JK Lakshmipat University

Laliya Ka Vas, P.O. Mahapura, Ajmer Road, Jaipur 302 026

Ph.: +91-141-7107500/504

INSTITUTE OF ENGINEERING AND TECHNOLOGY

4 Year B. Tech Program

(Branch: Chemical Engineering)

Batch 2015-19

Course Structure, Detailed Syllabus

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Scheme of Examination

JK Lakshmipat University, Jaipur

Institute of Engineering and Technology

Department of Chemical Engineering

Course Structure for the Batch 2015-19

Sem	Courses							(L T P) Credits Hrs/Week
I	English Communication Skills	Engineering Mathematics - I	Engineering Chemistry	Electrical & Electronics Engineering	Engineering Drawing	Workshop Practice		(16 4 6) 23
	LA101 (2 1 0) 3	MA101 (3 1 0) 4	CH101 (3 1 2) 5	EE101 (3 0 2) 4	CE102 (2 0 2) 3	ME141 (0 0 4) 2		26
II	Engineering Mathematics - II	Professional Communication Skills	Engineering Physics	Environmental Studies	Object Oriented Programming	Engineering Mechanics		(12 3 10) 20
	MA201 (3 1 0) 4	LA201 (1 1 2) 3	PH101 (3 1 2) 5	ID201 (2 0 0) 2	CSE202 (3 0 2) 4	ME201 (3 1 0) 4		25
III	Chemical Process Calculations	Fluid Flow Operations	Heat Transfer Operations	Unit Processes in Organic Synthesis	Principles of Management for Engineers	Engineering Mathematics – III		(17 4 4) 23
	CHE301 (3 1 0) 4	CHE302 (3 1 2) 5	CHE303 (3 1 2) 5	CHE304 (3 0 0) 3	HS302 (2 0 0) 2	MA301 (3 1 0) 4		25
IV	Chemical Engineering Thermodynamics	Chemical Reaction Engineering - I	Mechanical Operations	Mass Transfer Operations - I	Principles of Economics	Numerical & Statistical **Analysis**		(18 4 8) 26
	CHE403 (3 1 0) 4	CHE404 (3 1 3) 5.5	CHE405 (3 1 3) 5.5	CHE407 (3 1 0) 4	HS701 (3 0 0) 3	MA402 (3 0 2) 4		30
V	**Practice School - I (PS 501) - 4 to 6 Weeks Duration - 4 Credits**							
	Chemical Reaction Engineering - II	Process Modeling and Simulation	Chemical Engineering Materials	Mass Transfer Operations - II	Process Instrumentation & Control	Effective Public Speaking and Employability Skills		(17 4 7) 24.5+4
	CHE501 (3 1 0)4	CHE503 (3 1 2) 5	CHE505 (3 0 0) 3	CHE507 (3 1 3) 5.5	CHE508 (3 1 2) 5	LA501 (2 0 0) 2		**28**
VI	Chemical Process Technology	Process Equipment Design	Transport Phenomena	Computational Fluid Dynamics	(Elective – I)	(Elective – II)	(HS Elective)	(20 3 5) 25.5
	CHE602 (3 0 0) 3	CHE603 (3 1 3) 5.5	CHE604 (3 1 0) 4	ME625 (3 0 2) 4	(3 0 0) 3	(3 1 0) 4	(2 0 0) 2	28
VII	Process Utility and Industrial Safety	(Elective-III)	(Elective-IV)	Intelligent Machines (AI, Robotics, IoT)	Workplace and Interpersonal Communication			(14 3 0) 17
	CHE702 (3 1 0) 4	(3 1 0) 4	(3 1 0) 4	ID303 (2 0 0) 2	CCT708 (3 0 0) 3			**17**
VII	**Practice School – II (PS 801) – 16 Weeks Duration**							16
							Total Credits	**179**

JK Lakshmipat University

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INSTITUTE OF ENGINEERING AND TECHNOLOGY

4 Year B. Tech Programme

(Branch: Chemical Engineering)

Batch 2015-19

SEMESTER-ONE

Detailed Syllabus

&

Scheme of Examination

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
LA 101	English Communication Skills	2	1	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks**
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory)

- Definition and Characteristic Features of Effective Communication
- Barriers to Communication: Types, Ways to Overcome
- Vocabulary Extension: Roots, Prefixes and Suffixes
- Vocabulary Extension: Synonyms, Antonyms, Homophones, One Word Substitution
- Vocabulary Extension: Learning words through Situations
- Basics of English Grammar
- Applied English Grammar and Standard English Usage
- Standard English Usage, Listening Skills
- Phonetics and Spoken English: Sounds of English, Word Accent and Weak Forms in English, Intonation
- Introducing students to the rules of Word Accent and Weak Forms in English
- Reading Comprehension: Problems, Types of Reading Skills, Strategies
- Paragraph Writing: Definition, Structure of a Paragraph, Construction of a Paragraph, Unity and Coherence
- Book Review
- Movie Review
- Art of Condensation: Steps Required, Strategies

Text Book(s)

1. Sanjay Kumar and Pushp Lata, *Communication Skills,* New Delhi: OUP, 2011

Reference Book(s)

2. Meenakshi Raman and Sangeeta Sharma, *Technical Communication: Principles and Practice*, Second Edition, New Delhi: OUP, 2011.
3. Krishna Mohan and Meenakshi Raman, *Effective English Communication*, New Delhi: Tata-McGraw Hill, 2000.
4. Krishna Mohan and N.P.Singh, *Speaking English Effectively,* New Delhi: Macmillan,1994.
5. V. Sasikumar and P.V. Dhamija, *Spoken English: A Self-Learning Guide to Conversation Practice*, Tata-McGraw Hill, 2007.
6. Norman Lewis, Word Power Made Easy, Delhi: GoyalSaab Publishers and Distributors, 1994.
7. A.J.Thomson and A.V.Martinet, A Practical English Grammar, 4th Edition, New Delhi: OUP, 1999.
8. Asha Kaul, Business Communication, Second Edition, New Delhi: PHI, 2010.
9. Edgar Thorpe and Showick Thorpe, Objective English, 2nd Edition, New Delhi: Pearson Education, 2008.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
MA 101	Engineering Mathematics – I	3	1	0	4

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation	Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory)

Unit 1: Calculus of several variables

Functions of two or more variables, Partial Derivatives, Total derivative, chain Rule, Euler's Theorem, Jacobian and transformation, Applications to errors, Optimization using derivatives - Maxima-Minima of functions of two variables, Lagrange's method.

Unit 2: Curve Sketching

Asymptotes, Double and Triple Points, Cartesian, parametric and polar curve sketching

Unit 3: Vector function and its derivatives

Vector functions, their derivatives and integration, Arc length and unit tangent vector, Curvature and unit normal vector, Torsion and unit Bi-normal vector, Directional derivative and gradient vectors, Tangent plane, Divergence and curl of a vector field

Unit 4: Integral Calculus

Definite Integral - Integral calculus, Line integral, Arc length, Solids of revolution: Surface and volume, Multiple Integrals - Double integral: Area, change of order of integration, changing to polar coordinates, Triple integral, Volume integral, Improper Integrals - Gamma and Beta functions

Unit 5: Vector Integration

Line integral, flux, work done, circulation, Path independence, potential function and conservative fields, Green's theorem in the plane, Stoke's theorem, Divergence theorem,

Text books and Reference books

1. Babu Ram, *Engineering Mathematics* Part – I, Pearson.
2. B. S. Grewal, *Higher Engineering Mathematics*, 41st Ed., Khanna Publishers, Delhi, 2011.
3. G.B. Thomas, Jr., *Thomas' calculus*, 11th edition (Indian), Pearson education, Delhi, 2008
4. Dennis G. Zill and Warren S. Wright, *Advanced Engineering Mathematics*, Fourth Edition (Student Edition), Jones & Barlett, Viba, New Delhi, 2011
5. Rober Wrede, Spiegel M. R., *Schaum's outline of advanced calculus*, 3rd edition, Tata Mc-GrawHill, NewYork, 2011
6. Peter V. O'Neil, *Advanced Engineering Mathematics*, Seventh Indian Reprint, Cengage Learning, New Delhi, 2011.
7. Kreyszig, E., *Advanced Engineering Mathematics*, John Willey, Delhi (2011).
8. Potter M.C., Goldberg J.L., Edward F.A., *Advanced Engineering Mathematics*, 3rd Edition, Oxford University Press, 2005.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CH 101	Engineering Chemistry	3	1	2	5

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation	Total Marks**
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

UNIT-I Water Chemistry

Introduction, common Impurities in water, Hardness of water, Determination of hardness by Clark's test and complexometric (EDTA) method. Removal of hardness by Lime Soda, Zeolite and Ion exchange process.
Boiler feed water: troubles their causes, disadvantages and prevention, Scale & Sludge Carry over (Priming and Foaming), Boiler Corrosion and Caustic embrittlement.

UNIT-II Polymers

Introduction to Polymer, Classification of polymers. Methods of Polymerization, Plastics: Thermosets and Thermoplastic. Preparation, properties and uses of Vinyl resins, Bakelite, Polyesters and Nylons. Rubbers: Natural rubber, vulcanization, synthetic rubbers e.g. Buna-S, Buna-N, Butyl, Thiokol and Neoprene rubbers.

UNIT-III Corrosion &Lubricants

Definition and its significance, Theories of corrosion: Dry corrosion theory, Wet (Electrochemical) theory, Passivity, Types of electrochemical corrosion. Factors influencing rate of corrosion.
Introduction, classification and uses of lubricants. Types of lubrication. Viscosity & viscosity index, Flash point Fire point, cloud and pour point, steam emulsification number, precipitation number and neutralization number.

UNIT-IV Solid State Chemistry

Solid State, Types of solids, Space Lattice and Unit cell, Types of unit cell, Cubic System – Number of atoms per unit cell, Atomic Radius, Density Calculation of unit cell. Bragg's Law X-ray studies of Crystals.
Graphite – Structure, Properties and applications.
Liquid Crystal: Liquid Crystalline state, Classification of liquid crystal and their applications.

UNIT-V Engineering Materials

Cement: Definition, Composition basic constituents and their significance, manufacturing of Portland cement by Rotary Klin technology. Setting and hardening of cement and role of gypsum.
Nanotechnology and Nano materials: Fullerenes and Carbon Nano tubes - Introduction, Structural properties, preparation and their applications.

Syllabus (Practical)

1. To determine the hardness of water by complex metric method using EDTA.
2. To determine the strength of NaOH and Na2CO3 in given alkali mixture.
3. To determine the strength of copper sulphate with the help of Hypo solution.
4. Measurement of conductivity of given sample by conductivity meter.
5. Measurement of pH of given sample by pH meter.
6. Determination of Barium as barium sulphate gravimetrically.
7. Measurement of Fluoride in water sample.
8. Determination of Na/K/Ca by Flame photometer in a given sample.
9. To determine the amount of free chlorine in given sample.
10. To determine the viscosity of a given sample of lubricant oil at various temperature.
11. To determine flash and fire point of a given lubricant using Pensky-Martin's apparatus.
12. Measurement of Nitrate and Oxygen in water sample.
13. To determine cloud and pour point of a given sample of lubricating oil using Cloud and Pour point apparatus.

Text Book

1. Engineering Chemistry by Jain & Jain (Dhanpat Rai publication)

Reference Book(s)

1. Engineering Chemistry by B Sivasankar, (Mc-Graw Hill publication).
2. Engineering Chemistry by O.G. Palanna, (Mc-Graw Hill publication).
3. Engineering Chemistry (Wiely India publication).
4. Introduction to Nanotechnology by Poole Owens (Wiley)
5. Nanotechnology by Shah&Shah (Wiley)
6. *Chemistry* in *Engineering* & Technology by J. C. Kuriacose and J. *Rajaram*,, Vol. 1&2
7. The Physics and Chemistry of Solids by Elliott (Wiley)
8. Engineering Chemistry (Wiely India publication).
9. Polymer Chemistry by Stevens (Oxford)
10. Polymer Science and Technology by Ghosh (Tata Mc-Graw Hill publication)
11. Polymer Science and Technology by Fried (PHI publication)
12. Text book of Polymer Science by Billmeyer (Wiely)

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
EE101	Electrical & Electronics Engineering	3	0	2	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

UNIT I: INTRODUCTION

Basic physical laws, circuit elements, Source Transformation, KVL, KCL, Wye (Y) – Delta (Δ) and Delta (Δ) – Wye (Y) transformations

UNIT II: THEOREM

Norton, Thevenin, Superposition, Max power transfer Theorem

UNIT II: AC NETWORKS

Fundamental aspects of single phase ac supply, Sinusoidal Steady State, Real/Reactive Power, Phasor, Three phase circuits, Start-delta, Two watt-meter Method, simple circuits, RMS Average value, Transients in R-L, R-C, R-L-C.

UNIT IV: TRANSFORMER & MACHINE

Basics of transformer Faraday and Lenz law, Mutual Inductance, construction, Working Principles of Transformers, AC/DC machines.

UNIT V: INTRODUCTION TO SEMICONDUCTORS

Defining Insulator, Semiconductor, Conductors. Band gap energy and band formation, elementary idea about semiconductor behavior, conductivity, types of semiconductor, p-type and n-type, working principle, characteristics and applications of Diode and Transistor, Transistor CE, CB, CC configuration.

Syllabus (Practical)

ELECTRICAL LAB

1. Single line diagram of a power system and a distribution sub-station and basic functional study of main components used in power systems.
2. Make house wiring including earthling for 1-phase energy meter, MCB, ceiling fan, tube light, three pin socket and a lamp operated from two different positions. Basic functional study of components used in house wiring
3. Study the construction and basic working of ceiling fan, single phase induction motor and three phase squirrel cage induction motor. Connect ceiling fan along with regulator and single phase induction motor through auto-transformer to run and vary speed.
4. (a) Basic functional study and connection of moving coil & moving iron ammeters and Voltmeters, dynamometer, wattmeter and energy meter.

(b) Run a 3-phase squirrel cage induction motor at no load and measure its voltage, current, power and power factor. Reverse the direction of rotation.

5. Study the construction, circuit, working and application of the following lamps:
   (i) Fluorescent lamp, (ii) Sodium vapour lamp, (iii) Mercury vapour lamp, (iv) Halogen lamp and (v) Neon lamp
6. (a) Study the construction and connection of single phase transformer and auto-transformer. Measure input and output voltage and fin turn ratio.
   (b) Study the construction of a core type three phase transformer. Perform star and delta Connection on a 3-phase transformer and find relation between line and phase voltage.

ELECTRONICS LAB

7. Identification, testing and applications of resistors, inductors, capacitors, PN-diode, Zener diode,LED, LCD, BJT, FET, UJT, SCR, Photo diode and Photo transistor.
8. (a) Functional study of CRO, analog & digital multi-meters and function / signal generator.
   (b) Study the single phase half wave and bridge rectifier and effects of filters on waveform.
9. Study the BJT amplifier in common emitter configuration. Measure voltage gain, plot gain frequency response and calculate its bandwidth.
10. (a) Study the construction and basic working of SCR.
    (b) Study the single phase half wave and bridge controlled rectifier and observe the effect of firing angle on waveform.

Text Book(s)

1. S.N.Singh “Basic Electrical Engineering”, Prentice-Hall of India Pvt. Ltd, 2011.
2. J. Millman and C. Halkias, Integrated Electronics, McGraw Hill,2th Edition, 6th Indian Reprint, 2011.
3. B. L. Theraja, “Electrical Technology”, Vol.1, S. Chand Publication, New Delhi
4. V. K. Mehta, “Basic Electrical Engineering”, S. Chand and Company Ltd., New Delhi

Reference Book(s)

1. T.K.Nagsarkar,M.S. Sukhija,”Basic Electrical Engineering”, Oxford University press, 2nd edition, 2011.
2. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, 1991.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CE 102	Engineering Drawing	2	0	2	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

Unit I: Lines, Lettering & Dimension (Sketch Book); Scales: Representative factor, plain scales, diagonal scales, scale of chords; Conic sections: Construction of ellipse, parabola, & hyperbola by different methods; Engineering Curves: Cycloid, Epi-cycloid, Hypo-cycloid, Involutes, Archimedean and logarithmic spirals.

Unit II: Projection: Types of projection, orthographic projection, first and third angle projection, (Sketch Book)

Projection of points and straight lines: Line inclined to one plane, inclined with both the plane, methods for determining True Length, true Inclinations, and Traces of straight lines.

Unit III: Projection of planes and solids: Projection of Planes like circle and polygons in different positions; Projection of right and regular polyhedrons like prisms, pyramids and solids of revolutions like cylinder, cones in different positions.

Unit IV: Section of Solids: Section of right solids (like Prism, Pyramid, Cylinder and Cone) by normal and inclined planes in different positions; Intersection of cylinders.

Development of Surfaces: Parallel line and radial-line method for right, regular solids.

Unit V: Isometric Projections: Isometric scale, Isometric axes, Isometric Projection of solids from orthographic drawing; Computer Aided Drafting (CAD): Introduction, benefit, software's basic commands of drafting entities like line, circle, polygon, polyhedron, cylinders; transformations and editing commands like move, rotate, mirror, array; Draw Toolbar, Object & Modify toolbar; solution of projection problems on CAD.

