Shroff S.R. Rotary Institute of Chemical Technology

Teaching Scheme for
Second Year Bachelor of Chemical Technology

Semester-III (Chemical Technology) Structure

Category of Course	Code No.	Course Title	Hours Per Week			Total contact hrs/ week	Total Credits	E	M	I	V	Total marks
			L	T	P							
Humanities & Social Science	MH2201	CommunicationSkills in English	2	0	2	4	3	70	30	20	30	150
Basic Science	MH2202	Maths-III	3	2	0	5	5	70	30	50	0	150
Internship	MH1203	In Plant Training	0	0	1	1	1	0	0	0	50	0
Engineering Science	CT2201	Basics of FluidFlow	3	0	2	5	4	70	30	20	30	150
Professional Core Course	CT2202	Material & Energy Balance Calculations	3	1	0	4	4	70	30	20	30	150
Professional Core Course	CT2203	Organic Chemistry-1	3	0	4	7	5	70	30	20	30	150
Professional Core Course	CT2204 to CT2207	*Specialized Subjects-I	4	0	0	4	4	70	30	0	0	100
Total						**30**	**26**	**420**	**180**	**130**	**170**	**900**

***Specialized Subjects-I**

Category of Course	Code No.	Course Title
Pharma. Tech	CT2204	Introduction to Medicinal Chemistry, Biochemistry & Human Physiology
Dyes & Pig. Tech	CT2205	Introduction to Colorants
Pol & Rub. Tech	CT2206	Introduction to Polymer & Rubber
Glass Tech	CT2207	Introduction to Ceramics & Ceramic Raw Materials

Semester-IV (Chemical Technology) Structure

Sr No	Category of course	Code No.	Course Title	Hours Per Week			Total contact hrs/ week	Total Credits	E	M	I	V	Total marks
				L	T	P							
1	Humanities & Social Science	MH2204	Universal Human Values	3	0	0	3	3	70	30	0	0	100
2	Basic Science	CT2208	Physical Chemistry	3	0	2	5	4	70	30	20	30	150
3	Professional Core Course	CT2209	Basics of Heat Transfer	3	1	2	6	5	70	30	20	30	150
4	Professional Core Course	CT22010	Mechanical operation	3	0	2	5	4	70	30	20	30	150
5	Professional Core Course	CT2211 to CT2214	*Specialized Subjects-II	4	0	2	6	5	70	30	20	30	150
6	Professional Elective Course	CT2215 to CT2218	*Specialized Subjects-III	3	0	0	3	3	70	30	0	0	100
Total							**28**	**24**	**420**	**180**	**80**	**120**	**800**

***Specialized Subjects-II**

Category of Course	Code No.	Course Title
Pharma. Tech	CT22011	Medicinal Chemistry-I & Microbiology
Dyes & Pig. Tech	CT22012	Chemistry & Technology of Colorants
Pol & Rub. Tech	CT22013	Chemistry of Polymer & Rubber
Glass Tech	CT22014	Refractories -I

Specialized Subjects-III

Category of Course	Code No.	Course Title
Pharma. Tech	CT22015	Chemistry of Natural Products & Pharmaceutical Packaging Technology
Dyes & Pig. Tech	CT22016	Synthetic Colorants
Pol & Rub. Tech	CT22017	Synthesis and Analysis of Polymer & Rubber

Glass Tech	CT22018	Glass Science & Technology

A. Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
E	Theory External Examination Marks
M	Theory Internal Examination Marks
I	Practical Internal Examination Marks
V	Practical External Examination Marks

Bachelor of Engineering
Subject Code: MH2201
Subject Name: Communication Skills in English

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - III

Type of course: Language and Communication

Prerequisite: Zeal to learn the Language

Rationale: The rationale of the curriculum is to help students to express their original ideas in English and also develop interest in language and literature with a focus on comprehension, and reading, speaking and writing skills

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Dynamics of Communication: Definition and process Kinesics Proxemics Paralinguistic features Importance of Interpersonal and Intercultural Communication in today's organizations	6
2	Technical Writing: Report writing Technical proposal Technical description Business letters(sales, order, complaint, adjustment, inquiry, recommendation, appreciation, apology, acknowledgement, cover letter) Agenda of meeting, Minutes of meeting Resume writing	7
3	Technical Communication: Public speaking, Group discussion, Presentation strategies, Interview skills, Negotiation skills ,Critical and Creative thinking in communication	7
	SECTION-B	
4	T Ethics in Engineering: Scope of engineering ethics, Accepting and sharing responsibility , Resolving ethical dilemmas, Making moral choices	**6**

Bachelor of Engineering
Subject Code: MH2201
Subject Name: Communication Skills in English

5	Etiquettes: Telephone etiquettes for foreign business trips, Etiquettes for small talks, Respecting privacy ,Learning to say NO, Time management, Scope of engineering ethics, Accepting and sharing responsibility ,Resolving ethical dilemmas ,Making moral choices	**7**
6	Self-development and Assessment: Change, Grow, Persist, Prioritize, Read, Learn, Listen, Record, Remember, Asses, Think, Communicate, Relate, Dream.	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	15	15	15	5	5

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Language Laboratory Activities:

Sr. no	**Practical/ Exercise**	**Apprx. Hours required**
1	Role Play	02
2	Letter writing: Formal	02
3	Group Discussion	02
4	Presentations	02
5	Book Review(Preferably related to self-development)	04
6	Mock Interview	02
7	Report writing	02
8	Case studies related to unit 4, 5 and 6	02
9	Conducting meeting with Agenda	02
10	Minutes of Meeting	02

Bachelor of Engineering
Subject Code: MH2201
Subject Name: Communication Skills in English

Reference Books:

1. Raman and Sharma, Technical Communications, OUP, New Delhi, 2017
2. Lata and Kumar, Communication Skills, OUP, New Delhi, 2018
3. Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw Hill, New York, 2014
4. Mohapatra and Sreejesh S., Case Studies in Business Ethics and Corporate Governance, Pearson, UP, 2013
5. Ramesh and Ramesh, The Ace of Soft Skills, Pearson, UP, 2019
6. Sherfield, Montgomery and Moody, Cornerstone: Developing Soft Skills, UP, 2009
7. Open Sources: https://www.scu.edu/ethics/focus-areas/more/engineering-ethics/engineering-ethics-cases

Course Outcomes: After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Define and describe dynamics of verbal and non-verbal aspects of communication.
CO-2	Associate with various formal documents of technical and professional communication
CO-3	Interpret communication of diverse formal situations taking place in organizations.
CO-4	Illustrate and examine the knowledge of ethical aspects of engineering
CO-5	Establish and explain social and professional etiquettes.
CO-6	Recommend self -development and self - assessment.

List of Open Source Software/learning website:

Open Sources: https://www.scu.edu/ethics/focus-areas/more/engineering-ethics/engineering-ethics-cases

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: MH2202
Subject Name: Mathematics-III

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - III

Type of course: Engineering Science

Prerequisite: Algebra, Trigonometry, Geometry, Differentiation, Integration

Rationale: The study to compute area, volume and Transformation of functions

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	2	0	5	70	30	0	50	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Fourier Series:** Periodic function, Trigonometric series, Fourier series, Functions of any period, Even and odd functions, Half-range Expansion.	5
2	**Laplace Transforms**: Definition of the Laplace transform, Linearity, Shifting theorems, Laplace transformation of elementary function, basic properties of Laplace transformation, Differentiation of Laplace transformation(multiplication by t), Integration of Laplace transformation(division by t), Laplace transformation of derivatives and integrals, unit step function. Evaluation of integrals using Laplace transformation.	10
3	**Curve Sketching**: Curve sketching in Cartesian Co-ordinates and Polar co-ordinates, Relation between Polar and Cartesian Co-ordinates.	5
	SECTION-B	
4	**Double integral and it's applications of:** over rectangular and general regions, properties of double integrals, Change of order, in polar coordinates, change of variables, Area by double Integrals	5

Bachelor of Engineering
Subject Code: MH2202
Subject Name: Mathematics-III

5	**Inverse Laplace transformation and its application:** Properties of inverse Laplace transformation, shifting theorem, multiplication and division by differentiation and integration of Laplace transformation. Convolution theorem, inverse Laplace transformation using partial fraction, solution of linear differential equation.	10
6	**Fourier integral:** Sine and cosine integral, even and odd functions	4

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**20**	**30**	**10**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Text Books:

1. Advanced Engineering Matheamtics by Ravish Singh and Mukul Bhatt.MC Graw Hill Education Pvt Ltd.

2. Engineering Mathematics Vol 2, by Baburam, Pearson

Reference Books:

1. Thomas' Calculus, Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
2. Advanced Engineering Mathematics (8th Edition), by E. Kreyszig, Wiley-India (2007).
3. R. V. Churchill and J. W. Brown, Fourier series and boundary value problems (7th Edition), McGraw-Hill (2006).

List of Tutorial:

1. Tutorial-1 (Fourier Series)

2. Tutorial-2 (Fourier Series)
3. Tutorial-3 (Laplace Transform)
4. Tutorial-4 (Laplace Transform)
5. Tutorial-5 (Curve sketching)
6. Tutorial-6 (Double Integral and its application)
7. Tutorial-7 (Double Integral and its application)
8. Tutorial-8 (Fourier Integral)
9. Tutorial-9 (Inverse Laplace Transformation)
10. Tutorial-10 (Inverse Laplace Transformation)

Course Outcomes: After learning this course students will be able to

Sr. No.	CO statement
CO-1	**Define** Laplace and Inverse Laplace transformation, Fourier Series and Integral.
CO-2	**Solve** differential equations Using Laplace transform and inverse Laplace Transformation.
CO-3	**Sketch** the Cartesian and Polar graphs.
CO-4	**Calculate** the area using Double integrals
CO-5	**Construct** a Fourier integral to evaluate the Integral.
CO-6	**Evaluate** the sum of series using Fourier series

List of Open Source Software/learning website:

- https://nptel.ac.in/
- http://www.sosmath.com/

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: CT2201
Subject Name: Basics of Fluid Flow

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Engineering Science

Prerequisite: A good understanding regarding basic states of matter along with behavior of fluid under static and dynamic conditions. Mathematical background is also essential in this respect.

