



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
(With effect from Academic Year 2019-20)

DETAILED CURRICULUM

Core course

B. Sc. Semester - I – Industrial Chemistry

Paper ICH-CC-103 – Theory

Paper ICH-CC-104- Practical

SEMESTER PATTERN:

- The Course content has been designed on **semester pattern**.
- The workload for Theory & Practicals is allotted on semester pattern.
- There shall be **01 Theory papers 70 marks** and **2.30 hours duration** in University examination.
- Industrial Chemistry Practical Examination shall be of **70 marks** and **03 hours duration** in University examination.

There shall be continuous internal evaluation of 30 marks.

SEMESTER – I

SR. NO.	PAPER NO.	NAME OF THE PAPER	TOTAL MARKS EXT.+INT* = TOTAL	PASSING STANDARAD EXT.+INT = TOTAL	TOTAL TEACHING HOURS (15 Weeks)	EXAM HOURS	CREDITS
1	ICH-CC-103	Unit operations of chemical engineering – I	70+30=100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
2	ICH-CC-104	Ind. Chemistry Practicals	100	40	15 WEEKS 26 HOURS = 90	03	06

INTERNAL EVALUATION

1. TEST	15 Marks
2. ASSIGNMENT/PRESENTATION	10 Marks
3. SEMINAR/ATTENDANCE	<u>05 Marks</u>
TOTAL	30 Marks



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Semester-I

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-103

Title of the paper: ICH-CC-103: **Unit operations of chemical engineering – I**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">• Introduction of filtration, Theory of filtration, Types of filtration, Filter medium and filter aid, Filtration equipment (Sand filters, Bag filter, Plates & Frames filter press, Moor filter, Sweetland filter, Vallez filter, Drum filter and Centrifuge).• Introduction absorption, Selection criteria for solvent in gas absorption, Different between absorption and distillation, Absorption equipment (Standard mechanical agitated vessel, packed column / tower, Spray column, Bubble column).	15	18
Unit 2	<ul style="list-style-type: none">• Introduction of mixing, Mixing equipments, Impellers – types and properties, Draft tubes, Flow pattern, Baffles, Impeller location, Standard turbine design, Mixing of past and viscous material (Change-can mixer, Stationary Tank mixer, Gate mixer, Shear Bar mixer, Helical Blade mixer, Intensive mixer, Mixer – Extruders, Mixing rolls, Muller mixer and Pug mill), Mixing of solids, Mixers for dry powders (Ribbon blenders, Internal screw mixers and Tumbling mixers).• Introduction of extraction, Selection of solvent for extraction, Different between extraction and distillation, Extraction equipment (Packed tower, Rotating disk contractor - R.D.C., Mixer settlers, Spray tower, Pulse column – Sieve plate).	15	18
Unit 3	<ul style="list-style-type: none">• Introduction of crystallization, Formation of crystal, Solubility and solubility curves, Super saturation, Crystallization equipment (Tank crystallizer, Agitated crystallizer, Evaporator crystallizer, Draft tube crystallizer, Oslo cooling crystallizer, Swenson – walker Crystallizer).• Introduction of Distillation (Simple distillation, Fractional distillation, Distillation under reduced pressure / vaccum distillation, Steam distillation, Azeotropic distillations, Rectification).	15	17
Unit 4	<ul style="list-style-type: none">• Introduction of drying, Study of free moisture, bound moisture and drying curves, Drying equipment (Tray	15	17



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	<p>dryer, Drum dryer, Rotary dryer and Spray dryer, Fluidized bed dryer, Tunnel dryer, Pneumatic dryer).</p> <ul style="list-style-type: none">• Introduction of evaporation, Evaporation equipment (Forced circular evaporator, Wipped film evaporator, Falling film or Backward feed evaporator, Climing film Or Forward evaporator).		
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Reference Books:

1. Unit Operation of chemical engineering by R. S. Hiremath & A. P. Kulkarni, Everest Publishing House.
2. Unit Operations I & II, D. D. Kale, Pune Vidhyarthi Gruh Prakashan, Pune.
3. Chemical Process Industries by R. N. Shreeve.
4. Engineering Chemistry by Jain and Jain, Dhanpatrai Publishing Company.
5. Standard Hand Book of Plant Engineering by R. C. Rosaler, J. O. Rice, McGraw Hill Book Co.
6. Chemical Engineering Material by O.P. Agarwal, Goel Publishing House.
7. Stoichiometry by B. I. Bhatt an S. M. Vora.
8. Unit Operations – II, Heat and Mass transfer, by K. A. Gavhane, Nirali Prakashan.



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Semester I

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-104

Title of the paper: ICH-CC-104: **Ind. Chemistry Practicals**

Marks: 100

Credits: 06

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Detailed Syllabus	Teaching Hours
<ul style="list-style-type: none">• Calibration of thermometer.• Depressing & elevation in melting point / boiling point of solid and liquid (Minimum 07-07)• Simple laboratory techniques: crystallization, fractional crystallization (Minimum 07)• Simple laboratory techniques: evaporation (Minimum 07)• Simple laboratory techniques: distillation, fractional distillation (Minimum 07)• Field study tours / academic visits to laboratories, private companies / compulsory.• Viva-voce	90

Reference Books:

1. Vogel's Textbook of practical organic chemistry, 5th Edition by B. S. Furniss et al.
2. Inorganic qualitative Analysis by G. Svehla. (Vogel)
3. Organic preparation by G. Svehla. (Vogel)
4. Organic qualitative analysis by Mann sunder.
5. Comprehensive practical organic chemistry, V. K. Ahuwalia.
6. Industrial instrument by Donald p Eckmans.
7. Mechanical and industrial measurement by A. K. Jain.



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
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DETAILED CURRICULUM
B. Sc. Semester – II – Industrial Chemistry
Paper ICH-CC-203 – Theory
Paper ICH-CC-204 – Practical

SEMESTER PATTERN :

- The Course content has been designed on **semester pattern**.
- The workload for Theory & Practicals is allotted on semester pattern.
- There shall be **01 Theory papers 70 marks** and **2.30 hours duration** in University examination.
- Industrial Chemistry Practical Examination shall be of **70 marks** and **03 hours duration** in University examination.
- There shall be continuous internal evaluation of 30 marks.

SEMESTER – II

SR. NO.	PAPER NO.	NAME OF THE PAPER	TOTAL MARKS EXT.+INT* = TOTAL	PASSING STANDARAD EXT.+INT = TOTAL	TOTAL TEACHING HOURS (15 Weeks)	EXAM HOURS	CREDITS
1	ICH-CC-203	Industrial aspects of chemistry	70+30=100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
2	ICH-CC-204	Ind. Chemistry Practicals	100	40	15 WEEKS 26 HOURS = 90	03	06

INTERNAL EVALUATION

1. TEST	15 Marks
2. ASSIGNMENT/PRESENTATION	10 Marks
3. SEMINAR/ATTENDANCE	<u>05 Marks</u>
TOTAL	30 Marks



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
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Semester II