Syllabus (Practical)

Sketching and drawing of geometries and projections on Sketch Book & on AutoCAD based on above syllabus

Text Books:

1. Kulkarni D M, Rastogi A P, Sarkar A K, Engineering Graphics with AutoCAD, PHI Learning Pvt. Ltd., New Delhi, India, Fourth Printing (Revised Edition), 2012.
2. Bhatt N D, Engineering Drawing, Charotar Book Stall, Anand, India.

Reference Books:

1. Jolhe D A, Engineering Drawing with an introduction to AutoCAD, TMH, New Delhi, India.
2. Gill P S, Engineering Drawing (Geometrical Drawing), S K Kataria & Sons, Delhi, India
3. Jeyopoovan T.; Engineering drawing & Graphics Using AutoCAD; Vikas publishers.
4. Engineering Drawing, Basant Agarwal & CM Agarwal, Tata McGraw Hill.
5. Shah MB and Rana BC; Engg.drawing; Pearson Education
6. Luzadder WJ and Duff JM; Fundamental of Engg Drawing; PHI
7. Dhananjay A Jolhe; Engg. Drawing an Introduction; Tata McGraw Hill.
8. Visvesvaraya Tech. University; A Premier on Computer Aided Engg drawing; VTU Belgaum
9. Venugopal K.; Engineering Graphics; New Age

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
ME 141	Workshop Practice	0	0	4	2

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation	Additional Continuous Evaluation*	Total Marks**	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**
-	-	-	-	-	-	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Practical)

- Basics of manufacturing, types of production systems, ethics, safety in workshop.
- Metrology, quality, Least Count of a measuring Instrument, measurement with Vernier Caliper or Micrometer.
- Machining – Demonstration of Turning, Step Turning, Facing, etc.
- Casting – Demonstration of sand casting process
- Forging – Demonstration of forging operations
- Sheet metal working applications.
- Hands on practice of Sheet metal working operations using hand tools- Preparation of Funnel.
- Gas Welding, Demonstration of Gas Welding
- Hands on practice of Joining of metal parts by Arc Welding- Preparation of a Lap Joint model.
- Mechanical joining processes, Arc Welding
- Hands on practice of Joining of metal parts by Arc Welding- Preparation of a Butt Joint model.
- Introduction to wood working, Wood working Tools, Types of wood, Types of joints.
- Hands on practice of Wood working operations using hand tools- preparation of Lap Tee Joint, Mechanical joining processes, Soldering, Brazing.
- Machining – Demonstration of Shaping operations
- Hands on practice of Fitting operations using hand tools- Prepare a job in fitting shop.

Text Books:

1. H S Bawa, "Workshop Practice", TMH, New Delhi, 2nd Edition, 2011
2. B S Nagendra Parashar and R K Mittal, "Elements of Manufacturing Process", Prentice Hall of India, New Delhi, 2010 print
3. B S Raghuwanshi, "A Course in Workshop Technology", Dhanpat Rai & Co., New Delhi, Volume I & II, 2011 reprint,
4. Serope Kalpakjian and Steven R. Schmid, "Manufactuirng Engineering and Technology," Pearson Education (Low Cost Indian Edition), New Delhi, 4th Edition, 2005

Reference Books:

1. K. Venkata Reddy, "Workshop Practice Manual", BS Publications, Hyderabad,6th Edition, 2011 print
2. P. kannaiah and K. L. Narayana, "Engineering Practices Laboratory", SciTech Publications, Chennai, 2006

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INSTITUTE OF ENGINEERING AND TECHNOLOGY

4 Year B. Tech Programme

(Branch: Chemical Engineering)

Batch 2015-19

SEMESTER-TWO

Detailed Syllabus

&

Scheme of Examination

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
MA 201	Engineering Mathematics – II	3	1	0	4

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation	Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory)

Unit 1: Ordinary Differential equation

Differential equation of first order, Differential equation of higher order with constant coefficients, Differential equation of second order with variable coefficients, Solution in series.

Unit 2: Partial differential equation

Partial Differential Equations of First Order, Variable separable technique for solving PDE, Boundary value problems: Heat equation, wave equation, Laplace equation

Unit 3: Matrix Algebra

Matrices, Rank of a Matrix, System of Linear Algebraic Equations, Linear Independence and Dependence, Eigen Values and Eigen Vectors, Diagonalization, Cayley Hamilton Theorem

Unit 4: Linear Algebra

Unit Vector Space, Subspaces, Bases and Dimensions, Coordinates, Row Equivalence and Computations concerning Subspaces, Linear Transformations, The Algebra of Linear Transformations, Representation by matrices

Unit 5: Linear Programming Problems

Introduction to LP Problems, LP formulations, Graphical Methods, Convex Sets, Simplex Methods

Text books and Reference books

1. Babu Ram, *Engineering Mathematics Part II,* Pearson.
2. B. S. Grewal, *Higher Engineering Mathematics*, 41st Ed., Khanna Publishers, Delhi, 2011.
3. Dennis G. Zill and Warren S. Wright, *Advanced Engineering Mathematics*, Fourth Edition (Student Edition), Jones & Barlett, Viba, New Delhi, 2011.
4. B.V.Ramana, *Higher Engineering Mathematics*, Tata Mc-graw Hill.
5. Peter V. O'Neil, *Advanced Engineering Mathematics*, Seventh Indian Reprint, Cengage Learning, New Delhi, 2011.
6. Kreyszig, E., *Advanced Engineering Mathematics*, John Willey, Delhi (2011).
7. Potter M.C., Goldberg J.L., Edward F.A., *Advanced Engineering Mathematics*, 3rd Edition, Oxford University Press, 2005.
8. G.B. Thomas, *Jr., Thomas' Calculus*, 11th edition (Indian), Pearson education, Delhi, 2008.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
LA 201	Professional Communication Skills	1	1	2	3

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation	Additional Continuous Evaluation*	Total Marks**	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks**

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

- Professional Communication: Definition, Types, Process, Features
- Importance of Non-Verbal Communication: Eye contact, Facial Expressions, Gestures, Posture, Proxemics, etc.
- Importance of Paralinguistic Features: Voice, Volume, Pitch, Intonation, Pauses, Rate, Vocalized Pauses and Vocal Cues.
- Group Discussion: Purpose, Difference between GD and Debate, Personality Traits to be Evaluated, dynamics of Group Behaviour, Opening and Ending a GD
- Job Interviews: Process, Stages, Desirable Qualities, Steps to Preparation, Body Language, Confidence, Frequently Asked Questions
- Presentation Skills: Combating Nervousness and Stage Fright, Beginning and Ending of a Presentation, Dynamics of Team Presentations, Using Slides and Audio-Visual Aids
- Business Letters and Resume: Structure, Style, Types
- Professional Reports: Types, Features, Structure, Style (The Assignment on Report Writing will include technical input from other faculty members from the Institute of Engineering and Technology and will be oriented towards developing in students the competencies required for writing PS-I Reports)
- E-mail Writing, Other Business Writings

Syllabus (Practical)

- Sounds of English: Vowel and Consonant Sounds, Word Stress, Intonation - Listening and Practice
- Reading Comprehension: Reading Passages and Answering Questions
- Vocabulary Extension: :Learning Words through Situations and Modules
- Presentation Skills: Learning through Video Presentations
- Group Discussion: Learning through Recorded Group Discussions
- Job Interviews: Learning through Recorded Job Interviews

Text Book(s)

Sanjay Kumar and Pushp Lata, *Communication Skills,* New Delhi: OUP, 2011

Reference Book(s)

R1 Meenakshi Raman and Sangeeta Sharma, *Technical Communication: Principles and Practice*, Second Edition, New Delhi: OUP, 2011.

R2 Krishna Mohan and Meenakshi Raman, *Effective English Communication*, New Delhi: Tata-McGraw Hill, 2000.

R3 Krishna Mohan and N.P.Singh, *Speaking English Effectively,* New Delhi: Macmillan,1994.

R4 V. Sasikumar and P.V. Dhamija, *Spoken English: A Self-Learning Guide to Conversation Practice*, Tata-McGraw Hill, 2007.
R5 Norman Lewis, *Word Power Made Easy,* Delhi: GoyalSaab Publishers and Distributors, 1994.
R6 A.J.Thomson and A.V.Martinet, *A Practical English Grammar,* 4th Edition, New Delhi: OUP, 1999.
R7 Asha Kaul, *Business Communication,* Second Edition, New Delhi: PHI, 2010.
R8 Edgar Thorpe and Showick Thorpe, *Objective English*, 2nd Edition, New Delhi: Pearson Education, 2008.

Course code		Course Title		Teaching Scheme				
				L	T	P	Credits	
PH 101		Engineering Physics		3	1	2	5	
Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Examination – I	Mid Term Examination – II	End Term Examination	Internal Assessment	Total	Mid Term Examination	End Term Examination	Internal Assessment	Total **
20	20	50	10	100	20	50	30	100

*Internal Assesment: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Course Syllabi (Theory):

Coherence, Interference and Optical Technology

- Introduction to optics, Spatial Coherence, Temporal coherence, Coherence length, Coherence time and 'Q' factor for light
- Formation of Newton's rings, Measurement of wavelength of light, Diameter of Newton's rings
- Elementary idea of anti-reflection coating and interference filters

Diffraction

- Single slit diffraction, position of maxima / minima and width of central maximum, intensity variation.
- Construction and theory. Formation of spectra by plane transmission grating, Determination of wavelength of light using plane transmission grating.

Polarization

- Plane, circular and elliptically polarized light on the basis of electric (light) vector, Malus law.
- Quarter and half wave plates, construction, working and use of these in production and detection of plane, circular and elliptically polarized light.
- Introduction and law of optical rotation, specific rotation and its measurement using the half-shade and bi-quartz device.

Laser and Fibre Optics

- Theory of Laser Action, Einstein's Coefficients, Threshold Conditions for Laser Action.
- Theory, Design, and Applications of He-Ne Laser.
- Theory of Semiconductor Lasers.
- Optical Fibre, Numerical Aperture, and Maximum Angle of Acceptance.

Quantum Mechanics

- Heisenberg's Uncertainty Principle, Wave and Particle Duality of Radiation, De-Broglie's Concept of Matter waves, Quantum Nature of Light
- Concept of Compton Effect
- Concept of Wave Function, Physical interpretation of wave function and its properties
- Schrödinger's Wave Equation: Time dependent and time independent cases
- Particle in one-dimensional box
- Particle in three-dimensional boxes, Degeneracy.

Course Syllabi (Practical):

1. To determine the wave length of sodium light by Newton's Ring
2. To determine the specific rotation of Glucose (Sugar) solution using a Polarimeter

3. To measure the Numerical Aperture of an Optical Fibre.
4. To determine coherent length and coherent time of laser using He-Ne Laser
5. To determine the height of object with the help of a Sextant.
6. To determine the dispersive power of material of a Prism for Violet Red and Yellow colours of Mercury light with the help of a spectrometer.
7. To study the Charge & Discharge of a condenser and hence determine time constant (Both current and voltage graphs are to be plotted).
8. To study characteristics of G.M. Counting System.
9. To convert a Galvanometer in to an ammeter of range 1.5/3 amp and calibrate it.
10. To convert a Galvanometer in to a Volt of range 1.5/3 volt and calibrate it.

Text Books:

1. Mahesh C. Jain, “Textbook of Engineering Physics”, Part I , PHI
2. Mahesh C. Jain, “Textbook of Engineering Physics”, Part II, PHI
3. Lab Manuals for Physics

Reference Books:

1. Arther Beiser, “Concept of Modern Physics” Tata McGrawHill, New Delhi, 5th edn. 1997.
2. Ajoy Ghatak, “Optics”, Tata McGraw Hill, 4th edn
3. Eyvind H Wichman, “Quantum Physics” Tata McGraw Hill, Volume 4
4. Neeraj Mehta, “Applied Physics for Engineers”, PHI, I edn. 2011
5. Dattu R Joshi, “Engineering Physics”, Tata McGraw Hill Education Pvt. Ltd. New Delhi, I edn. 2010.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
ID 201	Environmental Studies	2	0	0	2

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation	Total Marks**	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation		Total Marks**
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Course Syllabi (Theory):

- Understanding environment, The global crisis, Basic Concepts
- Forest and Grassland ecosystems, Desert Ecosystems, Aquatic Ecosystems
- Introduction to Biodiversity, Biodiversity Conservation
- Water Resources, Energy Resources, Forest Resources
- Land, Food, and Mineral Resources
- Air and Noise Pollution, Water, Soil, and Marine Pollution
- Solid Waste Management and Disaster Management
- Population Growth, Environment and Human Health, Sustainable Development
- Global Warming, Acid Rain, and Ozone Depletion
- Different types of laws and regulations

Text Books:

1. Rajagopalan, R., "Environmental Studies: From Crisis to Cure", Oxford University Press, New Delhi, 2e, 2011

Reference Books:

1. Ranjit Daniels & J. Krishnaswamy "Environmental Studies", Wiley India
2. Davis & Cornwell "Environmental Engineering", Mc Graw Hill

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CSE 202	Object Oriented Programming	3	0	2	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Course Syllabi (Theory):

Identifiers and constants (Literals), Keywords, Data Types, The Operators, New Casting Operators, Typeid and throw, The Conditional structures and Looping Constructs

Difference between Struct and class in C++, The difference between Union and Class, Static Data members of a class, Pointer to objects and pointer to members of class, The local classes,

Assigning Objects

Introduction to Functions, The Inline function, Default Arguments to the function, Functions with object as parameters, Call by reference and return by reference, Prototyping and Overloading, Friend functions, Const and Volatile functions, Static functions, Private and Public functions

Introduction to constructors, The explicit constructors, Parameterized constructors, Multiple constructors, Constructors with default arguments, Dynamic Initialization, Constructor with dynamic allocation, copy constructors, The member initialization list, destructors

Overloading Operators, The need, Defining derived class using single base class, Derivation using public, private and protected access modifiers

The implementation of Inheritance in the C++ object model, multiple-inheritance, Abstract classes, Composite objects (container objects), Compile Time and Runtime Polymorphism

Introduction, Need for Exception handling, Components of exception handling mechanism

Course Syllabi (Practical):

Programs using C++/Java which covers following concepts:

- Declaration and Usage of Classes and Objects
- Constructors and Destructors.
- Overloaded Functions and Overloaded Operators.
- Inheritance
- Exception handling mechanism.

Text Books:

1. Object Oriented Programming using C++ and Java, E. Balagurusamy, Tata McGraw Hill.

Reference Books:

1. Programming with ANSI C++ by Bhushan Trivedi, Oxford University Press
2. An Introduction to Object Oriented Programming with Java, C Thomas WU, Fourth Edition, Tata McGraw Hill.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
ME 201	Engineering Mechanics	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation	Total Marks**	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation		Total Marks**
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory)

- Fundamentals of engineering mechanics, Laws of Motion, Equilibrium, Conditions for equilibrium, Equations of equilibrium.
- **Statics of Particles and Rigid Bodies:** System of forces, Resultant force, Resolution of force, Moment and Couples.
- **Trusses:** Truss analysis, analysis of frames and machines.
- **Friction:** Types of Friction, Laws of friction, Angle of friction, Angle of repose, Applications of Friction.
- **Lifting Machines:** Mechanical advantage, Velocity Ratio, Efficiency of machine, Ideal machine, Ideal effort and ideal load, Reversibility of machine, Law of machine, Lifting machines; System of Pulleys, Simple wheel and axle, Wheel and differential axle, Weston's differential pulley block, Worm and worm wheel.
- **Properties of Plane Surfaces:** Centroids & Centre of Mass, area of moments, principle moments of inertia, Second moment of mass.
- **Virtual work:** Principle of Virtual Work, Active forces and active force diagram.
- **Kinematics of Particles and Rigid Bodies:** Velocity, Acceleration, Types of Motion, Equations of Motion, Rectangular components of velocity and acceleration, Angular velocity and Angular acceleration, Radial and transverse velocities and accelerations, Projectiles motion on plane and Inclined Plane, Relative Motion.
- **Kinetics of Particles and Rigid Bodies**: Equation of motion in rectangular coordinate, radial and transverse components, Equation of motion in plane for a rigid body.
- **Work, Energy and Power:** Work of a force, weight, spring force and couple, Power, Efficiency, Energy, Kinetic energy of rigid body, Principle of work and energy, Conservative and Non-conservative Force, Conservation of energy.
- **Impulse and Momentum:** Linear and angular momentum, Linear and angular impulse, Principle of momentum for a particle and rigid body, Principle of linear impulse and momentum for a particle and rigid body, Principle of angular momentum and Impulse, Conservation of angular momentum, Angular momentum of rigid body.