Rationale: This subject is intended to make students aware about types and behavior of fluid with the basic fundamentals underlying the operation of fluid for chemical technologies. Apparently the subject aims at measurement techniques involved for the pressure concepts, fluid flow and equipment used for the transportation of fluids.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Fluid Static and Its Application: Properties of fluids and its classification, Pressure – Hydrostatic Equation, Pressure scales and Measurement, Manometers – different types of manometers, decanters like continuous gravity, centrifugal etc.	05
2	Fluid Flow Phenomena and Its Basic Equations: Types of flow, Mass velocity; average velocity; potential flow; streamlines, stream tubes, Reynolds number and its significance, Fluid flow over a flat plate, Boundary layer, Transition length, Wake formation, Continuity equation, Bernoulli's equation, Correction factors in Bernoulli's Equation, Pump Work.	08
3	Flow of Incompressible Fluids in Conduits and Thin Layers: Shear stress distribution, relation between skin friction and wall shear, friction factor, Hagen Poiseuille Equation, effect of roughness, friction factor chart, Flow through noncircular cross sections, Equivalent diameter, Hydraulic radius, friction loss from sudden expansion or contraction of cross section and fittings and valves, Form friction and skin friction.	08

Bachelor of Engineering
Subject Code: CT2201
Subject Name: Basics of Fluid Flow

	SECTION-B	
4	Flow Past Immersed Bodies: Drag, Drag Coefficients, Stream lining, Stagnation pressure. Flow of fluid through a bed – Fluidization, Types of fluidization and applications. Motion of particles through fluids	08
5	Transportation and Metering of Fluids: Pipes, tubes, joints and fittings selection of pipe size, Valves like Gate, Globe, Plug cocks, Ball, Check valves Introduction to fluid flow measuring instruments like venturimeter, orifice meter, area meters like Rota meter, target meters, coriolis meters, magnetic meters etc., insertion meters like pitot tubes.	08
6	Fluid Flow Through Machinery: Pumps, its characteristics like developed head, power requirement, suction lift and cavitations; positive displacement pumps like reciprocating, rotary pumps, centrifugal pump, fans, blowers like positive displacement, centrifugal blowers, compressor, vacuum pumps, jet ejectors, comparison of devices for moving fluids.	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	23	20	18	15	5

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. W. L. McCabe, J. C. Smith and P. Harriot, "Unit operations of chemical engineering", McGraw Hill International, Edition VII.
2. "Chemical Engineering" Vol - I and II by Coulson and Richardson. Pergamon Press Publications.
3. Noel de. Nevers, "Fluid mechanics for Chemical Engineers", McGraw Hill International edition.
4. Fluid Mechanics – Basic Concepts and Principles. Shiv Kumar, Ane Books Private Limited
5. "Fluid Dynamics and Heat Transfer", James G. Knudson and Donald L. Katz, Mc Graw Hill Publication.

Bachelor of Engineering
Subject Code: CT2201
Subject Name: Basics of Fluid Flow

List of Practical:

1. To observe Reynolds's number and flow pattern in Reynolds Apparatus.
2. To study and verify Bernoulli's Theorem
3. To calibrate Venturi meter and obtain it's coefficient of discharge.
4. To calibrate an Orifice meter and obtain it's coefficient of discharge.
5. To study a Rotameter and obtain it's coefficient of discharge.
6. To Study Notched Weirs Apparatus and obtain its discharge coefficient.
7. Pressure drop in various size of circular pipes.
8. Pressure drop and friction factor measurement in bend, valves and different fittings.
9. Estimation of viscosity of fluid by Stoke's law
10. Frictional pressures drop in annular pipe.
11. Centrifugal Pump testing and characteristic curves.

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To Identify fluid properties and memorize the concepts of pressure.
CO-2	To explain flow of fluid in different flow geometries and interpreting energy balance equation to estimate losses in different sections of flow
CO-3	To predict flow of incompressible fluid in conduits and thin layers with frictional losses encountered in flow situations.
CO-4	To analyze flow of fluids past immersed bodies with industrial applications of Fluidization.
CO-5	To describe application of industrial flow measuring instruments along with pipes, tubes, joints and valves
CO-6	To categorize fluid flow through different types of machinery such as pumps, blowers, compressors, vacuum pump and jet ejectors.

List of Open-Source Software/learning website:

Reference to NPTEL lectures can be made for a better understanding regarding fluid flow under different conditions.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2202

Subject Name: Material & Energy Balance Calculations

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Professional Core Course

Prerequisite: A good understanding regarding chemistry and physics with general idea about unit and dimension. Mathematical background is also essential in this respect.

Rationale: The main objective of course is to make a clear conceptualized knowledge regarding various unit operations carried out in Chemical Engineering. This will provide a background for applying these principles to industrial problems.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Units & Dimensions: Dimensions & system of units, Fundamental and derived units, Unit conversion and its significance.	03
2	Basic Chemical Calculations: Concepts of atomic weight, equivalent weight and mole. Composition of solids, liquids and solutions (weight percent, mole percent, molarity, normality etc.), other expressions for concentration, Average molecular weight and density, Gaseous mixtures, Ideal gas laws, Real gas laws and their applications, Raoult's law, Henry's law, Amagat's Law & Dalton's law	08
3	Material Balance without Chemical Reactions: Introduction, Process flow sheet, Material balance with and without recycle; Bypass, Purge streams, Material around equipments related unit operations like absorber and stripper, Distillation towers. Extractors. Dryers, Evaporators, Crystallizers, Humidification and dehumidification towers. Material balance of unsteady state operations.	08
	SECTION-B	

Bachelor of Engineering
Subject Code: CT2202
Subject Name: Material & Energy Balance Calculations

4	Material balances with Chemical reaction: Concept of limiting and excess reactants, percentage conversion and yield. Material balance involving reactions with special reference to fertilizers, petrochemicals, dyestuffs, electrochemical industries. Complex material balances	10
5	Energy balances: Heat capacity of gases and gaseous mixtures, liquids & solids, Sensible heat change in liquid & gases, enthalpy changes during phase transformation, enthalpy changes accompanied by chemical reactions, standard heat of reaction, Hess's law, Adiabatic reactions, Theoretical Flame temperature	08
6	Fuel & Combustion: Types of fuels, calorific value of fuels, liquid fuels, gaseous fuel etc. Proximate and ultimate analysis, combustion calculations, Air requirement and flue gases.	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	10	20	20	20	20

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Basic Principles & Calculations in Chemical Engineering, D. M. Himmelblau. 6th Ed., 2004
2. Stoichiometry, B. I. Bhatt & Thakore, Tata McGraw Hill Book Company, 5th Ed, 2010
3. Chemical Process Principles, Vol.1, O. A. Hougen, K. M. Watson, R. A. Ragatz., Indian print, CBS Publishers, 2nd Ed., 1995
4. Stoichiometry & Process Calculations, Narayanan K.V., & Lakshmikutti B., Prentice Hall, 2006
5. Process Calculations, V Venkataramani and N Anantharaman, PHI Learning, 2004
6. Chemical Process Calculations Manual, David Carr Igbinoghene, McGraw Hill Professional, 2004
7. Optimization of Chemical Processes, T F Edgar, D M Himmelblau and L S Lasden, Tata McGraw Hill, 2001

Bachelor of Engineering

Subject Code: CT2202

Subject Name: Material & Energy Balance Calculations

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To identify different system of units and dimensions with conversion.
CO-2	To distinguish concepts for expressing compositions and behaviour of different gases and solutions.
CO-3	To demonstrate material balance in steady and unsteady state unit operations with and without recycle.
CO-4	To analyze Material balance involving Chemical reactions in fertilizer, petrochemicals, dyestuff and electrochemical industries.
CO-5	To describe energy changes in liquid and gases accompanying various chemical reactions with terms used to associate energy changes in different phases.
CO-6	To evaluate fuel quality and to device requirement of gases in combustion

List of Open-Source Software/learning website:

Reference to NPTEL lectures can be made for a better understanding regarding fluid flow under different conditions.

Bachelor of Engineering
Subject Code: CT2203
Subject Name: Organic Chemistry-1

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Professional Core Course

Prerequisite: Needs basic knowledge of Chemistry which will help students to learn subject.

Rationale: The main objective of this subject is to make students aware about the basics of organic chemistry and the fundamentals of synthetic chemistry which are very useful in knowing the actual manufacturing process.

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Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	4	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
	SECTION-A	
1	**Electronic theory:** Types of bonds & bond fission process, resonance hyperconjugation, tautomerism. Reaction intermediates: generation, structure reactions such as carbocations, carbanions, free radicals & carbenes, elect nucleophile	**08**
2	**IUPAC nomenclature** of different Organic polyfunctional compounds	**06**
3	**Only preparation and chemical reaction of following compounds:** Halogenated compounds, nitro aromatic compounds, aromatic amines, aromatic s acids, phenols.	**08**
	SECTION-B	
4	**Name reactions in Organic chemistry :** 1. Hoffman reaction 2. Grignard reaction	**08**

Bachelor of Engineering
Subject Code: CT2203
Subject Name: Organic Chemistry-1

	3. Diazotization reaction 4. Hydrogenation reaction & Ozonolysis 5. Aldol & Cross aldol reaction 6. Cannizzaro reaction	
5	**Study of individual reaction with mechanism :** 1. Arndt Eister synthesis 2. Baeyer Villiger reaction 3. Baker- Venkatraman reaction 4. Reformatsky reaction 5. Curtius rearrangement 6. Favorskii rearrangement	**07**
6	**Study of individual reaction with mechanism :** 1. Pinner reaction 2. Benzilic acid rearrangement 3. Witting reaction 4. Diels-Alder reaction 5. Birch reduction 6. Mannich reaction.	**07**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**15**	**15**	**10**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Organic Chemistry, J. McMurry, Brroks / Cole, 5th Ed.,1999
2. Organic Chemistry ,T. W. Solomons& C. B. Fryhle, John Wiley &Sons.,7th Ed., 2000
3. Organic Chemistry , G.Marc Loudon, Oxford University Press ,4th Ed. , 2002
4. Organic Chemistry, L. G. Wade Jr., Pearson Education,5th Ed. , 2003
5. Organic Chemistry, Volumes I & II, I L Finar, ELBS & Longman Ltd., 5th Ed.,1996
6. Industrial Aromatic Chemistry: Raw materials, processes, products, H. G. Franck & J. W. Stadehofer, Berlin Springer Verlag, 1st Ed., 1988
7. Stereochemistry of Carbon Compounds, E. L. Eliel, McGraw – Hill, 1st Ed, 2003.

