Shroff S.R. Rotary Institute of Chemical Technology

Ref: UPL University /SRICT/BOS/CT/2022-23/
Date: 07-02-2023

Proposed Teaching Scheme for Third Year Bachelor of Chemical Technology

Semester-V (Chemical Technology) Proposed 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 and Social Sciences including Management courses	CT2301	Plant Economics and Management (PEM)	3	0	0	3	3	70	30	00	00	100
Professional core courses	CT2302	Basics of Mass Transfer (BMT)	4	0	2	6	5	70	30	20	30	150
	CT2303	Chemical Process Industries (CPI)	3	0	0	3	3	70	30	00	00	100
	CT2304-7	Specialized Subjects-I	3	0	2	5	4	70	30	20	30	150
Professional Elective courses relevant to chosen specialization/branch	CT2308-11	Specialized Subjects-II	3	0	0	3	3	70	30	00	00	100
Open subjects – Electives from other technical and /or emerging subjects	CT2312/ CT2326	Organic Chemistry-2/ Symmetry Stereochemistry and Applications (NPTEL (Swayam)	3	0	0	3	3	70	30	00	00	100
Project work, seminar andinternship in industry orelsewhere Mandatory Courses	MH2303	Industrial Internship	-	-	-	-	1	00	00	50	00	50
Mandatory Course	MH2301	Contributor Personality Development Program - I	1	1	0	2	2	50	30	20	00	100
Total						**25**	**24**	**470**	**210**	**110**	**60**	**850**

***Specialized Subjects-I**

Category of Course	Code No.	Course Title
Pharma. Tech	CT2304	Pharmaceutical Chemistry-1
Dyes & Pig. Tech	CT2305	Technology of Dyeing
Pol & Rub. Tech	CT2306	Technology of Thermoplastic
Glass Tech	CT2307	Glass Technology

***Specialized Subjects-II**

Category of Course	Code No.	Course Title
Pharma. Tech	CT2308	Pharmaceutical Chemistry-2
Dyes & Pig. Tech	CT2309	Functional dyes & Printing Technology
Pol & Rub. Tech	CT2310	Technology of Thermoset
Glass Tech	CT2311	Whitewares-I

Semester-VI (Chemical Technology) Proposed 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							
Professional core courses	CT2313	Fundamentals of Reaction Engg. (FRE)	3	0	2	5	4	70	30	20	30	150
	CT2314	Introduction to Materials Technology	3	0	0	3	3	70	30	0	0	100
Professional Elective courses relevant to chosen specialization/branch	CT2315-18	Specialized Subjects-III	3	0	0	3	3	70	30	0	0	100
	CT2319-22	Specialized Subjects-IV	3	0	2	5	4	70	30	20	30	150
Open subjects – Electives fromother technical and /or emerging subjects	CT2323/ CT2325	Process Instrumentation, Dynamics and Control/ Chemical Process Instrumentation (NPTEL Swayam)	4	0	0	4	4	70	30	0	0	100
	CT2324	Analytical Tech (AT)	3	0	2	5	4	70	30	20	30	150
Mandatory Course	MH2302	Contributor Personality Development Program - II	1	1	0	2	2	50	30	20	00	100
Total						**27**	**24**	**470**	**210**	**80**	**90**	**850**

***Specialized Subjects-III**

Category of Course	Code No.	Course Title
Pharma. Tech	CT2315	Pharmaceutical Chemistry-3
Dyes & Pig. Tech	CT2316	Engineering of Pigmented Dispersion
Pol & Rub. Tech	CT2317	Polymer Blends and Alloys
Glass Tech	CT2318	Process Ceramics

***Specialized Subjects-IV**

Category of Course	Code No.	Course Title
Pharma. Tech	CT2319	Pharmaceutical Formulation Technology
Dyes & Pig. Tech	CT2320	Technology of Inorganic and Functional Pigments
Pol & Rub. Tech	CT2321	Processing of Polymer & Rubber
Glass Tech	CT2322	Advanced Refractories & Whitewares

Bachelor of Engineering

Subject Code: CT2301

Subject Name: Plant Economics and Management

Shroff S. R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Humanities & Social Science

Prerequisite: Basic understanding of process equipment, chemical technology, knowledge of basic engineering mathematics.

Rationale:

This course brings together the concepts of engineering and economics with special reference to chemical process and plant design along with the hierarchy of decisions in synthesis and analysis of a chemical process and its alternatives. This course is intended to challenge chemical technologists to combine basic technical principles learned in other courses in the general curriculum with practical elements of economics, business practices and organization along with principles of safety, environmental and sociological issues to design an integrated chemical process plant like Pharma, Dyes & Pigments, Polymer & Rubber and Glass & Ceramics.

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.	**Introduction:** Process development, importance of pilot plant, synthesis of process flow sheet, process flow diagrams.	4
2.	**Process creation:** Techno economics feasibility analysis, factors affecting process selection, equipment specifications, plant location, plant layout and principles of plant layout related to Pharma, Dyes & Pigments, Polymer & Rubber and Glass & Ceramics Technology	7
3.	**Process auxiliaries and utilities**: Piping layout, and supports for piping insulations, pipe fittings, types of valves, optimum economic pipe diameter, selection of pumps,	7

Bachelor of Engineering

Subject Code: CT2301

Subject Name: Plant Economics and Management

	process water, boiler feed water, water treatment, steam, oil heating system, compressed air and vacuum.	
SECTION-B		
4.	**Cost estimation:** types of cash flow, factors affecting estimation of investment and production cost, breakeven point and its significance, total capital investment and its estimations, cost index, type of cost estimates, methods of cost estimation, capitalized cost, annuity, estimation of total product cost, contingencies, time value of money, nominal and effective interest rates. Case study related to Pharma, Dyes & Pigments (Colour), Polymer & Rubber and Glass & Ceramics industries.	**7**
5.	**Depreciation:** Types of depreciation, service life, salvage value and present value of assets Method for determining depreciation: straight line method, decline balance method, sum of the year digit method, shrinking fund method etc, **Profitability, alternative investments and replacement:** methods of profitability evaluation, % rate of return, practical factors in alternative investment and replacement studies.	**7**
6.	**Project management:** Production management**,** project planning & scheduling, BAR chart, CPM, PERT, comparison between CPM and PERT.	4

Suggested specification table with Marks(Theory):

DistributionofTheoryMarks					
R Level	U Level	A Level	N Level	E Level	CLevel
20	25	25	10	20	0

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

Text Book:

1. Peters, Max S., K.D. Timmerhaus and R.E. West, Plant Design and Economics for Chemical Engineers,5th Ed, McGraw-Hill International Editions, 2003.

Reference Books:

2. Douglas, James M., Conceptual Design of Chemical Processes, McGraw-Hill International Editions, 1988.

3. Biegler, L.T., I.E. Grossmann and A.W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall (Pearson Education), 1997.

4. Mahajani,V.V., Chemical Project Economics, Macmillan Indian Ltd., 2005.

5. Smith, R., Chemical Process: Design and Integration, John Wiley and Sons, 2005.

Bachelor of Engineering

Subject Code: CT2301

Subject Name: Plant Economics and Management

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	State the basic concepts of process development & construct flow sheet synthesis.
CO-2	Describe the principles of process creation and selection.
CO-3	Classify Plant auxiliaries& process utilities.
CO-4	Execute the capital investment & cost estimation.
CO-5	Explain profitability distinguish alternative investments
CO-6	Define project planning and scheduling.

List of Open Source Software/learning website:

- https://nptel.ac.in/

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2302

Subject Name: Basics of Mass Transfer

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Professional Core Courses

Prerequisite: Studied departmental fundamental chemical engineering subjects in previous semesters. Basic knowledge of chemical engineering is required.

Rationale: The objective of this course is to provide a means to teach undergraduate chemical technology students the basic principles of mass transfer and to apply these principles. The aim of this subject is to study mass transfer in unit operations in chemical Industries and different theories of mass transfer in chemical 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	Basics of Mass Transfer: Classification of mass transfer operation, choice of separation method, Methods of conducting mass transfer operations, Definition of molecular and eddy diffusivity, Fick's first law, Concept of N & J Flux, Steady state molecular diffusion in fluids at rest and in laminar flow, Diffusivity of gases, Diffusivity of liquids, Concept of overall mass transfer coefficient, F and k type mass transfer coefficients Film, penetration and surface renewal theory. Concept of equilibrium, diffusion between phases, Two resistance theory, Local overall mass transfer coefficient, controlling mass transfer resistances.	11
2	Humidification Operations: VLE and Enthalpy for pure substances, Saturated and unsaturated vapour-gas mixtures and related terminologies such as Absolute Humidity, dry bulb temperature, dew point, wet bulb temperature, percentage & relative saturation, adiabatic saturation temperature, humid heat, humid volume etc. Psychometric chart for air-water system, cooling towers.	06

Bachelor of Engineering
Subject Code: CT2302
Subject Name: Basics of Mass Transfer

3	Distillation: Introduction, Vapor-liquid Equilibria, concept of relative volatility and effect of P and T on equilibrium data, Ideal solutions, Raoult's Law, Deviation from ideality, Flash distillation, Simple distillation, Continuous rectification-Binary systems, Determination of number of stages by McCabe-Thiele method, Concept of minimum, total and optimum reflux ratio, Reboilers, Use of open steam, Partial condensers, cold hot circulating reflux Steam distillation, Batch fractionation, Azeotropic Distillation, Extractive Distillation	12
SECTION-B		
4	Gas Absorption: Equilibrium Solubility of gases in liquids, Ideal and non-ideal solution, Choice of solvent for absorption, Material balance and liquid-gas ratio for absorption and stripping, Counter current multi stage operation (isothermal), Absorption factor, Continuous contact equipments, Overall coefficient and Transfer units, Concept of HETP and HTU, NTU	08
5	Liquid-Liquid Extraction: Ternary liquid- liquid equilibrium and tie line data, system of three liquids-one pair partially soluble, system of two partially soluble liquids, Choice of solvent for extraction, Single stage extraction, multistage-Cross current and counter current extraction, Extraction equipment, Applications of liquid-liquid extraction.	08
6	Drying & Crystallization: Equilibrium relationship & hysteresis, Various types of moisture in drying, Rate of drying, time of drying, Drying at low temperature, Freeze drying. Drying equipment-Tray dryer, Rotary dryers, Spray dryers, Fluidized bed dryer. Saturation, Nucleation, Principle of crystallization, Crystallization rate, Nucleation, Crystal growth, Caking of crystals, Application of crystallization	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	20	15	10	05	05

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

Bachelor of Engineering
Subject Code: CT2302
Subject Name: Basics of Mass Transfer

Recommended Books:

1. "Mass Transfer Operations", R E Treybal, Mc Graw Hill
2. "Unit Operations of Chemical Engineering", Warren McCabe, Jubian Smith and Peter Harriot, Mc Graw Hill, 7th Ed.
3. "Principles of Mass Transfer and Separation Processes" B. K. Dutta, Prentice-Hall of India Private Ltd.
4. "Transport Processes & Unit Operations in Chemical Engineering", Gean Koplis, Prentice Hall.
5. "Coulson and Richardson's Chemical Engineering Volume 1 - Fluid Flow, Heat Transfer and Mass Transfer" Coulson, J.M.; Richardson, J.F.; Backhurst, J.R.; Harker, J.H. Elsevier, 6th Ed

List of Practical:

1. To determine mass transfer co-efficient.
2. To determine diffusion coefficient or diffusivity
3. Determine the Mass Transfer Coefficient (Kr) with Chemical Reaction
4. Determine the Mass Transfer Coefficient (Kr) without Chemical Reaction
5. Determine the percentage efficiency for single stage extraction
6. Determine the yield of crystals in batch crystallizer
7. To verify Rayleigh equation for batch distillation.
8. Carry out differential distillation for binary liquid-liquid system
9. To construct drying rate curve for a batch drying.
10. To study the steam distillation process

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To build a basic knowledge of mass transfer introduces the fundamental concepts, principles and applications of mass transfer processes
CO-2	To utilize the technological methods in problem solving of mass transfer operations in industries.
CO-3	To review the practical importance and relevance of mass transfer in chemical industry.
CO-4	To understand the applications of different mass transfer processes and various equipment in which mass transfer operations are conducted.
CO-5	To recognize the selection criteria for mass transfer process and equipment required by the industries.
CO-6	Evaluation of extent of mass transfer and efficiency of various separation process practiced in industry.

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: CT2303
Subject Name: Chemical Process Industries

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Professional Core Courses

Prerequisite: The students have already undertaken course work with different Unit Operations, Process engineering based aspects of various process applications. Basic knowledge of Chemistry is also required.

Rationale: The main objective of this subject is to make students aware about the manufacturing procedures of different chemical compounds and their engineering aspects as it is necessary for them to access the potential hazardous which can occur during the processes.

