SEMESTER V

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	ES	CM20501	Process Instrumentation	3	0	0	3
2	PC	CM20502	Mass Transfer I	3	0	0	3
3	PC	CM20503	Chemical Engineering Thermodynamics	3	0	0	3
4	PC	CM20504	Chemical Process Heat Transfer	3	0	0	3
5	PC	CM20505	Drugs and Pharmaceutical Technology	3	0	0	3
6	PE	CM2015*	Professional Elective I	3	0	0	3
Practical							
1	ES	CM20506	Process Instrumentation Laboratory	0	0	4	2
2	PC	CM20507	Heat Transfer Laboratory	0	0	4	2
3	EE	EN20501	Career Development Laboratory I	0	0	2	1
			Total	**18**	**0**	**10**	**23**

SEMESTER VI

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	HS	CM20601	Process Technology and Economics	3	0	0	3
2	PC	CM20602	Chemical Reaction Engineering	3	0	0	3
3	PC	CM20603	Mass Transfer II	3	0	0	3
4	PC	CM20604	Chemical Process Plant Safety	3	0	0	3
5	PE	CM2025*	Professional Elective II	3	0	0	3
6	OE	CM2090*	Open Elective I	3	0	0	3
Practical							
1	PC	CM20605	Chemical Reaction Engineering Laboratory	0	0	4	2
2	PC	CM20606	Mass Transfer Laboratory	0	0	4	2
3	EE	EN20601	Career Development Laboratory II	0	0	2	1
			Total	**18**	**0**	**12**	**23**

CM20501 **PROCESS INSTRUMENTATION** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- explain the basic principles of various measuring instruments and its static, dynamic response. errors in themeasurements.
- demonstrate the various instruments utilized to measure the temperature and calculate the temperature usingthermometer, thermistor, radiation pyrometer.
- calculate the pressure using manometer and demonstrate the fundamentals of pressure measuring devices.
- demonstrate the fundamentals of variable head meter, area flow meter, direct, inertial type level meter and density measurement devices.
- select suitable measuring device for gas mixture analysis, thermal, electrical conductivity, viscosity and constructpiping and instrumentation diagram.

UNIT I PRINCIPES OF MEASUREMENT **9**

Analysis: Measurement of Force, Strain and Torque- Use of strain gauges. Transducers - Resistive, capacitive, Inductive and piezoelectric pickups. Static and Dynamic response of Instruments. Errors in measurements

UNIT II TEMPERATURE MEASUREMENT **9**

Liquid filled, Gas filled and Vapour pressure Thermometers. Bimetallic and Resistance thermometers. Thermocouples and Thermistors. Optical and Radiation pyrometers.

UNIT III PRESSURE MEASUREMENT **9**

Manometers, Bourdon gauge and Bellow gauge. Measurement of pressure and Vacuum. Use of Transducers.

UNIT IV FLOW, DENSITY AND LEVEL MEASUREMENTS **9**

Variable head flow meters. Area flow meters. Positive displacement meters. Pressure Probes. Level measurements - Direct and Inertial types. Measurement of density and specific gravity. Instruments for weighing and feeding.

UNIT V MISCELLANEOUS MEASUREMENTS **9**

Analysis of gas mixtures. Thermal conductivity, Viscosity and Electrical conductivity. Supporting instrumentation - Standard cells, Balancing circuits and Terminating devices. Principles of Telemetering. P and I diagrams.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the measurement principles
- understand the temperature measurement
- understand the pressure measurement
- understand the flow, density and level measurement
- understand the measurement of conductivity, p and i diagrams

TEXT BOOKS

1. Eckman, D.P, Automatic Process Control, Wiley Eastern, New Delhi, 2006.
2. Jain, R.K, Mechanical and Industrial Measurements, Twelfth Edition Khanna Publishers, New Delhi 2015.

REFERENCES

1. Perry, R.H., Green, D.W., Perry's Chemical Engineer's Handbook, Eighth Edition, McGraw Hill (ISE), 2007.
2. Considine, D.N., "Process Instruments and Controls Handbook", Fifth Edition, McGraw Hill. New York, 1999.
3. Benedict, R.P, "Fundamentals of temperature, Pressure and Flow measurements", Third Edition, John Wiley, New York. 1984
4. Patranabis. D., Principles of Instrumentation, Second Edition, Tata-McGraw Hill, New Delhi, 2007.
5. Notlingk. B.E., Jones' Instrument Technology, Vol. I and II, Fourth Edition, ELBS, 1987.
6. George Stephanopoulos, "Chemical Process Control" PHI, 2010

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

CM20502 **MASS TRANSFER I** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- know the molecular diffusion of gases and liquids
- understand the analogies in mass transfer
- know about the humidification process
- understand the equilibrium moisture content and drying methods
- know how soluble components are removed from a solution

UNIT I DIFFUSION IN FLUIDS **9**

Molecular diffusion and eddy diffusion- Steady state molecular diffusion in fluids at rest and in laminar flow. Molecular diffusion in gases-steady state diffusion of gas A through non-diffusing gas B, steady state equimolar counter diffusion. Effective diffusivity-steady state diffusion in multicomponent mixtures; Measurement of diffusivity; Molecular diffusion in liquids.

UNIT II INTERPHASE MASS TRANSFER **9**

Mass transfer coefficients-Relation between mass transfer coefficients; Film Theory, Penetration theory, Danckwerts surface renewal theory, Two film theory; Wetted wall towers-Equilibrium stage modelling, equilibrium curve and operating line ; Analogy between momentum, heat and mass transfer.

UNIT III HUMIDIFICATION **9**

Basic concepts and terminologies; Adiabatic saturation process and theory of wet bulb temperature; psychometric chart for Humidification and dehumidification- calculations ; Cooling towers - Principle and design.

UNIT IV DRYING **9**

Theory and mechanism of drying ; drying characteristics of materials - batch and continuous drying , calculation for continuous drying ; Drying equipment: tray, rotary, drum, spray dryer and their applications.

UNIT V CRYSTALLIZATION **9**

Principles of crystallization-super saturation - theory of homogeneous and heterogeneous nucleation; law of crystal growth and growth coefficients ; Calculations involving material and energy balances ;Methods of crystallization based on super saturation and industrial equipment.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- estimate the mass transfer flux for molecular diffusion in fluids and measurement of diffusivity by pseudo diffusion model
- analyze mass transfer theories to predict the mass transfer coefficients, develop the analogy between momentum, heat and mass transfer and draw the operating line for stage-wise operations
- analyze humidification process and cooling tower principles
- estimate the moisture content of different drying equipments

- find the yield and purity of the commercial crystallization

TEXT BOOKS

1. McCabe W.L., Smith J.C., Harriott P., "Unit Operations of Chemical Engineering", Seventh Edition, McGraw Hill International Student Edition, 2005.
2. Anantharaman N and Meera Sheriffa Begum K.M., "Mass Transfer: Theory and Practice", Prentice Hall of India, New Delhi, 2011

REFERENCES

1. Binay K.Dutta, "Principles of Mass Transfer and Separation Processes", PHI Learning Ltd, 2013
2. K.V. Narayanan, B. Lakshmikutty, "Mass Transfer: Theory and Applications" First Edition, CBS Publications and distributors, 2014
3. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II, 4th Edition, Asian Books Pvt. Ltd., India, 1998
4. Sinha, A. P., and Parameswar De. "Mass Transfer: Principles and Operations". PHI Learning Pvt. Ltd.