8. Stereochemistry: Conformation & Mechanism, P. S. Kalsi, New Age International (P) Ltd.,6th Ed., 2005
9. Stereochemistry & Mechanism through solved problems, P. S. Kalsi, New Age International (P) Ltd.,3rd Ed, 2007
10. Organic Chemistry, Morrison & Boyd, Pearson, 7th Ed, 2011
11. Name reactions & Reagents in Organic synthesis, B.P.Mundy, M.G.Ellerd and F G Favaloro, John Wiley and Sons, 2005
12. Organic Building Blocks of the Chemical Industry, H HSzmant, John Wiley and Sons, 1989
13. Organic chemistry : Bahl and Bahl
14. Fundamentals of Organic chemistry : Puri& Sharma

List of Practical: (Any Ten)

1. Safety and Overview of an Synthetic Organic Laboratory
2. Organic Qualitative analysis of Solids (Binary mixture)
3. Organic Qualitative analysis of Liquids (Binary mixture)
4. one step organic synthesis
5. Two step organic synthesis
6. Techniques like TLC, UV etc
7. Organic estimation of Glycine
8. Crystallization and checking the purity by TLC
9. Distillation and checking the purity by Boiling point
10. Organic Estimation
11. VLAB/DEMO Practical: Separation using Chromatography
12. VLAB/DEMO Practical:Purification By Steam Distillation

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To state various chemical compounds using IUPAC nomenclature.
CO-2	To construct a bridge between theoretical and practical concept used in industry
CO-3	To apply the knowledge of Halogenated compounds, nitroaromatic compounds, aromatic amines, aromatic sulfonic acids, phenols in future subjects of chemical technology.
CO-4	To discriminate the relative stability of aromatic compounds and demonstrates their reaction mechanism.

Bachelor of Engineering
Subject Code: CT2203
Subject Name: Organic Chemistry-1

CO-5	To choose reaction conditions favoring one path over another, thereby giving maximum amounts of desired products and minimum amounts of undesired products.
CO-6	To design synthesis of various chemicals in laboratory.

List of Open-Source Software/learning website:

1. NPTEL
2. MIT Open course lecture available on Internet etc
3. Delnet

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2204

Subject Name: Introduction to Medicinal Chemistry, Biochemistry & Human Physiology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Professional Core Course

Prerequisite: The students should have a basic knowledge of Inorganic Chemistry, Organic Chemistry, Physical Chemistry & Biology. The students should have studied basic organic chemical reactions and fundaments of human body systems.

Rationale: The main objective of this subject is to offer an overview over the fundamentals of Human Physiology, Medicinal Chemistry & Biochemistry. The study also provides an overview of Pharmaceutical industries, synthesis & pharmacology of drugs and metabolism.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	0	4	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Introduction to Human Physiology: Introduction to human body:, Organization of human body, Different system of human body, cell & cell organelles, composition and functions of blood, Cardiac cycle, Digestive system, Urinary system, Respiratory system.	08
2	Overview of Pharmaceutical Industry: Indian Pharmaceutical Industry, Introduction to pharmacopoeias, Introduction to GMP, its importance & general application in pharmaceutical industry concept of GMP.	04
3	Introduction to Medicinal & Pharmaceutical Chemistry: Definitions of Medicinal Chemistry, Pharmaceutical Chemistry, Drug, Pharmacology, Structure activity Relationship, Mode of Action. Methods of classification of drugs based on structure & biological activity, Concept of acidity & basicity of drugs & pKa values. Introduction of absorption & distribution of drugs based on physicochemical properties, introduction to bio pharmaceutics. Anti – infective drugs-I: study of the chemistry of the following classes of drugs: nomenclature, classification, SAR, MOA, synthesis of : - Anti-	18

Bachelor of Engineering

Subject Code: CT2204

Subject Name: Introduction to Medicinal Chemistry, Biochemistry & Human Physiology

	infective agents: antiseptic & disinfectant, antibacterial –Sulfonamides, Quinoline Antiparasitic agents.	
SECTION-B		
4	Anti – infective drugs-II: study of the chemistry of the following classes of drugs: nomenclature, classification, SAR, MOA, synthesis of: Anti amoebic, Anti mycobacterial agents, Diagnostic agents.	13
5	Introduction to Biochemistry: Metabolism of carbohydrates: Photosynthesis, glycolysis, pentose phosphate cycle, TCA cycle. Metabolism of lipids, Metabolism of proteins & amino acids, urea cycle. DNA & RNA, Protein biosynthesis.	13
6	Drug metabolism: Metabolism Chemistry, Route of administration, metabolism pathways.	04

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**20**	**10**	**10**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Strategies for Organic Drug Synthesis & Design, & Daniel Led nicer, John Willey & Sons Inc. New York. 2nd Ed, 1998
2. Burger's Medicinal Chemistry & Drug Discovery: Vol. 1 to 6, A. Burger & M.E, Wolff,John Wiley & Sons – New Jersey,6th Ed, 2003
3. Foye's Principles of Medicinal Chemistry, W.O. Foye, Lippincott Williams & Wilkins-Philadelphia, Oxford, 6th Ed, 2008.
4. Text book of Medicinal & Pharmaceutical Chemistry, Charles Owens Wilson Lippincott Williams & Wilkins – Philadelphia. 1962.
5. Textbook of Medicinal Chemistry, Vol-I & Vol-II, Alagarsamy, 2nd Ed, Elsevier 2014.
6. Medicinal Chemistry, Ashutoshkar, 5th revised & expanded Ed, New Age International Publishers,2010.
7. Lehninger Principles of Biochemistry,Micheal Fox, David L Nelson, 5th Ed, W.H. freeman & Company, NY,2008.

8. Pharmacology, Satoskar – Bhandarkar, Popular Prakshan, Mumbai, 2003
9. Biochemistry by U. Satyanarayana, Elsevier, 4th Edition, 2013

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To know the basic knowledge of physiology of human body & cell structure.
CO-2	To explain the overview and importance of pharmaceutical Industry & GMP regulations
CO-3	To apply the knowledge of Medicinal Chemistry, Pharmaceutical Chemistry in the studies of drugs
CO-4	To illustrate the structure activity relationship, mode of action & metabolism of drug substances.
CO-5	To describe the metabolic path ways of carbohydrates, proteins & lipids by applying the knowledge of Biochemistry.
CO-6	To summarize chemistry & metabolism and routes of drug administration of drugs

List of Open-Source Software/learning website:

1. Literature available on internet
2. Medical dictionaries
3. Delnet
4. Literature available under R&D in Pharma industry.
5. Pharma Journals/ e-journals

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: CT 2205
Subject Name: Introduction to Colorants

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Professional Core Course

Prerequisite: Basic knowledge of Color chemistry, chemistry of aromatics and Technology

Rationale: The main objective of this subject is to study introduction of dyes & pigments their classifications, chemistry of aromatics, colour and chemical constitution.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	0	4	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Unit-I: Colour & its Chemical Constitution:** Definition and concept of colour, its chemical constitution, Witt's theory, Armstrong's theory, Baeyer's theory etc., recent advances in theories of colour & constitution, Colour Perception, Colour Measurement, Colour System and Atlases, Bathochromic & Hypsochromic Effect Introduction to Colorants, its types, functions and industrial applications	**10**
2	**Unit-II: Introduction to Pigments:** Introduction to Pigments: Definition, classification(Organic, Inorganic, White pigments, coloured pigments, effect pigments, metal effect pigments, pearl luster pigments etc.), general physical properties, industrial applications Introduction to Extenders: Definition, general properties, significance, practical difference between extenders and pigments	**8**
3	**Unit-III: Introduction to Dyes:** Definition of Dye, practical difference between dyes and pigments, Intermediates: Definition, Significance, Important dyestuff intermediates Classification of Dyes based on application: Direct dyes, Acid dyes, Basic dyes, Developed dyes, Mordant dyes, Vat dyes, Sulphur dyes, Disperse	**10**

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	dyes, Reactive dyes etc. Classification of Dyes based on Chemical Structure: Nitroso dyes, Nitro dyes, Azo dyes, Diphenyl methane dyes, Triphenyl methane dyes, Xanthene dyes, Heterocyclic Dyes etc.	
SECTION-B		
4	**Unit-IV: Chemistry of Intermediates:** Introduction to intermediates, Coal tar primaries like benzene, xylene, toluene, Market value of coal tar primaries classes of intermediates, Importance of intermediates, concept of pricing of intermediates.	**8**
5	**Unit-V: Chemistry of Benzenoid Aromatics:** Introduction, Electrophilic aromatic substitution reactions, Nucleophilic aromatic substitution reaction. Hammet substitution constants. Introduction of various functional groups into benzenoid aromatics, Synthesis of typical dyestuff intermediates based on benzene, xylene, toluene.	**10**
6	**Unit-VI: Chemistry of Naphthalene:** Electrophilic aromatic substitution reactions: Bucherer reaction, Reverse Bucherer reaction. Synthesis of naphthols, naphthylamines, naphthol sulphonic acid, naphthylamine sulphonic acids, amino naphthol sulphonic acids. Bon acid arylides as Azocoupling components. Anthracene& condensed aromatics. Anthraquinone & benzanthrone. Reactions of anthraquinone, benzanthrone & synthesis of dyestuff intermediates based onanthraquinone & benzanthrone.	**10**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**20**	**10**	**10**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Dr. G. R. Chatwal, "Synthetic Dyes", Himalaya Publications, 2009.
2. G. Buxbaum, "Industrial Inorganic Pigments", ISBN 3-527-28878-3, 2nd Ed., 1998.
3. Venkatraman K., "Chemistry of Synthetic Dyes – Vol I", Academic Press, New York, 2009
4. Venkatraman K., "Chemistry of Synthetic Dyes – Vol II", Academic Press, New York, 2009
5. Venkatraman K., "Chemistry of Synthetic Dyes – Vol III", Academic Press, New York, 2009
6. W M Morgans, "Outlines of Paint Technology", CBS Publishers, 3rd Ed.,

Bachelor of Engineering
Subject Code: CT 2205
Subject Name: Introduction to Colorants

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To know about Colour & its Chemical Constitution
CO-2	To illustrate the terminology of pigment and its classifications.
CO-3	To impart the knowledge regarding classification of dyes based on application and chemical structure.
CO-4	To know the chemistry of intermediates.
CO-5	To describes the chemistry of Benzenoid Aromatics and its derivatives.
CO-6	To understand the chemistry of naphthalene.

List of Open-Source Software/learning website:

1. NPTEL lectures
2. Dyes & Pigment magazines.
3. Encyclopedia of Chemical Technology

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2206

Subject Name: Introduction to polymer & Rubber

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Professional Core Course

Prerequisite: Basic understanding of chemistry is required along with some commonly known components knowledge is required. Basic structures of polymers and their derivatives are required.

