SYLLABUS

Saurashtra University

DDU Kaushal Kendra
Curriculum for
BACHELOR of VOCATION
in
CHEMICAL TECHNOLOGY

(Under UGC – DDU Kaushal Kendra sanctioned to Shree Manibhai Virani & Smt. Navalben Virani Science College-Rajkot)

(Sanction Letter No. 3-43/2015(KAUSHAL) dated 14.08.2015)

B.Voc. - Chemical Technology

Semester III & IV

Credit Based Semester System (CBSS)
Effective from June 2016-17

B.Voc. Chemical Technology

Name of the Program(s) (Diploma, Adv. Diploma, Degree)	Semesters	No. of Credits **30 Cr./Sem**	Job Roles and **NSQF**-Levels
Diploma in **Surface Coating**	1	60 Credits	**NSQF Level 5** Supervisor
	2		
Advance Diploma in **Petrochemicals & Polymers**	3	60 Credits	**NSQF Level 6** Technician / Trainer
	4		
B.Voc. in **Chemical Technology**	5	60 Credits	**NSQF Level 7** B.Voc. Graduate
	6		

Note: A student has to earn additional 1 credit per year for Universal Human Value Education Course.

B.Voc. Chemical Technology
Semester-I

S.N.	Paper No.	Subject	Credit	Marks
1.	BVCT-101	Fundamental Chemistry-I	3	100
2.	BVCT-102	Fundamental Industrial Chemistry-I	3	100
3.	BVCT-103	Elementary Physics & Mathematics	3	100
4.	BVCT-104	Functional English & Office Automation Tools (OAT)-1	3	100
5.	BVCT-105	Practicals-1, 2, 3(Physics) & 4(OAT)	18	300
		Total Credit Semester-I	**30**	**700**

B.Voc. Chemical Technology
Semester-II

S.N.	Paper No.	Subject	Credit	Marks
1.	BVCT-201	Analytical & Electro Chemistry	3	100
2.	BVCT-202	Chemistry of Surfactants	3	100
3.	BVCT-203	Surface Coating Techniques	3	100
4.	BVCT-204	Functional English & Office Automation Tools (OAT)-2	3	100
5.	BVCT-205	Training/ Project Report	3	150
6.	BVCT-206	Practicals-1, 2, 3 & 4(OAT)	15	250
		Total Credit Semester -II	**30**	**800**

B.Voc. Chemical Technology
Semester-III

S.N.	Paper No.	Subject	Credit	Marks
1.	BVCT-301	Fundamental Chemistry-II	3	100
2.	BVCT-302	Fundamental Industrial Chemistry-II	3	100
3.	BVCT-303	Industrial Unit Process & Operations	3	100
4.	BVCT-304	Water Analysis	3	100
5.	BVCT-305	Practicals-1,2,3 & 4	18	300
		Total Credit Semester -III	**30**	**700**

B.Voc. Chemical Technology
Semester-IV

S.N.	Paper No.	Subject	Credit	Marks
1.	BVCT-401	Petroleum & Petrochemicals	3	100
2.	BVCT-402	Chemistry of Polymer & Composite materials	3	100
3.	BVCT-403	Polymer Technology	3	100
4.	BVCT-404	Petroleum Analysis	3	100
5.	BVCT-405	Training/ Project Report	3	150
6.	BVCT-406	Practicals-2,3 & 4	15	250
		Total Credit Semester -IV	**30**	**800**

B.Voc. Chemical Technology
Semester-V

S.N.	Paper No.	Subject	Credit	Marks
1.	BVCT-501	Stereo Chemistry & Organic reaction Mechanism	3	100
2.	BVCT-502	Biochemistry	3	100
3.	BVCT-503	MAT- Modern Analytical Techniques	3	100
4.	BVCT-504	Pharmaceutical (Medicinal) Chemistry	3	100
5.	BVCT-505	Practicals-1,2,3 & 4	18	300
		Total Credit Semester -V	**30**	**700**

