytic cracking, FCC, Catalytic Reforming, Thermal Reforming, plat forming, Coking technology, Hydrogen Processes-Hydrocracking, Hydro treatment, Hydodesulpharization, Alkylation , Isomerisation Processes, Polymer Gasoline.

UNIT 4 – PROCESS TECHNOLOGY OF PETROCHEMICAL PRODUCTS 8 Hrs.

Petrochemical Industry feed stocks, Manufacture of BTX aromatics, naphthalene etc., Synthesis gas and chemicals, Petrochemicals derived from C1,C2,C3,C4 compounds , Petroleum Aromatics, Synthetic fibres, Petroleum Coke, Natural Gas Processing and transportation, Shale Gas, Gas Hydrates, Coal bed Methane, Oil Shale.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Outline the crude composition, properties and characterization methods of different petroleum fractions.
CO2 - Understand the purification and fractionation process of crude oil.
CO3 - Determine the different conversion processes of the heavier fractions by cracking and coking technology
CO4 - Illustrate the process technology of product upgradation units and Hydrogen processes.
CO5 - Review the treatment processes for preparing finished products using chemical or physical separation
CO6 - Facilitate the process technology of various important petrochemicals products

TEXT/REFERENCE BOOKS

1. J.H.Garry, G.E.Handwerk, M.J.Kaiser “Petroleum Refining Technology and Economics” CRC Press
2. B.K. Bhaskara Rao “ Modern Petroleum Refining Processes” Oxford &IBH
3. Speight, J. G., The Chemistry and technology of Petroleum, 5th Edition, M. Dekker, 1991.
4. W.L..Nelson " Petroleum Refining Engineering " Mc Graw- Hill

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: <Details> 60 Marks

Part B/Question: <Details> 40 Marks

Pandit Deendayal Energy University	School of Technology

20CH305T					Material Science and Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart the basic concept of material science.
- To understand the various properties, corrosion and heat treatment of engineering materials
- To understand the engineering requirement and selections of materials based on the properties for various applications.

UNIT 1 ATOMIC BONDING AND CRYSTAL STRUCTURES **12 Hrs**

Classes of engineering materials, Engineering requirement of materials, Selection of materials, Structure of atoms and molecules, Bonding in solids, Types of bonds and comparison of bonds, Crystal structure Crystal geometry, Structure of solids, Methods of determining structures, Imperfection in crystals, Types of imperfection, Point imperfection.

UNIT 2 PROPERTIES OF MATERIAL **8 Hrs.**

Mechanical, Electrical and magnetic properties of materials, Deformation of materials, Heat Treatment techniques, Corrosion, Theories of corrosion, Control and prevention of corrosion.

UNIT 3 METALS **10 Hrs.**

Engineering materials: Ferrous metals, Iron and their alloys Iron and steel Iron carbon equilibrium diagram, Non-ferrous metals and alloys, Aluminium, Copper, Zinc, lead, Nickel and their alloys with reference to the application in chemical industries.

UNIT 4 NON METALS **10 Hrs.**

Inorganic materials: Ceramics, Glass and refractories, organic materials: wood, plastics, and rubber and wood, Advanced materials (Biomaterials, nanomaterials and composites) with special reference to the applications in chemical Industries.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Tell the basics knowledge such as internal structure, crystal geometry, crystal imperfection of the engineering materials
CO2 – Explain various properties of material such as mechanical, electrical and magnetic.
CO3 – Identify the various properties and corrosion behaviour of the selected materials
CO4 – Examine the various materials for their potential application in chemical industry.
CO5 – Recommend the metallic and non-metallic material based on their properties.
CO6 – Predict material in chemical engineering in the areas of equipment design

TEXT/REFERENCE BOOKS

1. Lawrence H. Van Vlack, Elements of Material Science and Engineering.
2. S. K. Hajra Choudhury, Material Science and processes, 1st Edn., Indian Book Distribution Co., Calcutta.
3. William D. Callister, Materials Science and Engineering,7th edn, John Wiley & Sons, Inc.
4. V. Raghavan, Materials Science and Engineering, Prentice Hall, 2004

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Marks

Part B/Question: Marks

Pandit Deendayal Energy University					School of Technology					
20CH306T					**Fuel and Energy Technology**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	**0**	**0**	**3**	**3**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES

- To understand the various processing techniques and limitations of fossil fuels
- To analyze the processing techniques of Biofuels and Biomass as a Potential renewable energy source
- To understand the necessity of harnessing alternate energy sources such as Solar, wind, nuclear, fuel cell, geothermal and tidal.

UNIT 1 – OVERVIEW OF ENERGY SCENARIO AND PROCESSING OF COAL **8 Hrs.**

Production, present scenario and consumption pattern of fuels, Solid fuel: Fundamental definitions, properties and various measurements of fuels, Coal classification, composition and basis, Coal preparation and washing Different types of coal combustion techniques, Coal liquefaction, Coal Gasification,

UNIT 2 – LIQUID AND GASEOUS FUEL **10 Hrs.**

Liquid fuel: Exploration of crude petroleum, Crude & Vacuum distillation, Secondary Processing, Gaseous Fuel: Producer Gas, Water Gas, Hydrogen gas, Introduction to Biofuels, Process Technology of 1st, 2nd and 3rd generation Biofuels, Biorefinery,.

UNIT 3 – RENEWABLE ENERGY SOURCES- (SOLAR AND WIND ENERGY) **10 Hrs.**

Solar Energy : Measurement of solar radiation, solar energy collectors – flat plate collector, air collector, collectors with porous absorbers, concentrating collectors, applications & advantages of various collectors, solar pond, Wind energy: nature, power, forces, conversion and estimation. Components of wind energy system, types, design considerations,

UNIT 4 – ALTERNATE SOURCES **12 Hrs.**

Fuel Cell: introduction, hydrogen – oxygen fuel cell, ion exchange membrane cell, fossil fuel cell, molten carbonate cell, conversion efficiency, polarisation, type of electrodes, Nuclear Energy: fission, fusion, fuel for nuclear fission reactor, storage & transportation, , uranium enrichment process, study of different reactors , Geothermal Energy, Tidal Energy

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – List the available renewable and non-renewable energy resources and relate to fulfil global energy demand.

CO2 - Summarize the various characterization techniques used in solid and liquid fuels

CO3 - Execute the effective utilization of potential conventional energy source by advanced conversion technologies

CO4 – Analyze the potential utilization of biomass and bio-fuels as a substitute for the fossil fuel applications

CO5 - Assess the available non-conventional (renewable) energy resources and techniques to utilize them effectively.

CO6 – Facilitate the design and applications of related devices using renewable energy sources

TEXT/REFERENCE BOOKS

1. Energy Sources 2Ed. by G. D. Rai, Khanna Publications, New Delhi
2. Fuels & combustion by Samir Sarkar, Orient Longmans(1974)
3. Solar Energy by Sukatame, Tata McGraw Hill, New Delhi
4. Energy Technology by Rao & Parulaker.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: <Details> 60 Marks

Part B/Question: <Details> 40 Marks

20CH307T	Sustainability and Green Chemistry

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

COURSE OBJECTIVES

- To understand the basics importance of sustainability and green chemistry
- To understand principal, application and synthesis methods.
- To learn Conventional Process and Operations-Current status.
- Learn to understand new process developments.

Unit 1: **[9 hrs]**

Chemistry- from past to future, importance of sustainability, need of green chemistry. Fundamentals of sustainable development, growth, consumption and natural wealth, sustainable development at different scales.

Unit 2: **[10 hrs]**

Green Chemistry: - Principles and applications, Synthesis And Green Chemistry:- Micro-reactor technology, Solvent-less reactions, Use of green solvents, brief about Combinatorial chemistry.

Unit 3: **[10 hrs]**

Alternate Solvent:- Green solvents, Water as a solvent; Amphiphillic compounds., Conventional Process And Operations-Current status and modification

Unit 4: **[10 hrs]**

New Development In Processes:- Overview of green separation processes, distillation, chromatography, fluid extraction, membrane processes, pressurized hot water extraction, nanotechnology in separation. Life Cycle Assessment of the Technology.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: How sustainability and green chemistry subject is useful in Chemical Engineering.
CO2: Relate the concept of green solvents to minimize the environmental concerns.
CO3: Utilize principal, application and synthesis methods to identify the application of compounds.
CO4: Categorize conventional process for solvents and operations.
CO5: Importance of learning new development in various separation processes.
CO6: Develop the techniques and learn the significance of Life Cycle Assessment of the Technology.

TEXT/REFERENCE BOOKS

1. Doble M. and Kruthiventi A. K., Green Chemistry and Processes, Academic Press, 2007, London, UK.
2. Afonso C. A. M., Crespo J. G., Green Separation Processes, Wiley-VCH Verlag GmbH & Co., 2005, Weinheim, Germany.
3. Clark J., Macquarrie D., Handbook of Green Chemistry and Technology Blackwell Series, 2002, UK.
4. Atkinson G., Dietz S., Neumayer E., Handbook of Sustainable Development Edward Elgar Publishing Limited, 2007, Cheltenham, UK.

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

Part A/Question: Theoretical Questions 50 Marks
Part B/Question: Analytical Questions 50 Marks

20CH308T					Waste Management					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

Unit-I Introduction **8hrs**

Sources and generation of solid waste, their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste. Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution

Unit-II- Waste Management Techniques **9hrs**

Different techniques used in collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques.

Unit-III- Resource Recovery from Waste **9hrs**

4R – reduce, reuse, recycle and recover; biological processing – composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.

Unit-IV-Waste-to-Energy **10hrs**

Concept of energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification.

