List of Courses Focus on Employability/ Entrepreneurship/ Skill Development

Department : *Chemical Engineering*

Programme Name : *B.Tech.*

Academic Year : 2021-22

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
01.	CS201TES02	Computer Programming
02.	CS201PES02	Computer Programming Lab
03.	ME202PES04	Workshop Technology And Manufacturing Practices
04.	CH203TPC02	Fluid Mechanics
05.	CH203PPC02	Fluid Mechanics Lab
06.	CH203TPC01	Material And Energy Balance Calculations
07.	CH204TBS07	Numerical Methods In Chemical Engineering
08.	CH204PBS03	Numerical Methods In Chemical Engineering Lab
09.	CH204TPC05	Particle And Fluid Particle Processing
10.	CH204PPC03	Particle And Fluid Particle Processing Lab
11.	CH204TPC06	Process Instrumentation
12.	CH204PPC04	Process Instrumentation Lab
13.	CH204THS02	Business Communication And Presentation Skill
14.	CH05TPC08	Heat Transfer
15.	CH05PPC06	Heat Transfer Lab
16.	CH05TPC09	Mass Transfer-I
17.	CH05PPC07	Mass Transfer-I Lab
18.	CH05TPC10	Chemical Reaction Engineering-I
19.	CH05PPC08	Chemical Reaction Engineering Lab
20.	CH06TPC11	Mass Transfer-II
21.	CH06TPC12	Process Dynamics And Control
22.	CH06TPC13	Process Equipment Design-I
23.	CH06TPE31	Fertilizer Technology
24.	CH06TPE32	Fuel Combustion Energy Technology
25.	CH06TPE21	Environmental Engineering
26.	CH7TPC13	Process Equipment Design-II
27.	CH7TPC14	Chemical Reaction Engineering-II

28.	CH7TPC15	New Separation Processes
29.	CH7PPC08	Minor Project
30.	CH7PPC09	Vocational Training Viva Cum Seminar
31.	CH8TPC16	Process Equipment Design-III
32.	CH8TPC17	Project Engineering, Economics And Management
33.	CH8PPC10	Project
34.	CH7TPE41	Petroleum Refinery Engineering
35.	CH8TPE51	Petrochemical Technology
36.	CH8TPE53	Membrane Separations Processes
37.	CH7TOE32	Water Conservation And Management
38.	CH8TOE41	Optimization Techniques
39.	CH8TOE42	Process Modeling And Simulation
40.	CHPATT1	Advanced Heat Transfer
41.	CHPATT2	Advanced Separation Processes
42.	CHPATT3	Advanced Fluidization Engineering
43.	CHPATP2	Advanced Wastewater Treatment Technology
44.	CHPBTP1	Computational Fluid Dynamics
45.	CHPBTP2	Fuel Cell Technology
46.	CHPALT1	Chemical Engineering Computational Lab
47.	CHPBTP5	Industrial Pollution Control
48.	CHPBTP4	Design And Devlopment Of Catalyst
49.	CHPCPT1	Dissertation Stage-I
50.	CHPDPT1	Dissertation Stage-II
51.	CHPBTT2	Chemical Reactor Design

Scheme and Syllabus

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A CENTRAL UNIVERSITY)

CBCS-NEW, EVALUATION SCHEME

PROPOSED (W.E.F. SESSION 2020-21)

B. TECH. FIRST YEAR (SEMESTER- I)

(Common for CH, CE, IPE, ME)

S.No.	COURSE No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	SUB-TOTAL	
THEORY									
1.	MA201TBS01	MATHEMATICS-I	3	1	-	30	70	100	4
2.	CY201TBS02	CHEMISTRY	3	1	-	30	70	100	4
3.	CE201TES01	ENGINEERING MECHANICS	3	1	-	30	70	100	4
4.	CS201TES02	COMPUTER PROGRAMMING	3	0	-	30	70	100	3
5.	CM201TES03	BASIC CIVIL & MECHANICAL ENGINEERING	3	0	-	30	70	100	3
6.	LW201TMC01	INDIAN CONSTITUTION	2	0	-	-	-	-	-
		TOTAL	**17**	**3**	**-**	**150**	**350**	**500**	**18**
PRACTICALS									
1.	CY201PBS01	CHEMISTRY LAB	-	-	2	30	20	50	1
2.	CE201PES01	ENGINEERING MECHANICS LAB	-	-	2	30	20	50	1
3.	CS201PES02	COMPUTER PROGRAMMING LAB	-	-	2	30	20	50	1
		TOTAL	-	-	**6**	**90**	**60**	**150**	**3**
		GRAND TOTAL	**17**	**3**	**6**	**240**	**410**	**650**	**21**

Total Credits: **21** Total Contact Hours: **26** Total Marks: **650**

L:LECTURE, T:TUTORIAL, P:PRACTICAL, IA : INTERNAL ASSESSMENT, ESE:END SEMESTER EXAMINATION
*INTERNAL ASSESSMENT- Two Class Test of 15 Marks each will be conducted.

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
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CBCS-NEW, EVALUATION SCHEME

PROPOSED (W.E.F. SESSION 2020-21)

B. TECH. FIRST YEAR (SEMESTER- II)

(Common for CH, CE, IPE, ME)

S. No.	COURSE No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	SUB-TOTAL	
THEORY									
1.	MA202TBS03	MATHEMATICS-II	3	1	-	30	70	100	4
2.	PH202TBS04	PHYSICS	3	1	-	30	70	100	4
3.	EC202TES04	BASIC ELECTRICAL & ELECTRONICS ENGINEERING	3	1	-	30	70	100	4
4.	IT202TES05	INTRODUCTION TO INFORMATION TECHNOLOGIES	2	0	-	30	70	100	2
5.	EN202THS01	ENGLISH COMMUNICATION	3	0	-	30	70	100	3
		TOTAL	**14**	**3**	**-**	**150**	**350**	**500**	**17**
PRACTICALS									
1.	PH202PBS02	PHYSICS LAB	-	-	2	30	20	50	1
2.	ME202PES03	ENGINEERING GRAPHICS	1	-	3	30	20	50	3
3.	ME202PES04	WORKSHOP TECHNOLOGY & PRACTICES	1	-	2	30	20	50	2
4.	EC202PES05	BEE LAB	-	-	2	30	20	50	1
		TOTAL	**2**	**-**	**9**	**120**	**80**	**200**	**7**
		GRAND TOTAL	**16**	**3**	**9**	**270**	**430**	**700**	**24**

Total Credits: **24** Total Contact Hours: **28** Total Marks: **700**

L:LECTURE T:TUTORIAL, P:PRACTICAL, IA : INTERNAL ASSESSMENT, ESE:END SEMESTER EXAMINATION
*INTERNAL ASSESSMENT- Two Class Test of 15 Marks each will be conducted.

SYLLABUS	(SEMESTER-I)	Periods/ Week			Internal Assessment (IA)			ESE	Grand Total	Credits
Subject Code:	CS201TES02 / CS202TES04	L	T	P	CT-1	CT-II	TOTAL	70	100	03
Subject:	COMPUTER PROGRAMMING	3	0	-	15	15	30			

Course Learning Objectives:

- To understand the basic of Idea of Algorithm.
- To understand the programing concept of Arithmetic expressions and Basic Algorithms
- To learn the Functions and Structure of array.

Course Content:

UNIT-1: Introduction to Programming
Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) -
Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

UNIT-2: Arithmetic expressions and precedence
Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching Iteration and loops, **Arrays** (1-D, 2-D), Character arrays and strings

UNIT-3: Basic Algorithms
Searching, concept of binary search etc, Basic Sorting Algorithms Bubble sort etc, Finding roots of equations, introduction of Algorithm complexity

UNIT-4: Function
Functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference binary search etc.
Recursion functions Recursion, as a different way of solving problems. Example programs, such as, Finding Factorial, Fibonacci series, etc.

UNIT -5: Structure
Structures, Defining structures and Array of Structures
Pointers Idea of pointers, defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

extbooks/References:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
3. Brian W. Kernighan and Dennis M. Ritchie, the C Programming Language, Prentice Hall of India

Course Outcomes- At the end of the course students will be able to

- Develop the algorithm and programmers for various applications using Arithmetic expressions, arrays, pointers and Functions.

SYLLABUS	(SEMESTER-I)	Periods/ Week			INTERNAL ASSESSMENT (IA)			ESE	Grand total	Credits
Subject Code:	CS201PES02 / CS202PES05	L	T	P	IA	MSE	TOTAL	20	50	01
Subject:	COMPUTER PROGRAMMING LAB	-	-	2	30	--	30			

Course Learning Objectives:

- To learn the Branching and logical expressions and Loops
- To learn the Arrays and Function
- To understand the Numerical methods and Recursion

Course Content:
The laboratory should be preceded or followed by a tutorial to explain the approach or Algorithm to be implemented for the problem given.]

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical Integration):
Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Course Outcomes- At the end of the course students will be able to

- Utilization of Branching and logical expressions and Loops, Arrays and Function and Numerical methods and Recursion for writing the programmes for various engineering applications

SYLLABUS	(SEMESTER-II)	Periods/ Week			INTERNAL ASSESSMENT (IA)			ESE	Grand total	Credits
Subject Code:	ME201PES02 / ME202PES04	L	T	P	IA	MSE	TOTAL	20	50	2
Subject:	WORKSHOP TECHNOLOGY & PRACTICES	1	0	2	30	--	30			

Course Learning Objectives:

- To impart student knowledge on various hand tools for usage in engineering applications.
- Be able to use analytical skills for the production of components.
- Design and model different prototypes using carpentry, sheet metal and welding.
- Make electrical connections for daily applications.
- To make student aware of safety rules in working environments.

Course Content:

Lectures & videos:

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods (3 lectures)
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools
4. Electrical &Electronics
5. Carpentry
6. Plastic moulding, glass cutting
7. Metal casting
8. Welding (arc welding & gas welding), brazing

Textbooks/References:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishersprivate limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu, "Manufacturing Technology – I" Pearson Education, 2008. (iv)Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
4. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata Mc-Graw Hill House, 2017.

Course Outcomes: At the end of the course students will be able to:

- Make half lap joint, Dovetail joint and Mortise &Tenon joint
- Produce Lap joint, Tee joint and Butt joint using Gas welding
- Prepare trapezoidal tray, Funnel and T-joint using sheet metal tools
- Make connections for controlling one lamp by a single switch, controlling two lamps by a single switch and stair case wiring

total 44% change

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
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SCHEME FOR EXAMINATION (Effective from Session 2021-22)

B.TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

SECOND YEAR, THIRD SEMESTER (AICTE-NEW)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
	THEORY					Sessional			
			L	T	P	IA	ESE	TOTAL	
01.	CH203TBS05	Biology	3	0	0	30	70	100	3
02.	CH203TBS06	Mathematics-III	3	1	0	30	70	100	4
03.	CH203TPC01	Material and Energy Balance Calculations	3	1	0	30	70	100	4
04.	CH203TPC02	Fluid Mechanics	3	1	0	30	70	100	4
05.	CH203TPC03	Thermodynamics-I	3	0	0	30	70	100	3
	PRACTICAL	one subject removed-Engg and Solid Mechanics							
01.	CH203PPC01	Chemical Engineering Lab-I	0	0	3	30	20	50	1.5
02.	CH203PPC02	Fluid Mechanics Lab	0	0	3	30	20	50	1.5
		Total	15	3	6			600	21

IA – Internal Assessment
Total Marks – 600

ESE - End Semester Examination
Total Periods / week - 24

Total Credits: 21

BoS held on 01.10.2021

B. Tech. (Chemical Engg.)- II Year

w.e.f: Session 2021-22

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SCHEME FOR EXAMINATION (Effective from Session 2021-22)
B.TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING
SECOND YEAR, FOURTH SEMESTER (AICTE-NEW)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
	THEORY					Sessional			
			L	T	P	IA	ESE	TOTAL	
01.	CH204THS02	Business Communication and Presentation Skill	3	0	0	30	70	100	3
02.	CH204TBS07	Numerical Methods in Chemical Engineering	3	1	0	30	70	100	4
03.	CH204TPC04	Thermodynamics-II	3	0	0	30	70	100	3
04.	CH204TPC05	Particle and Fluid Particle Processing	3	1	0	30	70	100	4
05.	CH204TPC06	Process Instrumentation	3	1	0	30	70	100	4
	PRACTICAL								
01.	CH204PBS03	Numerical Methods in Chemical Engineering lab	0	0	2	30	20	50	1
02.	CH204PPC03	Particle and Fluid Particle Processing lab	0	0	3	30	20	50	1.5
03.	CH204PPC04	Process Instrumentation Lab	0	0	3	30	20	50	1.5
		Total	15	3	8			650	22

IA – Internal Assessment
Total Marks – 650

ESE - End Semester Examination
Total Periods / week - 26

Total Credits : 22

BoS held on 01.10.2021

B. Tech. (Chemical Engg.)- II Year

w.e.f : Session 2021-22

CH203TPC02 **Fluid Mechanics** **[L:3, T:1, P:0]**

Objectives:

The objective of this course is to introduce the mechanics of fluids (fluid statics and fluid dynamics), relevant to Chemical Engineering operations. The course will impart the knowledge of basic concepts of kinematics of flow, different forces on fluids, flow visualization, flow measurement, flow transportation and types of flow.

Unit I : Fluid Static & Applications: Hydrostatic equilibrium, hydrostatic equilibrium in centrifugal field and its applications in chemical engineering like manometers decanters. Fluid Flow Process: velocity gradient and shear, types of fluids, concept of viscosity, kinematic viscosity, nature of flow- laminar, turbulent, Reynolds number, boundary layer formation and separation.