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-203

Title of the paper: ICH-CC-203: **Industrial aspects of chemistry**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">• Surface chemistry and Interfacial Phenomena, Absorption & Adsorption isotherm, Colloids or Sols (Types, Characteristics and Preparation), Gels (Types and Preparation), Emulsions (Types and Preparation), Micelles.• Introduction of fuel, Classification of fuels, Calorific value, Characteristics of good fuel, Comparison between solid, liquid and gaseous fuels.	15	18
Unit 2	<ul style="list-style-type: none">• Introduction of metal and metallurgy, study of different methods used in the extraction of metals – ore dressing (Gravity separation or Hydraulic washing, Hydraulic classifier, Magnetic concentration, Froth floatation process, Calcination, Roasting)• Construction and working of Bomb Calorimeter, Coal (Origin, Classification, Selection, Analysis)	15	18
Unit 3	<ul style="list-style-type: none">• Physico – chemical principals of extraction of Chromium, Copper, Zink, Sodium, Silver, Iron, Magnesium, Aluminium.	15	17
Unit 4	<ul style="list-style-type: none">• Introduction to water treatment, Treatment of water for municipal purposes, Chemical and physical methods for sterilization, Sea water as a source of drinking water, Hard and soft water, Types of hardness, Softening of water (Lime soda process, Permutit or Zeolite process, Ion exchange process), Water for industrial purpose, Nomenclature for water treatment, Waste water treatment.	15	17

Reference Books:

1. Engineering chemistry by Jain and Jain, Dhanpatrai Publishing Company.
2. Chemical engineering material by O.P. Agarwal.
3. Chemical process industries by R. N. Shreeve.
4. Outline of chemical technology by Charles E. Dryden.
5. Text book of inorganic chemistry by P. L. Soni, S Chand & Sons.
6. Industrial chemistry by B. K. Sharma.



Title of the paper: ICH-CC-204: **Ind. Chemistry Practicals**

Marks: 100

Credits: 06

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Detailed Syllabus	Teaching Hours
<ul style="list-style-type: none">• Simple laboratory techniques: Absorption<ol style="list-style-type: none">1. To study the partition co-efficient of benzoic acid in kerosene / benzene and water.• Simple laboratory techniques: Adsorption<ol style="list-style-type: none">1. To study the adsorption of a given organic acid on animal charcoal.• Chemical kinetics:<ol style="list-style-type: none">1. To determine the relative strength of HCl and H₂SO₄ by the catalytic method.2. To determine the ester hydrolysis of HCl by kinetic method.• Preparation of standard solution (Primary and secondary standardization):<ol style="list-style-type: none">1. Preparation and standardization of 0.1M HCl with help of standard solution of 0.1M NaOH.2. Preparation and standardization of 0.1M NaOH with help of standard solution of 0.1M (CH₂COOH)₂ – succinic acid.3. Preparation and standardization of 0.02M KMnO₄ with help of standard solution of 1M H₂C₂O₄.2H₂O – oxalic acid.4. Preparation and standardization of 0.02M K₂Cr₂O₇ with help of standard solution of 0.1M FeSO₄(NH₄)₂SO₄.6H₂O – Ferrous ammonium sulphate.• Acquaintance with safety measures in a laboratory, Hazards of chemicals.• Water analysis:<ol style="list-style-type: none">1. Estimation of suspended solids2. Estimation of total dissolved solids3. Estimation of Ca & Mg by volumetric method4. Estimation of chloride by gravimetric method5. Estimation of sulphate by gravimetric method6. Estimation of hardness by volumetric method7. Estimation of total acidity by volumetric method8. Estimation of mix oxide (Al₂O₃ & Fe₂O₃) by gravimetric method9. Estimation of carbonate & bicarbonate by volumetric method• p^H measurement experiments. (Minimum 07)• Field study tours / academic visits to laboratories, private companies / compulsory.• Viva-voce	90



Reference Books:

1. Inorganic qualitative Analysis by G. Svehla. (Vogel)
2. Organic preparation by G. Svehla. (Vogel)
3. Industrial instrument by Donald p Eckman (ailly Estern Ltd).
4. Process instrumentation and control hand book by Donglass M Sonsidine.
5. Instrumentation analysis by Chatwal & Sharma.
6. Vogel's Textbook of practical inorganic chemistry, 5th Edition by B. S. Furniss et al.



DETAILED CURRICULUM

Core course

B. Sc. Semester – III – Industrial Chemistry

Paper ICH-CC-303 – Theory

Paper ICH-CC-304 – Theory

Paper ICH-CC-305 – Practical

SEMESTER PATTERN:

- The course content has been designed on **semester pattern**.
- The workload for theory and practicals is allotted on semester pattern.
- There shall be **02 theory papers of 70 marks** and **2.30 hours duration** in University examination.
- Industrial chemistry practical examination shall be of **100 marks** and **09 hours duration** in University examination.
- There shall be continuous internal evaluation of 30 marks.

SEMESTER – III

Sr. No.	PAPER NO.	NAME OF THE PAPER	TOTAL MARKS EXT.+INT* = TOTAL	PASSING STANDARAD EXT.+INT = TOTAL	TOTAL TEACHING HOURS (15 Weeks)	EXAM HOURS	CREDITS
1	ICH-CC-303	Material science	70+30=100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
2	ICH-CC-304	Fine and heavy chemicals - I	70+30=100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
3	ICH-CC-305	Industrial chemistry practicals	100	40	15 WEEKS 29 HOURS = 135	09	09

INTERNAL EVALUATION

1. TEST	15 Marks
2. ASSIGNMENT/PRESENTATION	10 Marks
3. SEMINAR/ATTENDANCE	<u>05 Marks</u>
TOTAL	30 Marks



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Semester-III

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-303

Title of the paper: ICH-CC-303: **Material science**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	Unit processes and unit operations:- <ul style="list-style-type: none">- Elementary concept of unit operations and unit processes- Flow sheet preparation and elements of flow diagram.- Symbols associated with flow sheet diagram.- Abbreviations and rules of flow sheet preparations.- Types of processes and flow sheets diagram. Cement:- <ul style="list-style-type: none">- Manufacture of lime,- Portland cement.	15	18
Unit 2	Electro-thermal and electro-chemical industries:- <ul style="list-style-type: none">- Introduction of electro-thermal and electro chemical industries.- Industrial manufacture of calcium carbide, silicon carbide and synthetic graphite. Chlor-alkali industries:- <ul style="list-style-type: none">- Introduction of chlor-alkali industries.- Industrial manufacture of soda ash, sodium bicarbonate, sodium hypochlorite, caustic soda and bleaching powder. Ceramic industries:- <ul style="list-style-type: none">- Basic ceramic industries,- Clay products,- Specialized ceramic products.	15	18
Unit 3	Corrosion chemistries:- <ul style="list-style-type: none">- Introduction and various types of corrosions- Theory of corrosion (dry and wet corrosion)- Special corrosions (brief accounts of pitting corrosion, waterline corrosion, stress corrosion, erosion corrosion, corrosion fatigue)- Prevention of corrosion.	15	17
Unit 4	Pigment industries:- <ul style="list-style-type: none">- Classification, properties and chemical composition of pigment- Industrial production of: White ($PbCO_3$, ZnO, TiO_2 and lithophone), Blue (ultra marine blue and cobalt blue), Black (carbon black and natural black), Green (chrom green) and Yellow (chrome yellow). Glass Industries:- <ul style="list-style-type: none">- Manufacture of different types of glasses,- Special glass.	15	17



Reference books:

1. Chemical engineering material by O.P. Agarwal (Tata Publication).
2. Chemical process industries by R. N. Shreeve (McGraw Hill Publication).
3. Unit operation in chemical engineering by W. L. Mc. Graw and J. C. Smith (McGraw Hill Book Company).
4. Industrial Chemistry by B. K. Sharma (Goel Publishing House).
5. Introduction to Ceramics by W. D. Kingery, H. K. Bowen, D. R. Uhlmann (Wiley Publishers, New Delhi).
6. Stoichiometry by B. I. Bhatt and S. M. Vora (McGraw Hill Publication).
7. Riegel's Hand Book of Industrial Chemistry (Reinhold Publication).
8. Chemical engineers hand book by J. H. Perry (Mc Graw Hill Book Co.)
9. Materials science by C. Kulkarni and R. S. Sedha (S. Chand and Co. Lt.).
10. Materials science and engineering by V. Raghavan (Prentice Hall and India Ltd.).
11. Materials science by C. B. S. Narang (Khanna Publishers).
12. A text book of engineering materials by B. N. Das and S. L. Chawla (orient Long Merk Pvt. Ltd.)



