GUJARAT TECHNOLOGICAL UNIVERSITY

ADVANCE ENGINEERING MATHS
SUBJECT CODE: 2130002
B.E. 3RD SEMESTER

Type of course: Engineering Mathematics

Prerequisite: The course follows from Calculus, Linear algebra

Rationale: Mathematics is a language of Science and Engineering

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	2	0	5	70	20	10	30	0	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Introduction to Some Special Functions:** Gamma function, Beta function, Bessel function, Error function and complementary Error function, Heaviside's function, pulse unit height and duration function, Sinusoidal Pulse function, Rectangle function, Gate function, Dirac's Delta function, Signum function, Saw tooth wave function, Triangular wave function, Halfwave rectified sinusoidal function, Full rectified sine wave, Square wave function.	02	4
2	**Fourier Series and Fourier integral:** Periodic function, Trigonometric series, Fourier series, Functions of any period, Even and odd functions, Half-range Expansion, Forced oscillations, Fourier integral	05	10
3	**Ordinary Differential Equations and Applications:** First order differential equations: basic concepts, Geometric meaning of $y' = f(x,y)$ Direction fields, Exact differential equations, Integrating factor, Linear differential equations, Bernoulli equations, Modeling , Orthogonal trajectories of curves.Linear differential equations of second and higher order: Homogeneous linear differential equations of second order, Modeling: Free Oscillations, Euler- Cauchy Equations, Wronskian, Non homogeneous equations, Solution by undetermined coefficients, Solution by variation of parameters, Modeling: free Oscillations resonance and Electric circuits, Higher order linear differential equations, Higher order homogeneous with constant coefficient, Higher order non homogeneous equations. Solution by [1/f(D)] r(x) method for finding particular integral.	11	20
4	**Series Solution of Differential Equations:** Power series method, Theory of power series methods, Frobenius method.	03	6
5	**Laplace Transforms and Applications:** Definition of the Laplace transform, Inverse Laplace transform, Linearity, Shifting theorem, Transforms of derivatives and integrals Differential equations, Unit step function Second shifting theorem,	09	15

	Dirac's delta function, Differentiation and integration of transforms, Convolution and integral equations, Partial fraction differential equations, Systems of differential equations		
6	**Partial Differential Equations and Applications:** Formation PDEs, Solution of Partial Differential equations f(x,y,z,p,q) = 0, Nonlinear PDEs first order, Some standard forms of nonlinear PDE, Linear PDEs with constant coefficients,Equations reducible to Homogeneous linear form, Classification of second order linear PDEs.Separation of variables use of Fourier series, D'Alembert's solution of the wave equation,Heat equation: Solution by Fourier series and Fourier integral	12	15

Reference Books:

1. Advanced Engineering Mathematics (8th Edition), by E. Kreyszig, Wiley-India (2007).
2. Engineering Mathematics Vol 2, by Baburam, Pearson
3. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005)
4. R. V. Churchill and J. W. Brown, Fourier series and boundary value problems (7th Edition), McGraw-Hill (2006).
5. T.M.Apostol, Calculus , Volume-2 (2nd Edition), Wiley Eastern , 1980

Course Outcome:

After learning the course the students should be able to

1. Fourier Series and Fourier Integral
   - Identify functions that are periodic. Determine their periods.
   - Find the Fourier series for a function defined on a closed interval.
   - Find the Fourier series for a periodic function.
   - Recall and apply the convergence theorem for Fourier series.
   - Determine whether a given function is even, odd or neither.
   - Sketch the even and odd extensions of a function defined on the interval [0,L].
   - Find the Fourier sine and cosine series for the function defined on [0,L]
2. Ordinary Differential Equations and Their Applications
   - Model physical processes using differential equations.
   - Solve basic initial value problems, obtain explicit solutions if possible.
   - Characterize the solutions of a differential equation with respect to initial values.
   - Use the solution of an initial value problem to answer questions about a physical system.
   - Determine the order of an ordinary differential equation. Classify an ordinary differential equation as linear or nonlinear.
   - Verify solutions to ordinary differential equations.
   - Identify and solve first order linear equations.
   - Analyze the behavior of solutions.
   - Analyze the models to answer questions about the physical system modeled.
   - Recall and apply the existence and uniqueness theorem for first order linear differential equations.
   - Identify whether or not a differential equation is exact.
   - Use integrating factors to convert a differential equation to an exact equation and then solve.
   - Solve second order linear differential equations with constant coefficients that have a characteristic equation with real and distinct roots.
   - Describe the behavior of solutions.
   - Recall and verify the principal of superposition for solutions of second order linear differential equations.
   - Evaluate the Wronskian of two functions.

- Determine whether or not a pair of solutions of a second order linear differential equations constitute a fundamental set of solutions.
- Recall and apply Abel's theorem.
- Apply the method of reduction of order to find a second solution to a given differential equation.
- Apply the method of undetermined coefficients to solve non-homogeneous second order linear differential equations.
- Model undammed mechanical vibrations with second order linear differential equations, and then solve. Analyze the solution. In particular, evaluate the frequency, period, amplitude, phase shift, and the position at a given time.
- Define critically damped and over damped. Identify when these conditions exist in a system.
- Describe the phenomena of beats and resonance. Determine the frequency at which resonance occurs.
- Recall the definition of linear independence for a finite set of functions. Determine whether a set of functions is linearly independent or linearly dependent.
- Use the method of variation of parameters to solve non-homogeneous higher order linear differential equations.