Text Books:

1. Meriam and Kraige, **"Engineering Mechanics-STATICS"**, John Wiley & Sons, Fifth Edition, 2010
2. Meriam and Kraige, **"Engineering Mechanics-DYNAMICS"**, John Wiley & Sons, Fifth Edition, 2010

Reference Books:

1. Engineering Mechanics, Basudeb Bhattacharyya, Oxford University Press
2. Vector Mechanics for Engineers, Beer and Johnston, Tata McGraw-Hill., Ninth Edition, 2009.
3. Engineering Mechanics, Hibbeler, Pearson Education, Sixth Edition, 2010

4. Engineering Mechanics, Andrew Pytel & Kiusalas, Cengage Learning, Third Edition, 2010.
5. Engineering Mechanics, Timoshenko and Young, Tata McGraw-Hill, Fourth Edition, 2006.
6. Engineering Mechanics- Statics and Dynamics, Shames, Pearson Education.
7. Engineering Mechanics, Boresi and Schmidt, CL-Engineering, First Edition, 2008.

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INSTITUTE OF ENGINEERING AND TECHNOLOGY

4 Year B. Tech Programme

(Branch: Chemical Engineering)

Batch 2015-19

SEMESTER-THIRD

Detailed Syllabus

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Scheme of Examination

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE 301	Chemical Process Calculations	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test – II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks
20	20	50	10	100	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical records/ Mock Interviews/ others

Syllabus (Theory)

Introduction to Chemical Engineering Calculations: Units and dimensions, the mole unit, conventions in methods of analysis and measurement, basis, temperature, pressure, the chemical equation and stoichiometry.

Gases, Vapours, Liquids and Solids: Ideal gas law calculations, real gas relationships, vapour pressure and liquids, saturation, partial saturation and humidity, introduction to vapour-liquid equilibria for multi-component systems, material balances involving condensation and vaporization.

Material Balances: Material balance of physical processes with and without chemical reaction, including recycle, purge and bypass.

Energy Balances: Concept and Units, calculation of enthalpy changes, general balance with and without reactions, heats of solution and mixing.

Unsteady-state material and energy balances. Solids, liquids and gaseous fuels, some industrial examples of the above, simple estimation of physical properties (transport, thermodynamic) of fluids and mixtures

Text Book

1. Himmelblau, D. M. “Basic principles & calculations in chemical Engg”, PHI, 6th ed., 1997.

Reference Book

1. Felder, R. M. & R. W. Rousseau, “Elementary Principles of Chemical Processes”, John Wiley & Sons, Inc., 3rd ed., 2000.
2. Bhatt and Vora, “Stoichiometry,” 3rd ed., Tata McGraw-Hill, New Delhi.
3. Hougen, Watson and Ragatz, “Chemical Process Principles,” Vol. 1, Asia Publishing House, New Delhi.
4. Saha, S. N., “Fundamentals of Chemical Engineering,” Dhanpat Rai Publishing Co., New Delhi, 2000.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE302	Fluid flow Operations	3	1	2	5

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test – II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

Definition of a fluid, Basic equations, Dimensions and unit, Dimensionless equations and Consistent units, Dimensional equations, Method of analysis.

Concept of fluid continuum, Velocity and stress field, Viscosity, Viscosity of gases and liquids, Surface tension, Description and classification of fluid motions. Introduction to Newtonian and non-Newtonian fluids flow and their behaviours.

Basic equations of fluid statics, Pressure variation in static fluids, Hydrostatic Equilibrium in a centrifugal field, Buoyancy and stability.

Types of flows, steady and unsteady, laminar and turbulent flows; Relationship between shear stress and pressure gradient, Hagen-Poiseuille equation. Prandtl's mixing length theory and eddy diffusivity losses in pipes and fittings, Darcy-Weisbach equation for frictional head loss, Moody diagram. Flow through packed and fluidized beds.

Basic laws for a system, Conservation of mass and momentum equations for integral control volumes, Angular momentum principle [fixed control volume analysis only], First and second law of thermodynamics.

Conservation of mass and momentum equation [Navier-Stokes equations: Rectangular coordinates only], Motion of fluid elements.

Euler's equations, Bernoulli's equation, Relation between first law of thermodynamics and Bernoulli's equation

Buckingham PI theorem/ Reyleigh method, Significant dimensionless group in fluid mechanics

Flow between parallel plates, Flow in pipes of various cross-sections, Energy considerations of the flow, Flow measurement techniques (venturi and orifice meters, pitot tubes etc.)

Pumps and compressors for handling different fluids, types, cavitation, priming NPSH and characteristics of centrifugal pumps. Comparison of centrifugal and reciprocating pumps. Valves, pipe fittings and their standards. Power requirement for flow. Pipe layout and economical pipe diameter.

Velocity Profile and Boundary layer concept, Boundary layer thickness, Pressure gradient in boundary layer, Drag & flow through beds of solids

Agitated vessels and accessories, flow patterns in vessels, velocity patterns and gradients, power consumption, blending & mixing, static mixers

Syllabus (Practical)

1. Bernoulli's theorem
2. Losses due to friction in pipe lines
3. Losses due to pipe fittings, sudden enlargement & contraction
4. Discharge through venturimeter, orificemeter & rotameter
5. Pitot tube
6. Darcy's law apparatus
7. Pressure drop through packed bed
8. Hydrodynamics of packed bed
9. Fluidized bed characteristics
10. Flow through helical coil
11. drag co-efficient apparatus
12. pressure drop in two phase flow

Text Books

1. Fox, R.W. and A.T. McDonalds, *Introduction to Fluid Mechanics (5th Ed.)*, John Wiley & Sons Inc., 2001. [ISBN: 9971-51-355-2]
2. McCabe, W.L., J.C. Smith and P. Harriott, *Unit Operations of Chemical Engineering (7th Ed.)*, McGraw Hill Inc., 2005. [ISBN 007-124710-6]

Reference Books

1. Bird, R.B., W.E. Stewart and E.N. Lightfoot, *Transport Phenomena (2nd Ed.)*, John Wiley and Sons Inc., 2002.
2. Welty, J.R., C.E. Wicks, R.E. Wilson, and G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer (4th Ed.), John Wiley and Sons Inc., 2001.
3. Coulson, J. M. and J. F. Richardson (with J. R. Backhurst and J. H. Harker), Coulson & Richardson's Chemical Engineering-Volume 1 (5th Ed.), Pergamon Press. Strength of Materials- A Rudimentary Apprach – M.A. Jayaram,
4. Bansal, R. K. A textbook of Fluid Mechanics and Hydraulic Machines

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE 303	Heat Transfer Operations	3	1	2	5

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory):

Analogy with momentum transfer, Introduction to conductive, convective and radiative heat transfer

One dimensional steady state conduction for cartesian, radial and spherical coordinate system, with and without heat source, Fins and their function, Thermal contact resistance

Lumped heat capacity system, Transient heat flow in a semi-infinite solid, Convective boundary conditions

Viscous flow; Inviscid flow; Laminar and turbulent boundary layer; Boundary layer heat transfer

Empirical relations for pipe and tube flow; Flow across cylinders and spheres; Flow across tube banks; Liquid metal heat transfer

Theory and empirical relations for free convection from different geometric configurations such as plates, inclined surface, cylinder, sphere etc.; Combined free and forced convection

Mechanism and properties of radiation; Shape factor; Back body and gray body radiation; Gas radiation; Radiation shield; Radiation network

Theory and empirical relations for film and dropwise condensation and boiling phenomena; Heat pipe

Concept of overall heat transfer coefficient; LMTD method, effectiveness-NTU method, and Kern's method for heat exchanger design; Compact heat exchangers

Types of evaporators; Evaporator capacity and economy; Single and multiple effect evaporators

Syllabus (Practical)

1. Friction in pipelines and fittings
2. Flow through packed beds
3. Flow through fluidized beds
4. Diffusion coefficient
5. Gas absorption
6. Helical coil heat exchanger
7. Shell and tube heat exchanger
8. Double pipe heat exchanger
9. Heat transfer in boiling kettle
10. Mass transfer with chemical reaction

Text book:

1. Holman, J.P., "Heat Transfer (9th Ed.)", McGraw Hill, 2002.

Reference books:

1. McCabe, W.L., J.C. Smith, and P. Harriott, “Unit Operations of Chemical Engineering (6th Ed.)”, McGraw Hill, 2001.
2. Bird, R.B., W.E. Stewart, and E.N. Lightfoot, “Transport Phenomena”, John Wiley & Sons, 1994.
3. Welty, J.R., C.E. Wicks, R.E. Wilson, and G.L. Rorrer, “Fundamentals of Momentum, Heat and Mass Transfer (4th Ed.)”, John Wiley & Sons, 2001.
4. Binay, K. Dutta, “Heat Transfer- Principles and Applications (1st Ed.) ”, Prentice-Hall of India, 2001.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE304	Unit Processes in Organic Synthesis	3	0	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Atoms to molecules to materials for Engineers, Hybridization, sigma and pi bonds shape of the simple inorganic compounds, Molecular orbital theory and its application; Structure and stereo structure of molecules, Conformations, Newman, Sawhorse, Fischer, projections wedge and dash structural representation, equivalence of structural representations, Chirality, optical activity and isomerism, Dynamic stereochemistry, Geometrical isomerism in simple acyclic and cyclic molecules; Materials and their Characterization, Micro and macroscopic properties of molecules, Intermolecular forces, Molecular aggregation micelles;

Reactions Dynamics, Chemical kinetics, Order and molecularity, zero, first and second order reactions, pseudo first order reaction , temperature dependence of reaction rates, Catalysis and some industrially important catalytic reactions; Stability and Reactivity of Molecules, Electron displacement effects – inductive, electromeric, resonance and hyper conjugation, Reactive sites in molecules - functional groups. Reaction Mechanism, Fission of a covalent Bond, types of reactions – nucleophilic (SN1 & SN2, SNi, SNAr) and electrophilic substitution reactions (Nitration, Sulphonation, Halogenation, and Friedel Crafts reaction) and their mechanism , regio and Stereochemistry of involved reactions

Purification, Physical (crystallization, fractional crystallization , distillation , fractional distillation, steam distillation) and chemical methods of purification; General chromatographic (Adsorption and partition) techniques(column thin layer and paper chromatography) and their application; Criteria of purity, Melting and Boiling point, chromatography , particle size measurement and surface area Characterization, Surface tension, Viscosity ,Conductivity , and Absorption Spectroscopy (IR, UV – Visible , NMR);

Water and its treatment , Alkalinity of water, estimation of alkalinity, Hard and soft water, hardness- units, determination of hardness by complexometric Titration, Removal of hardness of water- Zeolite , ion exchange process, Boiler Feed water, descaling of boilers desalination of brackish water, Reverse osmosis, potable water;

Polymers and Polymerization (ionic, anionic and free radical induced), Properties of polymers , Number average and Weight average molecular weighs, characterization of polymer samples , polymer blends, Stereo structures of polymers, Dendrimers, Some examples of common polymers used in Industry, Natural and Synthetic rubber, Silicones, Composites, Adhesives, Conducting polymers, Biodegradable polymers; Metallic corrosion and its preventi on, electrolysis , Industrial electrolytic processes-(aluminium). Fuel cells and batteries.

Text/References Books:

1. Organic Chemistry, P.Y. Bruice , Ninth Impression, 2011, Pearson India
2. Chemistry 3 , A. Burrows, john Holman, A, Parsons, G. Pilling, G.Price, Oxford University Press, 2009
3. Engineering Chemistry, A Text book of Chemistry for Engineers published by John Wiley and Sons,India 2011
4. Unit processes in Organic Synthesis by Groggins, Tata McGraw Hill, 2001
5. Spectroscopic Methods in Organic Chemistry, D H Williams and I. Fleming, Tata McGraw Hill, 1991
6. Engineering Chemistry, R. Mukhopadhyay, S. Datta, New age international publishers, 2007

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
MA 301	Engineering Mathematics – III	3	1	0	4

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation	Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory)

Unit 1: Laplace Transform: Laplace transform and its properties and applications

Unit 2: Sequences and Series: Sequences, Series, Orthogonal function, Fourier series

Unit 3: Fourier Transform: Fourier transform and its properties and applications

Unit 4: Special Functions: Gamma and Beta functions, Bessel functions, series representations and recurrence relations

Unit 5: Complex Analysis: Functions of complex variables and its derivatives, Integration in complex planes, Series, Singularities and Residues, Evaluation of Real Integrals, Conformal mappings

Text books and Reference books

1. Babu Ram, *Engineering Mathematics Part II,* Pearson
2. Dennis G. Zill and Warren S. Wright, *Advanced Engineering Mathematics*, Fourth Edition (Student Edition), Jones & Barlett, Viba, New Delhi, 2011
3. Peter V. O'Neil, *Advanced Engineering Mathematics*, Seventh Indian Reprint, Cengage Learning, New Delhi, 2011.
4. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley 9th Edition.
5. B. S. Grewal, *Higher Engineering Mathematics*, 41st Ed., Khanna Publishers, Delhi, 2011.
6. H. K. Dass, *Advanced Engineering Mathematics*, 12^{th} editions with corrections, S. Chand and Company, Meerut, 2004
7. B. V. Ramana, *Higher Engineering Mathematics*, Tata Mcgraw Hill.
8. Potter M.C., Goldberg J.L., Edward F.A., *Advanced Engineering Mathematics*, 3rd Edition, Oxford University Press, 2005

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
HS302	Principles of Management for Engineers	2	0	0	2

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Course Syllabi (Theory):

Concepts of management: Functions and Responsibilities of managers, Principles of management and visiting various, Schools of management Thoughts in developing, excellent managers

Planning: Nature and purpose of planning, Planning process and principles, Types of planning, Advantages and disadvantages of planning, Concept of objectives and types of objectives, Case analysis

Organizing: Nature and purpose of organizing, Process of organizing, Span of management and determination of span of management, Principles of organizing, Departmentalization, delegation and, Decentralization. Case analysis

Directing and leading: Requirements of Effective directions, giving orders, motivation, Nature of leadership, leadership and management, Recapitulation and case discussion

Controlling: concept and process, Need for controlling and types of control methods, Essentials of effective control, Benefits and problems in control systems. Case analysis

Social responsibilities of business: Meaning, Social responsibility of business towards different groups, Social performance of business in India, Social audit, Business ethics and corporate governance

Text Books:

1. Tripathy, P.C. and Reddy, P. N. "Principles of Management". . McGraw Hill, New Delhi.4th ed. 2008.

Reference Books:

1. Koontz, Herold and Weihrich, Heinz. "Management". McGraw Hill, New York. 9th ed. 1988.
2. Stoner, James A. F. and Freeman, R Edward. "Management". Prentice Hall of India, New Delhi. 6th e, 1989.
3. Bateman, T. S. and Snell, S. A. "Management: Leading and Collaborating in a Competitive World", McGraw Hill Irwin. 8th edition,2009.
4. Draft, R. L. "Principles of Management". Cengage learning.2009
5. Schermerhron, J. R. "Introduction to Management", 10th edition, Wiley India. 2009

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INSTITUTE OF ENGINEERING AND TECHNOLOGY

4 Year B. Tech Programme

(Branch: Chemical Engineering)

Batch 2015-19

SEMESTER-FOURTH

Detailed Syllabus

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Scheme of Examination

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE404	Chemical Reaction Engineering - I	3	1	3	5.5

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test	End Term Test	Class Participation/ Additional Continuous Evaluation**	Total Marks
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

Introduction: Definition of reaction rates, variable affecting reaction rates, classification of reactions, order, and molecularity.

Kinetics of Homogenous Reactions: Concentration dependent term of a rate equation, temperature dependent term of a rate equation, searching for a mechanism.

Interpretation of Batch Reactor Data: Constant volume batch reactor, variable volume batch reactor, temperature and reaction rate.

Introduction to Reactor Design: Ideal reactors for single reaction: Ideal batch reactor, steady state mixed flow Reactor, steady state PFR, Holding time and space time for flow systems.

Design for single reactions: Size comparison, multiple reactor systems, recycle reactor, auto catalytic reactions.

Design for multiple reactions: Reactions in parallel, reactions in series, series –parallel reactions.

Temperature and Pressure Effects on Reactions: Single reactions: Heat of reaction, equilibrium constants, graphical design procedure, optimum temperature progression, adiabatic operations. Multiple reactions: Product distribution and temperature.

Stability of Multiple Steady –States: Multiple steady-states of a CSTR with a first order reaction, Ignition –extinction curve.

Syllabus (Practical)

1. Isothermal CSTR
2. Cascade CSTR
3. Plug flow reactor (straight tube type)
4. Isothermal plug flow reactor (coiled tube type)
5. Isothermal batch reactor
6. Isothermal semi-batch reactor
7. Packed bed reactor
8. Combined flow reactor
9. Liquid phase chemical reactor

10. RTD studies in CSTR
11. RTD studies in plug flow reactor (coiled tube type)
12. RTD of packed bed reactor
13. Hydrodynamics of trickle bed reactor
14. Condensation polymerisation set-up
15. Spinning basket reactor

Text/Reference Books:

1. Levenspiel, O., "Chemical Reaction Engineering" 3rd ed., John Wiley & Sons, Singapore 1999.
2. Fogler, H.S., "Elements of Chemical Reaction Engineering" 3rd ed., Prentice Hall of India, 2003.
3. Smith, J.M. "Chemical Engineering Kinetics", 3rded., McGraw-Hill, 1981.
4. Dawande S.D. "Principles of Chemical Reaction Engineering," 2nd ed., Central Techno Publications, Nagpur, 2003.
5. Richardson, J.F. and peacock D.G., "Coulson and Richardson's Chemical Engineering,"Vol.3, 3rd ed. Asian Books Pvt. Ltd. New Delhi 1998.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE407	Mass Transfer Operations-I	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*		Total Marks**
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory)

Unit–I: Unit operations and unit process, Basic concepts: phase, equilibrium, property, system, driving force, chemical potential. Classification of mass transfer operations. Molecular diffusion and fluxes

Diffusion phenomenon: Molecular and eddy diffusion in gases, liquids and solids, interface mass transfer Mass transfer theories: Film theory, penetration theory and surface renewal theory.