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	Basic of Petroleum and its properties: Role of Crude oil in global economy, Present Scenario of Crude Oil Refinery, Importance, Occurrence, Origin(formation), Exploration, Composition, Classification and Evaluation of Crude oil, Crude Assay Analysis, Distillation Characteristics such as TBP,ASTM&EFV, Various types of Petroleum Fraction and its properties like ASTM Distillation, RVP, Octane Number, Oxidation Stability, Sulphur Content Viscosity Index, Carbon Residue, Penetration Index, Softening Point, Flash& Fire Point, Smoke Point , Aniline Point etc.	08
2	Paints, Inorganic pigments and Enamels: Paints, different types of pigments such as white, blue, red, yellow, green, brown, black, etc. Varnishes, Industrial Coatings, printing inks, Polishes etc.	06
3	Fermentation industries : Industrial alcohol, absolute alcohol, beers, wines and liquors, Manufacturing of Butyl alcohol & Citric acid by Fermentation	06

Bachelor of Engineering
Subject Code: CT2303
Subject Name: Chemical Process Industries

	SECTION-B	
4	Introduction to industrial gases: Gases like carbon dioxide, oxygen, nitrogen, hydrogen, rare gases of atmosphere, helium, acetylene, sulfur dioxide, carbon monoxide and nitrogen oxide.	07
5	Petrochemicals: Process engineering aspects of manufacture of Methanol & methanol based chemicals such as acetic acid, dimethyl ether, dimethyl carbonate, etc. Ethylene oxide, glycols, vinyl chloride, vinyl acetate, Propylene oxide, hydroformylation of propene to manufacture butyraldehyde. Manufacture of aromatics, terephthalic acid, phthalic anhydride, phenol, nitrobenzene, aniline.	08
6	Polymerization Technology: Polyethylene, polypropylene, LDPE, HDPE, PVC, SBR, NBR, fibers, polyamides, polyesters, Acrylic fibers.	09

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
28	24	18	16	14	--

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

Recommended Books:

1. Chemical process Industries Shreve, Brink & Austin, Mc Graw Hill ,4th Ed., 1984
2. Dryden's outlines of chemical technology for the 21st century, third edition by M Gopala Rao &Marsal Sitting, East-West Press Publications.
3. Chemical Process Technology, J Moulijn, M Makkee and A Diepen, John Wiley & Sons, 2001
4. Encyclopedia of Industrial Chemistry ,Ullmann, VCH, 1996
5. Industrial Organic Chemistry ,Weissermel K &Arpe H.J., Weinheim, 1978
6. Unit process in Organic Synthesis, P.H Groggins, Tata Mc Graw Hill Publishing Company.
7. Pandey G.N., "A Text Book of Chemical Technology", Volume 1 and 2, Vikas Publications
8. From Hydrocarbons to Petrochemicals, Hatch L.F. & Matar S., Gulf Pub. Co., 1981
9. B. K.Bhaskar Rao, Modern Petroleum Refining Processes, Oxford and IBH 2007 .
10. B.K.Bhaskar Rao, A Text on Petrochemicals, 2ndEdition, Khanna Publishers, Delhi, 1998

Bachelor of Engineering
Subject Code: CT2303
Subject Name: Chemical Process Industries

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To build a basic technical knowledge of the process carried out in chemical industry.
CO-2	To interpret technical knowledge with real system and understand the basic working of system.
CO-3	To analyze conventional system with new technological updating.
CO-4	To determine which unit operations and unit process can be used so that productivity can be increases.
CO-5	To collect all information about from initialization to end of the unit process.
CO-6	To summarize the pros and cons of the unit process and their components so improvement can be done in the future.

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: CT2304

Subject Name: Pharmaceutical Chemistry-1

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Professional Core Course

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

Rationale: The main objective of this subject is to offer an overview over the retro synthesis, Different class of drugs, drugs acting on hormonal system, anti-diabetic drugs, antibiotics.

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	Retrosynthetic analysis: Concepts of retrosynthetic analysis, construction of simple carbon-hetro bonds, Understanding of molecular complexity, identification of building blocks and strategies of building molecules by joining the blocks, chemo selectivity issues, Retrosynthetic analysis, Synthesis of 10 drugs in the class of anti-infective, antihistamines, CNS drugs, anti-diabetic drugs	**10**
2	Drugs acting on hormonal system: Steroid hormones-adreno corticoids, Sex steroids & antagonists, oral contraceptives -its classification & uses	**08**
3	Anti-diabetic agents : Classification, Synthesis, MOA & SAR of oral anti-diabetic drugs	**06**
	SECTION-B	
4	Retrosynthetic analysis, Synthesis of 10 drugs in the class of ANS drugs, CVS drugs, NSAIDs with aromatic structure.	**10**
5	**Antibiotics:** Classification, Synthesis, MOA & SAR of β - lactam antibiotics	**06**
6	Phytochemistry: Chemical constituents in the production of plants (carbohydrates, lipids, alkaloids, protein enzyme, glycosides, steroids). Detailed study of extraction and isolation of one reprehensive from each of the above mentioned chemical class (5 drugs).Recent advances in Phytopharmaceuticals	**08**

Bachelor of Engineering
Subject Code: CT2304
Subject Name: Pharmaceutical Chemistry-1

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 Synthesis- The Disconnection Approach; Ed.: Warren S.; John Wiley & Sons-Chichester
2. Organic Chemistry- Louden
3. Organic Chemistry- Carey
4. Logic of Chemical Synthesis- E.J. Corey
5. Classics in Organic Synthesis- K.C. Nicolaou
6. Synthesis of drugs-Synthon approach- R P Iyer, Mariam S Degani, Janhavi Rao
7. Strategies for Organic Drug Synthesis & Design, &Daniel Led nicer, John Willey &SonsInc. New York., 2nd Ed, 1998
8. Burger's Medicinal Chemistry & Drug Discovery: Vol. 1 to 6, A. Burger &M.E.Wolff,John Wiley & Sons – New Jersey,6th Ed, 2003
9. Foye's Principles of Medicinal Chemistry, W.O. Foye, Lippincott Williams & Wilkins-Philadelphia,
   Oxford, 6th Ed, 200
10. Text book of Medicinal & Pharmaceutical Chemistry, Charles Owens Wilson Lippincott Williams & Wilkins – Philadelphia. 1962
11. Textbook of Medicinal Chemistry, Volume I & II, Edition 2 by V. Alagarsamy
12. Pharmaceutical Substances, 5th Edition, 2009: Syntheses, Patents and Applications of the most relevant API, A. Kleemann, J. Engel, B. Kutscher, D. Reichert, Thieme, 2014

List of Practicals:

1. Synthesis of Aspirin
2. Synthesis of a drug intermediate -Benzil
3. Synthesis Sulphanilamide
4. Synthesis of Acetophenone
5. Synthesis of PABA
6. Synthesis of Paracetamol
7. Synthesis Acetanilide by Green process.
8. To understand bromination reaction
9. Preparation of Phenytoin
10. Isolation of Casein from milk
11. Isolation of caffeine from tea leaves
12. Isolation of curcumin from turmeric

Bachelor of Engineering
Subject Code: CT2304
Subject Name: Pharmaceutical Chemistry-1

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To describe the retro synthesis concept & retrosynthetic analysis of different drugs.
CO-2	To illustrate the organic synthesis of drugs acting on hormonal system
CO-3	To demonstrate the techno-commercial synthesis of different class of drugs
CO-4	To analyze the synthesis, SAR, MOA of anti-diabetic drugs
CO-5	To explain the MOA, synthesis & SAR of β-lactam antibiotics
CO-6	To evaluate the methods of synthesis/extraction/isolation of drug substances

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: CT2305

Subject Name: Technology of Dyeing

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - V

Type of course: Professional Core Course

Prerequisite: Basic Knowledge of Dyeing Technology.

Rationale: The main objective of this subject provides fundamental knowledge of various dyeing technology in chemical industries.

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	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Technology of textile fibers: Classification of coloring matters according to their application to the textile fibers; Physical and chemical structures of fibers and dyes in relation to dyeing; Interaction between dye moleculesand the fibers. Dyeing of different dyestuffs onto various natural textile fibers, Rapid dyeing concept, Dye-fiber bonds and parameters affecting them.	**10**
2	Methods of dyeing & dying machineries-I: Basic features of batch dyeing machines, Dyeing machines for loose fibre and sliver, Machines for dyeing yarn: Hank dyeing, Package dyeing machines, Machines fordyeing fabric: Winch dyeing, Jig dyeing machines, Beam dyeing machines, Jet dyeing machines	**08**
3	Methods of dyeing & dying machineries-II: , Continuous dyeing equipment: Padding mangles, The Thermosol process, Roller steamers, Continuous washing units, Recent advances in dyeing technology	**08**
	SECTION-B	
4	Textile Finishing Technology: Preparation, in which the goods are scoured and bleached in readiness for finishing; dyeing or printing; mechanical finishing procedures, usually performed on dry material; thermal processes including drying and heat setting; wet finishing processes in which the goods are treated with solutions of appropriate chemicals and subsequently dried.	**08**

Bachelor of Engineering
Subject Code: CT2305
Subject Name: Technology of Dyeing

5	Physicochemical properties of dye-fiber systems: Thermodynamics of dyeing process; Kinetics of dyeing; Affinity of dyes towards the fibers; Adsorption isotherms; Equilibrium adsorption and factors influencing the same; Saturation value; Diffusion coefficient; Glass transition temperature and its effect on dyeability; Electro-kinetic properties of dye-fiber systems.	**10**
6	Fabric Dyeing Technology: Dyeing of fabric like cellulosic, polyester, cotton, nylon etc.	**08**

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
35	**25**	**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)

Reference Books:

1. Handbook of Synthetic Dyes and Pigments, K. M. Shah, Multitech Publishing Company, Bombay, 2nd edition, 1998.
2. Technology of Dyeing, Shenai V.A., Vol. 6, Sevak Publication, Bombay, 2nd edition, 1994.
3. A manual of Dyeing : For use of Practical Dyers, Manufactures, Students and all interested in art of dyeing, E.Knecht, C. Rawson, R.Loewenthal, Charles Griffin and Company Ltd., London, Vol.1,1983.
4. Dyeing and Printing, Cockett S.R., Hilton K.A., Leonard Hill Books Ltd., London, 1961.
5. Rouette Hans-Karl, Encyclopedia of Textile Finishing, Springer-Verlag, Berlin, vol No 2, 1613, (2002).
6. Ramachandran T., Karthik T., and Shetty Guruprasad S., The Indian TextileJournal, 114(9), 23, (2004).

List of Experiments:

1. Dyeing of Acid Dyes on silk fabric.
2. Dyeing of Reactive Dyes on rayon fabric.
3. Dyeing of Disperse Dye on Polyester fabric
4. Dyeing of Acid Dye on wool fabric.
5. Dyeing of Basic Dye on various fabric.
6. Dyeing of Direct dyes on cotton fabric.

Bachelor of Engineering
Subject Code: CT2305
Subject Name: Technology of Dyeing

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To get an introductory knowledge of textile fibre technology	15
CO-2	To know the Rapid dyeing concept, physicochemical properties of dye-fiber systems	20
CO-3	To understand the methods of dyeing & dying machineries	25
CO-4	To elaborate the textile finishing technology	15
CO-5	To be able to understand fabric dyeing technology	15
CO-6	To build a bridge between theoretical and practical concept used in dyes industry	10

List of Open Source Software/learning website:

- Literature available on internet
- Dyes dictionaries
- Delnet
- Literature available under R&D in Dyes industry
- Dyes & Pigments journal

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2306

Subject Name: Technology of Thermoplastic

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - V

Type of course: Professional Core Course

Prerequisite: Student should know the basics of polymeric materials.

Rationale: The main objective of this subject is to provide the knowledge about the different types of thermoplastic materials and its synthesis processes.

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	Introduction to engineering and commodity plastics, Specialty plastics- PES, PEEK, PEAK.	**08**
2	Introduction to synthetic Polymers, **Polyethylene**: Different grades of polyethylene such as LDPE, HDPE, LLDPE, UHMWPE, chlorinated PE (CPE). **Polypropylene**: Isotactic, Syndio tactic and Atactic PP.	**10**
3	**Polystyrene**: Polystyrene, HIPS & copolymers of styrene (SAN & ABS). Acrylics: PMA, PMMA, PAN Polyvinyl chloride	**16**
	SECTION-B	
4	Introduction to ester family, Poly esters: Thermoplastic (PET & PBT), Poly carbonate	**10**
5	Aliphatic and Aromatic Polyamides: Nylon 11, Nylon 66, Difference between Aliphatic and aromatic polyamides, Polyimides (PI), Polybenzimidazole (PBI).	**10**

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: CT2306
Subject Name: Technology of Thermoplastic

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
40	**25**	**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)

Reference Books:

1. Brydson, J. A. Plastics materials; Butterworth-Heinemann; 7 edition, Iliffe; London, 1966
2. W. Mayo Smith, Manufacture of Plastics - Vol. I & II; Van Nostrand Reinhold; New York, 41 1964
3. Irvin.I. Rubin, Hand Book of Plastics Materials & Technology; John Wiley & Sons Inc.; New York, 1990.
4. Handbook of Thermoplastic, Edited by Olagoke Olabisi, Kolapo Adewale, CRC Press, Taylor & Francis Group, Second Edition, 2016.
5. Handbook of Engineering and Speciality Thermoplastics by Sabu Thomas and Visakh P.M., Wiley, Scrivener, volume 3.
6. Text book of Polymer Science, Billmeyers, John Wiley & Sons 1984.
7. Encyclopedia of Polymer Science & Technology, John Wiley & Sons, Inc 1965
8. Encyclopedia of Polymer Science & Engineering, John Wiley & Sons, Inc 1988.
9. Introduction to Polymer Science & Technology, H.S.Kaufman & J.J.Falcetta, Wiley – Interscience Publication, 1977
10. Kirk-Othmer Encyclopedia of Chemical Technology, 27 Volume Set, 5th Edition
11. Ullmann's Polymers and Plastics: Products and Processes

List of Experiments:

1. Determination of density of polymeric sample using specific gravity bottle.
2. To identify the given polymeric sample.
3. To determine the amine value of given sample.
4. To determine the acid value of given sample.
5. To determine the iodine value of given sample.
6. To determine the epoxy equivalent weight of given sample.
7. To determine the viscosity of given sample
8. Synthesis of polymers by emulsion Bulk, solution & suspension and emulsion, Polymerization.
9. Preparation of PMMA from its monomer.
10. Synthesis of Polystyrene.