3. Series Solution of Differential Equations

- Manipulate expressions involving summation notation. Change the index of summation.
- Find the general solution of a differential equation using power series.
- Given an initial value problem, use the differential equation to inductively determine the terms in the power series of the solution, expanded about the initial value.

4. Laplace Transforms and Applications

- Sketch a piecewise defined function. Determine if it is continuous, piecewise continuous or neither.
- Evaluate Laplace transforms from the definition.
- Determine whether an infinite integral converges or diverges.
- Evaluate inverse Laplace transforms.
- Use Laplace transforms to solve initial value problems.
- Convert piecewise defined functions to functions defined in terms of step functions and vice versa.
- Find the Laplace transform of a piecewise defined function.
- Apply the shifting theorems to evaluate Laplace transforms and inverse Laplace transforms.
- Use Laplace transforms to solve differential equations with discontinuous forcing functions.
- Define an idealized unit impulse function.
- Use Laplace transforms to solve differential equations that involve impulse functions.
- Evaluate the Laplace transform of a convolution of functions.
- Use the convolution theorem to evaluate inverse Laplace transforms.

5. Partial Differential Equations and Applications

- Determine the order of a partial differential equation.
- Classify a partial differential equation as linear or nonlinear.
- Verify solutions to partial differential equations.
- Apply the method of separation of variables to solve partial differential equations, if possible.
- Find the solutions of heat conduction problems in a rod using separation of variables.
- Solve steady state heat conduction problems in a rod with various boundary conditions.
- Solve the wave equation that models the vibration of a string with fixed ends.
- Describe the motion of a vibrating string.

- Solve Laplace's equation over a rectangular region for various boundary conditions.
- Solve Laplace's equation over a circular region for various boundary conditions.

List of Open Source Software/learning website:

1. NPTEL
   http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Signals%20and%20System/Course_home4.30
   https://www.youtube.com/watch?v=DPg5T-YBQjU
   https://www.youtube.com/watch?v=7fJeo1fylKI
   https://www.youtube.com/watch?v=1FnBPmEWpus
   https://www.youtube.com/watch?v=dgDIQ0VA0pA
   https://www.youtube.com/watch?v=SoBs-YGQUdc
   https://www.youtube.com/watch?v=Fh8m6ZdFaqU

2. **Instructor(s):** Prof. Haynes Miller, Prof. Arthur Mattuck

   http://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/video-lectures/

3. **Instructor:** Prof. Haynes Miller, Prof. Arthur Mattuck, Dr. John Lewis

   http://ocw.mit.edu/courses/mathematics/18-03sc-differential-equations-fall-2011/

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICS OF SOLIDS
SUBJECT CODE: 2130003
B.E. 3RD SEMESTER

Type of course: Applied Physics

Prerequisite: System of units
Laws of motion
Basic idea of force
Concept of centroid
Fundamentals of stress, strain and their relationships

Rationale: Mechanics of Solids is conceptual applications of principles of mechanics in Engineering

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Sr. No.	Topics	Teaching Hrs.	Module Weightage
	Module 1		
1	**Introduction** Definition of space, time, particle, rigid body, deformable body. Force, types of forces, Characteristics of a force, System of forces, Composition and resolution of forces. Fundamental Principles of mechanics: Principle of transmissibility, Principle of superposition, Law of gravitation, Law of parallelogram of forces.	02	20
2	**Fundamentals of Statics** **Coplanar concurrent and non-concurrent force system:** Resultant, Equilibrant, Free body diagrams. **Coplanar concurrent forces:** Resultant of coplanar concurrent force system by analytical and graphical method, Law of triangle of forces, Law of polygon of forces, Equilibrium conditions for coplanar concurrent forces, Lami's theorem. Application of statically determinate pin – jointed structures. **Coplanar non-concurrent forces:** Moments & couples, Characteristics of moment and couple, Equivalent couples, Force couple system, Varignon's theorem, Resultant of non-concurrent forces by analytical method, Equilibrium conditions of coplanar non-concurrent force system, Application of these principles.	08	
	Module 2		
3	**Applications of fundamentals of statics**	08	15

	Statically determinate beams: Types of loads, Types of supports, Types of beams; Determination of support reactions, Relationship between loading, shear force & bending moment**,** Bending moment and shear force diagrams for beams subjected to only three types of loads :i) concentrated loads ii) uniformly distributed loads iii) couples and their combinations; Point of contraflexure, point & magnitude of maximum bending moment, maximum shear force.		
Module 3			
4	**Friction** Theory of friction, Types of friction, Static and kinetic friction, Cone of friction, Angle of repose, Coefficient of friction, Laws of friction, Application of theory of friction: Friction on inclined plane, ladder friction, wedge friction, belt and rope friction.	06	20
5	**Centroid and moment of inertia** **Centroid:** Centroid of lines, plane areas and volumes, Examples related to centroid of composite geometry, Pappus – Guldinus first and second theorems. **Moment of inertia of planar cross-sections:** Derivation of equation of moment of inertia of standard lamina using first principle**,** Parallel & perpendicular axes theorems, polar moment of inertia, radius of gyration of areas. Examples related to moment of inertia of composite geometry,	08	
Module 4			
6	**Simple stresses & strains** Basics of stress and strain: 3-D state of stress (Concept only) Normal/axial stresses: Tensile & compressive Stresses :Shear and complementary shear Strains: Linear, shear, lateral, thermal and volumetric. Hooke's law, Elastic Constants: Modulus of elasticity, Poisson's ratio, Modulus of rigidity and bulk modulus and relations between them with derivation. Application of normal stress & strains: Homogeneous and composite bars having uniform & stepped sections subjected to axial loads and thermal loads, analysis of homogeneous prismatic bars under multidirectional stresses.	10	20
Module 5			
7	**Stresses in Beams:** **Flexural stresses –** Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis, determination of bending stresses, section modulus of rectangular & circular (solid & hollow), I,T,Angle, channel sections **Shear stresses –** Derivation of formula, shear stress distribution across various beam sections like rectangular, circular, triangular, I, T, angle sections.	06	25
8	**Torsion:** Derivation of equation of torsion, Assumptions, application of theory of torsion equation to solid & hollow circular shaft, torsional rigidity.	04	

