VI Semester:

S. No.	Course Code	Course Title	Category	Type	Credit	L	T	P
1.	22CHT351	Petroleum Refining and Petrochemicals	PC	Theory	3	3	0	0
2.	22CHT352	Plant Design & Process Economics	PC	Theory	4	3	1	0
3.	22CHT353	Process Equipment Design	PC	Theory	4	3	1	0
4.	22CHT354	Transport Phenomena	PC	Theory	4	3	1	0
5.	22CHP355	Petroleum Lab	PC	Lab	1	0	0	2
6.	22CHP356	Process Equipment Design Lab	PC	Lab	1	0	0	2
7.	22BMT922	Management Principles for Engineers	IC	Theory	3	3	0	0
Total					**20**	**15**	**3**	**4**

SEMESTER – VI

1. **Subject Code: 22CHT351 Course Title: Petroleum Refining and Petrochemicals**
2. Contact Hours: L: 3 T: 0 P: 0
3. Credits: 3 Semester: VI
4. Pre-requisite: Nil.
5. Course Objective: To impart knowledge of petroleum refining, hydrocarbon processing, and derived petrochemicals
6. Course Outcomes: Upon completion of this course, the students will be able to:
   i. Select the appropriate characterization parameters
   ii. Specify the properties of petroleum products
   iii. Attain knowledge of various separation & conversion processes involved in petroleum refining
   iv. Attain knowledge of manufacturing of various petrochemical products
7. Details of Course:

Unit No.	Contents	Contact Hours
1.	**Introduction:** World petroleum resources, Petroleum industries in India, Chemistry and composition of crude oil, Transportation and pretreatment of crude oil, **New trends in refinery**	8
2.	**Classification & Characterization and Crude Oil Distillation:** Classification of petroleum, Characterization of petroleum fractions, Impurities in crude oil, Desalting of crude oil, Atmospheric distillation and vacuum distillation units.	8
3.	**Conversion Processes:** Thermal conversion processes, Conventional vis-breaking and soaker visbreaking process, Coking processes, Catalytic conversion processes, Fluid catalytic cracking, Catalytic reforming, Hydrocracking, Catalytic alkylation, Catalytic isomerization and catalytic polymerization, Distillation Conversion Method.	12
4.	**Finishing Processes:** Sulphur conversion processes, Sweetening processes, Solvent extraction process, Hydro treating process.	4
5.	**Lube oil Manufacturing Processes:** Solvent extraction of lube oil fractions, Manufacture of petroleum wax, Hydro finishing process,	3
6	**Petrochemicals:** Primary petrochemicals such as acetylene, propylene, butadiene, benzene, toluene, naphtha, xylene and their derived polymers.	5

8. **Books:**

(A) Text Books

S.No.	Authors / Name of Book / Publisher	Year of Publication
1	BhaskaraRao, B.K., "Modern Petroleum Refining Processes", 6thEd.,Oxford& IBH Publishing Company Pvt. Ltd. New Delhi.	2018
2	Prasad, R., "Petroleum Refining Technology", Khanna Publishers	1998
3	Mall, I.D. Petrochemical Process Technology, 2nd Ed., Laxmi Publications Private Limited.	2017

(B) Reference Books

S.No.	Authors / Name of Book / Publisher	Year of Publication
1.	Nelson, W. L., „Petroleum Refinery Engineering", 4thEd.,Tata McGraw Hill Publishing Company Limited.	1958
2.	Garry,J.H., "Petroleum Refining Technology and Economics", 5th Ed., CRC Press	2007
3.	Wells G. M., "Handbook of petrochemicals and processes", Gower Publishing	1991
4.	Spitz P. H., "Petrochemicals: The rise of an industry", John Wiley & Sons.	1988
5.	Sarkar, G.N., "Advanced Petroleum Refining", 2nd Ed., Khanna Publishers.	1996

1. **Subject Code: 22CHT352 Course Title: Plant Design and Process Economics**
2. Contact Hours: L: 3 T: 1 P: 0
3. Credits: 4 Semester: VI
4. Pre-requisite: Nil.
5. Course Objective: To provide comprehensive knowledge of various process parameters and economics involved in the development of process and plant design.
6. Course Outcomes: Upon completion of this course, the students will be able to:
   i. Understand the concepts of engineering and economics for chemical plant design and optimization
   ii. Synthesize a process flow sheet for recycle structure
   iii. Calculate different costs involved in a process plant
   iv. Perform breakeven analysis and optimum design of a process
7. Details of Course:

Unit No.	Contents	Contact Hours
1.	**Process Design and Development:** General design considerations, hierarchy of chemical process design, nature of process synthesis and analysis, Developing a conceptual design and finding the best flow sheet, input information and batch versus continuous, Input/output structure of the flow sheet, Recycle structure of the flow sheet, Separation system, Heat Exchanger Networks, Site selection and feasibility analysis.	10
2.	**Project Concept to Commissioning:** Milestones, project execution as conglomeration of technical and non-technical activities, contractual details. Contract: meaning, contents, types of contract. Lump-sum Turnkey (LSTK), Eng, Procurement and Construction (EPC), Eng, Procurement and Construction Management (EPCM). Mergers and Acquisitions	4
3.	**Estimation of Project Cost:** Introduction to various components of project cost and their estimation. Introduction to concept of Inflation, location index and their use in estimating plant and machinery cost. Various cost indices, Relationship between cost and capacity. Relationship between price of a product and project cost and cost of production	8
4.	**Project Financing:** Debt, Equity ratio, Promoter‟s contribution, Shareholder‟s contribution, source of finance, time value of money, annuity. Concept of interest, time value of money, selection of various alternative equipment or system based on this concept. Indian norms, EMI calculations. Depreciation concept, Indian norms and their utility in estimate of working results of project.	6
5.	**Estimate of Profitability Analysis of Project:** Capacity utilization, Gross profit, operating profit, profit before tax, Corporate tax, dividend, Net cash accruals. Project evaluation: Cumulative cash flow analysis	8

	Break-Even analysis, incremental analysis, various ratios analysis, Discounted cash flow analysis	
6.	**Techno-commercial Analysis**: Reading of Balance Sheets and evaluation of Techno-commercial Project Reports, PERT, CPM, bar charts and network diagrams	4

8. **Books:**

(A) Text Books

S. No.	**Authors / Name of Book / Publisher**	**Year of Publication**
1	Douglas, James M., "Conceptual Design of Chemical Processes", McGraw-Hill, International Editions (Chemical Engineering Series), New York, USA.	1988
2	Peters, Max S., K.D. Timmerhaus and R.E. West, "Plant Design and Economics for Chemical Engineers", (5th Ed.,), McGraw-Hill International Editions (Chemical Engineering Series), New York, USA.	2017
3	Mahajani, V.V., "Chemical Project Economics", Macmillan Indian Ltd., New Delhi, India.	2005

(B) Reference Books

S.No.	**Authors / Name of Book / Publisher**	**Year of Publication**
1	Biegler, L.T., I.E. Grossmann and A.W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall (Pearson Education), New Jersey, USA	1997
2	Smith, R. Chemical Process Design and Integration. John Wiley & Sons, West Sussex, England.	2005

1. Subject Code: 22CHT353 Course Title: Process Equipment Design

2. Contact Hours: L:3 T: 1 P:0

3. Credits: 4 Semester: VI

4. Pre-requisite: Heat Transfer, Mass Transfer-I, Mass Transfer-II.

5. Course Objective: To learn the design procedures of process equipment used in chemical process industries

6. Course Outcomes: Upon completion of this course, the students will be able to:

   i. Design shell and tube heat exchanger design
   ii. Design distillation column
   iii. Design packed bed, absorption column
   iv. Design agitated vessels and evaporators

7. Details of Course:

Unit No.	Contents	Contact Hours
1.	**Shell and Tube Heat Exchanger Design:** Kern method; Bell‟s method of Shell-and-tube heat exchanger design, Plate heat exchanger design; Finned tube heat exchanger.	10
2.	**Condenser design:** horizontal condenser, vertical condenser, **Reboilers:** Design of forced-circulation reboiler, kettle and thermosyphon reboilers. **Evaporators:** Design of single and multi-effect evaporators.	10
3.	**Gas-Liquid Contact Systems:** Distillation column, tray hydraulics of sieve and valve trays; Absorption tower, Design of packed bed columns.	10
4.	**Agitated Vessels:** Design of mixing vessels, gas-spraying systems; impellers, propellers, anchors and helical ribbon-type agitators.	10

8. Books:

(A) Text Books

S.No.	Authors / Name of Book / Publisher	Year of Publication
1	Sinnott, R.K., “Coulson and Richardson‟s Chemical Engineering Design,” 6th Ed., Butterworth-Heinemann	2021
2	McCabe, W. L., Smith, J. C. and Harriot, P., “Unit Operations of Chemical Engineering”, 7thEd., McGraw-Hill, NY.	2017
3	Kern, D. Q., “Process Heat Transfer,” McGraw-Hill.	1950