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Semester-III

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-304

Title of the paper: ICH-CC-304: Fine and heavy chemicals – I

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<p>Catalysis:-</p> <ul style="list-style-type: none">- General principles and properties of catalysts.- Theories and types of catalysis, acid–base catalysis, positive and negative catalysis, enzyme catalysis, autocatalysis,- Characterization and deactivation, promoters, inhibitors, catalytic poisoning,- Importance of catalysts in industry. <p>Basic concept of catalyst and their applications in industries:-</p> <ul style="list-style-type: none">- Raney nickel and other from of nickel, Palladium, Copper chromate, Vanadium and vanadium pentoxide, Titanium tetrachloride and titanium dioxide.	15	18
Unit 2	<p>Phosphorous Industries:-</p> <ul style="list-style-type: none">- Industrial production of elemental phosphorous (P), phosphorous pentoxide (P_2O_5) and phosphoric acid (H_3PO_4). <p>Sulphur Industries:-</p> <ul style="list-style-type: none">- Occurrence of sulphur & industrial production of elemental sulphur, sulphuric acid (H_2SO_4) and oleum sulphuric acid ($H_2S_2O_7$). <p>Nitrogen Industries:-</p> <ul style="list-style-type: none">- Industrial production of ammonia (NH_3), nitric acid (HNO_3), ammonium nitrate and ammonium sulphate.	15	18
Unit 3	<p>Industrial production of fine chemicals:-</p> <ul style="list-style-type: none">- Bromine, iodine and fluorine,- Hydrobromic acid, borax and boric acid.- Sodium chloride, sodium sulphate and sodium sulphite.- Potassium chloride,	15	17
Unit 4	<p>Detergent Industries:-</p> <ul style="list-style-type: none">- Introduction and principal groups of synthetic detergents,- Classification of surface active agents,- Anionic, cationic and amphoteric detergents <p>Soap Industries:-</p> <ul style="list-style-type: none">- Introduction and mechanism of soap.- Manufacture of soap (toilet, transparent and metal soap)- Cleansing action of soap and detergent.	15	17



Reference books:

1. Chemical process industries by R. N. Shreeve (McGraw Hill Publication).
2. Outlines of chemical technology by C. E Dryden 3rd edition (WEP East-west press).
3. Synthetic organic compounds by O. P. Agarwal (Tata Publication).
4. Industrial chemistry by B. K. Sharma (Goel Publication House).
5. Riegel's Handbook of Industrial Chemistry by J. A. Kent (CBS Publishers, New Delhi).
6. Industrial Chemistry, Vol. – I by E. Stocchi (Ellis Harwood Ltd. UK).
7. Chemical process principles part – I by O. A. Hougen, K. M. Watson, R. A. Regartz (Asia publishing House).
8. Agrocabons to petrochemicals by L. F. Hatch and S. Matarm (Gulf publishing Co.)
9. Thermal engineering by P. L. Ballaney (Khanna Publishers).
10. Chemical process principles – I by Haygen, Watson and Regartz (Asia Publishing House).



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Semester-III

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-305

Title of the paper: ICH-CC-305: **Industrial Chemistry Practicals**

Marks: 100

Credits: 09

Marking Scheme: External Examination: 100 Marks

Detailed Syllabus	Teaching Hours
<ul style="list-style-type: none">• Preparation of fine chemicals:-<ol style="list-style-type: none">1. Magnesium hydroxide from sea-water.2. Magnesium carbonate from sea-water.3. Magnesium trisilicate from sea-water.4. Cuprous chloride from cupper sulphate.5. Magnesium stearate from stearic acid.6. Zinc stearate from stearic acid.7. Aluminium stearate from stearic acid.8. Chrome alum from potassium chromate.9. Sodium cobaltinitrite form cobalt nitrate.10. Ferrous ammonium sulphate from ferrous sulphate.• Qualitative organic analysis of binary mixtures. (Minimum 14)• Field study tours / academic visits to laboratories, private companies / compulsory.• Viva-voce	135

Reference books:

1. Vogel's Textbook of practical organic chemistry, 5th Edition by B. S. Furniss et al. (Prentice Hall).
2. Inorganic qualitative Analysis by G. Svehla. (Vogel) (Prentice Hall).
3. Organic preparation by G. Svehla. (Vogel) (Prentice Hall).
4. Comprehensive practical organic chemistry, V. K. Ahuwallia (University Press).
5. Industrial instrument by Donald p Eckmans (John Wiley).
6. Mechanical and industrial measurement by A. K. Jain (Khanna Publishers).



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DETAILED CURRICULUM
B. Sc. Semester - IV - Industrial Chemistry

Paper ICH-CC-403 - Theory
Paper ICH-CC-404 - Theory
Paper ICH-CC-405 - Practical

SEMESTER PATTERN :

- The course content has been designed on **semester pattern**.
- The workload for theory & practicals is allotted on semester pattern.
- There shall be **02 theory papers of 70 marks** and **2.30 hours duration** in University examination.
- Industrial chemistry practical examination shall be of **100 marks** and **09 hours duration** in University examination.
- There shall be continuous internal evaluation of 30 marks.

SEMESTER - IV

SR. NO.	PAPER NO.	NAME OF THE PAPER	TOTAL MARKS EXT.+INT * = TOTAL	PASSING STANDARAD EXT.+INT = TOTAL	TOTAL TEACHING HOURS (15 Weeks)	EXAM HOURS	CREDITS
1	ICH-CC-403	Study of various unit processes - I	70+30= 100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
2	ICH-CC-404	Fundamentals of chemical engineering and analytical chemistry - I	70+30= 100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
3	ICH-CC-405	Industrial chemistry practicals	100	40	15 WEEKS 29 HOURS = 135	09	09