Total: 36 Hrs

COURSE OUTCOMES: On completion of this course, the students will able to

CO1. List various wastes present in solid waste
CO2. Classify the technologies for the waste upgradation
CO3. Build fundamental knowledge in waste management technologies
CO4. Distinguish the resource recovery potential from different wastes
CO5. Compare the available technologies in waste management
CO6. Provide solution to the growing urban and rural waste handling

TEXT/REFERENCE BOOKS

1. Asnani, P.U. 2006. Solid waste management. India Infrastructure Report 570
2. Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press.
3. McDougall, F.R., White, P. R., Franke, M., & Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley & Sons.

20CH309T				Safety and Risk Analysis					
Teaching Scheme				Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand safety, accident & loss statistics, standards and from major disasters.
- To gain knowledge about toxic substance, hazard analysis and personal protective equipments.
- To understand hazard survey, HAZOP study, evaluation and their prevention.
- To have knowledge of industrial hygiene, evaluation of toxicants and control.
- To understand the risk analysis theory and concept.

UNIT 1 – INTRODUCTION TO SAFETY AND MAJOR DISASTERS 12 Hrs.

Safety and Accident loss statistics, Nature of accident and major disasters, basic laboratory & personal protective equipments, National and International standards for health and safety, Acts and legislation (OSHA, ISO standards), toxic substance and confined spaces, Inherent safety in process, Indore air quality management,

UNIT 2 – HAZARD IDENTIFICATION, EVALUATION AND CONTROL 10 Hrs.

Identification: Hazard surveys, Hazard & operability study, Hazard analysis, Fire and explosion hazards: Fire triangle, Flammability characteristics of fluids, Limiting oxygen concentration, Flammability diagram, DOW F&I Index, Prevention- Inerting, Ventilation, Sprinkler systems, Explosion proof instruments and equipments and control rooms.

UNIT 3 – INDUSTRIAL SAFETY AND HYGIENE 10Hrs.

Government Regulations, Identification-Material safety data sheet, Evaluation-volatile toxicants, dust, noise, toxic vapor, etc., and control-Respirators and ventilation.

UNIT 4 – RISK ANALYSIS 8 Hrs.

Fault tree analysis (FTA), Event tree analysis (ETA), Review of probability theory, Quantitative Risk Analysis, LOPA concept, Bow-Tie analysis.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define the safety principles & standards, loss statistics, toxic substance & hazard and industrial hygiene.
CO2 - Classify measures to diminish risk and execution of safety and industrial hygiene.
CO3 - Apply knowledge in risk analysis through FTA, ETA, QRA, LOPA and BTA.
CO4 - Examine industrial safety & hygiene identification, evaluation and control.
CO5 - Assess characteristic sources of risk in a process plant by learning from case studies.
CO6 - Estimate fire & explosion hazard and their evaluation and prevention & control.

TEXT/REFERENCE BOOKS

1. Daniel A. Crowl and Joseph F. Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall (1990).
2. A M Flynn and L Theodore, Health, safety, and accident management in the Chemical Process Industries, Marcel Dekker, 2002

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: <Details> <> Marks
Part B/Question: <Details> <> Marks

Course Curriculum

20HS301P					Communication Skills – III					
Teaching Scheme					Examination Scheme					
					Theory			Practical		Total Marks
L	T	P	C	Hrs/Week	MS	ES	IA	LW	LE/Viva	
0	0	2	1	2 hours per week	--	--	--	50	50	100

Course Objectives:

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

Course Objectives:

1. To strengthen the communication skills of professionals to make them ready for the modern workplace.
2. To fine tune their professional skills and expertise using communication skills.
3. To participate in the life-long learning process with confidence and certainty.

Syllabus:

Unit I **10 hrs**

- Writing research proposals
- Writing technical projects

Unit II **15 hrs**

- The Art of Presentation
  - ✓ *Sapiens: A Brief History of Humankind* (2011), Yuval Noah Harari
  - ✓ *Thank You for Being Late: An Optimist's Guide to Thriving in the Age of Accelerations* (2016), Thomas L. Friedman
  - ✓ (Presentation in teams of 4 students each, not more than two from the same branch, with a view to promote cross-disciplinary research)

Unit III **5 hrs**

- Uploading portfolios on SlideShare
  - ✓ Uploading Video modules

Max.: 30hrs

Course Outcomes:

On completion of the course, student will be able to

CO1 : Demonstrate enhanced communications skills for enhanced team work for a better result.

CO2 : Apply critical analysis for innovative thinking and well-rounded perspectives in different settings and contexts.

CO3 : Analyse situations to identify opportunities for professional and career growth through strong communication skills.

CO4 : Develop high competence of oral, written and visual communication skills for a workplace ready professional.

CO5 : Demonstrate a realization and application of communication skills and language processes for multiple perspectives and interdisciplinary approach in profession.

CO6 : Evaluate the application of communication skills for improved research, organizational, and critical thinking and perspective.

Text/Reference Books:

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

Assessment Tools:

Component	Marks	Assignments
Lab Work	50	• Business Proposal – 15 • Research Project Proposal – 15 • Reviews on the two books – 20
Lab Exam/Viva	50	• Presentation on the reviews of the two books (Intra Branch) – 15 • Presentation on a technical topic (Inter Branch) – 15 • Slideshare/Video Modules (Prescribed Texts) – 20

Semester 6

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 6	PC	20CH310T	Instrumentation and Process Control	3	0	0	3	3
	PC Lab	20CH310P	Instrumentation and Process Control Lab	0	0	2	2	1
	PC	20CH311T	Chemical Reaction Engineering II	3	0	0	3	3
	PC Lab	20CH311P	Chemical Reaction Engineering II Lab	0	0	2	2	1
	PCE	20CH312T	Nano Technology and Energy Storage	2	0	0	2	2
	PCE	20CH313T	Membrane Processes	2	0	0	2	2
	PCE	20CH314T	Piping Design	2	0	0	2	2
	PCE Lab	20CH312P	Nano Technology and Energy Storage-Lab	0	0	2	2	1
	PCE Lab	20CH313P	Membrane Processes –Lab	0	0	2	2	1
	PCE	20CH314P	Piping Design-Lab	0	0	2	2	1
	PCE	20CH315T	Pharmaceuticals Technology	3	0	0	3	3
	PCE	20CH316T	Corrosion Engineering	3	0	0	3	3
	PCE	20CH317T	Polymer Science & Technology	3	0	0	3	3
	PCE	20CH318T	Biochemical Engineering & Bioenergy	3	0	0	3	3
	OE	20CH319T	Novel Separation Processes	3	0	0	3	3
	Project	20TP310	Industrial Training/ IEP (6 weeks-summer break)	0	0	0	0	2
				17	**0**	**6**	**23**	**22**

20CH310T					Instrumentation and Process Control					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Provide understanding of Control Processes from Transfer function point of view.
- Provide understanding of various controllers used in Process Control.
- Provide acquaintance of various instruments used in chemical indusries.

UNIT 1 Introduction **8 Hrs.**

Introduction and Motivation to do process control, Block diagram representation, Input-output model of a process, Laplace transform, inverse Laplace transform and transfer functions.

UNIT 2 Response of Dynamic systems and Controllers **12 Hrs.**

First order systems, Linearization, Second and higher order systems, Feedback control, Complex block diagram, Criteria for controller design, Introduction of P, PI, PID controllers.

UNIT 3 Stability Analysis **12 Hrs.**

Introduction to Stability, Stability analysis by using transfer function poles, Controller tuning, Frequency domain analysis, Bode plots.

UNIT 4 Instrumentation **8 Hrs.**

Sensors and Measurement of process variables: Pressure, force, Torque and flow measurement, Transducers and their dynamics.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 Defining and identifying dynamical processes and their block diagram representation using transfer functions

CO2 Estimating Laplace transforms, inverse Laplace transforms of various signals, and, expressing response of first and second order processes using Laplace transformation.

CO3 Integrating complex block diagram systems to a simple form and examining the controller actions such as Proportional (P), Proportional-integral (PI) and Proportional-integral-derivative (PID).

CO4 Explaining the stability of control processes and estimating the stability by Routh's test and tuning of controllers using stability criterion.

CO5 Measuring frequency response problems and predicting stability in frequency domain by means of Bode plots.

CO6 Mixing the knowledge of Process control with Instrumentation with main focus on various sensors such as flow, pressure and temperature sensors.

TEXT/REFERENCE BOOKS

1. George Stephanopoulos, Chemical Process Control,Prentice Hall India Learning Pvt.Ltd., 2008.
2. Donald R. Coughanowr and Steven E. LeBlanc, Process Systems Analysis and Control, McGraw Hill Education; Third edition, 2017
3. Donald P Eckman, Industrial Instrumentation, CBS Publishers 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Problems with multiple questions (each carrying 2-3 marks) 70-80 Marks

Part B/Question: Detailed analytical Problems 20-30 Marks

20CH310P					Instrumentation and Process Control Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2				50	50	100

COURSE OBJECTIVES

- To gain practical knowledge of dynamic behavious of control systems.
- To learn the working of automated control strategies.
- To understand various kind of valves and their working.

LIST OF EXPERIMETS

Valves
Air to open and air to close valves, linear, equal and quick opening valve, Calculation of Valve coefficents, Inherent and Installed characterstics of valves

Dynamic response of first order systems
Level control of a Single tank system with respect to , Two non-interacting tank systems, Interacting tank systems,

Dynamic response of second order system
Study of U tube manometer

Controller Action
P, PI, PID controllers, Cascade and ratio control strategies, Controller tuning.

