RAMAKRISHNA MISSION VIDYAMANDIRA

BELURMATH, HOWRAH, WEST BENGAL

DEPARTMENT OF INDUSTRIAL CHEMISTRY

PROGRAMME OFFERED : B.Sc. INDUSTRIAL CHEMISTRY HONOURS

PROGRAMME CODE :INCA

DURATION : 6 SEMESTERS

TOTAL CREDIT : 148

FULL SYLLABUS WITH COURSE OUTCOME

VALID & ONGOING AS ON 30TH JUNE, 2019

Following is the credit distribution for B.Sc. Industrial ChemistryHons. Programme:

	CR SEM 1	CR SEM 2	CR SEM 3	CR SEM 4	CR SEM 5	CR SEM 6	Total Credit
Core Course / Hons.	14	14	14	14	26	26	**108**
Generic Elective	6	6	6	6	--	--	**24**
AECC-Lang.	2	2	2	2	--	--	**4**
AECC-ENVS	--	--	--	--	--	--	**4**
SEC- ICSH	1	1	1	1	2	2	**8**
	23	**23**	**23**	**23**	**28**	**28**	**148**

Following is the Grade Point distribution:

% of Marks	Descriptor	Grade	Grade Point
85 - 100	OUTSTANDING	**O**	**10**
70 - 84.99	EXCELLENT	**A+**	**9**
60 - 69.99	VERY GOOD	**A**	**8**
55 - 59.99	GOOD	**B+**	**7**
50 - 54.99	ABOVE AVERAGE	**B**	**6**
40 - 49.99	AVERAGE	**C**	**5**
35 - 39.99	PASS (HONOURS)	**P**	**4**
30 - 34.99	PASS (OTHERS)	**P**	**4**
LESS THAN 35	FAILED (HONOURS)	**F**	**0**
LESS THAN 30	FAILED (OTHERS)	**F**	**0**

Name of the Core Course	Credit for the Core Course	Generic Elective Course and the Credit
Industrial Chemistry Hons	108	Total Credit : 24 At present, considering the future prospect of the students the college offers following two Generic Elective subjects Courses for all students of this Hons programme: a) Mathematics and b) Physics

B.Sc. Industrial Chemistry Hons.Programme hasintroduced Discipline Specific Elective Course (DSE) and/or Project in 5h and/or 6th semester:

Sl. No.	Name of the Programme	Discipline Specific Elective / Project
1	Industrial Chemistry Hons	Project & Internship in Industry

Students of B.Sc. Industrial Chemistry Hons. Programmemust take following courses :

- Ability Enhancement Compulsory Courses (AECC):
  - Environmental Science : 4 Credit
  - English Language and MIL (Bengali Language/ AlternativeEnglish) : 4 Credit
- Value-Oriented Course (Indian Cultural and SpiritualHeritage) : 8 Credit

Total Credit to be earned by a student to complete B.Sc. Industrial Chemistry Hons. Programme: 148 Credit
Mark sheet after each semester will be given both with SGPA and detailed marks obtained by the examinee.

Similarly Mark sheet after the final semester will be given with CGPA and detailed marks obtained by the examinee.

Calculation of SGPA = (Total Credit X Total Grade Point = Total Credit Point);
Total Credit Points / Total Credits
Calculation of CGPA = (Total SGPA X Total Credits in each Sem.) / Total Credits earned in all the semesters

B.Sc. Industrial Chemistry Honours

6 Semester Course

Course Structure

Sl No	Name of the Course	Semester	Course Code	Credit	Marks in the Course	Course outcome
1	INORGANIC CHEMISTRY- I, ORGANIC CHEMISTRY- I & PHYSICAL CHEMISTRY- I	1	INCA-P-1-T **New Course vide Dated 03.07.2014**	10	75	•Students will acquire an idea about the Valence bond theory, Stereochemistry, reaction mechanism, Atomic Structure, Chemical periodicity, Chemical Bonding, Ideal and Real gases, Thermodynamics.
2	INORGANIC CHEMISTRY	1	INCA-P-1-P **New Course vide Dated 03.07.2014**	4	25	• Development of the concept of the detection of acid & basic radicals and quantitative analysis of inorganic samples.
3	INORGANIC CHEMISTRY- II, ORGANIC CHEMISTRY- II & PHYSICAL CHEMISTRY- II	2	INCA-P-2-T **New Course vide Dated 03.07.2014**	10	75	• This course will provide a comprehensive idea about the aliphatic nucleophilic substitution, elimination mechanisms, Nucleophilic addition to carbonyl compound, acid base theory, concept of a redox titration, concept of electrochemical cells.
4	ORGANIC CHEMISTRY	2	INCA-P-2-P **New Course vide Dated 03.07.2014**	4	25	• Development of the concept of the detection of special elements and functional groups of organic samples..
5	MATERIALS SCIENCE, METALLURGY & SPECTROSCOPY	3	INCA-P-3-T	10	75	• Students will acquire an idea about the Rotational & Vibrational spectroscopy, concept of lattice, lattice energy. symmetry, crystal class, crystal system, unit cell and concept of Pyrometallurgy, hydrometallurgy & electrometallurgy
6	PHYSICAL CHEMISTRY	3	INCA-P-3-P	4	25	• Students will gain an idea about the acid base titrations methods, Instrumental method of analysis for Surface tension, viscosity, Partition Coefficient.

