PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

B.Tech. CHEMICAL ENGINEERING

REGULATIONS 2016

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM

SEMESTER VII

S.No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	CM16701	Transport Phenomena	3	0	0	3
2	PC	CM16702	Process Dynamics and Control	3	2	0	4
3	PC	CM16703	Process Economics and Management	3	0	0	3
4	PE	CM1625*	Programme Elective II	3	0	0	3
5	OE	CM1690*	Open Elective II	3	0	0	3
Practical							
1	PC	CM16704	Process Control Laboratory	0	0	4	2
2	PC	CM16705	Chemical Reaction Engineering Laboratory	0	0	4	2
3	PC	CM16706	Process Equipment Design II	0	0	4	2
			Total	15	2	12	22

SEMESTER VIII

S.No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	CM16801	Energy Management	3	0	0	3
2	PE	CM1635*	Programme Elective III	3	0	0	3
3	PE	CM1645*	Programme Elective IV	3	0	0	3
Practical							
1	EE	CM16811	Project Work	0	0	12	6
			Total	6	0	12	12

LIST OF ELECTIVES

PROGRAMME ELECTIVE II

S.No	Category	Course Code	Course Title	L	T	P	C
1	PE	CM16251	Oil and Natural Gas Engineering	3	0	0	3
2	PE	CM16252	Polymer Technology	3	0	0	3
3	PE	CM16253	Food Technology	3	0	0	3
4	PE	CM16254	Green Chemistry and Engineering	3	0	0	3

OPEN ELECTIVE II

S.No	Category	Course Code	Course Title	L	T	P	C
1	OE	CM16903	Corrosion Technology	3	0	0	3
2	OE	CM16904	Process Instrumentation	3	0	0	3

PROGRAMME ELECTIVE III

S.No	Category	Course Code	Course Title	L	T	P	C
1	PE	CM16351	Fertilizer Technology	3	0	0	3
2	PE	CM16352	Process Optimization	3	0	0	3
3	PE	CM16353	Computational Fluid Dynamics	3	0	0	3
4	PE	CM16354	Piping Engineering	3	0	0	3

PROGRAMME ELECTIVE IV

S.No	Category	Course Code	Course Title	L	T	P	C
1	PE	CM16451	Process Modelling and Simulation	3	0	0	3
2	PE	CM16452	Modern Separation Processes	3	0	0	3
3	PE	CM16453	Petroleum Refining Engineering	3	0	0	3
4	PE	BA16523	Total Quality Management	3	0	0	3

CM16701 TRANSPORT PHENOMENA 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the fundamentals in transport processes
- study fundamentals to solve real life problems involving transports of momentum
- do energy and mass balance analysis.
- develop steady and time dependent solutions along with their limitations.
- analyse industrial problems along with appropriate boundary conditions.

UNIT I TRANSPORT PHENOMENA - FUNDAMENTALS 9

Importance of transport phenomena - analogous nature of transfer process - basic concepts - conservation laws - Newtonian and non - Newtonian fluids - rheological models - theories of transport properties of gases and liquids effect of pressure and temperature

UNIT II SHELL MOMENTUM TRANSPORT IN LAMINAR FLOW 9

General method of shell balance approach to transfer problems - boundary conditions - momentum flux and velocity distribution in falling film - circular tube - annulus and two adjacent immiscible fluids - creeping flow around a Sphere - Equations of Continuity and Motion - solutions to flow problems.

UNIT III SHELL ENERGY AND TEMPERATURE DISTRIBUTION IN LAMINAR FLOW 9

Heat Conduction with Electrical, Nuclear and Viscous Heat Sources; Heat Conduction - Composite Walls and Cooling Fin; Forced and Free Convection; Use of equations of change to solve heat transfer problems- tangential flow in an annulus with viscous Heat Generation and Transpiration cooling.

UNIT IV SHELL MASS BALANCEAND CONCENTRATION DISTRIBUTION IN LAMINAR FLOW 9

Diffusion - Stagnant Gas Film, Heterogeneous and Homogeneous Chemical Reactions, Falling Liquid Film (Gas Absorption); Diffusion and Chemical Reaction inside a Porous Catalyst.

UNIT V ANALOGIES BETWEEN TRANSPORT PROCESSES 9

Importance of analogy - development and applications of analogies between momentum and mass transfer – Reynolds – Prandtl - Von Karman and Colburn analogies

TOTAL PERIODS 45

COURSE OUTCOMES

On completion of the course the students will be able to

- understand the principles of momentum, heat and mass transport by developing mathematical models to determine respective fluxes
- apply the shell momentum balance and velocity distribution in laminar flow and understand equation of continuity and motion

- use equations of change to solve heat transfer problems; Develop shell balance approach for condensation and convection
- develop solutions for homogeneous and heterogeneous chemical reactors by applying shell mass balance
- analyze the analogy between the transports processes of heat- momentum and mass transfer

TEXT BOOKS

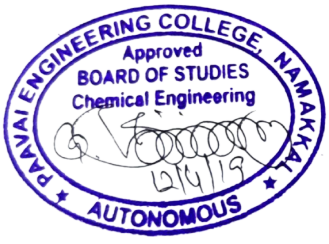
1. R.B. Bird- W.E. Stewart and E.W. Lightfoot, "Transport Phenomena", John Wiley II Edition 2006.
2. J.R. Welty- R.W. Wilson- and C.W.Wicks Rorer G.E- Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer, 5th Edition, John Wiley and Sons, 2007.

REFERENCES

1. L.S.Sissom and D.R.Pitts "Elements of Transport Phenomena", McGraw- Hill, New York- 1972.
2. R.W.Fahien "Elementary Transport Phenomena", McGraw-Hill- New York- 1983.
3. Robert- S Brodkey- Harry C. Hershey, "Transport Phenomena A Unified Approach ", Brodkey Publishing 2003
4. Geankoplis Christie J. "Mass transport phenomena". Holt- Rinehart and Winston- 1972.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1	1					1	2	3
CO2	2	2	1	1	1	1	1	-	-	-	-	1	2	3
CO3	2	2	2	1	1	-	-	-	1	-	-	2	2	3
CO4	3	2	1	2	1	-	-	-	1	1	-	2	2	3
CO5	3	2	2	2	1	-	-	-	-	1	-	2	2	3



CM16702 PROCESS DYNAMICS AND CONTROL 3 2 0 4

COURSE OBJECTIVES

To enable the students to

- have knowledge on Laplace transformation
- have knowledge about first order system and their dynamics in open loop system.
- design various control schemes
- convert the model to a form amenable to solution and analysis
- apply the control system in various processes.

UNIT I LAPLACE TRANSFORMATION 7+6

Laplace transformation and its application in process control- transient response for standard input functions- development of block diagram

UNIT II OPEN LOOP SYSTEMS 9+6

First order system, First order system in series - linearization and its application in systems and their dynamics - transportation lag. Second order system

UNIT III CLOSED LOOP SYSTEMS 12+6

Closed loop control systems - development of block diagram for feed - back control systems - servo and regulatory problems - transfer function for controllers and final control element - principles of pneumatic and electronic controllers - transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE 9+6

Introduction to frequency response of closed-loop systems - control system design by frequency response techniques - Bode diagram - stability criterion - tuning of controllers Z-N tuning rules - C-C tuning rules.

