

# SAURASHTRA UNIVERSITY



ACCREDITED GRADE "A" BY NAAC  
(CGPA 3.05)

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COURSE DETAILS OFF. Y. B.Sc.

SEMESTER - I  
PAPER: BS-IC-101 (CBCS)  
&  
SEMESTER - II  
PAPER: BS-IC-201 (CBCS)

INDUSTRIAL CHEMISTRY  
(In Force from June - 2016)

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SAURASHTRA UNIVERSITY  
UNIVERSITY CAMPUS  
RAJKOT-5  
(GUJARAT) (INDIA)

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## CREDIT SYSTEM & MARKS OF SYLLABUS

Stream	Paper	Unit	Name of Unit	Credit	Lectures	Marks		
						External	Internal	
<b>B.Sc. Sem-1 (UG) Paper- 101</b>	<b>BS-IC- 101 Credit (04)</b>	1	PETROLEUM AND METALLURGY	0.8	12	70	14	30
		2	COAL AND RENEWABLE NATURAL SOURCES	0.8	12		14	
		3	DIMENSIONS-UNITS AND EVAPORATION	0.8	12		14	
		4	MATERIAL BALANCE WITHOUT CHEMICAL REACTION	0.8	12		14	
		5	DISTILLATION, ABSORPTION AND EXTRACTION	0.8	12		14	
	<b>Total</b>			<b>04</b>	<b>60</b>	<b>100</b>		
	<b>BS-IC-P-102 Credit (02)</b>	VOLUMETRIC ANALYSIS, WATER ANALYSIS, DISTILLATION TECHNIQUES & PARTITION CO-EFFICIENT		02	30	35	15	
<b>Total</b>			<b>02</b>	<b>30</b>	<b>50</b>			
<b>B.Sc. Sem-2 (UG) Paper- 201</b>	<b>BS-IC- 201 Credit (04)</b>	1	FUNDAMENTALS OF COMPUTER AND UTILITIES IN CHEMICAL INDUSTRY	0.8	12	70	14	30
		2	SURFACE CHEMISTRY, COLLOIDAL SOLUTIONS AND CATALYSIS	0.8	12		14	
		3	MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS AND ENERGY BALANCE	0.8	12		14	
		4	CRYSTALLIZATION, FILTRATION, CENTRIFUGE AND DRYING	0.8	12		14	
		5	MIXING, FLUID FLOW AND HEAT-EXCHANGER	0.8	12		14	
	<b>Total</b>			<b>04</b>	<b>60</b>	<b>100</b>		
	<b>BS-IC-P-202 Credit (02)</b>	PHYSICAL CHEMISTRY & OFFICE UTILITIES & SOFTWARE BASED TOOLS FOR CHEMICAL SCIENCES		02	30	35	15	
<b>Total</b>			<b>02</b>	<b>30</b>	<b>50</b>			

**SAURASHTRA UNIVERSITY**  
FIRST YEAR B.Sc. (INDUSTRIAL CHEMISTRY)  
Syllabus of BS-IC-101 (INDUSTRIAL CHEMISTRY) (CBCS)  
(Effective from June - 2016)

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**SEMESTER – I**

**UNIT 1(CREDIT-0.8, LECTURES-12, MARKS-14)**

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**PETROLEUM AND METALLURGY**

**1.1 PETROLEUM**

Introduction of petroleum, Processing of crude petroleum, Fractional distillation techniques, Natural gas, Uses of natural gas, Liquefied Petroleum Gas & its Uses, Secondary fuels derived from petroleum, Thermal cracking, Mechanism of thermal cracking, Catalytic cracking, Fixed bed cracking, Fluidized bed cracking, Reforming process, Isomerisation, Shell process and Girbotol process, Doctor process, Hydro-desulfurization.

**1.2 METALLURGY**

Division of metallurgy, Occurrence of metals, Definition of Gangue, Minerals and ore, Ore dressing with classification, Hydraulic washing, Magnetic separation, Froth floatation process, Chemical process, Reduction of metal oxide into metal by carbon, other reactive metal and electrolysis, Calcinations, Roasting, Smelting, Fluxes, Slags, Extraction of metals such as Fe, Al, Refining process, Liquefaction, Oxidation, Electrolysis.