Course Outcomes:

On completion of the course, student will be able to -
CO1. Identify appropriate valves for different industrial applications.
CO2. Estimate the parameters of a control systems by experiments.
CO3. Examine dyanmic response of control systems with respect to step and delta inputs.
CO4. Estimation of appropriate parameters of P, PI, PID controllers in controller tuning.
CO5. Measuring valve coefficients and different valve charactistics.
CO6. Investigate different control strategies commonly adopted in plants.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

20CH311T					Chemical Reaction Engineering II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To accustom with the concepts of non-ideality in the reactor systems and studying RTD.
- To provide details on modeling the non-ideality using zero and one parameter models
- To give a wholesome picture on catalysis, catalytic reactions and catalytic reactors
- To give detail insight on external and internal mass transfer effects in catalytic reactions

UNIT 1 NON IDEALITY AND RTD MEASURMENTS **12 Hrs.**

Basics of non-ideality, distribution of residence times for chemical reactors – general characteristics, RTD measurement, reactor modeling with RTD, models for non-ideal reactors: zero-parameter models and one parameter models, research studies on modeling of real reactors

UNIT 2 CATALYSIS AND CATALYTIC REACTORS **12 Hrs.**

Basics of catalysis, catalytic reactions, steps in a catalytic reaction, synthesizing a rate law, mechanism and rate-limiting step, design of reactors for gas-solid reactions, heterogeneous data analysis for reactor design, catalyst deactivation, multiphase catalytic reactors.

UNIT 3 EXTERNAL DIFFUSION EFFECTS **08 Hrs.**

External diffusion effects on heterogeneous reactions – mass transfer fundamentals, binary diffusion, external resistance to mass transfer, correlations for the mass transfer coefficient, the shrinking core model

UNIT 4 INTERNAL DIFFUSION EFFECTS **08 Hrs.**

Internal diffusion effects on heterogeneous reactions, diffusion and reaction in catalysts, thiele modulus, Weiz-Prater criterion, Mear's criterion, internal effectiveness, overall effectiveness, falsified kinetics, estimation of mass transfer and reaction limited regimes, Hatta number

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Relate to the basics of non ideality and characteristics of residence time distributions
CO2 – Interpret the RTD profiles and experimental data to model the non ideal reactors
CO3 – Select proper reaction mechanism and design the catalytic reactor by rate data analysis
CO4 – Compare the reactor performance with or w/o internal of external mass transfer limitations
CO5 – Appraise the performance of different reactors in multi phase systems
CO6 – Design, Develop and/or Modify reactor systems for specific purpose of real life problems

TEXT/REFERENCE BOOKS

1. H. S. Fogler, "Elements of Chemical Reaction Engineering", 3rd Ed, New Delhi-Prentice Hall, 2001
2. O. Levenspiel," Chemical Reaction Engineering" Willey Eastern, 3rd Ed., 2000
3. J. M. Smith, "Chemical Engineering Kinetics", 3rd Ed., McGraw- Hill, 1988

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical knowledge and understanding	20-30 Marks
Part B/Question: Problem Solving, Design and Analysis	70-80 Marks

20CH311P					Chemical Reaction Engineering II - Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Understand the non-ideality of different reactors by performing RTD studies
- To execute the homogeneous reactions with and without catalysts.
- To observe the effect of catalyst presence on the reaction performance.
- Study the effect of mass transfer with and without reaction
- Understand the modelling aspects using zero and one parameter model

LIST OF EXPERIMENTS

1. Residence time distribution studies in CSTR
2. Residence time distribution studies in PFR
3. Residence time distribution studies in PBR
4. To study non-catalytic homogeneous second order liquid phase reaction in packed bed reactor
5. To study the kinetics of dissolution of benzoic acid in water
6. To study the catalytic decomposition of hydrogen peroxide in an adiabatic reactor
7. To model the kinetics of PBR using segregation model and maximum mixedness model
8. To model the RTD of PBR by T-I-S model and dispersion model

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Relate to the basics of non ideality in reactors and application of the same in practical
CO2 – Interpret the RTD data; evaluate different parameters and interpretations for different reactors
CO3 – Utilize the catalyst for the reaction and identify the catalytic effect on the performance of reaction
CO4 – Examine the effect of presence/absence of mass transfer limitations on the reaction
CO5 – Choose to model the RTD of a given reactor system and estimate the performance
CO6 – Develop an ability to work in group, learn report making, and improve soft skills in representing the findings

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Practical Performance, Report Submission and Pre Viva	50 Marks
Part B/Question: Written Exam and Practical Viva	50 Marks

20CH312T					Nano Technology and Energy Storage					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the fundamentals of Nanotechnology.
- Explain the nanoscale paradigm in terms of properties at the nano scale dimension.
- Identify current nanotechnology solutions in design, engineering and manufacturing.
- To understand the use of nanotechnology in Energy Storage.

UNIT I **[8 hrs]**

Introduction and History of Nanotechnology, Nano-materials and their properties: physical, chemical and biological properties from their constituent atoms or molecules and from the bulk materials. Case studies demonstrating non-classical behavior at nanoscale in successful and emergent nanotechnologies.

Unit –II **[8 hrs]**

Synthesis of nano materials, bottom-up approach: self-assembly and self-organization, apor phase deposition, plasma assisted deposition processes, colloidal, sol-gel, or simple pyrolysis, top-down approach: miniaturization of smaller structures from larger ones like milling, lithography, machining will be presented with suitable examples.

Unit III **[7 hrs]**

Detailed characterization technique based on radiation matter interactions and their analytical applications like Transmission electron microscope (TEM), Scanning electron microscope (SEM), Atomic force microscope (AFM), scanning tunnelling microscope (STM), Dynamic light scattering (DLS), Spectroscopy. The safety and storage issues and the impact of nanotechnology on the environment will be stressed at the end.

Unit-IV **[8 hrs]**

Nanotechnology for sustainable energy-Materials for light emitting diodes-batteries-advanced turbines-catalytic reactors-capacitors-fuel cells. Energy challenges, development and implementation of renewable energy technologies –nanotehology enabled renewable energy technologies –Energy transport, conversion and storage, Nano , micro and meso scale phenomena and devices.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1:- Tell the basics of Nanotechnology along with properties.
CO2:- Explain the chemical methods for synthesis of nanoparticles.
CO3:- Develop various nanomaterials and basic understanding in the relevant analytical techniques.
CO4:- Categorize the various echniques for nano-materials characterization.
CO5:- Explain the physical methods for synthesis of nanoparticles.
CO6:- Discuss the use of nanotechnology in Energy Storage.

TEXT/REFERENCE BOOKS

1. Nanoscale science and technology, John Wiley & Sons., 2005.
2. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
4. Nanobiotechnology, concepts, applications and perspectives, Wiley-VCH, 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Questions 50 Marks
Part B/Question: Analytical Questions 50 Marks

20CH312P					Nano Technology and Energy Storage Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	00	00	00	50	50	100

COURSE OBJECTIVES

- To understand physical methods for synthesis of nanoparticles.
- To understand the limitations of the synthesis techniques.
- To understand various advancement in Techniques for synthesis at nanoscale.
- To understand the use of nanotechnology in Energy Storage.

LIST OF EXPERIMENTS

1. Ball milling route for making nanoparticles and particle size distribution estimation.
2. Sol-gel synthesis and characterization of CdS nanocrystals.
3. Preparation and characterization of ZnO nanoparticles embedded in silica matrix
4. Microwave assisted synthesis of ZnO nanoparticles.
5. Eco-Friendly Bio-Chemical synthesis of nanomaterials.
6. Synthesis and Characterization of carbon nanotubes by cracking of gas mixture
7. Physical vapor deposition and chemical vapor deposition techniques for thin film deposition.
8. Fabrication of suitable structures on thin films for device applications.
9. To investigate refluxing and distillation techniques for synthesis of II-VI ceramic nanostructures.
10. To study solvothermal synthesis method of nanoparticles

COURSE OUTCOMES

On completion of the course, student will be able to
CO1:- Tell the basics of Nanotechnology along with properties.
CO2:- Explain the chemical methods for synthesis of nanoparticles.
CO3:- Develop various nanomaterials and basic understanding in the relevant analytical techniques.
CO4:- Categorize the various techniques for nano-materials characterization.
CO5:- Explain the physical methods for synthesis of nanoparticles.
CO6:- Discuss the use of nanotechnology in Energy Storage.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

20CH313T					Membrane Separation Processes					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Acquire in-depth knowledge in membrane fabrication mechanisms, characterization and its application.
- To understand different transport models and membrane modules.
- To develop the understanding of concentration polarization and membrane fouling.
- To obtain profound knowledge of different membrane processes and applications.

UNIT 1 –MEMBRANE OVERVIEW AND PREPARATION METHODS 8 Hrs.

Historical Development of Membranes, Membrane Processes and materials, polymeric, inorganic and liquid, Membrane preparation: phase inversion, immersion precipitation, track-etch method, sol-gel process, interfacial polymerization, dip-coating process, film stretching and template leaching, membrane characterization.

UNIT 2 – MEMBRANE TRANSPORT THEORY AND MODULES 6 Hrs.

Solution-Diffusion Model, Structure-Permeability Relationships, Pore-Flow Membranes, Isotropic Membranes, Anisotropic Membranes, Inorganic Membranes, Liquid Membranes, Membrane Modules.

UNIT 3 – CONCENTRATION POLARIZATION AND FOULING 6 Hrs.

Concentration Polarization in Liquid Separation Processes, Gel Layer Model, Osmotic Pressure Model, Boundary Layer Resistance Model, Concentration Polarization in Gas Separation Processes, Membrane Fouling, Fouling Control.

UNIT 4 – MEMBRANE PROCESSES 7 Hrs.

Reverse osmosis, Nanofiltration, Ultrafiltration, Microfiltration, Gas separation, Pervaporation. Electrodialysis, Fuel cell Membranes, Membrane contactors, Membrane distillation, Membrane bioreactors, Stimuli responsive membranes.

Max. 27 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define the membrane separation processes for solving separation problems in the various fields.
CO2 - Illustrate skills in the areas of membrane fabrication and characterization.
CO3 - Identify the different membrane modules in membrane separation applications.
CO4 - Examine the mechanism of concentration polarization and membrane fouling.
CO5 - Assess transport models in membrane separation processes.
CO6 - Estimate the membrane performance and separation characteristics of different processes.

TEXT/REFERENCE BOOKS

1. R. W. Baker,, Membrane Technology and Applications, 2nd Edison, WILEY
2. Kaushik Nath, Membrane separation processes, PHI learning.