B.Voc. Chemical Technology
Semester-VI

S.N.	Paper No.	Subject	Credit	Marks
1.	BVCT-601	Pharmaceutical Engineering	3	100
2.	BVCT-602	Pharmaceutical Technology	3	100
3.	BVCT-603	Industrial Formulation & GLP	3	100
4.	BVCT-604	Entrepreneurship Development & Soft Skill Training	3	100
5.	BVCT-605	In plant Training/Project Report	3	150
6.	BVCT-606	Practicals-1, 2 &3	15	250
		Total Credit Semester -VI	**30**	**800**

B. Voc. Chemical Technology
SEMESTER – III

BVCT-301	Fundamental Chemistry-II

Unit-I: Fundamental Concepts of Organic Chemistry
Types of chemical bonds, patterns of bond cleavages, Types of reagents – electrophiles & nucleophiles, Reactive intermediates – carbocation, carbanion and free radicals, Types of reactions – Addition reaction and Substitution reaction involving S_N^1, S_N^2, E^1, E^2

Unit-II: Carboxylic Acid and Carbonyl Compounds
Carboxylic Acids, Aldehydes & Ketones: Nomenclature, structure & bonding, physical properties, preparation and chemical reactivity, HVZ reaction, Method of Decarboxylation, Method of Acid Derivatization, Tautomerism, Condensation reactions of carbonyl compounds

Unit-III: Alcohol, Phenol & Ether
Nomenclature and classification, structure and bonding, Physical Properties, preparation, chemical reactions, test for identification.

Unit-IV: Amines, Nitroalkanes and Nitroarenes
Amines: Nomenclature, classification, stereochemistry of amines, basicity of amines, preparation, chemical reactivity, test for identification separation of primary, secondary and tertiary amine mixture. Nitroalkanes: Preparation, reduction in different media, picric acid.

Unit-V: Open-chain and Cyclic Hydrocarbons
IUPAC Nomenclature of Branched and unbranched hydrocarbons, classification of carbon atom, method of formation, physical properties and chemical reactivity. Cyclopropane ring-banana bond, Markownikoff's rule, polymerization of alkynes.

Reference Books:

1. Chemistry for Degree Students – First Year, Dr. R. L. Madan, S. Chand & Co. Ltd.
2. Chemistry for Degree Students – Second Year, Dr. R. L. Madan, S. Chand & Co. Ltd.
3. Chemistry for Degree Students – Third Year, Dr. R. L. Madan, S. Chand & Co. Ltd.
4. The language of Chemistry or Chemical Equations, G. D. Tuli & P. L. Soni, S. Chand & Co. Ltd.
5. Principles of Organic Chemistry, Peter R. S. Murray, CBS Publications

B. Voc. Chemical Technology
SEMESTER – III

BVCT-302	Fundamental Industrial Chemistry-II

Unit-I: Utilities in Industry
Fuel: Types of fuels – advantages and disadvantages. Combustions of fuels, Calorific value, Specifications of fuel oil.
Water: Specifications for Industrial use, various water treatments.

Unit-II: Boilers
Types of boilers and their functioning, Steam generation and uses, Specifications of air and its industrial use, Processing of air.

Unit-III: Transport Equipments
Fans, Blowers, Compressors, Reciprocating pump, Centrifugal pumps, Gear pumps.

Unit-IV: Heat exchangers
Construction and Working of Shell & tube type heat exchangers, finned tube exchanger, Plate type heat exchangers.

Unit-V: Size Reduction
Principles of comminution, Rittinger's and kick's laws, Bond's crushing law and work index, Size reduction equipments, crushers, grinders, Ultra fine grinders, Cutting machines.

Reference Book:

1. Industrial Chemistry, Regregel, Reinhold Publication.
2. Chemical Engineer Hand Book, J. H. Perry, McGraw Hill Book Comp.
2. Introduction to Chemical Engineering, Badger Banchero McGraw Hill Comp.
4. Engineering Chemistry by S.S. Dara.