9	**Principle stresses:** Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and their applications	04	
Module –VI			
10	**Physical & Mechanical properties of materials: (laboratory hours)** Elastic, homogeneous, isotropic materials; Stress –Strain relationships for ductile and brittle materials, limits of elasticity and proportionality, yield limit, ultimate strength, strain hardening, proof stress, factor of safety, working stress, load factor, Properties related to axial, bending, and torsional & shear loading, Toughness, hardness, Ductility ,Brittleness	05	50% (Practical) & 0% (Theory)
11	**Simple Machines: (laboratory hours)** Basics of Machines, Definitions: Velocity ratio, mechanical advantage, efficiency, reversibility of machines. Law of Machines, Application of law of machine to simple machines such as levers, pulley and pulley blocks, wheel and differential axle, Single purchase, double purchase crab, screw jacks. Relevant problems.	05	

Course Outcome:

After learning the course the students should be able to:

1. apply fundamental principles of mechanics & principles of equilibrium to simple and practical problems of engineering.
2. apply principles of statics to determine reactions & internal forces in statically determinate beams.
3. determine centroid and moment of inertia of a different geometrical shape and able to understand its importance.
4. know basics of friction and its importance through simple applications.
5. understand the different types of stresses and strains developed in the member subjected to axial, bending, shear, torsion & thermal loads.
6. know behaviour & properties of engineering materials.
7. know basics of simple machines and their working mechanism.

List of Experiments:

The students will have to solve atleast five examples and related theory from each topic as an assignment/tutorial. Students will have to perform following experiments in laboratory and prepare the laboratory manual.

Mechanics of rigid body

1. Equilibrium of coplanar concurrent forces
2. Equilibrium of coplanar non-concurrent forces
3. Equilibrium of coplanar parallel forces: Determination of reactions of simply supported beam
4. Verification of principle of moment: Bell crank lever
5. Determination of member force in a triangular truss
6. Determination of coefficient of static friction using inclined plane
7. Determination of parameters of machines (Any two)

(a) Wheel and differential axles
(b) Single purchase crab
(c) Double purchase crab
(d) System of pulleys

Mechanics of deformable body

8. Determination of hardness of metals: Brinell /Vicker/Rockwell hardness test
9. Determination of impact of metals: Izod/Charpy impact test
10. Determination of compression test on
    (a) Metals – mild steel and cast iron
    (b) Timber – along and parallel to the grains
11. Determination of tensile strength of metals
12. Determination of shear strength of metals

Design based Problems (DP): (any two)

1. For a real industrial building having roof truss arrangement, (a) take photograph & identify type of truss, (b) draw sketch of truss with all geometrical dimension, cross sections details, type of joints, type of support conditions (c) prepare a model of truss (d) identify & determine types of load acts on it (d) determine support reactions & member forces due to dead load & live load only.
2. Take a case of the Mery-Go-Round used in the fun park. Draw its sketch showing radius of wheel, no of seats, capacity of each seats and other related information. Determine the amount of resultant produced at the centre of wheel during rest position, when (i) it is fully loaded (2) it is 30% loaded with symmetric arrangement. Draw support arrangement and determine support reactions. Also determine amount of torque required to start its operation.
3. Prepare working models for various types of beams with different shape of cross section, supporting conditions and study the effect of cross section on the deflection of beams.
4. Prepare working model of simple lifting machine using different types of pulley systems and calculate various parameters like load factor, velocity ratio, law of machine, efficiency of machine etc.

Major Equipments:

1. Force table
2. Beam set up
3. Truss set up
4. Bell crank lever
5. Friction set up
6. Lifting machine
7. Hardness testing machine
8. Impact testing machine
9. Universal testing machine with shear attachment

List of Open Source Software/learning website:
www.nptel.iitm.ac.in/courses/

Active learning Assignments (AL) : Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will

allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

DESIGN ENGINEERING
SUBJECT CODE: 2130005

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks			Practical Marks		
L	T	P	C	ESE (E)	PA (M)		PA (V)	PA (I)	
					PA	ALA	ESE		
0	0	3	3	0	0	0	80	20	100

Design Engineering 1, 2 and 3

What is design? Design is a plan of a system, its implementation and utilization for attaining a goal. It is to change undesired situation into desired situation means to find solution for undesired/uncomfortable situation.
Designs can be for
(1) Technical systems (power plant)
(2) Educational systems (Montessori Method)
(3) Aesthetic systems (logo designs, advertisements)
(4) Legal systems
(5) Social, religious or cultural systems
(6) Theories, Models, etc.