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END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: <Details> <> Marks
Part B/Question: <Details> <> Marks

20CH313P					Membrane Separation Processes Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0-	0-	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- To understand the preparation method of polymeric membrane.
- To learn the porous nature, hydrophilicity and fouling property.
- To obtain profound knowledge of morphology and surface properties.
- To understand the transport and retention properties of the membrane.

LIST OF EXPERIMENTS

1. Preparation of polymeric flat sheet membranes without and with pore forming agent.
2. Evaluation of porosity and equilibrium water content of the membranes.
3. Measurement of hydrophilicity/hydrophobicity of the membranes.
4. Determination of fouling resistant nature by protein adsorption experiments.
5. Measurement of permeation property of membranes using batch filtration setup.
6. Measurement of permeation property of membranes using cross flow filtration setup.
7. Determination of solute rejection property and performance of the membranes.
8. Study of morphology, surface properties and functional groups of the membranes.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 - Define the significance and importance of membrane separation processes laboratory.
CO2 - Show the punctuality and capability of team work on small membrane base projects.
CO3 - Build a bridge between theoretical and practical concepts used in environmental engineering.
CO4 - Examine the results of analytical study introduced in lecture to the experimental results.
CO5 - Learn Importance of effective communication to prepare laboratory reports.
CO6 - Develop the ability to execute and write experiments individually.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

20CH314T					Piping Design Theory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Create, select, and apply appropriate modern software tools for fluid flow and pipeline engineering
- Identify and learn the usage of proper fluid moving machines and pressure changers in a process plant.
- Learn application and solve pipe flowsheeting problems more quickly, efficiently and successfully using computer aided tools.
- Understand pressure drops to maximize flow and mitigate the risk for flow assurance issues, Learn and analyse piping networks along with process equipments.

UNIT 1 PIPE FLOW HYDRAULIC ANALYSIS AND DESIGN **8 Hrs.**

Introduction to piping engineering, Basic of fluid flow through pipes. Codes & standards for piping engineering & design Piping elements viz. pipes, fittings, flanges, gaskets, bolting, valves etc. Types of valves, Piping drawing layout and instruments diagram,

UNIT 2 PRESSURE CHANGERS **7 Hrs.**

Handling fluid streams to change its pressure for different reasons, pressures changers, pumps, compressors, valves etc. design and analysis using commercial software (Aspen Plus), Selection and efficiency

UNIT 3 PIPING NETWORK ANALYSIS **8 Hrs.**

Head losses due to contraction and expansion, other types of losses Network analysis, Overall loss estimation through network analysis, optimizing piping network with respect to losses, dynamic multi-phase pipeline modeling. integrate pipeline models with processing facilities to conduct what-if analyses and optimizations.

UNIT 4 **7 Hrs.**

Pipings for oil and gas industries, underground piping, Design of liquid handling piping system, sizing for equal velocity, sizing for equal areas, optimal sizing, water hammer, Steam piping design, stream traps

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 - Understand, create, select, and Describe computer tools for chemical process simulation
CO2 – CHOOSE AND apply blocks and streams from a simulators library to make a process flow sheet
CO3 - Apply stream and block parameters to a chemical unit operation for computer simulation
CO4 - Determine flow sheeting solution by using design specification and sensitivity analysis approach
CO5 - Solve process design and simulation calculations of various unit operations using Aspen software
CO6 – Outline process intensification and construct Heat exchanger networks

TEXT/REFERENCE BOOKS

1. Chemical Process design and Simulation by Juma Haydary, 2019 John Wiley &sons, Inc
2. Process plant layout and piping design by Ed Bausbache and Rogur hunt, Prentice hall

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**
Part A/Question: Theoretical Questions 50 Marks
Part B/Question: Analytical Questions 50 Marks

20CH314P					Piping Design lab (software)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	0	2	2	-	-	-	-50-	-50-	100

COURSE OBJECTIVES

- To learn and apply appropriate modern software tool (Aspen plus) for modelling and analysis of piping networks.
- Identify and analyze the fluid movers and pressure changers used in process industries.
- Learn application and solve piping problems more quickly, efficiently and successfully using computer aided tools
- Learn concepts of pipe network design and analysis in chemical process plants.

LIST OF EXPERIMENTS

Process Simulation Exercises Using Aspen Plus:

1. Construct a simulation sheet with process blocks and streams
2. Specify pipe and pipeline in Aspen plus.
3. Thermodynamic property estimation and analysis, of fluid through pipe
4. Choose and analyse different types of pumps,
5. Choose and analysis different types of compressors
6. Choose and analysis different types of valves
7. Thermal analysis, simulation of pipe line.
8. Design and Simulation of piping network,
9. Costing and economic analysis; of piping
10. Dynamic simulation of a pipe network

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Estimate, fluid flow and do a flow analysis through pipe in Aspen plus.
CO2 – Estimate heat transfer trough pipe with thermal stress
CO3 – Construct various performance curves for pumps and valves using Aspen plus.
CO4 - Determine performance curves for single and multistage compressors
CO5 - solve design and simulation calculations involving piping network
CO6 - demonstrate economic and cost analysis of a piping network using Aspen plus software

TEXT/REFERENCE BOOKS

1. Chemical Process design and Simulation by Juma Haydary, 2019 John Wiley &sons, Inc
2. “Process plant layout and piping design by Ed Bausbache and Rogur hunt, Prentice hall
3. Aspen piping manual.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

20CH315T					Pharmaceutical Technology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Acquire the knowledge of basic pharmaceutical technology and characteristics of pharmaceutical industries.
- Gain an understanding of Sterilization applications and Dosage farms.
- Understand and apply methods for Manufacturing and packaging of pharmaceutical products.

UNIT 1 BASICS OF PHARMACEUTICAL TECHNOLOGY **8 Hrs.**

Characteristics of Pharmaceutical industries, Product Standards: IP, BP, USP, Methods of production, Chemical synthesis, Isolation from plants, isolation from animals, Fermentation, API and Formulation.

UNIT 2 STERILIZATION **10 Hrs.**

Sterility and requirement of sterility, Concept of sterilization. Methods of Sterilization with, applications, Heat sterilization, Steam sterilization, Dry heat sterilization, Radiation sterilization Gas sterilization, Filtration sterilization. Sterile facilities.

UNIT 3 CLEAN FACILITIES AND DOSAGE FORMS **12 Hrs.**

Design parameters for clean facilities: Air change rate, Pressurization, Temperature control, Humidity control. Architectural design issues. Material of construction for wall, doors, ceilings, floors, Clean construction. HEPA filters. Solid dosage forms: Tablets, Coated tablets, Gelatine capsules, Chewable tablets. Excipients in solid dosage forms. Semi-Solid dosages: Ointments and creams, Bases for ointments and creams, Types of Gels, Commercial Gelling agents

UNIT 4 MANUFACTURING AND PACKAGING **10 Hrs.**

Manufacturing, tablets and capsules, Packaging and storage of ointments and creams, Critical aspects of liquid manufacturing: particle size of raw materials, parameters of compounding, uniformity, stability problems. Packaging materials: General considerations, Glass, Plastic and metal. Quality control of packaging materials

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand key concepts of Pharmaceutical technology

CO2 - Identify appropriate methods in medicine production.

CO3 - Apply various methods of sterilization.

CO4 - Use design parameters for clean facilities

CO5 - Produce different dosage forms

CO6 - Identify appropriate packaging materials.

TEXT/REFERENCE BOOKS

1. Pharmaceutical Process Engineering, Hickey, Anthony J, David Ganderton. Marcel Dekker Inc. USA, 2001.
2. Pharmaceutical Manufacturing handbook. Gad, Shayne Cox. John Wiley and Sons, 2008
3. Good pharmaceutical Manufacturing practice. Sharp, John, CRC press, New York, 2005.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Question 70 Marks

Part B/Question: Analytical Question 30 Marks

20CH316T					Corrosion Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Be introduced to the principles of chemistry behind corrosion as well as the essential elements of electrochemical corrosion.
- Lay a foundation for understanding the forms of corrosion, the mechanisms of corrosion, electrochemical methods.
- Develop the thermodynamic and kinetic aspects of electrochemistry.
- Design methods for combating corrosion, the principles and methods leading to mitigation of corrosion problems that might occur in engineering practice.

UNIT 1 INTRODUCTION **10 Hrs.**

Definitions of Corrosion, Overall classification of types of corrosion, Basic electrochemistry, Galvanic and electrolytic cells, Potential measurements, EMF and Galvanic series, Galvanic corrosion and bimetallic contacts, Eh – pH diagrams, Cost of Corrosion, Metallurgical properties influencing corrosion.

UNIT 2 TYPES OF CORROSION **10 Hrs.**

Uniform attack, Galvanic, Crevice, Pitting, Inter granular, Selective leaching, Erosion and Stress corrosion, Mechanisms, Testing procedures and Their protection.

UNIT 3 ELECTRODE KINETICS AND POLARIZATION PHENOMENA **10 Hrs.**

Electrode, Solution interface, Electrode kinetics and Polarization phenomena, Exchange current density, Polarization techniques to measure corrosion rates, Mixed potential theory, Activation and diffusion controlled mixed electrodes.

10 Hrs.

UNIT 4 METHODS OF CORROSION PREVENTION AND CONTROL

Design, Coatings and inhibition, Cathodic protection, Stray current corrosion, Passivity phenomena and development of corrosion resistant alloys, Anodic control.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define the basics of corrosion and its electrochemical aspects.

CO2 - Demonstrate the testing procedures for corroding systems.

CO3 - Apply the electrochemical and metallurgical aspects of combating eight forms of corrosion.

CO4 - Inspect the corrosion and provide correct prevention and control method.

CO5 - Evaluate the polarization behavior of corroding systems.

CO6 - Predict the function of corrosion inhibitors.