Rationale: The main objective of this subject is to deliver the knowledge of polymer and rubber materials used in polymer and rubber industries.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	0	4	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	A brief History, Basic concepts and development in polymeric material. Polymer formation: Covalent bonds. Double bonds & functionality of monomers. Polymer Structure and Properties.	6
2	Different polymerization Techniques such as Bulk, solution, suspension & emulsion polymerization.	5
3	Physical behavior of polymers in comparison to small molecular compounds in terms of molecular weight & distribution, glass transition temperature, solubility etc. Basic characteristics of addition & condensation polymerization, ionic polymerization, copolymerization.	7
	SECTION-B	
4	**Sources and History of natural Rubber.** Advantages and Disadvantages of Natural Rubber, Difference between Heavea and Gutta Percha Rubber.	8

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5	Production of different grades of natural rubber from latex such as pale crepe and smoke sheet rubber and different grades use of latex. Latex NR latex types and grades; preservation, concentration, stability, gelatin, coacervation.	7
6	**Introduction to Vulcanization Techniques**. Specialty Rubbers: Polyacrylic Rubber, Fluorinated Rubber, Chlorinated PE, Chlorosulphonated PE, Polyurethanes, EVA.	8

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	30	15	10	15	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. "Polymer Science" Vasant R. Gowariker, New Age International, 1986.
2. "Text Book of Polymer Science ", F. W. Billmeyer, John. Wiley & Sons, 1990.
3. "Polymer Science and Technology ", Premamoy Ghosh, Tata McGraw Hill Education, 1990.
4. "Principles of Polymerization ", George Odian, Wiley, 1981.
5. "Principles of Polymer Chemistry ", Paul J. Flory, Cornell University Press, 1953.

Course Outcomes:

After learning this course, students will be able to:

CO No.	**CO statement**
CO-1	To get the knowledge various history of polymeric material.
CO-2	To explain about various polymeric techniques.
CO-3	To Identity the basic characteristics of polymeric material.
CO-4	To be able to understand history of rubber materials.
CO-5	To be able to evaluate various grades of rubber materials.
CO-6	To be able to correlate various specialty rubber materials.

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List of Open-Source Software/learning website:

1. www.iri.net.in
2. www.ipiindia.org
3. Delnet
4. Literature available under R&D in Polymer & Rubber industry.
5. Polymer & Rubber journals
6. Polymer & Rubber dictionaries

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2207

Subject Name: Introduction to Ceramics and Ceramic Raw Materials

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Professional Core Course

Prerequisite: The students should have a clear concept on basic chemistry, geology and Mineralogy that will help them to have an easy grasp of the subject.

Rationale: The main objective of this subject is to offer an overview over the fundamentals and basics of glass and ceramic materials, the raw feed materials for batch preparation, their availability, their properties, their beneficiation processes, process of recovery and their application.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	0	4	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Natural raw materials:** Structure & properties of silicates, different clays, mica, talc, sillimanite, Properties of non – plastic materials, Polymorphic forms of SiO2 & their transformation, Properties, composition, thermal effects, uses of natural materials such as pyrophillite, talc, sillimanite minerals, zircon etc.	05
2	**Plastic raw materials:** Classification of clay, composition, particle size & shape of clays, flocculation & deflocculation, plasticity etc. Major deposits of clays for ceramic industry.	08
3	**Refractory materials:** Properties & deposits of materials such as Bauxite, Magnesite, Dolomite, Limestone, Graphite etc.	08
	SECTION-B	
4	**Fluxing agents:** Composition, availability & properties of different fluxing agents such as Nepheline Syenite, Bone ash, Wollastonite etc.	08
5	**Synthetic raw materials:**	08

Bachelor of Engineering

Subject Code: CT2207

Subject Name: Introduction to Ceramics and Ceramic Raw Materials

	Properties , characteristics, importance & synthesis of important raw materials such as Al2O3, TiO2, Barium titanate, Sodium aluminum silicate, ZrO2, Fumed silica etc.	
6	**Importance of Physical properties:** Particle shape, size, porosity, density & other physical properties.	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
19	26	13	11	11	20

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Elements of ceramics ,Norton F.H, Longman higher education, 2nd Ed, 2001
2. Introduction to ceramics, Barsoum, Institute of Physics Publishing (gb) 2002
3. Introduction to Ceramics, Kingery W.D, Wiley New York : 2nd Ed, 1976
4. Material Science ,Smith, Mcgraw Hill Higher Education, 4th Ed,2005
5. Industrial ceramics ,Singer & Singer, , Oxford &Ibh (From Technip), 1st Ed.,2008

List of Practical: NA

Course Outcomes:

After learning this course, students will be able to:

CO No.	**CO statement**
CO-1	To express their technical knowledge over fundamentals of the subject
CO-2	To understand the difference in raw materials of different kinds of ceramic materials and products
CO-3	To be able to utilize the knowledge of raw materials in correlating other highly technical subjects in the Glass & Ceramic Technology course curriculum

Bachelor of Engineering

Subject Code: CT2207

Subject Name: Introduction to Ceramics and Ceramic Raw Materials

CO-4	To be able to apply this knowledge in their higher study, research work with related technical subjects.
CO-5	To build a bridge between theoretical and practical concept used in industry.
CO-6	To utilize the subject knowledge in solving industry oriented problems in the form of consultancy projects, industry defined projects.

List of Open-Source Software/learning website:

1. NPTEL
2. MIT Open course lecture available on Internet etc.
3. Delnet

Bachelor of Engineering
Subject Code: MH2204
Subject Name: Universal Human Values

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Humanities, Social Science including Management courses (HSMC)

Prerequisite: None. Basics of Universal Human Values (desirable)

Rationale: Course helps the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	-	-	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Introduction to Value Education :** Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity–the Basic Human Aspirations, Right Understanding, Relationship and Physical Facility, Happiness and Prosperity–Current Scenario, Method to Fulfill the Basic Human Aspirations.	8
2	**Harmony in the Family:** Harmony in the Family – the Basic Unit of Human Interaction, Values in Human-to-Human Relationship, Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation.	5
3	**Harmony in the Nature/ Existence:** Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at all levels, The Holistic perception of Harmony in Existence.	7
	SECTION-B	

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Subject Name: Universal Human Values

4	**Harmony in the Human Being :**Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health	8
5	**Harmony in the Society:** Understanding Harmony in the Society: Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive human goals, Visualizing a universal harmonious order in society.	4
6	**Implications of the Holistic Understanding – A Look at Professional Ethics :**Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession	7

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**20**	**20**	**10**	**10**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Text Books:

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93- 87034-47-1.

2. R R Gaur, R Asthana, G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2.

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Subject Name: Universal Human Values

Reference Books:

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. A.N. Tripathi,, Human Values, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book)
4. Mohandas Karamchand Gandhi "The Story of My Experiments with Truth"
5. E. F Schumacher, "Small is Beautiful".
6. Cecile Andrews, "Slow is Beautiful".
7. J C Kumarappa, "Economy of Permanence"
8. PanditSunderlal, "Bharat Mein Angreji Raj"
9. Dharampal , "Rediscovering India"
10. Mohandas K. Gandhi, "Hind Swaraj or Indian Home Rule"
11. Maulana Abdul Kalam Azad , "India Wins Freedom"
12. Romain Rolland, "Vivekananda" (English)
13. Romain Rolland, "Gandhi" (English)

Course Outcomes:

After learning this course students will be able to:

Sr. No.	CO statement
CO-1	Relate themselves with the surroundings (family, society, nature)
CO-2	Explain sustainable solutions with respect to problems, keeping in mind the correlation between human relationships and human nature.
CO-3	Apply what they have learnt, into various day to day schedule.
CO-4	Distinguish between ethical and unethical practices and start working out the strategy in order to materialize a harmonious environment in the work place.
CO-5	Justify their commitment with respect to their understanding regarding human values, relationship and society.
CO-6	Develop the understanding of the intricacy of the problem and design appropriate solution.

Bachelor of Engineering
Subject Code: MH2204
Subject Name: Universal Human Values

List of Open Source Software/learning website:

- **https://www.uhv.org.in**
- **https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw**

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: CT2208
Subject Name: Physical Chemistry

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Basic Science

Prerequisite: Needs basic knowledge of Chemistry which will help students to understand the subject.

Rationale: The main objective of this subject is to provide a strong basis of physical chemistry that will be applicable to other areas of the degree course such as chemical reaction engineering and the design project, with specific reference to applications relating to sustainable development**.**

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				otal Mar
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Gaseous state & Interfacial chemistry:** Molecular Molecular diffusion & effusion, critical constants & liquefaction of gasses, equation of state, supercritical fluids & their applications. Surface free energy, capillary & surface tension, bubbles, droplets, Young Laplace equation, super saturation, solid – liquid interfaces, surface active agents, emulsions.	**08**
2	**Kinetics & molecular reaction dynamics:** Significance of reaction kinetics, rate law, rate constants, order of reaction, reversible reactions & equilibrium, parallel & consecutive reactions, chain reactions, rate determining parameters. Chemical potential & chemical reactions. Effect of temperature on reaction rates, free energy of reaction, collision theory.	**08**
3	**Catalysis:** Criteria for catalysis, Homogenous catalysis: Acid Base, Enzymatic & Catalysis, Heterogeneous catalysis, Concept of promoters, inhibitors & poisoning.	**06**

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Subject Code: CT2208
Subject Name: Physical Chemistry

	SECTION-B	
4	**Electrochemistry:** Equilibrium electrochemistry – electrochemical cells, half-cell reactions, type of electrochemical cells, free energy & EMF, Nernst equation, EMF measurements. Relevance of electrochemical reactions.	**08**
5	**Phase rule:** Definition & various terms, Gibb's phase rule, Application of Phase rule to one component system : Water & Sulphur & two component system : Lead & Silver	**06**
6	**Thermodynamics:** Internal Energy ,Isothermal reversible expansion work of an ideal gas, Isothermal irreversible expansion work of an ideal gas, First Law of Thermodynamics, Enthalpy of a System, Molar Heat Capacities at constant pressure & volume, Relation between Cp and Cv Entropy, Statement of second law of thermodynamics, Free energy function(G) and work function(A),Gibb's Helmholtz equations	**08**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**15**	**15**	**10**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Physical Chemistry , 4th Edition, Silbey, Alberty and Bawendi, Wiley, 2006.
2. Physical Chemistry of surfaces,6th Edition , Arthur W.Adamson, Alice P. Gast, Wiley, 1997.
3. Essential of Physical Chemistry, G D Tuli, B S Bahl, ArunBahl, S.Chand Publisher, 2000. Physical Electrochemistry: Fundamentals, Techniques and Applications, EliezerGileadi, Wiley-VCH, 2011.
4. Physical Chemistry : A molecular approach , D. A. Mcquarrie& J.D.Simon,1998 Surfaces, Interfaces& Colloids: Principles & applications, Drew Myers, Wiley VCH, 2nd Ed., 1999
5. The Elements of Physical Chemistry , Peter Atkins, Oxford ,3rd Ed. ,2000

6. Introduction to Colloid & Surface Chemistry, Duncan J Shaw, Butterworth-Heinemann, 5th Ed.,1992
7. Physical Chemistry of Surfaces, Arthur W. Adamson, Alice P. Gast, John Wiley & Sons, Indian Ed.,1997
8. Chemical Kinetics & Catalysis, Masel R.J., John Wiley & Sons, 1st Ed, 2001
9. Chemical Kinetics & Reaction Dynamics, Houston P.H., McGraw Hill Book Company, 2nd Ed, 2001
10. Elements of Physical Chemistry, Atkins P., Oxford Press, 3rd Ed., 2000
11. Catalytic Chemistry, Gates B.C., John Wiley & Sons,2nd Ed., 1992
12. Principles & Practice of Heterogeneous Catalysis, Thomas J.M. & Thomas W.J., John Wiley & Sons, 1996