Unit II : Basic Equations for Fluid Flow: Mass balance & momentum balance equations, Bernoulli's equation without and with corrections for solid boundaries, kinetic energy, friction factor, pump work.

Unit III : Incompressible Fluids : Flow through pipes, flow characteristics- shear stress, friction factor, laminar flow for newtonian fluids, Hagen Poiseuille equation, laminar flow for non-newtonian liquids, turbulent flow through pipes and close channels and its characteristic equations, friction factor and its dependence on roughness, Reynolds number, friction factor for flow through channels of non-circular cross section – concept of equivalent diameter, frictional losses due to sudden change in velocity or direction of flow; expansion, contraction, effect of fittings, flow of liquids in thin layers.

Unit IV : Transportation of Fluids: pipe fitting like bends, elbows, flanges, tee and different types of valves, seals for moving parts, pumps, NPSH, power requirement, types of pumps – centrifugal & positive displacement, trouble shooting in operation – priming & cavitation, characteristic curves – head / capacity / power / efficiency, capacity- head flow and head work relationship, metering of fluids: variable head meters- venturi meter & orifice meter, variable area meter – rotameter, insertion meters – pitot tube.

Unit V : Differential analysis: mass and momentum balances, Navier-Stokes equation, unidirectional flow, viscous flow, Stokes law, skin drag and pressure drag, potential flow, potential function, solution of Laplace equation.

Suggested Text Books :

1. M. White, Fluid Mechanics, Tata-McGraw Hill.
2. V. Gupta & S. K. Gupta, Fundamentals of Fluid Mechanics, New Age International.
3. W. L. McCabe, J. C. Smith & P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition.

BoS held on 01.10.2021 **B. Tech. (Chemical Engg.)- II Year** **w.e.f: Session 2021-22**

Outcomes :

- Velocity profiles by simplification of equations of motion in simple 1-D flows
- Boundary layer thicknesses, friction factor, pressure drop, power requirements in single phase flow in pipes
- Two phase gas/liquid pressure drop
- Power requirements, NPSH requirements of pumps

CH203PPC02 **Fluid Mechanics Lab** **[L:0, T:0, P:3]**

Objectives :

The objective of this course is to give the students the practical exposure of the theory and concepts of the subject fluid mechanics. The course will provide the knowledge of different flow meters and pressure measurement through the experiments. It will also help in understanding the theoretical concepts through experiments.

List of experiments:

1. To determine the coefficient of discharge of the given venturimeter.
2. To determine the coefficient of discharge of the orifice meter connected in between a pipe line.
3. To determine the coefficient of discharge of the Rotameter.
4. To determine the velocity of the flowing fluid and coefficient of the given pitot tube.
5. Study and verification of the Bernoulli's theorem.
6. Experimental determination of hydraulic coefficients.
7. To measure the pressure using manometer.
8. To determine the type of flow and Reynold's number through Reynold's experiment.

* Any other experiments may be added further, if needed.

Outcomes :

- The students will be able to visualise the concepts.
- The students will understand about different components of the flow system.
- The students will be able to operate different meters.
- The students will be able to measure and calculate different flow parameters.

BoS held on 01.10.2021 **B. Tech. (Chemical Engg.)- II Year** **w.e.f : Session 2021-22**

Department of Chemical Engineering 1%

CH203TPC01 Material and Energy Balance Calculations [L:3, T:1, P:0]

Objectives:

The course will serve as a basis for all further chemical engineering courses that are part of the curriculum.

Unit I : Introductory concepts of units, physical quantities in chemical engineering, Dimensionless groups, "basis" of calculations Gases, Vapours and Liquids: Equations of state, Vapour pressure, Clausius Clapeyron equation, Cox chart, Duhring's plot, Raoult's law.

Unit II : Humidity and saturation, humid heat, humid volume, dew point, humidity chart and its use.

Unit III : Material Balance: Introduction, solving material balance problems without chemical reaction, material balances with recycle, bypass and purge, material balance with chemical reaction, concept of stoichiometry and mole balances, examples, including combustion.

Unit IV : Energy Balance: open and closed system, heat capacity, calculation of enthalpy changes.

Unit V : Energy balances with chemical reaction, heat of reaction, heat of combustion.

Suggested Text Books:

1. S. N. Saha, "Chemical Process Engineering Calculation", Dhanpat Rai Publication Co. (Pvt.) Ltd., New Delhi
2. B. I. Bhatt & S. M. Vora, "Stoichiometry", Tata McGraw Hill Publishing Co. Ltd.

Suggested References Books:

1. R. M. Felder & R. W. Rousseau, "Elementary Principles of Chemical Processes", John Wiley & Sons.
2. O. A. Hougen, K. M. Watson & R. A. Ragatz, "Chemical Process Principles, Part I Material & Energy Balances", CBS Publishers & Distributors.
3. D. M. Himmelblau & J. B. Riggs, "Basic Principles and Calculations in Chemical Engineering", Pearson India Education Services.
4. V. Venkataramani, N. Anantharaman, K. M. Begum & S. Meera, "Process Calculations", Prentice Hall of India.
5. D. C. Sikdar, "Chemical Process Calculations", Prentice Hall of India.

Outcomes:

Students completing the course will

- Develop mastery over process calculations relevant to Chemical Engineering Processes
- Be able to handle elementary flow-sheeting, material and energy balance calculations
- Be able to solve problems based on without and with chemical reactions, and involving concepts like recycle, bypass and purge.
- Be familiar with equations of state and properties of gases and liquids, including phase transition.

BoS held on 01.10.2021 **B. Tech. (Chemical Engg.)- II Year** **w.e.f : Session 2021-22**

CH204TBS07 Numerical Methods in Chemical Engineering [L:3, T:1, P:0]

Objectives:

The objective of this subject is to introduce students to numerical methods used to solve engineering problems, in particular chemical engineering problems, using numerical methods and computer programming.

Unit I : Introduction of errors and their analysis, types of errors, numerical problems on error analysis, curve fitting: method of least squares, fittings of straight line and parabola and by method of moments.

Unit II : Numerical Solution of Algebraic and Transcendental Equations: Secant method, Regula-falsi Method, Newton Raphson method, solution of a system of simultaneous linear algebraic equations direct method: Gauss elimination method, iterative methods, Gauss Seidel iterative method.

Unit III : The Calculus of Finite Differences: Finite differences, difference formula, operators and relation between operators, inverse operator, interpolation with equal intervals: - Newton's forward and backward interpolation formula, interpolation with unequal intervals: - Lagrange's interpolation.

Unit IV : Numerical Differentiation and Integration: Numerical differentiation Newton's forward and backward difference interpolation formula. Numerical Integration: Trapezoidal rule, simpson's $1/3^{rd}$ and $3/8^{th}$ rule, Boole's rule, Weddle rule.

Unit V: Numerical solution of ordinary differential equation: Taylor series method, Euler's method, Modified Euler method Range's method Runge-Kutta method.

Books Recommended:

1. Jain & Iyngar, Numerical Methods for Scientific and Engineering Computations.
2. G. S. Rao, Numerical Analysis.
3. B. S. Grewal, Numerical Methods in Engineering and Science.
4. H. K. Das, Advance Engineering Methods.
5. V. Rajaraman, Computer Oriented Numerical Methods

Outcomes:

After successful completion of this course students will be able to solve chemical engineering problems involving linear and non-linear equations and solve ordinary differential equations.

BoS held on 01.10.2021 **B. Tech. (Chemical Engg.)- II Year** **w.e.f : Session 2021-22**

CH204PBS03 **Numerical Methods in Chemical Engineering Lab** **[L:0, T:0, P:2]**

Objectives :

The course would enable students to write their own computer programs using programming languages like C and commercial software like Matlab. Hands-on experience will be provided to apply these computer programs to solve problems in different areas of chemical engineering e.g. fluid flow, heat and mass transfer, chemical reaction engineering etc.

List of Experiments :

1. Write a program in 'C' to find simple interest
2. Write a program in 'C' to calculate sum of three numbers
3. Write a program in 'C' to calculate number of months and days
4. Write a program in 'C' to find whether a year is leap year or not
5. Write a program in 'C' to convert the given temperature in Fahrenheit to Celsius
6. Write a program in 'C' to find whether a number is odd or even
7. Write a program in 'C' to calculate factorial of a given number
8. Write a program in 'C' to find the real roots of a quadratic equation
9. Write a program in 'C' to for Secant Method
10. Write a program in 'C' and 'MATLAB' to for Newton Raphson Method
11. Write a program in 'C' to for Regula falsi Method
12. Write a program in 'C' and 'MATLAB' to for Gauss Elimination and Gauss Seidal Methods
13. Write a program in 'C' to for Lagrange's Interpolation
14. Write a program in 'C' and 'MATLAB' to for Simpson's Rule
15. Write a program in 'C' and 'MATLAb' to for Euler's Method and Runge-Kutta Method

* Any other experiments may be added further, if needed.

Outcome :

Students will be able to solve chemical engineering problems involving Linear and non-linear equations and solve ordinary differential equations using programming languages like C and software like MATLAB.

BoS held on 01.10.2021 **B. Tech. (Chemical Engg.)- II Year** **w.e.f : Session 2021-22**

CH204TPC05 Particle and Fluid Particle Processing [L:3, T:1, P:0]

Objectives :

Objective of this course is to introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle fluid interactions are important. The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. Industrial applications are discussed. The course is concluded with an introduction to colloidal systems, soft materials and nanoparticles. Applications of these novel systems are discussed.

Unit I: Solids Properties, Handling, Mixing : Introduction: Relevance of fluid and particle mechanics, and mechanical operations, in chemical engineering processes. Solid particle characterization: Particle size, shape and their distribution, Screen analysis, standard screens; Relationship among shape factors and particle dimensions; Specific surface area; Measurement of surface area. Mixing and storage of Solids: Types of important mixers like kneaders, dispersers, masticaters, roll mills, muller mixer, pug mixer, blender, screw mixer etc., mixing index.

Unit II: Storage and Transportation, Size Reduction : Types of storage equipments, Bin, Silo, Hoper, etc. Transport of fluid-solid systems: mechanical conveying, pneumatic and hydraulic conveying. Major equipment's- Crushers, grinders, ultrafine grinders, laws of communition, Close circuit and open circuit grinding.

Unit III: Fluid Solid Separation : Sedimentation: Elutraition, Classification and sedimentation, Free Settling, hindered settling, flow of solids through fluid, Stoke's law, Richardson-Zaki equation, design of settling tanks. Centrifugal separation, design of cyclones and hydro cyclones, filter bags, venturi scrubber, electrostatic precipitator.

Unit IV: Mechanical Separation and Filtration : Industrial screen; their capacity and effectiveness. Types of filtration, principle of filtration, plate and frame filter, leaf filter, rotary drum filter, etc.

Unit V: Fluidization : Fluidization: Fluidized bed, minimum fluidization velocity, pressure drop etc. Types of fluidization: Particulate fluidization, Bubbling fluidization, Applications of fluidization. Packed bed: Void fraction, superficial velocity, channelling, Ergun equation and its derivation, Kozeny Carman equation, Darcy's law and permeability, Blaine's apparatus.

Suggested Text Books :

1. W. McCabe, J. Smith, J. & P. Harriott, Unit Operations of Chemical Engineering.

Outcomes:

Students will be able to

- Calculate pressure drop in fixed and fluidized beds.
- Know the significance and usage of different particulate characterization parameters, and equipment to estimate them.
- Describe Size reduction energy requirements, estimate performance of equipment, selection and sizing of equipment.
- Analyse filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage.

CH204PPC03 Particle and Fluid Particle Processing Lab [L:0, T:0, P:3]

Objectives:

1. To understand the working and importance of various mechanical operations used in process industry.
2. To apply principles of basic sciences and chemical engineering for designing various size reduction, size separation and filtration equipment.

List of Experiments

1. To verify laws of crushing for crushing solid particles in Jaw crusher.
2. To verify laws of crushing for crushing solid particles in roll crusher.
3. To verify laws of crushing for crushing solid particles in Ball mill.
4. To find out the Effectiveness of Triple deck Vibrating Screen.
5. To determine the average diameter of a mixture of solid particles of different size using sieve analysis.
6. To determine the collection efficiency at different flow rate for separating dust particles from air.
7. To study the working of continuous Rotary Vaccum Drum Filter.
8. To determine the filter medium resistance and specific cake resistance of plate and frame filter press.

* Any other experiments may be added further, if needed.

Outcomes:

At the end of the laboratory course students will be able to :

1. Apply the principles of unit operations through experimentation and
2. Demonstrate the ability to understand the various mechanical operation equipment used in chemical and allied process industry.

BoS held on 01.10.2021 B. Tech. (Chemical Engg.)- II Year w.e.f : Session 2021-22

CH204TPC06 **Process Instrumentation** **[L:3, T:1, P:0]**

60% CHange

Objectives:

This course is to introduce students to learn the basics of instrumentation and handling the process variables, course address fundamentals & amp; operation of different measuring devices such as temperature, level, pressure, flow, pH, humidity and compositions. Course introduced to impart basic knowledge of transmitters, transducers, control valves, digital and analog components related to PLC, DCS.

Unit I : Instruments Characteristics: Introduction to process variables, static and dynamic characteristics of instruments, and their general classification, elements of measuring system and their functions.

Unit II: Transmitters & amp; Transducers: Signal transmission, transmitters, electronic, pneumatic, transducers.

Unit III: Measuring Instruments : Principles, construction and operations of instruments for the measurement of various process variables such as temperature, pressure, flow, liquid level, humidity, viscosity and composition.

Unit IV: Controllers & amp; Regulators : Principles and construction of electro- pneumatic controllers, multiplexers, final control elements such as pneumatic control vale, stepper motor.