TEXT/REFERENCE BOOKS

1. M. G. Fontana, Corrosion Engineering (Third Edition) McGraw-Hill Book Company.
2. Denny A Jones, Principles and Prevention of Corrosion (second edition), Prentice-Hall, N. J. (1996)
3. H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY) .
4. P. Roberge, Corrosion Engineering: Principles and Practice (1st Edition),, McGraw-Hill, (2006)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Questions 50 Marks

Part B/Question: Analytical Questions 50 Marks

20CH317T					Polymer Science and Technology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To equip students with basic knowledge of polymer synthesis that will help them to develop new materials.
- To impart the awareness of recent advances in polymer material synthesis.
- To teach the students to understand and evaluate new high-performance and specialty application materials.

UNIT 1 INTRODUCTION TO POLYMER SCIENCE **7 Hrs.**

Classification and nomenclature of polymers, Monomer and functionality, Polymerization and degree of polymerization, Types of molecular weights and its distribution, Molecular Weights determination, Factors affecting molecular weight and molecular weight distribution, Chain-transfer reactions, Thermal and Mechanical properties of polymers, concept of stereochemistry of polymers

UNIT 2 CHEMISTRY OF POLYMERIZATION **10 Hrs.**

Classification of polymerization mechanism, Stepwise polymerization, Kinetics and statistics of linear stepwise polymerization, Radical chain (Addition) polymerization – reaction mechanisms and associated kinetics, Coordination polymerization, Ring opening polymerization, Catalytic polymer systems, techniques of Polymerization: Bulk, Solution, Suspension & Emulsion.

UNIT 3 INDUSTRIAL POLYMER PRODUCTION AND SPECIALITY POLYMERS **11 Hrs.**

Production of bulk polymers: polyethylene, polypropylene, polyvinylchloride, styrene butadiene rubber, polyester and Polyamide (Nylon); **Specialty polymers**: Conducting polymers, Block copolymers, Polymer composites, polyurethanes, Liquid crystalline polymers, Silicones and other inorganic polymers: silicones, polyphosphazenes, polythiazyl. Rubbers: silicones, epichlorohydrin, fluroelastomers, polysulphides, polyurethane, acrylic rubbers and silane-containing polymers.

UNIT 4 POLYMER PROCESSING TECHNIQUES & CONCEPT OF SELF-ASSEMBLY IN POLYMERS **12 Hrs.**

Polymer Processing: Molding, Extrusion, Thermoforming, calendaring, injection molding, Concept of self-asssembly - from primary structure to complex structure, types of self assembly and non-covalent interactions, macromolecular systems via secondary bonding, use of H-bonding and ionic charge to build structures, self-assembled polymers, Molecular Simulations studies of polymers in solutions.

40 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – list & recall the basic concepts of polymer chemistr/y.

CO2 – classify and compare different polymerization reactions and interpret polymerization methods judiciously.

CO3 – Identify and develop the knowledge of different processes of bulk polymers production.

CO4 – discover the importance of speciality polymers for different industrial and day-to-day applications.

CO5 – assess and compare the different techniques of polymer processing in industries.

CO6 – compile the theory of polymer self-assembly and h-bonding for different applications

TEXT/REFERENCE BOOKS

1. Textbook of Polymer Science/ F.W. Billmeyer/ John Wiley 2008
2. Polymer Science/ V.R. Gowarikar/ New Age International 2016
3. Polymer Chemistry/ M.P. Stevens/ Oxford University Press 1999
4. Principle of Polymerization/ G Odian/ Wiley 2004

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: 12 short answer questions of 2 marks each 24 Marks

Part B/Question: 6 long answer questions 76 Marks

20CH318T					Biochemical Engineering and Bio-energy					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the fundamentals of kinetics and mass transfer aspects of enzyme catalyzed reaction
- To understand the principles of designing of bioreactors and acquainted with product purification strategies
- To understand the process technology of various important biochemical products

UNIT 1 – KINETICS AND MASS TRANSFER ASPECTS OF ENZYME SUBSTRATE INTERACTION 12 Hrs.

Introduction to Biochemical Engineering, Enzyme kinetics, Mechanistic models for enzyme kinetics, Michaelis-Menten Kinetic model, Determination of rate parameters, Effects of Ph and temperature, Inhibited enzyme kinetics, Immobilized enzyme systems: effects of intra and inter-phase mass transfer on enzyme kinetics

UNIT 2 – DESIGN ASPECTS OF BIOCHEMICAL REACTOR 12 Hrs.

Stoichiometric aspects of biological process, Concept of Yield coefficient, Reactor configurations: Enzyme reactors, Batch growth of micro-organisms, Continuous culture of microorganism, CSTF with recycle of biomass, Cascade CSTF, Plug flow fermenters, Aeration and Agitation Introduction, Balance between oxygen demand and supply, Scale up and Scale down.

UNIT 3 – PRODUCT RECOVERY AND PURIFICATION STRATEGIES 8 Hrs.

Bioproduct Recovery and Purification: Strategies to recover and purify products, Separation of insoluble products- Filtration, Centrifugation, Coagulation and Flocculation, Disruption of cells, Separation of soluble products- Liquid - Liquid Extraction, Adsorption, Chromatography, Dialysis, RO etc.

UNIT 4 – BIOCHEMICAL PROCESS INDUSTRIES 8 Hrs.

Introduction to biochemical process industries: Production of Ethanol, Lactic acid, Citric acid, Penicillin vitamins, alkaloids, enzymes, lactic acid. Etc, Environmental biotechnology: Biological waste water treatment, Biogas Production, Biomethane and Biohydrogen, Biorefinery.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Identify and outline the various modelling strategies to express the kinetics of enzyme catalyzed reaction.

CO2 -Understand the various mass transfer and reaction engineering aspects of enzyme inhibition and immobilization

CO3 - Determine the various reactor configurations as well as to implement the design fundamentals of bioreactors.

CO4 - Illustrate the different mechanism of separation of soluble and insoluble biochemical products

CO5 - Review the conversion processes of the various industrially important biochemical products.

CO6 – Facilitate the various applications of biochemical engineering in allied chemical and energy sector

TEXT/REFERENCE BOOKS

1. J. E. Baley, D. F. Ollis, Biochemical Engineering Fundamentals, 2nd ed. McGraw Hill, 1986

2. Coulson and Richardson's Chemical Engineering- Vol-3, Chemical and Biochemical Reactors and process control, Asian Book Pvt. Ltd.

3. M.L.Shuler, F.Kargi, Bioprocess Engineering: Basic concepts, PHI Learning Private Ltd.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Questions 50 Marks

Part B/Question: Analytical Questions 50 Marks

20CH319T					Novel Separation Processes					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Students will understand fundamental of separation processes
- Students will understand the principles and applications of super critical fluid extractions.
- Students will learn about the different types of membrane separation processes.
- Students will acquire knowledge of surfactant based and other separation processes.

UNIT 1 SUPER CRITICAL FLUID EXTRACTION **8 Hrs.**

Fundamentals of separation processes, Separation factor, various separation processes and identification of novel separation process, Introduction of Supercritical Fluid Extraction (SFE), Physiochemical principles, thermodynamics modelling, process synthesis and energy analysis.

UNIT 2 MEMBRANE PROCESSES **8 Hrs.**

Brief review, module design and module characteristics, plant design and operation, Reverse osmosis, ultrafiltration and microfiltration, pervaporation.

UNIT 3 SURFACTANT BASED SEPARATION **6 Hrs.**

Fundamentals of surfactants at surfaces and in solution, liquid membrane permeation, foam separations, micellar separations.

UNIT 4 OTHER SEPARATION PROCESSES **6 Hrs.**

Chromatographic separation and ion exchange techniques, Centrifugal separation processes and their calculations, Electrophoretic separation processes.

Max. <40> Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define the basic principles of different separation processes.

CO2 - Explain the complete details including problem-solving approach and the applications of theory learned regarding SFE, Membrane Separation, Surfactant Based separation and other separation processes.

CO3 - Apply the principles of separation processes like SFE, Membrane Separation, Surfactant Based separation and other separation processes.

CO4 - Analyze the problems related to SFE, Membrane Separation, Surfactant Based separation and other separation processes.

CO5 - Estimate desired separation from the give separation processes.

CO6 - Design separation modules based upon the conditions given in the problem statement.

TEXT/REFERENCE BOOKS

1. R. Rautenbach, and R. Albercht, Membrane Processes, John Wiley & Sons, 2004
2. R W Rousseau, Handbook of Separation Process Technology, John Wiley & Sons
3. M. A. McHugh and V. J. Krukonis, Supercritical Extraction, Butterworths, 2005
4. R. G. Gutman, Membrane Filtration, Adam Hilger, Bristol, 1997.
5. J. F. Scamehorn, and J. H. Harwell, Surfactant Based Separation Processes, Surfactant Science Series, Vol. 33, Marcel – Dekkar Inc., New York.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: <> Marks

Part B/Question: <> Marks

					Industrial Training					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2					--	--	--			100

COURSE OBJECTIVES

- To provide comprehensive learning platform to students where they can enhance their ability skills and become job ready along with real corporate exposure.
- To enhance students' knowledge in one particular technology
- To increase self-confidence of students and help in finding their own proficiency
- To cultivate students' leadership ability and responsibility to perform or execute the given task
- To provide learners hands on practice within a real job situation

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Relate greater clarity about academic and career goals, lifelong learning skills, make a gradual transition from academia to career

CO2 – Demonstrate understanding of administrative functions and company culture

CO3 – Develop the ethical basis of professional practise in relevant industry and become updated with all the latest changes in technologies in world

CO4 – Examine the role of the professional/ specialist/manager/supervisor confidently in the chemical industry

CO5 – Support the work in industrial training in formatted report explaining and describing the experience

CO6 – Construct the adequacy of training and have ability to identify, formulate and model problems and find engineering solution based on a systems approach.