B. Voc. Chemical Technology
SEMESTER – III

BVCT-303	Industrial Unit Process & Operations

Unit-I: Oxidation & Hydrogenation

Oxidation: Introduction, Types of oxidation reactions, oxidizing agents, Chemical factors, Physical factors, Outline of chemical kinetic, mechanism and thermodynamics, Manufacturing process of acetic acid, Manufacturing process of acetaldehyde, Manufacturing process of benzoic acid, Manufacturing process of phthalic anhydride, Manufacturing process of maleic anhydride, Manufacturing process of acrolein.

Hydrogenation: Introduction, Various methods of reduction, Chemical factors, Physical factors, Outline of chemical kinetic, mechanism and thermodynamics, Various hydrogenating catalyst, Hydrogenation process of vegetable oils, Synthesis process of methanol, Reforming process.

Unit-II: Sulphonation & Nitration

Sulphonation: Definition, Sulfonating agents, Chemical factors, Physical factors, Outline of chemical kinetic, mechanism and thermodynamics, Sulphonation process of benzene, Sulphonation process of naphthalene, Sulphonation process of dodecyl benzene.

Nitration: Introduction, nitrating agents, mechanism & nitration of paraffin hydrocarbons – benzene to nitrobenzene, m-dinitrobenzene, acetanilide to p-nitro acetanilide, continuous vs. batch wise nitration.

Unit-III: Halogenation

Definition, Types of halogenation reactions, Various halogenating agents, Chemical factors, Physical factors, Outline of chemical kinetic, mechanism and thermodynamics, Manufacturing process of mono chloro acetic acid, Manufacturing process of sodium mono chloro acetate, Manufacturing process of chloral, Manufacturing process of chloro benzene, Manufacturing process of freon-12, Chlorination of methane.

Unit-IV: Distillation

Introduction, boiling point, driving force, equilibrium stage, vapour- liquid equilibrium, boiling point diagram, raoult's law, dalton's law, relative volatility, differential distillation, flash distillation, fractionating column, mccabe-thiele method, reflux ratio, azeotropic distillation, extractive distillation, types of plate, packed column, types of packing.

Unit-V: Gas Absorption

Introduction, Phase Equilibrium, Absorption with Chemical Reaction, Non-isothermal Absorption, Absorption Equipment: Packed Towers, Plate Towers, Agitated Vessels, Centrifugal Absorbers, Spray Towers, Gas absorption Calculations.

Reference Books:

1. Industrial Chemistry, Regregel, Reinhold Publication.
2. Unit Operations in chemical Engineering, McCabe & Smith, McGraw Hill Book Comp.
3. Unit Operations I & II, D.D. Kale Pune Vidyarthigriha Prakashan-Pune.

B. Voc. Chemical Technology
SEMESTER – III

BVCT-304	Water Analysis

Unit-I: Introduction
Introduction, distribution of water in the body, function of water in human body, water required meant in human body ,guideline of WHO for the drinking water, sampling of water, preservation of sample of water, pre-concentration of sample of water , basic terminology and relationship.

Unit-II: Physical examination of water
pH, temperature, total dissolved solid, solid, suspended solid, acidity, alkalinity, conductivity, colour, test, order, turbidity, density, hardness of water .

Unit-III: Analysis of inorganic non-metallic constitute
chloride, sulphate, sulphide, fluoride, phosphate, sulphur, nitrate, nitrite, carbon dioxide, ammonia, cyanide.

Unit-IV: Analysis of metal ion
Mineral ion: calcium, magnesium, iron, sodium, silver, zinc, manganese. Toxic ion: lead, mercury, arsenic, beryllium, cadmium, chromium, copper, selenium

Unit-V: Analysis of organic content and water treatment process
Dissolved oxygen (OD), biochemical oxygen demand (BOD), chemical oxygen demand (COD), UV absorbing constituent. Water treatment process: membrane separation process, Reverse osmosis, Ultra filtration, Dialysis, Ion exchange process.