INTERNAL EVALUATION

1. TEST	15 Marks
2. ASSIGNMENT/PRESENTATION	10 Marks
3. SEMINAR/ATTENDANCE	<u>05 Marks</u>
TOTAL	30 Marks



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Semester-IV

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-403

Title of the paper: ICH-CC-403: **Study of various unit processes – I**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">Nitration:- Introduction, nitrating agents, study of aromatic nitration, nitration of paraffinic hydrocarbons, process equipment for technical nitrations, mixed acid for nitrations, typical industrial nitration processes, industrial production of nitrobenzene, m – dinitrobenzene, p – nitroacetanilide and α – nitronaphthalene.	15	18
Unit 2	<ul style="list-style-type: none">Sulfonation:- Introduction of sulfonation and sulfation, uses and application of sulfonates and sulfates, sulfonating and sulfating agents and their principal application, chemical and physical factors in sulfonation and sulfation, commercial sulfonation methods (batch sulfonation kettle, ball – mill sulfonator), industrial production of ethanol, sulfanilic acid and anthraquinone-1-sulfonic acid.	15	18
Unit 3	<ul style="list-style-type: none">Reduction:- Introduction, methods of reduction, iron and acid reduction, metal and alkali reductions, reduction equipments (jacketed reducer), industrial production of aniline, p – phenylenediamine, xyloidine and m – nitroaniline.	15	17
Unit 4	<ul style="list-style-type: none">Oxidation:- Introduction, types of oxidative reactions, oxidizing agents, industrial production of acetic acid, formaldehyde, acetone and phthalic anhydride.Halogenation:- Introduction, brief study of chlorination, bromination and iodination, industrial production of chloroacetic acid, DDT [1, 1, 1 – trichloro – 2, 2 – bis (p – chlorophenyl) ethane], vinyl chloride, chloral and chlorobenzene.	15	17

Reference books:

- Unit processes in organic synthesis by P. H. Groggins (McGraw Hill Publication).
- Shreve's chemical process industries by George T. Austin (McGraw Hill Publication).
- Chemical process industries by R. N. Shreeve (McGraw Hill Publication).
- Outlines of chemical technology by Charles E. Dryden (WEP East-west press).
- Engineering chemistry by Jain and Jain (Dhanpatrai Publishing Company).
- Chemistry and Technology of basic organic and petroleum synthesis by N. N. Libed (Mir publisher).
- Chemical process principles – I by Haygen, Watson and Regartz (Asia Publishing House).



Title of the paper: ICH-CC-404: **Fundamentals of chemical engineering and analytical chemistry-I**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	Basic chemical calculations:- <ul style="list-style-type: none">- Dimensions and units, basic chemical calculation with different type of examples.- Theory of atomic weight, molecular weight & equivalent weight.- Mole composition of liquid mixture, gaseous mixture and solid mixture.- Scale of specific gravity and behavior of mixtures.- Average molecular weight and density of gaseous mixtures.- Combustion and calorific values of fuels.- Numerical based on above topics.	15	18
Unit 2	Material balance without chemical reaction:- <ul style="list-style-type: none">- Simple material balance with or without recycle or by-pass for chemical engineering operations such as, distillation, absorption, crystallization, evaporation, extraction, mixing, drying and filtration.- Numerical based on above topics.	15	18
Unit 3	Analytical reagents with their applications in chemistry:- <ul style="list-style-type: none">- Sodium carbonate, sodium bicarbonate, sodium potassium tartrate and potassium bicarbonate.- Oxalic acid, succinic acid and Fehling A and B solution.- Karl-flasher reagent & lithium aluminum hydride.- Ninhydrine, tetrazolium blue, methyl violet and methylene blue.- Industrial solvents: DMF, THF, dioxane, diethyl ether.- zeolites as catalyst.	15	17
Unit 4	Industrial manufacture of fine chemicals:- <ul style="list-style-type: none">- Isomerisation, dehydration / hydroxylation material derived from acetylene:- propargyl alcohol, 1,4-butandiol, acrylates, vinyl esters, vinyl chloride, formaldehyde and formic acid.- Phenol, acetone and phthalic anhydride.- Glycerol, sorbitol and melamine.- Chlorination of methane and Ethanol amine: mono, di, tri, ethanolamine.	15	17



Reference books:

1. Chemical Process Principles- I by Haygen, Watson and Regartz. (Asia Publication House).
2. Stoichiometry by Bhatt, B. I. and Vora S. M. (Tata McGraw Hill).
3. Basic Principals and Calculation in Chemical Engg. By David M. Himmelblan (Prentices Hall Inc.)
4. Thermal Engg. By P. L. Bllaney (Khanna Publishers, Delhi).
5. Outlines of Chemical technology by Charles E. Dryden (WEP East-west press).
6. Fuel and combustion by S. P. Sharma and Chandramohan (Tata McGraw Hill book Co.).



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Semester-IV

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-405

Title of the paper: ICH-CC-405: **Industrial chemistry practicals**

Marks: 100

Credits: 09

Marking Scheme: External Examination: 100 Marks

Detailed Syllabus	Teaching Hours
<ul style="list-style-type: none">• Organic preparations (One step):-<ol style="list-style-type: none">1. Acetanilide from aniline2. Acetyl salicylic acid from salicylic acid3. p-Nitro acetanilide form acetanilide4. p-Bromo acetanilide form acetanilide5. Methyl Salicylate from salicylic acid6. Benzanilide from aniline7. Benzoic acid from toluene8. Phenol from aniline9. m-Dinitro benzene from nitro benzene10. m-Nitro aniline from m-dinitro benzene11. Aniline from nitro benzene• Inorganic qualitative analysis (4 Radicals – Minimum 14)• Field study tours / academic visits to laboratories, private companies / compulsory.• Viva-voce	135

Reference books:

1. Vogel's Textbook of Practical Inorganic Chemistry, 5th Edition by B. S. Furniss et al (Prentice Hall).
2. Inorganic Qualitative Analysis by Vogel (Prentice Hall).
3. Practical organic chemistry by Vogel (Prentice Hall).
4. Comprehensive practical organic chemistry by V. K. Ahuwalia (University Press).
5. Unit processes in organic synthesis by P. H. Groggins (McGraw Hill Publication).
6. Shreve's chemical process industries by George T. Austin (McGraw Hill Publication).



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
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DETAILED CURRICULUM

Core course

B. Sc. Semester - V - Industrial Chemistry

Paper ICH-CC-503 - Theory,

Paper ICH-CC-504 - Theory

Paper ICH-CC-505- Theory,

Paper ICH-CC-506 - Theory

Paper ICH-SEC-501 - Theory,

Paper ICH-CC-507 - Practical

SEMESTER PATTERN:

- The Course content has been designed on **semester pattern**.
- The workload for theory and practicals is allotted on semester pattern.
- There shall be **04 Core course theory papers of 70 marks, 01 Subject elective course theory paper of 70 marks** and **2.30 hours duration** in University examination.
- Industrial chemistry practical examination shall be of **200 marks** and **12 hours duration** in University examination.
- There shall be continuous internal evaluation of 30 marks.

SEMESTER - V

SR. NO.	PAPER NO.	NAME OF THE PAPER	TOTAL MARKS EXT.+INT* = TOTAL	PASSING STANDARAD EXT.+INT = TOTAL	TOTAL TEACHING HOURS (15 Weeks)	EXAM HOURS	CREDITS
1	ICH-CC-503	Study of various unit processes - II	70+30 =100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
2	ICH-CC-504	Petroleum industry	70+30 =100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
3	ICH-CC-505	Chemical process industry - I	70+30 =100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
4	ICH-CC-506	Synthetic drugs	70+30 =100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
5	ICH-SEC-501	Safety in industry - I	70+30 =100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	03
6	ICH-CC-507	Industrial chemistry practicals	200	80	15 WEEKS 2 12 HOURS = 180	18	12

INTERNAL EVALUATION

- | | |
|----------------------------|-----------------|
| 1. TEST | 15 Marks |
| 2. ASSIGNMENT/PRESENTATION | 10 Marks |
| 3. SEMINAR/ATTENDANCE | <u>05 Marks</u> |
| TOTAL | 30 Marks |