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

Semester 7

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 7	PC	20CH401T	PC-13 (Process Modeling and Optimization)	3	0	0	3	3
	PC Lab	20CH401P	Process Modeling and Optimization Lab	0	0	2	2	1
	PC	20CH402T	PC-14 (Plant Design and Process Economics)	3	0	0	3	3
	PC	20CH403T	PC-15 (Transport Phenomenon)	3	0	0	3	3
	PCE	20CH323T	CE-6 (Catalysis and Surface Sciences)	2	0	0	2	2
		20CH324T	Computer Aided Process Design	2	0	0	2	2
	PCE	20CH404P	Catalysis and Surface Sciences-Lab	0	0	2	2	1
		20CH405P	Computer Aided Process Design-Lab	0	0	2	2	1
	PCE	20CH406T	Dyes & Pigments	3	0	0	3	3
		20CH407T	Process Plant Safety Health & Hygiene	3	0	0	3	3
		20CH408T	Project Management	3	0	0	3	3
		20CH409T	IPR	3	0	0	3	3
	Project	20TP420	Seminar	0	0	0	0	3
				14	**0**	**4**	**18**	**19**

20CH401T					Process Modeling and Optimization					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	2	4	5	25	50	25	--	--	100

COURSE OBJECTIVES

- To make the students understand the various essential features of physical and mathematical modelling and their applications of chemical engineering processes.
- To develop the mathematical models and solutions for these models using analytical and numerical solutions. The students will also learn to use the commercial process simulators.
- To provide an overview of state-of-the-art optimization algorithms, the theoretical principles that support them, and to provide students with the modelling skills necessary to describe and formulate optimization problems.
- To develop the technical skills for solving several types of practically relevant optimization problems arising in process systems engineering.

UNIT 1 – OVERVIEW OF MODELING OF CHEMICAL PROCESSES 11 Hrs.

Introduction to mathematical modelling: Uses of Mathematical models, Scope of coverage, Principles of formulation. Fundamental laws: continuity equations, energy equations, equations of motion, transport equations, equations of state, equilibrium, chemical kinetics

UNIT 2 – MATHEMATICAL MODEL DEVELOPMENT 15 Hrs.

Examples of mathematical models of chemical engineering systems: Introduction, series of Isothermal constant-holdup CSTRs, CSTRs with variable holdups, two heated tanks, gas phase, pressurised CSTRs, Non isothermal CSTR, single component vaporizer, multi-component flash drum, batch reactor, reactor with mass transfer.

UNIT 3 – INTRODUCTION OF OPTIMIZATION AND TRADITIONAL OPTIMIZATION TECHNIQUES 13 Hrs.

Single variable optimization algorithms: Optimal problem formulation, Optimization algorithms, Optimality criteria, Bracketing methods, region elimination methods, point-estimation method, Gradient based methods, root finding using optimizing technique. Multi variable optimization algorithms, Unidirectional search, direct search methods Linearized search techniques, feasible direction method, Generalized reduced gradient method, Gradient projection methods: Big-M Method, Two Phase method, Simplex method, graphical method and Sequential simplex method

UNIT 4 – NON-TRADITIONAL OPTIMIZATION TECHNIQUES 13 Hrs.

Specialized algorithms: Integer programming, Geometric programming. Non-traditional optimization algorithms: Genetic algorithms, simulated annealing, Differential evolution, Global optimization, Optimization using Neural Network

Max. 52 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Relate the important physical phenomena from the problem statement, various types of models such as empirical models, hybrid models etc.

CO2 - Translate chemical process systems into mass balance, energy balance and momentum balance formulations

CO3 - Develop model equations for the given system, demonstrate the model solving ability for various processes/unit operations, develop various models for various systems such as reactor, distillation column, heat exchangers and analyze their behavior.

CO4 – Be able to theoretically examine different types of optimization problems.

CO5 - Assess the utilization of different optimization techniques.

CO6 - Ability to solve various multivariable optimization problems.

TEXT/REFERENCE BOOKS

1. T. F. Edgar and D. M. Himmelblau, Optimization of Chemical Processes, 2nd Edition, McGraw Hill, 2001
2. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, Optimization of Chemical Processes, 2nd Edition, McGraw-Hill, 2001
3. B.V. Babu, Process Plant Simulation,Oxford Higher Education2007
4. J. K. Sharma, Operations research Theory and Applications, MacMillan, 5th edition

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: <> Marks

Part B/Question: <> Marks

20CH401P					Process Modeling and Optimization Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	1	1.5	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To know the fundamentals of computer aided calculations
- To understand the basics of Matlab, GAMS and CFtool
- To learn the importance of softwares in optimization
- To involve in writing codes and development of models for the given data
- To practice about solving ordinary differential equations

LIST OF EXPERIMENTS **34 Hrs.**

1. Introduction to Matlab
2. Linear regression derivation and coding in Matlab with examples
3. Multiple linear regression derivation and coding in Matlab with examples
4. Non- linear regression derivation and coding in Matlab with examples
5. Use and practice of CFTOOL in Matlab
6. Matlab Coding of Ordinary Differential equations using inbuilt function of ODE
7. Basic understating about different aspects (training, learning, adaptive nature, neurons, transfer functions, etc) of neural network theory and applications were discussed and applied with solving examples using ANN toolbox in Matlab
8. Introduction to GAMS and understanding the basic syntax
9. Solving various problems in GAMS: Linear and Integer Programming problems majorly
10. Matlab Core Coding of Ordinary Differential equations without using inbuilt function of ODE. (RK-1,2,3,4 methods)
11. Practising GAMS using the inbuilt codes in the model libraries
12. Practise of various chemical engineering problems related to ODEs, linear and non-linear algebria and regression in Polymath

Max. 34 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Tell the basics of Matlab, GAMS and CFtool

CO2 -Compare the process calculations obtained with various softwares

CO3 - Choose best fit models for the given experimental data

CO4 - Simplify the complex data into a set of equations and graphs

CO5 - Explain linear and non-linear programming

CO6 - Build new models to minimize the error in the predictions

TEXT/REFERENCE BOOKS

1. Steven C Chapra, Raymond P Canale, Numerical methods for engineers, 7th Edition, McGraw-Hill, 2010
2. Rudra Pratap, Getting started with Matlab, Oxford

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

20CH403T					Transport Phenomena					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3			3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To Provide mathematical framework in order to model a transport problem.
- To provide analytical skills to solve simple transport problems.

UNIT 1 TRANSPORT FLUXES **8 Hrs.**

the role of transport phenomena in the understanding of chemical engineering, equation of motion, viscosity and mechanism of momentum transport, thermal conductivity and mechanism of energy transport, diffusivity and mechanism of mass transport.

UNIT 2 SHELL BALANCE **10 Hrs.**

Cartesian, cylinderical and spherical coordinate systems and their shells, derivation of momentum transport equation, heat transport equation and mass transport equation using shell balance in different coordinate systems. Different types of Boundary conditions. Solving simple transport problems by using shell balances.

UNIT 3 EQUATIONS OF CHANGE **12 Hrs.**

Frame independent form of Momentum, Enenrgy and Mass transport equations. Dimensional analysis and different flow regimes. Solving transport problems by using Navier-Stokes, Energy and Mass transport equations in different coordinate systems. Coupling between various equations and breif introduction to CFD.

UNIT 4 MORE THAN ONE INDEPENDENT VARIABLE SYSTEMS **10 Hrs.**

More than one independent variable systems: Velocity distribution, temperature distribution, concentration distribution. Introduction to Turbulent Flow.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1. Define the momentum, energy and mass fluxes and their individual components.

CO2. Compare various coordinate systems and accordingly identify the direction of forces and fluxes on given type of shell.

CO3. Application of shell balance methods to find out equations of momentum, energy and mass transport in terms of flux quantities.

CO4. Simplifying various transport problems by using various equations of change.

CO5. Choose boundary conditions and mathematical techniques to solve equations of change.

CO6. Compose and formulate moderately complex transport problems from scratch.

TEXT/REFERENCE BOOKS

1. R. B. Bird, W. E Stewart, and E. N. Lightfoot, Transport Phenomena, Edition-I John Wiley, 1960.
2. L. Garry Leal, Advanced Transport Phenomena, Cambridge University Press, 2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Problems with multiple questions of 2-3 marks 50-60 Marks

Part B/Question: Detailed analytical problems 40-50 Marks

20CH323T					Catalysis and Surface Sciences					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	2	3	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To provide a brief review to chemical kinetics, catalysis and applications
- To provide insight to the surface chemistry and diffusion fundamentals in catalytic reactions
- To give a wholesome picture on catalytic reactions and catalytic reactors and modelling
- To give details on catalyst synthesis, characterization and instrumentation involved

UNIT 1 INTRODUCTION TO CATALYSIS AND REVIEW OF CHEMICAL KINETICS **07 Hrs.**

Review of chemical kinetics, ideal reactors and non-ideality, rate equations and design, review on catalysis, catalytic processes, industrial catalysis, acid base catalysis, homo-hetero catalysis, catalysts in pollution control abatement, bio catalysis, bio-mimetic catalysts

UNIT 2 SURFACE CHEMISTRY AND DESIGN OF CATALYSTS **07 Hrs.**

Surfaces as defects in crystalline materials, adsorption and chemisorption, desorption, structure of solid surfaces, electronic properties of structures, acid base properties. redox properties, surface analysis: techniques and methods, design of catalysts – effect of metal, effect of support, morphology of catalyst, strong metal support interaction (SMSI)

UNIT 3 CATALYST PREPARATION AND CHARACTERIZATION **08 Hrs.**

Synthesis methods; conventional methods, novel techniques for micro porous and meso porous material, soft and hard templating methods, analytical equipments to study the properties of catalytic surfaces: temperature-programmed methods, spectroscopic methods; surface area analysis, microscopic techniques, crystallographic study

UNIT 4 CATALYTIC REACTORS AND MODELING **08 Hrs.**

Multiphase catalytic reactors; fixed bed reactor, trickle bed reactor, fluidized bed reactor, slurry reactor, deactivation of catalysts, Fundamental modeling for catalytic processes, modelling with deactivation, design of reactors for gas-solid reactions, heterogeneous data analysis for reactor design, research case studies on modelling and catalytic reactor.