Unit–II: Concept of Mass transfer coefficient: Individual and film coefficients, overall mass transfer co-efficient and their inter relationships. Continuous contact and differential contact, mass transfer concepts of NTU and HTU, their inter relationship.

Interphase Mass Transfer: Equilibrium, diffusion between phases, material balances, stages and concept of operating line and tie line.

Unit–III: Equipment for gas liquid contact : Sparged vessel, mechanically agitated vessel, tray towers, venture scrubber, wetted wall towers, spray towers and packed towers, tray tower vs packed tower.

Absorption: Absorption in continuous contact columns, Co-current, Counter current and cross current contacting of fluids, calculation of NTU and HTU, concept of HETP.

Unit–IV: Adsorption: Adsorption theories, types of adsorbent, activated carbon silica, silica and molecular sieves, Batch and column adsorption. Break through curves, gas adsorption, BDST models for adsorption calculation.

Unit–V: Humidification and Drying: General theory, psychometric chart, fundamental concepts in humidification and dehumidification, dry bulb and wet bulb temperature, adiabatic saturation temperature, measurement of humidity, calculation of humidification operation, cooling towers and related equipments.

Equilibrium mechanism theory of drying, drying rate curve, Batch and continuous drying, working principle of different types of dryers such as tray driers, Drum dryers, spray and tunnel dryers.

Text Books:

1. Treybal, R.E., "Mass Transfer Operations," 3rd Ed. (International Edition), McGraw-Hill Book Company, Singapore, 1980.
2. McCabe, W. L., Smith, J. C., Harriott, P., "Unit Operations of Chemical Engineering," 7th Ed. (International Edition), McGraw-Hill Education (Asia), Singapore, 2005.

Reference Books:

1. Dutta, B. K., "Principles of Mass Transfer and Separation Processes", PHI Learning Pvt. Ltd. New Delhi, 2007.
2. Foust, A. S., Wenzel, L. A., Clump, C. W., Anderson, L. B., "Principles of Unit Operations," 2nd Ed., John Wiley and Sons, New York, 1980.

3. Perry, R. H., Green, D. W., "Perry's Chemical Engineers' Hand Book," 7th Ed., McGraw-Hill, New York, 2001.
4. Smith, B.D., "Design of Equilibrium stage Processes", McGraw-Hill, NY
5. King, C.J. "Separation Processes", McGraw –Hill, NY.
6. Coulson, J.M. and Richardson, J.F., "Chemical Engineering", Vol. I and II, Asian Books Pvt., New Delhi.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE403	Chemical Engineering Thermodynamics	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory)

Scope and Objectives of course, methodology, First law, Closed System, State and State functions

Equilibrium, Phase rule, Reversible Process, Const-V and Const-P Processes, Enthalpy, heat capacity, First law for Open systems, PVT behaviour of pure substances, Virial Equations, Ideal gas

Applications of Virial Equations, Cubic Equations of State, Generalized correlations for gases and liquids, Sensible heat effects, Latent heat, Standard heats of reaction, formation, combustion

Temperature dependence of $\Delta H°$, heat effects of industrial reactions, Statements of second law, Heat engines, Thermodynamic temperature Scale, Entropy, ΔS for an ideal gas, Entropy balance for Open Systems, Ideal work, Lost work, Third law, Property relations for homogeneous phases.

Residual properties and their calculations by cubic equations, Two-phase systems, thermodynamic diagrams and tables

Generalized property correlations for gases, Duct flow of compressible fluids, Expansion Processes, Compression Processes, Carnot refrigerator, Vapour-compression cycle, Choice of refrigerant, Absorption refrigeration, Heat pump, Liquefaction Processes

Nature of Equilibrium, Phase rule, Duhem's theorem, VLE; Qualitative behavior, Simple models for VLE, VLE by Modified Raoult's law, K-value correlations, Fundamental Property Relation, Chemical potential and Phase equilibrium, Partial Properties, Ideal gas mixtures, Fugacities of pure species

Fugacities of Species in solution, Generalized Correlations, Ideal Solution, Excess Properties,

Liquid-phase properties from VLE data, Models for Excess Gibbs energy, Property changes of Mixing, Heat effects of Mixing processes, Reaction coordinate, Equilibrium criteria for chemical reactions, Equilibrium constants and their variation with temperature

Evaluation of Equilibrium constants, Relation of Equilibrium Constants with Compositions, Equilibrium conversions for Single Reactions, Phase Rule and Duhem's theorem for Reacting Systems, Multireaction Equilibria

Text Book:

1. Smith, J. M., Van Ness, H. C. and Abbott, M. M., "Introduction to Chemical Engineering Thermodynamics", 6 th Ed., McGraw-Hill, 2001.

Reference Books:

1. Rao, Y. V. C., "An Introduction to Thermodynamics," John Wiley, 1997.
2. Kyle, B.G., "Chemical and Process Thermodynamics", 3rd ed., PHI New Delhi
3. KV Narayanan, "A Textbook of Chemical Engineering Thermodynamics". Prentice Hall of India, 2001.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE405	Mechanical Operations	3	1	3	5.5

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others
**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

Characterization of Solid particles, properties of masses of particles, Storage and conveying of solids, mixing of solids, Mixers, Size reduction, equipment for size reduction

Screening, screening equipment, Filtration equipment, Filtration calculations, Membrane filtration, gravity settling processes, Centrifugal sedimentation processes

Solid-Gas Separation: Cyclone separators and electrostatic precipitator- Principles and applications.

Fluidization: Fluidization of solids and its applications, Hydraulic and Pneumatic transport of solids.

Ion Exchange, Chromatography, Separation of gases , Separation of liquids,

Syllabus (Practical)

1. Crushing, grinding, screening
2. Vacuum filtration
3. Plate and frame filtration
4. Rotary drum filtration
5. Froth flotation
6. Sedimentation and thickening
7. Centrifugal double cone classifier
8. Drying
9. Centrifugal pump characteristics
10. Reciprocating pump characteristics

Text Books:

1. McCabe W. L., and Smith J. M., &Harriott P., *Unit Operations of Chemical Engineering*, 7th Ed., McGraw-Hill International Edition, 2006.

Reference Books:

1. Brown, G. G., et al, "Unit Operations," CBS Publishers & Distributors, New Delhi, 1995.
2. Coulson, J. H. and Richardson, J. F., Backhurst, J. R., and Harker, J.H., "Coulson & Richardson's Chemical Engineering," Vol. 2, 4th ed., Asian Books Private Ltd., New Delhi, 1998.
3. Perry, R. H. and Green, D.W., "Perry's Chemical Engineers Handbook," 7th ed., McGraw-Hill, 1998.
4. Foust, A.S., et al., "Principles of Unit Operations", 2nd ed., John Wiley, Singapore.
5. Chattopadhyay, P. "Unit Operations of Chemical Engineering", Vol. I., Khanna Publishers, Delhi, 1998.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
MA 402	Numerical and Statistical Analysis	3	0	2	4

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation	Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks**
20	20	40	10	10	100	20	40	15	25	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

Modeling, Computers, and Error Analysis: Mathematical Modeling and solution using Programming and Software, Computer Arithmetic and Errors: Approximations and Round-Off Errors, Truncation Errors and the Taylor Series

Transcendental and polynomial equation: Solution of non-linear Equations: Bisection Method, Regula-falsi Method, Secant Method, Newton Raphson Method

Linear Algebraic Equations: LU Decomposition Method, Gauss Elimination Method, Gauss Jordan Elimination Method, Iterative methods for solving system of linear equations.

Interpolation and approximation: Netwon Formula for forward and backward interpolation, Sterling Central difference interpolation, Lagrangian Interpolation

Numerical Differentiation and Integration: Numerical Differentiation and Integration, Newton-Cotes Integration Formulae.

Ordinary Differential Equations: Picard Method, Euler Method, Modified Euler Method, Runge-Kutta 4th order Method, Milne Predictor-Corrector Method

Random Variables and probability distributions: Introduction to probability, Discrete and continuous random variables, Probability Distributions: Binomial, Possion, Exponential, Normal distributions, Mathematical expectation, Chebyshev's inequality, Discrete and continuous probability distributions

Sampling distributions: Sampling, Types of sampling, sampling errors, sampling distribution of means, variance and proportions for normal population, The Central Limit Theorem, Chi-Square, t and F distributions

Estimation: Estimators, Point and interval estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions

Testing of Hypotheses: Null and alternative hypotheses, the critical and acceptance regions, two types of error, Parametric Tests, Chi-square goodness of fit test, Contingency tables.

Correlation and regression: Types of Relationships, Scatter Diagrams, Regression Line, Coefficients of Determination and Correlation

Syllabus (Practical)

Numerical Methods using MATLAB and Statistical Analysis using SPSS in Computer Labs that includes:

1. Numerical solution of algebraic and transcendental equations.
2. Numerical solution of system of linear equations.
3. Interpolation.
4. Numerical differentiation.
5. Numerical integration.
6. Numerical solution of differential equations.
7. Data Analysis using Correlation and Regression
8. Test of Hypothesis

Text books and Reference books

1. K. E. Atkinson, *Introduction to Numerical Analysis*, John Wiley and Sons.
2. M.K. Jain, S. R. K. Iyengar, R. K. Jain, *Numerical Methods For Scientific And Engineering Computation*, New age International publishers, New Delhi.
3. Steven C Chapra, Raymond P Canale, *Applied Numerical Methods with MATLAB for Engineers and Scientists*, 3rd Editions, Tata Mc Graw Hill, New Delhi, 2012.
4. Srimanta Pal, *Numerical Methods: Principles, Analyses and Algorithms*, Oxford University Press, New Delhi.
5. Cheney and Kincaid, *Numerical Methods and Applications*, Cengage Publications, New Delhi.
6. Cleve B. Moler, *Numerical Computing with MATLAB*, Prentice Hall of India, New Delhi .
7. Rishard A. Johnson, *Miller and Freund's probability and Statistics for Engineers*, PHI, 8th Ed.
8. Ravichandran J., *Probaility and statistics for Engineers*, Wiley India, New Delhi.
9. Douglas C. Montgomery and George C. Runger, *Applied Statistics and Probability for Engineers*, John Wiley & Sons, Inc., 3rd Edition (2004).
10. Prem S. Mann, *Introductory Statistics*, Wiley publication, 7th edition.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
HS701	Principle of Economics	3	0	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory)

Definition of Economics and role of economics in Engineering and Technology; Basic economic terms; The economy, working of an economy, kinds of an economy and its basic problems; Laws of Demand and Supply and market Equilibrium; Elasticity of demand its measurements and application, Production function and law of Variable Proportion and Law of Returns to Scale; Concepts of cost and revenue, short run and long run cost function; Profit maximization hypothesis, Price and output determination under Perfect Competition, Monopolistic competition and Monopoly.

Measurement of macroeconomic aggregates, National Income, Consumption, saving and investment function; Macroeconomic issues: Inflation, Unemployment and Economic growth International aspects of macroeconomics; Foreign Exchange rate and Balance of payments.

Text Book(s)

T.R. Jain and M.L. Grover, “Economics for Engineers”, V. K. (India) Enterprises

Reference Book(s)

1. D N Dwivedi “Principles of Economics”, Vikas Publishing House Pvt Ltd.
2. G. Mankiew. Economics Principles and Applications. Cengage Learning

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Ph.: +91-141-7107500/504

INSTITUTE OF ENGINEERING AND TECHNOLOGY

4 Year B. Tech Programme

(Branch: Chemical Engineering)

Batch 2015-19

SEMESTER-FIFTH

Detailed Syllabus

&

Scheme of Examination

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE501	Chemical Reaction Engineering - II	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**
20	20	50	10	100	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others
**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

Catalysts: Description, method of preparation and manufacture; catalyst characterization –BET surface area, pore volume, pore size distribution.

Catalyst Reaction Kinetic Models: Physical and chemical absorption; determination of rate expressions using absorption, surface reaction and desorption as rate-controlling steps.

Determination of Global Rate of Reaction: Heterogeneous laboratory reactors; Determination of rate expressions from experimental data.

Effect of Intrapellet Diffusion on Reaction Rates in Isothermal Pellets: Concept of effectiveness factor, Thiele modulus,experimental determination of effectiveness factor-wesiz-Prater criteria, Non-Isothermal effectiveness factor; Prater number, maximum temperature rise in a pellet, multiple steady states in heterogeneous reactors.

Non-catalytic Gas-Solid Reactions: Progressive conversion model, Shrinking core model; various controlling regimes, design of gas-solid reactors.

Gas-Liquid Reactions: Effect of diffusion on rate of reaction, enhancement factor.
Introduction to Design of Heterogeneous Reactors: One dimensional model for fixed-bed reactors, parametric sensitivity; design of fluidized bed reactors

Text/Reference Books:

1. Levenspiel, O., "Chemical Reaction Engineering"3rdEd., John Wiley, 1999.
2. Smith, J.M., "Chemical Engineering Kinetics"3rdEd., Mc Graw-Hill, 1981.
3. Fogler, H.S., "Elements of Chemical Reaction Engineering"3rdEd., Prentice-Hall of India, Delhi, 2003.
4. Carberry, J.J., "Catalytic Reaction Engineering"Mc Graw-Hill, 1976.
5. Dawande, S.D., "Principles of Reaction Engineering"Central Techno Pub.,Nagpur, 2001.
6. Levenspiel, O., "The Chemical Reactor Omnibook"OSU Bookstores, Corvallis Oregon, 1996.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE508	Process Instrumentation and Control	3	1	2	5

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

- Introduction to instrumentation and process control. Measuring instruments for: Temperature, pressure, level, flow, composition, pH.
- Dynamic behavior of first, second and higher order physical systems. Interacting and non-interacting processes. Linearization of non-linear systems. Controller hardware, transducers, sensors, transmitters and control valves.
- Basic concepts of feedback control: Control loop and its elements; servo and regulatory problems; P, PI, PID controllers.
- Stability of control loop using Routh's test. Introduction to root locus method. Frequency response analysis: Bode stability criteria and Nyquist plot.
- Introduction to advanced control systems: feed forward, cascade, ratio control. Design of single loop feedback control systems and tuning of feedback controllers. Cohen-Coon method, 1/4th decay ratio method, direct synthesis methods, gain and phase margins, Ziegler-Nichols method. Control schemes with applications to distillation systems, chemical reactors, heat exchangers, boilers etc. State space representation of physical system. Transfer function matrix and multivariable control.
- Instrumentation symbols introduction to process flow diagram (PFD) and piping & instrumentation diagram (P&ID)

Syllabus (Practical)

1. PRESSURE CONTROL TRAINER
2. LEVEL CONTROL TRAINER
3. TEMPERATURE CONTROL TRAINER
4. FLOW CONTROL TRAINER
5. CONTROL VALVE CHARACTERISTICS (Linear, Equal Percent & Quick Opening)
6. CHARACTERISTICS OF PID CONTROLLER
7. STUDY OF I/P AND P/I WITH MINI COMPRESSOR
8. CASCADE CONTROL TRAINER: LEVEL + FLOW (SCADA) WITH MINI COMPRESSOR AND SCADA SOFTWARE
9. MULTIPROCESS TRAINER: LEVEL, FLOW, CASCADE, RATIO &FEEDFORWARD (SCADA)
10. FIRST-ORDER AND SECOND-ORDER SYSTEM
11. PLC TRAINER

12. FLAPPER - NOZZLE SYSTEMWITH MINI COMPRESSOR
13. MULTI VARIABLE CONTROL TRAINER
14. INTERACTING & NON - INTERACTING SYSTEM
15. DCS TRAINER (HYBRID CONTROLLER)

Text Book:

- Coughanowr, D.R., Process Systems Analysis and Control, 2nd Ed., McGraw-Hill, 1991.
- George Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall, 1984.

Reference Books:

- Seborg, D. E., Edgar, T. F. and Mellichamp, D.A., "Process Dynamics and Control", 2nd Ed., John Wiley and Sons, 2004
- Ogunnaike, B.A., Ray, W.H., "Process Dynamics, Modelling and Control", Oxford University Press,1994
- Nakra, "Instrumentation, Measurement and Analysis"; Tata McGraw Hill, New Delhi.
- Patranabis, D., "Principles of Industrial Instrumentation"2nded. Tata McGraw Hill, New Delhi.
- Eckman, D.P., "Industrial Instrumentation", Wiley Eastern, 1978.
- Liptak, B.G., "Industrial Engineers'Handbook"Vol.1 and 2, CRC Press, 1994.
- Andrew, W.G., et al., "Applied Instrumentation in the Process Industries," Gulf Pub.1993.
- Wightman, E.J., "Instrumentation in Process Control," Butterworth, 1972.
- Doebelin, E., "Measurement Systems: Applications and Design,"4thed., McGraw Hill, 1990

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE503	Process Modelling and Simulation	3	1	2	5

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation / Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

Introduction: Use and scope of mathematical modeling, Principles of model formulation, Role and importance of steady-state and dynamic simulation, Classification of models, Model building, Modeling difficulties, Degree-of-freedom analysis, Selection of design variables, Types of equations.