UNIT V ADVANCED CONTROL SYSTEMS 8+6

Introduction to advanced control systems - cascade control - feed forward control - Smith predictor - control of distillation towers and heat exchangers - introduction to computer control of chemical processes.

TOTAL PERIODS 75

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- understand the working principle of various instruments.
- apply the Laplace transforms for different systems
- model and study the system behavior
- check the stability criterion and follow the tuning rules
- gain knowledge on different control stations

TEXT BOOKS

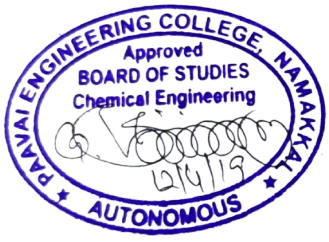
1. Stephanopoulos. G. “Chemical Process Control”, Prentice Hall of India- 2003
2. Donald R Coughnowr “Process Systems Analysis and Control”, 3rd Edition. McGraw Hill- New York- 2008

REFERENCES

1. Marlin- T. E.- “Process Control”- 2nd Edition- McGraw Hill- New York- 2000.
2. Jason L. Speyer- Walter H.Chung- “Stochastic Processes- Estimation- and Control”- PHI Ltd (2013).
3. Peter Harriott- “Process Control” Tata McGraw-Hill Education-2000
4. Nageshwar Govind Das, Sudheer S.Bhagade “Process Dynamics and Control” PHI Ltd (2013).

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



CM16703 PROCESS ECONOMICS AND MANAGEMENT 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- have the knowledge on planning and techniques of measurement of work.
- attain the importance of cost estimation and projects.
- estimate the project profit and techniques for investment.
- analyze the performance, preparation of annual report.
- sustain the knowledge on economic balance.

UNIT I PRINCIPLES OF MANAGEMENT AND ORGANISATION 9

Planning, organization, staffing, coordination, directing, controlling, communicating, organization as a process and a structure; types of organizations. Method study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning; routing; scheduling; dispatching; costs and costs control, inventory and inventory control.

UNIT II INVESTMENT COSTS AND COST ESTIMATION 9

Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, capital budgeting and project feasibility.

UNIT III PROFITABILITY, INVESTMENT ALTERNATIVE AND REPLACEMENT 9

Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.

UNIT IV ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE 9

Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.

UNIT V ECONOMIC BALANCE 9

Economic decisions in Chemical Plant - Economics of size - Essentials of economic balance – Economic balance approach, economic balance for insulation, evaporation, heat exchanger

TOTAL PERIODS 45

COURSE OUTCOMES

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

- know the importance of planning and types of organization.
- have knowledge on value of money and how to utilize for the projects.
- impact the investment alternatives and its forecasting.
- gain the knowledge on balance sheet and their performance.
- attain the idea of economic growth and balance.

TEXT BOOKS

1. Peters, M. S. and Timmerhaus, C. D. RE West , “Plant Design and Economics for Chemical Engineers”, III Edn, McGraw Hill, 2003.

2. Holand, F.A., Watson, F.A. and Wilkinson, J.K., "Introduction to Process Economics", 2nd Edn, John Wiley, (1983)

REFERENCES

1. Perry, R. H. and Green, D., “Chemical Engineer’s Handbook “, 7th Edition, McGraw Hill.
2. Allen, L.A., “Management and Organization”, McGraw Hill

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3

CM16704 PROCESS CONTROL LABORATORY 0 0 4 2

All Tables / Chemical Engineers' Handbook / Data Books / Graph Sheets are permitted during the Examination

COURSE OBJECTIVES

To determine experimentally the response and controlling methods

- for first and second order system
- for Open and closed loop on level- flow and thermal system
- for control valve with different characteristics
- tuning of pressure system with loop study

LIST OF EXPERIMENTS

1. Response to the first order system
2. Response to the second order system
3. Response of Non-Interacting level System
4. Response of Interacting level System
5. Open loop study on a thermal system
6. Closed loop study on a level system
7. Closed loop study on a flow system
8. Closed loop study on a thermal system
9. Tuning of a pressure system
10. Characteristics of different types of control valves
11. Flow co-efficient of control valves
12. Closed loop study on a pressure system

TOTAL PERIODS 60

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- have knowledge on the development and use of right type of control dynamics for level and thermal
- have knowledge on the development and use of right type of control dynamics for flow and pressure
- have knowledge on controlling processes under different operative conditions
- have knowledge on different characteristic of control valve

TEXT BOOKS

1. Stephanopoulos- G. "Chemical Process Control" - Prentice Hall of India, 2003.
2. Coughnowr. D "Process Systems Analysis and Control", 3rd Edn.- McGraw Hill- New York- 2008

REFERENCES

1. Marlin- T. E.- "Process Control "- 2nd Edition- McGraw Hill- New York- 2000

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	2	1	1	-	1	-	-	1	2	3
CO2	3	2	2	2	1	-	-	-	1	-	-	2	2	3
CO3	3	2	1	2	2	-	-	1	1	1	-	2	2	3
CO4	2	3	2	2	2	-	-	-	1	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

CM16705 CHEMICAL REACTION ENGINEERING LABORATORY 0 0 4 2

COURSE OBJECTIVES

To enable the students to

- impart knowledge on design of batch reactors
- gain knowledge on CSTR reactor
- study about coupled reactors
- learn about performance characteristics of reactors

LIST OF EXPERIMENTS

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug flow reactor
3. Kinetic studies in a CSTR
4. Kinetic studies in a Packed bed reactor
5. Kinetic studies in a PFR followed by a CSTR
6. RTD studies in a PFR
7. RTD studies in a Packed bed reactor
8. RTD studies in a CSTR
9. Studies on micellar catalysis
10. Study of temperature dependence of rate constant using CSTR.
11. Combined reactor

TOTAL PERIODS 60

COURSE OUTCOMES

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

- get a sound working knowledge on different types of reactors.
- Learn kinetics studies
- evaluate the RTD studies
- learn the temperature dependence of reactor

TEXT BOOKS

1. Scott Fogler H., "Elements of Chemical Reaction Engineering", Third Edition, Prentice Hall of India, Eastern Economy Edition, New Delhi, 2006.
2. Lanny D. Schmidth, "The Engineering of Chemical Reactions", Second Edition, Oxford University Press, 2005
3. G.Fronment, K.B.Bischoff, "Chemical Reactor Analysis and Design" , John Wiley and Sons, 1979

CO/PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	**Programme Outcomes (PO's)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	2	1	-	2	-	-	-	-	-	-	1	-	2	-
CO2	2	1	-	2	-	-	-	-	-	-	1	-	2	-
CO3	2	1	-	2	-	-	-	-	-	-	1	-	2	-
CO4	2	1	-	2	-	-	-	-	-	-	1	-	2	-
CO5	2	1	-	2	-	-	-	-	-	-	1	-	2	-

CM16706 PROCESS EQUIPMENT DESIGN II 0 0 4 2

(All Tables/Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.)