Design thinking gives students a taste of the rich internal-remunerations associated with knowledge-creation and in curiosity and problem-driven contexts. Design need to satisfy technical functions, ergonomics functions, aesthetic functions, cost function and environment functions.

Essential features of Design:
Design solution of a problem starts with planned constructions for achieving goal/s. Designing means evolving goal oriented processes. At the beginning of the design process only goals are known while at the end, both the goals and plans are known and that to with more clarity. Goal and plans evolve together and they influencing each other. In designing process some goals are more important than others and similarly some plans are better than others. Designing does not guarantee that the design will work.

Design thinking process:
(1) Find goals or need
(2) Evaluate goals or need
(3) Generate proposals to satisfy goals
(4) Evaluate proposals
(5) Improve goals and proposals

Teaching methodology:
The design engineering should be with fun and should create excitement. It should be integrated theme across the various courses. It should promote the team work. Design is thinking and doing. The complete design process should be included in design engineering 1, 2 and 3. The prototype design must consider technical, aesthetic, ergonomics, cost and environmental requirements.

Content:

Design Engineering 1: (3 credits in Semester 3, 3 credits in Semester 4)
Introduction to product innovation process (Need-requirement-concept-detail-prototype-services-business)
Modules on: Task clarification and conceptualization: Problem-idea-solution-evaluation

- Problem identification
- Ideation
- Consolidation
- Evaluation

Project: identifying need to developing proof of concept to demonstrate solution selected

Students can tackle simple design problems with engineering content – posed by the teacher or based on a survey of real life concerns of the public. The second is more effective – the students "own the problem" - but has to be accepted by the teacher.

Examples: (a) A device to help carry heavy luggage to the upper floors of a building – a building that has no lifts. (b) Systems to ensure that water does not come out as a jet from the taps in the lower floors of a tall building. One can insist on multiple realistic solutions and all should be part of the submission along with statements of their shortcomings or advantages. Teacher should not entertain fancy solutions – based on fancy ideas - with no engineering or scientific basis.

Short lectures on the topics in the syllabus should parallel the activity.

Design Engineering 2: (3 credits in Semester 5, 3 credits in Semester 6)
Introduction to detail design
Modules on

- Design for performance, safety, reliability
- Design for ergonomics and aesthetics
- Design for manufacturability
- Design for cost, environment

Project: developing the concept into a detailed design with a functional prototype

Here one could ask students to develop products based on themes - "Garbage compactors, Energy from kitchen waste, etc" making sure that the problems identified by the students within the themes possess an engineering content and insisting on some facets of design for assembly, for manufacturability, ...and so on while preparing the design and the prototypes. One could encourage students to innovate, arrive at multiple solutions and conduct a detailed design of one of the solutions.

Prototyping requires funds and effort, so it pays to identify one subsystem of the design of the whole machine. One can insist on prototyping demonstrating at least that sub-system, if not the whole system.

Design Engineering 3: (3 credits in Semester 7, 3 credits in Semester 8)
Introduction to services and business planning
Modules on

- Design of services
- Intellectual property
- Materials and recourse planning
- Business planning

Project: developing a business model

OR

Research or Technology Development project
Modules on

- Detailed literature survey and to find out technology gap
- Intellectual property
- Re-evaluate prototype of DE-2 and proposal of novel idea

Project: developing a novel functional prototype

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING

ORGANIC CHEMISTRY AND UNIT PROCESSES
SUBJECT CODE: 2130501
B.E. Semester: III

Type of course: Chemical Engineering.

Prerequisite: Students having background of chemistry at higher secondary level.

Rationale: It is the basic subject for Chemical Engineering Students.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**General Principles of Organic reactions and Mechanisms:** Fission Reaction and reaction intermediates: Free Radical, Carbonium, Carbanion, Carbenes and Nitrenes. Nucleophilles and Electrophilles. Types of Organic reactions and its mechanism: Especially Nucleophillic and Electrophillic Addition and Substitution reactions.	**6**	**60 %**
2	**Stereochemistry:** Optical, Geometrical and Conformational Isomerism: Optical activity, Polarimeter, Specific rotation, Enantiomers, Diasteromers, Optical activity in Lactic and Tartaric acid, R and S configuration of Optically active compound and E and Z designation of Geometrical isomers. Resolution of racemic mixture.	**4**	
3	**Introduction to various Unit Processes and Operations:** Nitration, Amination, Hydrogenation, Halogenations, Oxidation, Reduction, Sulphonation, Hydrolysis, Alkylation and Polymerization.	**6**	
4	**Carboxylic acid :** Introduction, Preparation and Properties Manufacture Process of Acetic acid, Formic acid, Oxalic acid, Palmitic acid & Stearic acid Derivatives of Carboxylic acids: Acid Amides, Esters, Acid Anhydrides and Acid Chlorides. Mechanism of Esterification and Strengths of Acids.	**4**	
5	**Polynuclear and Heterocyclic Compounds:**	**4**	