CO/PO MAPPING

Mapping of Course Outcomes with Programme Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes (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	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

CM20503 CHEMICAL ENGINEERING THERMODYNAMICS 3 0 0 3

COURSE OBJECTIVES

To enable students to

- understand the concepts and laws of thermodynamics
- know the thermodynamic properties
- predict the vapour liquid and phase equilibria
- know the standard free energy change
- familiar with the applications of thermodynamics

UNIT I BASIC CONCEPTS AND LAWS OF THERMODYNAMICS **9**

Terminologies of thermodynamics - Categorization of systems and processes - Laws of thermodynamics Concept of temperature and heat - zeroth law - first law - application to closed and open systems - internal energy of second law – Kelvin - Planck and Clausius statements - Reversible and irreversible process – and cycle - Clausius inequality - Third law

UNIT II THERMODYNAMIC PROPERTIES **9**

Maxwell relations - Thermodynamic relations to calculate enthalpy, entropy, internal energy - PVT behavior of Fluids - laws of corresponding states and equations of state approaches to PVT relationship of non-ideal gas - Compressibility factor - fugacity and fugacity coefficients of real gases - Formulations involving Cp and Cv

UNIT III PHASE, VAPOUR -LIQUID AND CHEMICAL EQUILIBRIA **9**

Phase equilibria - Activity and activity coefficients - Gibbs Duhem equation-Van Laar - Margules equation – test - Prediction of VLE - Criteria of equilibrium - Standard free energy change of equilibrium constants

UNIT IV THERMODYNAMIC CYCLES AND ENGINES **9**

Thermodynamics analysis of steam power plants - Rankine cycle - Internal combustion engine - Otto engine - diesel Engine - Jet engine

UNIT V APPLICATION OF THERMODYNAMICS **9**

Compression and Expansion of fluids - Classification of compression process - Multistage compression-convergent and divergent flow - ejectors - Application of Thermodynamics to flow process – Pumps - turbines – Compressors - Refrigeration principle and applications

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the terminologies and applications of laws of thermodynamic
- experiment the thermodynamic properties and to calculate PVT behavior of gases
- use empirical correlations to evaluate thermodynamic quantities that relate to vapour-liquid, liquid-liquid equilibria of ideal and non-ideal chemical mixtures, Gibbs free energy and equilibrium compositions

- understand the working of internal combustion engines and its applications
- classify the compression process and its effects in various compression equipments and to understand principle and applications of refrigeration process

TEXT BOOKS

1. Smith, J.M,Van Ness ,H.C ana Abbot M.M "Introduction to Chemical Engineering Thermodynamics" Tata McGraw hill publishers ,7th Edition, 2007
2. K.V.Narayanan "A text book of Chemical Engineering Thermodynamics" Prentice hall India, 2004

REFERENCES

1. Kyle.B.G., "Chemical and Process Thermodynamics" 3rd edition, PHI Pvt, Ltd.
2. Elliot J.R., Lira C.T. "Introductory Chemical Engineering Thermodynamics", Prentice hall,1998
3. Pradeep Ahuja, "Chemical Engineering Thermodynamics", PHI Pvt. Ltd., 2009
4. Y.V.C. Rao, "Chemical Engineering Thermodynamics", Universities Press, 1997
5. K.A.Gavhane, "Chemical Engineering Thermodynamics-I", Nirali Prakashan, 2016

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 (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	3	1	1	1	-	-	-	-	1	2	3
CO2	2	1	2	1	1	-	-	-	1	-	-	2	2	3
CO3	3	2	1	3	2	-	-	-	1	1	-	2	2	3
CO4	2	1	2	2	1	-	-	-	-	1	-	2	2	3
CO5	2	2	1	2	1	-	-	-	-	-	1	2	2	3

CM20504 CHEMICAL PROCESS HEAT TRANSFER 3 0 0 3

COURSE OBJECTIVES

To enable students to

- understand the modes of heat transfer
- know the correlations for calculation of heat transfer coefficients
- design various types of heat exchangers and condensers
- understand the heat transfer to fluids and types of condensation
- understand the concept of evaporation and radiation

UNIT I CONDUCTION **9**

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Fourier's law of heat conduction – one dimensional steady state heat conduction equation for flat plate- hollow cylinder- Heat conduction through a series of resistances- effect of temperature on thermal conductivity-Combined Conduction- Convection Heat transfer-Critical radius of insulation-Heat transfer in extended surfaces.

UNIT II CONVECTION **9**

Concepts of heat transfer by convection - Natural and forced convection, Dimensional analysis in heat transfer-Correlations for the calculation of heat transfer coefficients-heat transfer coefficient for flow through a pipe, flow through a non -circular conduit-Concepts of thermal boundary layer-Von karmaan Integral & energy- Equation for flow past flat plate- Heat transfer by natural convection

UNIT III HEAT EXCHANGERS **9**

Parallel and counter flow heat exchangers - Log mean temperature difference - Single pass and multipass heat exchangers-plate heat exchangers; use of correction factor charts- heat exchangers effectiveness-number of transfer unit - Chart for different configurations - Fouling factors - Design of various types of heat exchangers and condensers

UNIT IV CONDENSATION AND BOILING **9**

Heat transfer to fluids with phase change - heat transfer from condensing vapours-drop wise and film wise condensation,Nusselt equation for vertical and horizontal tubes-condensation of superheated vapours, effect of non-condensable gases on rate of condensation- Heat transfer to boiling liquids - mechanism of boiling-nucleate boiling and film boiling

UNIT V EVAPORATION AND RADIATION **9**

Theory of evaporation - single effect and multiple effect evaporation - Types of Evaporators -Design calculation for single and multiple effect evaporation - Radiation heat transfer - Emissive power-Black body radiation- Emissivity, Stefen - Boltzman law-Planck's law- radiation between surfaces

TOTAL PERIODS 45

COURSE OUTCOMES

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

- solve one-dimensional steady state heat conduction problems for the rectangular, cylindrical and spherical composite walls.
- analyze the convection heat-transfer problems for laminar and turbulent flows
- estimate heat exchanger design parameters like heat transfer area and overall heat transfer coefficient using LMTD and effectiveness - NTU method
- estimate the heat transfer co-efficient for condensation, boiling heat transfer
- apply fundamental laws of radiation to determine the heat transfer rate

TEXT BOOKS

1. Binay K. Dutta., "Heat Transfer: Principles and Applications", Fifth Printing, Prentice Hall of India Private Limited,2006
2. Holman, J. P., "Heat Transfe"r, Eighth Edition, McGraw Hill, 1997

REFERENCES

1. McCabe W.L., Smith J.C., Harriott. P., "Unit Operations of Chemical Engineering", Seventh Edition, McGraw Hill International Student Edition, 2005.
2. Kern, D.Q., "Process Heat Transfer", McGraw-Hill, 1999.
3. Coulson, J.M. and Richardson, J.F., "Chemical Engineering Vol-1", Fourth Edition, Asian Books Private Limited, India, 1998
4. K.A. Gavhane, "Heat Transfer", Eighteenth Edition, Niralai Publication, 2016

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

CM20505 DRUGS AND PHARMACEUTICAL TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

To enable students to

- understand the sources of drugs
- know the principles and basic pharmacodynamics
- manufacture tablets and capsules
- know about the microbiological products
- understand the concept of drug delivery

UNIT I INTRODUCTION **9**

Development of drugs and pharmaceutical industry; organic therapeutic agents, uses and economics

UNIT II DRUG ACTION, METABOLISM AND PHARMACOKINETICS **9**

Mechanism of drug action – physico-chemical principles of drug metabolism - radioactivity; Pharmacokinetics, Pharmacodynamics: Factors modifying drug action, adverse drug reaction, drug interactions, Bioassay of drugs, drug discovery and development.

UNIT III MANUFACTURING PRINCIPLES **9**

Compressed tablets and coating - Wet granulation, Dry granulation or Slugging, Capsules, Parenteral solutions, Oral liquids, Ointments, Good Manufacturing Practice as per Drugs and Cosmetics Act.