COURSE OBJECTIVES

To enable the students to

- learn basic drawing for cooling tower, drier and evaporator
- design and draw heat exchanger
- know about basic drawing for distillation
- basic drawing for extraction and absorption

LIST OF EXPERIMENTS

1. Basic design and drawing considerations of cooling tower
2. Basic design and drawing considerations of evaporator
3. Basic design and drawing considerations of drier
4. Basic design and drawing considerations of heat exchanger
5. Basic design and drawing considerations of reboiler
6. Basic design and drawing considerations of sieve tray distillation
7. Basic design and drawing considerations of bubble cap distillation
8. Basic design and drawing considerations of packed column distillation
9. General design and drawing considerations of absorption column
10. General design and drawing considerations of extraction equipment

TOTAL PERIODS 60

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- have skill to design and install process equipments like cooling tower- drier - evaporator
- have skill in design and drawing of heat exchanger
- have skill in design and drawing of different types of distillation
- have skill in design and drawing for extractor and absorption

TEXT BOOKS

1. Kuppan Thulukkanam- " Heat Exchanger Design Handbook, Second Edition" CRC press 2013
2. J.M. Coulson and J.Richardson- "Chemical Engineering"- vol. 6- Asian Books Printers Ltd.

REFERENCES

1. R.H. Perry- "Chemical Engineers' Handbook"- McGraw-Hill
2. McCabe- W.L- Smith J.C and Harriott- P.- "Unit Operations in Chemical Engineering"- McGraw-Hill Fourth Edition- 2010.
3. S.D.Dawande "Process Design of Equipments" Central Techno Publications- Nagpur- 2000.
4. M.V.Joshi and V.V. Mahajan- "Process Equipment Design"- MacMillan India Ltd.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
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CO1	3	2	1	1	2	1	1	-	1	-	-	1	2	3
CO2	2	2	2	2	1	-	-	-	1	-	-	2	2	3
CO3	3	2	1	2	2	-	-	1	1	1	-	2	2	3
CO4	3	3	2	2	3	-	-	-	1	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

CM16801 ALTERNATIVE ENERGY TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- know the fundamentals of energy conversion.
- understand the interaction between different energy system.
- gain knowledge on the relevance and applications of nuclear and biomass energy.
- comprehend the principles of power generation using hydro, wind and solar energy.
- understand about energy management and conducting energy audit in chemical industries.

UNIT I ENERGY 9

Introduction to energy – Global energy scene – Indian energy scene - Units of energy - conversion factors – general classification of energy - energy crisis - energy alternatives

UNIT II NUCLEAR ENERGY & FOSSIL FUELS 9

Nuclear energy - Fission and fusion - Types of nuclear reactors. Coal - types and classification – Conversion. Technologies – Petroleum - products and properties - shale oil and gas - Oil - tar sand - Natural gas-CNG and LNG

UNIT III RENEWABLE ENERY SOURCES 9

Fundamentals of Power generation systems – Hydro – Wind – solar - Geothermal and ocean energy - fuel cells.

UNIT IV BIOMASS ENERGY 9

Biomass origin – Resources - Biomass estimation - Thermochemical conversion - Biological conversion - Chemical Conversion - Hydrolysis & hydrogenation – solvolysis - bio crude - biodiesel power generation gasifier – biogas - Integrated gasification.

UNIT V ENERGY CONSERVATION & MANAGEMENT 9

Energy forecasting and planning - Energy conservation - Waste heat recovery and heat pipes - Energy Audit in Chemical process industries - Cogeneration practices in industries

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- apply the fundamentals of energy conversion in applications.
- understand the sources- applications and conversion technologies for nuclear and fossil fuels
- grasp the principles of power generation using hydro- wind and solar energy
- gain knowledge on the relevance and applications of biomass energy
- understand the importance on the necessary of conservation and audit

TEXT BOOKS

1. Rao- S. and Parulekar- B.B - “Energy Technology”- Khanna Publishers- 2005.
2. Rai- G.D - “Non-conventional Energy Sources”- Khanna Publishers- New Delhi- 1984.

REFERENCES

1. Nejat Vezirog- "Alternate Energy Sources"- IT- McGraw Hill- New York
2. El. Wakil- "Power Plant Technology"- Tata McGraw Hill- New York- 2002.
3. Albert Thumann- P.E.- C.E.M & William J Younger C.E.M- "Handbook of Energy Audit by 7th edition" Faiment Press 2008
4. Nagpal- G.R.- "Power Plant Engineering"- Khanna Publishers- 2008

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1	2	1	1	-	1	-	-	1	2	3
CO2	2	2	2	2	1	-	-	-	1	-	-	2	2	3
CO3	3	2	1	2	2	-	-	1	1	1	-	2	2	3
CO4	3	3	2	2	3	-	-	-	1	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

CM16811 PROJECT WORK 0 0 12 6

COURSE OBJECTIVES

The objective of the project is

- to make use of the knowledge gained by the student at various stages of the degree course.
- to make students to prepare a report individually on the project assigned to him and submit it to the department.
- to prepare report based on the information available in the literature or data obtained in the laboratory/ industry.
- students- in addition will be permitted to undertake industrial/ consultancy project
- student can work- outside the department- in industries/Research labs for which proportional weight age will be given in the final assessment.

GUIDELINES

1. The students are expected to get formed into a team of convenient groups of not more than 4 members for a project.
2. Every project team shall have a guide who is the member of the faculty of the institution.
3. The group must identify and select the problem to be addressed as their project work through literature survey and finalize a comprehensive aim and scope of their work.
4. Reviews of the progress of the project work must be conducted by a team of faculty (minimum 3 and a maximum of 5) along with their faculty guide as a member the review team.
5. Progress of project work must be monitored by the project guide and committee periodically.
6. Attendance for review is mandatory. If a student fails to attend review for some valid reasons, one more chance may be given
7. The project report should be submitted by the students around the first week of April.

COURSE OUTCOME

At the end of the course, the students will be able to

- take up any challenging practical problems and find solution by formulating proper methodology
- collect literature through research journals and identify the gap in selected area
- devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimisation techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project.
- prepare project report as per format and confidently face viva voce with proper PPT for presentation

TOTAL PERIODS 180

CO/PO MAPPING

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CO1	3	2	1	1	2	1	2	-	1	-	-	2	3	3
CO2	2	3	2	2	1	-	-	-	1	1	-	3	2	3
CO3	3	2	1	2	2	-	-	1	1	2	-	2	2	3
CO4	2	3	2	2	3	-	-	-	1	2	-	3	3	3
CO5	3	3	1	1	1	-	-	-	-	-	1	3	3	3

CM16251 OIL AND NATURAL GAS ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable students to

- understand the occurrence of petroleum- exploration techniques- types of rigs and platforms
- examine the composition of natural gas- compression- purification- liquefaction.
- understand the shale oil occurrence- extraction and purification
- understand the storage- transportation of natural gas and power generation in industrial needs
- examine the hydrodynamic equations for flow- PVT properties and multiphase flow correlations

UNIT I OCCURRENCE AND EXPLORATION 9

Occurrence of petroleum - types of reservoirs - Exploration Methods. Drilling and Production of crude and natural Gas - types of rigs and platforms.

UNIT II NATURAL GAS 9

Composition and properties - compression and liquefaction of natural gas - purification methods - Shale gas: Occurrence - extraction and purification.

UNIT III STORAGE AND TRANSPORT 9

Storage and transportation of Natural gas- application in Chemical Process- Power generation- domestic - Industrial and transportation sectors.

