II/IV B. Tech. 1st Semester

Code No.	Subject	Category	Instruction Periods per week				Maximum Marks			Credits
			Lecture	Tutorial	Lab	Total	Sessional	External	Total	
CHE 211	Engineering Mathematics – III	BS	3	1	-	4	40	60	100	3
CHE 212	Organic Chemistry	BS	3	1	-	4	40	60	100	3
CHE 213	Mechanical Engineering and Strength of Materials	ES	3	1	-	4	40	60	100	3
CHE 214	Basic Electrical and Electronics Engineering	ES	3	1	-	4	40	60	100	3
CHE 215	Chemical Process Calculations	PC	4	1	-	5	40	60	100	4
CHE 216	Organic Chemistry Laboratory	BS	-	-	3	3	50	50	100	2
CHE 217	Mechanical Engineering Laboratory	ES	-	-	3	3	50	50	100	2
	Total		**16**	**5**	**6**	**27**	**300**	**400**	**700**	**20**

II/IV B. Tech. 2nd Semester

Code No.	Subject	Category	Instruction Periods per week				Maximum Marks			Credits
			Lecture	Tutorial	Lab	Total	Sessional	External	Total	
CHE 221	Engineering Mathematics – IV	BS	3	1	-	4	40	60	100	3
CHE 222	Momentum Transfer	PC	4	1	-	5	40	60	100	4
CHE 223	Mechanical Operations	PC	4	1	-	5	40	60	100	4
CHE 224	Process Instrumentation	PC	4	1	-	5	40	60	100	4
CHE 225	Chemical Engineering Thermodynamics -I	PC	4	1	-	5	40	60	100	4
CHE 226	Momentum Transfer Laboratory	PC	-	-	3	3	50	50	100	2
CHE 227	Mechanical Operations Laboratory	PC	-	-	3	3	50	50	100	2
	Total		**19**	**5**	**6**	**30**	**300**	**400**	**700**	**23**

ENGINEERING MATHEMATICS-III

(Common for Chemical, Mechanical, EEE and ECE)

CHE 211 **Credits: 3**

Instruction: 3 periods & 1 tutorial / week Sessional Marks: 40

End Exam: 3 Hours End Exam Marks: 60

Course Objective:

The knowledge of Mathematics is necessary for a better understanding of almost all the Engineering and Science subjects. Here our intention is to make the students acquainted with the concept of basic topics from Mathematics, which they need to pursue their Engineering degree in different disciplines.

Course outcomes:

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

1. Understand the concepts of Gradient, Divergence and Curl and finding scalar potential function of irrotational vector fields.
2. Understand the concepts of Green's, Stoke's, Divergence theorems and evaluate their related integrals like line, surface, flux.
3. Understand some basic techniques for solving partial differential equations.
4. Apply the knowledge of partial differential equations to various engineering problems.
5. Understand the characteristics, properties of Fourier transforms and gain knowledge in the application of Fourier Transforms.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	1	2	2								1	1	1
	2	3	1	2	2								1	1	1
	3	3	1	1	1								1	2	2
	4	3	1	2	2								1	2	2
	5	3	1	1	1								1	1	1

UNIT I: VECTOR DIFFERENTIATION **9L + 3T**

Differentiation of Vectors – Scalar and Vector point function – Del applied to Scalar point functions - Gradient geometrical interpretations – Directional Derivative - Del applied to vector point function – divergence - Curl – Physical interpretation of Divergence and Curl - Del applied twice to point functions- Del applied to product of point functions.

UNIT II: VECTOR INTEGRATION **9L + 3T**

Integration of vectors – Line integral – Surface – Green's theorem in the plane – Stokes theorem – Volume integral – Gauss Divergence theorems (all theorems without proofs) – Irrotational fields .

UNIT III: PARTIAL DIFFERENTIAL EQUATIONS **9L + 3T**

Introduction – Formation of Partial Differential Equations – Solution of Partial Differential Equations by Direct Integration – Linear Equations of the First order – Higher order Linear Equations with Constant Co-efficients – Rules for finding the complementary function - Rules for finding the Particular integral – Non- Homogeneous linear equations with constant coefficients.

UNIT IV: APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **9L + 3T**

Introduction – Method of separation of variables – Vibrations of a stretched string- Wave equation – One dimensional Heat flow - Two dimensional Heat flow – Solution of Laplace's equation.- Laplace's equation in Polar Co-ordinates.

UNITV: FOURIER TRANSFORMS **9L + 3T**

Introduction – definition – Fourier integral theorem - Fourier sine and cosine integrals – Complex form of Fourier integrals – Fourier integral representation of a function – Fourier Transforms – Properties of Fourier Transforms – Convolution Theorem – Parseval's identity for Fourier transforms – Fourier Transforms of the Derivatives of functions – Application of Transforms to Boundary value problems – Heat conduction – Vibrations of a string.

Text Books:

1. Dr. B.S. Grewal, "Higher Engineering Mathematics", 43rd ed., Khanna Publishers,New Dehli.

Reference books:

1. N.P. Bali etal, "A Text book on Engineering Mathematics", 8th ed., Laxmi pub.(p)Ltd., 2011.
2. H.K.Dass , "Advanced. Engineering Mathematics", 1st ed., S. Chand, 2008.
3. Erwin kreyszig , "Advanced Engineering Mathematics", 10th ed., wiley publishers.
4. Dr.M.K. Venkataraman, "Higher Engineering Mathematics", National Pub.Co.,Madras.