UNIT IV PHARMACEUTICALS AND MICROBIOLOGICAL PRODUCTS **9**

Laxatives, Radiopharmaceuticals, Cardiovascular agents, Central Nervous System stimulants, External Antiseptics, Analgesics, Antacids, Antibiotics, Antineoplastic drugs, Antidiabetic drugs, Hormones, Vitamins.

UNIT V DRUG DELIVERY PHARMACEUTICAL ANALYSIS AND QUALITY CONTROL **9**

Transdermal drug delivery, Polymers in drug delivery, Liposomal drug delivery, Nano drug delivery, Opthalmic drug delivery, Design of Controlled Drug Delivery Systems.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- develop nomenclature for upcoming drugs and gain knowledge of therapeutic agents to be used for treatment
- estimate the pharmacokinetic parameters and analyze the transformation of drugs in the body
- employ standards of hygiene in the manufacturing processes of drugs and pharmaceuticals
- examine the constituents present in pharmaceutical and microbiological products
- formulate drug delivery systems to transport pharmaceutical agents in the body to achieve therapeutic effect.

TEXT BOOKS

1. Chatwal G.R., Synthetic Drugs, Himalaya Publishing House, Delhi, 2009
2. Brahmankar D.M. and Jaiswal S.B. Biopharmaceutics and Pharmacokinetics - A Treatise, Vallabh Prakashan, New Delhi, 2015

REFERENCES

1. Juergen Siepmann, Ronald A. Siegel, Michael J. Rathbone, Fundamentals and Applications of Controlled Release Drug Delivery, Springer, 2011
2. Tyagi O.D., Yadav M. A., Text Book of Synthetic Drugs, Anmol Publications, New Delhi, 2011
3. Lachman L. Lieberman H.A. and Kanig J.L., The Theory and Practice of Industrial Pharmacy, Indian Edition, Varghese Publishing House, Mumbai, 2013
4. Felton, Linda A., Remington: Essentials of Pharmaceutics, College of Pharmacy, Philadelphia, 2013.

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

CM20506 **PROCESS INSTRUMENTATION LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable students to

- acquire fundamental knowledge about chromatography and spectroscopy
- gain fundamental and industrial knowledge about temperature and pressure measurement
- obtain fundamental and industrial knowledge about flow and level measurement devices
- study about photometers and thermometers

LIST OF EXPERIMENTS

1. Precision and validity in an experiment using Absorption Spectroscopy
2. Chromatography analysis using TLC
3. Chromatography analysis using Column Chromatography
4. Gas Chromatography analysis
5. Use of Flame Photometer in estimation of trace metals like Sodium and Potassium
6. Estimating Color of solutions using Spectrophotometer
7. Temperature measurement
8. Pressure measurement
9. Flow measurement
10. Density measurement
11. Level measurement

TOTAL PERIODS 60

COURSE OUTCOMES

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

- differentiate measuring devices in temperature, pressure.
- measure the flow and level using industrial equipment.
- understand the density measurement devices
- measure the flow and level

REFERENCES

1. Perry, R.H., Green, D.W., Perry's Chemical Engineer's Handbook, Eighth Edition, McGraw Hill (ISE), 2007.
2. Considine, D.N., "Process Instruments and Controls Handbook", Fifth Edition, McGraw Hill. New York, 1999.
3. Benedict, R.P, "Fundamentals of temperature, Pressure and Flow measurements", Third Edition, John Wiley, New York. 1984
4. Patranabis. D., Principles of Instrumentation, Second Edition, Tata-McGraw Hill, New Delhi, 2007.

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	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	2	-	-	-	1	1	-	2	2	3

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CM20507 **HEAT TRANSFER LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable students to

- acquire fundamental and industrial knowledge about heat transfer modes like conduction
- gain fundamental and industrial knowledge about modes like convection
- obtain fundamental and industrial knowledge about heat transfer modes like radiation
- study about various heat exchangers used in industries

LIST OF EXPERIMENTS

1. Composite wall
2. Natural and Forced Convection
3. Stefan Boltzmann experiment – Radiation.
4. Emissivity Apparatus
5. Double pipe Heat Exchanger (Parallel and Counter flow)
6. Plate type Heat Exchanger
7. Shell and tube Heat Exchanger
8. Condenser (Horizontal)
9. Condenser (Vertical)
10. Open Pan Evaporator
11. Heat transfer in extended surfaces

TOTAL PERIODS 60

COURSE OUTCOMES

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

- calculate heat transfer through conduction using classical models.
- calculate heat transfer through different types of convection using classical models.
- estimate coefficients for different types of exchangers in different surfaces
- calculate heat transfer through radiation using classical models.

REFERENCES

1. McCabe W.L., Smith J.C., Harriott. P., "Unit Operations of Chemical Engineering", Seventh Edition, McGraw Hill International Student Edition, 2005.
2. Kern, D.Q., "Process Heat Transfer", McGraw-Hill, 1999.
3. Coulson, J.M. and Richardson, J.F., "Chemical Engineering Vol-1", Fourth Edition, Asian Books Private Limited, India, 1998
4. K.A. Gavhane, "Heat Transfer", Eighteenth Edition, Niralai Publication, 2016

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	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	2	-	-	-	1	1	-	2	2	3

EN20501 **CAREER DEVELOPMENT LABORATORY I** **0 0 2 1**

COURSE OBJECTIVES

To enable students to

- enhance their writing skills.
- evaluate their presentation skill to face the corporate world.
- solve the quantitative aptitude problems and improve their mental ability.
- improve the critical thinking and reasoning skills.

UNIT I WRITING SKILLS **6**

Writing Skills: The Essentials of Writing – The Importance of Structure – Types of Writing – Common Mistakes in Writing

Activities: Email Writing - Paragraph writing – Report Writing – Story Writing - Story Telling Session: 2 – JAM Session 1

UNIT II PRESENTATION SKILLS AND GROUP DISCUSSION **6**

Presentation Skills: Types of Presentation– Methods of Delivering Presentation –Ways to improve the Presentation – Presentation Aids; Group Discussion: Introduction –Types and Importance – Why GD – Types of GD- Evaluation Criteria – Do's and Don'ts of GD

Activities: Presentation Session I, Group Discussion Session I, Role Play Session (Team): Level II – Personality Profile Session II – Company Profile Analysis Session II

UNIT III QUANTITATIVE APTITUDE **6**

Simplification – Cubes and Cube Roots – Squares and Square Roots – Boats and Streams – Trains – Profit and Loss – Pipes and Cisterns

UNIT IV LOGICAL REASONING - I **6**

Series Completion – Letter Series – Symbol Series – Number Series – Arithmetic Reasoning

UNIT V LOGICAL REASONING - II **6**

Blood Relations – Seating Arrangement - Character Puzzle

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- excel in drafting mails and speaking
- demonstrate the participative skills in group discussions.
- solve problems based on quantitative aptitude.
- enhance their logical and verbal reasoning.

TEXTBOOKS

1. Agarwal, R.S. "A Modern Approach to Verbal and Non Verbal Reasoning", S.Chand & Co Ltd, new delhi.2015.
2. Agarwal, R.S. "Objective General English", S.Chand & Co.2016.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude", Tata-Mcgraw Hill.2015.
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications.2016.
3. Johnson, D.W. Reaching out – Interpersonal Effectiveness and self actualization. Boston: Allyn And Bacon.2019.
4. Infosys Campus Connect Program – students' guide for soft skills.2015.