Bachelor of Engineering
Subject Code: CT2306
Subject Name: Technology of Thermoplastic

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To recognize the knowledge about the Chemistry, manufacturing process, properties and applications of polyolefin's.	15
CO-2	To identify the knowledge of Chemistry, manufacturing process, properties and applications of styrene's and acrylics.	15
CO-3	To apply this knowledge for the Chemistry, manufacturing process, properties and applications of polyamides with real world situation.	20
CO-4	To analyze the knowledge of Chemistry, manufacturing process, properties and applications polyester material.	15
CO-5	To formulate speciality polymeric materials.	15
CO-6	To correlate between theoretical and practical concept used in industry.	20

List of Open Source Software/learning website:

- Literature available on internet
- www.iri.net.in
- www.ipiindia.org
- Delnet

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: CT2307
Subject Name: Glass Technology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

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)	
3	0	2	4	70	30	30	20	150

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.	11
2	Conditions of vitrification. Structural theory (Zachariasen model etc.). Kinetic theory of glass (Nucleation & Growth). Structure of Glass: XRD, SAXS and other methods of determining glass structure. Structural models of glass. Reaction mechanisms. Ion exchange & network breakdown processes. Glass durability Controlling factors.	06
3	Thermodynamic basis of phase separation in glasses. Immiscibility in glasses. Kinetics of demixing. Application of immiscibility diagrams. Spinodal decomposition.	12

Bachelor of Engineering
Subject Code: CT2307
Subject Name: Glass Technology

SECTION-B		
4	Density & Thermal expansion measurements & their implications and their 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 & Photochromic glasses.	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. 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 Practicals:

1. Preparation of Soda-Lime-Silica glass with different coloring oxides.
2. Preparation of Borosilicate glass with alkali & alkaline earth oxides.
3. Preparation of Opal glass with different opacifying agents -- Fluoride & Phosphate opal.
4. Preparation of low melting Phosphate glass in various systems
5. Determination of Alkali resistance of glass
6. Thermal shock test on glass wares

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
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: CT2308

Subject Name: Pharmaceutical Chemistry-2

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Professional Elective Course

Prerequisite: Needs basic knowledge of Organic Chemistry.

Rationale: The main objective of this subject is to offer an overview over the retro synthesis, Retro synthesis of natural products & heterocyclic drugs, antithyroid drugs, antibiotics.

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	-	-	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Retrosynthetic analysis of natural products: Retrosynthetic analysis of relatively simple natural products and their Synthesis	08
2	Drugs acting on hormonal system: Thyroid & anti thyroid agents, Drugs acting on Calcium homeostasis	08
3	Study of nomenclature, classification, SAR, MOA and synthesis of diuretics. Iron preparation & Anemia	06
	SECTION-B	
4	Heterocyclic & fused ring systems: Drugs having heterocyclic & fused ring systems giving approximate conditions & emphasis on techno commercial potential routes of synthesis.	08
5	**Antibiotics:** Classification, Synthesis, MOA & SAR of Cephalosporin, Chloramphenicol & penams	08
6	Phytochemistry: Chemical constituents in the production of plants (tannins, terpenoids, flavonoids, plant pigments).Detailed study of extraction and isolation of one reprehensive from each of the above mentioned chemical class (5 drugs).Recent advances in Phytopharmaceuticals	06

Bachelor of Engineering
Subject Code: CT2308
Subject Name: Pharmaceutical Chemistry-2

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 Synthesis- The Disconnection Approach; Ed.: Warren S.; John Wiley & Sons-Chichester
2. Organic Chemistry- Louden
3. Organic Chemistry- Carey
4. Logic of Chemical Synthesis- E.J. Corey
5. Classics in Organic Synthesis- K.C. Nicolaou
6. Synthesis of drugs-Synthon approach- R P Iyer, Mariam S Degani, Janhavi Rao
7. Strategies for Organic Drug Synthesis & Design, &Daniel Led nicer, John Willey &SonsInc. New York., 2nd Ed, 1998
8. Burger's Medicinal Chemistry & Drug Discovery: Vol. 1 to 6, A. Burger &M.E.Wolff,John Wiley & Sons – New Jersey,6th Ed, 2003
9. Foye's Principles of Medicinal Chemistry, W.O. Foye, Lippincott Williams & Wilkins-Philadelphia, Oxford, 6th Ed, 200
10. Text book of Medicinal & Pharmaceutical Chemistry, Charles Owens Wilson Lippincott Williams &Wilkins – Philadelphia. 1962
11. Textbook of Medicinal Chemistry, Volume I & II, Edition 2 by V. Alagarsamy
12. Pharmaceutical Substances, 5th Edition, 2009: Syntheses, Patents and Applications of the most relevant API, A. Kleemann, J. Engel, B. Kutscher, D. Reichert, Thieme, 2014

Bachelor of Engineering
Subject Code: CT2308
Subject Name: Pharmaceutical Chemistry-2

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To describe the importance of Iron, iron deficiency & its preparation.
CO-2	To illustrate the organic synthesis of drugs acting on hormonal system
CO-3	To demonstrate the techno-commercial synthesis of drugs having heterocyclic ring.
CO-4	To analyze Retrosynthetic analysis of relatively simple natural products and their Synthesis
CO-5	To explain the MOA, synthesis & SAR of diuretics, cephalosporin & chloramphenicol
CO-6	To evaluate the methods of synthesis/extraction/isolation of drug substances

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: CT2309

Subject Name: Functional Dyes & Printing Technology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: -V

Type of course: Professional Elective Course

Prerequisite: Basic Knowledge of Dyes and Printing Technology.

Rationale: The main objective of this subject provides fundamental knowledge of various functional dyes and printing technology.

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	New functional dyes: Introduction, Interactions of Functional Dyes. Metal-Complex Dyes: Introduction, Chemical Constitution and Properties. Solvent Dyes: Introduction, Chemical Constitution and application properties. Fat and Oil Soluble Dyes: Dyes Soluble in Polymers; Solvent Dyes for Other.	**10**
2	Applications of Functional Dyes-I: Functional Dyes by Application: history of printing, its objective; Thermal Printing; Gravure Printing, Electrophotography, Screen Printing, Dye Sublimation printers	**08**
3	Applications of Functional Dyes-II: Other Technologies: Non-Impact Printing Technology, Digital Printing, its advantages, Laser Printing and Photocopying Ink-Jet Printing Dyes in Solar cells, Dyes in Fluorescent Sensors and Probes, Dyes in electrophotography.	**08**
	SECTION-B	
4	Hair Dyes: Bleaching, Dyeing with Oxidation Dyes, Dye Classes, Product Forms, Dye-Removal Preparations, Testing of Hair Dyes. Food Dyes: Introduction, Uses and Individual Substances, Examples of Chemical Structures, Purity Requirements.	**08**
5	Recent development in dyeing Technology: Technology involved is based on solvents used in typical dyes synthesis reactions with emphasis on selection criteria. Ionic liquids as solvents. Solid- solid reaction. Statistical quality control techniques. Specifications of raw materials, process	**08**

Bachelor of Engineering

Subject Code: CT2309

Subject Name: Functional Dyes & Printing Technology

	parameters, other quality parameters & their statistical treatment. Methods of dyeing.	
6	Recent Applications of dyeing Technology: Dye-sensitized solar cell (DSSC) Technology, Electrochemical dyeing, Plasma technology, Supercritical Dye system.	**08**

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
40	**25**	**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)

Reference Books:

1. G. Buxbaum (Ed.) Industrial Inorganic Pigments, Second, Completely Revised Edition, 1998 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.
2. H. M. Smith (Ed.) High Performance Pigments 2002 WILEY-VCH Verlag GmbH & Co.KGaA, Weinheim.
3. Willy Herbst, Klaus Hunger, Industrial Organic Pigments- Production, Properties,Applications Third, Completely Revised Edition (With Contributions byGerhard Wilker, Heinfred Ohleier and Rainer Winter) 2004 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim

Course Outcomes:

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	To get knowledge of new functional, metal complex, solvent and fat soluble dyes.	15
CO-2	To apply the knowledge of functional dyes & recent dyes technology.	15
CO-3	To understand the applications of functional dyes	20
CO-4	To illustrate the manufacturing of hair & food dyes.	20
CO-5	To describe the recent applications of dyeing technology	20
CO-6	To build a bridge between theoretical and practical concept used in dyes industry	10

List of Open Source Software/learning website:

- Literature available on internet
- Dyes & Pigments dictionaries
- Delnet
- Literature available under R&D in dyes industries

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2309

Subject Name: Functional Dyes & Printing Technology

Bachelor of Engineering
Subject Code: CT2310
Subject Name: Technology of Thermoset

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - V

Type of course: Professional Elective Course

Prerequisite: Student should know the basics of polymeric materials.

Rationale: The main objective of this subject is to provide the knowledge about the different types of thermosets materials and its synthesis 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)	
3	0	0	3	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Epoxy resins: Raw materials like epichlorohydrin and di hydroxy phenol. Classification of epoxy resins and Synthesis of epoxy resins. Ratios of reaction components and their effect on the properties of reaction product and molecular weight in particular. Curing of the resin: curing agents like amines, acids, anhydrides, etc.	**08**
2	Polyester resins: Unsaturated polyester resins, composites & fibre reinforced polyesters, Alkyd resins- Modified alkyls, raw materials, oils & film forming materials	**10**
3	Amino resins: Basic raw materials, synthesis and applications of UF & MF resins. Phenolic: Phenolic resins- Alkali catalyzed & acid catalyzed reactions, CNSL based resins.	**12**
	SECTION-B	
4	Polyurethanes: Basic components: diisocyanates and diols, different diisocyanates and diols used and Reactions of isocyanates with various other functional groups Synthesis of polymers Polyurethane foams, polyester and polyether foams. Processes like one-shot process, Polyether pre-polymers, Quasi-pre-polymer polyether foams, etc.	**10**
5	Thermosetting acrylics: Synthesis of acrylic polymers and co-polymers, different techniques. Structure property relationship application of thermosetting acrylics, like anaerobic adhesives, laminating resins, etc.	**10**
6	Vulcanization of Polymers & Rubbers, Devulcanization of Polymers & rubbers.	**12**

Bachelor of Engineering
Subject Code: CT2310
Subject Name: Technology of Thermoset

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
40	**25**	**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)

Reference Books:

1. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
2. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
3. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984.
4. Ellis, B. (ed.) (1993). Chemistry and Technology of Epoxy Resins. Springer Netherlands. ISBN 978-94-010-5302-0
5. Composite Polymeric Material, R. P. Sheldon, Applied Science Publishers, 1982.
6. Text book of Polymer Science, Billmeyers, John Wiley & Sons 1984.
7. Encyclopedia of Polymer Science & Technology, John Wiley & Sons, Inc 1965
8. Encyclopedia of Polymer Science & Engineering, John Wiley & Sons, Inc 1988.
9. Introduction to Polymer Science & Technology, H.S.Kaufman & J.J.Falcetta, Wiley – Interscience Publication, 1977
10. Polymer and Resins; Their Chemistry and Chemical Engg, Brage Golding, D.Van Nostrand Company Inc, 1959.
11. Brydson, J. A. Plastics materials; Butterworth-Heinemann; 7 edition, Iliffe; London, 1966.
12. W. Mayo Smith, Manufacture of Plastics - Vol. I & II; Van Nostrand Reinhold; New York, 1964
13. Irvin. I. Rubin, Hand Book of Plastics Materials & Technology; John Wiley & Sons Inc.; New York, 1990.
14. Rubber Technology, Maurice Morton, Springer, 1st Ed, 1987

Bachelor of Engineering
Subject Code: CT2310
Subject Name: Technology of Thermoset

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To recognize the knowledge about the basic concepts such as chemistry and various raw materials for the synthesis of epoxy resins.	15
CO-2	To identify the knowledge of unsaturated polyester resins and its properties and applications in coating industries.	15
CO-3	To apply this knowledge for the Chemistry, synthesis process, properties and applications of amino resins with real world situation.	20
CO-4	To analyze the chemistry of Alkali catalyzed & acid catalyzed reactions of phenolic resins.	15
CO-5	To formulate speciality polymeric materials such as polyurethanes and thermosetting acrylics.	15
CO-6	To correlate between theoretical and practical concept used in industry by studying the vulcanization and Devulcanization processes of rubbers.	20

List of Open Source Software/learning website:

- Literature available on internet
- www.iri.net.in
- www.ipiindia.org
- Delnet

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: CT2311
Subject Name: Whitewares-I

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

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, 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)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Scope of whitewares products in India & its classification and its use in various fronts. Details of various types of raw materials including synthetic materials.	11
2	Body preparation including all the unit operations and fabrication Transport, Storage, Batching, Body compositions, Wet-Process - Grinding, Screening, Magnetic separation, Agitators, Aging, Slip treatment, Spray drying.	06
3	Drying - Types of water present, Factors affecting drying (internal & external factors), Convection, Radiation, High frequency heating. Glazing - Purpose & advantages of glazing, Raw glazes, Fritted glazes, Special glazes, Fusibility of glazes, Opacity & opacifiers, Stains, Colloidal colours, Different coloring oxides, Empirical formula of glazes, Glaze defects, Glazing techniques.	12

Bachelor of Engineering
Subject Code: CT2311
Subject Name: Whitewares-I

SECTION-B		
4	Testing of whitewares bodies Firing: Factors determining firing schedule, Effect of heat on whitewares bodies, Formation of different phases at different temperatures, Final phases of porcelain bodies, Analysis of microstructure.	08
5	Diffusion in Glasses. Electrical conductivity of glasses. Dielectric properties. Optical properties of glasses. Refractive index, Molar volume & Ionic refractivity, Birefringence. Photosensitive/Photo chromic glasses.	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):

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

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

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

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
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: CT2312
Subject Name: Organic Chemistry-2

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Open Elective

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.