Unit V: Data Acquisition & amp; Analysis : Introduction to data acquisition system and intelligent instruments, instrumentation of process equipment such as distillation column, heat exchanger etc.

Text Books:

1. S. K. Singh, Industrial Instrumentation and Control, McGraw-Hill.
2. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGrawHill.

References Books:

1. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw-Hill Publishing Co. Ltd.
2. T. G. Beckwith, R. D. Marangoni & J. H. Lienhard, Mechanical Measurements, Addison Wesley.
3. R. K. Jain, Mechanical and Industrial Measurements, Khanna Publishers, New Delhi
4. C. D. Johnson, Process Control Instrumentation Technology, Pearson Education, Inc.

Outcomes :

BoS held on 01.10.2021 **B. Tech. (Chemical Engg.)- II Year** **w.e.f : Session 2021-22**

Students will be well-familiar with instrumentation and automation as relevant to modern chemical plant operation.

CH204PPC04 **Process Instrumentation Lab** **[L:0, T:0, P:3]**

Objectives:

To help the student to enhance their knowledge of different process measuring instruments that used in industry

Content:

1. Study of Mercury in glass thermometer with different temperature range.
2. Study the characteristics of various flow measuring instruments
3. Study the characteristics LVDT, Strain gauge
4. Study the characteristics of Level meter, pH meter, Density meter
5. Study the characteristics of different thermocouples & RTD sensors.
6. Determination of transient response of bimetallic thermocouple.
7. Determination of dissolved oxygen using DO meter.
8. Concentration analysis of gas-liquid chromatograph.
9. Concentration analysis using U-V-visible Photo-spectrometer & to study its principle of operation.
10. Measurement of Humidity using hair hygrometer & to study its principle.
11. Pressure measurement using different pressure gauges, U-tube manometer, pressure transducer and study of their characteristics.

* Any other experiments may be added further, if needed.

Outcomes:

Practical experiences and soft skills associated with this course, the student able to demonstrate the following industry oriented COs associated with course.

1. Able to understand the characteristics of instrument for various chemical processes.
2. Able to understand the temperature measuring instruments in chemical industry.
3. Able to understand the pressure, Level, pH etc. various measuring instruments in chemical industry.
4. Measure the flow and level using various measuring instruments in chemical industry.

BoS held on 01.10.2021 **B. Tech. (Chemical Engg.)- II Year** **w.e.f: Session 2021-22**

CH204THS02 Business Communication and Presentation Skill [L:3, T:0, P:0]

Objectives:
To develop the communication skills like writing technical letters, reports and presentation skills.

Contents:
Unit I : Business communication covering, role of communication in information age; concept and meaning of communication; skills necessary for technical communication; communications in a technical organization; barriers to the process of communication.

Unit II : Style and organization in technical communication covering, listening, speaking, reading and writing as skills; objectivity, clarity, precision as defining features of technical communication; various types of business writing: letters, reports, notes, memos; language and format of various types of business letters; language and style of reports; report writing strategies; analysis of a sample report.

Unit III : Communication and personality development covering, psychological aspects of communication, cognition as a part of communication; emotional intelligence; politeness and etiquette in communication; cultural factors that influence communication; mannerisms to be avoided in communication; language and persuasion; language and conflict resolution.

Unit IV : Language laboratory emphasizing listening and comprehension skills; reading skills; sound structure of English and intonation patterns;

Unit V : Oral presentation and professional speaking covering, basics of English pronunciation; elements of effective presentation; body language and use of voice during presentation; connecting with the audience during presentation; projecting a positive image while speaking; planning and preparing a model presentation; organizing the presentation to suit the audience and context; basics of public speaking; preparing for a speech

Suggested Text Books :
1. Fred Luthans, Organizational Behaviour, McGraw Hill
2. Lesikar & petit, Report writing for Business
3. M. Ashraf Rizvi, Effective Technical Communication, McGraw Hill
4. Wallace & masters, Personal Development for Life and Work, Thomson Learning

Suggested Reference Books :
1. T. M. Farhathullah, Communication skills for Technical Students
2. Michael Muckian, John Woods, The Business letters Handbook
3. Herta A. Murphy, Effective Business Communication
4. MLA Handbook for Writers of Research Papers

Outcomes :
BoS held on 01.10.2021 **B. Tech. (Chemical Engg.)- II Year** **w.e.f : Session 2021-22**

Students should be able to :
- Communicate properly, write technical letters and reports.
- Present reports and seminars in an attractive way.

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

SCHEME FOR EXAMINATION (Effective from session 2020-21)

B.TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

THIRD YEAR, FIFTH SEMESTER (AICTE)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
						Sessional			
	THEORY		L	T	P	IA	ESE	TOTAL	
01.	CH05TPC08	Heat Transfer	3	1	0	30	70	100	4
02.	CH05TPC09	Mass Transfer-I	3	1	0	30	70	100	4
03.	CH05TPC10	Chemical Reaction Engineering-I	3	1	0	30	70	100	4
04.	CH05TPE1X		3	0	0	30	70	100	3
05.	CH05TOE1X		3	0	0	30	70	100	3
06.	CH05TMC02	Constitution of India-Basic Features and Fundamental Principles	3	0	0	0	0	0	0
	PRACTICAL								
01.	CH05PPC06	Heat Transfer Lab	0	0	3	30	20	50	1.5
02.	CH05PPC07	Mass Transfer-I Lab	0	0	3	30	20	50	1.5
03.	CH05PPC08	Chemical Reaction Engineering Lab	0	0	3	30	20	50	1.5
		Total	18	3	9			650	22.5

IA – Internal Assessment
Total Marks – 650
ESE - End Semester Examination
Total Periods / week - 30
Total Credits – 22.5

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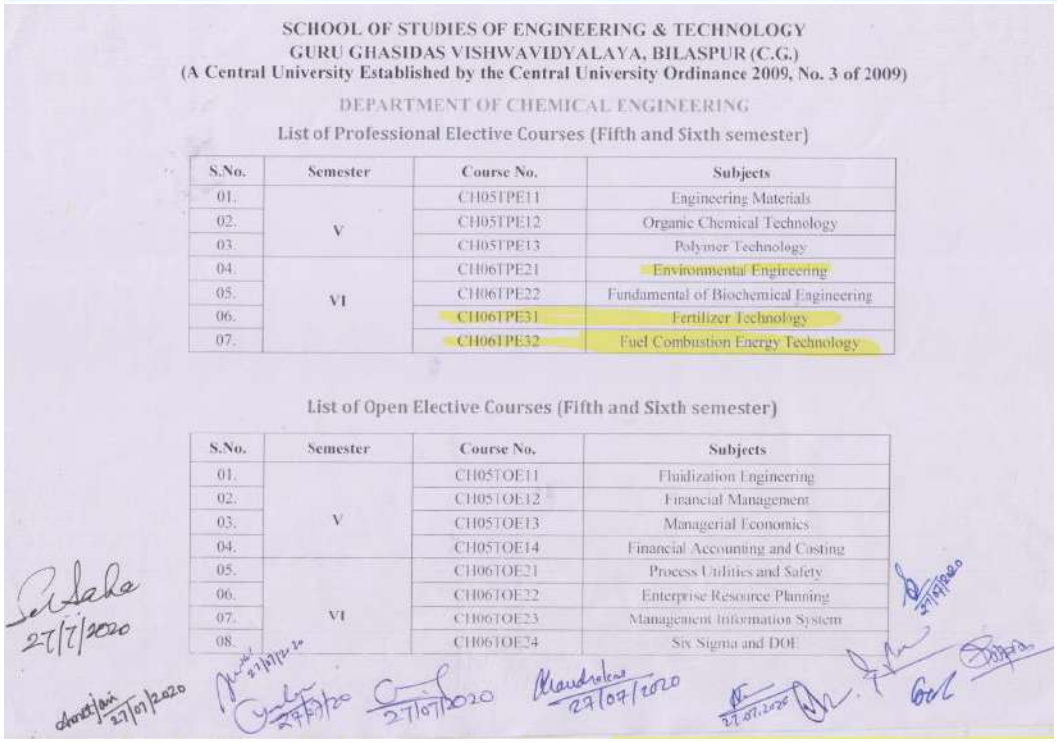
SCHEME FOR EXAMINATION (Effective from session 2020-21)

B.TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

THIRD YEAR, SIXTH SEMESTER (AICTE)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
						Sessional			
	THEORY		L	T	P	IA	ESE	TOTAL	
01.	CH06TPC11	Mass Transfer-II	3	1	0	30	70	100	4
02.	CH06TPC12	Process Dynamics and Control	3	1	0	30	70	100	4
03.	CH06TPC13	Process Equipment Design-I	3	1	0	30	70	100	4
04.	CH06TPE2X		3	0	0	30	70	100	3
05.	CH06TPE3X		3	0	0	30	70	100	3
06.	CH06TOE2X		3	0	0	30	70	100	3
	PRACTICAL								
01.	CH06PPC09	Process Dynamics and Control Lab	0	0	3	30	20	50	1.5
02.	CH06PPC10	Mass Transfer-II Lab	0	0	3	30	20	50	1.5
		Total	18	3	6			700	24

IA – Internal Assessment
Total Marks – 700
ESE - End Semester Examination
Total Periods/ week - 27
Total Credits – 24



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DEPARTMENT OF CHEMICAL ENGINEERING

List of Professional Elective Courses (Fifth and Sixth semester)

S.No.	Semester	Course No.	Subjects
01.	V	CH05TPE11	Engineering Materials
02.		CH05TPE12	Organic Chemical Technology
03.		CH05TPE13	Polymer Technology
04.	VI	CH06TPE21	Environmental Engineering
05.		CH06TPE22	Fundamental of Biochemical Engineering
06.		CH061PE31	Fertilizer Technology
07.		CH061PE32	Fuel Combustion Energy Technology

List of Open Elective Courses (Fifth and Sixth semester)

S.No.	Semester	Course No.	Subjects
01.	V	CH05TOE11	Fluidization Engineering
02.		CH05TOE12	Financial Management
03.		CH05TOE13	Managerial Economics
04.		CH05TOE14	Financial Accounting and Costing
05.	VI	CH06TOE21	Process Utilities and Safety
06.		CH061OE22	Enterprise Resource Planning
07.		CH061OE23	Management Information System
08.		CH061OE24	Six Sigma and DOE

CH05TPC08 **Heat Transfer** [L:3, T:1, P:0]

Objectives

1. To provide a fundamental understanding of heat transfer in the mode of conduction, convection and radiation.
2. To understand the fundamental laws and their correlation.
3. To understand basic knowledge of various heat transfer equipments.

Contents:

Unit-I: Introduction to three modes of heat transfer. Derivation of heat balance equation-Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Unit-II: Heat convection, boundary layers, Forced convection, Natural convection, Dimensionless parameters for forced and free convection heat transfer, Correlations for forced and free convection, Approximate solutions to laminar boundary layer equations (momentum and energy), Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Unit-III: Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.

Unit-IV: Heat Transfer Equipments: Types of heat exchangers, General design of parallel and counter-current, Double pipe and Shell and Tube heat exchanger, Analysis and design of heat exchangers using both LMTD and ε- NTU methods, Similarity between heat and mass transfer.

Unit-V: Heat Transfer with phase change: Evaporation- Types of evaporators and fields of their applications, Single and multiple effect evaporators: their design and operation, Vapour recompression, Heat transfer from condensing vapours, Heat transfer to boiling liquids, Boiling and Condensation heat transfer, Pool boiling curve

Suggested Text Books :

1. Fundamentals of Momentum, Heat and Mass Transfer by J. R. Welty, C. E. Wicks, R. E. Wilson and G. L. Rorrer, John Wiley & Sons.
2. Unit Operations of Chemical Engineering by W. L. McCabe, J. C. Smith and P. Harriot, McGraw Hill Education.
3. Heat Transfer by J. P. Holman, S. Bhattacharya, McGraw Hill Education.
4. Process Heat Transfer by D. Q. Kern, Tata McGraw-Hill Publishing Company Limited.

Course Outcome:

Students would be able to

1. Understand and identify the basic principle of heat transfer.
2. Solve problems related to conduction, convection, radiation and analyze heat exchangers.
3. Explain the concepts of evaporation and condensation.

CH05TPC09 **Mass Transfer-I** [L:3, T:1, P:0]

Objectives

1. To provide the understanding of mass transfer operations and equipments.
2. To impart the understanding of separation processes such as diffusion, distillation and absorption.

Contents:

Unit-I: Constitutive laws of diffusion; unsteady state diffusion, molecular diffusion in gases and liquids, Diffusion velocities, Convective mass transfer, interphase mass transfer and mass transfer coefficients, mass transfer correlations.

Unit-II: Phase Equilibria: Vapor-liquid equilibrium curves and boiling point diagram, Volatility, Solubility of gases, Enthalpy-concentration diagrams. Equilibrium Stage Operations Principles, Determination of number of ideal stages for two-component systems by graphical and absorption factor methods.

Unit-III: Flash distillation, differential distillation, steam distillation, Azeotropic distillation and Extractive distillation, Continuous distillation with rectification, Reflux ratio, Minimum reflux ratio, calculation of number of plats – Lewis sorel method, McCabe Thiele method.

Unit-IV: Fenske equation, Optimum reflux ratio, Analysis of fractionating column by enthalpy concentration diagram method, Plate efficiencies, Packed Column, Height Equivalent to Theoretical Plate.

Unit-V: Gas Absorption: Design of packed towers, Principles of absorption, Rate of absorption, Two film theory, Overall coefficients, HTU method, Interrelation between heat transfer, momentum transfer and mass transfer.