Reference Books:

1. Instrumental Analysis, H H Willard, CBS Publishing Co.
2. Wastewater Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Tata McGraw-Hill
3. Food Science & Technology – Potable Water, S. N. Mahindru, APH Publishing Corp.

B. Voc. Chemical Technology
SEMESTER – III

BVCT-305	Practical

Laboratory course of B.Voc - Chemical Technology includes practical based on following subjects.

Paper No.	Subject
BVCT-301	Fundamental Chemistry-II
BVCT-302	Fundamental Industrial Chemistry-II
BVCT-303	Industrial Unit Process & Operations
BVCT-304	Water Analysis

B. Voc. Chemical Technology
SEMESTER – IV

BVCT-401	Petroleum & Petrochemicals

Unit-I: Introduction of Petroleum and Petrochemicals

Petroleum: Introduction to petroleum, Occurrence, Colour & Consistency of petroleum, Origin of Petroleum, Petroleum Production, Composition of Petroleum, Classification of Petroleum.

Petrochemical: Introduction to Petrochemicals, Important petroleum products including gasoline, kerosene, ATF, diesel, fuel oils, lubricants, Manufacture of petrochemicals, Feedstock for petrochemicals. Petrochemical industry in India and Nature of Indian Crude.

Unit-II: Processing Crude Petroleum and Petroleum Product Analysis

Preparation of petroleum for processing, Overview of Treatment methods for petroleum emulsion & Desalting of petroleum, Fractional Distillation of crude petroleum, Cuts and composition of fractional distillation, Cracking and Reforming, Chemical treatment for upgrading a liquid fuel, Petroleum product Analysis

Unit-III: Chemicals from C1 Compounds and C2 Compounds

Manufacture of the following compounds from **C1 hydrocarbons**: Methanol, Hydrogen Cyanide, Carbon disulphide.

Manufacture of any four from the following compounds from **C2 hydrocarbons**: Ethyl chloride, Ethanol, Ethylene oxide, Ethylene glycol, Acetic acid, Styrene, Vinyl Acetate

Unit-IV: Chemicals from C3 Compounds and C4 Compounds

Manufacture of any four from the following compounds from **C3 hydrocarbons**: Isopropanol, Cumene, Polypropylene, Glycerine, Acrylonitrile, Propylene oxide, Acrylic Acid, Bis-Phenol.

Manufacture of any four from the following compounds from **C4 hydrocarbons**: Butadiene, Isobutane, Butanol, Methaacrylic acid, Maleic anhydride, Adipic Acid, Sulpholane.

Unit-V: Aromatic compounds, Syngas and SNG Production

Manufacture of the BTX & Naphthalene, Linear alkyl benzenes and their Sulphonates,
Syngas production by Steam reforming: from natural gas and from naphtha.
SNG production: from naphtha and from via partial oxidation.

Text Books:

1. B.K. Bhaskar Rao (1990), “Petrochemicals”, Khanna Publishers, Delhi.
2. Sarkar Samir (1998), “Fuels & Combustion”, 2nd Edition, Orient Longman Limited.
3. A.L. Waddams (1970), “Chemicals from Petroleum”, 2nd Edition, ELBS, London
4. G.N. Pandey (1977), “Chemical Technology”, 3rd Ed., Vikas Publishing House Pvt. Ltd.
5. Gopal Rao M and Marshall Sittig (1997),”Dryden’s Outlines of Chemical Technology”, 3rd Edition, East-West Press

B. Voc. Chemical Technology
SEMESTER – IV

BVCT-402	Chemistry of Polymer & Composite materials

Unit-I: Fundamental concepts of Polymer
Introduction, classification of polymer, nomenclature, trade and common name of polymer, monomers and functionality concept of monomers (with example), concept of cross linking and isomerism, general applications of polymer.

Unit-II: Solvents, Fillers and Additives
Solvents: Introduction, Classification, types of solvents, types of solutions, method of finding chain length, demixing, flexible chains, particle size & shape, compatibility, phase transition, ternary systems.
Fillers: Introduction, types of fillers, particle geometry, organic fillers, cellulosic, fibers, and inorganic fillers, applications.
Additives: Introduction, plasticizers, classification, effect on chemical properties & stability, flexibilizers, release agents, antioxidants, applications.