ORGANIC CHEMISTRY

CHE212 **Credits: 3**

Instruction: 3 periods & 1 tutorial / week Sessional Marks: 40

End Exam: 3 Hours End Exam Marks: 60

Course Objectives:

1. To impart knowledge on the basic concepts of organic chemistry.
2. To know the importance of stereo chemical approach of organic reactions.
3. To create basic idea on the mechanism of organic reactions involving reaction intermediates.
4. To understand the industrial preparation methods of certain organic compounds and their synthetic applications.
5. To create awareness on various applications of chemical reagents and biological activity of few organic compounds.

Course Outcomes:

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

1. Understand the basics of reaction intermediates and polar effects.
2. Design organic molecules in stereo chemical models.
3. Arrive at an idea on mechanism of addition and condensation reactions.
4. Meet the need to understand the industrial preparation of organic compounds at various conditions.
5. Develop further organic applications using synthetic reagents and understand the biological activity of few organic compounds.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	1										1	1	1
	2	3		2									1	1	1
	3	3	1	1	1								1	1	1
	4	3	1	1									1	1	1
	5	3	1	1									1	1	1

UNIT I **9L +3T**

FUNDAMENTALS OF ORGANIC CHEMISTRY:

Introduction to organic functional groups- IUPAC nomenclature and Isomerism.Organic reactions – Types-addition, elimination, substitution, rearrangement, polymerization-examples.Types of reagents- electrophile, nucleophile. Reaction intermediates &hybridisation-carbocation, carbanion, free-radical, examples. Polar effects – Inductive effect, mesomeric effect, electromeric effect and Hyper conjugation with examples; Acidic nature of carboxylic acid and phenol; basic nature of Amines.

UNIT II **9L +3T**

STEREOCHEMISTRY OF ORGANIC COMPOUNDS:

Stereosisomerism- definition-types. Representation of compounds – saw horse projection, newmann projection, fisher-projection, wedge formula- examples.Conformational isomerism- examples of ethane, n-butane, cyclohexane & potential energy diagrams.Axial & equatorial bonds in cyclohexane- Examples of 1,2& 1,3 interactions in substituted cyclohexanes.Geometrical isomerism- Cis-trans & E-Z isomerism-sequence rules and examples.R & S configuration- sequence rules-examples.Optical activity- chirality.Enantiomers, diastereomers, mesomers, racemic mixture.Racemisation, Resolution of racemic mixture.

UNIT III **9L +3T**

CHEMISTRY OF ALCOHOLS, PHENOLS & CARBONYL COMPOUNDS:

Industrial Preparations of Ethyl alcohol(molasses), Differences between alcohols- oxidation, Lucas Test, catalytic dehydrogenation, victor-meyer test. Chemical reactions of phenols- Fries rearrangement, Kolbes reaction ,Reimar-tiemann reaction.Reactivity of carbonyl compounds. Chemical reactions-Cannizaro, Aldol, Reformatsky and Wittig reactions, Perkin, Cope, Knoevenagel and Pinacol-Pinacolone reactions, Differences between Aldehyde and Ketone.

UNIT IV **9L +3T**

CHEMISTRY OF CARBOXYLIC ACIDS& DERIVATIVES & AMINES:

Industrial Preparations of Acidic acid, chemical reactions- Hell-Volhard-Zelinsky reaction, Wolf rearrangement.Functional derivatives of carboxylic acids- esters (acid &base catalyzed hydrolysis of Ester, Claisen condensation), amides, (Hoffmann Bromamide reaction) and acid halides (Rosenmunds reduction).Aniline preparation, differences between amines and chemical reactions - Hoffmann elimination, Hinsberg test, mustard oil test, carbyl amine reaction.Benzene Diazonium salts and Synthetic applications-coupling reactions, Schiemann reaction, Gatterman reaction, Sandmayer reaction.

UNIT V **9L +3T**

HETEROCYCLIC COMPOUNDS & SYNTHETIC APPLICATIONS OF SOME ORGANIC REAGENTS:

Aromaticity, Preparation, Properties and uses of –Five membered heterocyclic compounds- Pyrrole, Furan, Thiophene, Indole.Six membered heterocyclic compounds- Pyridine, Quinoline.Elementary idea on mode of action of sulpha drugs (Sulphanilamide, Sulphapyridene).Chemical nature and Synthetic applications of $LiAlH_4$and OsO_4.

Text Books:

1. ArunBahl and B.S.Bahl, "Text Book of Organic Chemistry", 21st ed., S.Chand, 2012.
2. Morrison & Boyd, "Text Book of Organic Chemistry", 7th ed. Pearson, 2008.

Reference Books:

1. Jerry March, "Organic chemistry", 6th ed., Wiley ind. (P).Ltd., 2012
2. I.L.Finar, "Text Book of Organic Chemistry" 7th ed., Vol.1&2, Pearson, 2011.

MECHANICAL ENGINEERINGANDSTRENGTH OF MATERIALS

CHE 213 **Credits: 3**

Instruction: 3 periods & 1 tutorial / week Sessional Marks: 40

End Exam: 3 Hours End Exam Marks: 60

Course Objectives:

1. To provide knowledge on thermodynamic laws and their applications.
2. To impartknowledge on boilers and use of steam tables.
3. To provide knowledge on various types of IC engines.
4. To impart knowledge on stress and strain concepts.
5. To provide knowledge on stress relations in various types of shells.