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Semester-V

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-503

Title of the paper: ICH-CC-503: **Study of various unit processes – II**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">Amination (Amination by ammonolysis):- Introduction, classification of reactions, aminating agents, catalyst used in amination reactions, kinetics and thermodynamics of ammonolysis, industrial production of ammonia, aniline, N-methyl aniline, p-nitro aniline and urea.	15	18
Unit 2	<ul style="list-style-type: none">Hydrogenation:- Introduction, definition and scope, production and properties of hydrogen, analysis of hydrogen, kinetics and thermodynamics of hydrogenation reactions, general principles concerning hydrogenation catalysts, apparatus – high pressure autoclave, hydrogenation of fats and cotton seed oil, industrial production of methanol.	15	18
Unit 3	<ul style="list-style-type: none">Esterification:- Introduction, esterification by organic acids, esterification of carboxylic acid derivatives, design and operation of esterification plants, industrial production of polyethylene terephthalate, vinyl acetate, cellulose acetate and nitro glycerine.	15	17
Unit 4	<ul style="list-style-type: none">Hydrolysis:- Introduction, definitions and scope, hydrolyzing agents, kinetics, industrial production of furfural, ethanol, glycerol and phenol.Alkylation:- Introduction, types of alkylation, alkylating agents, factors controlling alkylation, industrial production of alkyl aryl detergents, ethyl benzene and tetra ethyl lead.	15	17

Reference books:

1. Unit processes in organic synthesis by P. H. Groggins (McGraw Hill Publication).
2. Shreve's chemical process industries by George T. Austin (McGraw Hill Publication).
3. Chemical process industries by R. N. Shreeve (McGraw Hill Publication).
4. Outlines of chemical technology by Charles E. Dryden (WEP East-west press).
5. Engineering chemistry by Jain and Jain (Dhanpatrai Publishing Company).
6. Chemistry and Technology of basic organic and petroleum synthesis by N. N. Libed (Mir publisher).
7. Chemical process principles – I by Haygen, Watson and Regartz (Asia Publishing House).



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Semester-V

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-504

Title of the paper: ICH-CC-504: **Petroleum industry**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">• Building Blocks for petrochemicals, their separation and purification.• Introduction of petrochemicals and size & scope of petrochemical industry in India.• Manufacturing of specific hydrocarbon derivatives with special emphasis on: C₁ (Industrial production of methanol, formaldehyde, chloromethane, perchloro ethylene, tri chloro ethylene and acetylene).	15	18
Unit 2	<ul style="list-style-type: none">• Classification and chemical composition of petroleum.• Production of crude petroleum.• Manufacturing of specific hydrocarbon derivatives with special emphasis on: C₂ (Industrial production of ethylene di chloride, vinyl chloride, ethylene oxide, ethanol amine, ethanol, ethylene and vinyl acetate).	15	18
Unit 3	<ul style="list-style-type: none">• Manufacturing of specific hydrocarbon derivatives with special emphasis on: C₃ (Industrial production of iso propenol, acetone, acrylonitrile, isoprene, propylene, propylene oxide and poly propylene).• Manufacturing of specific hydrocarbon derivatives with special emphasis on: Aromatic hydrocarbon (benzene, toluene, phenol)	15	17
Unit 4	<ul style="list-style-type: none">• Manufacturing of specific hydrocarbon derivatives with special emphasis on: C₄ (Industrial production of maleic acid, butadiene, butanol, methyl ethyl ketones, butyl acetate, butylene and butanol amine).• Manufacturing of specific hydrocarbon derivatives with special emphasis on: Aromatic hydrocarbon (phthalic anhydride, cumene, styrene and DDT).	15	17

Reference books:

1. Chemical Engineering Material by O.P. Agarwal (Tata Publication).
2. Chemical Process Industries by R. N. Shreeve (McGraw Hill Publication).
3. Outline of Chemical Technology by Charles E. Dryden (WEP East-west press).
4. Engg. Chemistry by Jain and Jain (Dhanpatrai & Sons).
5. Industrial Chemistry by B. K. Sharma (Goel Publishing House).
6. Introduction to Ceramics by W. D. Kingery, H. K. Bowen, D. R. Uhlmann (Wiley Publishers, New Delhi).



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Semester-V

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-505

Title of the paper: ICH-CC-505: **Chemical process industry - I**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">Marine chemicals derived from sea:- Introduction, industrial manufacture of magnesium salt like magnesium chloride, magnesium hydroxide, magnesium carbonate, magnesium trisilicate, potassium chloride, sodium chloride and miscellaneous sodium salts like sodium silicate, sodium sulphate, sodium sulfide, sodium peroxide, precipitated silica and calcium silicate.	15	18
Unit 2	<ul style="list-style-type: none">Fertilizer industries:- Introduction, classification, merits and demerits of chemical fertilizers (N.P.K), manufacture of urea, ammonium sulphate, ammonium phosphate (D.A.P), double and triple super phosphate, potassium chloride, agro chemicals (insecticides and pesticides), herbicides, fungicides, plant nutrients and regulators.	15	18
Unit 3	<ul style="list-style-type: none">Fermentation industries:- Brief history and brief introduction to fermentation, manufacture of industrial alcohol:- absolute alcohol (ethanol-99.9%), butanol, acetone, acetic acid, citric acid and lactic acid.Pulp and paper industries:- Brief history and introduction to pulp and paper, manufacture of pulp – Kraft process & Sulphite process, manufacture of paper – Hollander machine, Jordan machine & Fourdrinier machine, brief introduction to coated papers, specialty papers and structural boards.	15	17
Unit 4	<ul style="list-style-type: none">Sugar and starch industries:- manufacture of sugar from cane, cane – sugar refining, depolarization – char filtration, manufacture of sugar from beet, corn sweeteners, manufacture of starch, dextrin and dextrose from corn and miscellaneous starches (amylase, white potato starch, rice starch, cassava starch, sago starch and other starch sources).	15	17

Reference books:

1. Chemical Engineering Material by O.P. Agarwal (Tata Publication).
2. Chemical Process Industries by R. N. Shreeve (McGraw Hill Publication).
3. Outline of Chemical Technology by Charles E. Dryden (WEP East-west press).
4. Engg. Chemistry by Jain and Jain (Danpatray & Sons).
5. Industrial Chemistry by B. K. Sharma (Goel Publishing House).
6. Introduction to Ceramics by W. D. Kingery, H. K. Bowen, D. R. Uhlmann (Wiley Publishers, New Delhi).