Fundamental Laws: Equations of continuity, energy, momentum, transport, and state, Transport properties, Equilibrium and chemical kinetics, Review of thermodynamic correlations for the estimation of physical properties like phase equilibria, bubble and dew points etc, Prediction of enthalpy departure and VLE characteristics from equation of state by the application of numerical methods.

Modeling of Specific Systems: Constant and variable holdup CSTRs under isothermal and non-isothermal conditions, Stability analysis, Gas phase pressurized CSTR, Two phase CSTR, Non-isothermal PFR, Batch and semi-batch reactors, Heat conduction in a bar, Laminar flow of Newtonian liquid in a pipe, Gravity flow tank, Single component vaporizer, Multi-component flash drum, Absorption column, Ideal binary distillation column and non-ideal multi-component distillation column, Batch distillation with holdup etc.

Syllabus (Practical)

Simulation of the models, Sequential modular approach, Equation oriented approach, Partitioning and tearing, Introduction and use of process simulation software (ASPEN/Hysis or ChemCAD) for flow sheet simulation.

Text Books:

1. Luyben W.L., Process Modeling, Simulation, and Control for Chemical Engineering, McGraw-Hill (1998).

Reference Books:

1. Denn, M. M., Process Modeling, Longman Sc & Tech. (1987).
2. Himmelblau, D.M and Bischoff, K.B., Process Analysis and Simulation: Deterministic Systems, John Wiley (1968).
3. Holland, C. D., Fundamentals and Modeling of Separation Processes: Absorption, Distillation, Evaporation and Extraction, Englewood Cliffs, Prentice-Hall (1974).
4. Babu, B.V., Process Plant Simulation, Oxford University Press (2004).

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE507	Mass Transfer Operations - II	3	1	3	5.5

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

Unit–I

Distillation: Vapor liquid Equilibria, Boiling point diagram, Relative volatility, flash and differential distillation for two component mixture, steam distillation, azeotropic distillation, extractive distillation.

Continuous and differential contact distillation: Rectification, reflux ratio and its importance, Minimum reflux, total and optimum reflux ration, material balance and Q-line equation, open steam, multiple feed and multiple product calculations, Enthalpy concentration diagram, panchon-Savarit and McCabe Theile method for calculation of number of plates. Approximate equation; Fensky and underwood equation for minimum reflux and minimum number of plate calculation, Batch distillation.

Unit–II

Liquid–Liquid extraction : Liquid-Liquid equilibrium, packed and spray column, conjugate curve and tie line data, plait-point, ternary liquid-liquid extraction, co-current, counter current and parallel current system, Hunter-Nash graphical equilibrium stage method, selection of solvent for extraction.

Unit–III

Leaching: Solid-liquid equilibrium, Equipment, principles of leaching, co-current and counter current systems and calculation of number of stage required

Unit–IV

Crystallization: Supersaturation, methods to achieve supersaturation, Factors governing nucleation and crystal growth rates, controlled-growth of crystals, super saturation curve, principle and design of batch and continuous type crystallizers, Inverted soliability, fractional crystallization.

Syllabus (Practical)

1. LIQUID-LIQUID EXTRACTION IN A PACKED TOWER
2. YORK SCHEIBEL'S EXTRACTION UNIT
3. SOLID-LIQUID EXTRACTION (BONNOTTO TYPE)
4. SIEVE PLATE DISTILLATION COLUMN
5. SIMPLE BATCH DISTILLATION SETUP
6. ABSORPTION IN WETTED WALL COLUMN

7. VAPOUR IN AIR DIFFUSION APPARATUS
8. FLUIDIZED BED DRYER
9. BATCH CRYSTALLIZER
10. VAPOUR-LIQUID EQUILIBRIUM SET-UP
11. MASS TRANSFER WITH & WITHOUT CHEMICAL REACTION (SOLID- LIQUID)
12. ADSORPTION IN PACKED BED

Text Books:

1. Treybal, R.E., "Mass Transfer Operations," 3rd Ed. (International Edition), McGraw-Hill Book Company, Singapore, 1980.
2. McCabe, W. L., Smith, J. C., Harriott, P., "Unit Operations of Chemical Engineering," 7th Ed. (International Edition), McGraw-Hill Education (Asia), Singapore, 2005.

Reference Books:

1. Dutta, B. K., "Principles of Mass Transfer and Separation Processes", PHI Learning Pvt. Ltd. New Delhi, 2007.
2. Seader, J.D., Henley, E.J., "Separation Process Principles," 2nd Edition, Wiley India Pvt. Ltd., NewDelhi, 2006.
3. Foust, A. S., Wenzel, L. A., Clump, C. W., Anderson, L. B., "Principles of Unit Operations," 2nd Ed., John Wiley and Sons, New York, 1980.
4. Perry, R. H., Green, D. W., "Perry's Chemical Engineers' Hand Book," 7th Ed., McGraw-Hill, New York, 2001.
5. Smith, B.D., "Design of Equilibrium stage Processes", McGraw-Hill, NY
6. King, C.J. "Separation Processes", McGraw –Hill, NY.
7. Coulson, J.M. and Richardson, J.F., "Chemical Engineering", Vol. I and II, Asian Books Pvt., New Delhi.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE505	Chemical Engineering Materials	3	0	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks
20	20	50	10	100	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory)

- Introduction, Unit cell, Crystallographic directions and planes, Linear and planner densities, close-packed crystal structures, Crystal structures of ceramics
- Determination of crystal structure, Bragg's Law, diffraction technique, Vacancies and interstitials, dislocations and grain boundaries, Optical and electron microscopy, grain size determination
- Steady and non-steady diffusion, Stress-strain, elastic and plastic deformations, Slip systems, plastic deformation, strengthening mechanisms
- Phases, microstructures, phase equilibria, Fe-Fe3C phase diagram, development of microstructure in Fe-C alloys, Avrami rate equations, Isothermal transformation diagrams, continuous cooling transformations, Mechanical behavior of Fe-C alloys, tempered martensite, Molecular weight, molecular configurations of polymers,
- Mechanisms of deformation and strengthening in polymers, glass transitions

Text Book:

1. Materials Science and Engineering-An introduction by W.D. Callister, 7th edition, John Wiley (2007) ISBN 10: 81-265-1076-5 or ISBN 13: 978-81-265-1076-4.

Reference Books:

1. Materials science and engineering by V. Raghavan, 4th edition, Prentice Hall of India, ISBN 10: 81-203-1261-9
2. Materials science and engineering by Smith, Hashemi, and Prakash, 4th edition (2008), Tata McGraw Hill education pvt. Limited, ISBN 10: 0-07-066717-9 or ISBN 13: 978-0-07-066717-4.
3. Materials science and engineering by Askeland and Fulay, Cengage Learning, ISBN 10: 81-315-1255-X or ISBN 13: 978-81-315-1255-5.
4. Essentials to Materials Science and Engineering by Askeland and Phule, Thomson learning, Indian reprint 2007, ISBN 10: 81-315-0233-3.

Effective Public Speaking and Employability Skills

Course Code	**:**	**LA 601**
Course Title	**:**	**Effective Public Speaking and Employability Skills**
Total Hours per Week	**:**	**02**

Course Syllabi (Theory):

- Planning, Preparing and Organizing a Presentation: Collecting the Material, Making an Outline, Drafting, Editing
- Structuring the Presentation: Choosing and Pattern such as Chronological, Causal, Spatial, Directional, Psychological, etc.
- Audience Analysis: Recognizing Needs, Expectations and Attitudes
- Combating Nervousness: Signs and Symptoms; Hidden Causes of Stage Fright; Remedies
- Designing a Presentation: Planning Innovative Beginnings; Developing and Substantiating the Main Body; Casting Effective Endings
- Using Body and Voice to Communicate Effectively: Nuances of Body Language such as Gestures, Posture, Eye Contact, Hand Movements, Facial Expressions; and Elements of Voice such as Volume, Pitch, Articulation, Inflections, Pauses, Vocalized Pauses, etc.
- Choosing Appropriate Language for the Right Effect: Vocabulary, Wit and Humour
- Preparing Speeches for Special Occasions: Welcome Speech, Welcome Speech, Introduction Speech, Felicitation Speech, Farewell Speech, Vote of Thanks, etc
- Preparing Resume and Curriculum Vitae
- Group Discussion: Understanding the Purpose and Relevance; Learning Tips for Effective Participation; Various Traits to be Evaluated such as Reasoning Ability, Group Dynamics, Leadership Skills, Openness, Assertiveness, Motivation, Non-verbal Communication, Originality, Composure, Expression; Learning through Mock Group Discussions, etc
- Job Interviews: Discussing with students the different steps and strategies required in job interviews; highlighting the importance of preparation, alertness, confidence and knowledge; preparing for commonly asked questions during interviews, marshalling techniques for answering effectively, reviewing different job interviews; displaying effective body language; sailing through dicey questions; Learning through Mock Interviews.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
PS501	Practice School – I				4

Evaluation Scheme

S. No.	Evaluation Component	Marks (100) (Weightage %)
1	Quiz-I	4
2	Quiz-II	4
3	Group Discussion-I	4
4	Group Discussion-II	4
5	Seminar-I	4
6	Seminar-II	4
7	Diary-I	4
8	Diary-II	4
9	Observation-I	4
10	Observation- II	4
11	Mid Term Evaluation (Project Report and Presentation/Viva)	20
12	Final Evaluation (Project Report and Presentation/Viva)	40

Course Syllabi:

This course is for 6 weeks at the end of 4th semester during summer term of 4 year full time B. Tech. and 5 year Integrated Dual degree (B.Tech + M.Tech, B.Tech + MBA) programs in all the engineering disciplines. The objective of this programme is to provide the students an understanding of working of corporate world in various functions associated with an Industry/Organization. During this programme, they will observe and learn various real world applications of their curricula and develop an understanding of vast engineering operations and its various facets such as inventory, productivity, management, information systems, human resource development, data analysis etc. The general nature of PS-1 assignments is of study and orientation.

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INSTITUTE OF ENGINEERING AND TECHNOLOGY

4 Year B. Tech Programme

(Branch: Chemical Engineering)

Batch 2015-19

SEMESTER-SIXTH

Detailed Syllabus

&

Scheme of Examination

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE602	Chemical Process Technology	3	0	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks
20	20	50	10	100	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- Chemical Industries – Facts and figures, Unit operations and Unit Process concepts, General Principles applied in studying an Industry, Unit operations and Unit Process concepts, General Principles applied in studying an Industry
- Project formulation, its evaluation and implementation, Chamber Process, Contact Process, DCDA Process, Ammonia Oxidation Processes: Mono Pressure and Mixed Pressure Processes, Urea Production Processes; Ammonium Nitrate Production Processes;
- Phosphate and Potash based fertilizers production processes; Phosphoric acid manufacturing processes, Kraft Process, sulfite Process, Mechanical Pulping; Paper making, Production of lignin chemicals
- Dry and wet cement manufacturing processes, Mechanical and solvent based extraction processes, Hydrogenation of oils; isomerization, interesterification, Soap manufacturing processes, glycerin recovery process, alfol process of detergent production
- Coal combustion, carbonization and liquefaction technologies, Origin and classification of petroleum, atmospheric and vacuum distillation processes; Reforming, Solvent deasphalting, solvent dewaxing, Chemicals from C_1 compounds, Chemicals from C_2 compounds, Chemicals from C_3 compounds, Chemicals from C_4 compounds, Various polymerization processes

Text Book:

1. "Dryden's Outlines of Chemical Technology for the 21st Century" Edited by M. GopalaRao and Marshall Sittig. East West Press, 3rd Ed., 1997.

Reference Books:

1. George T. Austin, Shreve's Chemical Process Industries by, McGraw Hill, 5th Edn., 1984.
2. D. Sen, Reference book on Chemical Engineering, Vol- I", New Age International Publishers, 2005

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE603	Process Equipment Design	3	1	3	5.5

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

**The ratio of weightage between Theory and Practical content will be 60%: 40%

Syllabus (Theory)

- Introduction, Considerations in process equipment design, Materials of construction, Mechanical Properties, Materials, Corrosion, Protective Coatings, Choice of Materials, Criteria in vessel design, Design of shells for flat bottomed cylindrical vessels.
- Shell design of large storage tanks, Design of bottoms and roofs for flat bottomed cylindrical vessel, Proportioning and Head Selection for cylindrical vessels with formed closures, Stress Considerations in the selection of Flat plate and conical closures, Design of pressure vessels
- Design of high pressure vessels, Design of shell & tube heat exchanger, Process Design, Design of shell & tube heat exchanger, Mechanical Design, Design of Distillation and Absorption column, Column sizing approximation, Plate Contactors, Plate Hydraulic Design, Design of Distillation and Absorption column
- Stresses in column shell, Design and construction features of column internals, Design of reaction vessels, Design considerations of heating systems,Design of agitator system components
- Shaft, agitator, couplings, bearings, stabilizers, seals, Design of supports for vessels, Skirt supports, saddle supports, Design of Flanges, Process Hazards and safety measures in equipment design

Syllabus (Practical)

1. Mechanical design of storage vessel including roof design
2. Mechanical design of high pressure vessel
3. Mechanical design of reaction vessel carrying out exothermic reaction
4. Mechanical design of distillation column
5. Mechanical design of heat exchanger unit
6. Hydraulic design of distillation column
7. Hydraulic design of absorption column
8. Mechanical design of agitated vessel
9. Mechanical design of chimney

Text Book:

1. **"**Process Equipment Design"- Lloyd E. Brownell, Edwin H. Young, John Wiley & Sons Publications, 2004.
2. "Process Equipment Design"- M V Joshi, V VMahajani, Macmillan India Limited, New Delhi.

Reference Book

1. Coulsonos and Richardson's Chemical Engineering, Volume 6, Sinnott, R.K., Asian Books Pvt. Ltd, 1998

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE604	Transport Phenomena	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- Scope and objectives of course, methodology, Newton's law of viscosity, molecular theories of viscosity, Convective momentum transport, Shell momentum balances, boundary conditions, Examples, Equations of continuity, motion and mechanical energy, Examples
- Dimensional analysis, Time-dependent flow of Newtonian fluids, Solving flow problems using stream functions and velocity potential, Boundary layer theory, Fourier's law of heat conduction, molecular theories of thermal conductivity, Convective transport of energy, work associated with molecular motions, Shell energy balances, examples, Forced and free convection, Various forms of energy equations, Examples
- Dimensional analysis, Unsteady state heat conduction in solids and in laminar flow, Boundary layer theory for non-isothermal flow, Fick's law of binary diffusion, molecular theories of diffusion, Mass and molar transport by convection, summary of mass and molar fluxes, Shell mass balance, boundary conditions, Examples, Equations of continuity, summary of multicomponent equations of change, Examples
- Dimensional analysis, Time-dependent diffusion, Steady state transport in binary boundary layers, Time-smoothed equations of change and velocity profiles, Empirical expressions for turbulent momentum flux; turbulent flow in ducts etc., Time-smoothed equations of change and temperature profiles for turbulent flow in tubes, Time-smoothed concentrations and equation of continuity and applications

Text Book:

1. Bird, Stewart and Lightfoot, 'Transport Phenomena', John Wiley & Sons, 2002, 2nd ed.

Reference Books:

1. Fox and McDonald, 'Introduction to fluid dynamics,' John Wiley & Sons, 2000, 5th ed.
2. Holman, J.P., 'Heat transfer', McGraw Hill, 1997, 8th ed.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
ME 625	Computational Fluid Dynamics	3	0	2	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks**
20	20	50	10	100	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Course Syllabi (Theory):

- **Mathematical modeling:** Governing equations of fluid flow and heat transfer; Introduction to discretization methods: Finite difference and finite volume methods for heat transfer problems; Time stepping methods for unsteady problems; Solution techniques for system of algebraic equations; Grid generation techniques; Solution techniques for Navier-Stokes equation; Finite element method for heat transfer and fluid flow problems; Turbulence modeling.
- **Introduction:** Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description.
- **Classification and Overview of Numerical Methods:** Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods.
- **Finite Difference Technique:** Finite difference methods; different means for formulating finite difference equation; Taylor series expansion, integration over element, local function method; treatment of boundary conditions; boundary layer treatment; variable property; interface and free surface treatment; accuracy of f.d. method.
- **Finite Volume Technique:** Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem.
- **Finite Element Methods:** Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications.
- **Methods of Solution:** Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform.
- **Time integration Methods:** Single and multilevel methods; predictorcorrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems.
- **Numerical Grid Generation:** Numerical grid generation; basic ideas; transformation and mapping.
- **Navier-Stokes Equations:** Explicit and implicit methods; SIMPLE type methods; fractional step methods.