	Introduction and Classification. Preparation, Properties and Uses of: Naphthalene, Anthracene, Pyrrole, Furan, Thiophene, Pyridine and Quinoline		
6	**Application of following reactions with Mechanism:** Diazotisation, Sandmeyer, Canninzaro, Wolf Kishner, Clasien, Curtius, Baeyer Villiger, Hoffman and Michael Dieckmann reaction.	**5**	
7	**Carbohydrates:** Introduction, Classification, Configuration and Chemical reactions of mono, oligo and poly saccharides, especially of Glucose, Fructose and Starch. Conversion of higher to lower and lower to higher aldose (Killiani Synthesis, Ruff & Wohl's Degradation). Conversion of Aldose to Ketose.Manufacturing of Cane Sugar from Sugarcane with flow sheet.	**4**	**40%**
8	**Amino acid &Protein Chemistry:** Introduction, Composition, Classification & Isolation of Proteins, Qualitative tests of Proteins, Classification of Amino acids & their synthesis. Amphoteric nature, Isoelectric point, Primary, Secondary, Tertiary and Quartanery Structure of Protein, RNA and DNA.	**4**	
9	**Synthetic Drugs:** Synthesis of drugs, Antiseptics, Halogenated compounds, Antimalarials, Quinoline derivatives, Antibacterials, Sulpha Aspirin, Phenacetin, Paracetamol, Sulphanilamide, Sulphaguanidine, Chloromycetin, Chloroquine.	**6**	
10	**Colour, Dyes and Pigments:** Introduction, Classification of dyes based on Application and Structural representation.Colour and Constitution Theory: Quinonoid, Valence bond and Molecular Orbital theory Application of Dyes and Pigments.Preparation of some imp derivatives: Congo red, Malachite Green, Crystal Violet, Alizarin, Phenolphthalein, Fluorescein, Eosin and Indigo .	**5**	
11	**Petroleum Chemistry:** Occurrence- Composition of Crude oil- Distillation of the Crude oil, Cracking, Knocking, Octane number & Cetane number, Synthetic petrol.	**6**	

Reference Books:

Sr. No.	Title/Author/Publisher
1.	A Text Book Of Organic Chemistry by P. L. Soni, Sultan Chand & Sons, New Delhi.
2.	A Text Book of Organic Chemistry by Arun Bahl and B.S. Bahl, Sultan Chand & Sons, New Delhi
3.	A Textbook of Organic Chemistry by Raj K Bansal, New Age International, New Delhi
4.	Organic Chemistry By Solomons, John Willey & Sons, USA.
5.	Organic Chemistry, I. L. Finar Vol. I & II ELBS & Longmans, Green – UK
6.	Organic Chemistry

	By Morrison and Boyd, Pearson Education, Singapore.
7.	A Textbook of Organic Chemistry By Francis A Carey, Springer –USA
8.	Organic Reaction and their Mechanisms By P S Kalsi, New Age International, New Delhi
9.	Atomic Structure and the Chemical Bond By Manas Chanda, Tata Mcgrawhill
10.	Heterocyclic Chemistry By Bansal B K, New Age International, New Delhi
11.	Organic Chemistry By R L Madan, S. Chand & Company, New Delhi
12.	Laboratory Techniques in Organic Chemistry By Ahluwalia V K, I K International, New Delhi
13.	Unit Process in Organic Synthesis By P H Groggins, Tata Mc Graw Hill, New Delhi.
14.	Vogel's textbook of Qualitative Organic Analysis, By Arthur I Vogel, Revised by Jefferey et al. Publisher: Addison Wessley Longmann Ltd, England

Course Outcome:

After learning the course the students should be able:

1. To build a basic knowledge of the Fundamental structure of Organic molecules.
2. To analyze scientific concepts and think critically.
3. To understand and explain the reactions in Organic molecules.
4. To correlate the same as per their utility in field of Chemical Engineering.

List of Experiments and Open Ended Projects:

Minimum 5 practicals to be performed and remaining Open-ended Projects / Study Reports / Latest outcomes in technology study **:-**

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Projects / Study Reports / Latest outcomes in technology.
2. Literature survey including patents and research papers of basic chemistry

- Design based small project **or**
- Study report based on latest scientific development **or**
- Technology study report/ modeling/ simulation/collection report **or**
- Computer based simulation/ web based application/ analysis presentations of applied science field which may help them in chemical engineering fields .

3. These can be done in a group containing maximum **Three** students in each.
4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
5. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.
6. In the semester student should perform **minimum 5 set of experiments** and complete **one small open ended dedicated project** based on engineering applications. This project along with any performed experiment should be **EVALUATED BY EXTERNAL EXAMINER.**

LIST OF PRACTICALS: (Minimum 5 out of any three set to be performed.)

(I) Qualitative analysis of different Organic molecules :

1	ACIDS	:	Benzoic, Salicylic, Cinnamic, Sulphanilic, Anthranilic
2	PHENOLS	:	alpha-Naphthol, beta-Naphthol, Resorcinol
3	BASES	:	Aniline, o-m and p-Nitro aniline, p-Toluidine, Diphenylamine

4	ALDEHYDES KETONES ESTERS	: : :	Benzaldehyde Acetone, Methyl ethyl ketone Methyl acetate, Ethyl acetate
5	ALCOHOLS	:	Ethyl alcohol, Methyl alcohol
6	HYDROCARBONS	:	Benzene, Toluene
7	CARBOHYDRATES	:	Glucose, Fructose
8	AMIDES	:	Urea, Benzamide
9	ANILIDES	:	Acetanilide
10	HALOGENATED COMPOUNDS	:	Chlorobenzene, Bromobenzene

(II) Organic Estimation by volumetric method of any two of the following :

1. Estimation of Phenol by Bromination.
2. Glucose by Hypoiodite method.

(III) Organic preparations of any two of the following :

1. Acetanilide from aniline.
2. Tribromophenol from Phenol.
3. m-dinitrobenzene from Nitrobenzene.
4. Anthraquinone from Anthracene.
5. Phthalic anhydride from Phthalic acid.