Course Outcomes:

By the end of the course, student will be able to

1. Understand the application of thermodynamic laws.
2. Identify the use of boilers in industries.
3. Classify IC engines and their applications.
4. Evaluate stress-strain analysis
5. Understand the design of thin and thick cylinders.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	1	1	1								1	1	1
	2	3	1												
	3	3	1												
	4	3	1	1									1	1	1
	5	3	1	1									1	1	1

Part A: Mechanical Engineering

UNIT I: Thermodynamics **9L +3T**

Definitions, systems, classification of thermodynamic systems, cycle, and zeroth law of thermodynamics, first law of thermodynamics, Second law of thermodynamics, Carnot cycle, inequality of Classius-reversible Carnot cycle, entropy, general expression for entropy change, entropy change of a perfect gas during various thermodynamic processes, air standard cycles, Otto, diesel, dual combustion cycles.

UNIT II: Boilers **9L +3T**

Properties of steam and use of steam tables,Boilers, classification steam boilers, simple vertical, Cocheran locomotive boiler, Babcock and Wilcox boiler, steam generation, Rankine cycle.

UNITIII: IC engines **9L +3T**

Classification-main composition of IC engines, carburetter, fuel pump injector, cooling systems for IC engines, working of 2-stroke and v4- stroke petrol and diesel engines, power and efficiency of IC engines.

Part B: Strength of Materials

UNIT IV: Simple stress and strains **9L +3T**

Hook's law, stress strain curve for mild steel, stress in compound assemblies, thermal stresses, Poisson ratio, relation between elastic modulus, Principal stresses and principal planes, maximum shear stress and its plane.

UNITV: Thin and Thick Cylinders **9L +3T**

Stress in thin cylindrical shells and spherical shells, stress in thick cylinders, compound cylinders, pressure due to shrink-fitting.

Text books:

1. P.K.Nag, "Engineering Thermodynamics",5th ed., McGraw Hill education, 2013.
2. V. Ganeshan, "Internal Combution Engines", 4th ed., McGraw Hill education,2012.
3. Ramamrutaham, "Strength of Materials", 18th ed., Dhanpati Publishing Company (P) Ltd., 2014.

Reference books:

1. J.B.Jones and R.E.Dugar, "Engineering Thermodynamics", 1st ed., PHI Learning, 2009.
2. R.K.Rajput, "A Text Book of Engineering Thermodynamics", 4th ed. Laxmi Publications, 2007.
3. E. Popov, "Mechanics of solids" Prentice Hall, 1998.

BASIC ELECTRICAL & ELECTRONICS ENGINEERING

CHE214 **Credits: 3**

Instruction: 3 periods & 1 tutorial / week Sessional Marks: 40

End Exam: 3 Hours End Exam Marks: 60

Course Objective:

To make the students to understand the basic concept of electrical and magnetic circuits, principle and construction, operation of both AC&DC machines and apply them to some practical applications. To make the students to understandthe basic concept of Electronics devices like Diode, Zener Diode and Transistor.

Course Outcomes:

1. Able to understand the basic concepts of electrical and magnetic circuits and electromagnetic induction.
2. Able to understand the Construction details & Principle of operations of D.C Machines, methods of Excitation, Starting methods of D.C Motor and applications.
3. Able to understand the AC circuit analysis and asses efficiency and regulation of transformer with and without loading.
4. Able to analyzed the performance of Three phase induction motor, and Regulation methods of Alternator, construction of synchronous motors
5. Able to understand the basic concepts of electronic components like diode, zener diode and transistor.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	1											1	1
	2	3	1											1	1
	3	3	1	1										1	1
	4	3	1	1										1	1
	5	3	1											1	1

UNIT I **9L +3T**

Magnetic circuits & Electromagnetic induction: Definitions of magnetic circuit, reluctance, magneto motive force (mmf), magnetic flux, simple problems on magnetic circuits, hysteresis loss, Faraday's laws of electromagnetic induction, induced E.M.F, dynamically induced E.M.F, statistically induced E.M.F, self inductance, mutual inductance.

UNIT II **9L +3T**

D.C. Machines: D.C generator principle, construction of D.C generator, E.M.F equation of D.C generator, types of D.C generators, armature reaction, losses in D.C generator, efficiency, characteristics of D.C generators, applications of D.C generators. D.C motor principle, working of D.C motors, significance of back E.M.F, torque equation of D.C motors, types of D.C motors, characteristics of D.C motors, applications of D.C motors, Swinburne's test, losses and efficiency.

UNIT III **9L +3T**

A.C. circuits & Transformers: Introduction to steady state analysis of A.C circuits, single and balanced 3 phase circuits, Transformer principle, EMF equation of transformer, transformer on load, equivalent circuit of transformer, voltage regulation of transformer, losses in a transformer, calculation of efficiency and regulation by open circuit and short circuit tests.

UNIT IV **9L +3T**

AC Machines: Induction motor working principle, construction of 3-phase induction motor, principle of operation, types of 3-phase induction motor, power stages of induction motor, efficiency calculation of induction motor by direct loading, Alternator working principle, EMF equation of alternator, voltage regulation by Synchronous impedance method. Synchronous motor principle of operation, construction, methods of starting of synchronous motor.

UNIT V **9L +3T**

Principles of Electronics: Semiconductors materials, p-n junction, properties of p-n junction, Semiconductor Diode, Zenor Diode, Transistor construction, operation and their configurations.

Text books:

1. V.K. Mehta, "Elements of Electrical Engineering & Electronics", S.Chand& Co., 2010.
2. Robert L. Boyiestad, Louis Nashelsky,"Electronic Devices and Circuit Theory"11th ed., Pearson, 2015.