**BOOKS FOR REFERENCES(SEM-1-UNIT-1):**

1. Industrial Chemistry by B. K. Sharma.
2. Metallurgy By B.K.Sharma
3. Principles of Extractive Metallurgy, Herbashi Vol.1,2.
4. Textbook of Metallurgy, Baiky A.R.

**UNIT 2 (CREDIT-0.8, LECTURES-12, MARKS-14)**

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**COAL AND RENEWABLE NATURAL SOURCES**

**2.1 COAL**

Fuels, Classification of fuels, Primary fuels and Secondary fuels, Origin and formation of coal, Rank of coal, Cleaning and storage of coal, Analysis of coal, Calorific value or heating value of coals, Classification of coal, Chemical constitution of coal, Secondary fuels and other products derived from coal, Process of carbonization, Production of coke and gas, Beehive oven, Horizontal Chamber Coke Oven, Vertical Gas Retorts (Intermittent and Continuous), properties and uses of coke, coal gas and coke oven gas, Coal gas and Coke oven gas.

## 2.2 RENEWABLE NATURAL SOURCES

Cellulose, its preparation and properties, Nitrocellulose, Cellobiose, Celluloid Artificial silk, Acetate Silk, Cuprammonium process (CupraSilk), Viscose silk (Rayon), Paper, Caustic soda process and Sulphite process, Starch, Manufacturing of starch from corn, Properties & Uses of Starch (Dextrin, Glycogen, Inulin, Raw starch, Tapioca starch, Iodized starch), Alcohols (Methyl alcohol, Ethyl alcohol, Denatured alcohol, Special solvent alcohol, Propyl alcohol, Butyl alcohol), Proof value of alcohol.

### BOOKS FOR REFERENCES (SEM-1-UNIT-2):

1. Fuels & Combustion by Samir Sarkar
2. Coal conversions, E.J. Hoffman, The energon co. Lavamic, Wyoming USA.
3. Cotton – Cellulose: It's Chemistry & Technology, Hall A.G.
4. Chemistry of Cellulose, Heuser C.

## UNIT 3 (CREDIT-0.8, LECTURES-12, MARKS-14)

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### DIMENSIONS-UNITS AND EVAPORATION

#### 3.1 DIMENSIONS-UNITS

Fundamental quantities, Derived quantities, Dimensions and System of Unit, Conversions of units, Basis of calculation, Atomic weight, Molecular weight, Equivalent weight, Molarity, Normality, Molality, Methods of expression, Composition of mixtures and solutions, Mole fraction, Weight fraction.

#### 3.2 EVAPORATION

Introduction, classification of evaporation, application of evaporation, Construction, working, merits and demerits of Short tube evaporator, Forced circulating evaporator, Falling film evaporator, Climbing film evaporator, Wiped film evaporator & Multiple effect of evaporator.

### BOOKS FOR REFERENCES (SEM-1-UNIT-3):

1. Unit Operation I & II by Gavhane.
2. Unit Operations I & II, D.D. Kale Pune Vidyarthigriha Prakashan-Pune.
3. Stoichiometry by Gavhane

## UNIT 4 (CREDIT-0.8, LECTURES-12, MARKS-14)

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### MATERIAL BALANCE WITHOUT CHEMICAL REACTION

#### 4.1 MATERIAL BALANCE OF VARIOUS UNIT OPERATIONS

Outlines of procedure for material balance, Calculation by using various operations carried out in industry: their significance and block diagrams of distillation, evaporation, adsorption, extraction (liquid-liquid), drying, filtration, mixing/blending, dissolution and crystallization.

### BOOKS FOR REFERENCES (SEM-1-UNIT-4):

1. Stoichiometry, B.I. Bhatt & Vora McGraw Hill Publication

2. Stoichiometry by Gavhane
3. Chemical Engineer Hand Book, J. H. Perry, McGraw Hill Book Comp.

## **UNIT 5 (CREDIT-0.8, LECTURES-12, MARKS-14)**

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### **DISTILLATION, ABSORPTION AND EXTRACTION**

#### **5.1 DISTILLATION**

Introduction, Equilibrium or Flash Distillation, Batch or Differential Distillation, Steam Distillation, Continuous Distillation, Plate column and Packed Column, Separation of azeotropes, comparison between Distillation and Gas absorption

#### **5.2 ABSORPTION**

Introduction, Various type of tray for absorption column, Packed columns, Packing materials, Merits and Demerits of plate & packed tower, Selection of solvent for gas absorption, Mechanical Contactor, Rotating disc contactor

#### **5.3 EXTRACTION**

Introduction, Selection of solvent for extraction, Equipment spray column & packed column for extraction, Mixer settler cascade.