UNIT IV APPLIED HYDRODYNAMICS IN OIL WELLS 9

Hydrodynamic equations for flow of fluids through porous media - PVT properties for oil gas systems - Multiphase flow correlations to determine flow ratio and pressure traverse in flowing oil wells

UNIT V REGULATORY PROBLEMS 9

Safety - environmental and economic aspects of oil and gas exploration - Oil Spill Management Alaska and Gulf of Mexico case studies.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- understand the occurrence of petroleum- exploration techniques- types of rigs and platforms
- examine the composition of natural gas- compression- purification- liquefaction and understand the shale oil occurrence- extraction and purification
- understand the storage- transportation of natural gas and power generation in industrial needs
- examine the hydrodynamic equations for flow- PVT properties of gas and multiphase flow correlations.
- recognize legal aspects governing gas oil exploration- oil spill management and case studies

TEXT BOOKS

1. Katz Donald L. and Lee Robert L. “Natural Gas Engineering” McGraw Hill Publishing Company- New York- 1990.

2. Medici M. “The Natural Gas Industry”- Newnes-Butterworths- London- 1974.

REFERENCES

1. Econonides M.J. And Daniel A. “Petroleum Production Systems”- Prentice Hall Petroleum Engineering Series- 2012.
2. William C Lyons- Gary C Plisga- “Standard Hand Book of Petroleum and Natural Gas Engineering”- 2nd Edition- Gulf Professional Publishing- 2004.
3. Boyun Guo- Ali Ghalambor- “Natural Gas Engineering Handbook”-2nd Edition- Gulf Publishing Company-2014
4. G.G.Nasr- N.E.Connor- “Natural Gas Engineering and safety challenges”- Springer Publishing- 2014

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3

CM16252 POLYMER TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

To enable the students

- to develop an understanding of the basic concepts of polymer technology
- to study the molecular weight distribution, Condensation polymerization and transition in polymers.
- to understand the principles related to the synthesis and characterization of polymers.
- to comprehend the properties and manufacturing processes of polymers
- to grasp the methods of preparation and moulding of plastics

UNIT I INTRODUCTION 9

History of Macromolecules - structure of natural products like cellulose rubber - proteins - concepts of macromolecules - Staudinger's theory of macromolecules - difference between simple organic molecules and Macromolecules.

UNIT II ADDITION POLYMERIZATION 9

Chemistry of Olefins and Dienes - double bonds - Chemistry of free radicals - monomers – functionality - Polymerization: Initiation - types of initiation - free radical polymerization - cationic polymerization - anionic polymerization - coordination polymerization - industrial polymerization – bulk - emulsion - suspension and solution polymerization techniques - Kinetics – Copolymerization concepts.

UNIT III CONDENSATION POLYMERIZATION 9

Simple condensation reactions - Extension of condensation reactions to polymer synthesis - functional group reactivity - poly condensation - kinetics of poly condensation - Carother's equation - Linear polymers by poly condensation - Interfacial polymerization - cross linked polymers by condensation - gel point.

UNIT IV MOLECULAR WEIGHTS OF POLYMERS 9

Difference in molecular weights between simple molecules and polymers - number average and weight average molecular weights - degree of polymerization and molecular weight - molecular weight distribution - poly dispersity - molecular weight determination. Different methods – Gel Permeation Chromatography

UNIT V TRANSITIONS IN POLYMERS 9

First and second order transitions - Glass transition - Tg - multiple transitions in polymers - experimental study - significance of transition temperatures - crystallinity in polymers - effect of crystallization in polymers - factors affecting crystallization crystal nucleation and growth - relationship between T_g and T_m - Relationship between properties and crystalline structure.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course- the student would be able to

- understand the principles related to the synthesis and characterization of polymers.

- develop the knowledge to characterize the plastics by using different instruments
- gain insight into the structure and properties of polymers
- comprehend the properties and manufacturing processes of polymers
- grasp the methods of preparation and moulding of plastics

TEXT BOOKS

1. Billmeyer.F.W.-Jr "Text Book of Polymer Science"- Ed. Wiley, Interscience- 1984
2. Gowariker.V.T, Viswanathan.N.V and Sreedar.J. "Polymer Science", 9th Reprint- New Age International Pvt. Ltd, India- 1996.

REFERENCES

1. Joel-R.F; "Polymer Science and Technology"- Eastern Economy Edition- 1999
2. Rodriguez- F.- Cohen.C.- Oberic.K and Arches- L.A.- "Principles of Polymer Systems"- 5th edition- Taylor and Francis- Great Britain- London- 2003
3. Arora M.G. and Singh M. "Polymer Chemistry"- Anmol Publications Pvt. Limited- 2003.
4. Seymour.R.B. and Carraher.C.E.- Jr.- "Polymer Chemistry", 2nd Ed.- Marcel Dekker- 1988.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3

CM16253 FOOD TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- acquire knowledge on general aspects on food industry and their needs.
- categories the quality and nutritive aspects of food.
- point out the processing methods and their preservation.
- familiarize the food preservation methods.
- know the production and utilization of food products.

UNIT I INTRODUCTION 9

General aspects of food industry; world food needs and Indian situation.

UNIT II FOOD CONSTITUENTS, QUALITY AND DERIVATIVE FACTORS 9

Constituents of food; quality and nutritive aspects; food additives; standards; deteriorative factors and their Control.

UNIT III GENERAL ENGINEERING ASPECTS AND PROCESSING METHODS 9

Preliminary processing methods; conversion and preservation operations.

UNIT IV FOOD PRESERVATION METHODS 9

Preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurization; fermentation and pickling; packing methods.

UNIT V PRODUCTION AND UTILISATION OF FOOD PRODUCTS 9

Cereal grains; pulses; vegetables; fruits; spices; fats and oils; bakery; confectionery and chocolate products; soft and alcoholic beverages; dairy products; meat; poultry and fish products.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain the general aspects of food industries, food products, food constituents.
- analyzes the quality, standards and detractive factors and their control.
- understand the engineering aspects of food processing and preservation and its various methods.
- study the various kinds of food products; their production and utilization to the standard.
- design the equipment for food industries.

TEXT BOOKS

1. Jowitt R., Hygienic Design and Operation of Food Plant, AVI Pvt. Co., West Port, 1980.
2. Head man D.R. and Singh R.P., Food Processing Technology, AVI Pvt. Co., West Port.

REFERENCES

1. Brennan J., Butters G.J.R., Cowell, N.D. and AEV Lilly, ―Food Engineering Operations, 3rd Edition, Applied Scientific Publishers, London, 1990.
2. Ronald H. Schmidt and Gary E. Rodrick, ―Food Safety Handbook‖, John Wiley and Sons, New Jersey, 2005.
3. Charm S.E., The Fundamentals of Foods Engineering, The AVI Publishing Co., Westport,1963

4. Heid J.L. Joslyn M.A., Fundamentals of Food Processing Operation, The AVI publishing Co., West port 1967.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
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CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3

CM16254 GREEN CHEMISTRY AND ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- identify the grand challenges of green chemistry and consider what it will take to resolve them.
- explain the meaning and importance of low dose adverse chemical effects and endocrine disruptors, which present major environmental and health threats.
- develop an understanding of the importance of pollution and wastefulness in modern cultures by reflecting on the big chemistry, big technology issues such as energy use and the protection of the atmosphere.
- gain the knowledge of energy calculation and environmental wastes.
- acquire knowledge on various assessment methods.