Reference books:

1. 'A first course in Electrical Engineering' by Kothari.
2. V.K. Mehta, "Principles of Electronics",11th ed.,S.Chand& Co., 2008

CHEMICAL PROCESS CALCULATIONS

CHE 215 **Credits: 4**

Instruction: 4 periods & 1 tutorial / week Sessional Marks: 40

End Exam: 3 Hours End Exam Marks: 60

Course Objectives:

1. To master fundamentals of stoichiometry and gas laws.
2. To familiarize and to apply material and energy balance for various chemical operations and processes
3. Utilize the knowledge of subject for better understanding of core subjects

Course Outcomes:

By the end of the course, student will be able to

1. Understand and solve basic stoichiometry calculations.
2. Evaluate composition of gases at various temperatures and pressures.
3. Apply material balance on various unit operation and processes.
4. Apply energy balance on various unit operation and processes.
5. Implement the concepts of humidity to humidification and dehumidification processes.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	1		1	1							1	2	2
	2	3	1		1			1					1	2	2
	3	3	2	2	1			1					1	2	3
	4	3	2	2	1			1					1	2	3
	5	3	1	1	1								1	2	3

UNIT I **12L +3T**

Stoichiometry and composition relationships:

The gram-mole and pound-mole, limiting reactant, excess reactant, degree of completion, basis of calculation, weight percent, volume percent and mole percent, density and specific gravity-Baume and API gravity scales.

UNIT II **12L +3T**

Behavior of ideal gases:

Application of the ideal-gas law, Dalton and Amagat laws to gaseous mixtures, composition of gases on dry basis and on wet basis.

UNIT III **12L +3T**

Material Balances: Tie substance, yield, conversion, and processes involving chemical reactions, material balance- calculations involving drying, dissolution, and crystallization, processes involving recycle, bypass and purge.

UNIT IV **12L +3T**

Energy Balances:

Effect of temperature on vapor pressure, Antoine equation, vapor pressure plots, vapor pressure of immiscible liquids, ideal solutions and Raoult's law, non-volatile solutes.

Heat capacities of gases and gaseous mixtures- effect of temperature on heat capacity of gas, Kopp's rule, latent heatsof fusion and vaporization, Trouton's rule, Kistyakowsky equation for non-polar liquids.

Standard heat of reaction - Laws of thermochemistry,Standard heat of formation, standard heat of combustion, standard heat of reaction and their calculations,effect of temperature on heat of reaction, adiabatic and non-adiabatic reactions, theoretical and actual flame temperatures.

UNIT V **12L +3T**

Humidity:

Percentage saturation, relative saturation or relative humidity, dew point, vaporization, condensation, wet and dry bulb temperatures, adiabatic vaporization and adiabatic saturation temperature.

Text books:

1. David M. Himmelblau,"Basic principles and Calculations in Chemical Engineering", 6th ed., Prentice Hall of India Pvt Ltd, 1995.

Reference books:

1. Olaf A Hougen, K.M. Watson and R.A.Ragatz, "Chemical Process Principles, Part-I - Material and Energy balances"2nd ed., CBS Publishers and Distributors,1995.
2. K.V. Narayanan and B. Lakshmikutty, "Stoichiometry and Process Calculations", 5th ed., Prentice Hall of India Pvt Ltd , 2006.
3. B.I. Bhatt and S.M. Vora, "Stoichiometry", 3rded., Tata McGraw Hill Publishing Company Limited, New Delhi, 1996.

ORGANIC CHEMISTRY LABORATORY

CHE216 **Credits: 2**

Practical/week:3 Sessional Marks: 50

End Exam: 3 Hours End Exam Marks:50

Course Objectives:

1. To improve skills in synthesizing organic compounds using various chemical techniques.
2. To enable the students to analyze the functional group in the organic compound through qualitative analysis.

Course Outcomes:

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

1. Synthesize and analyze the properties and nature of the organic compound.
2. Use different types of solvents and reagents in analyzing the functional group of the organic compound.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	2	2	2					1	3		1	1	1
	2	3	2	2	2					1	3		1	1	1

LIST OF EXPERIMENTS:

CYCLE-1

One step synthesis or Microwave assisted synthesis of organic compounds and determination of melting point:

1. Phthalimide
2. Nerolin
3. Benzanilide
4. Aspirin
5. m-dinitrobenzene
6. Methyl Orange

CYCLE-2

Qualitative analysis for the identification of functional group in the organic compound:

1. Demonstration of Qualitative analysis
2. Analysis of Compound -1
3. Analysis of Compound -2
4. Analysis of Compound -3
5. Analysis of Compound -4
6. Analysis of Compound -5
7. Analysis of Compound -6

Text book:

1. Organic Chemistry Lab Manual prepared by Department of Chemistry.

Reference book:

1. Vogel's textbook of Practical Organic Chemistry, 5th edition, Pearson education.

MECHANICAL ENGINEERING LABORATORY

CHE217 **Credits: 2**

Practical/week:3 Sessional Marks: 50

End Exam: 3 Hours End Exam Marks:50

Course Objectives:

1. To improve skills in measuring the physical properties of a given sample.
2. To enable the students to familiarize with the load test and valve timing diagram.