#### **BOOKS FOR REFERENCES (SEM-1-UNIT-5):**

1. Unit Operation I & II by Gavhane.
2. Unit Operations in chemical Engineering, McCabe & Smith, McGraw Hill Book Comp.
3. Introduction to Chemical Engineering, Badger Banchemo McGraw Hill Comp.

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**SEMESTER – II**

**UNIT 1 (CREDIT-0.8, LECTURES-12, MARKS-14)**

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**FUNDAMENTALS OF COMPUTER AND UTILITIES IN CHEMICAL INDUSTRY**

**1.1 BASICS OF COMPUTER**

Introduction of O.S., Application of Office automation tools:-Word, Excel, Power Point, Characteristics and Applications of Input and Output devices.

INTERNET: Basic concepts, Literature Data Search, Web browsing Tools.

**1.2 UTILITIES IN CHEMICAL INDUSTRY**

Fuels: Types of fuels, Advantages and disadvantages, Combustions of fuels, Calorific value, Specifications of fuel oil.

Boiler: Introduction, Types of boilers and their functioning, Steam generation and uses, Specifications of air and its industrial use, Processing of air, Source of water & various physical & chemical water softening techniques.

**BOOKS FOR REFERENCES (SEM-2-UNIT-1):**

1. Computer Fundamentals P.K. Sinha by BPB Publication.
2. Industrial Chemistry by B. K. Sharma.
3. Microsoft Office 2010 by HI Publication
4. Internet-An Introduction, TATA McGraw Hill Publication.

**UNIT 2 (CREDIT-0.8, LECTURES-12, MARKS-14)**

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**SURFACE CHEMISTRY, COLLOIDAL SOLUTIONS AND CATALYSIS**

**2.1 ADSORPTION**

Adsorbate, Adsorbent, Adsorption of gases by solid, Physical & Chemical adsorption, Factors affecting adsorption, Adsorption isotherms, Freundlich isotherm, Langmuir adsorption, Adsorption of solute from solution, Applications of adsorption Application of ion exchange adsorption.

**2.2 COLLOIDAL SOLUTION**

Colloidal dispersion introduction & its classification, Lyophilic and Lyophobic colloids, Colloidal solution preparation and purification, Optical properties of sols, Kinetic properties of sols, Sedimentation of suspension, Electrophoresis, Electro-osmosis, Stability of suspension, Precipitation of sols, Emulsions, Gels, Surfactants, Hydrophile-Lipophile Balance.



### 2.3 CATALYSIS

Introduction of homogeneous & heterogeneous, positive & negative catalysis, Characteristics of catalytic reaction, Promoters, Catalytic poisoning, Autocatalysis, Activation energy & catalysis, Theories of catalysis with mechanism (intermediate compound formation & adsorption theories), Acid-Base catalysis, Enzyme catalysis, Mechanisms, Characteristics of enzyme catalysis, Some industrial importance of catalytic process.

#### BOOKS FOR REFERENCES (SEM-2-UNIT-2):

1. For Catalysis: Gavhane.
2. Catalysis: Heterogeneous and Homogeneous, Delmon B. and Janner G.
3. Catalysis in Theory and Practice, Rideal and Taylor.
4. Surface Chemistry: J. J. Bikeman Academic Press.
5. Physical Chemistry of Surface, A.W. Adamson.
6. Chemical Engineer Hand Book, J. H. Perry, McGraw Hill Book Comp.

## UNIT 3 (CREDIT-0.8, LECTURES-12, MARKS-14)

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### MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS AND ENERGY BALANCE

#### 3.1 MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS

Definitions of terms involved, Limiting reactants/components, Excess reactants, Conversion, Yield and selectivity, Liquid phase reactions, Gas phase reactions with/without recycle or bypass.