List of Practicals (Any Ten):

1. To study the relative strength in the hydrolysis of ester in presence of an acid.
2. To determine the solubility of Benzoic acid at different temperatures and calculate its heat of solution.
3. To study the first order reaction in the hydrolysis of ester in presence of an acid at two different initial concentrations
4. To standardize the solution of NaOH & HCl using 0.1 N oxalic acid.
5. To determine the strength of the given Hydrochloric acid using Sodium hydroxide pHmetrically.
6. To Determine the turbidity of given sample in NTU unit by turbidity meter.
7. To determine the Phase Diagram for acetic acid, chloroform and water system. (three component system)
8. To determine λ_{max} and concentration of unknown solution of $KMnO_4/K_2Cr_2O_{7/}$ in 2 N H_2SO_4 using Colorimeter.
9. To determine the activation energy for the hydrolysis of methyl acetate.
10. To determine the strength of the given Hydrochloric acid using Sodium hydroxide Conductometrically.
11. To study the effect of concentration of reactant on the rate of reaction between sodium Thiosulphate and hydrochloric acid
12. To study the effect of temperature of reactant on the rate of reaction between sodium Thiosulphate and hydrochloric acid
13. VLab demo:Colorimeter

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To define concept of science to solve engineering problems
CO-2	To understand rate and order of various chemical reaction.
CO-3	To apply this knowledge to other areas of the degree course to process development.

CO-4	To explain the importance and relevance of different chemistry like thermo, electro and surface in designing projects.
CO-5	To analyse various reaction kinetics, mechanism and systems to solve technical problems.
CO-6	To devise the ideas (not overshadowed by mathematics) about the behaviour of molecules and systems in order to be able to cope with experimental testing.

List of Open-Source Software/learning website:

1. NPTEL
2. MIT Open course lecture available on Internet etc
3. Delnet

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: CT2209
Subject Name: Basics of Heat Transfer

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Core Course

Prerequisite: A good understanding regarding basic modes of heat transfer viz. conduction, convection and radiation with governing laws underlying this heat transport mechanisms. Mathematical background is also essential in this respect.

Rationale: Heat transfer is a necessary process in virtually all forms of energy generation and use; from coal fired to nuclear power stations, from automobile engines to rocket motors, from refrigerating cold stores to air conditioning space vehicles. This subject is intended to make students aware about mechanisms involved in heat transfer process in many of aforementioned applications. This ultimately will enable the students to design the equipments for heat process viz., shell and tube heat exchangers, evaporators, condensers.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Basic Concepts: Overview of applications of heat transfer in different fields of engineering, heat transfer with and without change of phase. Conduction: Mechanism of heat conduction, Fourier's law, thermal conductivity, effect of temperature on thermal conductivity, General heat conduction equation, Boundary conditions, Formulation of heat transfer problems without generation of heat, Conduction through different systems of constant thermal conductivity. Electrical analogy to heat flow, Critical and Optimum thickness of Insulation. Unsteady State heat Conduction: Analysis of transient heat flow with negligible internal resistance-lumped capacity analysis, concept of Biot Modulus and Fourier number	10

Bachelor of Engineering
Subject Code: CT2209
Subject Name: Basics of Heat Transfer

2	Convection: Mechanism, thermal and velocity boundary layers, boundary layer thickness, relationship between hydrodynamic and thermal boundary layer thickness for flow over flat plates, the convective heat transfer coefficient, reference temperatures, thermal boundary layers for the cases of flow over a flat plate and flow through pipe, dimensionless numbers in heat transfer and their significance. Forced Convection: General methods for estimation of convection heat transfer coefficient, Correlation equations for heat transfer in laminar and turbulent flow for external and internal flows for constant heat flux and wall temperature conditions- flow in a circular tube, Analogy between momentum and heat transfer: Reynold's and Prandtl analogy. Overview of Colburn and Von-A Natural Convection: Dimensional analysis, natural convection from vertical and horizontal surfaces under laminar and turbulent conditions for plates, cylinders, physical significance of Grashoff and Rayleigh numbers.	10
3	Heat transfer by radiation: Introduction- theories of radiation, electromagnetic spectrum, thermal radiation, spectral emissive power, surface emission- total emissive power, emissivity. Radiative properties, Emission, irradiation, absorptivity, reflectivity and transmissitivity. Concept of black and grey body, radiation intensity, Laws of black body radiation, non-black surfaces- Grey, white and real surface, Lambert's cosine law, radiation between black surfaces and gray surfaces.	06
SECTION-B		
4	Heat Exchangers: Classification of heat exchangers, Shell and tube heat exchanger, fouling, concept of overall heat transfer coefficient, LMTD, correction factor for LMTD, Sizing and rating problem using LMTD method different flow of heat exchangers, Temperature – distance plots for different flow arrangements in single and multi-pass heat exchangers. Determination of area, length, number of tubes required for a given duty in different configurations using LMTD method of analysis. Concept of Effectiveness-NTU method, definition of effectiveness, effectiveness NTU relations for single pass exchangers in counter-flow and parallel flow configurations. Double pipe heat exchangers: - construction, various steps for the design of double pipe heat exchangers. Plate and spiral heat exchangers, Condensers	08
5	Boiling and Condensation: Pool boiling - Boiling curve, hysteresis in the boiling curve, mechanism of nucleate boiling, Forced convection boiling - Brief over view of internal forced convection boiling. Condensation: Physical mechanisms, types of condensation, factors affecting condensation.	08

Bachelor of Engineering
Subject Code: CT2209
Subject Name: Basics of Heat Transfer

6	Evaporation: Principle of Evaporation, types of evaporators- their construction and operation, Single effect and multiple effect evaporators, Performance of evaporators, capacity and economy of evaporators, Overall heat transfer coefficient, effect of liquid head and boiling point elevation. Material and energy balances for single effect evaporator and the calculations on single effect evaporator. Multiple effect evaporators, Energy Balance.	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	15	15	10	10	5

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Binay. K. Dutta, "Heat Transfer Principles and applications" Prentice Hall of India
2. Kern D Q, Process Heat Transfer, McGraw Hill Book Co. (1997).
3. Coulson J M and Richardson J F, Chemical Engineering Volume 1, Pergamon Press (1999).
4. Holman J. P, "Heat Transfer", McGrawHill.
5. Rao Y.V.C, "Heat Transfer", University Press, India
6. Cengel A. Yunnus. "Heat Transfer – A Practical Approach", McGraw Hill
7. Ozisik M. N, "Heat Transfer - A Basic Approach", McGraw-Hill.
8. Geankopolis C J, Transport Processes and Separation Process Principles, Prentice Hall of India, 4th Edition, Eastern Economy Edition (2004).

List of Practical:

1. Determination of thermal conductivity of solids
2. Determination of heat transfer coefficient by natural convection
3. Determination of heat transfer coefficient by forced convection
4. Determination of overall heat transfer coefficient for counter flow in laminar regime in double pipe heat exchanger
5. Determination of overall heat transfer coefficient and efficiency in shell and tube heat exchanger
6. Heat Transfer in Composite walls- Determination of effective thermal conductivity and overall resistance
7. Determination of overall heat transfer coefficient and efficiency in finned tube heat exchanger
8. Determination of overall heat transfer coefficient and efficiency in plate type heat exchanger

9. Determination of heat transfer coefficient in turbulent flow regime in a double pipe heat exchanger
10. Determination of Stephan Boltzmann constant experimentally.
11. Determination of economy and capacity of open pan evaporator.
12. Determination of economy and capacity of multiple effect evaporators.

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To identify different modes of heat transfer and understand basic mechanism of conduction.
CO-2	To explain heat transfer under different convective regimes.
CO-3	To predict extent of heat flow by radiation throguh grey, white and real surfaces.
CO-4	To analyze heat transfer through different types of heat exchangers used for various applications.
CO-5	To describe industrial applications and regimes involved in boiling and condensation.
CO-6	To categorize different types of evaporators with their performance evaluation and to analyze material and energy balance for single and multi-effect system.

List of Open-Source Software/learning website:

Reference to NPTEL lectures can be made for a better understanding regarding fluid flow under different conditions.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2210

Subject Name: Mechanical Operation

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Core Course

Prerequisite: A good understanding regarding fluid flow, material and energy balances. Basic knowledge about the principles and equipment of solid-solid unit operations and solid-liquid unit operations is mandatory for any professional chemical engineer.

Rationale: This subject is intended to make students aware about various types of equipments and unit operations used for processing different feed materials. This subject provides the fundamental knowledge regarding to particle size reduction and enlargement by various methods and also deals with the detail construction & working of equipment's used for mechanical operations.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Techniques: d its flow properties: Definitions of the mean diameters of the solid Characterization of solid particles, Mixed particles sizes and analysis, Scree properties of particulate masses, cumulative and differential analysis.	04
2	Size Reduction, Enlargement & Screening: Principles of comminution, Rittinger's and kick's laws, Bond's crushing law and work index, Size reduction equipment, crushers, grinders, Ultra-fine grinders, Cutting machines, Open circuit and closed circuit operation, Different screening equipment, Comparison of ideal and actual screens, Screen effectiveness.	08
3	Filtration: Various mechanism of filtration, Cake filters- constant pressure and constant rate filtration,, Filter press, Shell and leaf filters, Rotary drum filters, Centrifugal filters, Filter media, Filter aids.	08

Bachelor of Engineering
Subject Code: CT2210
Subject Name: Mechanical Operation

	SECTION-B	
4	Classification & Sedimentation: Classification, Sink and float method, Differential settling methods, Clarifiers and thickeners, Batch sedimentation, Rate of sedimentation, Thickeners, sedimentation zones in continuous thickeners, Cyclones, Hydrocyclones	10
5	Centrifugal methods of separation: Centrifugal filtration - batch, semi and continuous types of centrifuges - centrifuges for liquid-liquid and liquid-solid separation - critical speed.	08
6	Gas cleaning methods, Transportation & Storage of bulk solids: Bag filters, cyclone separation, electrostatic separation, scrubbing Storage of solids, liquids and gases. Transportation of bulk solids - different methods of transportation - type of conveyors and selection.	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	15	15	10	10	5

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. W.L.Mc.Cabe, J.C.Smith and P.Harriot, "Unit operations of chemical engineers", McGraw Hill International edition VII.
2. Badger and Banchero, "Introduction to Chemical Engineering" McGraw Hill.
3. Brown T., "Unit Operations", Asia publishing House
4. Allen T, "Particle Size Measurement" Chapman and Hall, London, 1977.
5. Foust, "Principles of Unit Operations", McGraw Hill.
6. Coulson and Richardson, "Chemical Engineering", Vol 2, Pergamon Press.