- **Turbulence modeling:** Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

Text Books:

1. Richard Pletcher, John Tannehill and Dale Anderson, `Computational Fluid Mechanics and Heat Transfer 3e', CRC Press, 2012
2. H.K. Versteeg and W. Malalasekera, `An introduction to computational fluid dynamics: The finite volume method 3e', Pearson Education, 2007.
3. Charles Hirsch, `Numerical Computation of Internal and External Flows', Vol.1 (1988) and Vol.2 (1990), John Wiley & Sons.

Reference Books:

1. J. H. Fergiger, M. Peric, `Computational Methods for Fluid Dynamics 3e', Springer, 2002.
2. T. J. Chung `Computational Fluid Dynamics 2e', Cambridge University Press, 2010.
3. C. A. J. Fletcher, `Computational Techniques for Fluid Dynamics Vol. 1 and 2 2e', Springer, 1991.
4. S.V. Patankar, `Numerical Heat Transfer and Fluid Flow', Hemisphere, 1980.
5. J. D. Anderson Jr., `Computational Fluid Dynamics', McGraw-Hill International Edition, 1995.
6. Anderson, D.A., Tannehill, J.C. and Pletcher, R.H. (1997). Computational Fluid Mechanics and Heat Transfer. Taylor & Francis.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE611 (Elective-1)	Energy Engineering	3	0	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Sources of Energy; Energy Conversion and Conservation; Energy efficiency, energy services; Plant engineering, environmental compliance and alternative energy technologies; Power generation by steam, Hydroelectric, Diesel oil, Nuclear fission and Natural gas, Co-generation of power. Selection of power generation process; Energy Economic Analysis, Energy Auditing and Accounting, Energy minimization; Energy Loads; Application in building design, HVAC, lighting, refrigeration, etc. to both reduce energy loads and increase efficiency of current systems; Energy production, conversion, transference, distribution, and utilization; Sustainability; Energy Management; Climate Change and Climate Modeling; Carbon Sequestration and Carbon reduction targets;

Text Books:

1. Albert Thumann, D. Paul Mehta, “Handbook of Energy Engineering”, Fairmount Press Inc., 2008
2. Roger A. Hinrichs, Merlin H. Kleinbach, “Energy: Its uses and the environment”, Cengage Learning, 5th edition, 2011

References:

1. Tyler Hicks, “ Handbook of Energy engineering Calculations”, McGraw Hill Professional, 2011
2. Francis, W and M.C. Peter, “Fuels and fuel technology”, Pergamon Press, 1980.
3. Nagpal, G.R, “Power Plant Engineering”, Khanna Publishers, 1973
4. Rused, C. K., Elements of Energy Conservation , McGraw-Hill Book Co., 1985

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE612(Elective-1)	Non – Conventional Energy Sources	3	0	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Introduction: Energy scene of supply and demand in India and the world, energy k2consumption in various sectors, potential of non-conventional energy resources. Detailed study of the following sources with particular reference to India

Solar Energy: Solar radiation and its measurement, limitations in the applications of Solar Energy, Solar collectors – types, and constructional details. Solar water heating, applications of Solar Energy for heating, drying, space cooling, water desalination, solar concentrators, photovoltaic power generation using silicon cells.

Bio-Fuels: Importance, combustion, pyrolysis and other thermo chemical processes forbiomass utilization. Alcoholic fermentation, anaerobic digestion for biogas production

Wind Power: Principle of energy from wind, windmill construction and operational details and electricity generation and mechanical power production.

Tidal Power: Its meaning, causes of tides and their energy potential, enhancement of tides, power generation from tides and problems. Principles of ocean thermal energy conversion (OTEC) analysis and sizing of heat exchangers for OTEC

Geothermal Energy: Geo technical wells and other resources dry rock and hot aquiferanalysis, harnessing geothermal energy resources.

Energy Storage and Distribution: Importance, biochemical, chemical, thermal, electric storage. Fuel cells, distribution of energy.

Text/Reference Books:

1. Rai,G.D,Non-conventional Energy Sources, Khanna Publishers, Delhi.
2. Twiddle, J. Weir, T. “Renewable Energy Resources,”Cambridge University Press, 1986.
3. Kreith, F. and Kreider, J. F., “Principles of Solar Engineering,”McGraw Hill, 1978.
4. Duffie, J. A., Beckman, W. A., “Solar Engineering of Thermal Processes,”John Wiley, 1980.
5. Veziroglu, N., “Alternative Energy Sources,”Volume 5 & 6, McGraw-Hill, 1978.
6. Sarkar, S., “Fuels and Combustion,”2nded., Orient Longman, 1989.
7. Sukhatme, S. P., “Solar Energy,”2nded., Tata McGraw-Hill, 1996.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE613(Elective-1)	Energy Conservation & Management	3	0	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Energy conservation, Growth and demand of energy, Energy availability, Comparison of specific energy use in select industry, Potential and status of energy in India, Energy saving potential in industries, Potential of energy efficiency in India, Energy available for industrial use and the role of conservation, Energy management and policy, Comprehensive energy conservation planning (CECP), Definition and principles of energy conservation, Energy conservation technologies, Cogeneration concept and scope, Energy audit and management, Energy conservation in utilities.

Text Books:

1. Energy Conservation In Process Industry, W. F. Kenny Energy Engineering and Management, AmlanChakrabarti - Prentice hall India 2011

Reference Books:

1. Energy Management Principles, CB Smith, - Pergamon Press, New York,
2. Bureau of energy efficiency, Hand outs New Delhi
3. Energy Management Hand Book, W. C. Turner. John Wiley and sons
4. Handbook on Energy Efficiency, TERI, New Delhi, 2009
5. Energy Auditing and Conservation; Methods, Measurements, Management & Case Study,
Hamies, - Hemisphere Publishing , Washington, 1980.
6. Industrial Energy Management & Utilization, Write, Larry C - Hemisphere Publishers, Washington, 1998.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE614(Elective-1)	Process Plant Simulation	3	0	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- Introduction, Mathematical Modeling, Chemical Systems Modeling, Modular Approaches to Process Simulation, Equation Solving Approach
- Decomposition of Networks, Convergence Promotion, Physical and Thermodynamic Properties, Optimization Techniques
- Specific Purpose Simulation, Dynamic Simulation

Text Books:

1. B V Babu, “Process Plant Simulation”, Oxford University Press, India (2004).

Reference Books:

1. Godfrey C Onwubolu and B V Babu, “New Optimization Techniques in Engineering; Springer-Verlag, Germany (2004).
2. William L Luyben, “Process Modeling, Simulation and Control for Chemical Engineers”, McGraw Hill Publishing Company, New York, 2nd Edition (1990).
3. R G E Franks, “Modeling and Simulation in Chemical Engineering”, John Wiley & Sons Inc., New York (1972).

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE615(Elective-1)	Biochemical Engineering	3	0	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- Various aspects of Biochemical Engineering, The structure of cells and Important cell types, Lipids, Polysaccharides, Nucleotides, Proteins etc.
- Reaction mechanisms, Comparison with chemical catalysis, Michaelies-Menten and Briggs-Haldane kinetic models. Various methods for kinetic parameter evaluation, Enzyme inhibition, Inhibition kinetic models, Application to drug industries, Physico-chemical factors influencing enzyme activity. Enzyme deactivation and kinetic models.
- Immobilized enzyme technology: Methods of immobilization; Immobilized enzyme kinetics; Analysis of external and intraparticle mass transfer, Terminology; Metabolic reaction coupling: ATP & NAD; Carbon catabolism and various pathways; Aerobic and anaerobic respiration.
- Stoichiometry of growth and product formation, Isolation of pure culture, Strain improvement by mutation, protoplast fusion and recombination DNA technique, Introduction, Ideal Reactors for Kinetics measurements, Biomass growth, Substrate uptake and product formation Kinetics measurements: Steady state and transient growth, Structured and unstructured kinetic models.
- Death kinetics, Mass and heat transfer in bioreactors, gassed reactors, immobilized and cell reactor systems, Ideal & non-ideal bioreactors, Modes of reactor operations: Batch, Fed-batch & continuous, Design of bioreactor, fermenter, Sterilization: Batch & Continuous, instrumentation, control, optimization, process scale-up, criteria and correlations
- Filtration, Centrifugation, Sedimentation, Emerging technologies for cell recovery, Extraction, Sorption, Cell disruption method, Precipitation, Coagulation, Flocculation, Dialysis, Electrodialysis, Reverse osmosis, Ion exchange, HPLC, Chromatography and fixed-bed adsorption, Membrane separations, and Electrophoresis, Complete commercial bioprocess: Commercial enzymes, antibiotics and Organic acids, Bioprocess economics and feasibility studies

Text Books:

1. 'Biochemical Engineering Fundamentals' by J. E. Bailey & D. F. Ollis (1987) 2nd Ed., McGraw Hill International Edition

References Books:

1. 'Bioprocess Engineering: Basic Concepts' by Michael L. Shuler & F. Kargi (2003) Prentice-Hall.
2. 'Principles of fermentation technology' P. F. Stanbury& A. Whitaker (1984), Pergamon Press.
3. Chemical Engineering, Vol. 3 by Coulson & Richardson (1998), Asian **Books**.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
MA 621 (Elective-1)	Engineering Optimization	3	0	0	3

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation	Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory)

- **Introduction:** Introduction to Optimization and its scope, Formulating a Mathematical Model, Deriving Solutions from the Model
- **Linear Programming Problems:** Revised Simplex Method, Duality Theory and Sensitivity Analysis, Dual Simplex Method, Transportation Problem, Assignment Problem
- **Non-linear Programming**: Introduction, Single variable and multi variable optimization, Constrained and unconstrained problems, Kuhn-Tucker conditions
- **Network Optimization Models:** The Terminology of Networks, Shortest-Path Problem, Minimum Spanning Tree Problem
- **Other Optimization Models:** Dynamic Programming, Integer Programming, Game Theory
- **Multi-objective optimization**: Introduction to various multi-objective optimization techniques and its scope, Linear Goal Programming and Its Solution

Text books and Reference books

1. Hillier F.S. and Lieberman G.J., *Introduction to Operations Research: Concepts and Cases*, Tata Mc Graw Hill, 8th Ed., (Indian Adapted Edition), 2005.
2. Taha. H. A, *Operations Research: An Introduction*, Pearson Education, 7th ed., 2003.
3. Ronald L. Rardin, *Optimization in Operations Research*. Pearson Education, First Indian Reprint 2002.
4. Pant.J.C*., Introduction to Optimization: Operations Research*, Jain Brothers, 5th Ed., 2000.
5. Sharma. S. D., *Operations Research*, Kedarnath Ramnath & Co., 15th Edition, 2006.
6. Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, PHI.
7. Kasana H.S. and Kumar K.D., Introductory Operations Research: Theory and Applications, Springer.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE621(Elective-II)	Process Design Decisions	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- Introduction, Nature of Process Synthesis & Analysis, Energy Integration Analysis, Engineering Economics for Conceptual Design
- Economic Decision Making, Input Information and Batch vs. Continuous, Input-Output Structure of the Flow sheet, Recycle Structure of the Flow sheet
- Separation System, Cost Diagrams & Quick Screening of Process Alternatives, Preliminary Process Optimization, Process Retrofits

Text Books:

1. James M. Douglas, "Conceptual Design of Chemical Processes", McGraw Hill, New York, International Edition (1988).

Reference Books:

1. Max Stone Peters, Klaus D. Timmerhaus, and Ronald West "Plant Design and Economics for Chemical Engineers", McGraw Hill, New York, 5th Edition (2002).
2. Warren D. Seider, J. D. Seader, and Daniel R. Lewin, "Product & Process Design Principles: Synthesis, Analysis, and Evaluation", John Wiley & Sons, New York, 2nd Edition (2004).
3. Robin Smith, "Chemical Process Design", International Editions, McGraw Hill, Singapore (2000).
4. Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz, "Analysis, Synthesis, and Design of Chemical Processes", International Edition, Prentice Hall, New Jersey (1998).
5. Dale F. Rudd, and Charles C. Watson, "Strategy of Process Engineering", John Wiley & Sons, New York (1968).

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE622 (Elective-II)	Mathematical Methods in Chemical Engineering	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Ordinary differential equations (ODE) – Solution of first order and secondorder differential equations, simultaneous ODEs. Solution by LaplaceTransformation. Series solution method.

Complex Algebra: Introduction; The complex number; the Argand diagram;principle values; Algebraic operations on the Argand diagram; Conjugatenumbers; De Moivere's theorem; the nth roots of unity; complex numberseries; Trigonometrical exponential Identities; Derivatives of a complexvariable; Analytic functions; complex variable and Cauchy's theorem, Laurent'sexpansion, and theory of residues. Laplace inverse by Contour integration,Bromwich's integral formula.

Functions and Definite Integrals: Introduction, error function, gammafunction, beta function, other tabulated functions defined by integrals; Definiteintegrals by contour integration.Vector Analysis: Addition and Subtraction of vectors, Multiplication of vectors,Scalar triple product, Vector triple product, Differentiation of vectors, Partialdifferentiation of vectors, Divergence, Continuity equation, Curl of a vector,Line integral, Vector area and Surface integral, Gauss' Divergence theorem,Green's theorem. Spherical and Cylindrical coordinate systems. Streamfunction, Creeping flow arounda sphere.

Partial differential equations (PDE)- Classifications of PDEs, FormulatingPDEs, Separation of variables method, Orthogonal functions and Sturm-Liouville conditions, The Laplace transform method.

Text/Reference Books

1. Jenson, V.G. and Jeffreys, G.V., "Mathematical Methods in Chemical Engineering,"2nd ed., Academic Press, New York, 1977.
2. Rice, R. G. and Do, D. D., "Applied Mathematics and Modeling for Chemical Engineers", John Wiley & Sons, New York, 1995.
3. Varma, A. and Morbidelli, M., "Mathematical Methods in Chemical Engineering," Oxford University Press, New York, 1997.
4. Kreyszig, E., "Advanced Engineering Mathematics," 8th ed., John Wiley & Sons, 2000.
5. Mickley, H.S., Sherwood, T.K., and Reed, C.E., "Applied Mathematics in Chemical Engineering," McGraw-Hill, 1957.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE623 (Elective-II)	Corrosion Engineering	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- Corrosion Engg., environments, corrosion damage, classification of corrosion, Introduction, corrosion rate expressions. Electrochemical aspects: Electrochemical reactions, polarization, passivity.
- Environmental effects: effects of oxygen and oxidizers, velocity, temperature, corrosive concentration, galvanic coupling. Metallurgical and other aspects: metallic properties, economic considerations, importance of inspection.
- Uniform attack, galvanic corrosion, Crevice corrosion:environmental factors, mechanism, combating crevice corrosion, Filiform corrosion, Pitting: pit shape and growth, autocatalytic nature of pitting, solution composition, velocity, metallurgical variables; evaluation of pitting damage, prevention
- Intergranular corrosion: Austenitic stainless steels, weld decay, control for austenitic stainless steels, knife-line attack, integranular corrosion of other alloys, Selective leaching: dezincification-characteristics, mechanism, prevention: graphitization, other alloy systems, high temperatures
- Erosion corrosion: surface films, velocity, turbulence, impingement, galvanic effect, nature of metal or alloy; combating erosion corrosion, cavitation damage, fretting corrosion.
- Stress corrosion: crack morphology, stress effects, time to cracking, environmental factors, metallurgical factors, meachanism, multi-environment charts, classification of mechanisms, methods of prevention, corrosion fatigue, Hydrogen damage: characteristics environmental factors, hydrogen blistering, hydrogen embrittlement, prevention
- Materials; Metals and alloys: cast irons, carbon steels and irons, Low alloy steels, Stainless steels, various metals and their alloys, Non-metallics: rubbers and other elastomers, various thermoplastics and thermosettings, laminates and reinforced plastics
- Other non-metallics: various ceramics, carbon and graphite, Materials selection: metals and alloys, non-metallics, Alteration of environment: changing mediums, lowering temperature, decreasing velocity, removing oxygen or oxidizers, changing concentration; Inhibitors of various types, Design: wall thickness, design rules, Cathodic and anodic protection, Coatings: metallic and other inorganic coatings; organic coatings

Text Book:

1. Fontana M.G., "Corrosion Engineering", McGraw-Hill Companies, 1986, 3rd ed.

Reference Book:

1. Mattsson E., "Basic Corrosion Technology for Scientists and Engineers", The Institute of Materials, London, 1996, 2nd ed.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE624 (Elective-II)	Pulp & Paper Technology	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Selection of pulp and paper making raw materials, Wood Anatomy- identification, Preparation of wood chips, Chip screening, Storage and chip conveying, Chemical composition of fibrous raw materials, Chemical Pulping, Mechanical Pulping, Chemical thermo-mechanical (CTP) processes, Waste Paper Pulping, Bleaching and washing, Chemical Recovery, Description of various grades of pulp & paper, Mechanical and chemical properties of pulp, Paper making, cellulose derivatives- preparation & end use, Environmental aspects in pulp and paper industry.