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	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	-	-	1	-	-	-	-	2	-	2	3
CO4	2	3	3	2	1	3	3	1	-	1	2	-	2	3

CM20601 **PROCESS TECHNOLOGY AND ECONOMICS** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- comprehend the unit operations/ processes in chlor-alkali industries
- identify the types of petroleum and its processing methods
- understand the utilities in process plants
- have the knowledge on planning and techniques of measurement of work and attain the importance of cost estimation
- estimate the project profit and techniques for investment and analyse the performance

UNIT I **INORGANIC CHEMICAL INDUSTRIES** **9**

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of inorganic chemicals, such as: inorganic acids, chlor-alkali, ammonia, fertilizers,

UNIT II **PETROLEUM AND PETROCHEMICAL INDUSTRIES** **9**

Petroleum refining and cracking operations - syngas and hydrogen - benzene, toluene, xylene, methane - olefins - acetylenes and aromatics and products obtained from them by various unit processes.

UNIT III **PROCESS PLANT UTILITIES** **9**

Industrially relevant fuels - coal, coal-based chemicals and fuels, Common utilities such as compressed air, electricity, cooling water, steam, hot oil, refrigeration and chilled water

UNIT IV **PRINCIPLES OF MANAGEMENT AND COST ESTIMATION** **9**

Planning, organization, staffing, coordination, directing, controlling, communicating, organization as a process and a structure; types of organizations. Method study; work measurement techniques; Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, capital budgeting and project feasibility.

UNIT V **INVESTMENT ALTERNATIVE AND ANALYSIS OF PERFORMANCE** **9**

Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact - Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the role of chemical engineers in process industries and develop block diagrams and flow charts for manufacture of different chemicals
- know the process by which petroleum refining and its derivatives are formed
- understand chemical industries utilities and its effective use
- understand the importance of planning and organization and have knowledge of money and its utilization for the projects

- gain the knowledge on balance sheet and their performance along with investment alternatives and its forecasting

TEXTBOOKS

1. Shreve's Chemical Process Industries, George T. Austin, McGraw-Hill International Editions Series, 1984
2. Plant Design and Economics for Chemical Engineers, Max Peters, Klaus Timmerhaus, Ronald West, McGraw Hill International Edition, 2013

REFERENCES

1. W Smith, R Chapman, "Chemical Process Industries: Inorganic Chemicals and Allied Industries Volume 1", CBS Publishers & Distributors limited
2. Shreve, Randolph Norris, and Joseph A. Brink Jr. "Chemical Process Industries" No. 4th Edition. McGraw-Hill Book Co., 1977.
3. Perry, R. H. and Green, D., "Chemical Engineer's Handbook ", 8th Edition, McGraw Hill (2007)
4. V. Sivasubramanian, "Process Economics and Industrial Management", 1st Edition, Galgotia publishers, 2008
5. M. Gopala Rao, Dryden's "Outlines of Chemical Technology", Marshall Sittig, East West Press, 1997
6. Mahajani V. V. and Mokashi S M., "Chemical Project Economics", MacMillan India Ltd. 2005

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

CM20602 CHEMICAL REACTION ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable students to

- formulate the rate equation from the stoichiometry and reaction mechanism for reactions
- analyse kinetic data and determine the components of the rate equation
- design of batch, plug flow and continuous stirred tank reactors based on the specific reaction conditions
- compute precisely the moments of RTD
- develop the reaction kinetics for a heterogeneous catalytic and non-catalytic reaction

UNIT I CHEMICAL KINETICS 9

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

UNIT II DATA ANALYSIS AND INTERPRETATION 9

Differential and integral methods of analysis of rate data, Interpretation of rate data in constant and variable volume systems, Kinetics of irreversible, Parallel and Series reactions in constant volume batch reactor.

UNIT III DESIGN OF IDEAL REACTORS 9

Development of design expressions for Batch, Plug flow and Continuous Stirred Tank Reactors and Non-isothermal reactors. Comparison, advantages and limitations. Concept of space time and velocity. Size comparison of single reactors. Plug flow reactors in series and parallel, Mixed flow reactors of equal and different sizes in series. Reactors of different types in series. Recycle reactor. Qualitative and quantitative treatment of parallel & series reactions.

UNIT IV NON- IDEAL FLOW 9

Residence time distribution Function. Relationship among E, F and C curves. Moments of RTD. Models for non-ideal flow - Segregation, Tanks in series and Dispersion models. Reactor modelling with RTD

UNIT V HETEROGENEOUS REACTIONS 9

Non catalytic fluid-solid systems: Kinetic models for non-catalytic fluid-solid systems - Progressive conversion and Unreacted core Models. Development of rate expressions for various controlling regimes. Heterogeneous Catalysis: Kinetics and rate expressions for fluid-solid catalytic reactions. Langmuir Hinshelwood and Eley Rideal mechanisms for surface Reactions. Reaction and diffusion within porous catalysts. Concept of effectiveness factor.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the kinetics of homogenous reaction
- develop performance equation and determine the conversion for different reactors
- understand the reactor arrangement in series and parallel configuration and the design of reactor

for multiple reactions.

- understand the non-isotherm operation of the reactor
- acquire knowledge in kinetics of heterogenous reaction

TEXT BOOKS

1. Octave Levenspiel, "Chemical Reaction Engineering", Third Edition., John Wiley and sons, New Delhi,2007.
2. Smith J.M., "Chemical Engineering kinetics", Third Edition, McGraw Hill, 1981.

REFERENCES

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
4. K.A.Gavhane, " Chemical Reaction Engineering", Nirali Publications, 2016

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

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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

CM20603 **MASS TRANSFER II** 3 0 0 3

COURSE OBJECTIVES

To enable students to

- deal with the methods by which soluble vapor is absorbed from its mixture.
- know the basic requirement and technique for a separation of components by distillation.
- identify the process by which homogeneous mixture is separated by various extractors.
- understand the operation by which solid extraction is done.
- enrichment of a chemical substance at the surface of the solid.

UNIT I ABSORPTION 9

Equilibrium and operating line concept in absorption calculations; types of contactors, design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors, concepts of NTU, HTU and overall volumetric mass transfer coefficients; multicomponent absorption; mechanism and model of absorption with chemical reaction; thermal effects in absorption process.

UNIT II DISTILLATION 9

Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by McGabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation

UNIT III LIQUID-LIQUID EXTRACTION 9

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

UNIT IV LEACHING 9

Solid-liquid equilibria- leaching equipment for batch and continuous operations, calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), equipments for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

UNIT V ADSORPTION, ION EXCHANGE AND MEMBRANE SEPARATION PROCESSES 9

Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process
- identify the suitable distillation techniques to determine the number of trays
- apply the ternary equilibrium diagram concepts to determine the number of stages
- describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation.
- understand the concept of adsorption techniques, various isotherms and ion exchange process.

TEXT BOOKS

1. Treybal, R.E., "Mass Transfer Operations ", 3rd Edn., McGraw-Hill, 1981.
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.

REFERENCES

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw-Hill, 2005.
2. Seader J.D. and Henley E.J., "Separation Process Principles", 2nd Ed., John Wiley, 2006.
3. King.C.J,"Separation Processes",2nd Edn.,Tata McGraw-Hill, 1980
4. Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.

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

CM20604 **CHEMICAL PROCESS PLANT SAFETY** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- have the awareness of safety codes and safety programmes
- identify and prevent the hazards and safe handling of materials.
- understand the risk analysis and its implementation
- learn the safety and hazard prevention
- have the knowledge of HAZOP

UNIT I **INTRODUCTION TO SAFETY PROGRAMMES** **9**

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling.

UNIT II **PLANT HAZARDS** **9**

Chemical process industries; potential hazards; high pressure; high temperature operation; dangerous and toxic chemicals; highly radioactive materials; safe handling and operation of materials and machineries; planning and layout. Hazards- fire, explosion and radiation; Occupational diseases - effects.