Unit-III: Polymerization Pathway
Step polymerization, chain polymerization, anionic polymerization, cationic polymerization, free radical polymerization (with kinetics), and ring opening polymerization.

Unit-IV: Polymer Synthesis
Synthesis and applications of polystyrene, polyvinyl acetate, nylon-6, nylon-66, polyvinyl chloride, unsaturated polyvinyl chloride, chlorinated polyvinyl chloride, teflon, poly (3-hydroxybutyrate-co-3-hydroxyvalerate)(PHBV), polyethylene terephthalate, poly glyptal, polymethyl methacrylate, poly urethane, neoprene, phenol formaldehyde, urea formaldehyde, melamine formaldehyde, epoxy resins, poly propylene, High-density polyethylene, low-density polyethylene.

Unit-V: Composite Materials
Introduction and industrial applications of composites,
Fiber Reinforced Composites (FRC): introduction, importance and properties, manufacture of fiber fabric, manufacture of fiber preforms, Forming processes, Bladder moulding, Compression moulding, Autoclave and vacuum bag, Mandrel wrapping, Wet layup, Chopper gun, Filament winding, Pultrusion, Resin transfer moulding, Carbon fibre, Aramid fibre material, Kevlar.
Introduction, example and application of Particle Reinforced Composites (PRC).

Reference Books:

1. A Textbook of Polymers – Vol I & II, M. S. Bhatnagar, S. Chand Publication
2. Plastic Materials – John Brydson, Elsevier Publication
3. Polymer Science & Technology – Joel Fried, PHI
4. Introductory Polymer Chemistry, G. S. Misra, New Age International
5. Polymer Science, G. Govariker, New Age International

B. Voc. Chemical Technology
SEMESTER – IV

BVCT-403	Polymer Technology

Unit-I: Polymer Processing & Technology
Mixing and compounding techniques and equipment.
Moulding, extrusion, spinning, foaming, film making techniques and equipment.
Printing and finishing techniques.

Unit-II: Polymer Reaction engineering
Techniques for polymerization: Bulk, solution, suspension, emulsion.
Types of Polymerisation reactors: Batch, CSTR, Plug Flow Reactor. Their merits & demerits, Effect of each type of reactor on polymer properties,

Unit-III: Rubbers
Introduction, types of rubber, chlorinated and oxygenated rubber, refining of crude rubber, vulcanization process, synthetic rubber (Poly isoprene, Lactoprene, Buna S, Buna N or GR-A, Silicone rubber, Thiokol, reclaimed rubber, polyurethane rubber, Sponge rubber), natural rubber.

Unit-IV: Adhesive, Laminates & Composites
Adhesive: Classification of adhesive, manufacturing, types of adhesive (protein adhesive, starch adhesive, synthetic adhesive, rubber based adhesive, cellulose adhesive).
Laminate: Introduction, parallel and cross laminates, wood laminates, and laminated plastic.
Polymer Composites: FRC – importance and properties, manufacturing of composites, aramid fiber material, Kevlar.

Unit-V: Polymer Testing & Characterization
Non-destructive tests for polymer.
Tests for mechanical properties of polymer, tensile strength, elasticity, plasticity, fatigue, compressibility, tenacity, impact resistance, wear resistance, Flexural Strength, Flexural Modulus, Failure Load, and Compressive Strength.
Tests for physical properties of polymer, weight average molecular weight, number average molecular weight, Equipment for testing of polymer.