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Semester-V

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-506

Title of the paper: ICH-CC-506: **Synthetic Drugs**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">• Introduction of drugs and ideal drugs.• Introduction, Synthesis and usefulness of some important groups of drugs-I:<ul style="list-style-type: none">• Antimalarial: - chloroquine, premaquine, camoquine.• Antipyretics and Analgesic drugs: - antipyrine, aminopyrine, phenacetin, paracetamol, aspirin, salol and heptazone.• Sulpha drugs or Antibacterial drugs: - sulphathiazole, sulfapyrimidines, sulfacetamide and sulphafurazole.	15	18
Unit 2	<ul style="list-style-type: none">• Classification of various drugs.• Introduction, Synthesis and usefulness of some important groups of drugs-I:<ul style="list-style-type: none">- Anti TB drugs: - p-amino salicylic acid and ethambutol.- Antilepreptic drugs: - dapsone, solapsone & andacedapsone.- Antidiabetic drugs: - tolbutamide.- Anthelmintcs : - vioform, 2,2-dichlorobutane, n-hexylrescinol (caprocol) and lubisan.- Antiseptic drugs: - chloramine-T, halazone, carvacrol and thymol.	15	18
Unit 3	<ul style="list-style-type: none">• Introduction, Synthesis and usefulness of some important groups of drugs-II:<ul style="list-style-type: none">- Anaesthetics : - diethyl ether, benzocaine, procaine, xylocaine and stovaine.- Antipasmotic: - atropine and papaverine.- Antihistamine: - benadryl, avil, pyribenzamine and mepyramine.- Anticoagulants drugs: - dicoumarol, tromexan, phenindion and valium.- Anticancer drugs: - chlorambucil.	15	17
Unit 4	<ul style="list-style-type: none">• Introduction, Synthesis and usefulness of some important groups of drugs-II:<ul style="list-style-type: none">- Antibiotic drugs: - chloramphenicol, staphicillin, streptomycin, tetracyclin, chlorotetracyclin and oxytetracyclin or terramycin.- Cardiovascular drugs: - amyl nitrile, glonoin, hydralazine, diazoxide and lidocaine.- Antifungal agents: - propionic acid, caprylic acid, salicylanilide and clotrimazol.- Antineoplastic drugs: - mechlorethamine hydrochloride, chlorambucil, melphalan and procarbazine.	15	17



Reference books:

1. Chemical Engineering Material by O.P. Agarwal (Tata Publication).
2. Chemical Process Industries by R. N. Shreeve (McGraw Hill Publication).
3. Outline of Chemical Technology by Charles E. Dryden. (WEP East-west press).
4. Engg. Chemistry by Jain and Jain (Danpatray & Sons).
5. Industrial Chemistry by B. K. Sharma (Goel Publishing House).
6. Introduction to Ceramics by W. D. Kingery, H. K. Bowen, D. R. Uhlmann (Wiley Publishers, New Delhi).



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Semester-V

Subject Elective Course – B.Sc. Industrial Chemistry

Paper No: ICH-SEC-501

Title of the paper: ICH-SEC-501: **Safety in industry - I**

Marks: 100

Credits: 03

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">• Safety:- Introduction, concept of safety, problems of industrial safety, philosophy of safety, safety related definitions and terminology (accident, incident, near miss, error, mistake, oversight, hazards, risk, danger, injury, major accident, major accident hazard, major emergency, unsafe act and unsafe condition)	15	18
Unit 2	<ul style="list-style-type: none">• Principles of accident prevention:- types of accidents, fundamentals of accident prevention (organization, fact finding, facts from accident reports, analysis of the facts, creating and maintaining interest and education) and five E's accident prevention.• Safety education and training:- meaning of education and training, assessment of training, elements of training cycle, techniques of training, methods of training, procedure for safety education and training and education in safety and health.	15	18
Unit 3	<ul style="list-style-type: none">• Planning for safety:- definition of planning, meaning of safety planning, purpose of planning, area of safety planning, aspects of safety planning, planning of safety, reasons for failure of planning, steps for planning and planning premises of safety.	15	17
Unit 4	<ul style="list-style-type: none">• Controlling for safety:- meaning, need of controlling, types of control, area of control, elements of control, control techniques (management by exception, monitoring by safety standards- ISO-14000, ISO-14001, OHSAS-18001), environment protection agency and international labour organization.	15	17

Reference books:

1. Industrial Accident Prevention by H. W. Heinrich (McGraw Hill Publication).
2. Environmental Health and Safety Management by Nicholas Cheunisinoﬀ & Madelyn Graﬃa (Noyes Publication).
3. Handbook of Industrial Safety by K. U. Mistry (Siddarth Prakashan, Surat, India).
4. Safety Management by R. C. Shah (Capital oﬀset, Gandhinagar).
5. Occupational Health and Industrial Hygiene by N. J. Joshi (McGraw Hill Publication).
6. Safety at Work by John Ridley (Butterworth-Heinemann Title).
7. Industrial Safety and Health Management – II by C. Ray Asfahi (Prentice Hall, New Jersey).
8. Human Factors Engineering by Mc Cormack E. J. (McGraw Hill Publication).



Title of the paper: ICH-CC-507: **Industrial chemistry practicals**

Marks: 200

Credits: 12

Marking Scheme: External Examination: 200 Marks

Detailed Syllabus	Teaching Hours
<ul style="list-style-type: none">Preparation of Drugs (One Step):- Paracetamol, Methyl Salicylate, Salol, PABA, Phthalic anhydride, Phthalamide, m-dinitrobenzene, Benzoic acid, m-nitro aniline, Picric acid.	180
<ul style="list-style-type: none">Exercises base on instruments:-<ol style="list-style-type: none">Determine the cell constant of the given conductivity cell and determine the normality of the given HCl solution by conductometric titration. For this you are given 0.25 N NaOH solutions.Determine the dissociation constant of the given acid by pH measurement.To titrate given HCl (0.1 N approx) against 0.5 N NaOH using quinhydrone electrodes by potentiometry.Determine the specific rotation of the given optical active substance using three different concentrations.Colorimetric estimation of iron (Fe⁺³) using Thiocyanate.Determine the viscosity of all the three known solutions, and the unknown solution by Ostwald viscometer.Determine the percentage composition of the mixture 'C' containing the pure liquids 'A' and 'B' by the Refractometer.	
<ul style="list-style-type: none">Estimation of following groups and compounds:- phenolic (-OH), amine (-NH₂ by brominating)Estimation of following compounds:- glucose, vitamin C (by Iodometry).Analysis of Ores:- DolomiteAnalysis of Cement:- (Loss of ignition. Total insoluble residue, Total silica and oxide)	
<ul style="list-style-type: none">Project Reports:- (Field study tours/academic visits to laboratories, private companies / compulsory)Viva-voce	

Reference books:

- Vogel's Textbook of Practical Inorganic Chemistry, 5th Edition by B. S. Furniss et al (Prentice Hall).
- Inorganic Qualitative Analysis by Vogel (Prentice Hall).
- Practical organic chemistry by Vogel (Prentice Hall).
- Comprehensive practical organic chemistry by V. K. Ahuwallia (University Press).
- Unit processes in organic synthesis by P. H. Groggins (McGraw Hill Publication).
- Shreve's chemical process industries by George T. Austin (McGraw Hill Publication).



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
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B. Sc. Semester – VI – Industrial Chemistry

Paper ICH-CC-603 – Theory,
Paper ICH-CC-604 – Theory
Paper ICH-CC-605 – Theory,
Paper ICH-CC-606 – Theory
Paper – ICH-SEC-601 – Theory
Paper ICH-CC-607 – Practical

SEMESTER PATTERN:

- The Course content has been designed on **semester pattern**.
- The workload for Theory & Practicals is allotted on semester pattern.
- There shall be **04 Core course theory papers of 70 marks, 01 Subject elective course theory paper of 70 marks** and **2.30 hours duration** in University examination.
- Industrial chemistry practical examination shall be of **200 marks** and **12 hours duration** in University examination.
- There shall be continuous internal evaluation of 30 marks.