UNIT III **RISK ANALYSIS** **9**

Overall risk analysis - emergency planning - on site & off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV **SAFETY AND HAZARD ANALYSIS AND PREVENTION** **9**

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety - Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, HAZAN past accident analysis Fixborough-Mexico-Madras-Vizag Bhopal analysis

UNIT V **HAZOP** **9**

Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse HAZOP study-case studies-pumping system-reactor-mass transfer system.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understanding the chemical process safety, plant layout, safety codes
- identify and protect the effect of occupational health hazards.
- understanding on risk management ISO 14000, EMS
- carry hazard identification safety audits, checklist, vulnerability models, what if analysis, event tree analysis fault tree analysis
- understand the HAZOP and case study

TEXT BOOKS

1. Daniel A. Crowl, J.F. Louvar, "Chemical Process Safety: Fundamentals with Applications", Prantice Hall, NJ, 1990.
2. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965

REFERENCES

1. Handley, W., "Industrial Safety HandBook", 2nd Edn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Taylor, J.R., "Risk Analysis for Process Plant, Pipelines and Transport", Chapman and Hall, London, 1994
4. Hyatt, N., "Guidelines for Process Hazards Analysis, Hazards Identification & Risk Analysis", Dyadem Press, 2004.

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														
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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

CM20605 CHEMICAL REACTION ENGINEERING LABORATORY 0 0 4 2

COURSE OBJECTIVES

To develop skill for design and experiment on reactors 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. Separation of binary mixture using Packed column distillation
4. Kinetic studies in a CSTR
5. Kinetic studies in a Packed bed reactor
6. Kinetic studies in a PFR followed by a CSTR
7. RTD studies in a PFR
8. RTD studies in a Packed bed reactor
9. RTD studies in a CSTR
10. Studies on micellar catalysis
11. Study of temperature dependence of rate constant using CSTR.
12. 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

REFERENCES

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
4. K.A.Gavhane, " Chemical Reaction Engineering", Nirali Publications, 2016

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

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CM20606 **MASS TRANSFER LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable students to

- develop sound working knowledge on different types of mass transfer equipment
- learn separation using distillation and drying characteristics
- estimate of coefficients in cooling tower
- studies on ion-exchange, RDC and gas-liquid absorption

LIST OF EXPERIMENTS

1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of Vacuum Dryer
7. Drying characteristics of Tray dryer
8. Drying characteristics of Rotary dryer
9. Water purification using ion exchange columns
10. Mass transfer characteristics of Rotating disc contactor
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Demonstration of Gas – Liquid absorption

TOTAL PERIODS 60

COURSE OUTCOMES

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

- determine design of process equipment like distillation and driers
- evaluate the drying characteristics
- estimate mass transfer coefficients
- understand the mass transfer principles which are having wide applications in various industries

REFERENCES

1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Fourth Edition, 1984.
2. Treybal, R.E., "Mass Transfer Operations ", 3rd Edn., McGraw-Hill, 1981.
3. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.
4. Seader J.D. and Henley E.J., "Separation Process Principles", 2nd Ed., John Wiley, 2006.

CO/PO MAPPING

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2
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CO3	3	2	1	2	2	-	-	-	1	1	-	1	2	3
CO4	3	2	2	2	2	-	-	-	-	1	-	2	2	3
CO5	2	2	1	1	3	-	-	-	-	-	1	1	2	3

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EN20601 **CAREER DEVELOPMENT LABORATORY II** **0 0 2 1**

COURSE OBJECTIVES

To enable students to

- draft resume and enhance their skills to manage stress to survive in corporate world.
- excel in interview skills.
- solve the quantitative aptitude problems and improve their problem-solving skills.
- improve their reasoning skills to get placed in reputed companies.

UNIT I **RESUME WRITINGS** **6**

Resume Writing Skills: Curriculum Vitae and Resume – Things to do while writing a Resume – Mistakes and Pitfalls to Avoid- Cover Letter: General Guidelines – The Content - Stress Management – Dressing Etiquette

Activities: Corporate Resume Building Session I – JAM Session: Level III – Role Play Session (Individual): Level III - Company Profile Analysis Session III – Personality Profile Analysis Session III

UNIT II **INTERVIEW SKILLS** **6**

Interview Skills: Introduction – Before the Interview – During the Interview – After the Interview – Types of Interview

Activities: Presentation Session: Level II- Group Discussion Session: Level III ,Mock Interview Practice Session, Corporate Resume Building Session II

UNIT III **QUANTITATIVE APTITUDE** **6**

Permutation and Combination – Probability: Dice, Colours, Coin, Cards ; Partnership – Ages – Calendars

UNIT IV **LOGICAL REASONING -I** **6**

Making Judgments – Matching Definitions – Cause and Effect

UNIT V **LOGICAL REASONING II** **6**

Directions – Syllogism – Analogy – Statements and Arguments

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- write resume and enhance their etiquettes.
- demonstrate the interpersonal skills in group discussions.
- compute problems based on quantitative aptitude.
- reveal their logical and verbal reasoning by scoring the expected percentage to get placed in reputed companies.

TEXTBOOKS

1. Agarwal, R.S. "A Modern Approach to Verbal & Non Verbal Reasoning", S.Chand& Co Ltd, new delhi.2015.
2. Agarwal, R.S. "Objective General English", S.Chand&Co.2016.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude", Tata-Mcgraw Hill.2015.
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications.2016.
3. Johnson, D.W. Reaching out – Interpersonal Effectiveness and self actualization. Boston: Allyn and Bacon.2019.
4. Infosys Campus Connect Program – students' guide for soft skills.2015.

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**														
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CO3	3	2	2	-	-	1	-	-	-	-	2	-	2	3
CO4	2	3	3	2	1	3	3	1	-	1	2	-	2	3

CM20151 CHEMICAL INDUSTRIES MANAGEMENT AND IPR 3 0 0 3

COURSE OBJECTIVES

To enable students to

- learn organization and organizational behavior
- understand the strategic innovation and technology transfer
- know about material management
- understand IPR
- know the registration process of IPR

UNIT I ORGANISATIONAL PROCESS AND BEHAVIOUR 9

Introduction and Meaning of Organization, Organization as a process, Span of Control, Authority, Responsibility and Accountability, Delegation of authority, Decentralization of authority. Enhancing Managerial Effectiveness through self and others, Individual Personality & Behaviour, Perception, Attitudes, Values and Aptitude, Frustration, Conflict, Organisational structure, Organisational culture, Organisational transformation, Organisational Effectiveness and Assessment.

UNIT II TECHNOLOGY MANAGEMENT 9

Strategies & their applications in industry, Business specifications versus Technical specifications, Introduction to Strategic Innovation, Introduction to technology transfer.

UNIT III MATERIALS MANAGEMENT 9

Definition, objectives, organization, stages, factors responsible, value analysis, Management of project materials and maintenance materials, Purchasing and vendor development, Spares strategy, warehousing, store-keeping and inventory control

UNIT IV INTRODUCTION TO IPR 9

Introduction to IPRs, basic concepts and need for Intellectual Property – Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, Technological Research, Inventions and Innovations – Important examples of IPR.