UNIT I QUALITY ISSUES AND RISK ASSESMENT 9

Overview of Major Environmental Issues, Global Environmental Issues. Air Quality Issues-Water Quality Issues, Ecology, Natural Resources, Description of Risk-Value of Risk Assessment in the Engineering Profession-Risk-Based Environmental Law-Risk Assessment Concepts-Hazard Assessment. Dose-Response-Risk Characterization.

UNIT II ENVIORNMENTAL EXPOSURE 9

Pollution Prevention- Pollution Prevention Concepts and Terminology. Chemical Process Safety-Responsibilities for Environmental Protection. Environmental Persistence. Classifying Environmental Risks- Based on Chemical Structure-Exposure Assessment for Chemicals in the Ambient Environment

UNIT III POLLUTION PREVENTION 9

Green Chemistry. Green Chemistry Methodologies. Quantitative/Optimization- Based Frameworks for the design of Green Chemical Synthesis Pathways- Green Chemistry Pollution Prevention in Material Selection for Unit Operations.-Pollution Prevention for Chemical Reactors. Pollution Prevention for Separation devices- Pollution Prevention Applications for Separative Reactors.-Pollution Prevention in Storage Tanks.

UNIT IV PROCESS AND ESTIMATION INTEGRATION 9

Process Energy Integration. Process Mass Integration. Case Study of a Process Flow sheet- Estimation of Environmental Fates of Emissions and Wastes.

UNIT V COST AND LIFE CYCLE ASSESMENT 9

Magnitudes of Environmental Costs-A Framework for Evaluating Environmental Costs-Hidden Environmental Costs. Liability Costs-Internal Intangible Costs-External Intangible Costs-Introduction to Product Life Cycle Concepts-Life- Cycle Assessment. Life-Cycle Impact Assessments- Streamlined Life-Cycle Assessments.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the issues in quality and risk assessment tools
- suggest the environment friendly techniques to reduce effluents
- acquire the knowledge in preventing pollution by following green chemistry principles
- estimate the energy balance sheet and predict the future
- assess the magnitude of product and optimize the cost

TEXT BOOKS

1. Allen, D.T., Shonnard, D.R, Green Engineering: Environmentally Conscious Design of Chemical Processes. Prentice Hall PTR 2002.
2. MukeshDoble and Anil Kumar Kruthiventi, Green Chemistry and Engineering, Elsevier,Burlington,USA, 2007

REFERENCES

1. Rao, C.S Environmental Pollution Control Engineering, Wiley- Eastern Ltd.1991.
2. Rao M.N and H.V.N. Rao. "Air pollution", Tata McGraw Hill Publishing Co.Ltd.1989
3.
4.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
Programme Outcome (POs)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	-	3	-	-	3	-	-	2	-	2	2
CO2	-	-	-	-	3	-	-	3	-	-	2	-	2	2
CO3	-	-	-	-	3	-	-	3	-	-	2	-	2	2
CO4	-	-	-	-	3	-	-	3	-	-	2	-	2	2
CO5	-	-	-	-	3	-	-	3	-	-	2	-	2	2

CM16903 CORROSION TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

To enable students

- to learn about different types of corrosion
- to make the students aware coating and protection methods
- to learn about corrosion in specific environments
- to control pollution with technological achievement and economic viability.
- to study the corrosion protection management with principle

UNIT I TYPES OF CORROSION AND TESTING METHODS 9

Basic principles of corrosion and its control – Forms of corrosion, uniform, Galvanic, Crevice, pitting, selective leaching, erosion, stress - corrosion, cracking Cavitation phenomena and their effects – Corrosion testing – Field testing – Electrochemical techniques for measurement of corrosion rates, corrosion detection and components examination – Accelerated salt - spray testing.

UNIT II CORROSION PROTECTION METHODS 9

Corrosion inhibitors, electroplated coatings, conversion coatings, anodizing, hot dipping, spray metal coatings, zinc coating by alloying, electrophoteric coatings and electro painting, powder coating, electrical methods of corrosion protection, composite materials in corrosion minimization – Cathodic and Anodic protections.

UNIT III CORROSION IN SPECIFIC ENVIRONMENTS 9

Corrosion damage to concrete in industrial and marine environments and its protection; biological corrosion, halogen corrosion of metals, environmental degradation of materials, corrosion and inspection managements in chemical processing and petrochemical industries.

UNIT IV CORROSION IN SPECIFIC CASES AND CONTROL 9

Corrosion in structure – corrosion of stainless steels – corrosion in power equipments, corrosion in electrical and electronic industry – corrosion and selection of materials of pulp and paper plants – corrosion aspects in nuclear power plants – corrosion of surgical implants and prosthetic devices.

UNIT V CORROSION AND COUNTRY'S ECONOMY 9

Corrosion protection management – process maintenance procedures under corrosion Environments.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- have an insight into all aspects of corrosion and testing methods
- apply the principles of corrosion inhibition for protection of process equipments
- develop knowledge of corrosion inspection and management in chemical industries
- control corrosion and select materials for different applications
- comprehend the impact of corrosion on nations economy

TEXT BOOKS

1. Fontana M.G., Corrosion Engineering, Tata McGraw Hill, 2005.
2. Jones D.A., Principal and Protection of Corrosion‖, Prentice-Hall, 1996

REFERENCES

1. Pierre R. Roberge, Corrosion Engineering: Principles and Practice‖, McGraw-Hill, 2008.
2. Sastri V.S., Ghali E. And Elboujdaini M., Corrosion Prevention and Protection: Practical Solutions‖, John Wiley and Sons, 2007.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3

CM16904 PROCESS INSTRUMENTATION 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the purpose of instrumentation in Industrial processes.
- learn the working of different types of temperature measuring instruments like RTD, Thermistor, and thermocouple.
- have a sound knowledge about analytical instrument and chromatography.
- have an idea about the fundamental of process control and programmable controllers.
- have an adequate knowledge on pressure, level and flow controllers with types of valves.

UNIT I BASICS OF INSTRUMENTATION 5

Introduction – Variables, Units & standards of measurement, Measurement terms – characteristic. Data Analysis.

UNIT II MEASUREMENT SYSYTEM 12

Process Variables Measurement–Temperature systems– Thermocouples, Thermo resistive system, Filled-system thermometers, Radiation thermometry, Location of temperature measuring devices in equipments, Pressure system – Mechanical pressure elements Pressure Transducers and Transmitters, Vacuum measurement, Resonant wire pressure Transducer, Flow system – Differential producers, Variable area flow meters, Velocity, vortex, mass, ultrasonic & other flow meters, positive displacement flow meters

UNIT III ANALYTICAL INSTRUMENTATION 12

Analytical instrumentation – Analysis instruments, Sample conditioning for process analyzers, X-ray Analytical methods, Quadrupole mass spectrometry, Ultra violet Absorption Analysis, Infra-red process analyzers, Photometric reaction product analysers Oxygen analyzers, Oxidation – reduction potential measurements, pH measuring systems, Electrical conductivity and Resistivity measurements, Thermal conductivity, gas analysis, Combustible, Total hydro carbon, and CO analyzer,

UNIT IV PROCESS CONTROL 9

Fundamentals of Automatic process control – Control algorithms-Automatic controllers – Electronic controllers -Electric controllers (Traditional) – Hydraulic controllers – Fluidics - Programmable controllers.