Course Outcomes:

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

1. Measure the physical properties of a given sample.
2. Perform the load test and draw the performance curves.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	1	1	1					1	3		1	1	1
	2	3	1	1	1					1	3		1	1	1

List of experiments:

1. Find the viscosity of the given sample of oil using Redwood viscometer-1
2. Find the viscosity of the given sample of oil using Redwood viscometer-II
3. Find the flash point of the given sample of oil using Abel's flash point tester
4. To calibrate pressure gauge using standard pressure and standard weights
5. Draw the valve timing diagram of a 4-stroke diesel engine and port timing diagram of a 2-stroke petrol engine
6. Perform load test at full load, half load, ¼ th load on a 4-stroke Ruston engine and draw the performance curves
7. Find the volumetric efficiency, isothermal efficiency of the given compressor
8. To determine the moment of inertia of a fly-wheel and shaft experimentally and compare the values with the calculated values
9. To determine experimentally the calorific value of a gaseous fuel by using Junkers gas calorimeter
10. To determine the modulus of rigidity of the material of the wire by torsional oscillators

Text Book:

1. V. Ganeshan, "Internal Combution Engines", 4th ed., McGraw Hill education, 2012.

Reference Book:

1. R.K.Rajput, "A Text Book of Engineering Thermodynamics", 4th edition. Laxmi Publications, 2007.

ENGINEERING MATHEMATICS-IV

(Common for Chemical and Mechanical)

CHE 221 **Credits: 3**

Instruction: 3 periods & 1 tutorial / week Sessional Marks: 40

End Exam: 3 Hours End Exam Marks: 60

Course Objective:

The knowledge of Mathematics is necessary for a better understanding of almost all the Engineering and Science subjects. Here our intention is to make the students acquainted with the concept of basic topics from Mathematics, which they need to pursue their Engineering degree in different disciplines.

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

1. Understand, interpret and use the basic concepts: analytic function, harmonic function, Taylor and Laurent series, singularity.
2. Familiarize the concepts of Finite Differencesinterpolation techniques.
3. Familiarize the concept and solving of differentiation and integration by numerical methods.
4. Examine, analyze, and compare Probability distributions.
5. Analyze the Statistical data by using statistical tests and to draw valid inferences about the population parameters.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	1	1	1								1	1	1
	2	3	1	2	2								1	2	2
	3	3	1	2	2								1	2	2
	4	3	1	2	2							1	1	2	2
	5	3	1	2	2							1	1	2	2

UNITI: FUNCTIONS OF A COMPLEX VARIABLE **9L + 3T**

Introduction –Limit of a Complex function- Derivative of $f(z)$ – Analytic functions- Harmonic functions - Applications to Flow problems. Complex Integration- Cauchy's Theorem- Cauchy's Integral Formula –Series of Complex terms(Statements of Taylor's and Laurent's Series without proof) - Zeros of an Analytic function .

UNIT II: FINITE DIFFERENCES & INTERPOLATION 9L + 3T

Finite Differences – Forward differences – Backward differences – Central differences – Differences of a Polynomial – Factorial Notation – Other difference operators – To find one or more missing terms – Newton's Interpolation Formulae – Central Difference Interpolation Formulae - Interpolation with Unequal Intervals – Lagrange's interpolation formula – Inverse Interpolation.

UNITIII: NUMERICAL DIFFERENTIATION AND INTEGRATION 9L + 3T

Numerical Differentiation – Formulae for derivatives – Maxima and Minima of a Tabulated Function – Numerical Integration – Newton-Cotes Quadrature Formula – Trapezoidal rule – Simpson's One-Third rule, Simpson's Three-Eighth rule.

UNIT IV: PROBABILITY AND DISTRIBUTIONS 9L + 3T

Introduction – Basic Terminology – Probability and set notations – Addition Law of Probability – Independent events – Baye's Theorem – Random variable – Discrete Probability Distribution – Continuous Probability Distribution – Binomial Distribution - Poisson distribution - Normal Distribution. (Mean , Variance , Standard Deviation and their properties without proofs).

UNIT V: SAMPLING THEORY 9L + 3T

Introduction – Sampling Distribution – Testing a hypothesis – Level of Significance – Confidence Limits – Test of Significance of Large samples (Test of significance of single mean, difference of means) – Confidence limits for unknown – Small samples – Students t-distribution – Significance test of a sample mean – Significance test of difference between sample means – Chi-Square (χ^2) Test – Goodness of fit.

Text Books:

1. Dr. B.S. Grewal, "Higher Engineering Mathematics", 43rd ed., Khanna Publishers, New Dehli.

Reference books:

1. N.P. Bali et al, "A Text book on Engineering Mathematics", 8th ed., Laxmi pub.(p) Ltd., 2011.
2. H.K.Dass , "Advanced. Engineering Mathematics", 1st ed., S. Chand, 2008.
3. Erwin kreyszig , "Advanced Engineering Mathematics", 10th ed., wiley publishers.
4. Dr.M.K. Venkataraman, "Higher Engineering Mathematics", National Pub.Co., Madras.

MOMENTUM TRANSFER

CHE 222 **Credits: 4**

Instruction: 4 periods & 1 tutorial / week Sessional Marks: 40

End Exam: 3 Hours End Exam Marks: 60

Course Objectives:

1. To provide an understanding of fluid mechanics and its scope in the chemical industry.
2. To impart fundamental concepts in fluid mechanics with the knowledge of applying basic quantitative laws and the equations of fluid flow.
3. To provide the basic knowledge on compressible fluids, pressure drop, friction factor, Reynolds number and their relations in flow systems.
4. To provide an understanding about flow past immersed bodies and fluidization.
5. To acquaint knowledge on fluid moving machinery and flow measuring devices.