7	CHEMICAL ENGINEERING & POLYMER SCIENCE	4	INCA-P-4-T	10	75	• This course will provide an idea about the concept of materials balance &energy balance, heat transfer co-efficient and concept of Polymerization methods & their kinetics.
8	MATERIALS SCIENCE	4	INCA-P-4-P	4	25	• Students will acquire an idea about the synthesis approach and characterizations tools of materials.
9	CERAMIC TECHNOLOGY, PETROLEUM & UNIT PROCESS	5	INCA-P-5-T	13	100	• Concept of the white wares, refractoriness, glass formation technology & petroleum Refinery.
10	CEMENT TESTING, UNIT OPERATION, PROJECT WORK-I & INDUSTRIAL TRAINNING AND REPORTING	5	INCA-P-6-P **New Course vide Dated 26.10.2017**	13	100	• Students will acquire an idea about the Nitration, Oxidation, Partial reduction, Esterification, Polymerization & chemical analysis methods of cement.
11	HEAVY INORGANIC CHEMICALS, PETROCHEMICALS, INDUSTRIAL & ENVIROMENTAL POLLUTION, FUEL & FURNACE, ANALYTICAL CHEMISTRY	6	INCA-P-7-T	13	100	• Concept of Heavy Inorganic chemicals & Petrochemicals and the concept of industrial pollution, water pollution & solid waste management.
12	CHEMICAL ENGINEERING, FUEL & FURNACE, PROJECT WORK-II, SEMINAR PRESENTATION	6	INCA-P-8-P	13	100	• : Development of the concept of the Flow measurement & analysis of fuels and during these course students will expand their idea on research.

B.Sc. Industrial Chemistry Honours
6 Semester Course
Mapping of Employability etc.

Sl No	Name of the Course	Semester	Course Code	Activities with direct bearing on Employability/ Entrepreneurship/ Skill development
1	INORGANIC CHEMISTRY- I, ORGANIC CHEMISTRY- I & PHYSICAL CHEMISTRY- I	1	INCA-P-1-T	While teaching these courses teachers involve the students with the course materials in such a way that they get the training which directly help them to get placed in industry as a R&D chemist.
2	INORGANIC CHEMISTRY	1	INCA-P-1-P	Skill upon chemical analysis of inorganic compounds can be grwon for the students in this field.
3	INORGANIC CHEMISTRY- II, ORGANIC CHEMISTRY- II & PHYSICAL CHEMISTRY- II	2	INCA-P-2-T	Students may develop their skill on basic electrical applications and oranic mechanism which is being used in chemical and biochemical industries and also in research area based on those properties.
4	ORGANIC CHEMISTRY	2	INCA-P-2-P	Skill upon functional group analysis of organic samples can be grwon for the students in the appropiate field.
5	MATERIALS SCIENCE, METALLURGY & SPECTROSCOPY	3	INCA-P-3-T	It may be very helpful for the students to get employed in the "Research & Development" section of any chemical industries and also the skill to handling of basic instruments on research purpose wiil be developed.
6	PHYSICAL CHEMISTRY	3	INCA-P-3-P	Skill on basic instrumentation and testing of chemicals may be improved, providing the scope of emplobility in chemical based industries.

7	CHEMICAL ENGINEERING & POLYMER SCIENCE	4	INCA-P-4-T	These course be very helpful for the students to get employed in the chemiscal industry & polymer industry.
8	MATERIALS SCIENCE	4	INCA-P-4-P	Employment in "Materials Testing laboratory" and "Research and Development" section of any respective industry can be achieved by the students.
9	CERAMIC TECHNOLOGY, PETROLEUM & UNIT PROCESS	5	INCA-P-5-T	During these course students will develop their knowledge in white wares, refractory, glass & petroleum which will provide the capability to get the job opportunity in ceramic industries & petroleum industries.
10	CEMENT TESTING, UNIT OPERATION, PROJECT WORK-I & INDUSTRIAL TRAINNING AND REPORTING	5	INCA-P-6-P	These course provides the capability to employable in chemical industries.
11	HEAVY INORGANIC CHEMICALS, PETROCHEMICALS, INDUSTRIAL & ENVIROMENTAL POLLUTION, FUEL & FURNACE, ANALYTICAL CHEMISTRY	6	INCA-P-7-T	Skill on basic instrumentation and testing of chemicals may be improved, providing the scope of emplobility in chemical based industries.
12	CHEMICAL ENGINEERING, FUEL & FURNACE, PROJECT WORK-II, SEMINAR PRESENTATION	6	INCA-P-8-P	While teaching these courses teachers involve the students with the course materials in such a way that they get the training which directly help them to get placed in oil industries.