Text Books/Reference Books:

1. Handbook of pulping and papermaking by Christopher J. Biermann, 2nd ed Academic press 1996.
2. Handbook for Pulp and Paper Technologists by G. A. Smook 3rd edition, Angus Wilde Publications, 1992

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE625 (Elective-II)	Fertilizer Technology	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Introduction

- Fertilizer industry in India
- Feed stock and raw materials

Phosphatic fertilizers

- Ground rock phosphate
- Single Super-phosphate

Technology/ Production of Fertilizer Products

- Phosphoric acid
- Nitric acid
- Sulphuric acid
- Ammonia

Modernization of Older Plants (Revamping)

Urea

Potassic Fertilizers

Complex fertilizers

Text Books

1. “Handbook on Fertilizer Technology”, Fertilizer Association of India, Sixth Edition, 2001.

Reference Books

1. G. F. Austin, “Shreve’s Chemical Process Industries”, 5th Edition, McGraw Hill Publication.
2. “Ammonia: Principles and Industrial Practice”, Max Appl, Wiley-Vch, 1999.
3. "Fertilizer Manual", United nations, New York, 1967.
4. "Synthetic Nitrogen Products", Gary_Maxwell, Springer Science, 2005.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE626 (Elective-II)	Advanced Process Control	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Control systems with multiple loops: Cascade control, time-delay compensation, split range control, Feedforward and Ratio control, feedforward-feed-back controller. Adaptive and Inferential control systems.

Predictions for SISO and MIMO problems, Multiple input multiple output (MIMO) control systems; Interaction and Decoupling of control loops; Digital Control systems, Z- Transforms, Discrete-time response of Dynamic Systems, Design of Digital feedback control systems, Process Identification and Adaptive control; Model predictive control: MPC calculations, Set-point calculations, design and tuning parameters, Signal processing, data filtering, tuning of digital PID controllers, minimum variance control

Text Book:

- Coughanowr, D.R., Process Systems Analysis and Control, 2nd Ed., McGraw-Hill, 1991.
- George Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall, 1984.

Reference Books:

- Seborg, D. E., Edgar, T. F. and Mellichamp, D.A., "Process Dynamics and Control", 2nd Ed., John Wiley and Sons, 2004

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
HS601 (HS Elective)	Organizational Behaviour	2	0	0	2

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus:

Unit-I: introduction to organizational behavior: introduction, evaluation of OB, fundamental concepts, model of OB & Challenges in OB.

Unit-II: Understanding self: perception, personality, emotions, values, attitudes, learning.

Unit-III: Understanding Groups: Group dynamics, teams and groups, interpersonal skills, communication, conflict and negotiation, motivation, leadership.

Unit-Iv: Understanding organizations: organizational culture, power, politics, decision making, changes and its management.

Text book:

1. Organizational behavior by Stephan P. Robbins, Pearson Education Asia.

Reference Book:

1. Organizational behavior by Fred Luthans
2. Organizational behavior by Mizra S Saiyadain
3. Organizational behavior by Dr. K. Ashwathappa.
4. Behaviour in Organizations by Jerald Greenberg & Robert A. Baron, Pearson Education Asia.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
HS602 (HS Elective)	Professional Ethics	2	0	0	2

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus:

Unit-I: Concept of Ethics: importance, human values, moral reasoning, and stakeholder theory.

Unit-II: Ethical issues in organizations: Engineering ethics, ethics in different areas of organizations.

Unit-III: Unethical business practices; corruption, bribe, smuggling, hawala, money laundering, tax heavens, unethical marketing communications, counterfeiting, piracy, dumping etc.

Unit-IV: Developing corporate citizenship; responsibility and rights, whistle blowing, developing ethical culture, ethical leadership.

Text book:

1. Professional Ethics and Human Values, Govindarajan, M., Natrajan, S. and Sethilkumar, V.S., PHI.

Reference Book:

1. Professional Ethics by R. Subramaniam, oxford University Press.
2. Human Values and Professional Ethics by S. Kannan, Taxmann

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
HS603 (HS Elective)	Technology Management	2	0	0	2

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus:

Unit-I: Introduction to technology Management; sources and types of technology change, incremental and disruptive change, product life cycles and dominant designs.

Unit-II: Technology Strategy; corporate and technology strategy, technology assessment, technology forecasting exploratory and normative.

Unit-III: Technology diffusion; diffusion of technology, technology indicators, technology transfer, technology management scenario in India.

Unit-IV: Organizational implications of technology; technical structure and organizational infrastructure, flexible manufacturing management systems (FMMS), financial aspects, social issues, environmental impact assessment, human aspects in technology management.

Text book:

1. Management of technology: the key to competitiveness and wealth creation by Tarek Khalil and Ravi Shanker, McGraw Hill Education India.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
HS604 (HS Elective)	Critical Interpretation of Literature and Cinema	2	0	0	2

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

Syllabus:

Significance of Literature and Cinema
Interpreting Literature through Devices such as Narrative Technique, Theme, Plot, Action, Characterization, Structure, Unity, Stylistic Features, Figures of Speech such as Simile, Metaphor, Alliteration, Personification, Paradox, Antithesis, Oxymoron, Onomatopoeia, Hyperbole, etc.
Interpreting Cinema through Devices such as Theme, Story and Screenplay, Characteristics, Semiotics, Cinematography and Editing - Time and Space, Narrative, Lighting Sound/Music etc.
Feature Films and Short Films, Documentaries, History of Indian Cinema, actors and personality, cults, mythological films, major turning points and trends in cinema, Parallel cinema in India.
Film Review, Discussions & Presentations on various aspects of Cinema and Literature
Analyzing Selected Poems, Short Stories, Plays and Works of Fiction
List of Selected Works: Poems by Robert Frost, Alexander Pope, Short Stories by Chekhov, Katherine Mansfield, and Somerset Maugham; John Osborne's Look Back in Anger, Jhumpa Lahiri'sThe Namesake

References:

1. Beaver, Frank Eugene, A Dictionary of Film Terms: The Aesthetic Companion to Film Art. New York: Peter Lang, 2006.
2. Bluestone, George, Novels into Films. California: University of California Press, 1957.
3. Hood, John W, The Essential Mystery: Major Film Makers of Indian Art Cinema, Hyderabad: Orient Blackswan, 2009.
4. Hutcheon, Linda, A Theory of Adaptation. Second Ed. New York: Routledge, 2013

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INSTITUTE OF ENGINEERING AND TECHNOLOGY

4 Year B. Tech Programme

(Branch: Chemical Engineering)

Batch 2015-19

SEMESTER-SEVENTH

Detailed Syllabus

&

Scheme of Examination

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE702	Process Utilities and Industrial Safety	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Water: Water resources, Storage and characterization, Conditioning.

Steam: Boilers, Steam Handling and distribution, Steam nozzles, Condensate utilization, Steam traps, Flash tank analysis, Safety valves, Pressure reduction valves, Desuperheaters.

Air: Air compressors, Vacuum pumps, Air receivers, Piping systems, Different types of ejectors, Air dryers.

Hazards and Safety: Classifications and assessment of various types of hazards, Risk assessment methods, General principles of industrial safety, Hazards due to fire, explosions, Toxicity and radiations, Industrial hygiene, Maximum allowable concentration and threshold limit value, Protective and preventive measures in hazards control, Introduction to industrial safety regulations.

Case studies of hazardous incidents in industries using HAZOP.

Text Books

1. Vasandhani, V. P., and Kumar, D. S, Heat Engineering, Metropolitan Book Co. Pvt. Ltd. (2009).
2. Crowl, D.A. and Louvar, J.F., Chemical Process Safety-Fundamentals with Applications, Prentice Hall, (2002).

Reference Books

1. Peavy, H. S., and Rowe, D. R, Environmental Engineering, McGraw Hill (1985).
2. Banerjee, S., Industrial Hazards and Plant Safety, Taylor & Francis 2003).
3. Lees, F.P., Prevention in Process Industries. Butterworth's (1996).
4. Sanders, R. E. Chemical Process Safety-Learning from Case Histories, Oxford (2005).
5. Perry, R.H., and Green, D. W, Chemical Engineer's Handbook, McGraw Hill (1997).

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE711 (Elective-III)	Advanced Heat Transfer	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- Steady-state conduction – multiple dimensions, Unsteady-state conduction, Principles of convection, forced and natural convection
- Radiation heat transfer, Condensation & boiling heat transfer, Heat exchanger analysis & design
- Heat Exchanger Networks

Text Book:

1. Holman J. P., "Heat Transfer", 9th Ed., Tata McGraw-Hill, New Delhi, 2004.

Reference Books:

1. Kern, D. Q., "Process Heat Transfer," McGraw-Hill, New York, 1950.
2. Douglas, J. M., "Conceptual Design of Chemical Processes", McGraw-Hill, New York, 1988.
3. Perry J. H. "Chem. Engrs Hand Book", 7th Ed., McGraw-Hill, 2001.
4. Frank Kreith& Mark. S. Bohn, "Principles Of Heat Transfer", 4th Ed., Harper & Row Publishers, New York, 1986.
5. Kays, W. M. &Crowford, M. E., "Convective Heat and mass Transfer", 3rd Ed., McGraw-Hill, 1993.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE712(Elective-III)	Energy Integration Analysis	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- Energy Targeting, Area Targeting, Unit Targeting, Cost Targeting, ΔT_{min} Optimization, Logic of Pinch Technology
- The Continuous Targeting Algorithm, Diverse Pinch for Different Heat Transfer Coefficient, Continuous Heat Cascades for Diverse and Conventional Pinch Concepts
- Basic Pinch Design Method, MER Networks for Multiple Utilities and Multiple Pinches, Balanced Grid Networks, Constrained Heat Exchanger Networks
- Loop Breaking and Path Relaxation, Systematic Energy Relaxation Approach, Eliminating Units Using Bypass, Design Tools to Achieve Targets, Evolution of Constrained Networks, Cost Evolution of Networks
- HRAT and EMAT, Pseudo-pinch Design Method, Flexible Pinch Design Method, Compensation Principle Design Method
- Basic Thermal Design, Kern's Method, Bell-Delaware Method, Rapid Design Algorithm, Area Targeting Based on Pressure Drops, The Interfacing Methodology, Stream Pressure Drop Optimization
- Retrofit by Inspection, Retrofit-Fixed Heat Transfer Coefficient, Retrofit-Specified Pressure Drops, Debottlenecking
- Distillation and Evaporation Processes, Reaction Processes
- Utility Targeting and MER Networks, Area Targeting, Optimal HEN through Superstructure, Network Load Optimization

Text Book:

1. Uday V Shenoy, "Heat Exchanger Network Synthesis: Process Optimization by Energy and Resource Analysis", I edition, Gulf Publishing Company, Houston Texas, 1995.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE713 (Elective-III)	Process Intensification	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- History, Philosophy, Principles, Definition, need of process, Intensification, Process Intensifying Equipment, Process Intensifying Equipments, Examples of their application on the commercial scale
- Use of high gravity fields, HiGee Reactor, Spinning Disc Reactors, Principles, Micro-reactors, Microchannel, heat exchangers, Monolithic, catalyst and reactors, Concept and principle, Reactive distillation, extraction, precipitation, adsorption, absorption, and fermentation-pervaporation,
- Adsorptive distillation, Membrance, absorption and stripping, Principles, Integration of reaction, heat and mass transfer, Reverse flow reactor, Reverse flow reactor, Reactive distillation, Extractive, fermentation, Membrane Reactors
- Methodology, Application, De-bottle-necking, Principles, Design, Integrated plants, Traditional Approach, Strategies

Text Book:

1. AndrzejStankiewicz, Jacob A. Moulijn. Re-engineering the Chemical Processing Plant: Process Intensification, Marcel Dekker, Inc., New York, 2004.

Reference Book:

1. Joseph Mizrahi, Developing an Industrial Chemical Process: An Integrated Approach, CRC Press, 2002.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE714(Elective-III)	Computer Aided Design in Chemical Engineering	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Role of Computer-Aided Design (CAD) in chemical industry;. Approaches to CAD, potential and pitfalls; Estimation of physical/chemical properties application to the design of chemical processing units; Evaluation of the design, sensitivity analysis; Applications include use of computer programs (software packages and student-created programs for the design of process units, e.g. distillation, towers, multiple effect evaporators, multicomponent absorbers, heat exchanger networks, etc.)

Text Book

1. Sinnot R K, “Chemical Engineering Volume 6, Chemical Engineering Design (Coulson and Richardson's Chemical Engineering Series)”, Third Edition, Butterworth Heinemenn (An imprint of Elsevier science)
2. Aspen Plus manual, CHEMCAD manual

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE715 (Elective-III)	Petroleum Refining & Petrochemicals	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

1. Origin & formation of petroleum, reserves &deposites of world, Indian refineries, oil & gas scene, HBJ gas grid, crude and gas reserves, Hydrocarbon series, isomeric compounds, composition of petroleum, sulpher compounds.
2. Evaluation of Petroleum, Thermal properties of petroleum fractions, Important products – properties and test methods, Desalting of Crudes, Heating of Crude – Pipe still heaters, Distillation of petroleum (Atmospheric, Vacuum), Thermal cracking, Catalytic cracking, Catalytic reforming, Naphtha cracking, Delayed coking, Hydro cracking, Hydro treating, Alkylation, Isomerisation.
3. Source of Asphalt (Bitumen), Air blowing of bitumen, Up gradation of heavy crudes, Natural gas, Petroleum, Classification of Petrochemicals., Ethylene, Propylene, Butylenes, Acetylene, Butadienes, Chloroprene, Cyclohexane, BTX.
4. Synthesis gas, Methanol, Ethanol, EO, PO, IA, Acetone, Allyl alcohol, Glycerol, Acrylonitrile, Acrylic acid and Derivatives, Phenol, Aniline, Nylon Monomers, Polyester Monomers, Styrene, Other monomers, Plastics, Rubbers, Fibers, Resins, Detergents, Pesticides, Dyes, Protein, Explosives.

Text Books:

1. B.K. BhaskaraRao, “Modern Petroleum Refining Processes”, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 4th ed., 2002.
2. Maiti S., “Introduction to Petrochemicals”, Oxford & IBH Publishing Co., Pvt., Ltd., New Delhi, 2nd Ed., 2002.

Reference Book:

1. Nelson, W.L., “Petroleum Refinery Engineering”, McGraw-Hill Kogakusha, Ltd., Tokyo, 4th ed., (International student edition), 1958.
2. Watkins, R.N., “Petroleum Refinery Distillation”, Gulf Pub. Company, Houston, 2nd ed., 1979.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE716 (Elective-III)	Nanofluid Engineering	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Introduction: Fundamentals of cooling, Fundamentals of nanofluids, Development of nanofluids, Experimental discoveries, Mechanisms and models for enhanced thermal transport.

Synthesis of Nanofluids: General issues of concern, Synthetic methods: Common issues of concern, Variety in nanomaterials, Microemulsion-based methods for nanofluids, Solvothermal synthesis, Synthesis using supports, Magnetic nanofluids, Inert gas condensation, Anisotropic nanoparticles, Other nanofluids.

Conduction Heat Transfer in Nanofluids: Conduction heat transfer, Measurement of thermal conductivity of liquids, Thermal conductivity of oxide nanofluids, Temperature dependence of thermal conductivityenhancement, Metallic nanofluids, Nanofluids with carbon nanotubes.

Theoretical Modeling of Thermal Conductivity in Nanofluids: Simple mixture rules, Maxwell's approach, Particle distributions, Particle geometries, Symmetrical equivalent medium theory, Matrix–particle interfacialeffects, Interfacial thermal resistance, Dynamic models of thermal conductivity in nanofluids, Near-field radiation model.

Convection in Nanofluids: Fundamentals of convective heat transfer, Convection in suspensions and slurries, Convection in nanofluids, Analysis of convection innanofluids, Numerical studies of convection in nanofluids, Convective simulation for chip cooling application.

Boiling of Nanofluids: Fundamentals of boiling, Pool boiling of nanofluids, Critical heat flux in pool boiling of nanofluids, Other investigations related to boilingof nanofluids.

Applications and Future Directions: Applications of nanofluids, Liquid cooling, Tribological applications, Biomedical applications, other potential applications, Applied research in nanofluids.

Text Books:

1. Das, S. K., Choi, S. U. S., Yu, W., and Pradeep, T., Nanofluids, John Wiley & Sons (2008).
2. Surya Kumar Saripella, Nanofluid heat transfer enhancement in engineering applications, University of Illinois at Urbana-Champaign (2007).

Reference Books:

1. Wilson, M., Kannangara ,K., Smith, G., and Simmons,M., Nanotechnology: Basic Science and Emerging Technology, Chapman & Hall (2004).
2. Liqiu Wang, Advances in Transport Phenomena, Springer (2009).