UNIT V TRANSMITTERS AND CONTROL VALVES 7

Sensors, Transmitters and control valves - Pressure, Flow, Level, Temperature and Composition sensors, Transmitters, Pneumatic and electronic control valves, Types, Actuator, accessories, Instrumentation symbols and Labels.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain the purpose of instrumentation in Industrial processes

- know the working of different types of temperature measuring instruments like RTD, Thermistor, and Thermocouple.
- apply the knowledge on chromatography techniques.
- explain the types and fundamentals of controllers.
- Know the various flow and level measurement devices used for industrial purposes.

TEXT BOOKS

1. Fribance, "Industrial Instrumentation Fundamentals", McGraw Hill Co. Inc. New York 1985
2. Considine D M and Considine G D "Process Instruments Controls" Handbook 3rd Edition, McGraw – Hill Book Co., NY, 1990.

REFERENCES

1. Marlin, T. E., "Process Control ", 2nd Edn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edn., John Wiley, New York, 1997
3. Jason L. Speyer, Walter H.Chung, "Stochastic Processes, Estimation, and Control", PHI Ltd
4. Eckman D.P. "Industrial Instrumentation", Wiley Eastern Ltd., 1989.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	**Programme Outcome (POs)**													
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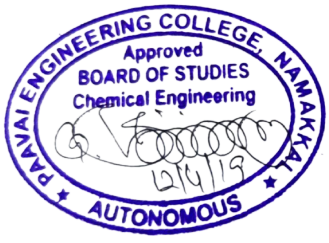
CO1	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO2	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO3	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO4	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO5	-	-	-	-	3	-	1	-	1	-	2	-	2	1



CM16351 FERTILIZER TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

To enable students to

- develop an understanding of the basic concepts of fertilizer technology
- study about various types of fertilizers
- learn about the manufacturing techniques of fertilizer.
- understand the design of the equipments in fertilizer industry
- apply the methodology in real life.

UNIT I NITROGENOUS FERTILISERS 9

Methods of production of nitrogenous fertilizer - ammonium sulphate - nitrate - urea and calcium ammonium nitrate; Ammonium chloride and their methods of production - characteristics and specifications - storage and handling.

UNIT II PHOSPHATIC FERTILISERS 9

Raw materials; phosphate rock - sulphur; pyrites etc. - processes for the production of sulphuric and phosphoric acids; phosphates fertilizers - ground rock phosphate; bone meal - single superphosphate - triple superphosphate - triple superphosphate - thermal phosphates and their methods of production - characteristics and specifications.

UNIT III POTASSIC FERTILISERS 9

Methods of production of potassium chloride - potassium schoenite - their characteristics and specifications.

UNIT IV COMPLEX AND NPK FERTILISERS 9

Methods of production of ammonium phosphate - sulphate diamSmonium phosphate - nitro phosphates -urea - ammonium phosphate - mono - ammonium phosphate and various grades of NPK fertilizers produced in country

UNIT V MISCELLANEOUS FERTILISERS 9

Mixed fertilizers and granulated mixtures; biofertilisers - nutrients - secondary nutrients and micro nutrients; fluid fertilizers - controlled release fertilizers - controlled release fertilizers.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course students would be able to

- develop an understanding of the basic concepts of fertilizer technology
- study about various types of fertilizers
- learn about the manufacturing techniques of fertilizer.
- understand the design of the equipments in fertilizer industry
- apply the methodology and techniques in real life.

TEXT BOOKS

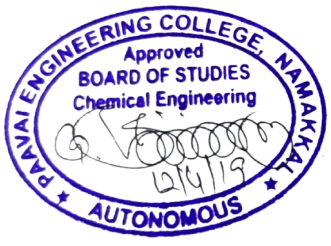
1. GopalaRao M. and Marshall Sittig "Dryden's Outlines of Chemical Technology", 3rd Edition East- West Press, New Delhi- 2008.
2. Menno- M.G.; "Fertilizer Industry - An Introductory Survey" Higginbotham's Pvt. Ltd.- 1973.

REFERENCES

1. "Handbook of fertilizer technology" Association of India, New Delhi- 1977.
2. Sauchelli- V.; "The Chemistry and Technology of Fertilizers" ACS MONOGRAPH No. 148- Reinhold Publishing Cor. New York- 1980.
3. Fertilizer Manual- "United Nations Industrial Development Organization" United Nations, New York- 1967.
4. Slack- A.V.; "Chemistry and Technology of Fertilizers" Interscience, New York- 1966.

CO/PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	**Programme Outcomes (PO's)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	1	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



CM16352 PROCESSES OPTIMIZATION 3 0 0 3

COURSE OBJECTIVE

To enable students to

- study the systems of equations for attaining optimum
- expose the students with basic function and interpretation of quadratic
- perform functional concepts using various mathematical methods
- study about unconstrained multivariable optimization methods
- expose the students in linear programming

UNIT I DEVELOPING MODELS FOR OPTIMIZATION 9

Scope and hierarchy of optimization - Essential features of Optimization problems - Classification of Models - building a model - Factorial experimental designs- Degree of freedom

UNIT II BASIC CONCEPTS 9

Formation of objective function - continuity of functions - NLP problem statement- convexity and applications - Interpretation of objective function based on its Quadratic approximation

UNIT III OPTIMIZATION OF UNCONSTRAINED FUNCTIONS 9

Methods for one dimensional search- Newton‘s method and Quasi - Newton methods for uni-dimensional search. Polynomial approximation methods

UNIT IV UNCONSTRAINED MULTIVARIABLE OPTIMIZATION 9

Methods using function value only - methods using first derivative - Newton‘s method- Quasi - Newton methods.

UNIT V LINEAR PROGRAMMING 9

Simplex method - Barrier method - sensitivity analysis - Linear mixed integer programs - Examples

TOTAL PERIODS 45

COURSE OUTCOMES

Through this course- the students would have learnt about

- designing experiments and formulate optimization models of chemical processes/equipment
- knowledge on the basic concepts of process optimization techniques
- solving different uni-dimensional search methods and polynomial approximations
- understanding the principles of unconstrained multivariable Optimization techniques
- familiarizing the methods of linear programming

TEXT BOOKS

1. Edgar- T.F, Himmelblau, D.M. “Optimization of Chemical Processes”, McGraw-Hill- 2001.
2. Kalyanmoy Deb “Optimization for Engineering Design: Algorithms and Examples”, Prentice Hall of India- New Delhi- 2005.