Course Outcomes:

After studying this subject, student will be able to

1. Understand the fluid statics and apply dimensional analysis
2. Apply quantitative laws to fluid flow problems.
3. Analyze the velocity distributions, frictional flow patterns in pipes.
4. Determine the pressure drop, velocities in packed and fluidized bed columns.
5. Analyze the performance aspects of pumps and flow metering devices.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	2		1					1	1		1	2	3
	2	3	2	3	1					1	1		1	2	3
	3	3	2	2	1					1	1		1	2	3
	4	3	2	2	1					1	1		1	2	3
	5	3	2	2	2					1	1		1	2	3

UNIT I **12L + 3T**

Basic concepts: Unit systems, units and dimensions, dimensional analysis – Rayleigh's method, Buckingham π theorem, equations of state, similarity.

Fluid statics: Nature of fluids, hydrostatic pressure, pressure distribution in a static fluid, pressure measuring devices.

UNIT II **12L + 3T**

Fluid flow phenomenon: Types of fluids, concept of stream lines, stream tubes, viscosity, rheological properties of fluids, turbulence, flow in boundary layers, its formation and growth in tubes and on plates, boundary layer separation.

Basic equations of fluid flow: Mass balance, steady state energy balance, equation of motion, momentum balance and Bernoulli's equation with the correction factors.

UNIT III **12L + 3T**

Flow of incompressible fluids: Relation between skin friction - wall shear, laminar flow in pipes, Hagen-Poiseuille equation, turbulent flow in pipes, velocity distribution equation, friction factor, friction from changes in velocity or direction.

Flow of compressible fluids: Basic equations, Mach number, flow through variable area conduits, adiabatic and isothermal frictional flow.

UNIT IV **12L + 3T**

Flow past immersed bodies: Flow through beds of solids, motion of particles through fluids, terminal velocity, fluidization, mechanism of fluidization, pressure drop in fluidization, applications of fluidization.

UNIT V **12L + 3T**

Transportation and metering of fluids: Pipes, fittings, valves, positive displacement and centrifugal pumps, fans, blowers and compressors, jet ejectors.

Flow measuring devices: venture meter, orifice meter, pitot tube, rotameter, notches and weirs.

Textbooks:

1. Warren L.McCabe and Julian C.Smith, "Unit Operations of Chemical Engineering", 7th ed., McGraw Hill, 2005.
2. R. K. Bansal, " A Text Book of Fluid Mechanics and Hydraulic Machines", 8th ed., Laxmi publisher, 2008. (for topics Unit systems, units and dimensions, dimensional analysis,notches and weirs)

Reference Books:

1. De Nevers N., "Fluid mechanics for chemical engineers", 3rd ed., McGraw Hill.
2. J.M.Coulson, J.F.Richardson, "Chemical engineering", 5th ed., Vol –I & II,,Elseveir,1999.
3. Cengel and Cimbala, "Fundamentals of fluid mechanics", 3rd ed.,McGraw Hill Education,2014.
4. R. K. Rajput, " A Text Book of Fluid Mechanics and Hydraulic Machines", 3rd ed., S. Chand, 2002.

MECHANICAL OPERATIONS

CHE 223 **Credits: 4**

Instruction: 4 periods & 1 tutorial / week Sessional Marks: 40

End Exam: 3 Hours End Exam Marks: 60

Course Objectives:

1. To familiarize with characteristics of solids, size reduction aspects, working of various size reduction equipment and its operations.
2. To know about the different screening techniques and screening equipments and other separation methods.
3. To understand the principles of filtration and the working of different filtration and centrifugation equipments.
4. To understand the principles of settling of solids in fluids and sedimentation.
5. To understand the concept of agitation and mixing of liquids.

Course Outcomes:

After studying this subject, student wii be able to

1. Identify the size reduction equipment for various samples.
2. Apply the screening techniques for different size separations.
3. Understand and apply the filtration techniques.
4. Predict the different settling regimes.
5. Classify various agitators and conveyors.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	1	1	2					1	1		1	2	3
	2	2	1	1	1					1	1		1	2	3
	3	2	1	1	1					1	1		1	2	3
	4	2	1	1	1					1	1		1	2	3
	5	2	1	1	1					1	1		1	2	3

UNIT I **12L + 3T**

Characteristics of solid particles: shape, size, differential and cumulative screen analyses, specific surface area, particle population, different mean diameters for a mixture of particles.**Principles of comminution:** Laws of crushing, description and working of size reduction equipment - jaw, gyratory and roll crushers, hammer mills, revolving mills, attrition mills, fluid energy mill, cutting machines, equipment operations, open and closed circuit grinding, wet and dry grinding, Grindability Index.

UNIT II **12L + 3T**

Miscellaneous separations: screening, industrial screens - grizzly, gyratory and vibratory screens, revolving screens - trommels, capacity and effectiveness of screens, magnetic separation, electrostatic separation, froth flotation.

UNIT III **12L + 3T**

Filtration: description and working of filtration equipment, plate and frame filter press, shell and leaf filters, rotary drum filter, filter aid, centrifugal filtration, top suspended batch centrifuge, theory of filtration, washing of cakes.

UNIT IV **12L + 3T**

Motion of particles through fluids: drag, free and hindered settling, settling velocities, classification, sink and float methods, differential setting methods - jigging and tabling, cyclone separators, batch sedimentation,thickeners, flocculation, centrifugal sedimentation, gravity and centrifugal decanters.

UNIT V **12L + 3T**

Agitation of liquids: power consumption in agitated vessels, mixing equipment for mixing of solids and pastes, mixers for dry powders, mixing index.