List of Practical:

1. Batch sedimentation test.
2. To determine critical speed, work index, Bond's constant, Rittinger's law constant, Kick's law constant for Ball mill
3. To determine screen efficiency for the given sample.
4. To verify laws of crushing.
5. To calculate efficiency of cyclone separator
6. To determine angle of nip, reduction ratio, rittinger's constant, Bond's constant, Kick's constant and work index for Roll crusher
7. To study the effect of froth flotation in recovery of sample from given solution.

8. To study filter press
9. To study experiments based on filtration
10. To study how power consumption of an agitator changes with Reynolds number and Froude number.

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To identify various terms associated with size of particles and their analysis in particulate handling operations.
CO-2	To explain various laws relating to size reduction and understanding regarding functioning of size reduction and screening equipments.
CO-3	To apply particulate techniques for separation of solids from bulk of fluid through filtration.
CO-4	To differentiate classification and sedimentation for separation of solid phase from liquid or concentration of solids from slurry using thickeners.
CO-5	To describe fundamentals of centrifugal separation with various types and industrial application.
CO-6	To relate functioning of different equipments used for gas cleaning along with conveyors for solid handling and transportation.

List of Open-Source Software/learning website:

Reference to NPTEL lectures can be made for a better understanding regarding fluid flow under different conditions.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2211

Subject Name: Medicinal Chemistry-I & Introduction to Microbiology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Core Course

Prerequisite: Studied subject Introduction to Medicinal Chemistry, Biochemistry & Human Physiology. Basic knowledge of Biology, Organic chemical reactions and fundaments of human body systems is required.

Rationale: The main objective of this subject is to study Drug discovery & drug design, chemistry & mechanism of action of drugs and basics of Microbiology, Immunology and morphological studies of microorganism.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Medicinal Chemistry:** MOA, SAR, metabolism, synthesis & drug profile of: Thrombolytics, Coagulants/Anticoagulants, Histamine & Antihistamines, Local anesthetics, Antacids, Antiulcer drugs, Anthelminitics, Antifungal agents, NSAIDs	13
2	**Introduction to Microbiology:** Microscope & Staining: Microscopy- concept of magnification resolution, basic of light microscopes. Dyes & stains, Observation of microorganism under light microscopy-wet mount, hanging drop, gram staining & acid fast stains.	5
3	**Culture:** Cultivation & growth requirements, nutritional aspects & other conditions. Basis of growth media classification-principles & application. Concept of pure culture, isolation, preservation & maintenance of pure cultures.	5
	SECTION-B	

Bachelor of Engineering
Subject Code: CT2211
Subject Name: Medicinal Chemistry-I & Introduction to Microbiology

4	**Drug Discovery Process and Drug Design:** General introduction to drug discovery, meaning of hit, lead, lead development, lead optimization. Various phases of clinical trials, Introduction to various sources and approaches for new chemical entities- Examples of drug discovery & design-Aspirin, Chloroquine, Cimetidine, Types of drug receptors, General screening approaches outline. Source: Medicines used in folklore and traditional system of treatment and their regulatory requirements to market. a) Random screening approach,. b) Analog design and tools: SAR, QSAR, CADD	11
5	**Morphology:** Basis of identification & Characteristics of microorganisms Study of morphology, characteristics & reproduction of bacteria, fungi, algae & viruses.	6
6	**Immunology & Concept of vaccine:** Basic classification of antigen/antibody, immunoglobulins, concept of allergy-antigen & antibody reaction. Concept of vaccines : Manufacture of bacterial & viral vaccines. Sterilization-methods & aseptic techniques, sterility testing.	6

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**20**	**10**	**10**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Burger's Medicinal Chemistry & Drug Discovery: Vol. 1 to 6, A. Burger &M.E.Wolff,John Wiley & Sons – New Jersey,6th Ed, 2003.
2. Foye's Principles of Medicinal Chemistry, W.O. Foye, Lippincott Williams & Wilkins-Philadelphia, Oxford, 6th Ed, 2008.
3. Pharmaceutical Microbiology,S S Purohit, Agrobios, 2003.
4. Medicinal Chemistry, Ashutosh Kar, 5th revised & expanded Ed, New Age International Publishers 2010.
5. Text Book of Medicinal Chemistry, Vol-I & Vol-II, Alagarsamy, 2nd Ed, Elsevier 2014.
6. Microbiology, Pelczar, Chan, Krieg, 5th Ed, McGraw Hill education 1993.

Bachelor of Engineering

Subject Code: CT2211

Subject Name: Medicinal Chemistry-I & Introduction to Microbiology

List of Practical:

1. To study microscope & other common Microbiology laboratory equipment.
2. To identify microorganism by different staining techniques.
3. To study the inoculation techniques in Microbiology.
4. To study the media and culture of microorganisms.
5. To study the motility of microorganisms by different techniques.
6. To study the reflux, distillation, vacuum distillation by setting up of these assemblies.
7. To study the esterification reaction and to prepare an ester intermediate.
8. To study Friedel-Craft reaction and to prepare an intermediate by this reaction.
9. To synthesis one/two simple drug substances by one step/two steps reaction.
10. Literature study of any two drug substances.

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To know the Medicinal Chemistry of drugs by applying the basic knowledge of Organic Chemistry, Physiology & Biochemistry.
CO-2	To explain Microscopy and the identification techniques of Microorganisms.
CO-3	To apply the knowledge of Microbiology in studying the culture of microorganisms.
CO-4	To illustrate the drug discovery process & drug design.
CO-5	To describe the morphology of microorganisms.
CO-6	To Summarize the concept of immunology & vaccine.

List of Open-Source Software/learning website:

1. Literature available on internet
2. Medical dictionaries
3. Delnet
4. Literature available under R&D in Pharma industry.
5. Pharma Journals/ e-journals

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT 2212

Subject Name: Chemistry & Technology of Colorants

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - IV

Type of course: Professional Core Course

Prerequisite: Basic knowledge of dyes and pigment chemistry, unit processes carried out in industries.

Rationale: The main objective of this subject is to study chemistry of dyes and pigments. Under technology part students is to study the various unit processes.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Unit-I: Chemistry of azo dyes:** Mechanism of diazotization & coupling reactions. Methods of diazotization, Coupling position of various coupling components. Azoic dyes. Monoazo & Disazo acid dyes. Substituent for benzidine.	**8**
2	**Unit-II: Chemistry & Technology of Dyestuff Intermediates-I:** **Basic Unit processes:** **Sulphonation:** Reaction mechanism and conditions, Sulphonating Agents and solvents, Work up and Material of construction, Substitution in benzene and substituted benzene, Plant and process flow, Safety and process control parameters **Halogenation:** Basic nucleophilic and Electrophilic substitution, Reaction and Material of construction	**10**
3	**Chemistry & Technology of Dyestuff Intermediates-II:** **Basic Unit processes:** **Nitration:** Reaction phenomenon and condition, Nitrating agents and solvents, Work up and Material of construction, substitution in benzene and substituted benzene, Plant and process flow, Safety and process control parameters,Nitration of toluene, anthraquinone, chloro derivatives,	**8**

Bachelor of Engineering
Subject Code: CT 2212
Subject Name: Chemistry & Technology of Colorants

	aromatic sulphonic acid, Nitosation reaction, Skraup's synthesis, Fridel-craft's reaction. **Reduction:** Reducing agents Reduction methods, Selection of best method for Benzene and substituent, Process and workup, Safety aspect	
SECTION-B		
4	**Unit-IV: Chemistry & Technology of Azo Pigments** Azo pigments: Diazo components & its derivatives, Coupling compounds and its derivatives, Monoazo yellow and Orange pigments, Bisazo pigments, β- Napthol pigments, Napthol AS pigments, BONA Pigments, Benzimidazolone pigments, Bisazo condensation pigments, Metal complex pigments	**10**
5	**Unit-V: Chemistry & Technology of Organic pigments-II:** Polycyclic pigments : Phtahlocyanine pigments, Quinacridone pigments, Perylene and Perinone pigments, Daketopyrrolo-pyrole pigments, Thioindigo pigments, Aminoanthraquinone pigments, Hydroxyanthraquinone pigments, Dioxazine pigments, Quinophthalone pigments etc.	**10**
6	**Unit-VI Chemical and Physical Characterization of Pigments:** Crystal Modification and Crystal Structure, Tinctorial Strength, Lightfastness and Weatherfastness, Solvent and Migration Fastness Specific Surface Area, Particle Size Distribution, Determination by Electron Microscopy, Color Depth, Color Differences, Hiding Power, Fastness to Solvents, Bleeding/Over spraying Fastness	**10**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**10**	**10**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

1. Dr. G. R. Chatwal, "Synthetic Dyes", Himalaya Publications, 2009.
2. G. Buxbaum, "Industrial Inorganic Pigments", ISBN 3-527-28878-3, 2nd Ed., 1998.
3. Lubs H.A., Robert E, "Chemistry of Synthetic Dyes", Krieger Publishing Company NewYork, 1st Ed., 1995.
4. Heinrich Zollinger, Wiley-VCH, "Color Chemistry: Syntheses, Properties and Applications of Organic Dyes and Pigments", 2nd Ed, 1991.
5. Venkatraman K., "Chemistry of Synthetic Dyes – Vol I", Academic Press, New York, 2009
6. Venkatraman K., "Chemistry of Synthetic Dyes – Vol II", Academic Press, New York, 2009

7. Venkatraman K., "Chemistry of Synthetic Dyes – Vol III", Academic Press, New York, 2009
8. W M Morgans, "Outlines of Paint Technology", CBS Publishers, 3rd Ed., 1996

List of Practicals

1. Preparation of Fluorescein
2. Preparation of Indophenol blue
3. Preparation of Mordant Yellow.
4. Preparation of Malachite Green Dye
5. Preparation of Rosaniline Dye
6. Preparation of Phenolphthalein Dye
7. Preparation of Alizarin
8. Preparation of Methyl orange
9. Preparation of Azo pigment
10. Preparation of Polycyclic pigments

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To know the Chemistry of azo dyes.	15
CO-2	To develop the knowledge of Chemistry & Technology of Dyestuff Intermediates	15
CO-3	To learn about the heterocyclic intermediates	20
CO-4	To illustrate the Chemistry & Technology of Azo Pigments	15
CO-5	To understand the Chemistry & Technology of Organic pigments-II	20
CO-6	To Chemical and Physical Characterization of Pigments	15

List of Open Source Software/learning website:

- Literature available on internet
- Dyes & Pigment dictionaries
- Delnet
- Literature available under R&D in Dyes & Pigments industry.
- Dyes & Pigments journals

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2213

Subject Name: Chemistry of Polymer & Rubber

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Core Course

Prerequisite: Basic Knowledge of various unit processes are required. Common chemical structures and its properties should be known to the students.