Suggested Text Books :

1. Principles of Mass Transfer and Separation Processes by B. K. Dutta, PHI Learning Private Limited.
2. Mass Transfer Operations by R. E. Treybal, McGraw Hill.
3. Diffusion - Mass Transfer in Fluid Systems by E.L. Cussler, Cambridge University Press.
4. Principles of Unit Operations by A. S. Foust, A. L. Wenzel, C. W. Clump, L. Maus and L. B. Anderson, John Wiley & Sons.

Course Outcome:

Students would be able to

1. Identify the concepts of phase equilibrium in mass transfer related problems.
2. Solve problems related to distillation, diffusion and absorption and mass transfer equipment.
3. Design plate /packed column for mass transfer operations.

CH05TPC10 Chemical Reaction Engineering-I [L:3, T:1, P:0]

Objectives

To impart the knowledge of the kinetics and thermodynamics of single and multiple reaction and the effect of temperature and pressure on reaction systems.

Contents:

Unit-I: Kinetics of Homogeneous Reactions: Kinetics and thermodynamics of chemical reactions, Kinetics of homogenous reactions rate theories, Analysis of rate equations.

Unit-II: Interpretation of Batch Reactor Data: Irreversible reactions, Total pressure method of kinetic studies, Analysis of complex rate equations, Complex reactions, Chain reactions, Variable volume reactions, Rate constants and equilibrium.

Unit-III: Ideal Reactor for Single Reaction: Ideal batch reactors, Steady state mixed flow reactor, Steady state plug flow reactor, Size comparison of single reactors, Multiple-reactor system.

Unit-IV: Design for Multiple Reaction: Introduction to multiple reaction, Qualitative treatment of product distribution and reactor size for parallel reactions, Reversible first order reactions in series, Favourable contacting patterns for irreversible reactions in series (First order &followed by first order).

Unit-V: Temperature and Pressure Effects: Single reaction, General graphical design procedure, Optimum temperature progression, Heat effects- adiabatic and non-adiabatic operations, van Heerden relationship.
Multiple reactions: Temperature and vessel size for maximum production.

Suggested Text Books :

1. Chemical Reaction Engineering by O. Levenspiel, John Wiley & Sons.
2. Elements of Chemical Reaction Engineering by H. S. Fogler, Prentice Hall.
3. Chemical and Catalytic Reaction Engineering by J. J. Carberry, Dover Publications.
4. Chemical Reactor Analysis and Design by G. F. Froment, K. B. Bischoff and J. D. Wilde, Wiley.

Reference Book:

1. Reaction Kinetics for Chemical Engineers by S. M. Walas, Butterworths Publishers.

Course Outcome:

Students would be able to

1. Develop rate of reaction for homogeneous reactions.
2. Interpret batch reactor data and design ideal reactors for single and multiple reactions.
3. Describe different aspects of design for multiple reactions.
4. Explain the effect of temperature and pressure on reaction rate.

B.Tech. VI Semester

CH06TPC11 **Mass Transfer-II** [L:3, T:1, P:0]

Objectives

1. To provide basic knowledge of fundamental mass transfer operations and mechanisms.
2. To understand the mass transfer in LLE, leaching, drying, crystallization, adsorption and humidification operation.

Contents:

Unit-I: Humidification Operations: Definitions, Humidity chart and its use in measurement of humidity and calculations of humidification operations. Adiabatic humidification. Design of Cooling Towers.

Unit-II: Leaching: Equipment, Principles of leaching, Calculation of number of ideal stages, Stage efficiency

Unit-III: Liquid- Liquid Extraction: Equipment, Principles of extraction, Panchon-Savorit method, Counter-current extraction using reflux application of McCabe method, Extraction in packed and spray column.

Unit-IV: Crystallization: Principles, yield of crystals, Super solubility curve, Crystal growth, Equipment and application of principles to design.
Adsorption: Fixed bed absorbers, break through; Ion-Exchange.

Unit-V: Drying: Equipment, Principles, Mechanism and theory of drying, Calculation of drying time.

Suggested Text Books :

1. 1. Principles of Mass Transfer and Separation Processes by B. K. Dutta, PHI Learning Private Limited.
2. Mass Transfer Operations by R. E. Treybal, McGraw Hill.
3. Diffusion - Mass Transfer in Fluid Systems by E.L. Cussler, Cambridge University Press.
4. Principles of Unit Operations by A. S. Foust, A. L. Wenzel, C. W. Clump, L. Maus and L. B. Anderson, John Wiley & Sons.

Course Outcome:

Students would be able to

1. Explain the basics of Mass Transfer and related laws.
2. Identification of mechanisms of mass transfer, Formulation of rate equations.
3. Solve problems related to drying, leaching and crystallization.

CH06TPC12 **Process Dynamics and Control** [L:3, T:1, P:0]

Objectives

1. To provide fundamental knowledge on process control strategies.
2. To impart knowledge on a theoretical analysis of open loop and closed loop systems.

Contents:

Unit-I: Process Control : Importance of process control in chemical plants and systems. Various types of Control systems viz. open loop and closed loop control, feedback and feed forward control, servo and regulator control; Importance of dynamic behaviour of processes in process control, Physical and block diagram representation of control system, Use of Laplace transformation in analysis of control systems.

Unit-II: Simple System Analysis: Laplace transformation and transfer function, Block diagrams, Linearization, First and higher order systems, Interacting and non-interacting systems, Distributed and lumped parameters systems, Dead time.

Unit-III: Linear Open Loop Systems: Response of first order, second order and higher order systems, Linearization of non-linear systems, Transportation lag. Linear Closed Loop Systems: Study of various control system and their components viz. controllers, final control elements, Measuring instruments, Closed loop transfer functions, Transient response of simple control system, Stability criterion and analysis.

Unit-IV: Root Locus, Stability Criterion and Transient Response: Transient response analysis form root locus, Application of root locus to control system, Routh stability criterion.

Unit-V: Frequency Response Analysis: Design of control system by frequency response, Closed loop response by frequency response, Frequency response technique: Phase margin and gain margin, Bode stability criterion; Nyquyist stability criterion, Controller tuning: Ziegler-Nichols method, Cohen-Coon method, Introduction to advanced controllers: cascade control, feed forward control.

Suggested Text Books :

1. Process Systems Analysis and Control by D.R. Coughanowr and S. LeBlanc, McGraw-Hill.
2. Process Dynamics and Control by D.E. Seborg, T.F. Edgar and D.A. Mellichamp, John Wiley.
3. Chemical Process Control: An Introduction to Theory and Practice by G. Stephanopoulos, Pearson Education.

Course Outcome:

Students would be able to

1. Evaluate dynamic behaviour of first and second order system.
2. Determine the process stability in Laplace domain.
3. Analyze open-loop systems and linear closed loop systems.
4. Develop working knowledge of control system by frequency response.

CH06TPC13 **Process Equipment Design-I** [L:3, T:1, P:0]

Objectives

To understand the chemical engineering principles applicable to mechanical process design for various process equipment and standard codes for design of chemical plant equipment.

Contents:

Pressure and Storage Vessels: Design of pressure and storage vessels and their supports. End closures, Flat plates, Flanged, Dished, Hemispherical, Ellipsoidal and conical ends.

Suggested Text Books :

1. Introduction to Chemical Equipment Design (Mechanical Aspects) by B.C. Bhattacharya, Chemical Engineering Education Development Center.
2. Process Equipment Design by L.E. Brownell and E.H. Young.
3. Design of Process Equipment Design by M.V. Joshi and V.V. Mahajan, MacMillan, India
4. Chemical Engineering by J. M. Coulson and J. F. Richardson, Vol-I, MacMillan, Newyork.
5. Process Equipment Design by S.D. Dawande, Dennet & Co.

Reference Books:

1. Perry's Chemical Engineers' Handbook by D. W. Green and R. H. Perry, McGraw Hill Publication.
2. IS Codes.

Course Outcome:

Students would be able to

1. Design pressure and storage vessels and their supports.
2. Evaluate the parameters of equipment design and important steps involved in design.

CH6TPE21 **Environmental Engineering** [L:3, T:0, P:0]

Objectives

To understand the significant issues of environmental pollution and their control principles.

Contents:

Unit-I: Environmental Pollution and Its Effect: Environment and its components. Sources and type of pollutants, General effects on man, animal, vegetation and property.

Unit-II: Air Pollution : Air quality criteria and standards. Ambient air sampling and analysis. Stack emission standards. Stack sampling and analysis. Meteorology and dispersion of air pollutants. Atmospheric lapse rate and stability. Plume behaviour. Control of gaseous and particulate pollutants from mobile and stationary sources.

Unit-III: Water Pollution : Water quality criteria and effluent discharge standards. Domestic and industrial sources of waste water. Waste water sampling and analysis methods as per BIS specifications. Physico-chemical and biological methods of waste water treatment. Recovery of material from process effluents.

Unit-IV: Pollution Due to Hazardous Industrial Waste: Nature of hazardous waste materials from various chemical and allied Industries. Methods of disposal, destruction and reuse. Nuclear wastes and their management. Solid waste from commercial, domestic and industrial sectors-composition and characterization, recycle, resource recovery and disposal.

Unit-V: Environmental Pollution Management: Case studies of air and water pollution control in chemical industries.

Suggested Text Books :

1. Environmental Pollution Control Engineering by C. S. Rao, New Age International Ltd.
2. Environmental Engineering by N. N. Basak, Tata McGraw-Hill Pub. Co. Ltd.
3. Essentials of Environmental Studies by K. Joseph and R. Nagendran, Pearson Education (Singapore) Pvt. Ltd.

Course Outcome:

Students would be able to

1. Explain environmental pollution and its effect.
2. Describe methods of controlling of Water Pollution and Air Pollution.
3. Analyze the characteristics of hazardous industrial waste and its handling and management.
4. Explain case studies of air and water pollution control in chemical industries.

CH06TPE31 **Fertilizer Technology** [L:3, T:0, P:0]

Objectives

To impart the understanding of essential knowledge of fertilizer industry which includes production process, reaction and separation steps in a flow diagram for variety of fertilizers.

Contents:

Unit-I: Chemical fertilizers and organic manures – types of chemical fertilizers. Role of essential Elements in plant Growth, Macro elements and Micro elements, Development of fertilizer industry; Fertilizer production and consumption in India; Nutrient contents of fertilizers; Secondary nutrients; Feedstock and raw materials for nitrogenous, phosphatic and potassic fertilizers.

Unit-II: Nitrogenous fertilizers- Methods of production, Characteristics, Specification and storage of ammonium sulphate, ammonium nitrate and ammonium chloride and urea.

Unit-III: Phosphatic fertilizers Methods of production, Characteristics, Specification and storage of single super phosphate, triple super phosphate.

Unit-IV: Potassic fertilizers- Methods of production, Characteristics, Specification and storage of potassium chloride, potassium sulphate and potassium schoenite.

Unit-V: Complex and NPK fertilizers-Methods of production, Characteristics, Specification and storage of Mono ammonium phosphate, Di-ammonium phosphate, Nitro phosphates, Fertilizers and Environment.

Suggested Text Books :

1. Dryden's Outlines of Chemical Technology by M. G. Rao and M. Sittig, East-West Press.
2. Shreve's Chemical Process Industries by G. T. Austin, Tata McGraw Hill Publications.
3. Chemistry & Technology of Fertilizers by A.V. Slack, Interscience.
4. Chemical Technology by G.N. Pandey and S.D. Shukla, Vani Books Company.

Course Outcome:

Students would be able to

1. Explain reactions and unit operations steps in manufacturing of various fertilizers.
2. Explain characterization process and engineering problems in fertilizer industries.

CH06TPE32 Fuel Combustion Energy Technology [L:3, T:0, P:0]

Objectives

To understand the basics of various types of solid, liquid and gaseous fuels, basic principles of their combustion processes, its appliances, the fundamentals of the applied sciences dealing with various types of conventional and non-conventional energy resources.

Contents:

Unit-I: Solid Fuel : Classification of fuel, Origin, Composition, Characteristics and analysis of coal washing & storage of coal, Physical & chemical processing of coal, Various classification systems of coal briquetting, Carbonization, Gasification of coal. Liquid fuels: Origin, composition, characteristics and classification of crude oil, crude oil processing cracking and reforming, storage and handling of liquid fuel.
Gaseous fuel: Classification of gaseous fuel, Natural gas, Coal gas, Coke oven and blast furnace gas, producer gas, water and Carburetted water gas

Unit-II: Fuel Combustion Calculation: Fundamentals of various combustion calculations with numerical examples.

Unit-III: Combustion Process: General Principles of combustion, Flame, Draught, Limits of In flammability, Types of combustion Process- Surface, Submerged, Pulsating, Slow combustion.

Unit-IV: Energy Conservation: Energy consumption pattern in various sectors, various ways of energy conservation in various process industries including petroleum.

Unit-V: Non – Conventional Energy Technologies : General principles with applications and technology of Biomass Energy, Solar Energy, Geothermal Energy, Wind Energy, Nuclear Energy, Hydal, Tidal and Ocean Energy.

Suggested Text Books :

1. Elements of Fuel Combustion & Energy Engineering by S.N. Saha, Dhanpat Rai Publication Co. Pvt. Ltd. New Delhi.
2. Fuels and Combustion by S. Sarkar, Orient Longman, Hyderabad

Course Outcome:

Students would be able to

1. Analyze solid, liquid, gaseous fuels and their characterization.
2. Compute fuel combustion calculation in industries with recommendation of better combustion processes in relation to better efficiency and pollution control technologies.
3. Study and recommend the various energy conservation routes in various industries.
4. Study and recommend the alternative sources of energies including the renewable energies in view of energy conservation to utilize them effectively.