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	-	-	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Aromaticity:** Characteristics of aromatic compounds, Huckel rule, benzenoid & non-benzenoid compounds, mechanism of aromatic electrophilic substitution reactions. IUPAC nomenclature of aromatic compounds, Isomerism in substituted benzenes & naphthalenes, orienting influence of substituent.	**08**
2	**Stereochemistry:** Classification of stereomers, diasteromers, separation of enantiomers, absolute configuration (R/S, E/Z) , elements of symmetry, Resolution of racemic mixture, Optical activity in the absence of chiral carbons like biphenyl.	**08**
3	**CONFORMATIONAL ANALYSIS**: Inter-conversion of Fischer, Newman and Sawhorse projections. Newer method of asymmetric synthesis (including enzymatic and catalytic nexus), enantio and diastereo selective synthesis. Simple acyclic and cyclic (chair and boat cyclohexanes) systems. Effects of conformation on reactivity in acyclic compounds and substituted cyclohexanes.	**08**

Bachelor of Engineering
Subject Code: CT2312
Subject Name: Organic Chemistry-2

	SECTION-B	
4	**Name reactions in Organic chemistry :** 1. Beckmann rearrangement 2. Meerwein-Ponndorf – Verley reduction 3. Michael reaction 4. Knoevenagel condensation, 5. Leuckart reaction 6. Gabriel synthesis	**08**
5	**Study of individual reaction with mechanism :** 1. Rosenmund reaction 2. Clemmensen reduction mechanism 3. Claisen - Dieckmann condensation 4. Darzens reaction 5. Hydroboration – oxidation reaction 6. Pinacol & Benzidine rearrangement	**08**
6	**Study of Heterocyclic chemistry:** Introduction-nomenclature-properties-synthesis & reactions involved in five member & six member heterocycles. Heterocycles with one, two or more hetero atoms. Biological importance of heterocycles.	**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. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
3. Advanced Organic Chemistry by Carey & Sundberg (3rd edition).
4. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Advanced Organic Chemistry, F. A. Carey and R. J. Sandburg, Plenum.
6. Organic chemistry 2nd ed. Jonathan clayden, Nick Greeves, Stuart Warren.
7. Reaction Mechanism and Reagents in Organic Chemistry by C. R. Chatwal (Himalaya Publishing House, Bombay, 1987).
8. Stereochemistry of Carbon Compounds; By Ernest L. Eliel, Published by Tata McGraw Hill Publishing Company
9. Stereochemistry Conformation and Mechanism; By P.S. Kalsi, New Age International (P) Ltd. Publisher

Bachelor of Engineering
Subject Code: CT2312
Subject Name: Organic Chemistry-2

Course Outcomes:

After learning this course, students will be able to

CO No.	CO statement
CO-1	State the concept of aromaticity and various chemical compounds using IUPAC nomenclature.
CO-2	Explain the concept stereochemistry and its importance.
CO-3	Apply the knowledge of heterocyclic compounds used as precursor compounds for the design and synthesis of new materials.
CO-4	Identify the selection of one reagent over another in terms of efficacy in relation to a particular synthetic problem.
CO-5	Prepare the basic practical skills for the synthesis and analysis of organic compounds.
CO-6	Interpret reaction pathways and outcomes on the basis of mechanistic understanding.

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: CT2326

Subject Name: Symmetry Stereochemistry and Applications (NPTEL- Swayam)

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - V

Type of course: Open subjects – Electives from other technical and /or emerging subjects

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

Rationale: The main objective of this subject is to highlight the concepts and applications of molecular symmetry, isomerism, chirality, applications of stereochemistry in simple organic reactions etc. The students will be introduced to various symmetry elements and symmetry operations observed in various organic molecules, how to identify the symmetry elements and then determine the point groups etc. Then the students would learn the difference between conformation and configuration, various aspects of stereochemistry and will learn to visualize molecules in 3D. Then the course will deal with various organic reactions where stereochemistry plays a major role.

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	-	-	100

Content:

Content	Total Hrs.
Week1: Introduction, IUPAC nomenclature of organic compounds, Conformation and Configuration, Molecular symmetry elements **Week2:** Molecular point groups, Conformational analysis of alkanes and substituted alkanes, Newman and Saw-horse projection **Week3:** Conformation of cyclic molecules: cyclohexane, mono and substituted cyclohexane, cyclohexene, cis- and trans- decalene etc **Week4:** Isomerism: Stereoisomerism, topicity of ligands and faces, Enantiomers and Diastereomers, asymmetry and dissymmetry, Fisher Projection **Week5:** Stereoisomerism in chiral molecules- optical isomerism, Circular Dichroism (CD) and Optical Rotatory Dispersion (ORD) and their applications,	12 weeks

racemization, D/L and R/S nomenclature, meso-compounds etc. **Week6:** Pseudoasymmetry, Stereochemistry of Allenes, substituted Allenes, Atropeisomerism in Biphenyl and Spiro compounds, Geometrical isomerism (cis-/trans- and E/Z notations) **Week7:** Diastereoisomerism in cyclic system- cyclopropane, cyclobutane, cyclohexane, compounds containing C=O, C=N, fused ring compounds **Week 8**:Application of stereochemistry in chemical reactions: Stereoselectivity, Stereospecificity, Regiospecific, Regioselective, Chemoselective reactions Introduction to rate of a reaction, rate determining step etc. **Week9:**Stereochemical aspects of basic organic reactions: SN1, SN2, SNi, NGP, E1 and E2 reaction mechanism, reactions of cyclohexane derivatives **Week10:** Cycloaddition reactions: Diels-Alder reactions, Hydroboration-Oxidation of alkenes,, Baeyer-Villiger Oxidation. Stereochemistry of Aldol condensation, Wittig reaction, Carbonyl addition reaction **Week11:** Stereochemistry of Molecular rearrangements: Pinacol rearrangement, Hoffman, Curtius, Schmidt and Lossen rearrangemnet, Beckmann, Wolff Rearrangement, Cope, Claisen rearrangement **Week 12:** Introduction to crystallographic symmetry: 1D symmetry, Concept of2D symmetry and lattices, notations of symmetry elements, space groups in 2D,3D lattices, 32 point groups and their notations, crystal systems and Bravais lattices	

Books and references:

1. Stereochemistry of Organic Compounds Principles and Applications by D. Nasipuri, 3rd Edition, New Age International (P) Ltd Publishers

2. Basic Stereochemistry of Organic Molecules, 2nd Edition, Book Syndicate Pvt. Ltd

3. Guidebook to Mechanism in Organic Chemistry by Peter Sykes, 6th Edition, Pearson Publication.

4. Basic Organic Stereochemistry by Ernest L. Eliel, Samuel H. Wilen and Michael P. Doyle, 2001 edition, Wiley Interscience.

Bachelor of Engineering

Subject Code: CT2326

Subject Name: Symmetry Stereochemistry and Applications (NPTEL- Swayam)

Course Outcomes:

After learning this course, students will be able to

CO No.	CO statement
CO-1	To introduce the Molecular symmetry elements and Conformational analysis of alkanes and substituted alkanes
CO-2	To understand the concepts of Conformation of cyclic molecules and Isomerism
CO-3	To study of Stereoisomerism in chiral molecules and it's applications and Pseudoasymmetry.
CO-4	To introduce the Diastereoisomerism in cyclic system- cyclopropane and Application of Stereochemistry in chemical reactions.
CO-5	To elaborate the Stereochemical aspects of basic organic reactions and Cycloaddition reactions.
CO-6	To develop the knowledge of Stereochemistry of Molecular rearrangements and Crystallographic symmetry.

List of Open-Source Software/learning website:

1. **NPTEL**

Bachelor of Engineering
Subject Code: MH2301
Subject Name: Contributor Personality Development Program – 1

Shroff S.R. Rotary Institute of Chemical Technology

Type of course: Work-Personality Development

Prerequisite: To keep open mind and will to learn humanity for oneself and society.

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them to recognize how they, as technical professionals, can participate and make a positive contribution to their communities and to their state.

Towards this goal, the Contributor Program has been designed to awaken and strengthen students from within, in terms of building positive self-esteem, increasing their confidence level and I-can attitude, improving their aspirations, giving them new methods of thinking, building their cognitive capacities, exposing them to the skills and practices associated with being contributors in the workplace (not mere employees).

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Gujarat.

The Contributor Program syllabus has been evolved and fine-tuned over several years, (a) to address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire and (b) by working extensively with universities and students building an appreciation of their challenges and concerns. At the core, the program is guided by the higher ideas and principles of practical Vedanta in work.

Bachelor of Engineering
Subject Code: MH2301
Subject Name: Contributor Personality Development Program – 1

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)	
1	1	0	2	50	30	00	20	100

Note:

- Weekly 2 hours of Classroom facilitated sessions are planned which include Solutioning and Self- discovery sessions.
- In addition, there will be individual/ team projects as part of Practical's. Students can do this on their own, with faculty as guide.

Note:

It is the responsibility of the institute heads that marks for PA of theory & ESE and PA of practical for each Students are entered online into the UPL University Portal at the end of each semester within the dates Specified by UPL University.

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**The Contributor Work Ideal** In this topic, students explore what is their "ideal" of work - is the ideal to be a "worker" or to be a "contributor"? For example, an employee who has the ideal of a "worker" goes to work to pass time, earn a living, get benefits; in contrast to an employee with the ideal of a "contributor" who wants to make a difference, get things done well, create value for the company. This enables students to transform their expectation of themselves in work	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)

2	**Identity & Self-esteem** In this topic, students engage with the question "who am I?" or on what basis they define themselves. Is their identity defined by what others think of them (extrinsic self-esteem) or by what they think of themselves (intrinsic self-esteem)? Further, they discover positive identities that lead to intrinsic self-esteem, such as an I-can identity based on one's capacity and inner strength. This enables them to build confidence and self-esteem.	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)
3	**Become a Creator of one's destiny** In a "victim stance", we see the career environment as full of difficulties and hurdles. We feel powerless or blame our circumstances for not having many opportunities. This makes us fearful of uncertainty and makes us settle for jobs where we remain mediocre. In this topic, students discover the "creator of destiny stance" to challenges and situations. This stance frees them to try out new things, open up new possibilities, take on responsibility, and see the opportunity hidden in their environment.	04 hrs Classroom engagement (including self- discovery/ solutioning sessions)
	SECTION-B	
4	**Achieving Sustainable Success** In this topic, students discover how to achieve sustainable or lasting success, by building one's "engine of success", making them success- worthy. Where their focus shifts to building one's "engine of success"rather than being on chasing the "fruits of success". This is important, because over a lifetime of work, all people go through ups and downs – where the fruits are not in their control. People who are focused on the fruits of success, fall prey to disappointment, loss in motivation, quitting too early, trying to find shortcuts – when fruits don't come. Whereas people focused on building their engine of success continue to contribute steadily, irrespective of whether fruits come or not. And with a strong engine of success, fruits come to them in time.	04 hrs Classroom engagement (including self- discovery/ solutioning sessions)

5	**Career Development Models** In this topic, students explore a range of diverse "career development models" and the possibilities for contribution each opens up to them (e.g. start-up career model, change-maker career model, etc.). This opens their mind to different and even unconventional career models possible, beyond the usual (such as "stable large company career model" where one gets an engineering degree, then MBA, then get a job in a large company). This frees them from a herd mentality when making career choices.	04 hrs Classroom engagement (including self- discovery/ solutioning sessions)
6	**Expanding contribution in every role** In this topic, students explore the many roles they can play in their life & discover the power they have to expand the contribution possible in any role. (E.g. role of student, role of manager, role of a project site engineer). So, the potential of a role is in the individual's hands. This opens their mind to an alternative way of career growth.	04 hrs Classroom engagement (including self- discovery/ solutioning sessions)

Suggested Specification table with Marks (Theory):

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

Reference resources:

A. Basic reference for both students and teachers

1. Contributor Personality Program textbook cum workbook developed by Illumine

2. Web-based ActivGuide™ for self-exploration of rich media resources to vividly understand many of the ideas, watch role models, learn from industry people, get reference readings – that help them enrich the understanding they gained in the class published by Illumine Foundation

B. Advanced reference for teachers

1. On Contributors, Srinivas V.; Illumine Ideas, 2011
2. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989
3. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya Vidya Bhavan
4. Karma Yoga, Swami Vivekananda; Advaita Ashrama
5. Vivekananda: His Call to the Nation, Swami Vivekananda; Advaita Ashrama
6. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
7. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
8. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007
9. Why not?: how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003
10. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004
11. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
12. Creating Shared Value, Michael E. Porter and Mark R. Kramer; Harvard Business Review; Jan/Feb2011, Vol. 89 Issue 1/2
13. The Speed of Trust: The One Thing That Changes Everything, Stephen M. R. Covey, Rebecca,R. Merrill, Stephen R. Covey; Free Press, 2008
14. The Courage to Meet the Demands of Reality, Henry Cloud; HarperCollins, 2009
15. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 200

Bachelor of Engineering
Subject Code: MH2301
Subject Name: Contributor Personality Development Program – 1

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Students will be able to recognize & appreciate two alternative ideals of work – "worker" and "contributor".
CO-2	Students will be able to recognize & appreciate alternative ways in which they could define themselves & their identity – that will lead to building intrinsic self-esteem and confidence in oneself.
CO-3	Students will be able to recognize & appreciate the way people approach challenges and situations; and how it frees individuals to take on challenges and open up Opportunities.
CO-4	Students will be able to differentiate between two alternative approaches to success - 'building one's engine of success' and 'chasing the fruits of success'Lead to sustainable or lasting success in the long run.
CO-5	Students will be able to recognize & appreciate different career models and their Value; to help them make more informed career-related choices.
CO-6	Students will be able to recognize & appreciate how one can expand the contribution possible in any role, thereby opening up an alternative way of career Growth to them.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2313

Subject Name: Fundamentals of Reaction Engineering

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Professional Core Courses

Prerequisite: Reactor design uses information, knowledge and experience of areas like fluid mechanics, heat transfer and mass transfer & mathematics.