#### 3.2 ENERGY BALANCE

Enthalpy, Forms of energy common unit of thermal energy, Flow process, General energy balance procedures, Heat capacity, Specific heat, Heat capacity of pure gases and gaseous mixtures at constant pressure, Enthalpy changes accompanying chemical reactions.

#### BOOKS FOR REFERENCES (SEM-2-UNIT-3):

1. Stoichiometry, B.I. Bhatt & Vora McGraw Hill Publication
2. Stoichiometry by Gavhane
3. Chemical Process Principles- (Part-I), Hougén, Ragaraz, Watson, Asia Publication House.

## UNIT 4 (CREDIT-0.8, LECTURES-12, MARKS-14)

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### CRYSTALLIZATION, FILTRATION, CENTRIFUGE AND DRYING

#### 4.1 CRYSTALLIZATION

Introduction, solubility, Super saturation, Nucleation, Crystal growth, The Mier's super saturation theory,  
Construction, Working, Merits and Demerits of following Equipment:

Tank crystallizer, Swenson-Walker crystallizer, Circulating magma vacuum crystallizer, Oslo crystallizer.

#### **4.2 FILTRATION**

Introduction, Filter media, Filter aids, classification of filtration, Construction, Working, Merits and Demerits of following Equipment:

Bed Filter/Sand filter, Sparkler filter, Rotary drum filter, Nutch filter, Nutrex Filter, Bag filter, Plate and frame filter, Leaf filter.

#### **4.3 CENTRIFUGE**

Introduction, Construction, Working, Merits and Demerits of following Equipment:

Centrifuge, Tubular bowl, Disc bowl

#### **4.4 DRYING**

Introduction, Free moisture, Bound moisture, Drying curve, Factors on which rate of drying depends, Classification of dryer. Construction, Working, Merits and Demerits of following Equipment: Tray dryer, Rotary dryer, Flash dryer, Fluidized bed dryer, Drum dryer, Spray dryer.

#### **BOOKS FOR REFERENCES (SEM-2-UNIT-4):**

1. Unit Operation I & II by Gavhane.
2. Unit Operations in chemical Engineering, McCabe & Smith, McGraw Hill Book Comp.
3. Introduction to Chemical Engineering, Badger Banchemo McGraw Hill Comp.

### **UNIT 5 (CREDIT-0.8, LECTURES-12, MARKS-14)**

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#### **MIXING, FLUID FLOW AND HEAT-EXCHANGER**

##### **5.1 MIXING**

Introduction, Type of impellers used for mixing, Importance of baffle in mixing, Construction, Working, Merits and Demerits of following equipment: Change-can mixer, Ribbon blenders, Internal Screw Mixers, Tumbling mixers, Kneader, Dispersers & Masticators.

##### **5.2 FLUID FLOW**

Introduction, factor influencing the choice of pump, Fans, Centrifugal Blower, Positive-displacement compressor, Reciprocating pump, Centrifugal pump, Piston pump, Cavitation, Air binding and priming, Vacuum pump, Gear pump

##### **5.3 HEAT-EXCHANGER**

Introduction, Construction, Working, Merits and Demerits of following Equipments: Double pipe heat exchanger, Shell & tube heat exchanger, finned tube heat exchanger, Plate type heat exchanger

**BOOKS FOR REFERENCES (SEM-2-UNIT-5):**

1. Unit Operation I & II by Gavhane.
2. Unit Operations I & II, D.D. Kale Pune VidyarthigrihaPrakashan-Pune.
3. Introduction to Chemical Engineering, Badger Banchemo McGraw Hill Comp.

## B.SC. SEM-1 & SEM-2 PRACTICALS

### SEMESTER I (BS-IC-P-102)

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#### PRACTICAL BASED ON VOLUMETRIC ANALYSIS, WATER ANALYSIS, DISTILLATION TECHNIQUES & PARTITION CO-EFFICIENT.

##### LIST OF PRACTICAL:

1. Find out the Normality, gm/lit., Molarity of a given xN NaOH solution by using 0.1N Succinic acid.
2. Find out the Normality, gm/lit., Molarity of a given xN NaOH and yN HCl by using 0.1N Succinic acid.
3. To determine  $\text{Ca}^{++}$  content in given unknown sample.
4. To determine  $\text{Mg}^{++}$  content in given unknown sample.
5. To determine  $\text{Zn}^{++}$  content in given unknown sample.
6. To determine  $\text{Cu}^{++}$  content in given unknown sample.
7. To study the distillation technique for given sample (Polar & Non-polar solvent)
8. To study the fractional distillation for given mixture of liquid (Polar & Non-polar solvent)
9. To determine the molecular condition of benzoic acid in kerosene and distilled water by the method of partition coefficient.