COURSE OUTCOMES

CO1 – Recall the basics of kinetics and catalysis
CO2 – Illustrate and Interpret surface phenomenon of catalytic properties
CO3 – Utilize proper synthesis method and characterize the catalysts by different instrumental analysis
CO4 – Compare the reactor performance with or w/o internal of external mass transfer limitations
CO5 – Appraise the performance of different reactors in multi phase systems
CO6 – Design and Develop catalytic systems for specific purpose of real life problems

TEXT/REFERENCE BOOKS

1. H. S. Fogler, “Elements of Chemical Reaction Engineering”, 3rd Ed, New Delhi-Prentice Hall, 2001
2. O. Levenspiel, “Chemical Reaction Engineering” Willey Eastern, 3rd Ed., 2000
3. J. M. Smith, “Chemical Engineering Kinetics”, 3rd Ed., McGraw- Hill, 1988
4. Krijn P. de Jong, “Synthesis of Solid Catalysts”, Wiley, 2009

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical knowledge and understanding 40 Marks
Part B/Question: Problem Solving, Design and Analysis 60 Marks

20CH404P					Catalysis and Surface Chemistry (Lab)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	2	4	5	--	--	--	50	50	100

COURSE OBJECTIVES

- Understand the different catalyst synthesis procedure and preparation procedure
- To give students a hands-on experience with the analytical instrument for characterization
- To make student analyze the data obtained the analytical instrument and assessment therein

LIST OF EXPERIMENTS

1. Synthesis of Oxides by Sol Gel Method / Precipitation
2. Synthesis of Micro porous MOF - ZIF-8 material
3. Synthesis of Micro-Meso Porous MCM-41
4. Synthesis of Mesoporous Silica / Oxides – Soft Templating and Hard Templating
5. Hand-on experience with FTIR Technique and analyzing results
6. Hand-on experience with SEM Analysis and analyzing results
7. Hand-on experience with XRD Analysis and analyzing results
8. Hand-on experience with TG-DTA Analysis and analyzing results

COURSE OUTCOMES

CO1 – Choose a specific method and get the skill of catalyst synthesis
CO2 – Compare the different methods of synthesis and different parameters affecting the synthesis
CO3 – Experiment with the synthesis procedure of catalyst to cater the changes need for functionalization
CO4 – Examine the data obtained from the analytical equipments and get the knowhow of operations
CO5 – Assess the data obtained from the catalyst characterization and interpret the catalyst properties
CO6 – Develop an ability to work on an instrument, synthesize catalysts to cater the requirement

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Practical Performance, Report Submission 50 Marks
Part B/Question: Written Exam and Practical Viva 50 Marks

20CH324T					Computer Aided Process Design Theory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Create, select, and apply appropriate modern software tools including modelling to complex chemical engineering processes with an understanding of the limitations
- Identify the components of physical and thermodynamic property models and Learn software aspects of rapid solution.
- Learn application and solve chemical process flowsheeting problems more quickly, efficiently and successfully using computer aided tools
- Learn concepts of process integration and to solve heat exchanger network problems.

UNIT 1 BASICS OF COMPUTER AIDED PROCESS DESIGN **8 Hrs.**

Integrated process plant design with computer aided tools, BFD, PFD, P&ID, pre-FEED, FEED stages. Commercial Process simulators: components and architecture, blocks and streams library, CAPD problem formulation and solvers, model equations and Degrees of freedom, Design, rating, specification and optimization formulation; sequential modular and Equation oriented approach, tearing of stream, scopes of Aspen Plus/hysis simulator, flowsheeting problem solving using design specifications, sensitivity analysis,

UNIT 2 PHYSICAL PROPERTY, METHODS AND MODELS **7 Hrs.**

Computerized physical property, methods and models, ideal and non-ideal model selection criteria, Thermodynamics databanks; estimation of activity coefficient and EOS model parameters using data regression system, Case studies and flow sheeting problem solving of mass and energy balance, phase equilibrium, chemical equilibrium and reactor design using commercial software (Aspen Plus).

UNIT 3 COMPUTER SIMULATION OF MASS AND HEAT TRANSFER EQUIPMENT'S **8 Hrs.**

Design and simulation of distillation and absorption column, equilibrium and rate-based approach; design, rating and simulation of heat exchangers, Petroleum fractionation columns, Various unit models available in Aspen Plus library and their usage.

UNIT 4 INTRODUCTION TO PROCESS INTENSIFICATION **7 Hrs.**

Process Integration, Heat Exchanger networks (HEN), cold, hot composite and Utility curves, pinch point analysis, Solving HEN problems using Aspen Plus

Max. 30 Hrs.

COURSE OUTCOMES :

On completion of the course, student will be able to

CO1 - Understand, create, select, and Describe computer tools for chemical process simulation

CO2 - CHOOSE AND apply blocks and streams from a simulators library to make a process flow sheet

CO3 - apply stream and block parameters to a chemical unit operation for computer simulation

CO4 - determine flow sheeting solution by using design specification and sensitivity analysis approach

CO5 - solve process design and simulation calculations of various unit operations using Aspen software

CO6 – Outline process intensification and construct Heat exchanger networks

TEXT/REFERENCE BOOKS

1. Chemical Process design and Simulation by Juma Haydary, 2019 John Wiley &sons, Inc
2. Introduction to Chemical Engineering Computing" by Bruce A. Finlayson Wiley Interscience,
3. Process Simulation and Control using Aspen by Amiya K. Jena. PHI Learning PVT LTD

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Questions 50 Marks

Part B/Question: Analytical Questions 50 Marks

20CH405P					Computer Aided Process Design Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	4	2	4				50	50	100

COURSE OBJECTIVES

- Create, select, and apply appropriate modern software tools including modelling to complex chemical engineering processes with an understanding of the limitations
- Identify the components of physical and thermodynamic property models and Learn software aspects of rapid solution.
- Learn application and solve chemical process flowsheeting problems more quickly, efficiently and successfully using computer aided tools
- Learn concepts of process integration and to solve heat exchanger network problems.

LIST OF EXPERIMENTS

Process Simulation Exercises Using Aspen Plus:

Construct a simulation sheet with process blocks and streams

1. Physical property estimation, Critical properties, ΔH, ΔG etc.
2. Thermodynamic property estimation and analysis, T-xy, P-xy and xy diagrams
3. Regression, Vapour-liquid equilibrium data, Flash separation, dew point, bubble point,
4. Mass and Energy balances calculations in a flow sheet with mixers, splitters, reactors
5. Flow sheet Simulation by applying design specification, and stativity analysis
6. heat exchangers, design, rating, calculation with TEMA specification
7. Thermal analysis, simulation of heat exchanger
8. process simulations of Kinetic reactors (Batch, CSTR, PFR);
9. Gibbs reactor, equilibrium reactor, yield reactors
10. Design and Simulation of distillation and absorption column,
11. Azeotropic distillation using pressure swing
12. Costing and economic analysis; (case study: ammonia production process)
    - Open loop process
    - Closed loop process
13. Dynamic simulation
14. Solving Heat exchanger network

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Estimate, physical and thermodynamic properties of new organic compounds.
CO2 – Estimate and list mass and energy balance of a process flow sheet using Aspen plus
CO3 – Construct thermodynamic phase diagrams using activity coefficient and Equation of state models using computer simulation.
CO4 - Determine flow sheeting solution by using design specification and sensitivity analysis approach
CO5 - Solve process design and simulation calculations of various unit operations using Aspen software
CO6 - Demonstrate Heat exchanger networks using Aspen Process simulators.

TEXT/REFERENCE BOOKS

1. Chemical Process design and Simulation by Juma Haydary, 2019 John Wiley &sons, Inc
2. Aspen Plus: All Manuals and PDF documents

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Viva Voce Examination	50 Marks
Practical Examination	50 Marks

20CH406T					Dyes and Pigments					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To make the students understand chemistry of several intermediates used for chemical industry in particular to Dyestuff industry
- To make them understand the unit processes and relevance in chemical industries
- To enable to analyse and identify the suitable manufacturing method and accordingly choose the supplementary processes to produce intermediates
- To develop capacity to understand proper selection of the chemical processes based on economy and ecological aspects

UNIT 1 BASICS OF DYES AND PIGMENTS **9 Hrs.**

History of colorants; Definition and function: Dyes, Pigments, fillers, toner and lakes, classifications of organic and inorganic pigments, characterization and properties; concept of colour mixing theory

UNIT 2 RAW MATERIALS AND PROCESSING **9 Hrs.**

Feedstock for organic pigments, synthesis of organic pigments and applications, Processing and synthesis of inorganic pigments ,Fillers pigments: Sources, manufacture, properties and applications

UNIT 3 PIGMENTS **12 Hrs.**

Manufacturing, sources, properties and compositions, applications and economic aspects of industrially important pigments: White pigment, black pigment, blue pigments and green pigments

UNIT 4 DYES **12 Hrs.**

Manufacturing, sources, types, properties, commercial applications of industrially important organic dyes and pigments: Azo pigments, polycyclic pigments
Health and Safety Aspects

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 - To define the basics of dyestuff industry and name the terms like types and classifications
CO2 - To understand basic raw materials utilized and processes used
CO3 - To utilize the basic understanding to select suitable processes for production
CO4 - To analyse the various aspects of synthesis of different intermediates used in dyes and pigment industries
CO5 - To compare the various technology for dyes and pigment production process
CO6 - To discuss economic and safety aspects of dyes and pigment production process