Rationale: The Fundamentals of Reaction Engineering principles learned in these subjects can also be applied in area such as waste water treatment and living systems in addition to the more traditional area of the manufacture of chemicals and pharmaceuticals. Reaction engineering is that engineering activity concerned with the exploitation of chemical reaction on commercial scale.

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	Kinetics of homogenous reactions Classification of reactions, Definitions of reactions rate, variables affecting reaction rate, concentration dependent term of rate equation for single, multiple, elementary and non-elementary reactions. Molecularity and order of reaction. Kinetic models for non-elementary reactions. Temperature dependant term of rate equations from Arrhenius theory and comparison with collision and transition state theory. Activation Energy and Temperature Dependency. Temperature dependency from thermodynamics, comparison of theories. Prediction of reaction rate by theories. Searching for the mechanism.	08
2	Conversion and reactor sizing Batch reactor design equations, Design equation of flow reactors: CSTR, PFR and PBR. Application of design equations for continuous flow reactors, Reactors in series, combination of CSTRs and PFRs in series, Comparing the CSTR and PFR reactor volumes and reactor sequencing, space-time and space velocity. Introduction to semi batch reactor.	10

Bachelor of Engineering
Subject Code: CT2313
Subject Name: Fundamentals of Reaction Engineering

3	Collection and Analysis of Rate Data Constant volume batch reactor, Differential method of analysis, Integral Method, Method of Half-lives, Method of initial rates.	10
SECTION-B		
4	Multiple Reactions Types of reaction, series – parallel reactions, concept of instantaneous and overall yield, Reactor/reactors selection based on yield of the desired product.	08
5	Temperature and pressure effects Single Reactions Calculations of heats of reactions and equilibrium constants from thermodynamics, equilibrium conversion, General graphical design procedure, Adiabatic and non-adiabatic operations, strategies for heat transfer for reactors for exothermic reactions.	07
6	Introduction to Heterogeneous catalysis Catalyst, Promoter, Inhibitor, Catalyst properties, classification of catalyst, Steps in a catalytic reaction. Synthesizing rate law, Mechanism and rate limiting step, Deactivation of catalyst.	09

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. Octave Levenspiel, "Chemical Reaction Engineering", 3rd Edition, John Wiley & Sons (Asia) Pvt Ltd.
2. H. Scott Fogler, "Elements of Chemical Reaction Engineering" 3rd Edition November, Prentice Hall of India Pvt Ltd.
3. L. D. Schmidt, "The Engineering of Chemical Reactions", Oxford Press.
4. J.M. Smith, "Chemical Engineering Kinetics", 2nd, McGraw-Hill.
5. J. J. Carberry, "Chemical and Catalytic Reaction Engineering", McGraw Hill, New York, 1976.

Bachelor of Engineering
Subject Code: CT2313
Subject Name: Fundamentals of Reaction Engineering

List of Practical:

1. To determine order of reaction
2. To measure the kinetics of a reaction
3. Integral Method of analysis
4. Differential method of analysis
5. Kinetics by Half Lives Method
6. To determine the activation energy and frequency factor for the reaction
7. Isothermal CSTR
8. Plug Flow reactor
9. Adiabatic Batch reactor
10. Study experiment on preparation techniques for catalyst
11. Study experiment on characterization techniques for catalyst

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	Build basic knowledge of classification of reactions, kinetics of competing reactions and their influence on product yield and selectivity.
CO-2	Describe the batch, CSTR, and PFR and Derive performance equations from general material balances.
CO-3	Apply the fundamentals of kinetics including definitions of rate and forms of rate expressions.
CO-4	Develop the skills to choose the right reactor among single, multiple, recycle reactors etc.
CO-5	Explain the concepts of heat capacity, latent heat, heat of reaction, heat of combustion, and heat of formation.
CO-6	Classify catalysts and predict physical properties of catalyst, surface area, void volume and Understand the nature and mechanism of catalytic reactions.

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: CT2314

Subject Name: Introduction to Materials Technology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Chemical Technology

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)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Introduction. Fundamental Concepts. Electrons in Atoms. The Periodic Table. Bonding Forces and Energies. Primary Interatomic Bonds. Secondary Bonding or Van der Waals Bonding Molecules	20
2	Introduction. Fundamental Concepts of Unit Cells. Metallic Crystal Structures. Density Computations Polymorphism and Allotropy. Crystal Systems. Point Coordinates. Crystallographic Directions. Crystallographic Planes. Linear and Planar Densities. Close-Packed Crystal Structures. Single Crystal Polycrystalline Materials. Anisotropy. X-Ray Diffraction: Determination of Crystal Structures	20
3	Introduction. Point Defects: Vacancies and Self-Interstitials. Impurities in Solids. Specification of Composition. Miscellaneous Imperfections. Dislocations–Linear Defects. Interfacial Defects. Bulk or Volume Defects. Atomic Vibrations Microscopic Examination. General Microscopic Techniques. Grain-Size Determination	20
	SECTION-B	

Bachelor of Engineering
Subject Code: CT2314
Subject Name: Introduction to Materials Technology

4	Introduction. Simple Ceramic Crystal structures: ionic and covalent bonding in simple ceramic compounds. Simple ionic arrangements found in ionically bonded solids. Cesium chloride, sodium chloride, crystal structures. Interstitial sites in FCC and HCP crystal structures. Zinc blende crystal structures. Calcium fluoride crystal structures. Antifluorite crystal structure. Corundum crystal structure. Spinel crystal structure. Perovskite crystal structure. Traditional ceramics and engineering ceramics. Mechanical properties of Ceramics: general. Mechanisms of deformation of ceramic materials. Factors affecting strength of ceramic materials. Toughness of ceramic materials. Transformation toughening of partially stabilized zirconia. Thermal properties of ceramics: acidic refractories. Basic refractories. Ceramic tile insulation for space shuttle orbiter.	10
5	Introduction. Concepts of Stress and Strain. Elastic deformation. Stress-Strain Behavior Anelasticity. Elastic Properties of Materials. Plastic deformation. Tensile Properties. True Stress and Strain Elastic Recovery after Plastic Deformation. Compressive, Shear Deformation. Hardness.	20
6	Introduction. Basic Concepts. Characteristics of Dislocations. Slip Systems. Slip in Single Crystals. Plastic Deformation of Polycrystalline Materials. Deformation by Twinning. Mechanisms of Strengthening in metals: Strengthening by Grain Size Reduction. Solid-Solution Strengthening. Strain Hardening. Recovery, Recrystallization and grain growth. Recovery. Recrystallization. Grain Growth	10

Suggested Specification table with Marks (Theory):

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

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

Recommended Books:

1) Materials Science and Engineering an Introduction. William D. Callister, Jr. Fifth Edition, John Wileyand Sons, Inc. 1999.
2) Unit Operations of Chemical Engineering. McCabe W., J. Smith, and P. Harriott,:, 7th Ed., McGraw-Hill, New York, 2004.
3) Principles of colloid and surface chemistry. P.C Hiemenz, R. Rajagopalan. M.Dekker, New York,1997
4) M. Rhodes, Introduction to particle technology, John Wiley & Sons, 19982. V. Raghavan, Materials Science and Engineering, Prentice-Hall of India Pvt. Ltd., 2004

Bachelor of Engineering
Subject Code: CT2314
Subject Name: Introduction to Materials Technology

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To identify the fundamentals materials
CO-2	To process the material by using different techniques.
CO-3	To study the knowledge of polymeric materials and Colloidal and nano-particlesystems.
CO-4	To ascertain and correlate the knowledge of smart materials.
CO-5	To design the smart materials
CO-6	To formulate the smart material used in chemical industry.

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: CT2315

Subject Name: Pharmaceutical Chemistry-3

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Professional Elective Course

Prerequisite: Needs basic knowledge of Pharmaceutical Chemistry & Organic Chemistry.

Rationale: The main objective of this subject is to study nomenclature, SAR, MOA, metabolism and synthesis of drugs.

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	-	-	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Study of nomenclature, classification, SAR, MOA and synthesis of Cardio-vascular drugs, anti-hyperlipidemics, anti-osteoporotic drugs	08
2	Study of nomenclature, classification and MOA and synthesis of anticancer drugs, antiviral drugs-anti-HIV drugs	08
3	**Drugs affecting CNS:** Study of nomenclature, classification, SAR and synthesis of CNS drugs- General anesthetics, anti-seizure drugs, anti-anxiety drugs.	08
	SECTION-B	
4	**Drugs affecting CNS:** Study of nomenclature, classification, SAR and synthesis of CNS drugs- Sedatives, Hypnotics, antipsychotic drugs, anti-parkinsonism drugs.	**08**
5	**Drugs affecting ANS:** Study of nomenclature, classification, SAR and synthesis of ANS drugs- adrenergic drugs and adrenergic blockers; Cholinergic drugs and Cholinergic blockers	**08**
6	**Medicinal Natural Products:** Scope of the subject, Source of the drug of natural origin, Classification of drug, factors involved in the production of drugs.	**08**

Bachelor of Engineering
Subject Code: CT2315
Subject Name: Pharmaceutical Chemistry-3

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. Text book of Medicinal Chemistry Volume –I & II by V. Alagarsamy
2. Text book of Medicinal Chemistry by Ashutoshkar
3. Strategies for Organic Drug Synthesis & Design, & Daniel Led nicer, John Willey & Sons Inc. New York., 2nd Ed, 1998.
4. Burger's Medicinal Chemistry & Drug Discovery: Vol. 1 to 6, A. Burger & M.E.Wolff, John Wiley & Sons – New Jersey,6th Ed, 2003
5. Foye's Principles of Medicinal Chemistry, W.O. Foye, Lippincott Williams & Wilkins-Philadelphia, Oxford, 6th Ed, 2008.
6. Organic Chemistry of Drug Synthesis: Vol.1 to 6, Daniel Lednicer, John Wiley & Sons Inc
7. Text book of Medicinal & Pharmaceutical Chemistry, Charles Owens
8. Natural Products: chemistry and biological significance J. Mann, R.S. Davidson
9. Introduction to Flavanoids, B,A. Bohm
10. Insecticides of Natural Origin, Sukh Dev

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To understand and appreciate the molecular design principles by studying Structure-Activity Relationship (SAR) and molecular mechanism of action of drug substances.
CO-2	To illustrate the synthesis of CNS, ANS and other drug substances
CO-3	To demonstrate the nomenclature, and metabolism of all drug substances.
CO-4	To analyze the factors involved in the synthesis/isolation of drug substances
CO-5	To describe the scope and classification of medicinal natural products.
CO-6	To evaluate the methods of synthesis/extraction/isolation of drug substances

Bachelor of Engineering

Subject Code: CT2315

Subject Name: Pharmaceutical Chemistry-3

List of Open-Source Software/learning website:

1. NPTEL
2. MIT Open course lecture available on Internet etc
3. Delnet
4. Literature available in any laboratory manual of Pharmaceutical Industries.
5. Medical dictionaries
6. Pharmacopoeia

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Bachelor of Engineering

Subject Code: CT2316

Subject Name: Engineering of Pigmented Dispersion

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Professional Elective Course

Prerequisite: Basic Knowledge of Pigment Technology.

Rationale: The main objective of this subject is to study fundamental knowledge of various types of coloured & high performance pigments and how to carry out manufacturing & applications of these pigments in chemical industries.

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	00	00	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Stages of Pigment Dispersion: Immersion & wetting of pigments, penetration and separation of agglomerates, statistical considerations of mechanical deagglomeration, Stabilization of colloidal pigment dispersion- entropic & charged double layer mechanism of stabilization, variables affecting stabilization,	**08**
2	Adhesion & cohesion phenomenon associated with dispersion; initial dispersion, mill base & letdown compositions; flow point curves, instrumental analysis of fineness of dispersion.	**08**
3	Dispersion mills: High speed mixers: underlying fluid mechanics, mill base rheology, tank & impeller dimensions, different impeller geometries & orientations, power input, Heavy duty & miscellaneous mills: sigma kneaders, pug mixers, planetary mixers.	**10**
	SECTION-B	
4	Attritor: mechanism of attrition, batch & & continuous operation, design aspects, comparison with ball mill. Micro bead mill: vertical open, vertical closed & horizontal mills, mechanism of bead milling; effect of retention time/ flow rate, grinding media size, shape & composition, pigment size and size distribution, nature of premix processing, mill base composition on fineness and stability of micro bead dispersion,	**10**

Bachelor of Engineering

Subject Code: CT2316

Subject Name: Engineering of Pigmented Dispersion

5	Ball mill: Cascading principle, size, speed & design of ball mill; size, shape & composition of balls; mill base composition, power consumption, batch & continuous operation. Roll mills: single, Double, Triple roll mills, flow of mill base through rolls, material balance, mill base composition, roll design & power inputs.	**08**
6	Fire, explosion & health hazards: General industrial hazards, prime causes of fire & explosion, safety considerations in arrangement of underground and above ground primary & secondary solvent storage tanks, design of piping, pumps & vessels from safety point of view, cleaning & disposal considerations, safety norms & regulations	**12**

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
15	**15**	**25**	**25**	**10**	**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. 'Organic coatings : Science and Technology', Edited by Zeno W. Wicks, Jr., Frank N. Jones, S. Peter Pappas; Douglas A. Wicks,Third Edition, John Wiley & Sons, Inc., Hoboken, New Jersey. 2007.
2. Morgans, W.M., 'Outline of Paint Technology', 3rd Edition, CBS Publishers and Distributors, New Delhi, 1996
3. "Surface Coatings" Volume 1 "Raw material and their usages" Oil and Colour Chemists' Association, TAFE Educational Books, NSW, Australia, 1987.
4. Paul Swaraj, "Surface Coatings –Science and Technology", Wiley Interscience Publishers, John Wiley and Sons, Inc.1986.
5. 'Paints, Coatings and Solvents', Dieter Stoye; Werner Freitag (ed.), 2nd. Edition, Wiley-VCH.Weinheim; (1998).