##### LIST OF EQUIPMENTS/INSTRUMENTS/ GLASSWARES:

1. Distillation assembly
2. Separating funnel
3. Stoppered bottles
4. Titration glassware assembly

## SEMESTER II (BS-IC-P-202)

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### PRACTICAL BASED ON PHYSICAL CHEMISTRY

#### LIST OF PRACTICAL:

1. To determine the Refractive Index of Pure liquids (Water, Carbon tetra chloride, Chloroform, Methylene dichloride)
2. To determine the Refractive Index of liquid mixtures (Benzene and Carbon tetra chloride)
3. To determine Surface Tension of liquids by drop number method (Water, Benzene and Toluene)
4. To determine Viscosity of liquid, flow time and concentration of unknown solution.
5. To determine Viscosity, flow time and concentration of liquid mixture (Glycerol & Water)
6. To determine practical yield for crystallization of Benzoic acid (By Cooling)
7. To determine practical yield for crystallization of Copper Sulphate (By evaporation)
8. To Synthesize organic compound using Phase Transfer Catalyst (P.T.C.)
9. To prepare Colloidal solution of Oil and Water using Soap.

#### LIST OF EQUIPMENTS/INSTRUMENTS/GLASSWARES:

1. Abb's Refractometer
2. Ostwald Viscometer
3. Stalagmeter

### PRACTICAL BASED ON OFFICE UTILITIES & SOFTWARE BASED TOOLS FOR CHEMICAL SCIENCES:

MS-Word Indexing, Table of Content, Footnotes, Cross Reference, Mark Citation options. Review Options, Insert hyperlink, Bookmarks, Header, Footer & Equations, Saving formats. Power point presentation: Slide options, Slide design, Animation & slide transition, Slide show options, saving formats.

Drawing chemical structures their IUPAC nomenclature, Reaction mechanisms, 3D molecules, drawing glassware assembly, saving in different formats.

#### LIST OF PRACTICAL:

1. To utilize various Microsoft Office Tools of Home Tab & Insert Tabs.
2. To utilize various Microsoft Office Tools of Page Layout, References & View Tabs.
3. To utilize various Slide Design Tools in Microsoft Office PowerPoint.
4. To utilize various Animation options in Microsoft Office PowerPoint.
5. To utilize various Slide Show options in Microsoft Office PowerPoint.
6. To save the Microsoft Office PowerPoint in various formats.
7. To Utilize Various Microsoft Office Excel tools.
8. To draw various chemical structures (Aliphatic, Aromatic, Bicyclo & Spiro) & generate their IUPAC names.
9. To draw a chemical reaction mechanism in chemical assistance software.

#### LIST OF EQUIPMENTS:

Computer, Projector.

## SEMESTER – I:

BSIC – 101 (Theory + Internal Theory + Practical + Internal Practical) (70+30+35+15)  
&  
BS-IC-P -102

### Theory:

Paper carries 70 Marks  
Six Lectures/Week

### Practical:

Practical carries 35 Marks  
Two days/Week

- 1) Partition Coefficient (20 Marks)
  - 2) Volumetric Analysis, Water Analysis, Distillation techniques (15 Marks)
- 

## SEMESTER – II:

BSIC – 201 (Theory + Internal Theory + Practical + Internal Practical) (70 + 30 + 35+15)  
&  
BS-IC-P-202

### Theory:

Paper carries 70 Marks  
Six Lectures/Week

### Practical:

Practical carries 35 Marks  
Two days/Week

- 1) Physical Exercise (20 Marks)
- 2) Computer lab (15 Marks)

PAPER NO.	SUBJECT PER SEMESTER	NO. OF PAPER	THEORY EXAM TIME	PRACTICAL EXAM HOURS
BS-IC-101 & BS-IC-P-102	INDUSTRIAL CHEMISTRY	One	3 Hours	3
BS-IC-201 & BS-IC-P-202	INDUSTRIAL CHEMISTRY	One	3 Hours	3