Rationale: The main objective of this subject is to deliver the knowledge of basics of polymer technology and raw materials used in polymer and rubber industries.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Polymer Structure & Properties relationship.** Polymer formation: Covalent bonds. Double bonds & functionality of monomers. Physical behavior of polymers in comparison to small molecular compounds in terms of molecular weight & distribution, glass transition temperature, solubility etc. Behavior of polymer solutions, LCST & UCST.	4
2	**Polymer Reaction:** Hydrolysis, Acidolysis, Aminolysis, Hydrogenation, addition and substitution reactions of various specific groups, cyclisation reaction, cross linking reaction, miscellaneous reactions.	8
3	Kinetics of polymerization & its relevance to engineering aspects. Bulk, solution, suspension & emulsion, polymerization processes & engineering problems associated with these techniques.	5
	SECTION-B	
4	Chemistry of Natural rubber and its intermediates, latex collection & purification, Chemistry of Neoprene, Butyl rubber, Nitrile rubber, Synthetic rubbers, & elastomers.	7

5	Chemistry of natural polymers such as cellulose, starch, lignin, Chitin, Chitosan, proteins and biopolymers.	7
6	**Rubber Mastication:** Machinery of mastication, Chemistry of mastication. Compounding of natural and synthetic rubber compounding ingredients and methods of compounding.	8

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	15	15	10	5	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Rubber Materials and their components, by J. A. Brydson
2. Rubber Technology : by Maurice Morton
3. Natural Rubber Science and Technology, by Roberts
4. Handbook of Rubber Projects, Technology and Product Formulations, by SBP Consultants & Engineers (P) Ltd.
5. Raw Materials for Industrial Polymers , H Ulrich, Hanser Publication ,1989
6. Principles of Polymer Science, Bahadur&Sastry, Narosa Publishing Houses, 2002
7. Polymer Science , Gowarikar,John Wiley & Sons ,1986.
8. Encyclopedia of Polymer Science & Engineering, John Wiley & Sons, Inc, 1988
9. Textbook of Polymer Science, Billmeyer,John Wiley & Sons, 1984
10. Textbook of Polymer Science, P Nayak and S Lenka, Kalyani Publishers, 1986
11. Polymer Chemistry, Seymour and Carraher, Marcel Dekker, 2003

List of Practical:

1. Identification of given polymeric samples.
2. To find out Acid value of a given sample.
3. Determination of Viscosity Average Molecular Weight of Polymer.
4. To find out Amine Value of a given sample.
5. Determination of Iodine Value of the oil Sample.

6. To determine the ester value of given sample.
7. To determine the epoxy equivalent weight of given sample.
8. Molecular weight determination of polymers.
9. Techniques of ensuring end capping polymerization.
10. Softening point and temperature stability testing of polymers.

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To know about the structure and properties relation of polymers.
CO-2	To be able to utilize the knowledge for the polymerization reaction of polymers.
CO-3	To be able to apply this knowledge for understanding the kinetics of polymers.
CO-4	To be able to understand chemistry of rubber and its intermediates.
CO-5	To be able to compare various biopolymers.
CO-6	To be able to modified rubber material with the help of mastication process.

List of Open-Source Software/learning website:

1. www.iri.net.in
2. www.ipiindia.org
3. Delnet
4. Literature available under R&D in Polymer & Rubber industry.
5. Polymer & Rubber journals
6. Polymer & Rubber dictionaries

Bachelor of Engineering
Subject Code: CT2214
Subject Name: Refractories-I

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Core Course

Prerequisite: The students should have a clear concept on basic chemistry, geology and Mineralogy that will help them to have an easy grasp of the subject.
Rationale: The main objective of this subject is to offer an overview over the fundamentals and basics of refractory and ceramic materials, types of refractories, their availability, their properties, their beneficiation processes, process of recovery, testing and their application.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Scope of refractory Industry - Global and Domestic Market Scenario. Fundamentals of refractory science and engineering, Brief review of raw materials, gap grading, continuous grading.	05
2	Manufacturing, Properties and applications of following refractories: Silica Refractories, Super duty, Semi silica refractories, High Alumina and Alumino Silicate Refractories: Significance of Phase diagram in the development of different phases – Sintered and fused alumina.	08
3	Basic Refractories: Magnesite, dolomite, lime and chromite, Production of Burnt refractories – Sintered and fused refractories: - Chemically bonded and Direct bonded.	08
	SECTION-B	
4	Testing of important properties of Refractories: Chemical analysis, Phase analysis ,Physical Testing: - A.P., B.D., Total Porosity, Gravity, Pore size distribution, C.C.S., Cold M.O.R.	08
5	Importance of Phase diagram in refractory, Phase rule, Eutectic, peritectic, Two component systems – Al_2O_3 – SiO_2; Al_2O_3 – MgO; MgO – Cr_2O_3; MgO – CaO	08

Bachelor of Engineering
Subject Code: CT2214
Subject Name: Refractories-I

6	Hot M.O.R., PCE, RUL, Compressive Strength, PLCAR, Spalling Resistance, reversible thermal Expansion, CO – disintegration, corrosion resistance	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
19	26	13	11	11	20

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Elements of ceramics ,Norton F.H, Longman higher education, 2nd Ed, 2001
2. Introduction to ceramics, Barsoum, Institute of Physics Publishing (gb) 2002
3. Introduction to Ceramics, Kingery W.D,. Wiley New York :, 2nd Ed, 1976
4. Material Science ,Smith, Mcgraw Hill Higher Education, 4th Ed,2005
5. Industrial ceramics ,Singer & Singer, , Oxford &Ibh (From Technip), 1st Ed.,2008

List of Practical:

1. Powder Preparation -- Crushing fireclay grog. Size separation of grog
2. Characterization of different clays -- Ball clay, Plastic clay etc
3. Determine grain B.D., Grain porosity, Grain Sp. Gr., Tap density of ceramic materials
4. Body preparation with Temporary binders (Dextrin, Starch etc.) and Ceramic binders
5. Study of effect of Composition, Forming pressure & Firing temperature on some properties of refractory bricks.
6. Fabrication of some high alumina & basic bricks
7. Testing of various important properties of refractories as per IS
8. Refractory corrosion test
9. Differential Thermal Analysis : Studies with Ceramic Raw Materials like China clay, Ball clay, Fireclay, Pyrophillite, Quartz, Magnesite

10. Differential Thermal Analysis: Dolomite, calcite, Aluminium hydroxide, Magnesium hydroxide etc. Interpretation of data.

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To express their technical knowledge over fundamentals of the subject
CO-2	To understand the difference in raw materials of refractories from other ceramic raw materials.
CO-3	To be able to utilize the knowledge of raw materials in correlating other highly technical subjects in the Glass & Ceramic Technology course curriculum
CO-4	To be able to apply this knowledge in their higher study, research work with related technical subjects.
CO-5	To build a bridge between theoretical and practical concept used in industry.
CO-6	To utilize the subject knowledge in solving industry oriented problems in the form of consultancy projects, industry defined projects.

List of Open-Source Software/learning website:

1. NPTEL
2. MIT Open course lecture available on Internet etc.
3. Delnet

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2215

Subject Name: Chemistry of Natural Products & Pharmaceutical Packaging Technology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Elective Course

Prerequisite: Studied subject Introduction to Medicinal Chemistry, Biochemistry & Human Physiology. Basic knowledge of Biology, Organic chemical reactions and fundaments of human body systems is required. Basic knowledge of drug dosage forms and their packaging is desirable.

Rationale: The main objective of this subject is to study the classification, Chemistry, biological roles of Natural products and to study the various packaging technologies of drug dosage forms.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Vitamins, Peptide, Protein & Carbohydrate drugs:** Synthesis & Bioorganic chemistry of Vitamins, Peptide & protein drugs, Carbohydrate drugs, role of vitamins as coenzyme.	10
2	**Pyrethroids and Retinones:** Occurrence, reactions, biological activity, structure and Chemistry **Eicosanoids:** Classifications, nomenclature, and chemical properties, and biological activity of Thromboxanes, Prostaglandins, Leukotrienes **Pheromones:** Structure, general chemistry and properties, examples	07
3	**Marine Natural Products:** Introduction, occurrence and characteristic structural features, And structure of few marine products **Porphyrins**:Structure, general chemistry and properties, examples Haemoglobin, chlorophyll, cytochromes.	06
	SECTION-B	

Bachelor of Engineering

Subject Code: CT2215

Subject Name: Chemistry of Natural Products & Pharmaceutical Packaging Technology

4	**Pharmaceutical Packaging:** Introduction to Packaging, classification of Packaging, essential requirements, Functions of Packaging, Importance, significance of Pharma Packaging, Properties, of Ideal Package, Packaging formats in Pharma Industry, FDA Definitions	05
5	**Introduction to packaging material**: classifications of packaging materials. Introduction to glass, plastic and metal as packaging material, types of glass, plastic & metal and their advantages & disadvantages; type of glass, plastic and metal containers and their evaluation methods. Introduction to ancillary packing materials. Introduction to Closures & sealing system, classification of contemporary closures by their utility, Special closures, sealing system, closure liners, tamper proof closures	09
6	**Introduction of blister packing and strip packing**: types of blisters, blister & strip packaging process, advantages & disadvantages, machinery used for blister and strip packing, other packages, child resistant packing. Introduction, Packaging of Sterile Pharmaceuticals, Packaging Components, Packaging of Ophthalmics, Selection of Packaging, packaging of aerosols. Defects in packaging, New trends in pharmaceutical packaging	09

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**20**	**10**	**10**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Burger's Medicinal Chemistry & Drug Discovery: Vol. 1 to 6, A. Burger &M.E.Wolff,John Wiley & Sons – New Jersey,6th Ed, 2003
2. Foye's Principles of Medicinal Chemistry, W.O. Foye, Lippincott Williams & Wilkins-Philadelphia, Oxford, 6th Ed, 2008.
3. Bentley's Textbook of Pharmaceutics, E.A. Rawlins,8th Ed.,Reed Elsivier India.
4. Phytopharmaceutical Technology, P.H.List &P.C.Schmidt, Wiley India Pvt. Ltd.
5. Text Book of Medicinal Chemistry, Vol-I & Vol-II, Alagarsamy, 2nd Ed, Elsevier 2014.
6. Organic Medicinal & Pharmaceutical Chemistry, Wilson & Gisvold, 12th Ed. Lippincott Willmas & Wilkins Publishers.
7. Krishna's Organic Chemistry- Natural Products, Vol-II,O.P Agarwal, Krishna Prakashan Media (P) Ltd.