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE721(Elective-IV)	Fluidization Engineering	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- Types of adsorption; type of isotherm; adsorption kinetics; adsorbent, Basic modeling approach with suitable boundary condition, Upcoming adsorption techniques and their modeling approach; application of adsorption in different areas
- Introduction to cryogenic systems; low temperature properties and phenomena; application as separation and purification technique, Gas liquefaction, different air liquefaction cycles
- Cryogenic distillation; refrigeration systems, techniques for storage and transportation, Classification of membrane based on structures, flow, fabrication *etc.*Gas and liquid phase separation; pervaporation; liquid membrane; membrane reactor, Modeling approach; design considerations and applications
- Introduction to bio-kinetics, Types of bio-reactors and different techniques for bio-separation, Modeling approach, design considerations and applications, Concept of reactive distillation; supercritical fluid extraction, Modeling approach, design considerations and applications

Text Book:

1. Gupta, R. K. and A. K, Ghoshal "Advanced Separation Technology", *EDD Notes*[*], BITS, Pilani, 2000.

Reference Books

1. Seader, J. D. and E. J. Henley, " Separation Process Principles", *John Wiley & Sons, Inc. (Wiley India (P) Ltd.,* New Delhi), 2nd Ed., 2006.
2. Ruthven, D. M., S. Farooq and K. S. Knaebel, "Pressure Swing Adsorption", *VCH Publishers*, NY, 1994.
3. Barron, R., "Cryogenic Systems", *Oxford University Press*, NY, 2nd Ed. 1985.
4. Bailey, J. E. and D. V. Ollis, "Biochemical Engineering Fundamentals", *Mc-Graw Hill*, 1986.
5. Ruthven, D. M. "Principles of Adsorption and Adsorption Processes", John Wiley and Sons, 1984.
6. Mukhopadhyay M., "Natural Extracts using Supercritical Carbon Dioxide", *CRC Press*, LLC, Boca Raton, Florida, USA, 2000.
7. Research Papers from Refereed Journals / Resources.
8. Dynamic addition of reference material will be shared.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE722(Elective-IV)	Advanced Separation Processes	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Adsorption-based separation, Concept of adsorber design, application of adsorption in different areas; cryogenic separation, Gas liquefaction, different air liquefaction cycles, Cryogenic distillation, refrigeration systems, techniques for storage and transportation; Membrane separation, Gas and liquid phase separation, pervaporation, liquid membrane, membrane reactor; biotechnology-based separation, Introduction to bio-kinetics, Types of bio-reactors and different techniques for bio-separation; Recent advancements on the above areas and new concepts such as simulated moving bed adsorption, thermally coupled pressure swing adsorption, reactive distillation, bio-filtration, supercritical fluid extraction

Text Book:

1. Seader, J. D. and E. J. Henley, " Separation Process Principles", *John Wiley & Sons, Inc. (Wiley India (P) Ltd.,* New Delhi), 2nd Ed., 2006.

Reference Books:

1. Ruthven, D. M., S. Farooq and K. S. Knaebel, "Pressure Swing Adsorption", *VCH Publishers*, NY, 1994.
2. Barron, R., "Cryogenic Systems", Oxford University Press, NY, 2nd Ed. 1985.
3. Bailey, J. E. and D. V. Ollis, "Biochemical Engineering Fundamentals", Mc-Graw Hill, 1986.
4. Ruthven, D. M. "Principles of Adsorption and Adsorption Processes", John Wiley and Sons, 1984.
5. Mukhopadhyay M., "Natural Extracts using Supercritical Carbon Dioxide", CRC Press, LLC, Boca Raton, Florida, USA, 2000.
6. Research Papers from Refereed Journals / Resources.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE723(Elective-IV)	Sugar Technology	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Composition of cane and cane juice, Aim of clarification , clarification efficiency; Cabonation process, Double sulphitation process, PhosphitationProcess;Various juice heaters, Various clarifiers , Vacuum Filters.Milk of lime preparation, Sulphur burner and preparation of SO_2 Gas; Juice Sulphitation , Syrup Sulphitation , Use of different chemicals; Aim of evaporation, Different types of evaporators, Different types of vapour bleeding System , Steam economy , DEVC cum Quad System, Quintuple System; Scale formation, De scaling, Cleaning procedure.Different types of condensers, Condensates, Ammonia gas, Entrainment; Syrup / Melt Clarification , Filtrate Clarification.

Text Books

1. Introduction To Cane Sugar Technology by G.H. Jenkin
2. Principles of Sugar Technology by P. Honig.

References:

1. Hand Book of Sugar Technology by R.B.L. Mathur.
2. Hand Book of Cane Sugar Engineering by E. Hugot.
3. Cane Sugar Hand Book by Meade And Chen.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE724(Elective-IV)	Pharmaceutical Engineering	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Introduction, Pharma engineering and its significance, unit operations and unit processes; Stoichiometry, General principles, material balance-tie substances, chemical reactions and molal units, rate process, steady, unsteady and equilibrium state, laws of combining weights, applications of gas laws, energy balance, fuels and combustion; Fluid Flow, Type of steady flow, Reynold number & its significance, types of pressure, viscosity, concept of boundary layers, total energy balance and total mechanical energy balance, losses in mechanical energy of fluids, basic equations of fluid flow, valves, flow meters, manometers and measurement of flow rate and pressure; Transportation of Materials, Solids- Bins, bunkers, conveyers, air transport, Liquids- Pipelines, fittings, valves, pumps, measurement of flowing liquids, Gases- Fans, blowers and compressors; Filtration, Theory and mechanism of filtration process, factors affecting rate of filtration, filter media, filter aids, types of filters, operation of filters, industrial filters-leaf filter, filter press, rotary filter, Edge filters etc, Mathematical problems on filtration, optimum cleaning cycle in batch filters, Applications in pharmacy. Centrifugation, Principle and theory of centrifugation, industrial centrifuges-perforated basket, centrifuge, sedimentation type centrifuge, continuous centrifuges etc. Mathematical problems, applications in pharmacy, Materials of Pharmaceutical Plant, Construction, Factors affecting the material selection for pharmaceutical plants, metals and nonmetals, corrosion and its prevention.

Text Books/References:

1. Elementary Chemical Engineering - Max S. Peters, Published by McGraw Hill BookCompany, New York, 1954
2. Perry's Chemical Engineer's Handbook - Robert H Perry, Green D.W., Maloney J.O.7th Edition, 1998, McGraw – Hill Inc., New York.
3. Tutorial Pharmacy by Cooper & Gunn, ed. S.J.Carter, CBS Publishers & Distributors, Delhi, 6th Edition, 2000.
4. Unit Operations of Chemical Engineering, 5th edition - McCabe, Smith &Harriott, McGraw – Hill Inc., New York.
5. Pharmaceutical Engineering – K.Sambamurthy, 2002 NAI (P) Ltd., Delhi.
6. Pharmaceutics : The Science of Dosage Form Design - M.E. Aulton.
7. The Theory & Practice of Industrial Pharmacy – Lachman L., Lieberman H.A. &Kanjig J.L., 3rd edition, 1990 Varghese Publishing House, Bombay.
8. Alfonso G. Remington: The Science & Practice of Pharmacy. Vol.I& II 20th edition, 2000. Lippincott, Williams & Wilkins Philadelphia.
9. Paradkar A.R. Introduction to Pharmaceutical Engineering, 3rd Edition, 2001, NiraliPrakashan, Pune.
10. Subramanyam C.V.S., Thimma J, Suresh S.S. et. al., Pharmaceutical Engineering : Principles and Practice, 2002, VallabhPrakashan, Delhi.
11. P.J.Shah, A Textbook of Engineering Drawing Vol. I and II, 6th Edition, 2003, Ahmedabad

12. Engineering Drawing, 34th edition, N.D.BhattCharutar Publishing House, 1994
13. Engineering Drawing & Graphic Technology, 13th edition by Thomas E. French, Charles J. Vierch, Rebot J. Foster, McGraw Hill International Edition, New Delhi, 1972
14. Filtration in Pharma. Industry by Tehodere H. Meltzed, Marcel Dekker Inc., New York, 1987
15. Introduction to Chemical Engineering by Walter L. Badger & Julius T. Banchero, Mcgraw Hill International edition, New Delhi, 1955.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE725(Elective-IV)	Chemical Vapor Deposition	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

A simplified multi-step fab sequence, Applications of thin films, thin film deposition, chemical vapor deposition, advantages and disadvantages of various methods of chemical vapor deposition; Process Fundamentals, definition, CVD reaction rate control, heat transport; APCVD Fundamentals, use of APCVD in semiconductor processing, typical APCVD continuous belt reactor., deposition area boundaries, APCVD process gases, equipments; LPCVD Fundamentals, the pressure and temperature characteristics of the LPCVD process, key components of a typical LPCVD system, two practical advantages of LPCVD processing, major types of LPCVD reaction chambers and the advantages and disadvantages; PECVD Fundamentals, plasma, ion, RF, radical, excitation, relaxation, ionization, recombination, plasma potential and plasma shielding, regions of various plasma discharge.

Text Books:

1. D.M. Dobkin, Michael K. Zuraw, “Principles of Chemical Vapor Deposition”, Kluwer Academic Publishers, 2003
2. Anthony C. Jones, Michael L. Hitchman , “Chemical Vapour Deposition”, RSC Publishisng, 2009

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CHE726(Elective-IV)	Scale-Up and Pilot Plant Methods in Chemical Engineering	3	1	0	4

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
20	20	50	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

- **Scale up:** Description and evolution of a process system, Introduction to Scale up procedures, Dimensional analysis, Similitude.
- **Reactors for Fluid Phase Processes Catalyzed by Solids**: Pseudo-homogeneous and heterogeneous models, Two-dimensional models, Scale up considerations.
- **Fluid-fluid Reactors:** Scale-up considerations in packed bed absorbers andbubble columns,
- Applicability of models to scale-up.
- **Mixing Processes:** Scale-up relationships, Scale-up of polymerization units, Continuous stages gas-liquid slurry processes, Liquid-liquid emulsions.
- **Fluidized Beds:** Major scale-up issues, Prediction of performance in large equipment, Practical commercial experience, Problem areas.
- **Solid-Liquid Separation Processes**: Fundamental considerations, Small scale studies forequipment design and selection, Scale-up techniques, Uncertainties.
- **Continuous Mass Transfer Process**: Fundamental considerations scale-up procedure for distillation, Absorption, Stripping and extraction units.

Text Books:

1. Marko Zlokarnik, Scale-up in chemical engineering, Wiley-VCH (2006).
2. R.E. Johnstone and M.W. Thring, Pilot Plants, Models and Scale-up Methods in Chemical Engineering, McGraw-Hill (1957).

Reference Books:

1. Colin Divall, Sean Johnston, Scaling up: the Institution of Chemical Engineers and the rise of a new profession, Springer (2000).
2. Bisio, A. and Kabel, R.L., Scale-up of Chemical Processes, John Wiley (1985).

Course code	Course Title				Teaching Scheme			
					L	T	P	Credits
CHE803 (elective-IV)	Industrial Pollution Abatement				3	0	2	4
Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks
20	20	50	10	100	20	50	30	100

*Additional Continuous Evaluation: Quizzes/Assignments/Presentations/Practical Records/Mock Interviews/others

Syllabus (Theory):

Introduction: Industrial pollution, Different types of wastes generated in an industry, Different water pollutants, Air pollutants and solid wastes from industry, Their effects on living and non-living things, Environmental regulatory legislations and standards, Importance of industrial pollution abatement, Concept of sustainable development, Greenhouse gases, Global warming and climate change.

Water Pollution: Identification, quantification and analysis of wastewater, Classification of different treatment methods into physico-chemical and biochemical techniques, Physico-chemical methods, General concept of primary treatment, Liquid-solid separation, Design of a settling tank, Neutralization and flocculation, Biological methods, Concept of aerobic digestion, Design of activated sludge process, Concept of anaerobic digestion, Biogas plant layout, Different unit operations and unit processes involved in conversion of highly polluted water to potable standards.

Air Pollution: Classification of air pollutants, Nature and characteristics of gaseous and particulate pollutants, Analysis of different air pollutants, Description of stack monitoring kit and high volume sampler, Atmospheric dispersion of air pollutants, Gaussian model for prediction of concentration of pollutant down wind direction, Concept of temperature inversion, Plume and its behavior, Concept of effective stack height, Operating principles and simple design calculations of particulate control devices like gravity settling chamber, cyclone, bag filters, electrostatic precipitators and scrubbers, Brief concepts of control of gaseous emissions by absorption, adsorption, chemical transformation and combustion.

Solid Wastes: Analysis and quantification of hazardous and nonhazardous wastes, Treatment and disposal of solid wastes, Land filling, Leach ate Treatment, Incineration.

Environmental Management System: Environment impact assessment, Its concept and constituents, Environmental audit, ISO-14000 system.

Syllabus (Practical)

Characterization of waste water (pH, BOD, COD, Nitrate, Phosphate, Solids, Turbidity, Alkalinity, Hardness, Dissolved oxygen and fluoride), Ambient air quality measurement by high volume sampler (Particulate, SOX, NOX), Gas analysis with Orsat apparatus, Determination of sludge volume index.

Text Books:

1. Peavy, H.S., Rowe, D.R., and Tchobanoglous, G. Environmental Engineering, McGraw Hill International (1985).
2. Metcalf & Eddy, Wastewater Engineering, Tata McGraw-Hill Education Private Limited (2009).

Reference Books:

1. Masters, G.M., Introduction to Environmental Engineering and Science, Prentice hall off India, (2008).
2. De Nevers, N., Air Pollution Control Engineering, McGraw-Hill (2000).

Rao, C.S., Environmental Pollution Control Engineering, Wiley Eastern (2010).

Course Title and Code :Intelligent Machines (AI, Robotics, IoT): ID303		
Course Description This course introduces an understanding of the fundamental concepts of Artificial Intelligence and Machine Learning, Internet of Things and Robotics. Focus of this course would be on discussion of case studies on various aspects.		
Prerequisites		**Basic Programming Course**
Hours per Week		**L-T-P: 2-0-0**
Credits		**2**
Sr. No	**Specifications**	**Marks**
01	Attendance	Nil
02	Assignment	40
03	Class Participation	20
04	Quiz	40
05	Theory Exam	Nil
06	Theory Exam	Nil
07	Theory Exam (Final)	Nil
08	Report-1	Nil
09	Report-2	Nil
10	Report-3	Nil
11	Project -1	Nil
12	Project -2	Nil
13	Project -3	Nil
14	Lab Evaluation1	Nil
15	Lab Evaluation2(Final)	Nil
16	Course portfolio	Nil
	Total (100)	**100**

Syllabus

IoT: Introduction to Embedded IOT System: Interfacing sensors and motor, Controlling Devices and Reading input Status from sensors using webpage, Introduction to API and web services, Designing SMS API and security OTP app, Camera Interfacing using sensors, Basic SMTP protocol and Mail server and Sending Mail (Security application) mail based, Creating applications with weather updates.

Artificial Intelligence and Machine Learning: Understanding what we mean when we say machines think, how does AI relate to the rest of predictive analytics, How AI works and its inherent limitations., AI till date, Expectations from the field of AI, Introduction to Machine Learning, Preprocessing your data, Regression model, Classification model, Clustering Model, Case-study-Water Jug Problem, Titanic Data Set

Robotics: Elements of robots: joints, links, actuators, and sensors. Position and orientation of a rigid body, Representation of joints, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, purpose of sensors, internal and external sensors, common sensors, Kinematics of serial robots, Degrees-of-freedom of parallel mechanisms and manipulators.

Reference / Textbooks

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)
3. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Second Edition, Pearson Education, 2003.

4. Luger, "Artificial Intelligence: Structures and Strategies for complex problem solving", Fourth Edition, Pearson Education, 2002.
5. David Poole, Alan Mackworth, Randy Goebel," Computational Intelligence: a logical approach", Oxford University Press, 2004.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
CCT708	Workplace and Interpersonal Communication	3	0	0	3

Evaluation Scheme (Theory)					Evaluation Scheme (Practical)			
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks	Mid Term Test - I	End Term Test	Class Participation/ Additional Continuous Evaluation*	Total Marks
20	20	50	10	100	20	50	30	100

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INSTITUTE OF ENGINEERING AND TECHNOLOGY

4 Year B. Tech Programme

(Branch: Chemical Engineering)

Batch 2015-19

SEMESTER-EIGHT

Detailed Syllabus

&

Scheme of Examination

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
PS801	Practice School - II	-	-	-	16

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test - I	Mid Term Test - II	End Term Test	Class Participation	Additional Continuous Evaluation	Total Marks	Mid Term Test - I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks
-	-	-	-	-	-	-	-	-	-	-

** Duration for practice school is Five and a half month

Course Syllabi:

This course is for five and half months (summer and one semester) in VII or VIII Semester. The objective of this programme is to provide the students, an opportunity to work on live projects of corporate world in various fields. During this programme, they will work on real world applications of their curricula through organizational function of their choice. The students are expected to be involved directly in problem solving efforts of specific interest to the host organization. The learning of PS-I will help them in completing PS-II successfully.

Evaluation Scheme:

S. No.	Evaluation Component	Marks (100) (Weightage %)
1	Quiz-I	4
2	Quiz-II	4
3	Group Discussion-I	4
4	Group Discussion-II	4
5	Seminar-I	4
6	Seminar-II	4
7	Diary-I	4
8	Diary-II	4
9	Observation-I	4
10	Observation- II	4
11	Mid Term Evaluation (Project Report and	20
12	Final Evaluation (Project Report and Presentation/Viva)	40