Course Outcomes:

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	To get an knowledge of stages of pigmented dispersion	15
CO-2	To know about analysis of pigment dispersion	15
CO-3	To know the high speed mixer & heavy duty mills	20
CO-4	To enhance the knowledge of attritor & micro-bead mill.	20
CO-5	To be able to utilize the knowledge and skills for dispersion in pigment by using ball mill & roll mill.	20
CO-6	To describe the methods for Fire, explosion & health hazards	10

Bachelor of Engineering

Subject Code: CT2316

Subject Name: Engineering of Pigmented Dispersion

List of Open Source Software/learning website:

1. Literature available on internet
2. Pigments dictionaries
3. Delnet
4. Literature available under R&D in Pigments & Paints industries
5. Dyes & Pigments, Pigments & Resin & Paint India journals

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2317

Subject Name: Polymer Blends and Alloys

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Professional Elective Course

Prerequisite: Student should know the basics of polymer and rubber materials, properties and their compounding processes.

Rationale: The main objective of this subject is to provide the knowledge about the different polymeric blends and composites materials.

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	00	00	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Introduction to Polymer Blends & Alloys: Historical outline of industrial development of polymer blends and alloys, Blends of Polymers & rubbers, definitions of terms used in polymer blends & alloys, Compounding of Polymer Blends, Fundamentals of polymer mixing, Blending methods and equipment, Type of blends: RTM DMC, SMC, and IPN. Commercial Polymer Blends.	**08**
2	Factors affecting miscibility of polymer blends- Thermodynamics, compatibility, solubility parameter, interaction parameter, composition, molecular weight, transition temperature, mechanism of blending, etc. Properties of miscible and immiscible blends.	**10**
3	Blends of engineering and commodity plastics: like PVC/ABS, PVC/SAN, PVC/NBR, PC/PET, PC/PBT, PC/ABS and PPO/HIPS	**12**
	SECTION-B	
4	Polymer Toughening: Mechanism and theory of toughening, Toughening of thermoplastics and thermosets; Thermoplastic elastomers (TPEs). Characterization of polymer blends	**10**
5	Introduction to Composites: Definition, Raw Materials, Functions of constituent phases, Classification of composites, Advantages and	**10**

	limitations of polymer matrix composites over MMC and CMC, Applications.	
6	Applications of Composites & Nanocomposites- Flame retardant textiles, Toughened plastics, Automotive bodies, Belts, Vacuum cleaners, Covers for mobile phones, Power tools.	**12**

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
40	**25**	**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)

Reference Books:

1. Composite Polymeric Material, R. P. Sheldon, Applied Science Publishers, 1982.
2. Composites: Design Guide, Industrial Press Inc, 1987.
3. Composite Material Handbook, M. M. Schwartz, McGraw-Hill Company, 1984.
4. Polymer Science and Technology: Plastics, Rubbers, Blends and Composites, P Ghosh, Mc Graw Hill, 2nd ed., 1990
5. L A Utracki. Polymer blends and alloys, Hanser Publication, 1989.
6. Paul and Newman. Polymer blends, Academic press, NewYork, 1978.
7. Lloyd M Robeson. Polymer blends– A comprehensive review, Hanser publishers, 2007.
8. John Mason and Leslie H Sperling. Polymer blends and composites, Plenum Press, New York, 1976.
9. S T Peters. Handbook of Composites, 2nd edition, Chapman and Hall, London, 1998.
10. Sanjay K Mazumdar. Composite manufacturing, materials, product and process engineering, CRC Press, London, 2002.
11. D V Rosato and D V Rosato. Reinforced Plastics Handbook, 3rd edition, Elsevier, UK, 2004.
12. K K Chawla. Composite Materials Science and Engineering, 2nd edition, Springer publications, New York, 1998.
13. T G. Gutowski. Advanced composite manufacturing, 1st edition, John Wily and Sons, New Jersey, 1997.
14. L C Hollaway. Handbook of Polymer Composites for Engineers, 1st edition, Woodhead Publishing, UK, 1994.
15. J C Bittence and F Cverna. Engineering Plastics and Composites, 2nd edition, ASM International, Materials Park, OH, 1990.

Bachelor of Engineering
Subject Code: CT2317
Subject Name: Polymer Blends and Alloys

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To recognize the fundamentals of polymer blends, alloys and blending equipments.	15
CO-2	To identify the various factors affecting polymer blends.	15
CO-3	To apply this knowledge for the blending of various engineering and commodity plastics.	20
CO-4	To analyze the toughening effect of blends.	15
CO-5	To be able to formulate various polymeric composites.	15
CO-6	To correlate between theoretical and practical concept by applying this knowledge in making various composites material.	20

List of Open Source Software/learning website:

- Literature available on internet
- www.iri.net.in
- www.ipiindia.org
- Delnet

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: CT2318
Subject Name: Process Ceramics

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

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, 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)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Material Characterization: a) Characterization and specification of ceramic materials b) Chemical and Phase compositions c) Particle size and shapes d) Density, pore structure and specific surface area. Particle mechanics and rheology: a) Particle packing characteristics – Models of one, two of spherical balls	20
2	Gap grading, continuous grading c) Rheological behavior of slurries and pastes: -Newtonian fluid, plastic flow, dilatant liquid, thixotropy, Deflocculation, Zeta potential, effect of electrolytes on Zeta potentials, applications in ceramic processings	20
3	Beneficiation Process: Comminution – Equipments, milling, particle size distribution. Batching and mixing: Mixing mechanism and mixing equipments. Particle separation, concentration and washing processes – particle sizing, filtration, washing, particle concentration processes.	20
	SECTION-B	

Bachelor of Engineering
Subject Code: CT2318
Subject Name: Process Ceramics

4	Granulation – direct granulation, spray granulation. Forming processes: Dry pressing – powder flow and die filling, compaction behavior, ejection and transfer, die wall effects, control of compaction defects, Cold isostatic Pressing , Plastic forming – Extrusion	20
5	Jiggering, Jolleying , Casting process- Slip Casting –drying processes, Mechanisms in drying process	10
6	Shaping, surface finishing, glazing. Firing – Firing system, Pre sintering processes, sintering, and vitrification and cooling. Glass processing – selection of raw materials, effects of different oxides on glass properties, batch preparation, melting in glass tank furnace, refining of glass	10

Suggested Specification table with Marks (Theory):

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

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

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
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: CT2319

Subject Name: Pharmaceutical Formulation Technology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Professional Elective Course

Prerequisite: Needs basic knowledge of Pharmaceutics & Chemistry.

Rationale: The main objective of this subject is to study the Formulation technology of Liquids, Topical, sterile & Solid 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	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Technology of Liquid formulation**: Preparation and evaluation of oral syrups, elixirs, tinctures, ear drops, nasal drops. Preparation and evaluation of suspensions/ dry syrup/emulsions of containing hydrophilic and hydrophobic drug. Layout design and Unit operations related to above dosage forms	08
2	**Technology of Topical Formulation:** Preparation and evaluation of topical Liniments and lotion, Preparation and evaluation of ointments representing each type of base, and gel, Preparation of Suppositories (any 2 base). Layout design and Unit operations related to above dosage forms	08
3	**Sterile Dosage Forms: Pre-formulation & Formulation:** Evolution, Large scale manufacture & packing with focus on equipment with reference Parenterals & ophthalmic dosage forms.Layout design & Unit operations related to above dosage forms	08
	SECTION-B	
4	**Technology of Solid Dosage Forms- Tablets** Pre-formulation, formulation, evaluation, large scale manufacture and packing with focus on equipment with reference to tablets, Coated tablets.Layout design & Unit operations related to above dosage forms.	**08**

Bachelor of Engineering
Subject Code: CT2319
Subject Name: Pharmaceutical Formulation Technology

5	**Technology of Solid Dosage Forms-Capsules** Pre-formulation, formulation, evaluation, large scale manufacture and packing with focus on equipment with reference to Hard gelatin capsule, Soft gelatin capsule & Microcapsule.Layout design & Unit operations related to above dosage forms.	**08**
6	**Stability evaluation**: Stability evaluation of pharmaceutical dosage forms	**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. Pharmaceutical Dosage Forms & Drug Delivery Systems, Ansel, Philadelphia, Fea & Febiger, 1985
2. Introduction to Pharmaceutical Dosage Forms, Ansel, Henry Kimpton Publishers, 1976.
3. Pharmaceutics: The Science of Dosage Form Design, Aulton,New Delhi, B.I. Naverly Pvt.Ltd.1995.
4. Dermatological Formulations, B.W.Barry, New York, Marcel Dekker1983.
5. Modern Pharmaceutics, G.S.Banker, New York, Marcel Dekker1990.
6. Textbook of Pharmaceutics, Rawlins,Bentely Cassell Ltd, 8th Ed.,1977.
7. Fundamentals of Pharmacy, Blome H.E., Philadelphia, Fea&Febiger,1985.
8. Pharmaceutical Production Facilities: Design & Applications, G.C.Cole, New York Ellis Horwood 1990.
9. Husa'a Pharmaceutical Despensing, Martin E.W., Easton MackPub.Co.1971.
10. Tran dermal Delivery of Drugs, A.Kydonieus, Florida, CRC Press,1987.
11. Textbook of Pharmaceutics, A C Bentley, Oxford University Press,1969.
12. The Theory and Practice of Industrial Pharmacy, Lachman Bombay, K. M. Warghese Co. 1976.
13. Remington's Pharmaceutical Sciences, A.R.Gennaro Mac Pub. Co. Easton, Pennsylvania 1990.
14. Coated Pharmaceutical Dosage Forms, K.H. Bauer, CRC Press, Boca Raton. Med Pharm.1998.
15. Indian pharmacopoeia, British Pharmacopoeia, United States Pharmacopoiea.
16. Pharmaceutical Coating Technology, G.C. Cole, New York, Ellis, Horwood,1990.

17. Pharmaceutical Dosage Forms Vol. I & II, Liebermann, New York, Marcel Dekker,1996.
18. Hard Capsules : Development & Technology, K.Ridgway , London Pharmaceutical Press, 1987.
19. High-Throughput Formulation Development of Biopharmaceuticals: Practical Guide to Methods and Applications, Vladimir I. Razinkov and Gerd Kleemann, Elsevier Science, 2016

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To describe the liquid, topical, sterile and solid Pharmaceutical dosages forms and study their preparation.
CO-2	To illustrate large scale manufacture and packing with focus on equipment with reference to liquid, topical, sterile and solid dosage forms.
CO-3	To demonstrate the layouts and unit operations involved in liquid, topical, sterile and solid dosage forms
CO-4	To analyze the formulation methods of liquid, topical, sterile and solid dosage forms.
CO-5	To explain the pre-formulation methods of liquid, topical, sterile and solid dosage forms.
CO-6	To evaluate the stability of liquid, topical, sterile and solid dosage forms.

List of experiments:

1. Study the pre formulation characteristics of active pharmaceutical ingredients
2. To prepare and evaluate Paracetamol granules and tablet
3. To prepare effervescent granules.
4. To study the disintegration studies of solid dosage forms
5. To study the dissolution studies of solid dosage forms
6. To prepare and evaluate Amoxicillin trihydrate capsule
7. Preparation & Determination of moisture content for effervescent granules
8. To study the preparation of parenterals.
9. To study the preparation of ophthalmic ointments
10. To study the preparation of eye drops.

Bachelor of Engineering

Subject Code: CT2319

Subject Name: Pharmaceutical Formulation Technology

List of Open-Source Software/learning website:

1. NPTEL
2. MIT Open course lecture available on Internet etc
3. Delnet
4. Literature available in any laboratory manual of Pharmaceutical Industries.
5. Medical dictionaries
6. Pharmacopoeia

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Bachelor of Engineering

Subject Code: CT2320

Subject Name: Technology of Inorganic and Functional Pigments

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Professional Elective Course

Prerequisite: Basic Knowledge of Pigment Technology.

Rationale: The main objective of this subject is to study fundamental knowledge of various types of colored & high performance pigments and how to carry out manufacturing & applications of these pigments in chemical industries.