Bachelor of Engineering

Subject Code: CT2215

Subject Name: Chemistry of Natural Products & Pharmaceutical Packaging Technology

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To know the bioorganic Chemistry of Vitamins, Peptide & protein drugs, Carbohydrate drugs.
CO-2	To explain the Chemistry and biological activity of Pyrethroids, Retinones, Eicosanoids and Pheromones.
CO-3	To apply the knowledge of structural features & characteristics of marine natural products,& porphyrins.
CO-4	To illustrate the classification, functions of Pharmaceutical Packaging.
CO-5	To describe the packaging materials and closures.
CO-6	To Summarize the concept of different packaging technologies and sterile packaging.

List of Open-Source Software/learning website:

1. Literature available on internet
2. Medical dictionaries
3. Delnet
4. Literature available under R&D in Pharma industry.
5. Pharma Journals/ e-journals

Bachelor of Engineering
Subject Code: CT 2216
Subject Name: Synthetic Colorants

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - IV

Type of course: Professional Elective Course

Prerequisite: The student should have studied the chemistry of colorants.

Rationale: The main objective of this subject is to study the synthesis of various types of dyes and pigments used in chemical industries.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE I	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	00	100

L-Lectures; T-Tutorial/Teacher Guided Student Activity; P-Practical; C-Credit; ESE-End Semester Examination; PA-Progressive Assessment

Content:

Sr. No.	Content	Total Hrs
	SECTION-A	
1	Azo Dyes: Diazotisation, Methods of Diazotization, Diazo coupling. Acid azo dyes: Methyl orange, Methyl red, Orange dyes, Fast red A, Metanil yellow Basic Azo dyes: Aniline yellow, Butter yellow, Chrysodine G, Bismark brown, Acid red. Direct or Substantive Azo dyes: Congo red, Direct deep black, Benzopurpurin, Rosanthrene O, Procion Dyes, Ramazol Mordant Azo Dyes: Diamond black F, Chromotrope 2B, Erichrome Black T, Erichrome Red B etc.	10
2	Reactive Dyes: Introduction, Chemical Constitution of Reactive Systems, Dye Classes (Chromogens) for Reactive Dyes, Synthesis & applications. Chemistry of reactive dyes with special emphasis on environmental issues. High fixation, low salt, highly substantive reactive dyes. Neutral fixing & acid fixing reactive dyes. Heterocyclic reactive systems & multifunctional reactive dyes. Reactive basic dyes.	10
3	Disperse Dyes: Introduction, Chemical Constitution: Azo Dyes; Anthraquinone Dyes; Other Chromophores; Synthesis & applications. Chemistry of disperse dyes with special emphasis on environmental safety. Dispersant free disperse dyes. Replacement of anthraquinone disperses dyes – Heterocyclic diazo & coupling components. Styryl & extended styryl disperse dyes	10
	SECTION-B	

Bachelor of Engineering
Subject Code: CT 2216
Subject Name: Synthetic Colorants

4	Synthesis and applications of Organic pigments-I: Azo pigments: Diazo components & its derivatives, Coupling compounds and its derivatives, Monoazo yellow and Orange pigments, Disazo pigments, Diarylide pigments, Disazopyrazolone pigments, β- Napthol pigments, Napthol AS pigments, BONA Pigments, Benzimidazolone pigments, Disazo condensation pigments, Metal complex pigments, Isoindolinone and Isoindoline pigments and its derivatives.	10
5	Synthesis and applications of Organic pigments-II: Polycyclic pigments : Phtahlocyanine pigments, Quinacridone pigments, Perylene and Perinone pigments, Diketopyrrolo-pyrole pigments, Thioindigo pigments, Aminoanthraquinone pigments, Hydroxyanthraquinone pigments, Dioxazine pigments, Quinophthalone pigments etc.	10
6	Heterocyclic Intermediates: Skeletons of heterocyclic system, Ethylene oxide Epichlorohydrin, Phthalamide, carbazole, pyrazolones and its derivatives, Pyridiene and its derivatives quinacridone and its derivatives and their uses etc.	8

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**10**	**5**	**5**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

1. Synthetic Dyes, Dr. G. R. Chatwal, Himalaya Publications, 2009.
2. Industrial Organic Pigments, Second, G. Buxbaum (Ed.), ISBN 3-527-28878-3, 1998.
3. Industrial Organic Chemistry, Arpe H.J.VCH, Weinheim, Weissermal K.1993

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To study the synthesis of azo dyes.	20
CO-2	To introduce the chemistry and synthesis of reactive dyes.	20
CO-3	To know the chemistry and synthesis of disperse dyes.	20
CO-4	To understand the synthesis and applications of Organic pigments	20
CO-5	To be able to utilize this knowledge in industries	10
CO-6	To build a bridge between theoretical and practical concept used in industry.	10

Bachelor of Engineering
Subject Code: CT 2216
Subject Name: Synthetic Colorants

List of Open Source Software/learning website:

- Literature available on internet
- Dyes & Pigment dictionaries
- Delnet
- Literature available under R&D in Dyes & Pigments industry.
- Dyes & Pigments journals

Bachelor of Engineering

Subject Code: CT2217

Subject Name: Synthesis and Analysis of Polymer & Rubber

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Elective Course

Prerequisite: Basic Knowledge of various polymer and rubber material. Students should know the basic introduction of polymeric materials. Common chemical structures and its properties should be known to the students.

Rationale: The main objective of this subject is to deliver the knowledge of basics of polymer technology and raw materials used in polymer and rubber industries.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Ethylene Polyethylene** – LLDPE, LDPE, HDPE, ULDPE; Polypropylene & copolymer of propylene with ethylene, including ethylene – propylene – rubber, polyisobutylene, modified polyethylene.	4
2	**Vinyl Chloride Polyvinyl chloride**, copolymers with vinyl acetate, vinyl alcohol, maleic anhydride etc.; polyvinylidene chloride. Polyesters PET, PBT, PTT.	8
3	**Styrene Polymers** - polystyrene, HIPS, SAN, ABS, important copolymers of styrene with maleic anhydride & acrylics. Toughening of thermoplastics & mechanism of the same. Thermoplastic elastomers	5
	SECTION-B	
4	**Polymamides** – Nylon 6, Nylon 6.6, Nylon 11, aromatic polyamide such as Kevlar, Polycarbonates, polyoxymethylene i.e. Polyacetal. Acrylic polymers-polyacrylic acid, polyacrylamide, PMMA, Polyacrylonitrile etc.	7

5	Liquid Crystalline Polymers, specialty plastics- PES, PAES,PEEK,PEAK etc.	7
6	**Specialty Rubbers**: Polyacrylic Rubber, Fluorinated Rubber, Chlorinated PE, Chlorosulphonated PE, Polyurethanes, EVA.	8

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	15	15	10	5	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Rubber Materials and their components, by J. A. Brydson
2. Rubber Technology : by Maurice Morton
3. Natural Rubber Science and Technology, by Roberts
4. Principles of Polymer Science, Bahadur&Sastry, Narosa Publishing Houses, 2002
5. Polymer Science , Gowarikar,John Wiley & Sons ,1986
6. Handbook of Rubber Projects, Technology and Product Formulations, by SBP Consultants & Engineers (P) Ltd.

Course Outcomes:

After learning this course, students will be able to:

CO No.	**CO statement**
CO-1	To know about the polyethylene and its copolymers.
CO-2	To be able to apply the knowledge of vinyl chloride to formulate its derivatives.
CO-3	To be able to prepare various copolymers of styrene.
CO-4	To be able to get knowledge about polyamide materials.
CO-5	To be able to understand the detail chemical structure liquid crystalline materials.
CO-6	To be able to modified the rubber materials.

Bachelor of Engineering

Subject Code: CT2217

Subject Name: Synthesis and Analysis of Polymer & Rubber

List of Open-Source Software/learning website:

1. www.iri.net.in
2. www.ipiindia.org
3. Delnet
4. Literature available under R&D in Polymer & Rubber industry.
5. Polymer & Rubber journals
6. Polymer & Rubber dictionaries

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2218

Subject Name: Glass Science & Technology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Elective Course

Prerequisite: The students should have a clear concept on basic chemistry, geology and Mineralogy that will help them to have an easy grasp of the subject.

Rationale: The main objective of this subject is to offer an overview over the fundamentals and basics of glass and ceramic materials, types of glass, their availability, their properties, process of recovery, testing and their application.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	The non-crystalline solids & the glasses. Formation from liquid phase. Formation from a gaseous phase. Formation from a solid phase. Definition of glass. Vitreous transition. Phenomenological study. Thermodynamic study. Theory of vitreous transition. Determination of transition temperature	05
2	Conditions of verification. Structural theory (Zachariasen model etc.). Kinetic theory of glass (Nucleation & Growth). d) Structure of Glass: XRD, SAXS and other methods of determining glass structure. e) Structural models of glass. Reaction mechanisms. Ion exchange & network breakdown processes. Glass durability controlling Factors.	08
3	Thermodynamic basis of phase separation in glasses. Immiscibility in Glasses. Kinetics of demixing. Application of immiscibility diagrams. Spindale decomposition.	08
	SECTION-B	

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4	Density & Thermal expansion measurements & their implications andtheir dependence on compositions. Thermal history effects. Effect of Crystallization. Additive rule.	08
5	Diffusion in Glasses. Electrical conductivity of glasses. Dielectric properties. Optical properties of glasses. Refractive index, Molar volume & Ionic refractivity, Birefringence. Photosensitive/Photo chromicglasses	08
6	Glass production, Basic processes of glass making, Batch process, Continuous process, Raw materials selection, Batch house & mixing,Batch transportation, Tank furnace, Batch feeding, Melting & refining. Bottle glass, Sheet glass, Other glasses, Annealing, Thermal treatment, Chemical treatment, Production control & planning	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
19	26	13	11	11	20

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Recommended Books:

1. Chemistry of Glasses - A. Paul
2. Handbook of Glasses – R. H. Doremus
3. Introduction to Glass Science & Technology - J. Shelby
4. Material Science ,Smith, Mcgraw Hill Higher Education, 4th Ed,2005

List of Practical: NA

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To express their technical knowledge over fundamentals of the subject

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Subject Code: CT2218
Subject Name: Glass Science & Technology

CO-2	To understand the difference in raw materials of refractories from other ceramic raw materials.
CO-3	To be able to utilize the knowledge of raw materials in correlating other highly technical subjects in the Glass & Ceramic Technology course curriculum
CO-4	To be able to apply this knowledge in their higher study, research work with related technical subjects.
CO-5	To build a bridge between theoretical and practical concept used in industry.
CO-6	To utilize the subject knowledge in solving industry oriented problems in the form of consultancy projects, industry defined projects.

List of Open-Source Software/learning website:

1. NPTEL
2. MIT Open course lecture available on Internet etc.
3. Delnet