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SCHEME FOR EXAMINATION
B.Tech. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

FOURTH YEAR, SEVENTH SEMESTER

S. No.	Course No.	Subject	Periods			Evaluation Scheme					Credits
						Sessional			ESE	Sub Total	
	THEORY		L	T	P	IA	MSE	Total			
01.	CH7TPC13	Process Equipment Design- II	3	1	-	20	20	40	60	100	4
02.	CH7TPC14	Chemical Reaction Engineering-II	3	1	-	20	20	40	60	100	4
03.	CH7TPC15	New Separation Processes	3	1	-	20	20	40	60	100	4
04.	CH7TPE4X		3	1	-	20	20	40	60	100	4
05.	CH7TOE3X		3	1	-	20	20	40	60	100	4
	PRACTICAL										
01.	CH7PPC08	Minor Project	-	-	6	30	-	30	20	50	3
02.	CH7PPC09	Vocational Training Viva Cum Seminar	-	-	3	50	-	50	-	50	2
	TOTAL		15	5	9					600	25

IA – Internal Assessment
MSE – Mid Semester Examination
ESE - End Semester Examination
Total Marks – 600
Total Periods - 29
Total Credits - 25

BOS held on 15th May 2018

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)
SCHEME FOR EXAMINATION
B.Tech. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

FOURTH YEAR, EIGHTH SEMESTER

S. No.	Course No.	Subject	Periods			Evaluation Scheme					Credits
						Sessional			ESE	Sub Total	
	THEORY		L	T	P	IA	MSE	Total			
01.	CH8TPC16	Process Equipment Design- III	3	1	-	20	20	40	60	100	4
02.	CH8TPC17	Project Engineering, Economics & Management	3	1	-	20	20	40	60	100	4
04.	CH8TPE5X		3	1	-	20	20	40	60	100	4
06.	CH8TOE4X		3	1	-	20	20	40	60	100	4
	PRACTICAL										
01.	CH8PPC10	Project	-	-	8	60	-	60	40	100	4
	TOTAL		12	4	8					500	20

IA – Internal Assessment
MSE – Mid Semester Examination
ESE - End Semester Examination
Total Marks – 500
Total Periods - 24
Total Credits – 20

BOS held on 15th May 2018

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
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LIST OF PROFESSIONAL ELECTIVES OFFERD BY DEPARTMENT OF CHEMICAL ENGINEERING FOR VII and VIII SEMESTER

Semester	Subject Code (PE)	Subject
VII	CH7TPE41	Petroleum Refinery Engineering
	CH7TPE42	Polymer Technology - I
	CH7TPE43	Design and Development of Catalyst
VIII	CH8TPE51	Petrochemical Technology
	CH8TPE52	Polymer Technology - II
	CH8TPE53	Membrane Separation Processes

PE - Professional Elective

BOS held on 15th May 2018

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

LIST OF OPEN ELECTIVES OFFERD FOR VII and VIII SEMESTER

Semester	Subject Code (OE)	Subject
VII	CH7TOE31	Transport Phenomena
	CH7TOE32	Water Conservation and Management
VIII	CH8TOE41	Optimization Techniques
	CH8TOE42	Process Modeling & Simulation
	CH8TOE43	Renewable Energy

OE- Open Elective

Note: In addition to the open elective courses, as prescribed above, the students are free to opt for any other subject of same credit from inter/intra school duly approved by the Board of Studies of the respective departments.

BOS held on 15th May 2018

B.Tech. VII Semester

CH7TPC13 : Process Equipment Design- II (3 1 0)

Design of Heat Transfer Equipments : Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Vertical & Horizontal Condensers and Evaporators.

The candidates will be allowed to use the following reference book in the examination hall :

1. Hand book of Chemical Engineering J. H. Perry
2. Tubular Heat Exchange Manufacture Association Manual
3. ISI Codes.

Candidates have to bring their own copies of the above books and they will be not supplied by the university or the examination centers.

Text Books :

1. Process Heat Transfer by D. Q. Kern
2. Heat Transmission by McAdams
3. Unit Operations of Chemical Engineering by McCabe Warren, L Smith Julian and Harriot Peter, Fifth Edition, McGraw Hill Inc.
4. Chemical Engineering by J. M. Coulson and Richardson, Volume- I

Course Outcomes

Students should be able to design, calculate size/power/internals, etc required for all the process equipment in the PFD together with necessary instrumentation, safety aspects. Students should be able to calculate costs of equipment. Students should be able to perform a techno economic feasibility of the selected process.

CH7TPC14 : Chemical Reaction Engineering - II (3 1 0)

Unit-I : Basics of Non-Ideal Flow : Exit Age Distribution of Fluid, RTD, Conversion in Non-ideal Flow Reactors, Models for Non-ideal Flow- Dispersion Model, Chemical Reaction and Dispersion, Tank in Series Model.

Unit-II : Mixing of Fluids : Self Mixing of Single Fluid- Degree of Segregation, Early and Late Mixing, Mixing of Two Miscible Fluids.

Unit-III : Fluid Particle Reactions : Un-Reacted Core Model: Diffusion Through Gas Film Control, Diffusion Through Ash Layer Control, Chemical Reaction Control, Rate of Reaction for Shrinking Spherical Particles, Determination of Rate Controlling Step.

Unit-IV : Fluid – Fluid Reactions : Kinetic Regimes for Mass Transfer and Reaction, Rate Equations for Various Regimes, Film Conversion Parameter, Application to Design, Reactive and Extractive Reactions.

Unit V: Catalysis : Heterogeneous Catalysts, General Characteristics, Adsorption on Solid Surface, Physical Properties of Catalysts, Preparation of Catalyst, Steps in Catalytic Reaction.

Text Books :

1. Chemical Engineering Kinetics. J.M. Smith.
2. Chemical Reaction Engineering. Octave Levenspiel.
3. Chemical Reaction Engineering. H.Scott Fogler.
4. Principles of Reaction Engineering, Central Techno Publications. S.D.Dawande,
5. Chemical Engineering, Volume IV. Coulson and Richardson

Course Outcomes

Students would be able to (a) explain the concepts of reactor design and reaction kinetics; (b) interpret reactor data; (c) identify ideal reactors and explain various aspects of design for single reactions; (d) explain various aspects of design for multiple reactions, (e) analyze effects of temperature and pressure on conversion.

CH7TPC15 : New Separation Processes (3 1 0)

Unit I : Overview of Separation Processes: Basic Concepts of Separation Processes, Physico-Chemical Properties and Other Factors Controlling Separation, Limitations of Conventional Separation Processes and New Separation Processes, Equilibrium and Rate Governed Separation Processes and their Characteristics.

Unit II : Membrane Based Separation Processes: Principle of Membrane Separations Process, Advantages and Disadvantages, Classification, Membrane Materials, General Methods of Preparation and Characterization of Membranes, Membrane Modules, Concentration Polarization.

Unit III : Porous Membrane Based Processes: Reverse Osmosis, Ultrafiltration, Microfiltration, Nano-filtration, Dialysis, Ion-Selective Membranes and Electro-dialysis, Industrial Applications of Porous Membrane Based Processes.

Unit IV : Non-Porous Membrane Based Processes: Gas separation, Pervaporation, Liquid Membranes and their Industrial Applications, Medical Applications of Membranes, Miscellaneous Membrane Processes, Membrane Distillation, Membrane Reactors.

Unit V : Other Non-Conventional Separation Processes: Foam and Bubble Fractionation, Pressure and Temperature Swing Adsorption, Cloud Point Extraction, Centrifugal Separation Processes, Super Critical Fluid Extraction.

Text Books :

1. Separation Process Principles by J D Seader and E J Henley John Wiley & Sons, Inc.
2. Separation Processes by C J King, McGraw-Hill, Inc.
3. Membrane Separation Processes by K. Nath, PHI, New Delhi.
4. Membrane Technology and Applications by R W Baker, John Wiley and Sons, Ltd, UK.
5. Handbook of Industrial Membrane Technology by M.C. Porter, Crest Publishing House.

Course Outcomes

Explain membrane processes in terms of the membrane, feed, sweep, retentate, permeate, and solute membrane interactions. Distinguish among microfiltration, ultrafiltration, Nano filtration, virus filtration, sterile filtration, filter-aid filtration, and reverse osmosis in terms of average pore size. Explain common idealized flow patterns in membrane modules.

CH7TPE41: Petroleum Refinery Engineering (3 1 0)

Unit I : Petroleum Crude and Refining : Origin, Formation & Occurrence of Petroleum Crude, Exploration, Drilling and Processing, Reserve and Deposit of World, Indian Petroleum Refinery, Compositions, Classification & Physical Properties of Petroleum Crude.

Unit II : Physical Properties and Testing Methods of Petroleum Products : Evaluation of Petroleum, Physco-Chemical Properties of Various Petroleum Products as Per API / ASTM / BIS Specifications.

Unit III : Crude Processing : Pre-Treatment of Crude, Heating Techniques of Crude, Types of Distillation Columns & their Efficiencies, Atmospheric and Vacuum Distillation of Crude, Blending of Gasoline.

Unit IV : Chemical Treatment & Refining Operation : Chemical Treatment of Petroleum Products, Caustic Soda Treatment, Treatment With H_2SO_4 & H_2, Mercaptan Removal & Oxidation Process, Sulphur-Removal From Petroleum Products – Doctor's Treatment, Hydro De-Sulphurization, Dewaxing and Refining of Lubricating Oils.

Unit V : Cracking & Reforming Operation : Visbreaking, Thermal Cracking, Catalytic Cracking, Hydrocracking, Catalytic Reforming, Alkylation, Isomerization and Polymerization, Naphtha Cracking, Delayed Coking & Fluidized Coking.

Text Books :

1. Petroleum Refinery Engineering by W.L. Nelson
2. Petroleum Refining by Gary and Handwarke, Marcel Dekker
3. Petroleum Refining & Petrochemicals by N.K. Sinha, Umesh Publications New Delhi.
4. Petroleum Refining Technology by I.D. Mall, CBS Publishers & Distributors Pvt. Ltd. New Delhi.

Course Outcomes

Students would be able to (a) explain petroleum refining and thermal cracking processes; (b) detail catalytic cracking and catalytic reforming processes; (c) produce fuels such as aviation gasoline, motor fuel, kerosene, jet fuel; (d) manufacture lubricating oil; (e) store and transport petroleum products.

B.Tech. VIII Semester

CH8TPC16: Process Equipment Design- III (3 1 0)

Mass Transfer Equipments : Absorption Tower, Distillation Tower, Tunnel and Rotary Dryers.

Text Books :

1. Hand Book of Chemical Engineering J. H. Pery
2. Coulson & Richardson Volume–VI
3. Mass Transfer by R. Treybal
4. ISI Codes

Candidates have to bring their own copies of ISI Code book and they will be not be supplied by the university or the examination centers.

Course Outcomes

Upon completion of this course, the students will be able to: (a) design mass transfer equipment's for chemical process.; (b) prepare drawing for chemical process equipment's.

CH8TPC17: Project Engineering, Economics & Management (3 1 0)

Unit I : Nature and Importance of Project and Project Engineering : Concept of Project and Project Management, Characteristics of Project, Introduction to Project Engineering, Role of a Project Leader, General Design Considerations, Plant Layout and Site Selection, Flow Diagram, Concept of Scale Up, Concepts of Techno-Economic Feasibility Report.

Unit II : Technical and Financial Analysis : Technical Analysis, Financial Analysis, Significance of Financial Analysis, Elementary Knowledge of Book of accounts- Journal, Ledger, Balance sheet, Profit and Loss Account. Cost Estimation, Cash Flow Investment, Production Cost, Capital Investment, Cost Indices, Production and Overhead Cost, Interest and Taxes.

Unit III : Project Financing and Value Engineering : Meaning and Importance of Project Finance, Means of Finance and Sources of Project in India, Financial Institution Structure and Financial Assistance, Norms of Finance and Term Loan Procedure, Value Engineering – Function, Aims and Procedure.

Unit IV : Capital Expenditure, Profitability & Alternative Investments : Importance and Kinds of Capital Expenditure Decision, Capital Budgeting Process, Criteria of Capital Budgeting, Depreciation and its Calculation Methods, Methods of calculating profitability, Alternative investments, Break Even Analysis.

Unit V : Network Techniques for Project Management : Introduction, Development of Project Network, Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Time Analysis, Gantt Chart.

Text Books :

1. Plant Design & Economics for chemical Engineers by M.S. Peters & K. D. Timmerhaus.
2. Projects: Planning, Analysis, Selection, Financing, Implementation and Review by Prasanna Chandra.
3. Project Engineering of Process Plants by H. F. Rase
4. Pilot Plants and Models and Scale up Methods in Chemical Engineering by R. E. Johnston.

Course Outcomes

Upon completion of this course, the students will be able to: (a) select a site for the project from given alternatives, (b) calculate working capital requirement for a given project, (c) calculate cost of equipment used in a plant total project cost, (d) calculate cash flow from a given project, (e) understand the break-even analysis; (f) calculate depreciation; (g) list out various milestones related to project concept to commissioning.

CH8TPE51: Petrochemical Technology (3 1 0)

Unit I : Survey of Petrochemical Industries : Petrochemical Industries in India, Plastic and Synthetic Fiber Industries, Product of Petroleum Industries, Feed Stocks for Petrochemical Production, Purification and Separation of Feed Stocks, Chemicals from Methane.

Unit II : Chemicals From C_2 Hydrocarbons : Chemicals from Ethane, Ethylene and Acetylene, Naphtha Cracking and Reforming, Hydrogen from Reforming of Hydrocarbons.

Unit III : Chemicals From C_3, C_4 and Higher Fractions : Chemicals from Propane, Propylene, Butanes, Butylene etc. Production of Synthesis Gases from Higher Fractions. Carbon Compound, Dehydrogenation of Hydrocarbon and Higher Paraffins.