Open Ended Project fields:-

Students are free to select any area of organic chemistry and unit process based to define project. Some suggested projects are listed below:

- Detailed study of any unit process like nitration,halogenations,etc.
- Product profile and its manufacturing product any organic compound in detail.

Major Equipments:

- Magnetic Stirrer, Hot plates.
- Laboratory Oven.
- Melting Point Instrument,etc.

List Of Open Source Software/Learning Website:

Students can refer various video lectures available on NPTL, refer soft copies (CD) provided with reference books/text books , etc.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING

FLUID FLOW OPERATION
SUBJECT CODE: 2130502
B.E. Semester: III

Type of course: Chemical Engineering

Prerequisite: Basic Concepts of Engineering Mathematics and Physics.

Rationale: Chemical Engineering has to do with industrial processes in which raw materials are processed and separated into the useful products. The behavior of fluids is important to process engineering and constitutes one of the foundations for the study of the unit operations.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Topic	Teaching Hours	Module Weightage (%)
1.	**Fluid static and its application:** Nature of fluids, Pressure concept, Hydrostatic equilibrium, decanters like continuous gravity, centrifugal etc.	02	40
2.	**Fluid Flow Phenomena:** Velocity fluid, Velocity gradient and rate of shear, Newtonian and Non-Newtonian fluids, Viscosity and momentum flux, Reynolds number and its significance, laminar and turbulent flow; Turbulence, Reynolds stresses, Eddy viscosity, Laminar and Turbulent flow in boundary layers, boundary layer formation in straight tubes, boundary separation and wake formation.	05	
3.	**Basic equations of Fluid Flow:** Mass velocity; average velocity; potential flow; streamlines, stream tubes, macroscopic momentum balance, momentum correction factor, Equation of continuity, Bernoulli's equation, corrections for fluid friction, pump work in Bernoulli's equations, angular momentum equations	05	
4.	**Flow of incompressible fluids in Conduits and Thin Layers:** Flow of incompressible fluids in Conduits and Thin Layers in pipes, relation between skin friction and wall shear, friction factor laminar flow in pipes, kinetic energy correction factor and momentum correction factor for laminar flow of Newtonian fluids, Hagen-Poiseuille equation, effect of roughness, friction factor chart, friction factor inflow through channels of non-circular cross section, equivalent diameter, hydraulic radius, friction from changes in velocity or direction, flow through sudden enlargement of cross section, flow through sudden contraction of cross section, effect of fittings and valves, form friction losses in	07	

	Bernoulli's equations, separation of boundary layers in diverging channel.		
5.	**Flow of Compressible fluids:** Mach number, continuity equation total energy balance equation, velocity of sound, processes of compressible of flow like isentropic expansion, adiabatic frictional flow, isothermal frictional flow, velocity in nozzles.	04	60
6.	**Flow past immersed bodies:** Introduction to Drag, drag coefficient, form drag, and stream lining, friction in fluids through bed of solids, fluidization, condition of fluidization, types of fluidization, application of fluidization, continuous fluidization, slurry and pneumatic transport.	04	
7.	**Transportation and Metering of fluid:** Pipe and tubing, joint and fittings selection of pipe sizes, prevention of leakage around moving parts, stuffing boxes, mechanical seals, valves like Gate, Globe, Plug cocks, Ball, Check valves.	06	
8.	**Fluid moving machinery:** Pumps its characteristics like developed head power requirement suction lift and cavitations; positive displacement pumps like reciprocating, rotary pumps, centrifugal pumps and its theory, characteristic of head capacity relation, pump priming, fans, blowers like positive displacement, centrifugal blowers, compressor efficiency, vacuum pumps, jet ejectors, comparison of devices for moving fluids.	08	
9.	**Measurement of flowing fluids:** Full bore meter like venturimeter, orifice meter, coefficient of discharge of venturimeter, orifice meter, area meters like Rotameter, target meters, vortex-shedding meters, coriolis meters, magnetic meters etc., insertion meters like pitot tubes etc. Recent advancement in different pumps, valves and measuring devices.	08	
10.	**Dimensional Analysis:** Different methods of dimensional analysis applied to fluid flow problems.	05	

Reference Books:

- "Unit Operations of Chemical Engineering", McCabe W L, Smith J C, Harriott P, Mc Graw Hill Publication, 7th edition 2005.
- "Chemical Engineering" Vol. I – Fluid flow, Heat Transfer and Mass Transfer; Coulson & Richardson's, Butterworth – Heinemann Publication, 6th Edition.
- "Fluid Dynamics and Heat Transfer", James G. Knudson and Donald L. Katz, Mc Graw Hill Publication

Course Outcome: After learning the course the students should be able:

1. To create a vision of understanding the momentum transfer process.
2. To analyze fluid flow concepts.
3. To review the practical importance and relevance of fluid flow in process industry.
4. To be able to utilize the technological methods in problem solving in process plant.
5. To build a bridge between theoretical and practical concepts used in industry.

List of Experiments and Open Ended Projects:

Minimum **5** practicals to be performed and remaining Open-ended Projects / Study Reports / Latest outcomes in technology study**:-**

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Projects / Study Reports / Latest outcome in technology.