(B) Reference Books

S.No.	Authors / Name of Book / Publisher	Year of Publication
1	Ludwig, E.E., Applied Process Design for Chemical and Petrochemical Plants, Vol. 1,2, and 3, 4th Ed., Gulf Professional Publishing.	2007
2	Evans, F.L., "Equipment Design Handbook for refineries and Chemical Plants," 2nd Ed., Vol. 2, Gulf Publishing.	1980
3	Smith, B.D., "Design of Equilibrium Stage Processes," McGraw-Hill.	1963

1. Subject Code: 22CHT354 Course Title: Transport Phenomena

2. Contact Hours: L:3 T:1 P:0

3. Credits: 4 Semester: VI

4. Pre-requisite: Momentum Transfer Operations, Heat Transfer, Mass Transfer.

5. Course Objective: To impart knowledge about individual and simultaneous momentum, heat and mass transfer, model development along with appropriate boundary conditions.

6. Course Outcome: Upon completion of this course, the students will be able to:

i. Understand the chemical and physical transport processes and their mechanism
ii. Do heat, mass and momentum transfer analysis
iii. Analyze industrial problems along with appropriate approximations and boundary conditions
iv. Develop steady and time dependent solutions along with their limitations

7. Details of Course:

Unit No.	Contents	Contact Hours
1.	Continuum fluids, Newton‟s law of viscosity, Introduction to non-Newtonian fluids, pressure and temperature dependency of viscosity, viscosity of gases at low density.	4
2.	Laminar flow, shell momentum balance, boundary conditions, selected applications. Equations of change for isothermal systems–Navier-Stokes equation, use of equations of change to set up steady state flow problems with Newtonian fluids.	9
3.	Friction factor, similarity and dimensionless parameters, Buckingham pi-theorem, Microscopic mass, momentum and energy balance for isothermal systems, Bernoulli‟s equation, compressible flow, pipe flow.	7
4.	Shell energy balances, Fourier‟s Law of heat conduction, boundary conditions. Application to steady and unsteady problems, convective heat transfer, heat transfer coefficients for forced convection around submerged objects, for free convection for condensation of pure vapours on solid surface.	7
5.	Macroscopic energy balance, Bernoulli‟s Equation, parallel/counter flow heat exchanger – concepts, heating of a liquid in an agitated tank, similarity parameter.	5
6.	Fick‟s Law of diffusion, analogy with heat transfer, shell mass balances, boundary conditions, applications, species continuity equation, conductive mass transfer, mass transfer coefficients, applications, correlations, macroscopic balances and application to solve steady state problems.	8

8. Books:

(B) Text Books

S.No.	Authors / Name of Book / Publisher	Year of Publication
1	Bird, R. B., Stewart, W. E. and Lightfoot, E. N., Transport Phenomena, 2nd Ed., Wiley.	2006

(C) Reference books

S.No.	Authors / Name of Book / Publisher	Year of Publication
1	Batchelor, G. K., An Introduction to Fluid Dynamics, 2ndEd., Cambridge University Press, Cambridge.	2000
2	Slattery, J. C., Momentum, Energy and Mass Transfer in Continua, Robert E. Krieger Publishing Company, New York.	1981
3	Geankoplis, C. J., Transport Processes and Separation Process Principles, 4th Ed., Pearson Education India, New Delhi.	2013

1. Subject Code: 22CHP355 **Course Title: Petroleum Lab**

2. Contact Hours: L: 0 T: 0 P: 2

3. Credits: 1 Semester: VI

4. Pre-requisite: Nil

5. Course Objective: To make students do hands on practice on the characterization of petroleum products.

6. Course outcome: Upon completion of this course, the students will be able to:

i. Hands-on practice for characterization of crude oil and different petroleum products by standard methods

ii. Development of practical skills leading to research initiatives

7. Details of Course:

Experiment No.	Objective	Contact Hours
1.	To determine the vapour pressure of volatiles, non-viscous petroleum products except liquefied petroleum gases using Reid Vapour Pressure Apparatus.	2
2.	To determine the percentage of carbon residue of sample fuel oils using Rams Bottom Apparatus.	2
3.	To find out the smoke point of kerosene oil.	2
4.	To determine Flash Point of sample oil using Penskymarten‟s.	2
5.	To determine Flash point of kerosene using Abel apparatus.	2
6.	Distillation plant and distilled water.	2
7.	To determine Distillation of petroleum products.	2
8.	To determine Aniline Point of given sample.	2
9.	To determine viscosity of petroleum products and lubricants by Saybolt Viscometer Apparatus.	2
10.	To determine Cloud point and pour point of given sample.	2
11.	To determine the calorific value of given sample using bomb calorimeter apparatus.	2