Unit IV : Polymers of Olefins : Polymers and their Properties, Polymers from Olefins-Polyethylene (HDPE, LDPE), Polypropylene, Vinyl Polymers. Production of BTX, Benzene Derivatives, Products from Toluene, Oxidation Products of Toluene, Synthetic Fibers and their Production.

Unit V : Synthetic Rubber, Plastics and Detergents : Synthetic Rubber and its Production, Classifications of Plastics, Different types of Resin and their Production, ABS Plastics, Poly Carbonates (PC), Poly Urethanes, Polyamides, Polystyrene, Synthetic Detergents and their Production, Petroleum Coke and Carbon Black.

Text Books :

1. Modern Petroleum Technology by G.D. Hobson and W Pow.
2. A Textbook on Petrochemical Technology by Bhaskara Rao.

Course Outcomes

Upon completion of this course, the students will be able to: (a) select the appropriate characterization parameters; (b) specify the properties of petroleum products; (c) attain knowledge of various separation & conversion processes involved in petroleum refining; (d) attain knowledge of manufacturing of various petrochemical products.

CH8TPE53: Membrane Separation Processes (3 1 0)

Introduction to Membrane Separation Process, Principle of Membrane Separation, Physical and Chemical Properties of Membranes, Classification, Driving Forces in Membrane Separation Processes, Advantages and Limitations of Membrane Processes, Membrane Types, Materials, Preparation and Characterization, Various Methods of Membrane Manufacture, Structure and Function of Symmetric and Asymmetric Membranes, Membrane Modules, Module Cascading, Chemical Potential and Osmosis, Retention and Permeability and its Estimation, Salt Rejection, Concentration Polarization and Membrane Fouling, Concept of Zeta Potential, Major Application Areas of Membrane, Various Membrane Processes, Design, Operation, Maintenance and Industrial Applications of Membrane Based Processes.

Text Books :

1. Separation Process Principles by J. D. Seader, Ernest J. Henley, Wiley
2. Separation Process Engineering by Phillip C. Wankat, PHI
3. Membrane Technology and Applications by R W Baker, John Wiley and Sons, Ltd, UK.
4. Membrane Separation Processes by K. Nath, PHI, New Delhi

Reference :

1. Webcourse (NPTEL) Novel Separation Processes by Prof. Sirshendu De, IIT Kharagpur

CH8TOE41 : Optimization Techniques (3 1 0)

System Analysis and Modeling : Introduction to Systems Analysis and Modeling with Reference to Chemical Engineering Problems, Differential Method for Solving One and Two Variable Problems With and Without Constraints, Case Studies, Application of Langrangian Multiplier Method.

Search Methods: One Dimensional Search Method- Newton's Method, Quasi Newton's Method, Polynomial Approximation Methods, Sequential Search Methods - Golden Section Method, Dichotomous Search Method, Interval Halving Method, Fibonacci Method.

Linear Programming: Modeling, Graphical Method, Single Phase Simplex Method, Two Phase Simplex Method, Duality, Dual Simplex Method.

Geometric Programming: As Applied to Chemical Engineering Problems with Degree of Difficulty Equal to Zero and One, with and without Constraints.

Dynamic Programming: Introduction to Dynamic Programming as Applied to Discrete Multistage Problems Like Cascade of CSTR, Train of Heat Exchanger etc., Computer Programming Techniques applied to Optimization.
Methods for Global Optimization.

Text Books :

1. Optimization Theory and Practice by Beveridge and Schecheter
2. Optimization Techniques for chemical Engineers by AsgharHussain
3. Optimization by S.S. Rao
4. Linear Programming by Hadley

15/05/18 15/05/18 15/05/18 15/5/18 15/5/18 15/5/18 15/5/18

Course Outcomes

Upon completion of this course, the students will be able to: (a) formulate the objective functions for constrained and unconstrained optimization problems; (b) use different optimization strategies; (c) Solve problems using non-traditional optimization techniques; (d) use of different optimization techniques for problem solving.

CH8TOE42: Process Modeling & Simulation (3 1 0)

Introduction : Uses of Mathematical Models, Scope of Coverage, Principles of Formulations. Mathematical Modeling in Chemical Reaction Engineering: CSTR, PFR, Batch Reactor, Semibatch Reactor, Series of Isothermal CSTR, Constant Hold-Up CSTR's, CSTR's with Variable Hold Ups, Gas Phase Pressurized CSTR, Non Isothermal CSTR, Bioreactor, Trikle Bed Reactor.

Mathematical Modeling in Mass Transfer : Ideal Binary Distillation Column, Multi-Component Non-ideal Distillation Column, Batch Distillation with Hold Up, Steam Distillation, Multi-Solute Batch Liquid- Liquid Extraction, Continuous Extraction, Multistage Countercurrent Extraction, Plug Flow Type Liquid- Liquid Extraction, Reactor with Mass Transfer, Absorption, Adsorption.

Mathematical Modeling in Heat Transfer : Two Heated Tanks, Single Component Vaporizer, Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Multicomponent Flash Drum, Cooling Towers.

Mathematical Modeling of Other Chemical Processes: Interacting and Non-Interacting Systems with and without Heaters, Isothermal Hydraulic System, Forward and Backward Feed Triple Effect Evaporator.

Introduction of MATLAB and Use of Language, Simulation, Program Development and Numerical Solutions of Above Processes.

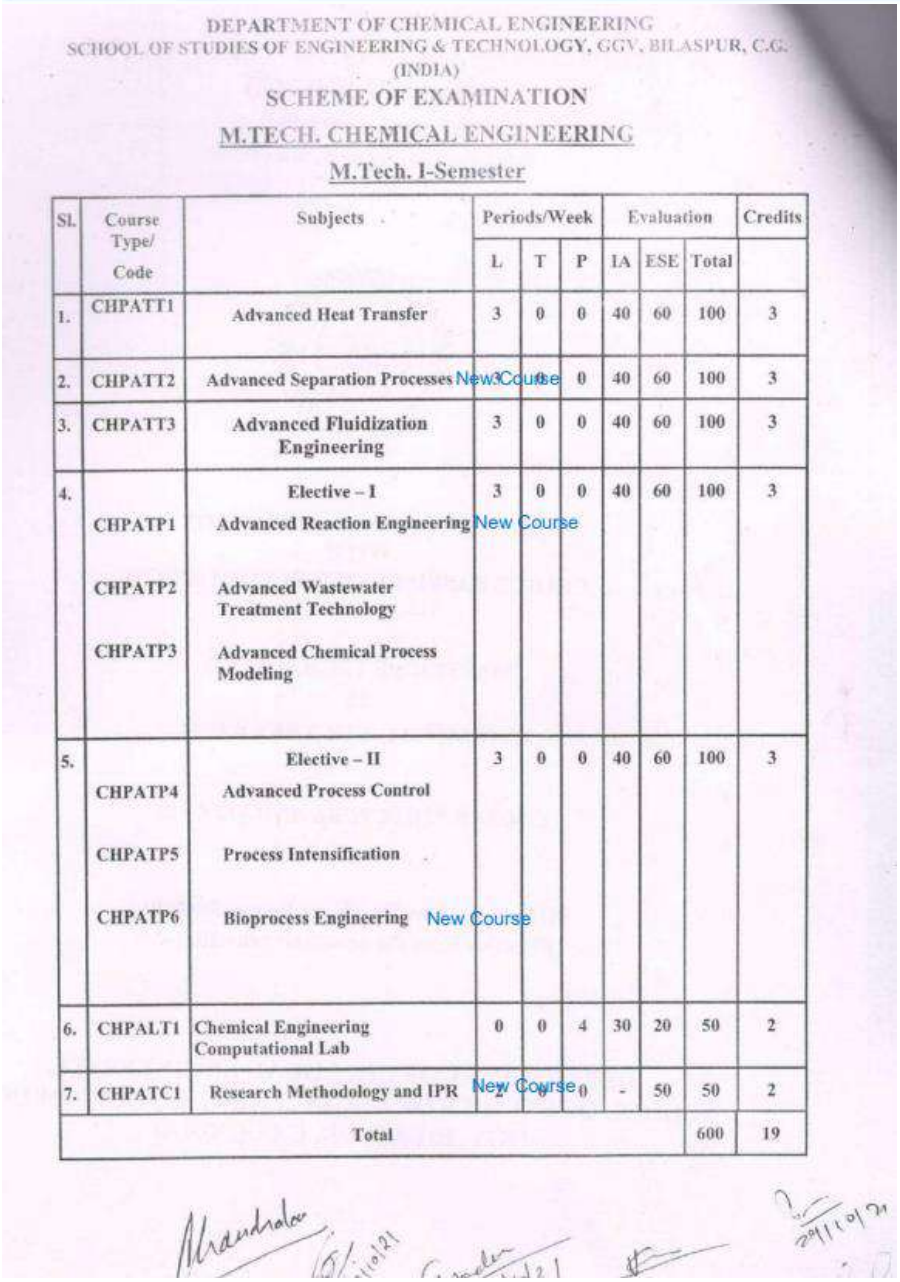
Text Books :

1. Process Modeling, Simulation and Control for Chemical Engineers by W. L. Luyben, McGraw Hill, 1990.
2. Process Plant Simulation by B. V. Babu, Oxford University Press, 2004.
3. Optimisation Techniques for Chemical Engineers by A. Hussain and K. Gangaiah, Macmillan, 2001.
4. Process Control: Modeling, Design and Simulation by B. W. Bequette. Prentice-Hall India, 2006.
5. Elements of Chemical Reaction Engineering by Fogler, Prentice Hall of India.

BOS held on 15th May 2018

Course Outcomes

Students would be able to (a) explain detail importance of ODE and PDE; (b) develop model equations for the given system; (c) solve structural, thermal, fluid flow problems; (d) demonstrate the model solving ability for various processes/unit operations; (e) demonstrate the ability to use a process simulation.



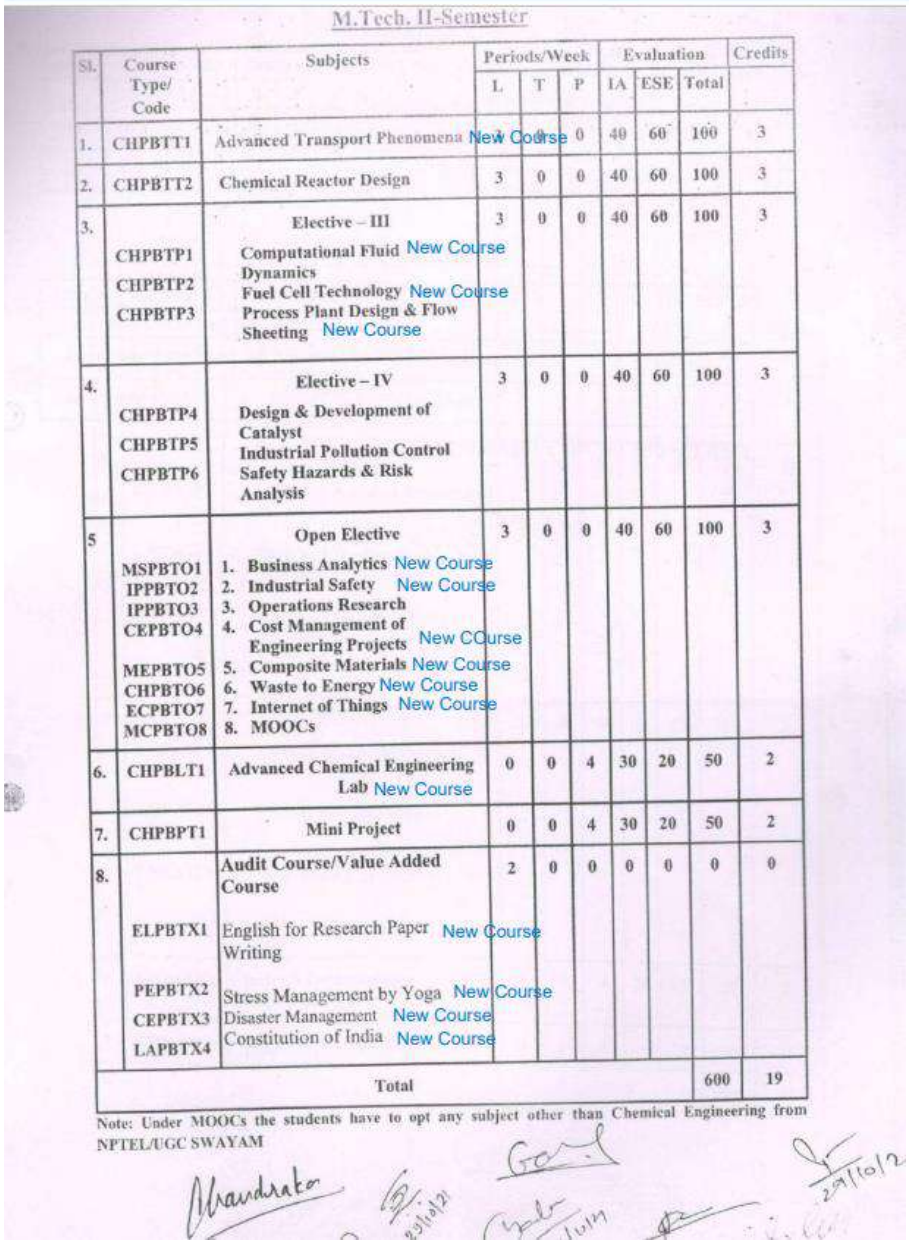
DEPARTMENT OF CHEMICAL ENGINEERING
SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY, GGV, BILASPUR, C.G.
(INDIA)