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	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**General methods of processing and synthesis of inorganic pigments:** Crushing and grinding, vaporization, co-precipitation, filtration, drying, flushing, calcinations/roasting, vapour phase oxidation etc.	**08**
2	**Extenders or filler pigments:** Sources, Methods of manufacturing, properties and uses of carbonates, sulphates and other extender pigments like Calcium carbonate, hydrated aluminium oxide, aluminum silicates/ china clays, Magnesium silicate/ talc.	**10**
3	**White pigments:** Introduction, properties, Methods of manufacturing, properties and composition, quality, after treatment, uses, economic aspects of TiO2, ZnO, Zinc sulphide and lithopone. **Black pigments:** Introduction, properties, Methods of manufacturing processes like Channel blacks, Furnace blacks, Gas black, Lamp blacks, Thermal back, Acetylene black, after treatment, testing & analysis	**12**
	SECTION-B	
4	**Colored Pigments:** Introduction, properties, methods of manufacturing, properties and composition, quality, after treatment, uses, economic aspects of iron oxide, chromium oxide, mixed metal oxide, cadmium, bismuth pigments, chromate, molybdate and molybdate orange, chrome green, Ultramarine Blue, Prussian Blue etc	**10**

Bachelor of Engineering
Subject Code: CT2320
Subject Name: Technology of Inorganic and Functional Pigments

5	**Specialty Pigments:** Introduction, Metallic, Interference and Cholesteric Pigments Aluminium, copper. Nacreous, luminescent (fluoresecent/phosphorescent) pigments-optical principles, substrate free pearlescent pigments. Special effect pigments based on mica (pigments formed by coating of substrates)	**10**
6	**Functional pigments:** **Antifouling pigments-** Introduction, cuprous oxide, other copper compounds, mercuric oxide, organotin pigments. functional pigments in paints, Anticorrosive pigments: Introduction and passivation mechanism of corrosion resistance Red lead, basic lead silicochromate, zinc and strontium chromates, calcium plumbate, etc.	**12**

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
40	**25**	**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)

Reference Books:

1. G. Buxbaum (Ed.), Industrial Inorganic Pigments, Second, Completely Revised Edition,1998,ISBN 3-527-28878-3 2.
2. Braun, J. H., White Pigments, Federation of Societies for Coatings Technology, Blue Bell,PA, 1995.
3. Challener, C., Update on Inorganic Pigments, JCT Coat. Tech, 2005, 2(18), 44.
4. Herbst, W.; Hunger, K., Industrial Organic Pigments, 3rd ed., Wiley-Interscience, NewYork, 2004.
5. Lewis, P. A., Ed., Pigment Handbook, 2nd ed., Vol. I, Wiley-Interscience, New York,1988.
6. Herbst, W.; Hunger, K., Industrial Organic Pigments, VCH, New York, 1997.
7. Vanderhoff, J. W.; et al., Polym. Mater. Sci. Eng., 1991, 64, 345. 8. Lewis, P. A., Organic Pigments, Federation of Societies for Coatings Technology, Blue Bell, PA,1995.
8. H.M. Smith, High Performance Pigments, Wiley-VCH, 2002.
9. J. Bieleman (Ed.) Additives for Coatings 2000 WILEY-VCH Verlag GmbH & Co. KGaA,Weinheim
10. Lewis, P.A. and patton, T.C.(Eds), Pigment Handbook, 3 vols. John wiely, Chichester, 1988. 5. Mclaren, K., The colour science of dyes and pigments, 2nd edn.Adam Hilger: Bristol, 1983.

Bachelor of Engineering
Subject Code: CT2320
Subject Name: Technology of Inorganic and Functional Pigments

List of Experiments:

1. Identification of Pigment- Spot Test.
2. To determine the Oil Absorption value of given pigment.
3. To determine the Bulk Density of given pigment
4. To determine the Bleeding Tendency of given pigment
5. To determine the % Moisture content of given pigment
6. To Determine the Acidity & Alkalinity of given pigment
7. Preparation of Zinc Oxide Pigment
8. Preparation of Phalocyanine Blue Pigment
9. Preparation of Azo Pigment- Para Red
10. Preparation of Barium Sulphate Extender
11. Preparation of Lead Chrome Pigment
12. Preparation of silica flake pigment.
13. Preparation of mica pigment.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To be able to utilize the knowledge and skills for general methods of processing and synthesis of inorganic pigments	15
CO-2	To illustrate the manufacturing of extenders.	15
CO-3	To explain the manufacturing processes of white & black pigments.	20
CO-4	To get an knowledge of synthesis of coloured pigments	15
CO-5	To be able to utilize the knowledge and skills for processing of specialty pigments	15
CO-6	To illustrate the manufacturing of functional pigments	20

List of Open Source Software/learning website:

- Literature available on internet
- Dyes dictionaries
- Delnet
- Literature available under R&D in Dyes industry
- Dyes & Pigments journal

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CT2321

Subject Name: Processing of Polymer & Rubber

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Professional Elective Course

Prerequisite: Student should know the basics of polymer and rubber material and its properties.

Rationale: The main objective of this subject is to provide the knowledge about the different polymer and rubber processing 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)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Introduction to Polymer Compounding: Raw polymeric (Plastics and Elastomers) materials, Compounding processes such as mastication and mixing, Properties & various applications of additives. Compounding machineries & parameters – different types of mixing roll mills, internal mixers, solution mixers and extruders. Curing of rubber materials, Making of Compounds for products such as tires, hoses, mats & other products.	**08**
2	Extrusion: Introduction basics of extrusion process, Different types of extruders, general constructional features of single screw and twin screw extruders, machine design features eg: drives, types of screw, L/D ratio, compression ratio, flight depth, pitch, helix angle and screw clearance. Rubber extrusion	**10**
3	Compression Moulding: Introduction and different types of moulds, the compression moulding cycles, breathing, trouble shooting, Compression moulding of thermoplastics. advantages and drawbacks of the process	**12**
	SECTION-B	
4	Injection moulding: Construction and specifications of Injection moulding machines. Types of Injection moulding machines, types of clamping - Toggle and hydraulic clamps, clamp force requirements. Injection	**10**

Bachelor of Engineering
Subject Code: CT2321
Subject Name: Processing of Polymer & Rubber

	moulding variables for ram and screw type machines (temp., pressure, time).	
5	Transfer moulding: Fundamental principles of transfer moulding, Different types of transfer moulding - pot, plunger and screw transfer moulding, Transfer molds: Integral moulds and auxiliary ram moulds. Advantages over other moulding techniques.	**10**
6	Blow moulding: Basic Principles of machines and processes for manufacture of bottles and other hollow products by extrusion blow moulding, injection blow moulding and stretch blow moulding. Thermoforming and Calendering: General constructions of the processes and its types. Rubber Calendaring	**12**

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
40	**25**	**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)

Reference Books:

1. Brent strong ,'Plastics: Materials and processing', Prentice-Hall Englewood cliffs, 2006
2. Isayev, Injection molding and compression molding fundamentals, Marcel Dekker,2010
3. Alan Griff ,Plastics Extrusion Technology, Krieger Publishing Company,1996
4. Rosato and Rosato. Injection Moulding Hand book, Hanser Publishers,2010
5. Rosato and Rosato, Blow Moulding Hand book , Hanser Publishers,2010
6. Ed.Corish ,Concise Encyclopedia of Plastics Processing and applications, , Pergamon Press,1996
7. F W Barlow. Rubber compounding: Principles, Materials and Techniques, 2nd edition, Marcel Dekker, CRC Press, New York, 1993.
8. Ica Manas-Zloczower. Mixing and Compounding of Polymers: Theory and Practice. 3rd edition, Hanser Gardner Publications, Munich, Germany, 2012.
9. Joel Fredos, Plastics Engineering Handbook, 2nd-3rd edition, Van Nostrand Reinhold , Newyork, 1976.
10. Reginald Alfred Elden and A. D. Swan, Calendaring of plastics, Plastics Institute, 1971
11. Middleman, Fundamentals of Polymer processing ,McGraw Hill, Newyork,1977
12. D.H. Morton Jones Polymer processing, Chapman & Hall, 1989
13. Understanding Injection Molding Technology, Herbert Rees, Hanser Publishers, 1994.
14. Understanding Extrusion, Chris Rauwendaal, Hanser Publishers, 1998

15. Rotational Molding, Glenn L. Beau, Hanser Publishers, 1998
16. Understanding Compounding, R. H. Wildi & Maier, Hanser Publisher mc, 1998
17. Fundamentals of Polymer Processing, S. Middleman, Houghton Mifflin Company, 1997
18. Rubber Compounding, Barlow, CRC Press, 2nd Ed, 1993
19. Rubber Compounding: Chemistry and Applications, Brendan Rodgers, CRC, 1st Ed, 2004

List of Experiments:

1. Rubber compounding with the help of two roll mill.
2. Calculation of density of compound from the rubber compound formulation.
3. Determination of density of raw compound and cured compound.
4. To study the specification of extruder available in the lab.
5. To Perform Single screw extruder practical for polymer and rubber materials.
6. Compression Moulding of polymer and rubber materials.
7. To study the mould analysis for Compression and injection moulding processes.
8. To study the effect of Additive in Polymers and rubbers.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To recognize the knowledge about the basic introduction of polymer and rubber compounding.	15
CO-2	To identify the processing of polymer and rubber materials by extrusion process.	15
CO-3	To apply this knowledge the processing of materials by getting knowledge about Compression molding and apply it with real world situation.	20
CO-4	To analyze the Injection molding processes for the polymer and rubber materials.	15
CO-5	To be able to formulate polymeric materials suitable for processed in transfer and rotational molding.	15
CO-6	To correlate between theoretical and practical concept by making final products by performing processes such as thermoforming and calendaring.	20

List of Open Source Software/learning website:

- Literature available on internet
- www.iri.net.in
- www.ipiindia.org
- Delnet

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Bachelor of Engineering

Subject Code: CT2322

Subject Name: Advanced Refractories & Whitewares

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

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)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Introduction of Monolithic Refractories, Shaped and Unshaped Refractories — Advantages and Disadvantages, Classification of Unshaped Refractories Aggregates used in monoliths. Refractory cement and other additives, Additives for ramming and gunning materials.	11
2	Classification of Castables: Conventional, Low cement, Ultra low cement No or zero cement, Gel bonded and self-flow castables, Silica free and Basic castables. Manufacture of Castables/Monoliths, Installation techniques, Applications. Refractory Cement, Morters, Concrete, Ramming Mass.	06
3	Non Oxide Refractories: Silicon Carbide - Fabrication Properties and applications. Nitride refractories – Silicon nitride, boron nitride,	12

Bachelor of Engineering
Subject Code: CT2322
Subject Name: Advanced Refractories & Whitewares

	Fabrication, properties and application. Pure oxide refractories - Alumina, Magnesia, and zirconia based refratories.	
SECTION-B		
4	Carbon bearing refractories: Importance of carbon bearing refractories. Advantages of these refractories, Properties variation with the amount of carbon in basic refractories, Properties of pitch, tar and resin used in brick manufacturing, tempering of these bricks, application of antioxidants, wear mechanism in LD converter.	08
5	Testing of whitewares bodies' Firing, Factors determining firing schedule, Effect of heat on whitewares bodies, Formation of different phases at different temperatures, Final phases of porcelain bodies, Analysis of microstructure.	08
6	Drying - Types of water present, Factors affecting drying (internal & external factors), Convection, Radiation, High frequency heating. Glazing - Purpose & advantages of glazing, Raw glazes, Fritted glazes, Special glazes, Fusibility of glazes, Opacity & opacifiers, Stains, Colloidal colours, Different coloring oxides, Empirical formula of glazes, Glaze defects, Glazing techniques.	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

Bachelor of Engineering
Subject Code: CT2322
Subject Name: Advanced Refractories & Whitewares

List of Practicals:

1. Powder Preparation -- Crushing fireclay grog. Size separation of grog.
2. Characterisation 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. Testing of various important properties of refractories as per IS
7. Refractory corrosion test
8. Fabrication of some high alumina & basic bricks

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
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:

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: CT2323

Subject Name: Process Instrumentation, Dynamics and Control

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Open Electives

Prerequisite: Students are expected to have a background in mathematics through differential equations, Laplace transformation, material and energy balance concepts.

Rationale: The main objective of this subject is to cover basics of process control and the instrumentation used in industries. The process control part begins with the introductory concepts, and mathematical modeling and its use for control purposes. A special emphasis will be placed on the controller tuning and stability analysis. The instrumentation part will elaborate the valve characteristics along with the working principle, specifications, design and selection aspects of various measuring instruments.

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 of Process Control: Introduction to Industrial Process Control, Strategies for Control: Feedback/ Feed forward, Steady state system, Transient response, Block diagram, Parts of control system	04
2	Laplace Transforms: Definition, Transforms of simple functions, Ramp functions, Sine functions, Inversions of transform function by partial fractions, Solutions of differential equations, Final value and initial value theorems, Translation of transforms, Transforms of unit impulse functions, Transforms of integral.	08
3	First and Second Order Systems: Mercury thermometer, Transient response of step functions, Sinusoidal input, Impulse functions. Physical Examples of First Order Systems such as Liquid level, Mixing process, linearization. Response of First Order	12

Bachelor of Engineering
Subject Code: CT2323
Subject Name: Process Instrumentation, Dynamics and Control

	System in Series: Non-interacting system of liquid level, Generalization of several non-interacting systems in series, Interacting systems, Development of transfer functions for 2nd Order system, Liquid manometer, Step response & impulse response, Terms used to describe second order system like Overshoot, Decay ratio,Rise time, Response time, Period of oscillation, Natural period of oscillation, Sinusoidal response , Transportation lag.	
SECTION-B		
4	The Control Systems and Controllers: Block diagram, Negative and positive feedback, Servo problem v/s regulator problems, Development of block diagrams, Process measuring element, Controller, Final control element. Closed Loop Transfer Functions: Standard block diagram symbols, Overall transfer function for single loop system, Overall transfer function for change in load, Overall transfer function for multi loop control system. Controller algorithms: P, PI, PD, PID control actions. Pneumatic controller mechanism of proportional control, Proportional integral (PI) control, Proportional derivative (PD) control, Proportional integral derivative (PID) control. Control valve, Control valve characteristics. Transient Response of Simple Control Systems: Proportional control for Set point change (Servo Problem), Proportional control for load change (Regulator Problem), Proportional integral control for load change, Proportional Integral control for set point change, Proportional control for system with measurement lag. Selection of Controller & Control Criteria.	12
5	Stability: Concept of stability, Definition of stability (linear system), Stability criterion, Characteristic equation, Routh test for stability, Routh array, Method of Root Locus for stability analysis, Nyquist stability criterion.	07
6	Instrumentation: Introduction of Process Measurement: Elements of instruments, Parts of instruments, Static and dynamic characteristics. Different types of Temperature Measurement, Pressure Measurement, Liquid Level Measurement and Flow Measurement instruments	12

Suggested Specification table with Marks (Theory):

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

Bachelor of Engineering
Subject Code: CT2323
Subject Name: Process Instrumentation, Dynamics and Control

Recommended Books:

1. "Process System Analysis & Control", Coughanower and Kappel, Mc-Graw Hill Book Company.
2. “Chemical Process Control”, George Stephanopoulos, Prentice-Hall India
3. “Process Control: Modeling, Design and Simulation”, Wayne Bequette, Prentice Hall
4. “Essentials of Process Control”, Luyben and Luyben, Mc Graw Hill
5. "Industrial Instrumentation", Donald .P. Eckman, John Wiley & Sons Inc, New York.
6. “Process Instrumentation And Control”, A. P. Kulkarni, Nirali Prakashan.