SEMESTER – VI

SR. NO.	PAPER NO.	NAME OF THE PAPER	TOTAL MARKS EXT.+INT* = TOTAL	PASSING STANDARAD EXT.+INT = TOTAL	TOTAL TEACHING HOURS (15 Weeks)	EXAM HOURS	CREDITS
1	ICH-CC-603	Fundamentals of chemical engineering	70+30 =100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
2	ICH-CC-604	Polymer Chemistry	70+30 =100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
3	ICH-CC-605	Chemical process Industry – II	70+30 =100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
4	ICH-CC-606	Synthetic Dyes	70+30 =100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	04
5	ICH-SEC-601	Safety in industry - II	70+30 =100	28+12=40	15 WEEKS 24 HOURS = 60	2.30	03
6	ICH-CC-607	Industrial chemistry practicals	200	80	15 WEEKS 2 12 HOURS = 180	18	12

INTERNAL EVALUATION

1. TEST	15 Marks
2. ASSIGNMENT/PRESENTATION	10 Marks
3. SEMINAR/ATTENDANCE	<u>05 Marks</u>
TOTAL	30 Marks



Title of the paper: ICH-CC603: **Fundamentals of chemical engineering**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">Size reduction:- Introduction, properties of solids and particle size, mechanism of size reduction and energy utilization, factor influencing the size of the product and equipments of size reduction (blake jaw crusher, gyratory crusher, hammer mill, smooth roll crusher, toothed roll crusher, ball mill and rotary knife cutter).	15	18
Unit 2	<ul style="list-style-type: none">Fluid mechanics:- Introduction, state of matter, concept of fluid, properties of fluids, classification of fluids, study of fluids, types of fluid flow in pipe, types of flow pattern, flow measuring instrument (orifice meter, venturi-meter, rotameter), flow through pipes, pipes and pipe fitting and their related matter.	15	18
Unit 3	<ul style="list-style-type: none">Fluid flow (Transportation of fluid):- Construction, working and application of fans (propeller fan, tube axial fan, vane axial fan, centrifugal fan), pump (centrifugal pump, reciprocating pump, gear pump, ejector and vacuum pumps), flow controlling valves (gate valve, globe valve, ball valve, needle valve and butterfly valve).	15	17
Unit 4	<ul style="list-style-type: none">Heat Transfer:- Introduction, different mode of heat transfer, Fourier's law, heat exchanger – types of heat exchanger, construction, working and applications of shell and tube (1-1, 1-2 & 2-4) type heat exchanger, finned tube heat exchanger and plate heat exchanger.Leaching:- Definition of leaching, mechanism of leaching, mass transfer phenomena during leaching and rate of mass transfer, Bollman extractor and Hildebrandt extractor.	15	17

Reference books:

1. Chemical Engineering Material by O.P. Agarwal (Tata Publication).
2. Chemical Process Industries by R. N. Shreeve (McGraw Hill Publication).
3. Outline of Chemical Technology by Charles E. Dryden (WEP East-west press).
4. Engg. Chemistry by Jain and Jain (Danpatray & Sons).
5. Industrial Chemistry by B. K. Sharma (Goel Publishing House).
6. Introduction to Ceramics by W. D. Kingery, H. K. Bowen, D. R. Uhlmann (Wiley Publishers, New Delhi).



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Semester-VI

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-604

Title of the paper: ICH-CC-604: **Polymer chemistry**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">• Polymerization:- Classification, nomenclature, mechanism of chain polymerization, free radical, ionic polymerization, coordination polymerization, homo and co-poly condensation, methods of polycondensation and stepwise polymerization.• Elastomers or rubber:- Introduction, natural rubber, synthetic rubber (monomer production – butadiene, styrene, acrylonitrile, chloroprene), buna-S (SBR), buna-N (NBR), neoprene, vulcanization – types and mechanism of vulcanization.	15	18
Unit 2	<ul style="list-style-type: none">• Detailed study of thermoplastic polymer:- Brief introduction of physical properties, chemical properties, manufacturing process and applications of HDPE, polypropylene, polyvinylchloride, polystyrene, poly vinyl acetate, poly vinyl alcohol and teflon.	15	18
Unit 3	<ul style="list-style-type: none">• Detailed study of the following thermosetting polymers with respect to synthesis chemical properties and applications:- Alkyd resins – phenol formaldehyde, amino resins – urea formaldehyde and melamine formaldehyde, polyurethanes, epoxy resins.	15	17
Unit 4	<ul style="list-style-type: none">• Detailed study of synthetic fiber:- Brief introduction of physical properties, chemical properties, classification, manufacturing process and applications of cellulosic fiber, viscose rayon, nylon-6, nylon-6, 6, terylene, saran, vinyon and orlan.	15	17

Reference books:

1. Chemical Engineering Material by O.P. Agarwal (Tata Publication).
2. Chemical Process Industries by R. N. Shreeve (McGraw Hill Publication).
3. Outlines of Chemical Technology by Charles E. Dryden(WEP East-west press)..
4. Engg. Chemistry by Jain and Jain (Danpatray & Sons).
5. Industrial Chemistry by B. K. Sharma (Goel Publishing House).
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Semester-VI

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-605

Title of the paper: ICH-CC-605: **Chemical process industry - II**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">Explosive and propellants:- Introduction, classification and characteristics of explosive, synthesis (nitro, nitric esters, nitramines, nitramide, diazo compound explosive), toxic chemical weapons, screening smokes, solid and liquid propellants, matches, gun powder and explosive in India.Non textile uses of dyes:- leather dyes, paper dyes, food dyes.	15	18
Unit 2	<ul style="list-style-type: none">Food industry:- Introduction, food storage and transport, engineering aspects of cold storage, food processing, food additives and preservatives, food coloring agents and enzymes, food by product (manufacturing of leather, gelatin and adhesive).Non textile uses of dyes:- cosmetic dyes, fluorescent dyes, luminescence dyes.	15	18
Unit 3	<ul style="list-style-type: none">Perfume industry:- Brief history and brief introduction to perfume, solvents, fixatives, odorous compounds, important compounds used as perfumes (application of methyl anthralinate, N-methyl anthralinate, methyl salicylate, benzyl salicylate, benzyl alcohol, benzyl benzoate, ciretone, coumarin, phenyl aldehyde, vaniline, benzyl acetate, Citrenellol and diphenyl ether).Non textile uses of dyes:- solvent, wood and lacquers dyes, photography dyes and medicinal dyes.	15	17
Unit 4	<ul style="list-style-type: none">Detergent Industries:- Introduction and principal groups of synthetic detergents, Classification of surface active agents, Anionic, cationic and amphoteric detergentsSoap Industries:-Introduction and mechanism of soap, Manufacture of soap (toilet, transparent and metal soap), Cleansing action of soap and detergent.	15	17

Reference books:

1. Chemical Engineering Material by O.P. Agarwal (Tata Publication).
2. Chemical Process Industries by R. N. Shreeve (McGraw Hill Publication).
3. Outlines of Chemical Technology by Charles E. Dryden.
4. Engg. Chemistry by Jain and Jain (Danpatray & Sons).
5. Industrial Chemistry by B. K. Sharma (Goel Publishing House).
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Semester-VI