SCHEME OF EXAMINATION

M.TECH. CHEMICAL ENGINEERING

M.Tech. I-Semester

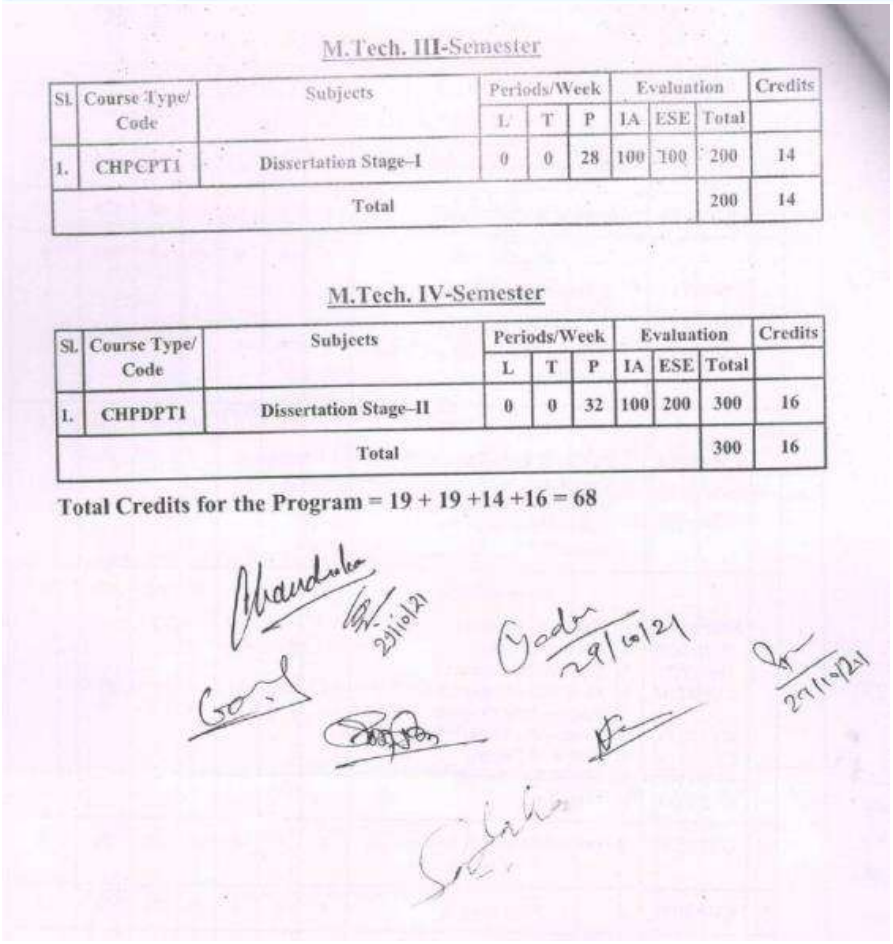
Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	CHPATT1	Advanced Heat Transfer	3	0	0	40	60	100	3
2.	CHPATT2	Advanced Separation Processes New Course	3	0	0	40	60	100	3
3.	CHPATT3	Advanced Fluidization Engineering	3	0	0	40	60	100	3
4.		Elective – I	3	0	0	40	60	100	3
	CHPATP1	Advanced Reaction Engineering New Course							
	CHPATP2	Advanced Wastewater Treatment Technology							
	CHPATP3	Advanced Chemical Process Modeling							
5.		Elective – II	3	0	0	40	60	100	3
	CHPATP4	Advanced Process Control							
	CHPATP5	Process Intensification							
	CHPATP6	Bioprocess Engineering New Course							
6.	CHPALT1	Chemical Engineering Computational Lab	0	0	4	30	20	50	2
7.	CHPATC1	Research Methodology and IPR New Course	2	0	0	-	50	50	2
Total								600	19



M.Tech. II-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week L	T	P	Evaluation IA	ESE	Total	Credits
1.	CHPBTT1	Advanced Transport Phenomena New Course	3	0	0	40	60	100	3
2.	CHPBTT2	Chemical Reactor Design	3	0	0	40	60	100	3
3.	CHPBTP1 CHPBTP2 CHPBTP3	Elective – III Computational Fluid Dynamics New Course Fuel Cell Technology New Course Process Plant Design & Flow Sheeting New Course	3	0	0	40	60	100	3
4.	CHPBTP4 CHPBTP5 CHPBTP6	Elective – IV Design & Development of Catalyst Industrial Pollution Control Safety Hazards & Risk Analysis	3	0	0	40	60	100	3
5	MSPBTO1 IPPBTO2 IPPBTO3 CEPBTO4 MEPBTO5 CHPBTO6 ECPBTO7 MCPBTO8	Open Elective 1. Business Analytics New Course 2. Industrial Safety New Course 3. Operations Research 4. Cost Management of Engineering Projects New COurse 5. Composite Materials New Course 6. Waste to Energy New Course 7. Internet of Things New Course 8. MOOCs	3	0	0	40	60	100	3
6.	CHPBLT1	Advanced Chemical Engineering Lab New Course	0	0	4	30	20	50	2
7.	CHPBPT1	Mini Project	0	0	4	30	20	50	2
8.	ELPBTX1 PEPBTX2 CEPBTX3 LAPBTX4	Audit Course/Value Added Course English for Research Paper Writing New Course Stress Management by Yoga New Course Disaster Management New Course Constitution of India New Course	2	0	0	0	0	0	0
Total								600	19

Note: Under MOOCs the students have to opt any subject other than Chemical Engineering from NPTEL/UGC SWAYAM



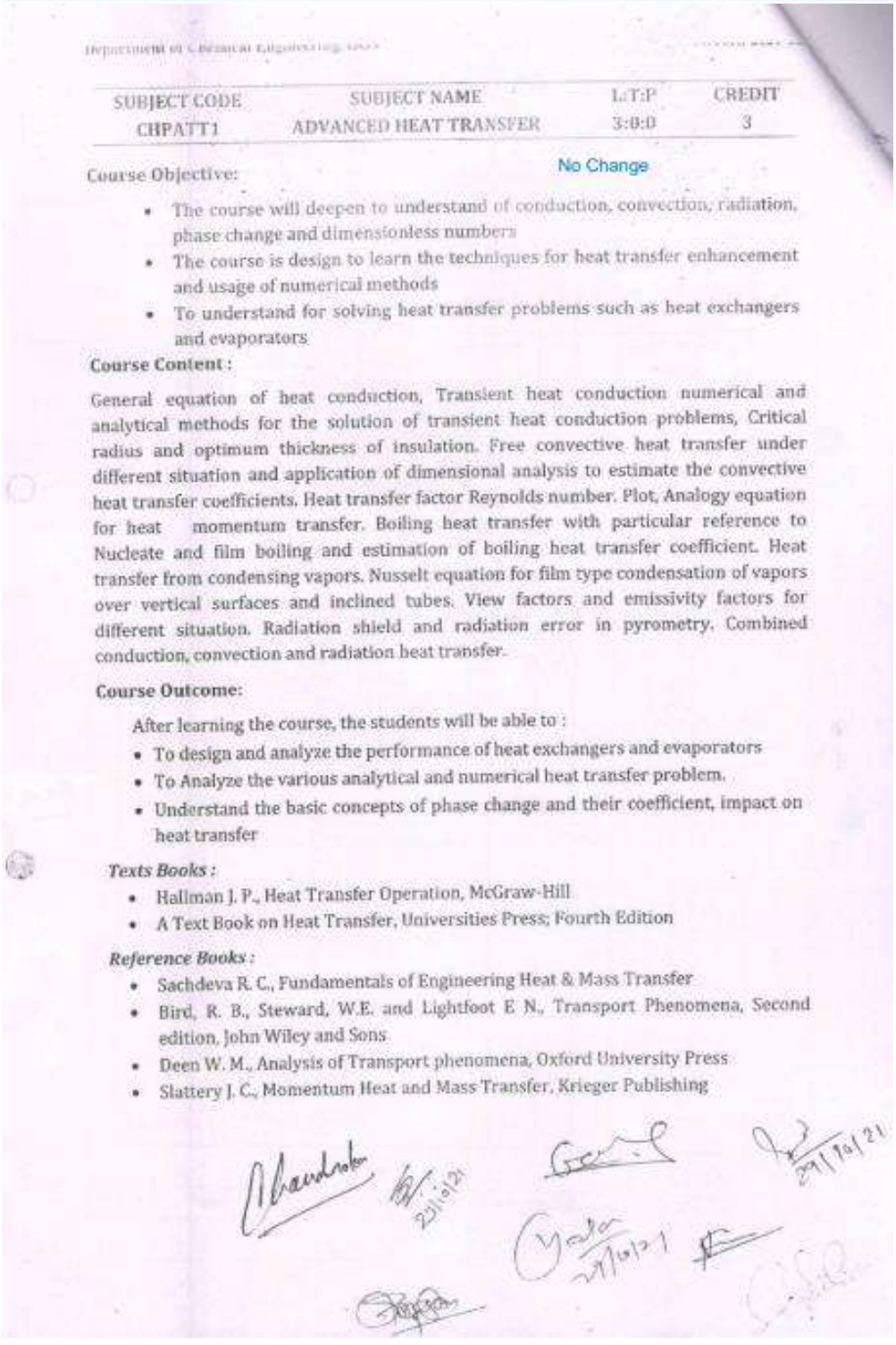
M.Tech. III-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	CHPCPT1	Dissertation Stage–I	0	0	28	100	100	200	14
Total								200	14

M.Tech. IV-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	CHPDPT1	Dissertation Stage–II	0	0	32	100	200	300	16
Total								300	16

Total Credits for the Program = 19 + 19 +14 +16 = 68



Department of Chemical Engineering

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPATT1	ADVANCED HEAT TRANSFER	3:0:0	3

No Change

Course Objective:

- The course will deepen to understand of conduction, convection, radiation, phase change and dimensionless numbers
- The course is design to learn the techniques for heat transfer enhancement and usage of numerical methods
- To understand for solving heat transfer problems such as heat exchangers and evaporators

Course Content :

General equation of heat conduction, Transient heat conduction numerical and analytical methods for the solution of transient heat conduction problems, Critical radius and optimum thickness of insulation. Free convective heat transfer under different situation and application of dimensional analysis to estimate the convective heat transfer coefficients. Heat transfer factor Reynolds number. Plot, Analogy equation for heat momentum transfer. Boiling heat transfer with particular reference to Nucleate and film boiling and estimation of boiling heat transfer coefficient. Heat transfer from condensing vapors. Nusselt equation for film type condensation of vapors over vertical surfaces and inclined tubes. View factors and emissivity factors for different situation. Radiation shield and radiation error in pyrometry. Combined conduction, convection and radiation heat transfer.

Course Outcome:

After learning the course, the students will be able to :

- To design and analyze the performance of heat exchangers and evaporators
- To Analyze the various analytical and numerical heat transfer problem.
- Understand the basic concepts of phase change and their coefficient, impact on heat transfer

Texts Books :

- Hallman J. P., Heat Transfer Operation, McGraw-Hill
- A Text Book on Heat Transfer, Universities Press; Fourth Edition

Reference Books :

- Sachdeva R. C., Fundamentals of Engineering Heat & Mass Transfer
- Bird, R. B., Steward, W.E. and Lightfoot E N., Transport Phenomena, Second edition, John Wiley and Sons
- Deen W. M., Analysis of Transport phenomena, Oxford University Press
- Slattery J. C., Momentum Heat and Mass Transfer, Krieger Publishing

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPATT2	ADVANCED SEPARATION PROCESSES	3:0:0	3

New Course Introduced

Course Objective :

- To familiarize students with various advanced aspects of separation processes and the selection of separation processes
- To enable students to understand the principles and processes of adsorption, membrane separation and chromatography and to design an absorber or a membrane unit to achieve a specified separation
- To introduce them to new trends used in the separation technologies

Course Content:

Conventional Separation Processes: Absorption, Adsorption, Conventional separation processes - Distillation, Drying, Extraction, Diffusion, Leaching, Crystallization. Advances in separation techniques based on size, surface properties, ionic properties. Cross flow filtration, Electro filtration, Dual functional filter, Surface based solid-liquid separations involving a second liquid, Sirofloc filter. Bubble and Foam Fractionation: Nature of bubbles and foams, stability of foams, foam fractionation techniques, batch, continuous, single stage and multistage columns. Types and choice of membranes, Plate and frame, Spiral wound membranes, Tubular and hollow fibre membrane reactors, Membrane Permeates, Dialysis, Reverse osmosis, Nano-filtration, Ultrafiltration, Microfiltration, Dialysis, Ceramic membranes. Membrane Separation: Characteristics of organic and inorganic membranes, basis of membrane selection, osmotic pressure, partition coefficient and permeability, concentration polarization, electrolyte diffusion and facilitated transport, Industrial applications of Micro-filtration, Ultra-Filtration, Reverse Osmosis, Electro-Dialysis. Special Processes: Liquid Membrane Separation, Super-Critical Extraction, Adsorptive Separation-Pressure, Vacuum and Thermal Swing, Pervaporation and Permeation, Nano-Separation. Chromatographic Methods of Separation Gel: Solvent, Ion and High Performance Liquid Chromatography.