Conveying: types of conveyors – mechanical, belt, chain and screw conveyors, elevators, pneumatic conveyors, size enlargement.

Text books:

1. W.L. McCabe, J.C. Smith and P.Harriot, "Unit Operations of Chemical Engineering", 4th ed., McGraw- Hill.
2. J.H.Coulson and J.F.Richardson, "Chemical Engineering -Vol.2" 5th ed., Elsevier Science, 2002 (for topics of trommels, magnetic separator, electrostatic separator and froth flotation).

Reference books:

1. R.H.Perry,"Chemical Engineer's Hand Book",8th ed., McGraw-Hill Book Co., 2007.
2. Brown et al., "Unit Operations", 1st ed., CBS Publisher,2005.
3. Badger and Banchero, "Introduction to Chemical Engineering", 1st ed.,McGraw-Hill, 2002.(forconveying topic).

PROCESS INSTRUMENTATION

CHE 224 **Credits: 4**

Instruction: 4 periods & 1 tutorial / week Sessional Marks: 40

End Exam: 3 Hours End Exam Marks: 60

Course Objectives:

1. To familiarize with characteristics of instruments and their response, types of layouts for the process instrumentation.
2. To know about the principles of expansion thermometer and thermoelectric temperature measurement.
3. To know about the principles of resistance and radiation thermometers.
4. To know the concept of composition analysis by various methods.
5. To know the measurement of pressure, vacuum, head and level, the principles and equipment used

Course Outcomes:

After studying this subject, student will be able to

1. Identify the characteristics of various instruments and the instrumentation process.
2. Recognize the relevant from expansion and thermoelectric thermometers.
3. Understand the working and use of various resistance and radiation pyrometers.
4. Apply the various techniques for composition analysis.
5. Interpret the pressure, head and level measuring devices.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3			1					1	1		1	1	1
	2	2			1					1	1		1	1	1
	3	2			1					1	1		1	1	1
	4	2			1					1	1		1	2	3
	5	2			1					1	1		1	1	1

UNIT I **12L + 3T**

Qualities of measurement: Measurement, functions and the elements of instruments, static and dynamic characteristics, dynamic response of first order and second order instruments.

Process Instrumentation: Recording instruments, types of charts indicating and signaling instruments, control center, different layouts, diametric control center.

UNIT II **12L+3T**

Expansion thermometers: Temperature scales, constant-volume gas thermometer, pressure spring thermometer, theory of volumetric and pressure thermometers, static accuracy of thermometer and comparison of pressure-spring thermometers.

Thermoelectric temperature measurement: Thermoelectricity, industrial thermocouples, thermocouple lead wires, thermal wells, response of thermocouples, the millivoltmeter, nullpotentiometer circuits.

UNIT III **12L + 3T**

Resistance Thermometers: Thermal coefficient of resistance, industrial resistance thermometer bulbs, resistance thermometer circuits, Wheatstone, Calender-Griffithus, double slide wire bridges, nullbridge resistance thermometers, deflectional resistance thermometers.

Radiation temperature measurement: Introduction, laws of radiation, blackbody conditions and devices, radiation receiving elements, radiation pyrometers, radiation receivers, photoelectric pyrometers and optical pyrometers.

UNIT IV **12L + 3T**

Composition analysis: Spectroscopic analysis, types, IR and UV absorption spectrometry, Beer – Lambert's law, mass spectrometry, gas analysis by thermal conductivity, analysis of moisture in gases (humidity), psychrometer, hygrometer and dew-point methods, pH measurement, gas chromatography, HPLC.

UNIT V **12L + 3T**

Measurement of pressure and vacuum: Pressure, vacuum and head, liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, electric pressure gauges, measurement of absolute pressure, measurement of pressure in corrosive fluids.

Measurement of Head and Level: Density and specific gravity, direct measurement of liquid level, pressure(level) measurement in open vessels, level measurement in pressure vessels, density measurement.

Text books:

1. Donald P.Eckman, "Industrial Instrumentation", Wiley Eastern Ltd., 2004.
2. R. Chatwal& Sham K. Ananad, "Instrumental methods of analysis", Gurudeep Himalaya publishing house (for topics of gas chromatography and HPLC).

Reference Books:

1. Principles of Industrial Instruments, Patrenabis, Tata McGraw Hill Inc,.

CHEMICAL ENGINEERING THERMODYNAMICS-I

CHE 225 **Credits: 4**

Instruction: 4 periods & 1 tutorial / week Sessional Marks: 40

End Exam: 3 Hours End Exam Marks: 60

Course Objectives:

1. To provide knowledge on first law of thermodynamics and its importance.
2. To impart the relation between Pressure, Volume and Temperature.
3. To provide the relation between various heat effects and their temperature dependence.
4. To provide knowledge on second law of thermodynamics and its importance.
5. To impart knowledge on different balance equations and their usage.

Course Outcomes:

By the end of the course, student will be able to

1. Apply first law of thermodynamics to various systems.
2. Predict the PVT behavior using Virial equations.
3. Calculate heat effects on industrial reactions.
4. Apply second law of thermodynamics to various systems.
5. Develop balance equations on various equipments.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	2	1	1					1	1		1	2	3
	2	3	2	2	2					1	1		1	2	3
	3	3	2	2	2					1	1		1	2	3
	4	3	2	1	1					1	1		1	2	3
	5	3	2	1	1					1	1		1	2	3

UNIT I **12L + 3T**

The first law and other basic concepts: Joule's experiments, internal energy, the first law of thermodynamics, thermodynamic state and path functions, enthalpy, steady-flow process, equilibrium, the phase rule, the reversible process, constant-V and constant-P processes, heat capacity.