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-606

Title of the paper: ICH-CC-606: **Synthetic dyes**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">Intermediate compounds:- Brief account of intermediate compounds as dyestuff i.e., aliphatic, heterocyclic and aromatic intermediate compounds. Synthesis of H-acid, G-acid, R-acid, Gama-acid, 1,2,4-acid and Bon-acid.Theory of colour:- colour and chemical constitutions, relation between colour and chemical constitution (Witt's theory-brief accounts on chromophore and auxochrome, Armstrong's theory).Classification of various dyes.	15	18
Unit 2	<ul style="list-style-type: none">A brief account of the following group of dyes:- Procaine or reactive (procian red, procian blue HB and remazole green), sulfur (sulphur blue – 9, sulphur blue – 13 and vat blue – 13), disperse (celliton fast yellow G and celliton violet R), phthaleins & xanthenes (phenolphthalein, phenolsulphophthalin, fluorescein, eosin, rodamine B and acid violet 4R), thiazine (thioflavin T), optical brighteners (blankophor – R and bistriazole) and pigment dyes (hansa yellow G, pigment yellow, pigment orange 5 and pigment red 344).	15	18
Unit 3	<ul style="list-style-type: none">Synthesis and study of important dyes of following groups:- Nitro (naphthol yellow S, pigment chloride GG and lithol fast yellow GG), nitroso (naphthol green, naphthol green B and disperse yellow), acridine (acridine, acriflavine, acridine yellow G, acridine orange NO and soframine T), diphenyl and triphenyl methane (light green SF yellowish, naphthalene green V, rosaniline, eriochrome azurol B and acid violet R) and anthraquinone (indanthrene yellow FFRK, indanthrene golden orange 3G, indanthrene red brown 5RF and indanthrene khakhi GG).	15	17
Unit 4	<ul style="list-style-type: none">Synthesis and applications of the following dyes:- methyl violet, congo red, auramine, malachite green, methylene blue, alizarin, naphthol AS and ASG, tartrazine, chrysophenine G, direct black EW, direct green, caledon jude green BB, indanthrene blue, rodamine B, dibenzanthrone, eriochrome black-T and remazole black-B.	15	17



Reference books:

1. Chemical Engineering Material by O.P. Agarwal (Tata Publication).
2. Chemical Process Industries by R. N. Shreeve (McGraw Hill Publication).
3. Outline of Chemical Technology by Charles E. Dryden.
4. Engg. Chemistry by Jain and Jain (Danpatray & Sons).
5. Industrial Chemistry by B. K. Sharma (Goel Publishing House).
6. Introduction to Ceramics by W. D. Kingery, H. K. Bowen, D. R. Uhlmann (Wiley Publishers, New Delhi)



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
(With effect from Academic Year 2019-20)

Semester-VI Subject Elective Course – B.Sc. Industrial Chemistry Paper No: ICH-SEC-601

Title of the paper: ICH-SEC-601: **Safety in industry - II**

Marks: 100

Credits: 04

Marking Scheme: External Examination: 70 Marks + Internal Examination: 30 Marks

Unit	Detailed Syllabus	Teaching Hours	Marks / Weight
Unit 1	<ul style="list-style-type: none">Hazards in unit processes and unit operations:- introduction and brief concept of unit processes and unit operations, control measures in fluid pumping, mixing, filtration, centrifuging, burners, pumps, vessels, valves, heaters and control panels.Petroleum act – 1934 and rules – 1976, explosive act – 1884 and rules – 1983.	15	18
Unit 2	<ul style="list-style-type: none">Personal protective equipment:- introduction, legal requirement, need of PPE, types of PPE, uses and area of body gets protection with hazards, classification of safety department works, safety equipments, hazard detection equipment (gas detection tube, oxygen meter, personal gas monitor, radiation meter).Gas cylinder rules – 1981, insecticide act – 1968 and rules – 1971.	15	18
Unit 3	<ul style="list-style-type: none">Ventilation and light:- purpose of ventilation, effects of good and bad ventilation, types of ventilation (natural, cross, roofed, mechanical, exhaust, plenum, comfort, dilution, local exhaust ventilation and air conditioning), purpose and advantages of lighting, effect of bad and poor lighting, principles of illuminations and principles of good lighting.Rules of transportation of hazardous goods from the motor vehicles rules – 2000.	15	17
Unit 4	<ul style="list-style-type: none">Fire and explosion:- chemistry of fire, elements of fire, classification of fire, special industrial fire detectors and alarms (human observer, auto fire detection system, smoke-flame-IR and UV-combustion gas detection), introduction to explosion and effect of explosion.Dock workers (safety, Health and welfare) act – 1986 and rules and regulations – 1990.	15	17



Reference books:

1. Site Safety by J. C. Landey (Butterworths).
2. Handbook of Industrial Lighting and Ventilation by S. L. Lyons (Butterworths).
3. A Handbook of Fire Technology by R. S. Gupta (Orient Longman Ltd. Bombay).
4. Encyclopedia of Occupational Health and Safety, 4th Edition, (ILO, Geneva).
5. The Factories Act – 1984 and the Gujarat Factories Rules – 1963.
6. Legislations on Safety and Health by R. C. Shah (Capital offset, Gandhinagar).
7. Occupational Health and Industrial Hygiene by N. J. Joshi (McGraw Hill Publication).
8. Safety at Work by John Ridley (Butterworth-Heinemann Title).



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
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Semester-VI

Core Course – B.Sc. Industrial Chemistry

Paper No: ICH-CC-607

Title of the paper: ICH-CC-607: **Industrial chemistry practicals**

Marks: 200

Credits: 12

Marking Scheme: External Examination: 200 Marks

Detailed Syllabus	Teaching Hours
<ul style="list-style-type: none">• Preparation of Dyes (One Step):- Methyl orange, Metanil yellow, Megneson-I, Megneson-II, Lack Red-D, Mordant yellow, Disperse Dye, Fluorescence, Orange-I-dye, Methyl Red, Fast green-O.	180
<ul style="list-style-type: none">• Exercises base on instruments:-<ol style="list-style-type: none">1. Determine the cell constant of the given conductivity cell and determine the normality of the given Acetic acid solution by conductometric titration. For this you are given 0.5 N NaOH solutions.2. Determine the cell constant of the given conductivity cell and determine the dissociation constant of a weak electrolyte conductometrically.3. Determine the degree of hydrolysis of the salt at different concentration by pH metry.4. Find out the normality and redox potential of ferrous Ammonium sulphate by Potentiometry titration.5. Study the rate of inversion of Cane Sugar in presence of 1.0 N HCl.6. Determine the percentage composition of the mixture 'C' containing the pure liquids 'A' and 'B' by the viscosity method.7. Colorimetric estimation of nickel (Ni²⁺).	
<ul style="list-style-type: none">• Paper chromatography:- Separation of ions: (1) Cu²⁺, Cd²⁺, Bi³⁺ (2) Fe²⁺, Cr³⁺, Al³⁺ (3) Ca²⁺, Ba²⁺, Sr²⁺ (4) Amino acids (Glycine, Aspartic acid, Tyrosine).• Analysis of Alloys:- German-silver, Bronze, Brass.	
<ul style="list-style-type: none">• Project Reports:- (Field study tours/academic visits to laboratories, private companies / compulsory)• Viva-voce	

Reference books:

1. Vogel's Textbook of Practical Inorganic Chemistry, 5th Edition by B. S. Furniss et al (Prentice Hall).
2. Inorganic Qualitative Analysis by Vogel (Prentice Hall).
3. Practical organic chemistry by Vogel (Prentice Hall).
4. Comprehensive practical organic chemistry by V. K. Ahuwalla (University Press).
5. Unit processes in organic synthesis by P. H. Groggins (McGraw Hill Publication).
6. Shreve's chemical process industries by George T. Austin (McGraw Hill Publication).