8. Books:

(A) Text & Reference Books

S.No.	Authors / Name of Book / Publisher	Year of Publication
1	Nelson, W. L. Petroleum Refinery Engineering, 4thEd., Tata McGraw Hill Publishing Company Limited	1958
2	Prasad, R., "Petroleum Refining Technology", Khanna Publishers	1996

(B) Reference Books

S. No.	Authors / Name of Book / Publisher	Year of Publication
1	Bhaskara Rao, B.K., "Modern Petroleum Refining Processes", 6thEd., Oxford& IBH Publishing Company Pvt. Ltd. New Delhi.	2018
2	Mall, I.D. Petrochemical Process Technology, 2nd Ed., Laxmi Publications Private Limited.	2017

1. Subject Code: 22CHP356 Course Title: Process Equipment Design Lab

2. Contact Hours: L: 0 T: 0 P: 2

3. Credits: 1 Semester: VI

4. Pre-requisite: Process Equipment Design.

5. Course Objective: To learn the design procedures of process equipment used in chemical process industries

6. Course Outcome: Upon completion of this course, the students will be able to:

i. Design shell and tube heat exchanger design
ii. Design distillation column
iii. Design packed bed, absorption column
iv. Design agitated vessels and evaporators

7. Details of Course:

Experiment No.	Objectives	Contact Hours
1	To study Aspen Plus manual and practice some simple flow sheeting problems. The objectives are: a. To know the various units available (reactor, distillation column, heat exchanger, etc.) b. To know how to connect the input and output ports of the units c. To carry out the flash calculation d. To add the components in the flowsheet	6
2	Material and energy balance calculations	3
3	To calculate the overall heat transfer coefficient of a shell and tube heat exchanger	3
4	To design a shell and tube heat exchanger using Kern‟s method	3
5	To design a shell and tube condenser	3
6	To design a thermosyphon reboiler	3
7	To design a plate heat exchanger	3
8	To carry out flash calculation manually and in Aspen Plus	3
9	To find number of theoretical plates graphically and in Aspen Plus	3
10	Cost estimation and profitability analysis	3

8. Books:

(A)Text Books

S. No.	Authors / Name of Book / Publisher	Year of Publication
1	Sinnott, R.K., "Coulson and Richardson"s Chemical Engineering Design," 6th Ed., Butterworth-Heinemann	2021
2	McCabe, W. L., Smith, J. C. and Harriot, P., "Unit Operations of Chemical Engineering", 7th Ed., McGraw-Hill, NY.	2017
3	Ludwig, E.E., Applied Process Design for Chemical and Petrochemical Plants, Vol. 1, 2, and 3, 4th Ed., Gulf Professional Publishing.	2007

22BMT922 Course Title: Management Principles for Engineers
(To be taught by Department of Management Studies)

	L	T	P	C
Prerequisite: Nil.	3	0	0	3

Course Learning Objectives

By the end of this course student will be able to:

1. Understand the global transition towards a new normal of management.
2. Demonstrate the managerial roles, skills and functions for responsible management.
3. Develop the understanding and cognizance of the importance of Professional management (ethical, responsible, and sustainable).
4. Perform various tools and techniques to be used in the performance of the managerial job.
5. Make effective application of acquired knowledge to diagnose and solve organizational problems and develop optimal managerial decisions.
6. Diagnoseandcommunicatethecomplexitiesassociatedwithmanagementofvariousissues In the organizations and integrate the learning in handling these complexities.

Course Content

- Management:Nature,ScopeandFunctions,ManagerialRolesandLevelsofManagement;
- General Management Processes and Principles, Management Practices;
- Essentials of Planning; Strategies, policies and planning premises; Decision making;
- Organizing: Organizational Design & Organizational Structures;
- Leading: Motivation; Leadership, Power and Authority; Leadership Styles;
- Controlling; Steps and types of Control Process;
- Dimensions of Management: Ethical management, Responsible Management, Sustainable Management.

References

1. Robbins, Stephen P. And Coulter, Mary (2019) 'Management', 14th edition, Prentice Hall of India
2. Laasch, O.(2021).Principles of Management- Practicing Ethics,
3. Responsibility, Sustainability, 2nd Edition, Sage Publications.
4. Hill, Charles WL and McShane, StevenL.(2017)Principles of Management, Special Indian Edition, McGraw Hill Education
5. Robbins,StephenP.,Decenzo,DavidA.&Bhattacharya,Sanghamitra(2009)Fundamentalsof Management, latest edition, Pearson Education
6. Koontz, Harold and Weihrich, Heinz & Ramachandra Aryasri A.(2016).Principles of Management, Latest edition, McGraw Hill Education