UNIT V REGISTRATION OF IPR 9

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade secrets and Industrial Design registration in India and Abroad.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- understand the organizational behavior
- know the technology management
- understand the material management
- learn IPR concepts
- learn the registration process of IPR

TEXTBOOKS

1. Industrial Management– I, Jhamb L. C. and Jhamb S.
2. S.V. Satakar, "Intellectual Property Rights and Copy Rights", Ess Ess Publications, New Delhi, 2002

REFERENCES

1. Industrial Management, Spriegel U.S.
2. Organizational Behaviour, Luthans F
3. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012
4. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011

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

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CM20152 **WATER CONSERVATION AND MANAGEMENT** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- learn the water cycle and storage
- learn about water management
- learn quality measurement
- know about the water audit
- learn water conservation

UNIT I **INTRODUCTION TO WATER CYCLE** **9**

Introduction: water cycle, water storage, water quality; controlling use and quality of water

UNIT II **WATER MANAGEMENT IN HOMES AND WORKPLACE** **9**

Water conservation in homes; water conservation in the workplace; water management

UNIT III **QUALITY MEASUREMENT AND CONTROL** **9**

Water Quality Water flow measurement, water quality control, testing water salinity, preserving water quality

UNIT IV **WATER AUDIT** **9**

Minimizing evaporation, water sanitation, water audits

UNIT V **WATER CONSERVATION** **9**

Water conservation in agriculture; water conservation in process industry; water conservation in construction industry; water conservation in service industry.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- understand the water cycle, storage
- understand the water conservation in home and workplace management
- understand the quality measurement
- understand the water audit
- understand the conservation of water

TEXT BOOKS

1. Frye, Wilbur W.; Pierce, Francis J, 2018 Advances in soil and water conservation a. CRC Press
2. Troeh F.R., Hobbs J.A., Donahue R.L, "Soil and Water Conservation for Productivity and Environmental Protection"

REFERENCES

1. Rangwala, "Water Supply and Sanitary Engineering", Charoter Publications
2. S.K. Garg, "Irrigation Engineering and Hydraulic Structures", Water Resource engineering (Volume II), Khanna Publishers, New Delhi

3. Glenn O. Schwab, "Soil and Water Conservation Engineering", 4th Ed, John Wiley and Sons (WIE), 1966
4. OP Gupta, "Elements of Water Pollution Control Engineering", Khanna Publishing House, Delhi

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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	-	-	-	-	1	2	3
CO2	2	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

PAVAI ENGINEERING COLLEGE, NAMAKKAL
Approved
BOARD OF STUDIES
Chemical Engineering
AUTONOMOUS

CM20153 **PULP AND PAPER TECHNOLOGY** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- learn the fundamental for raw materials for the pulp.
- understand the various operation to produce pulp.
- gain the manufacturing processing of pulp.
- infer the manufacturing processing of paper.
- interpret Properties and testing of paper and pulp.

UNIT I INTRODUCTION **9**

History of Papermaking, Raw Material for Pulp- wood, Chemical Composition of Wood, Cellulose, Hemicelluloses, Lignin, Wood Structure and Morphology, Ultrastructure and Distribution of Cell Wall Components, Lignification of the Cell Walls, Cell Types-Softwood and Hardwood Structure.

UNIT II WOODYARD OPERATION **9**

Woodyard Operation- Raw Material Storage; Debarking Method- Drum Debarker, Rotary Debarker, Ring Debarkers; Chipping and Screening, -Disc Chipper, Drum Chipper, Chip screening, Mechanical Screening, Wind Screening, Air Density Separator (ADS); Transport and Handling Systems; Chip Storage- Chip Storage Systems.

UNIT III PULP PROCESSING **9**

Processing of pulp- Cooking, Defibering, Deknotting, Washing, Screening and Thickening- Bleaching- Oxygen bleaching, Chlorine dioxide bleaching, Hydrosulfite bleaching, Peroxide bleaching, Ozone bleaching; Manufacture of pulp - pulping process, Kraft pulping; sulphite pulping; mechanical and thermomechanical pulping.

UNIT IV PAPER PROCESSING **9**

Secondary Fiber Processing: Paper making process- Wet end operations- Fourdrinier paper machine- Forming and Pressing- Dry end operations- Drying, Calendaring, Reeling, winding and Roll finishing - Surface treatments- Sizing, Coating and super calendaring.

UNIT V PROPERTIES AND TESTING **9**

Properties and testing of pulp - Properties and testing of paper - Paper end uses- Sheet finishing, Converting and Printing - Process control- Quality assurance.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- apply the knowledge on hardwood and soft wood.
- prepare the debarking, chipping, and screening process for the pulp production.
- summarize the synthesis of pulp production.
- illustrate the synthesis of paper production.
- analyse the testing of pulp and paper.

TEXTBOOKS

1. Herbert Sixta, - "Handbook of Pulp Handbook of Pulp" WILEY-VCH Verlag GmbH &Co. 2006.
2. George Austin, - "Shreve's Chemical Process Industries", McGraw Hill Education 2012.

REFERENCES

1. Smook G.A., -"Handbook for Pulp & Paper Technologists", 3rd Edition, Angus Wilde Publications, Incorporation, United States of America, 2003.
2. Christopher J. Biermann - "Handbook of Pulping and Paper making", Academic Press An Imprint of Elsevier, 2006.
3. Kenneth W. Brittt, -"Handbook of Pulp and Paper Technology", 2nd Edition, John Wiley & Sons Inc, United State of America, 1971.
4. Kent J.A., "Riggel's- Hand Book of Industrial Chemistry", 1st Edition, Van Nostrant Reinhold, United State of America, 1974

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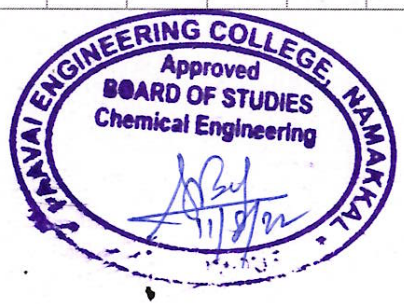
CO1	2	2	1	1	1	1	1	-	-	-	-	1	2	3
CO2	2	2	1	2	1	-	-	-	1	-	-	2	2	1
CO3	1	2	1	2	1	-	-	-	1	1	-	2	2	2
CO4	2	1	2	2	1	-	-	-	-	1	-	2	2	2
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



CM20154 NANOMATERIALS: SYNTHESIS, CHARACTERIZATION AND APPLICATION **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- learn the basis of nanoscience
- understand the general methods in synthesis of nanoparticles
- know the preparation and applications of nanomaterials
- learn the characterization techniques
- know the applications of nanotechnology

UNIT I INTRODUCTION **9**

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thin films-multi-layered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only

UNIT II GENERAL METHODS OF PREPARATION **9**

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS **9**

Nanoforms of Carbon – Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO_2,MgO, ZrO_2, NiO, nanoalumina, CaO, $AgTiO_2$, Ferrites, Nanoclays-functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES **9**

X-ray diffraction technique, Scanning Electron Microscopy – environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

UNIT V APPLICATIONS **9**

Nano InfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nano biotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging – Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products – In Photostat, printing, solar cell, battery.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- demonstrate the preparation of nanomaterials
- develop knowledge in characteristic nanomaterial
- produce different products based on nanotechnology
- know all characterization techniques
- learn all the applications of nanomaterials

TEXT BOOKS

1. A.S. Edelstein and R.C. Cammearata, eds., —Nanomaterials: Synthesis, Properties and Applications, Institute of Physics Publishing, Bristol and Philadelphia, 1996
2. N John Dinardo, — Nanoscale Characterisation of surfaces & Interfaces, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000

REFERENCES

1. G Timp, —Nanotechnology, AIP press/Springer, 1999.
2. Akhlesh Lakhtakia, "The Handbook of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations", Prentice-Hall of India (P) Ltd, New Delhi, 2007
3. Guozhong Cao, Ying Wang, "Nanostructures and Nanomaterials: Synthesis, Properties, and Applications", World Scientific, 2011
4. K.T.Ramesh, "Nanomaterials", Springer, 2010

CO/PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes

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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

CM20251 **BIOCHEMICAL ENGINEERING** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- understand the biochemical process and microbial structure.
- introduce the Immobilized enzyme technology and their kinetics
- acquire the knowledge on cellular growth structure and their kinetics.
- know the techniques in gas-liquid mass transfer and their power requirements.
- familiarize about the membrane separation and purification methods.