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	Identify different forcing functions of the control process.
CO-2	Obtain the response of physical systems for different forcing functions.
CO-3	Analyse the response of the feedback control system for set point and load change.
CO-4	Understand the effects of P, PI, PD, and PID controllers on a controlled process.
CO-5	Perform stability analysis and frequency response analysis for a given dynamic system.
CO-6	Evaluate the parameters required for controller tuning.

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: CT2324

Subject Name: Analytical Techniques

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Open Elective

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

Rationale: The main objective of this subject is to provide a strong basis of Analytical Chemistry that will be applicable to other areas of the degree course such as chemical reaction Engineering.

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	**Fundamentals of Analytical Chemistry**: Concept of quality: Definition of quality, Quality control & assurance, TQM. Correlation between quality & analysis, steps & types of chemical analysis, Stoichiometry & expression of concentration.	**05**
2	**Theory of errors**: Sources & classification of errors. Statistical treatment of analytical data & presentation of result. Sampling of solids, liquids & gases. Evaluation & validation of analytical methods. Good laboratory practices.	**05**
3	**Chromatographic methods**: Introduction & classification of chromatography. Theory, instrumentation & applications of the following chromatographic techniques: (i) Column chromatography (ii) TLC (iii) Paper chromatography (iv) GC (v) HPLC (vi) HPTLC	**14**

Bachelor of Engineering
Subject Code: CT2324
Subject Name: Analytical Techniques

SECTION-B		
4	**UV-Visible Spectroscopy**: Introduction , Theory of UV-Visible Spectroscopy & colourimetry, Beer Lambert law, Deviation from Beer Lambert law. **Infrared Spectroscopy**: Introduction, Infrared radiation & its interaction with organic molecules, vibrational mode of bonds, instrumentation & applications, interpretation of IR spectra. **Nuclear magnetic resonance spectroscopy**: Introduction of ^{1}H & ^{13}C, Theory & Instrumentation, chemical shift concept, spin coupling, isotopic nuclei, reference standards & solvents, applications. **Mass spectrometry**: Basic principles & brief outline of instrumentation. Ion formation, molecular ion, meta stable ion, fragmentation process in relation to molecular structure & functional groups. Problems based on above spectroscopy for structure elucidation	**14**
5	**Volumetric analysis**: Acid base titrations: Indicators; Oxidation-reduction titrations; Complexation using ligands, complexometric titration with EDTA, metal ion indicators; simple calculations; analysis of Na_2CO_3,Fe_2O_3 , Brass, etc.	**04**
6	**Quantitative analysis**: Precipitation, types of precipitates, impurities, co precipitation, post-precipitation, conditions for precipitation, precipitation from homogeneous solution. Gravimetric determination of Fe, Ni & Cu, calculations, TGA	**06**

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)

Bachelor of Engineering
Subject Code: CT2324
Subject Name: Analytical Techniques

Recommended Books:

1. Instrumental Methods of Chemical Analysis, E. W. Ewing, McGraw Hill, New York. 4th Ed, 1975
2. Instrumental Methods of Analysis, B. K. Sharma, Goel Publishing house.
3. Elementary Organic Spectroscopy, Y.R. Sharma, S.Chand & company Ltd. New Delhi 2008
4. Principles of Instrumental Analysis by Douglas Skoog,2nd Edition,1980.
5. Fundamentals of Molecular Spectroscopy by Colin N Banwell and Elaine M McCash , McGraw Hill, 4th edition, 2016.
6. Instrumental Methods of Analysis 7th Edition by Willard, CBS PUBLICATION,7th Edition,2004
7. Spectroscopy of Organic Compounds by P S Kalsi, New Age International Publishers,6th Edition, 2004.
8. Introduction to Spectroscopy by Donald L. Pavia, Gary M. Lampman, and George S. Kriz
9. Organic Spectroscopy by William Kemp 3rd edition.

Course Outcomes:

After learning this course, students will be able to

CO No.	CO statement
CO-1	To describe the theoretical principles and important applications of classical analytical methods within titration.
CO-2	To distinguishes various separation techniques in chromatography and typical applications of chromatographic techniques.
CO-3	To interpret assurance of quality, safety and efficacy of drugs, pharmaceuticals and of any Compound
CO-4	To identify the different types of errors and its significance
CO-5	To explain Gravimetric estimation of different alloys and its importance.
CO-6	To design the structure of unknown compound using different spectroscopy and interpret the data.

Bachelor of Engineering
Subject Code: CT2324
Subject Name: Analytical Techniques

List of Experiments:

1. Separation using Paper Chromatography
2. Separation using Thin Layer Chromatography
3. Volumetric Estimation of alloys
4. To find out concentration of unknown solution using Colourimeter
5. Separation using Column Chromatography
6. Working and principle of UV Spectrophotometer
7. Complexometric Titration by EDTA
8. Gravimetric Estimation
9. Potentiometric Titration of between $BaCl_2$ and K_2CrO_4
10. Turbidity meter
11. Vlab
12. Vlab

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: CT2325
Subject Name: Chemical Process Instrumentation (NPTEL- Swayam)

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Open subjects – Electives from other technical and /or emerging subjects

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

Rationale: The main objective of this subject is to a comprehensive introduction to principles and practices of measurement of important chemical process variables such as temperature, pressure, flow, level, concentration, etc.

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	-	-	100

Content:

Content	Total Hrs.
Week 1: General principles and representation of instruments Week 2: Performance characteristics of instruments and data analysis: 1 Theorem Week 3: Performance characteristics of instruments and data analysis: 2 Week 4: Transducer elements Week 5: Pressure measurement: Moderate and high pressure measuring instruments Week 6: Pressure measurement: High vacuum measuring instruments Week 7: Temperature measuring instruments: 1 Week 8: Temperature measuring instruments: 2 Week 9: Flow measurement Week 10:Level measurement Week 11:Measurement of concentration, density, viscosity, and pH Week 12: Control valve, Piping and instrumentation diagram	12 weeks

Bachelor of Engineering
Subject Code: CT2325
Subject Name: Chemical Process Instrumentation (NPTEL- Swayam)

Books and references:

E. O. Doeblin. "Measurement Systems: Application and Design", Tata McGraw-Hill Publishing Company Limited, New Delhi.

B. C. Nakra and K. K. Chaudhry. "Instrumentation Measurement and Analysis", Tata McGraw Hill Education Private Limited, New Delhi.

D. P. Eckman. "Industrial Instrumentation", CBS Publishers & Distributors Pvt. Ltd., New Delhi.

Course Outcomes:

After learning this course, students will be able to:

CO No.	CO statement
CO-1	To introduce the General principles and representation of instrument and Performance characteristics of instruments and data analysis
CO-2	To understand the Performance characteristics of instruments and data analysis: 2 and Transducer elements
CO-3	To measure the Pressure measurement: Moderate and high pressure measuring instruments and high vacuum measuring instruments
CO-4	To study the Temperature measuring instruments: 1 & 2.
CO-5	To elaborate the flow and level measurement.
CO-6	To develop the knowledge of Measurement of concentration, density, viscosity, and pH and Control valve, Piping and instrumentation diagram.

List of Open-Source Software/learning website:

NPTEL

Shroff S.R. Rotary Institute of Chemical Technology

Type of course: Work-Personality Development

Prerequisite: To keep open mind and will to learn humanity for oneself and society.

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them to recognize how they, as technical professionals, can participate and make a positive contribution to their communities and to their state.

Towards this goal, the Contributor Program has been designed to awaken and strengthen students from within, in terms of building positive self-esteem, increasing their confidence level and I-can attitude, improving their aspirations, giving them new methods of thinking, building their cognitive capacities, exposing them to the skills and practices associated with being contributors in the workplace (not mere employees).

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Gujarat.

The Contributor Program syllabus has been evolved and fine-tuned over several years, (a) to address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire and (b) by working extensively with universities and students building an appreciation of their challenges and concerns. At the core, the program is guided by the higher ideas and principles of practical Vedanta in work.

Bachelor of Engineering
Subject Code: MH2302
Subject Name: Contributor Personality Development Program – II

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)	
1	1	0	2	50	30	00	20	100

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Finding Solutions** The market environment in which organizations are operating, is becoming increasingly dynamic and uncertain. So, employers are increasingly seeking out people who can innovate and figure out solutions in the face of any challenge (unlike in the past when it was the people who were most efficient and productive, who were valued by organizations). At the heart of innovation lies this way of thinking of "finding solutions" rather than "seeing problems or roadblocks". Students learn how to build this way of thinking, in this topic.	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)
2	**Creating Value** Companies are also looking for employees who do not just work hard, or work efficiently or productively - but those who will make a valuable difference to the fortunes of the company. This difference may come from innovation, but it may also come from focusing on the right things and identifying what really matters – both to the company and to the customers. In this topic, students learn how to build this capability.	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)

3	**Engaging deeply** The environment we live in is becoming increasingly complex because more and more things are getting interconnected, new fields are emerging, technologies are rapidly changing, capabilities and knowledge one is trained in will become fast obsolete. In such a scenario, the student's ability to quickly understand and master what is going on, dive deep, get involved in any area, rapidly learn new capabilities that a job demands, is important. Engaging deeply is a core way of thinking that can help them in this. In this topic, students learn how to engage deeply.	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)
SECTION-B		
4	**Enlightened self-interest & collaboration at work** The changing nature of work in organizations and in the global environment is increasingly demanding that people work more collaboratively towards shared goals and more sustainable goals. A key to working successfully when multiple stakeholders are involved is "thinking in enlightened self-interest". In this topic, students learn how to develop this way of thinking (going beyond "narrow self-interest").	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)
5	**Human-centered thinking & Empathy** In this topic, students explore a human-centric approach to work – where the ability to recognize and respond to other people (whether they are users or customers or team members) as a human being with human needs and difficulties, is essential. This is at the heart of user-centric design of products and solutions, at the heart of genuine customer- centricity in services, and of any successful interaction with other people.	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)
6	**Trust Conduct** The biggest currency in a sustainable career is "trust" i.e. being trusted by team members, bosses, and customers. When we are trusted, people listen to us, they are willing to give us the chance to grow, give us the space to make	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)

	mistakes, and work seamlessly with each other without always having to "prove ourselves". In this topic, students learn how to demonstrate conduct that builds the trust of people.	

Suggested Specification table with Marks (Theory):

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

Reference resources:

A. Basic reference for both students and teachers

1. Contributor Personality Program textbook cum workbook developed by Illumine
2. Web-based ActivGuide™ for self-exploration of rich media resources to vividly understand many of the ideas, watch role models, learn from industry people, get reference readings – that help them enrich the understanding they gained in the class published by Illumine Foundation

B. Advanced reference for teachers

1. On Contributors, Srinivas V.; Illumine Ideas, 2011
2. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989
3. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya Vidya Bhavan
4. Karma Yoga, Swami Vivekananda; Advaita Ashrama
5. Vivekananda: His Call to the Nation, Swami Vivekananda; Advaita Ashrama
6. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
7. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
8. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007

9. Why not?: how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003
10. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004
11. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
12. Creating Shared Value, Michael E. Porter and Mark R. Kramer; Harvard Business Review; Jan/Feb2011, Vol. 89 Issue 1/2
13. The Speed of Trust: The One Thing That Changes Everything, Stephen M. R. Covey, Rebecca R. Merrill, Stephen R. Covey; Free Press, 2008
14. The Courage to Meet the Demands of Reality, Henry Cloud; HarperCollins, 2009
15. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 2007

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Students will be able to recognize & appreciate the thinking required to find solutions in the face of any challenge.
CO-2	Students will be able to recognize & appreciate different types of value that can be created and the different ways to create value for others.
CO-3	Students will be able to recognize & appreciate how to engage deeply, and its need, value, payoffs and consequences in different contexts.
CO-4	Students will be able to differentiate between 'enlightened self-interest' and 'narrow self-interest' & appreciate the payoffs/ consequences of both when working with multiple stakeholders.
CO-5	Students will be able to recognize & appreciate the human side of situations or interactions or projects that will help them develop a more human-centric approach/ response to work.
CO-6	Students will be able to recognize & appreciate conduct which builds trust of people in contrast to conduct which breaks trust of people - in teams / organization & the value of trust conduct in various situations.