2. Literature survey including patents and research papers of fundamental process
- Design based small project **or**
- Study report based on latest scientific development **or**
- Technology study report/ modeling/ simulation/collection report **or**
- Computer based simulation/ web based application/ analysis presentations of basic concept field which may help them in Chemical engineering.

3. These can be done in a group containing maximum **three** students in each.
4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
5. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.
6. In the semester student should perform **minimum** 5 set of experiments and complete **one small open ended dedicated project** based on engineering applications. This project along with any performed experiment should be **EVALUATED BY EXTERNAL EXAMINER.**

PRACTICALS (ANY FIVE):

Sr. No.	List of Experiments
1.	To study and verify Bernoulli's Theorem
2.	To calibrate Venturi meter and obtain it's coefficient of discharge.
3	To calibrate an Orifice meter and obtain it's coefficient of discharge.
4.	To study a Rota meter and obtain it's coefficient of discharge.
5.	To Study Notched Weirs Apparatus and obtain its discharge coefficient.
6.	Study of Pressure measurement devices.
7.	Friction Vs. Re losses in Pipe Friction using water.
8.	To study Reynolds's Experiment Apparatus.
9.	Centrifugal Pump testing.

Open Ended Project fields:-

Students are free to select any area of fluid flow technology based on Chemical engineering applications to define Projects. Some suggested projects are listed below:

- Carry out project on Notches and Weirs
- Designing of various fluid flow experiments set up.
- Projects on fluid moving machinery etc.

Major Equipments:

Venturi meter, Orifice meter, Rotameter, Various pumps, Notches, Pipes and Valves etc...

List of Open Source Software/learning website:

1) Literature available in any laboratory manual of Fluid Flow Operation.
2) NPTEL
3) MIT Open course lecture on Fluid dynamics.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING

PROCESS CALCULATION
SUBJECT CODE: 2130504
B.E. Semester: III

Type of course: Fundamental Chemical Engineering Calculations & stoichiometry

Prerequisite: None

Rationale: The prime objective of this subject is to clear fundamentals of chemical engineering in a simple and forthright manner and to provide the broad background for applying these principles to industrial and theoretical problems.

After learning the course the students should be able:

- To understand the importance of stoichiometry – material and energy balances
- To deal with the laws of conservation of mass and energy
- To apply principles of unit operations and chemical reaction engineering in problem solving

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	1	0	4	70	20	10	30	0	20	150

Course Contents:

Sr. No.	Topic	Teaching Hrs.	Module Weightage
1	**Dimensions and units:** Dimensions and system of units, Fundamental and derived units, Dimensional consistency, Dimensional equations, Different ways of expressing units of quantities and physical constant, Unit conversion and its significance	5	9
2	**Basic chemical calculations:** Calculations for mole, molecular weight, equivalent weight, etc., Composition of gaseous mixtures, liquid mixtures, solid mixtures, etc., Ideal gas law & other equations of state and their applications, Dalton law, Raoult's law, Henry's law, Solutions and their properties	7	13
3	**Material balance without chemical reactions:** Process flowsheet, Degree of freedom, Material balance with and without recycle; Bypass and purge streams, Material balance around equipments related to unit operations like absorber and stripper, distillation towers, extractors, dryers, evaporators, etc. Material balance of unsteady state operations.	8	15
4	**Material balance involving chemical reactions:** Concept of limiting and excess reactants, percentage conversion, yield, selectivity, etc., M aterial balance with chemical reactions - single and multiple reactions, Material balance involving reactions with special reference to fertilizers, petrochemicals, dyestuffs, electrochemical industries, metallurgical industries, etc.	10	18
5	**Energy balances:** Thermochemistry and 1st law of thermodynamics, Heat capacity of gases	9	17

	and gaseous mixtures, liquids & solids, Sensible heat change in liquids & gases, Enthalpy changes during phase transformation, Enthalpy changes accompanied by chemical reactions, Standard heat of reaction, Adiabatic reactions, Thermo-chemistry of mixing processes, Dissolution of solids, etc.		
6	**Stoichiometry and Unit operations:** Distillation, Absorption and stripping, Extraction & leaching, Crystallization, Psychrometric Operations, Drying, Evaporation etc.	**7**	**13**
7	**Fuels and combustion:** Types of fuels, Calorific value of fuels, Problems on combustion of coal, liquid fuels, gaseous fuels, etc., Proximate and ultimate analysis, Combustion calculations, theoretical flame temperature, etc., Air requirement and flue gases.	**8**	**15**

Reference Books:

1. "Stoichiometry", B.I. Bhatt, S.M. Vora, McGraw Hill Publishing Company Limited, 4th edition, 2004.
2. "Basic Principles & Calculations in Chemical Engineering", David M. Himmelblau, James B. Riggs, PHI Learing Pvt. Ltd, 7th edition, 2006.
3. "Elementary Principles of Chemical Processes", Richard M. Felder, Ronald W. Rousseau, Wiley, 3rd edition, 2004.
4. "Chemical Process Principles Part-I: Material and Energy Balances", O.A.Hougen, K.M.Watson, R.A.Ragatz, CBS Publishers New Delhi, 2nd edition, 2004.
5. "Stoichiometry and Process Calculations", K.V. Narayanan, B. Lakshmikutty, Prentice-Hall of India Pvt. Ltd., 2006.
6. "Industrial Stoichiometry: Chemical Calculations of Manufacturing Processes", H.C.Lewis, W.K.Lewis, A.H.Radasch, McGraw-Hill, 2nd edition, 1954.