REFERENCES

1. Biles- W.E.- Swain- J.J, “Optimization and Industrial Experimentation”, Inter Science- New York- 19

2. Seinfeld- J.H.; Lapidus- L; “Process Modelling- Estimation and Identification”, Prentice Hall- Englewood Cliffs- New Jersey- 1974.
3. Beveridge- C.S.; Schechter- R.S.; “Optimization: Theory and Practice”, McGraw-Hill.- New York.
4. Enrique del Castillo, “Process Optimization: A Statistical Approach”, springer-2007

CO/PO MAPPING

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak**														
CO’s	**Programme Outcomes (PO’s)**													
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CO2	1	2	1	2	1	-	-	-	1	-	-	2	2	1
CO3	1	2	1	2	1	-	-	-	1	1	-	2	2	2
CO4	2	1	2	2	1	-	-	-	-	1	-	2	2	2
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

CM16353 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

COURSE OBJECTIVE

To enable students to

- demonstrate competence in setting up computational fluid dynamics models.
- understand the computational fluid models
- enable technical competence in building and conducting CFD simulations.
- understand the basic fluid operation analogies.
- perform grid generation for models

UNIT I CONSERVATION LAWS AND TURBULENCE MODELS 9

Governing equations of fluid flow and heat transfer – mass conservation - momentum and energy equation - Differential and integral forms - conservation and non-conservation form. Characteristics of turbulent flows - time averaged Navier Strokes equations - turbulence models - one and two equation- Reynolds stress - LES and DNS

UNIT II FINITE DIFFERNCE APPROXIMATION 9

Mathematical behavior of PDE - finite difference operators - basic aspects of discretization by FDM - explicit and implicit methods - error and stability analysis.

UNIT III FINITE VOLUME METHOD 9

Diffusion problems - explicit and implicit time integration; Convection-diffusion problems - properties of discretization schemes- central- upwind- hybrid- QUICK schemes; Solution of discretised equations.

UNIT IV FLOW FIELD COMPUTATION 9

Pressure velocity coupling - staggered grid - SIMPLE algorithm - PISO algorithm for steady and unsteady flows

UNIT V GRID GENERATION 9

Physical aspects - simple and multiple connected regions - grid generation by PDE solution - grid generation by algebraic mapping. Growth and growth coefficients - Calculations involving material and energy balances - Methods based on super saturation and industrial equipment.

TOTAL PERIODS 45

COURSE OUTCOME

Upon completing the course, the students would have learnt about

- hands-on experience with a commercial CFD program.
- understand the computational fluid models
- enable technical competence in building and conducting CFD simulations.
- understand the basic fluid operation analogies.
- perform grid generation for models

TEXT BOOKS

1. Anderson- J. D., “Computational Fluid Dynamics: The Basics with Applications”- McGraw-Hill- 1995.

2. Fletcher- C. A. J., "Computational Techniques for Fluid Dynamics"- Springer Verlag- 1997.

REFERENCES

1. Chung T.J "Computational Fluid Dynamics" Cambridge University Press- 2003.
2. Muralidhar. K. and Sundararajan. T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House- New Delhi- 2001.
3. Subas- V. Patankar "Numerical heat transfer fluid flow"- Hemisphere Publishing Corporation- 1980.
4. Taylor. C and Hughes. J.B. "Finite Element Programming of the Navier Stock Equation", Pineridge Press Limited- U.K. 1981.

CO/PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak**														
CO's	**Programme Outcomes (PO's)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	3	2	2	1	1	-	2	1	1	-	3	2	2	3
CO3	3	3	1	2	1	-	-	-	1	1	2	2	2	3
CO4	3	2	3	2	1	-	1	1	-	1	2	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

CM16354 PIPING ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable students to

- to understand the concept of piping generic design
- to learn the fundamental principles of fluid flow phenomena
- to perform the design of pipeline systems for air and water systems
- to perform the design of pipeline system for refrigeration and slurry systems
- to apply operation and maintenance techniques to ensure safety operations

UNIT I PIPING FUNDAMENTALS 9

Equations of flow for Newtonian and Non-Newtonian fluids - losses in pipes and fittings - Types of pipes and Fittings. Piping standards and codes.

UNIT II PIPING GENERIC DESIGN 9

Piping layout - series and parallel pipes - Pipe network. Stress analysis and design of pipe supports.

UNIT III PIPING DESIGN-I 9

Design of pipeline system - Air- Water - Steam and Oil.

UNIT IV PIPING DESIGN- II 9

Design of pipeline system - Gases - Refrigeration and Slurry. Continuous drying - Drying equipment: tray - Rotary drum - spray dryer and their applications.

UNIT V OPERATION AND MAINTENANCE 9

Coating- cleaning; freeze prevention- leak detection- corrosion and protection. Pipeline failures - Piping insulation and heat tracing- repair techniques; Pipeline economics.

TOTAL PERIODS 45

COURSE OUTCOMES

On completion of the course the students will be able to

- understand the concept of piping generic design
- familiarize the fundamental principles of fluid flow phenomena
- perform the design of pipeline systems for air and water systems
- perform the design of pipeline system for refrigeration and slurry systems
- apply operation and maintenance techniques to ensure safety operations

TEXT BOOKS

1. John J Mcketta, "Piping Handbook", 3rd Edition, Marcel Dekker Publication- 1992.
2. Henry Liu, "Pipeline Engineering", 2nd Edition- Lewis Publishers- 2003.

REFERENCES

1. Mohinder L. Nayyar, "Piping Handbook", 7th Edition- McGraw Hill- 2000.
2. George A. Antaki- "Piping and Pipeline Engineering: Design- Construction- Maintenance- Integrity and Repair", Marcel Dekker Publications- 2003.

CO/PO MAPPING

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CO1	2	2	1	1	1	1	1	-	-	-	-	1	2	3
CO2	2	2	2	1	1	-	-	-	1	-	-	2	2	3
CO3	3	2	1	2	1	-	-	-	1	1	-	2	2	3
CO4	3	2	2	2	1	-	-	-	-	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

CM16451 PROCESS MODELLING AND SIMULATION 3 0 0 3

COURSE OBJECTIVES

To enable students to

- to give an overview of various method of process modeling
- to understood the development of process models based on conservation principles
- to learn Process data and computational techniques to solve the process models.
- to study different computational techniques for simulation.
- to learn the fundamental principles of steady and unsteady state models.

UNIT I INTRODUCTION 9

Introduction to modeling and simulation- classification of mathematical models-conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS 9

Degree of freedom analysis- single and network of process units- systems yielding linear and non-linear algebraic equations- flow sheeting – sequential modular and equation oriented approach- tearing-partitioning and precedence ordering- solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS 9

Analysis of liquid level tank- gravity flow tank- jacketed stirred tank heater- reactors- flash and distillation column- solution of ODE initial value problems- matrix differential equations- simulation of closed loop systems.

UNIT IV STEADY STATE DISTRIBUTED SYSTEM 9

Analysis of compressible flow- heat exchanger- packed columns- plug flow reactor -solution of ODE boundary value problems.

UNIT V CRYSTALLIZATION 9

Analysis laminar flow in pipe-sedimentation - boundary layer flow - conduction - heat exchanger - heat transfer in packed bed – diffusion - packed bed adsorption - plug flow reactor - hierarchy in model development - Classification and solution of partial differential equations. Empirical modeling-parameter estimation - Population balance and stochastic modeling.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon completing the course

- the student should have understood the development of process models based on conservation principles
- process data and computational techniques to solve the process models.
- overview of various method of Process modeling
- different computational techniques for simulation.
- the fundamental principles of steady and unsteady state models.

TEXT BOOKS

1. Ramirez- W.; "Computational Methods in Process Simulation "- 2nd Edn. Butterworths Publishers - New York- 2000.
2. Luyben- W.L. " Process Modelling Simulation and Control", 2nd Edn- McGraw-Hill Book Co.- 1990

REFERENCES

1. Felder R. M. and Rousseau R. W. "Elementary Principles of Chemical Processes", John Wiley- 2000.
2. Franks- R. G. E.- " Mathematical Modelling in Chemical Engineering", John Wiley- 1967
3. Amiya K. Jana "Process Simulation and Control Using ASPEN", PHI Learning Ltd (2012).
4. Amiya K. Jana "Chemical Process Modelling and Computer Simulation", PHI Learning Ltd- (2012).