UNIT II **12L + 3T**

Volumetric properties of pure fluids: PVT behavior of pure substances, virial equations, the ideal gas, application of the virial equations, cubic equations of state, generalized correlations for gases, generalized correlations for liquids, molecular theory of fluids, second virial coefficients from potential functions.

UNIT III **12L + 3T**

Heat effects: Sensible heat effects, internal energy of ideal gases, microscopic view, latent heats of pure substances, standard heat of reaction, standard of heat of formation, standard heat of combustion, temperature dependence of heat effects of industrial reactions.

UNIT IV **12L + 3T**

The Second Law of Thermodynamics: Statement of the second law, heat engines, thermodynamic temperature scales, thermodynamic temperature and ideal-gas scale, entropy, entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, entropy from the microscopic view point, Ideal work, lost work, Thermodynamic analysis of steady state flow process.

UNIT V **12L + 3T**

Thermodynamic Properties of Fluids: Property relations for homogeneous phases, residual properties, two-phase systems, thermodynamic diagrams, generalized property correlations for gases, Thermodynamics of flow processes, Equations of balance, duct flow of compressible fluids, turbines (expanders), compression processes.

Text Books:

1. J.M.Smith, H.C.Van Ness and M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics" 6thed., McGraw-Hill International Editions, 2000.

Reference Books:

1. Y.V.C.Rao, "Chemical Engineering Thermodynamics", University Press (India) Ltd., Hyderabad, 1997.
2. B.F.Dodge , "Chemical Engineering Thermodynamics", McGraw-Hill Book Co.,
3. Michael M. Abbott and HendrickC.VanNess, "Schaum Outline of Theory and Problems of Thermodynamics'", 3rd ed., McGraw-Hill education, 2013.
4. K.V. Narayanan, "A Text book of Chemical Engineering Thermodynamics", PHI publications, 2009.

MOMENTUM TRANSFER LABORATORY

CHE226 **Credits: 2**

Practical/week: 3 Sessional Marks: 50

End Exam: 3 Hours End Exam Marks:50

Course Objectives:

1. To improve skills in measuring the flow rates.
2. To enable the students to familiarize with the different pumps.

Course Outcomes:

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

1. Measure the flow rate by using different flow measuring devices.
2. Draw the characteristic curves of various pumps.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	2	3	3	3					3	2		1	2	3
	2	2	3	3	3					3	2		1	2	3

List of Experiments:

1. Identification of laminar and turbulent flows (Reynolds apparatus).
2. Measurement of point velocities (Pitot tube).
3. Verification of Bernoulli equation.
4. Calibration of rotameter.
5. Determination of orifice coefficient.
6. Determination of venturi coefficient.
7. Friction losses in fluid flow in pipes.
8. Pressure drop in a packed bed for different fluid velocities.
9. Pressure drop and void fraction in a fluidized bed.
10. To study the coefficient of contraction for a given open orifice.
11. To study the coefficient of discharge in a V – notch.
12. To study the characteristics of a centrifugal pump.

Text Book:

1. Warren L.McCabe and Julian C.Smith, “Unit Operations of Chemical Engineering”, 7th ed., McGraw Hill, 2005.

Reference Book:

1. Cengel and Cimbala, “Fundamentals of fluid mechanics”, 3rd ed., McGraw Hill Education, 2014.

MECHANICAL OPERATIONS LABORATORY

CHE 227 **Credits: 2**

Practical/week: 3 Sessional Marks: 50

End Exam: 3 Hours End Exam Marks:50

Course Objectives:

1. To understandingthe measuring of the average size of the given sample.
2. To enable the students to familiarize with the different crushing and grinding units and the concepts of equipment operation.
3. To understand the various separation techniques like screening, froth floatation and sedimentation.

Course Outcomes:

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

1. Measure the average size of a given sample.
2. Operate crushing and grinding equipment.
3. Analyze various separation techniques for a given sample.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	2	3	3	3					3	2		1	2	3
	2	2	3	3	3					3	2		1	2	3
	3	2	3	3	3					3	2		1	2	3

List of Experiments:

1. To take a representative sample from a bulk by two methods, viz. Riffle and cone & quartering and to find out the average size (volume-surface mean diameter) of the samples.
2. To determine the time of grinding in a ball mill for producing a product with 80% passing a given screen.
3. To verify the laws of crushing using any size reduction equipment like jaw crusher, crushing rolls or ball mill and to find out the work Index {WI} of the material.
4. To compare open circuit and closed circuit grinding by means of a ball mill.

5. To determine the optimum time of sieving for a given sample of material.
6. To find the effectiveness of hand screening of a given sample by a given screen.
7. To find the screen effectiveness of a trommel.
8. To separate a mixture of coal into two fractions using sink and float method.
9. To separate a mixture of coal into two fractions using froth flotation technique.
10. To find the size analysis of a given fine sample using beaker decantation method.
11. To obtain batch sedimentation data and to calculate the minimum thickener area under given conditions.
12. To determine the collection efficiency of a cyclone separator.
13. To determine the settling velocities of various particle sizes and densities.

Text Book:

1. Warren L.McCabe and Julian C.Smith, "Unit Operations of Chemical Engineering", 7th ed., McGraw Hill, 2005.

Reference Book:

1. Brown et al., "Unit Operations", 1st ed., CBS Publisher, 2005.