Text Books:

1. Sharma, B. K. (1997) “Industrial chemistry”, Goel publishing house, 9788187224006.
2. Gowariker, V., Viswanathan N. V., Sreedhar, J., (2005), “Polymer Science”, Reprint: New Age International Pvt. Ltd., ISBN: 085226-3074.
3. Crawford, R. J. (1998), “Plastic Engineering”, 3rd Edition: Elsevier, ISBN: 9780080524108.
4. McGraevy C (1994), “Polymer Reactor Engineering”, Chapman & Hall.
5. Brydson, J. (2000), “Plastic Materials”, seventh edition: Butter worth-Hienemann, ISBN: 0750641320.

B. Voc. Chemical Technology
SEMESTER – IV

BVCT-404	Petroleum Analysis

Unit-I: Overview of Petroleum Analysis
Petroleum – definition and composition, historical & modern perspectives, analysis, specifications, sampling, measurement, accuracy, precision, method validation (only concept).

Unit-II: Petroleum Assay
Carbon residues, Asphaltene content, density (specific gravity), distillation, light hydrocarbons, metallic constituents, salt content, Sulphur content, viscosity, pour point, water & sediment, wax content, miscellaneous tests.

Unit-III: Test Methods for Naphtha, Gasoline, Kerosene & Diesel
Naphtha: Aniline point & mixed aniline point, composition, density, evaporation rate, flash point, volatility, appearance, Kauri-Butanol Value. **Gasoline**: Additives, composition, corrosiveness, density, flash & fire point, volatility, water & sediments. **Kerosene**: Acidity, composition, flash & fire point, pour point, density, viscosity, water & sediments. **Diesel**: Acidity, composition, flash & fire point, pour point, density, viscosity, water & sediments.

Unit-IV: Test Methods for Distillate Fuel Oil, Residual Fuel Oil, Mineral Oil & Lubricating Oil
Composition, ash content, acidity or alkalinity, aniline point, asphaltene content, molecular weight, flash point, pour point, density, viscosity, water & sediments.

Unit-V: Test Methods for Grease, Wax, Asphalt & Coke
Composition, specific properties, mechanical or chemical stability, acidity or alkalinity, density, viscosity, specific tests for quality & property determination.

Reference Books:

1. Handbook of Petroleum Analysis, James Speight, Wiley International
2. Instrumental Analysis, H H Willard, CBS Publishing Co.

B. Voc. Chemical Technology
SEMESTER – IV

BVCT-405	Project / Training Report

Training / Project Report based on following subjects:

Paper No.	Subject
BVCT-401	Petroleum & Petrochemicals
BVCT-402	Chemistry of Polymer & Composite materials
BVCT-403	Polymer Technology
BVCT-404	Petroleum Analysis

B. Voc. Chemical Technology
SEMESTER – IV

BVCT-406	Practical

Laboratory course of B.Voc - Chemical Technology includes practical based on following subjects.

Paper No.	Subject
BVCT-402	Chemistry of Polymer & Composite materials
BVCT-403	Polymer Technology
BVCT-404	Petroleum Analysis

SEMESTER END UNIVERSITY EXAMINATION

THEORY QUESTION PAPER STYLE- Semester III & IV

Time: 2:30 hrs Theory- Total Marks-70

Que.:1 Objective type Q & A - 30 Marks

SN	Type	No. of Que.	Weightage	Marks
I	Objective	10	1 mark	10
II	Short Questions	10	2 marks	20
			Total	**30 marks**

Que.:2 Subjective type Q & A - 20 Marks

Any **Four** out of Six Questions - Each carrying **5 marks**- Total- 20 marks

Que.:3 Subjective type Q & A - 20 Marks

Any **Four** out of Six Questions - Each carrying **5 marks**- Total- 20 marks

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<table>
<tr><th>PRACTICAL - Semester III</th><th>PRACTICAL - Semester IV</th></tr>
<tr><td>Days: 02
Time: 6 hrs/day</td><td>Days: 03
Time: 6 hrs/day</td></tr>
<tr><td rowspan="2">Practical - 250 Marks
Viva voce - 50 Marks</td><td>Practical - 200 Marks
Viva voce - 50 Marks</td></tr>
<tr><td>Training Report or Project Report - 100 marks
Viva voce - 50 Marks</td></tr>
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