Course Outcome:

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

- Establish mathematical methodologies for the computation of material balances and energy balances
- Present an overview of industrial chemical processes.
- Develop a fundamental understanding of the basic principles of chemical engineering processes and calculations.
- Examine and select pertinent data, and solve material and energy balance problems.
- Give examples of important application of material balances in chemical engineering processes.
- Evaluate their own solutions and those of others to find and correct errors.

List of Open Source Software/learning website:

- Students can refer to video lectures available on the websites including NPTEL.
- Students can refer to the CDs which are available with some reference books for the solution of problems using softwares/spreadsheets. Students can develop their own programs/ spreadsheets for the solutions of problems.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING

CHEMICAL PROCESS INDUSTRIES - I

SUBJECT CODE: 2130505

B.E. Semester: III

Type of course: Chemical Engineering.

Prerequisite: Basic Concept of Chemistry.

Rationale: The main objective of this subject is to study the basics of chemical processes take place in chemical industries. This subject provides knowledge regarding to the basic aspects of manufacturing of various chemicals.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Topic	Teaching Hours	Module Weightage (%)
1.	**Chemical processing and the work of chemical engineering:** Basic chemical data, batch and continuous processing, flowcharts etc.	02	30
2.	**Water :** Water treatment for industrial and domestic use such as demineralization, deionization, desalination, reverse osmosis, etc…	06	
3.	**Sulfur and Sulfuric acid:** Mining of sulfur, Manufacture of sulfuric acid by DCDA process and its applications. Manufacturing technologies, Engineering problems, Energy recovery from the process. Introduction to Fertilizer industries, manufacturing processes of Ammonia, Urea, Nitric acid, Phosphoric acid their uses and applications, major engineering problems, NPK fertilizer.	08	
4.	**Chlor-alkali and Heavy Inorganic industry:** Manufacturing of caustic soda and chlorine by membrane cell process, Manufacturing of Sodium bicarbonate.	06	20
5.	**Introduction to industrial gases and carbon:** Gases like carbon dioxide, oxygen, nitrogen, hydrogen, rare gases of atmosphere, helium, acetylene, sulfur dioxide, carbon monoxide, nitrogen oxide. Carbon like carbon black, activated carbon, natural graphite, Manufacturing of graphite and carbon, industrial diamonds.	08	50
6.	Introduction to ceramic industries. Portland cements, calcium and magnesium compounds, glass industries.	08	
7.	Introduction to explosives, propellants and toxic chemical agents, photographic products industries.	08	
8.	**Introduction to pulp and paper industries**: Kraft process, Paper making process ,etc..	08	

Reference Books:

1. "Shreve's Chemical Process Industries", George T. Austin, McGraw Hill Publication, 5th edition
2. "DRYDENS outlines of chemical technology for the 21st century", M Gopalarao & Marshal Sitting, pub East-West Press, 3rd edition
3. "General chemical technology", Shukla and Pandey.

Course Outcome:

After learning the course the students should be able:

1. To build a basic knowledge of the process carried out in chemical industry.
2. To review the practical importance and relevance of process takes place in chemical industry.
3. To be able to utilize the technological methods in problem solving in process plant.
4. To study about the salient features of the process.
5. To build a bridge between theoretical and practical concept used in industry.

List of Experiments and Open Ended Projects:

Minimum **5** practicals to be performed and remaining time should be allotted to open-ended projects / study reports / latest outcomes in technology study **:-**

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Project / Study Report / Latest outcome in technology.
2. Literature survey including patents and research papers of fundamental process

- Design based small project **or**
- Study report based on latest scientific development **or**
- Technology study report/ modeling/ simulation/collection report **or**
- Computer based simulation/ web based application/ analysis presentations of basic concept field which may help them in chemical engineering.

3. These can be done in a group containing maximum **three** students in each.
4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
5. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.
6. In the semester student should perform **minimum** 5 set of experiments and complete **one small open ended dedicated project** based on engineering applications. This project along with any performed experiment should be **EVALUATED BY EXTERNAL EXAMINER.**

PRACTICALS (ANY FIVE):

1.	To prepare hydrated lime from the given calcium carbonate powder
2.	To prepare caustic soda by chemical method.
3	To prepare soap in the laboratory and carry out its cost analysis.
4.	To determine saponification value of oil sample.
5.	To prepare detergent in the laboratory and to carry out its cost analysis.
6.	To determine the acid value of the given sample of oil.
7.	To prepare m-dinitrobenzene from Nitrobenzene.
8.	To prepare ammonia from the ammonium salt with a strong base.
9.	To study the operations of water softener.
10.	To study deionization unit.

Open Ended Project fields:-

Students are free to select any area of science and technology based on chemical engineering applications to define Projects.

Some suggested projects are listed below:

- Laboratory set up of ionization unit.
- Carry out analysis (cost & composition) of soap, detergent, different oils, etc…
- Product profile and its manufacturing process like cement, glass, ceramic etc.

Major Equipments:

Muffle Furnace, Laboratory Oven etc...

List of Open Source Software/learning website:

1) Literature available in any laboratory manual of Chemical Process Industries.
2) Handbook on Soaps- Detergents & Acid Slurry 2nd Edition by Niir Board
3) NPTEL
4) MIT Open course lecture available on Internet etc…

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.