TEXT/REFERENCE BOOKS

1. R M Christie, Color Chemistry, Royal Society of Chemistry, 2001
2. A Gürses, M Açıkyıldız, K Güneş, M. S Gürses, 'Dyes And Pigments', Springer Briefs In Molecular Science: Green Chemistry For Sustainability, Edited By Sanjay Sharma, Springer, 2016
3. G Buxbaum, Industrial Inorganic Pigments, Third Edition, Wiley-Vch, 2005
4. W. Herbst, K. Hunger, Industrial Organic Pigments, Wiley-Vch, 2004
5. K. Hunger, Industrial Dyes: Chemistry, Properties, Applications, WILEY-VCH, 2003

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: < Question with no choice > <40> Marks
Part B/Question: < Question with choice > <60> Marks

20CH407T					Process Plant Safety Health and Hygiene					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To give an essence of process plant safety, health, industrial hygiene and general safety
- To accustom to fire and explosion hazards and its prevention
- To learn hazard identification and risk assessment, evaluation, control and management
- Learn about the disasters as case study and understand the ethical and technological flaws

UNIT 1 INDUSTRIAL SAFETY AND STANDARDS **10 Hrs.**

Basics of safety, accident and loss statistics, nature of accident process, inherent safety in process, personal safety aspects, national and international standards for health and safety, acts and legislation (OSHA, ISO standards), REACH regulations, case studies of major disasters

UNIT 2 FIRE AND EXPLOSION HAZARDS **10 Hrs.**

Fire triangle, flammability characteristics of fluids, flammability diagram, methods of fire and explosion, inerting, static electricity, ventilation, sprinkler systems, explosion proof instruments and equipments and control rooms, miscellaneous concepts of fire prevention

UNIT 3 INDUSTRIAL HYGIENE AND MISCELLANEOUS **10 Hrs.**

MSDS and their significance, industrial hygiene, evaluation, control and quality management of industrial hygiene, indoor air quality management, Miscellaneous aspects of industrial safety - Lock out Tag out, Electrical Safety, Confined Space Entry, Hotwork safety, Work at Height, PPE's, Lab Safety

UNIT 4 HAZARD IDENTIFICATION AND RISK ASSESSMENT **10 Hrs.**

Hazard identification, hazard analysis, hazard surveys, hazard & operability study, analytical and quantitative risk assessment, scenario analysis, failure mode effect analysis, fault tree analysis, event tree analysis, review of probability theory, layers of protection analysis.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Relate to the different standards and legislations for industrial health and safety

CO2 – Compare and interpret the fire and explosion hazards, disastrous effects and prevention

CO3 – Identify the issues with industrial hygiene and work on control and management measures

CO4 – Analyze the different disasters in chemical process industry and criticize shortcomings

CO5 – Evaluate the workplace situations and perform hazard identification and risk assessment

CO6 – Develop a safety perspective and give opinion from ethical and technological view point

TEXT/REFERENCE BOOKS

1. F. P. Lees, Loss Prevention in the Process Industries, Second Edition, Butterworth, 1996
2. D. A. Crowl & J. F. Louvar, Chemical Process Safety: Fundamentals with Applications, PHI, 1990
3. Paul Erickson, Practical Guide to Occupational Health & Safety, Academic Press, 1990

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical knowledge and understanding 60 Marks

Part B/Question: Problem Solving, Case Studies and Analysis 40 Marks

20CH408T					Project Management					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Acquire and fine-tune the skills and techniques for the 4 phases in the life cycle of a typical project:
- Gain an understanding of essential principles associated with effective project management
- Understand and apply methods for solving common difficulties associated with project management.

UNIT 1 Introduction to Project Management **10 Hrs.**

Definition of project, Project Management Vs. General Management, The life cycle of projects, Confronting Uncertainty, Project portfolio process, An approach to Project Formulation. The PM's Roles, The PM's responsibility to the project, Selection of a Project Manager. Fitting projects into the parent organization, The project team.

UNIT 2 Planning and Budgeting the Project **10 Hrs.**

The contents of a project plan, The planning process- detailed overview, The work breakdown structure and other aids, Multidisciplinary Teams-Balancing Pleasure and Pain. Methods of budgeting, Cost estimating, Improving Cost Estimates,
Budget Uncertainty and risk management

UNIT 3 Scheduling and Allocating the Resources to the Project **10 Hrs.**

PERT and CPM Networks, Project uncertainty and risk management, Simulation, The Gantt chart, Extensions to PERT/CPM. Expediting a Project, Resource Loading, Resource Leveling, Allocating Scarce resources to projects.

UNIT 4 Monitoring and Controlling the Project **10 Hrs.**

Project Monitoring and Control: Project Work Measurement, Performance Measurement, Earned Value Management, Estimate Revision, control of overrunning of project from time and cost. Project Closure and Review: Performance Evaluation – Scope, Time and Cost, Performance of Teams, Lessons Learnt, Project Closure Report

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand key concepts of project management and project lifecycle

CO2 - Ability to analyze the principles of management, planning, specifications and requirements.

CO3 - Understanding the processes involved in the effective planning and subsequent management of projects.

CO4 - Construct the key stages of managing projects, scheduling of tasks, risk analysis, the role of the project manager through various techniques such as CPM, PERT, Gantts chart, etc.

CO5 - Develop increased awareness of available resources to further develop project management skills.

CO6 - Elaborate new knowledge to their own projects and set realistic goals for moving forwards

TEXT/REFERENCE BOOKS

1. Maylor, Harvey (2003) Project Management, 3/e, Pearson, New Delhi
2. Pinto, Jeffrey K. (2009) Project Management: Achieving Competitive Advantage and MS Project, 1/e, Pearson.
3. Project Management and Appraisal by Sitangshu Khatua (Oxford)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Questions	65 Marks
Part B/Question: Analytical Questions	35 Marks

20CH409T					Intellectual Property Rights					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the basics importance of Intellectual property rights.
- To understand the concept of writing paper developing a Research Proposal and patent.
- To learn about the basic knowledge for Process of Patenting and Development.
- Learn to understand the Scope of Patent Rights, Licensing and transfer of technology

UNIT – 1: INTELLECTUAL PROPERTY RIGHTS (IPR) – AN INTRODUCTION **9 Hrs.**

Basic concept of Intellectual Property, Characteristics and Nature of Intellectual Property right, Justifications for protection of IP, IPR and economic development

UNIT – 2: PUBLICATIONS & PATENTS **10 Hrs.**

Effective technical writing: how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT – 3: UNDERSTANDING INTELLECTUAL PROPERTY RIGHTS (IPR) **10 Hrs.**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT – 4: PATENTS & COPYRIGHTS **10 Hrs.**

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, Traditional knowledge Case Studies, IPR and IITs.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Find the importance of Intellectual property.
CO2: Show the ability to write paper developing a Research Proposal and patent.
CO3: Apply the knowledge for Process of Patenting and Development
CO4: Distinguish between the Scope of Patent Rights, Licensing and transfer of technology.
CO5: Access and understand of New Developments in IPR.
CO6:- Develop the technique for IPR protection provides and follow the research ethics.

TEXT/REFERENCE BOOKS

1. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
2. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
3. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Theoretical Questions 50 Marks
Part B/Question: Analytical Questions 50 Marks

20TP410					Seminar					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	-	3	-	-	-	-	--	--	100

COURSE OBJECTIVE:

Seminar course is a Program requirement wherein under the guidance of a faculty member a student is expected to do an in depth study in a specialized area by doing literature survey, understanding different aspects of the problem and arriving at a status report in that area.

CONTENT:

While pursuing the seminar course, the student is expected to learn investigation methodologies, study relevant research papers, correlate work of various authors/researchers critically, study concepts, techniques, prevailing results etc., analyze it and present a seminar report. It is mandatory to give a seminar presentation before a panel constituted for the purpose. The grading is done on the basis of the depth of the work done, understanding of the problem, report and presentation by the student concerned.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 Outline the in depth study of a specialized research area
CO2 Understand the methodologies of carrying out a literature survey on a given topic.
CO3 Articulate and review the major findings of relevant literatures
CO4 Deduce the research objective and to identify the knowledge gap
CO5 Illustrate the research findings in the form of technical report and presentations.
CO6 Build up good oral and written communication skill

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Seminar evaluation	50 Marks
Part B/Question: Seminar work	50 Marks

Semester 8

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 8	Project	20TP420	Major Project/ Comprehensive Project	0	0	0	0	13

20TP420					Project					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	-	13	-	-	-	-	-50-	-50-	100

COURSE OBJECTIVES

- A project and dissertation are required to provide each student with the opportunity for growth and with maturity in independent professional activity.
- To perform an original research project and have a choice of 'broadening material' and 'advanced options' involve experimental, theoretical and/or computational/simulation work
- To choose a research project engineering project, to examine a scientific or technical problem relating to the specialist area.
- To give a flavor of research" by motivating them to work on a research topic/engineering Project topic

CONTENT

- A "project" may consist of a coordinated series of activities or tasks performed by the students of engineering disciplines and can have a good experience by putting in a lot of effort to examine a scientific or technical problem relating to the specialist area.
- It is expected them to know what is the practical application of the knowledge they gained in their courses of studies including Introduction, statement of the problem, scope, limitation applications
- Candidates will undertake as individuals or as a member of a team up to 4 students.
- A designated investigative project which could involve a critical literature review, experimental research and/or development, theoretical modelling, process simulation, and/or the solution of an industrial problem.
- Rigorous planning and scheduling of the project, time management, written and verbal technical communication, interpretation of results and team work will be required Involving creative problem solving. Each engineering design/research, software application or device project should have a clear engineering goal.
- Design projects where as part of a group of students design a complete process plant. This involves equipment design, costing and profitability, control, start up and shut down of the plant and assessment of hazards.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1-Appraise the capability to generate relevant information from literature survey
CO2- Acquire research skills to identify the research problem and Knowledge Gap
CO3- Formulate the Research methodology and design experiments for primary data generation
CO4- Acquaint with the modern research analysis tools, software and instruments.
CO5- Demonstrate the capable of working as individual and team player for designing the research project
CO6- Develop communication skills, both written and oral.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

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

Part A/Question: Project evaluation	50 Marks
Part B/Question: Project work	50 Marks