Course Outcomes :

At the end of the course, the student will be able to:

- List situations where liquid–liquid extraction might be preferred to distillation, make a preliminary selection of solvent using group-interaction rules, Size simple extraction equipment
- Differentiate between chemisorption and physical adsorption, List steps involved in adsorption of a solute, and which steps may control the rate of adsorption, explain the concept of breakthrough in fixed-bed adsorption
- Explain how crystals grow, Explain the importance of super saturation in crystallization
- Describe effects of mixing on super saturation, mass transfer, growth, and scale-up of crystallization

- Explain membrane processes in terms of the membrane, feed, sweep, retentate, permeate, and solute membrane interactions. Distinguish among microfiltration, ultrafiltration, Nano filtration, virus filtration, sterile filtration, filter-aid

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPATT3	ADVANCED FLUIDIZATION ENGINEERING	3:0:0	3

Course Objective :

- To study the phenomenon of fluidization with industrial processing objective
- To study the various regimes of fluidization and their mapping
- To study the design of equipments based on fluidization technique

70% Change

Course Content:

Introduction to fluidization and applications: Phenomenon of fluidization, behavior of fluidized bed, contacting modes, advantages and disadvantages of fluidization, fluidization quality, selection of contacting mode, Fluidized Beds for Industrial Applications like coal gasification, synthesis reactions, physical operations, cracking of hydrocarbons. Mapping of fluidization regimes: Characterization of particles, mechanics of flow around single particles, minimum fluidization velocity, pressure drop versus velocity diagram, The Geldart classification of solids, fluidization with carryover of particles, terminal velocity of particles, distributor types, gas entry region of bed, pressure drop requirements, various distributor plates, design of distributor plate. Bubbling fluidized beds: Davidson model for gas flow at bubbles in a fluidized bed, the wake region and movement of solids at bubbles, coalescence and splitting of bubbles, bubble formation above a distributor, slug flow, Turbulent and fast fluidization - mechanics, flow regimes and design equations, Emulsion movement, estimation of bed properties, bubble rise velocity, scale up aspects, flow models, two phase model, K-L model. Solids movement and Gas dispersion: Vertical and horizontal movement of solids, Dispersion model, large solids in beds of smaller particles, staging of fluidized beds Gas dispersion in beds, gas interchange between bubble and emulsion, estimation of gas interchange coefficient, Heat and mass transfer in fluidized systems, Mixing in fluidized systems - measurements and models. Entrainment or Elutriation of Fluidized Beds , Reactors : Entrainment and elutriation, Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization, Slugging, Spouted beds, Circulating Fluidized Beds. Mathematical model of a homogeneous fluidized bed, Design of catalytic reactors, pilot plant reactors, information for design, bench scale reactors, design decisions, deactivating catalysts, Design of no catalytic reactors, kinetic models for conversion of solids, models for shrinking particles, conversion of solids of unchanging size

Course Outcomes :

At the end of the course, the student will be able to:

- Performing and understanding the behavior fluidization in fluidized bed
- Evaluate the characterization of particles and power consumption in fluidization regimes
- Understanding the applicability of the fluidized beds in chemical industries

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPATP2	ADVANCED WASTEWATER TREATMENT TECHNOLOGY	3:0:0	3

No Change

Course Objective :

- It encompasses water and wastewater analytical and instrumental methods of analysis
- Design considerations of various unit operations and processes of water treatment facilities
- Learn aeration, sedimentation, coagulation and flocculation processes. Able to explain settling equations
- It also deals with biological sludge handling and treatment

Course Contents :

Introduction, Health and environment concern in wastewater management. Water quality: Definitions, characteristics and perspectives. The hydraulic cycle, Water quality, Physical, chemical and biological water quality parameters. Measurement of organic concentration, BOD, COD and TOC Test, reaction between BOD, COD, & TOC, Most probable number (MPN), Measurement of biological characteristics, Toxicity Test. Reactor used for transient of wastewater mass balance analysis, Modelling of ideal flow in reactor, Modelling of treatment process, Kinetic of processes, Process selection. Physical unit operations: Screening, mixing, Gravity separation, Primary sedimentation, Coagulation, Secondary treatment of waste water, adsorption. Biological waste water treatment, Micro-organism growth kinetics, modelling of suspended froth treatment process, Aerobic biological oxidation, Anaerobic process, heavy metal pollution remedies

Course Outcomes:

At the end of the course, the student will be able to:

- Explain the need for wastewater treatment, categorize the wastewater based on characteristics, and illustrate reactor types in wastewater treatment
- Understand and apply the design principles and criteria in designing units such as screen, grit chamber, primary settling tank. Establish bio-kinetic constants in the engineering design of wastewater treatment processes
- Describe the design criteria and design the suspended and attached growth biological wastewater treatment systems like activated sludge process, trickling filter
- Plan and perform aerobic and anaerobic treatment processes on both domestic wastewater and industrial effluent

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPBTP1	COMPUTATIONAL FLUID DYNAMICS	3:0:0	3

New Course Introduced

Course Objective :

- To provide an introduction to the scientific principles and practical engineering applications of computational fluid dynamics
- To give exposure to the commercial software ANSYS Fluent

Course Content :

Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations, Review of Navier-Stokes Equation and simplified forms, grid generation, structured and unstructured grids, choice of suitable grid, grid transformation of equations, some modern developments in grid generation for solving engineering problems, CFD essentials, Finite difference method (FDM), finite volume method (FVM) and finite element method (FEM): Discretization of ODE and PDE, , Explicit and Implicit scheme to solve heat and fluid flow problems, Application of 1st order and 2nd order Upwind Scheme, Application of SIMPLE, SIMPLER algorithm to solve fluid flow problems, Simulation of CFD problems using Fluent.

Course Outcome :

After learning the course, the students will be able to:

1. To discretize the momentum, mass and energy transport equations by finite volume technique.
2. To understand the subject of Computational Fluid Dynamics and know how to use it as tool to solve the Heat Transfer and Fluid Mechanics related Industrial Problems.
3. To solve some problems with the help of the ANSYS Fluent software.

Texts Books :

- Anderson J.D., Computational fluid dynamics, McGraw Hill
- Date A. W., Introduction to Computational Fluid Dynamics, Cambridge University Press

Reference Books :

- Versteeg H. K. and Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman Scientific & Technical
- Muralidhar K., and Sundararajan T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House
- Patankar Suhas, Numerical Methods in Fluid Flow & Heat Transfer, CRC Press

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPBTP2	FUEL CELL TECHNOLOGY	3:0:0	3

Course Objective: New Course Introduced

- Demonstrate a thorough understanding of the fuel cell power plant's and its components' performance characteristics
- Describe the performance and design characteristics of various fuel cells, as well as operational issues
- Discuss the design philosophy and challenges that must be overcome in order for this power plant to be economically viable
- Thermodynamics and electrochemistry will be the focus of the design and analysis

Course Content :

Low and high temperature fuel cells are discussed in this overview of hydrogen energy and fuel cells. Polymer electrolyte fuel cells, Alkaline fuel cells, Phosphoric fuel cells, Molten carbonate fuel cells, Solid oxide fuel cells, Microbial fuel cells, Fuel cell systems, and Sample calculations are all examples of fuel cell performance. Thermodynamics of fuel cells: heat, work potentials, reversible voltage prediction, and fuel cell efficiency. Electrocatalysts-design, activation kinetics, overvoltages, Tafel equation, charge transfer reaction, exchange currents, fuel cell reaction kinetics-electrode kinetics, overvoltages, Tafel equation, charge transfer reaction, exchange currents, electrocatalysts-design, activation kinetics Charge and mass transport in a fuel cell-flow field, transport in the electrode, and transport in the electrolyte Characterization of fuel cells:-characterization techniques in-situ and ex-situ, I-V curve, frequency response analyses Materials Science and Engineering, Process Safety and Process Design

Course Outcomes :

At the end of the course, the student will be able to:

1. Apply know-how of thermodynamics, electrochemistry, heat transfer, and fluid mechanics principles to design and analysis of this emerging technology
2. Have thorough understanding of performance behaviour, operational issues and challenges for all major types of fuel cells
3. Identify, formulate, and solve problems related to fuel cell technology keeping in mind economic viability
4. Use the techniques, skills, and modern engineering tools necessary for design and analysis of innovative fuel cell systems
5. Understand the impact of this technology in a global and societal context

Texts Books :

- Larminie J. and Dicks A., Fuel Cell Systems Explained, , John Wiley & Sons Inc.
- Barbir Frano, PEM Fuel Cells Theory and Practice, Elsevier Academic Press
- Hoogers G., Fuel Cell Technology Handbook, SAE International

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPHTP5	INDUSTRIAL POLLUTION CONTROL	3:0:0	3

Course Objective :

- To understand the importance of industrial pollution and its abatement
- To study the underlying principles of industrial pollution control
- To acquaint the students with case studies
- Student should be able to design complete treatment system

70% Change

Course Content :

Air pollution Sources and Effects, Air pollution laws and standards; Air pollution sampling and measurement from point, non-point, line and area sources, analysis of air pollutants; Air pollution control methods and equipment, Design details of Particulate emission control equipments like Gravitational settling Chamber, Cyclone Separator, Fabric Filter, Electrostatic Precipitator, Wet scrubber; Case studies of a few industrial pollution control system. Sources, effects and laws of water pollution; BOD, COD; Waste water treatment, Design details of Primary Treatment methods like Pretreatment, Sedimentation, Floatation, Design aspects of Secondary Treatment methods like Activated Sludge Process, Trickling Filter. Design aspects of Advanced waste water treatment including Ion Exchanger, Reverse Osmosis, Electrodialysis, Advanced Biological Systems. Solid Waste Management, design calculation of disposal methods, Incineration, Hazardous Waste Management strategy and treatment methods, landfill closure and underground disposal.

Course Outcome :

After learning the course, the students will be able to:

1. Recognize the causes and effects of environmental pollution
2. Analyze the mechanism of proliferation of pollution
3. Develop methods for pollution abatement and waste minimization
4. Design treatment methods for gas, liquid and solid wastes

Texts Books :

- Schnelle K.B. and Brown C.A., Air Pollution Control Technology Handbook, CRC Press
- Peavy H.S., Rowe D.R. and Tchobanoglous G., Environment Engineering, McGraw-Hill

Reference Books :

- Trivedy R.K. and Goel P.K., An Introduction to Air Pollution, Technoscience Pub.
- Sengar D.S., Environmental Law, PHI
- B. Chawla, Jain A.K., Jain A.K., Waste Water Engineering

29/10/21 29/10/21 29/10/21

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPBTP4	DESIGN & DEVELOPMENT OF CATALYST	3:0:0	3

Course Objective:

- To give the students insight into advances in catalytic reaction engineering
- To understand the mechanisms involved in catalytic reactions
- To study the catalyst characterization techniques
- To study the advanced industrial applications in catalysis
- To understand the principles behind catalyst deactivation and study their models

No Change

Course Contents :

Structure of solid surfaces; Chemisorption and Physisorption; Thermodynamics and kinetics of surface processes; Principles of heterogeneous catalysis; Preparation, characterization and classification; Structure and activity; Lattice imperfection; Geometric and electronic factors Preparation and characterization of catalysts. Kinetics of heterogeneous reactions. Physical, Chemical and mathematical description of catalyst deactivation; Deactivation by fouling, poisoning and sintering. Deactivation and regeneration of catalyst pellets. Deactivation and regeneration of fixed beds. Dynamics of polyfunctional catalysts. Electro catalysis and photo catalysis. Mechanism and kinetics of some typical heterogeneous catalytic reactions. Applications in fertilizer, petroleum, petrochemical industries and pollution control.

Course Outcomes :

At the end of the course, the student will be able to:

1. To understand the concepts of homogenous and heterogeneous catalysis, with specific examples.
2. To study reaction mechanisms and kinetics of homogenous and heterogeneous catalytic reactions.
3. To familiarize with the characterization of catalysts
4. To understand the application and mechanisms of several types of catalysts in chemical industry

Texts Books :

- Poncelet G., Martens J. and Delmon B.; Preparation of Catalyst VI : Scientific bases for the preparation of Haterogeneous Catalysts; Elseveir
- Regalbuto J., Catalyst Preparation : Science and Engineering; CRC Press

Reference Books :

- Emmett P.H., Catalysis Vol. I and II, Reinhold Corp., New York
- Smith J.M., Chemical Engineering Kinetics, McGraw Hill
- Thomas and Thomas, Introduction to Heterogeneous Catalysts, Academic Press, London

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPBTTZ	CHEMICAL REACTOR DESIGN	3:0:0	3

Course Objective: No Change

- This course introduces students to the application of kinetics and reaction engineering in chemical engineering processes.
- Understand the concepts such as standard states, chemical reaction rates, reaction mechanism mass balances and design equations for ideal reactors as well as non-ideal reactors

Course Content :

Review of Design of ideal isothermal homogeneous reactor for single and multiple reactions, RTD of Ideal reactor, interpretation of RTD data, Flow models for non-ideal reactors, dispersion model, N tanks in series, multi parameter model, diagnosing the ills of reactor , influence of RTD and micro mixing on conversion. Adiabatic and non adiabatic operations in batch and flow reactors, optimal temperature in progression. Hot spot in tubular reactor auto thermal operation and steady state multiple steady state introduction to bifurcation theory Catalytic reactors, effectiveness factor, selectivity, catalyst deactivation, Design of heterogeneous catalytic reactors.

Course Outcomes :

At the end of the course, the student will be able to:

1. Understand the Adiabatic and non-adiabatic operations in batch and flow reactors,
2. Understand the reactor design involving Catalytic reactors, effectiveness factor, selectivity, catalyst deactivation,
3. Understand the design of heterogeneous catalytic reactors.

Texts Books :

- Carberry James J, Chemical and Catalytic Reaction Engineering, McGraw Hill
- Smith J.M., Chemical Engineering Kinetics, Mcgraw Hill

Reference Books

- Levenspiel O., Chemical Reaction Engineering, Wiley Eastern
- Frinebt G. F. and Bischoff K. B; Chemical Reactor Analyzer and design, John Wiley & Sons
- Foggler H. S., Elements of Chemical Reaction Engineering