CO/PO MAPPING

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CO3	2	2	1	2	1	-	-	-	1	1	-	2	2	3
CO4	3	2	2	2	1	-	-	-	-	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

CM16452 MODERN SEPARATION PROCESSES 3 0 0 3

COURSE OBJECTIVES

To enable students to

- give an overview of various separation process
- understand the types of membrane and reactors
- learn adsorption technique for separation
- study different equipments involved in inorganic separation
- know the various techniques used for separation

UNIT I BASICS OF SEPARATION PROCESS 9

Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

UNIT II MEMBRANE SEPARATIONS 9

Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Ceramic-Hybrid process and Biological Membranes.

UNIT III SEPARATION BY ADSORPTION 9

Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption

UNIT IV INORGANIC SEPARATIONS 9

Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes

UNIT V OTHER TECHNIQUES 9

Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon completing the course

- the student should have understood the development of process models based on conservation principles
- process data and computational techniques to solve the process models.
- overview of various method of Process modeling
- different computational techniques for simulation.
- the fundamental principles of steady and unsteady state models.

TEXT BOOKS

1. King, C. J., "Separation Processes", Tata McGraw Hill, 1982.
2. Nakagawal, O. V., "Membrane Science and Technology"' Marcel Dekkar,1992.

REFERENCES

1. Felder R. M. and Rousseau R. W. "Elementary Principles of Chemical Processes", John Wiley-2000.
2. Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987.

CO/PO MAPPING

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CO4	2	3	2	2	2	-	2	-	-	-	-	2	2	2
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

CM16453 PETROLEUM REFINING ENGINEERING 3 0 0 3

COURSE OBJECTIVES

On completion of the course the students will be able to

- study the formation and composition of petroleum
- learn with properties and testing methods for crude and petroleum products
- learn the various treatment techniques of petroleum
- familiarize with upgrading process of petroleum products
- understand the material and energy balance

UNIT I FORMATION AND COMPOSITION OF PETROLEUM 9

Origin and formation of petroleum; composition; types and classification; Petroleum reserves.

UNIT II PROPERTIES AND TESTING METHODS 9

Physical properties and testing methods - crude and petroleum products;

UNIT III TREATMENT TECHNIQUES 9

Desalting of crudes- dehydration and fractionation methods; Thermal and catalytic cracking processes vis- Breaking - Dubbs two coil process - coking- FCC- Hydro cracking processes.

UNIT IV UPGRADING PROCESSES 9

Solvent extraction; hydro treatment processes; Reforming and Alkylation; Isomerization; polymerization; Finishing and purification processes.

UNIT V MATERIAL AND ENERGY BALANCES 9

Material and Energy balances calculation; controlling hydrocarbon losses in refinery; application of pollution Control techniques.

TOTAL PERIODS 45

COURSE OUTCOMES

On completion of the course the students will be able to

- understand the formation and composition of petroleum
- familiarize with properties and testing methods for crude and petroleum products
- understand the various treatment techniques of petroleum
- familiarize with upgrading process of petroleum products
- demonstrate the material and energy balance

TEXT BOOKS

1. Bhaskara Rao B.K. "Modern Petroleum Refining Processes", 5th Edition- Oxford and IBH Publishing Company- New Delhi- 2008.
2. Nelson W.L. “Petroleum Refinery Engineering”, 4th Edition- McGraw Hill Publishing Company Limited- 1958.

REFERENCES

1. Watkins R.N. “Petroleum Refinery Distillation”- 2nd Edition- Gulf Publishing Company- Texas- 1979.

2. Hobson G. D. “Modern Petroleum Technology"- Part 1&2 5th Edition- Wiley Publishers- 1984.
3. Mohamed A. Fahim- Taher A. Al-Sahhaf- Amal Elkilani “Fundamentals of Petroleum Refining” Elsevier-2010
4. Surinder Parkash “Refining Processes Handbook”- Gulf Professional publishing-2003

CO/PO MAPPING

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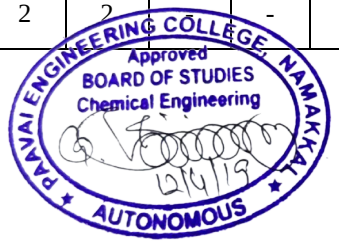
CO4	3	1	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



BA16523 TOTAL QUALITY MANAGEMENT 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- describe the basic concepts in Quality Management- Customer orientation and retention.
- facilitate the understanding of Quality Management principles and process.
- discuss the techniques in Six Sigma- Bench marking and FMEA.
- understand the basic concepts in Quality Function Development and TPM.
- become familiar with Quality System- Quality Auditing and HR practices.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - basic concepts of TQM - TQM Framework - Contributions of Deming - Juran and crosby - barriers to TQM - Quality statements - Customer focus - Customer orientation - customer satisfaction customer complaints- Customer retention - Costs of quality

UNIT II TQM PRINCIPLES 9

Leadership - strategic quality planning- quality councils - employee involvement – motivation – empowerment - team and teamwork - quality circles recognition and reward - performance appraisal - continuous process improvement - PDCA cycle - 5S- kaizen - supplier partnership - partnering- supplier selection- supplier rating.

UNIT III TQM TOOLS AND TECHNIQUES I 9

The seven traditional tools of quality - new management tools - six sigma: concepts – methodology - applications to manufacturing - service sector including IT - bench marking - reason to bench mark - bench marking process - FMEA – stages - types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Control charts - process capability - concepts of six sigma - quality function development (QFD) - taguchi quality loss function - TPM – concepts - improvement needs - performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements- Documentation- Quality Auditing - QS 9000 - ISO 14000 – Concepts - Requirements and Benefits - TQM Implementation in manufacturing and service Return on Investment - Personnel management. Recruitment - selection and training - Technology in Agri sectors.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- discuss the basic concepts in Quality Management- Customer orientation and retention.
- describe the principles and process of Quality Management.

- implement the quality control techniques in Six Sigma- Bench marking and FMEA.
- explain the basic concepts in Quality Function Development and TPM.
- understand the elements in Quality System- Quality Auditing and HR practices.

TEXT BOOKS

1. Dale H. Besterfiled- et al. "Total quality Management"- Pearson Education Asia- Third Edition, Indian Reprint (2006).
2. Jones D.A, “Principal and Protection of Corrosion”, Prentice-Hall- 1996

REFERENCES

1. James R. Evans and William M. Lindsay- "The Management and Control of Quality"- 8th Edition- First Indian Edition- Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel- "Total Quality Management"- Prentice Hall (India) Pvt. Ltd. 2006.
3. Janakiraman. B and Gopal .R.K.- "Total Quality Management - Text and Cases"- PHI (India)- 2006
4. Dennis AuBuchon- “Understanding the Concept of Quality”, Pronoun- 2017.
5. Donna C. S. Summers- “Quality”- Pearson- 5th edition- 2009.

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CO2	2	2	1	2	1	-	-	-	1	-	-	2	2	1
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CO4	2	1	2	2	1	-	-	-	-	1	-	2	2	2
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3