UNIT I INTRODUCTION **9**

Industrial biochemical processes with typical examples, comparing chemical and biochemical processes, development and scope of biochemical engineering as a discipline. Industrially important microbial strains; their classification; structure; cellular genetics

UNIT II KINETICS OF ENZYME ACTION **9**

Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action - modulation and regulation of enzyme activity - types of inhibition. Immobilized enzyme technology: enzyme immobilization, Immobilized enzyme kinetics: effect of external mass transfer resistance.

UNIT III KINETICS OF MICROBIAL GROWTH **9**

Kinetics of cellular growth in batch and continuous culture - models for cellular growth unstructured - structured and cybernetic models - medium formulation. Thermal death kinetics of cells and spores - stoichiometry of cell growth and product formation - Design and analysis of biological reactors.

UNIT IV TRANSPORT PHENOMENA **9**

Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems - determination of heat oxygen transfer rates, power requirements for sparged and agitated vessels - scaling of mass transfer equipment

UNIT V DOWN STREAM PROCESSING **9**

Downstream processing: Strategies to recover and purify products; separation of insoluble products - filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions - membrane separation (dialysis, ultrafiltration and reverse osmosis) - chromatographic Separation - gel permeation chromatography – electrophoresis - final steps in purification – crystallization and drying.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain the Basic biochemical engineering principles and applications relevant to bioprocesses.
- choose the immobilized techniques and their substrates.

- design the suitable biological reactors and models for cellular growth.
- determine the heat and mass transfer oxygen rates.
- sketch the steps in purification methods.

TEXT BOOKS

1. J.E.Bailey and D.F.Ollis, "Biochemical engineering fundamentals" 2nd edition, 1986, McGraw Hill
2. Michael L. Shuler and Fikret Kargi, "Bioprocess Engineering" 2nd edition, Pearson education.

REFERENCES

1. "Biochemical Engineering" by James M.Lee – Prentice-Hall-1992.
2. "Bioprocess Engineering Principles", Pauline M. Doran, Academic Press.
3. "Biochemical Engineering", H.W. Blanch and D.S. Clark, Marcel Dekker, 1997
4. Aiba, S; Humphrey, A.E., Milli, N.R., "Biochemical Engineering" 2nd ed., Academic Press, 1973

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

CM20252 POLYMER SCIENCE AND ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable students to

- know the basic concepts of polymer science
- understand the structure and physical properties of polymer
- learn the types of polymerization
- know the properties of polymers which are commercially used
- learn the different processing techniques of polymer

UNIT I POLYMER CHAINS AND THEIR CHARACTERIZATION 9

The science of large molecules - Basic concepts of polymer science. History of macromolecular science, molecular forces and chemical bonding in polymers. Polymer solutions. Criteria for polymer solubility, Conformations of dissolved polymer chains, Thermodynamics of polymer solutions, Phase separation in polymer solutions

UNIT II STRUCTURE AND PROPERTIES OF BULK POLYMERS 9

Morphology and order in crystalline polymers - Configurations of polymer chains, crystal structure of polymers, morphology of polymer single crystals. Rheology and the mechanical properties of polymers - Viscous flow, kinetic theory of rubber elasticity and viscoelasticity. Polymer structure and physical properties - The crystalline melting point, the glass transition, properties involving large deformations, properties involving small deformations, property requirement and polymer utilization.

UNIT III POLYMERIZATION 9

Step-reaction (Condensation) polymerization - Classification of polymers and polymerization mechanisms, chemistry of stepwise polymerization, kinetics and statistics of linear stepwise polymerizations. Radical chain (Addition) polymerization - chemistry of vinyl polymerization, laboratory methods in vinyl polymerization, steady state kinetics of vinyl radical polymerization. Ionic and coordination chain (Addition) polymerization - chemistry of non-radical chain polymerization, cationic polymerization, anionic polymerization, coordination polymerization. copolymerization - Kinetics of copolymerization, composition of copolymers, chemistry of copolymerization.

UNIT IV PROPERTIES OF COMMERCIAL POLYMERS 9

Hydrocarbon plastics and elastomers - low density (branched) polyethylene, High density (linear) polyethylene, polypropylene, natural rubber and other poly isomers, rubbers derived from butadiene. other carbon chain polymers - polystyrene and related polymers, acrylic polymers, poly (vinyl esters) and derived polymers. Hetero chain thermoplastics - Polyamides. Thermosetting resins - Phenolic resins, amino resins

UNIT V POLYMER PROCESSING 9

Plastic Technology - Moulding, other processing methods, fillers, plasticizers, and other additives. Fiber Technology - Textile and fabric properties, spinning, fiber after treatments. Elastomer technology –

Compounding and elastomer properties, vulcanization, reinforcement

TOTAL PERIODS 45

COURSE OUTCOMES

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

- reproduce the basic concepts of polymer science, thermodynamics, phase separations and conformational analysis.
- describe the physico-chemical, morphology, rheology and mechanical properties of bulk polymers by evaluating through respective experimentations
- classify the polymers, polymerization techniques and perform the kinetic and statistical considerations of polymers.
- compare and analyze the properties and performance of commercial polymers
- develop the recent advancements and apply in polymeric processing techniques like molding, compounding and vulcanizing

TEXT BOOKS

1. Billmeyer F.W., Textbook of Polymer Science, Third Edition, Wiley Interscience, 1984.
2. Charles E., Carraher Jr., Seymour carraher's polymer chemistry, Seventh Edition, CRC Press, 2012.

REFERENCES

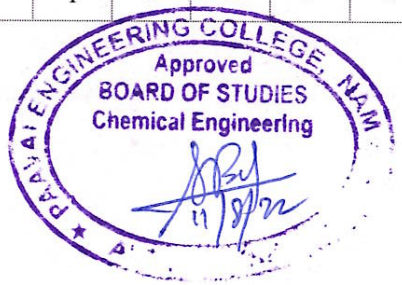
1. Fried J.R., Polymer Science and Technology, Second Edition, Prentice Hall of India Pvt Ltd., 2003.
2. Bhatnagar M.S., A Textbook of Polymers, Vol. 2, S.Chand and Company Ltd., 2012
3. Alfres Rudin, "The Elements of Polymer Science Engineering", Elsevier Science, 2012
4. Stoyko Fakirov, "Fundamentals of Polymer Science for Engineers", Wiley, 2017

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)													
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	1	1	1	1	1	-	-	-	-	1	2	2
CO2	2	1	2	2	1	-	-	-	1	-	-	2	2	2
CO3	2	1	1	2	1	-	-	-	1	1	-	2	3	2
CO4	1	2	1	2	2	-	-	-	-	1	-	2	1	2
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



CM20253 **FOOD TECHNOLOGY** **3 0 0 3**

COURSE OBJECTIVES

To enable 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, the 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

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CO's	Programme Outcomes (PO's)													
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CO1	2	2	1	1	1	1	1	-	-	-	-	1	2	3
CO2	2	2	1	2	1	-	-	-	1	-	-	2	2	2
CO3	3	2	1	2	2	-	-	-	1	1	-	2	2	2
CO4	2	3	2	2	1	-	-	-	-	1	-	2	2	2
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

CM20254 **MATERIAL TECHNOLOGY** 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- recognize the criteria for material selection based on properties of materials
- understand various metallurgical forming processes such as casting, rolling extrusion, drawing,
- demonstrate knowledge about powder metallurgy, ceramic and polymer processing methods.
- identify and choose the required surface treatment technique for coating formation
- understand the applicable joining and machining techniques and their limitations

UNIT I SELECTION OF MATERIALS 9

Motivation for selection - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability, corrosion and wear resistance - Relationship between materials selection and processing - Case studies - aero, auto, marine, machinery and nuclear applications, High and low temperature materials, superconductors, supramagnetic materials, high entropy alloys, nanomaterials and biomaterials.

UNIT II METALLURGICAL FORMING AND PROCESSING OF COMPOSITES 9

Metallurgical forming: Casting, rolling extrusion, drawing, development of grain structure for specific properties. Processing of composites: layup methods, press/ autoclave / resin transfer moulding, Reinforced reaction injection moulding (RRIM), obtrusion and filament winding

UNIT III POWDER METALLURGY, CERAMIC AND POLYMER PROCESSING 9

Powder metallurgy and ceramic processing; green fabrication methods, sintering, hot pressing, Hot isostatic pressing (HIP), spark plasma sintering, development of microstructure in powder processed materials. Polymer processing: extrusion, injection moulding, blow moulding, rotational moulding, vacuum forming and related processes processing of cellular polymers

UNIT IV COATING METHODS 9

Introduction to surface Engineering, Differences between surface and bulk, Properties of surfaces-wear, wettability. Chemical vapour deposition, physical vapour deposition, electro deposition, electroless deposition, thermal spray processes. Principle of various coating processes, process parameters, controlling the yield of coating and various surface properties of the coating. Criteria for selection of a surface coating technology. Product oriented surface coating technology

UNIT V JOINING AND MACHINING 9

Joining: fusion welding, solid state welding, adhesive bonding, mechanical joining and recent advancements in welding, Machining: Electromachining (electrochemical and electro-discharge), mechanical machining and recent advancement

TOTAL PERIODS 45

COURSE OUTCOMES

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

- comprehend the criterion for selection of materials for chemical process industries

- outline the properties and applications of smart materials and nano and bio materials
- apply the knowledge about various materials used in chemical process industries
- select materials for high temperature and sour service and gain knowledge of modern engineering materials.
- describe a polymer's elastic behavior above and below the glass transition.

TEXT BOOKS

1. Gowariker V R, Viswanathan N V, Jayadev Sreedhar, "Polymer Science", New Age International P Ltd., 2005.
2. David S. Rickerby, Allan Matthews, "Advanced surface coatings: a handbook of surface engineering", Blackie, 1991.
3. Rajput.R.K, a Textbook of Material Science and Engineering, III Edition, S.K.Kataria & Sons, Delhi, 2003.

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1. Thiruvadigal.J.D, Ponnusamy, Sudha. D and Krishnamohan.M, Materials Sciences, II Edition, Vibrant Publication, Chennai, 2013.
2. Rajendran.V, Materials Science, III Edition, Tata McGraw hill, New Delhi, 2011.
3. Khanna.O.P, A textbook of material science and metallurgy, IV Edition, Danpat raj Publications, 2099.
4. Parmar, R.S, "Welding Engineering and Technology", Khanna Publishers, 2003.

CO/PO MAPPING

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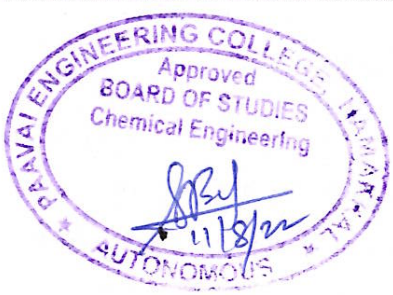
CO4	2	3	2	2	2	-	2	-	-	-	-	2	2	2
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



CM20901 **SOLID WASTE MANAGEMENT** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- learn the sources, generation, storage, processing and disposal of municipal solid waste.
- understand the nature and characteristics of municipal solid wastes
- ability to plan waste minimization and design storage
- make the students conversant with different aspects of the types
- process waste and utilize it in energy forms

UNIT I SOURCES AND TYPES **9**

Sources and types of municipal solid wastes - waste generation rates - factors affecting generation, Characteristics - methods of sampling and characterization; Effects of improper disposal of solid wastes- Public health and environmental effects. Elements of solid waste management - Social and Financial aspects - Municipal solid waste (M&H) rules – integrated management - Public awareness; Role of NGO"s

UNIT II ON-SITE STORAGE AND PROCESSING **9**

On-site storage methods - Effect of storage, materials used for containers - segregation of solid wastes - Public health and economic aspects of open storage - waste segregation and storage - case studies under Indian conditions - source reduction of waste - Reduction, Reuse and Recycling.

UNIT III COLLECTION AND TRANSFER **9**

Methods of Residential and commercial waste collection – Collection vehicles – Manpower– Collection routes – Analysis of collection systems; Transfer stations – Selection of location, operation and maintenance; options under Indian conditions - Field problems- solving

UNIT IV OFF-SITE PROCESSING **9**

Objectives of waste processing - Physical Processing techniques and Equipments; Resource recovery from solid waste composting and bio-methanation; Thermal processing options - case studies under Indian Conditions.

UNIT V DISPOSAL **9**

Land disposal of solid waste; Sanitary landfills - site selection, design and operation of sanitary landfills - Landfill liners - Management of leachate and landfill gas - Landfill bioreactor– Dumpsite Rehabilitation

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- an understanding of the nature and characteristics of municipal solid wastes
- understood the regulatory requirements regarding municipal solid waste management
- ability to plan waste minimization and design storage
- ability to process waste and utilize it in energy forms.
- sound knowledge on collection, transport, processing and disposal of solid waste

TEXTBOOKS

1. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid Wastes: Engineering Principles and Management Issues". McGraw Hill, New York, 1993
2. Paul T Willams, "Waste Treatment and Disposal", John Wiley and Sons,2000

REFERENCES

1. Bhide A.D. and Sundaresan, B.B. "Solid Waste Management Collection, Processing and Disposal"
2. George Tchobanoglous and Frank Kreith "Handbook of Solid waste Management", McGraw Hill, New york 2002
3. Khan.I.H, "Textbook of Solid Waste Management"
4. Ramesh chandrappa, DigantaBhusan Das, "Solid Waste Management", Springer Berlin Heidelberg, 2012

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

CM20902 **ENVIRONMENTAL POLLUTION AND CONTROL** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- learn pollution and its types
- learn air pollution and control measures
- learn water pollution and control measures
- learn solid waste and its management
- able to learn pollution control

UNIT I **INTRODUCTION TO POLLUTION** **9**

Introduction -types of pollution, water standards for potable and agricultural streams, air standards.

UNIT II **AIR POLLUTION** **9**

Air pollution - air pollutants and interaction products, preventive and control measures.

UNIT III **WATER POLLUTION** **9**

Water pollution-waste water sampling and analysis, primary, secondary and tertiary treatment methods and control measures

UNIT IV **SOLID WASTE MANAGEMENT** **9**

Solid waste management- collection, storage and transport, processing and transformation, incineration, composting and sanitary landfilling.

UNIT V **POLLUTION CONTROL** **9**

Pollution control in chemical process industry.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- understand pollution
- understand air pollution and its control measures
- understand water pollution and its control measures
- understand solid waste management
- understand pollution control in industry

TEXT BOOKS

1. Rao, C.S, Environmental Pollution Control Engineering, Wiley Eastern, New Delhi, 1991.
2. Peavy HS, Rowe DR, Tchobanoglous G (1985) Environmental Engineering. (Eds: McGraw-Hill International Editions),

REFERENCES

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004)
2. Sawyer,C.N., MacCarty, P.L. and Parkin, G.F., Chemistry for Environmental Engineering and Science, Tata McGraw – Hill, Fifth edition, New Delhi 2003
3. O.P.Gupta, "Elements of Environmental Pollution and Control", Khanna Publishing House, 2016
4. C.S.Rao, "Environmental Pollution Control Engineering", New Age International (P) Limited, 2020

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

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