Industrial Chemistry: 1st Semester

Detailed Syllabus

Course Code-INCA-P1T

Paper-I: Industrial Chemistry [Theory] Full Marks: 75

*[**Course outcome:** Students will acquire an idea about the Valence bond theory, Stereochemistry, reaction mechanism, Atomic Structure, Chemical periodicity, Chemical Bonding, Ideal and Real gases, Thermodynamics]*

Unit I- Organic Chemistry-I [Marks 25]

Part A: Bonding, physical properties and acyclic stereochemistry of organic molecules

Valence bond theory: concept of hybridisation, resonance (including hyperconjugation), orbital pictures of bonding (sp^3, sp^2, sp: C-C, C-N & C-O system). Inductive effect, bond polarization and bond polarizability, steric effect, steric inhibition.

Physical properties: bond distance, bond angle, bond energy, dipole moment in terms of structure and bonding. Heat of hydrogenation and heat of combustion.

Stereochemistry:

Representation of molecules in saw horse, Fischer, flying-wedge and Newman formulae and their inter translations, symmetry elements, molecular chirality.

Optical activity of chiral compounds: specific rotation, optical purity (enantiomeric excess).

Configuration: i) Geometrical isomerism: cis/trans, syn/anti, E/Z descriptors (for C=C, C=N). ii) Optical isomerism: systems involving 1, 2, 3 stereocentres, stereogenicity, chirotopicity. pseudoasymmetric (D/L and R/S descriptor, threo/erythro and syn/anti nomenclatures (for aldols)

Conformation: Conformational nomenclature, eclipsed, staggered, gauche and anti, dihedral angle, torsion angle, energy barrier of rotation, relative stability of conformers on the basis of steric effect, dipole-dipole interation and hydrogen bonding. Conformational analysis of ethane, propane, n-butane, 1,2dihaloethane and 1,2diols.

Part B: General treatment of reaction mechanism

Mechanistic classification: ionic, radical and pericyclic; heterolytic bond cleavage and heterogenic bond formation, homolytic bond cleavage and homogenic bond formation; representation of mechanistic steps using arrow formalism.

Reactive intermediates: carbocations (cabenium and carbonium ions), carbanions, carbon radicals, carbenes – structure using orbital picture, electrophilic/nucleophilicbehaviour, stability, generation and fate (elementary idea)

Concept of organic acids and bases: Effect of structure, substituent and solvent on acidity and basicity of organic molecules.

Reaction thermodynamics: concept of enthalpy, entropy, free energy and equilibrium constant; intermolecular and intramolecular reaction; application of thermodynamic principle in tautomerism.

Reaction kinetics: concept of rate equation, rate constant, order, molecularity and activation energy; Energy profile diagram single and multistep reactions, catalysed reactions; kinetic and thermodynamic control of reactions, isotope effects, principle of microscopic reversibility, Hammond postulate.

Unit II- Inorganic Chemistry-I [Marks 25]

Atomic Structure:

Bohr's theory of atomic structure and its applications andlimitations, Atomic spectra, Sommerfeld's modifications, quantum numbers, idea of deBroglie matter waves,Heisenberg's

uncertainty principle, concept of atomic orbital, Pauli's Exclusion principle, Hund'srule, Auffbau principle and its limitations, Term symbol of metal ions (up to atomic number 30).

Chemical periodicity:

Effective nuclear charges, screening effects, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, Ionization potential, electron affinity and electronegativity (Pauling and Allred-Rochow scale) and factors influencing these properties. Group trends and periodic trends in physical properties.Modern periodic table (IUPAC).General characteristic of s, p, d and f block elements.

Chemical Bonding:

General idea of ionic and covalent bonding, Lattice Energy, Born Lande equation, Bond Haber cycle, Lattice Energy, Solvation energy and Solubility, Fajan's rule, Radius ratio rule, Limiting radius ration for Trigonal, Tetrahedral and Cubic system.

Metallic bonding: qualitative ideas of band theory, conducting, semi-conducting (p type & n type) and insulatingproperties.

Unit III- PhysicalChemistry-I [Marks 25]

Ideal and Real gases

Kinetic theory gas, Barometric distribution law, Maxwell's distribution of speeds, Law of equipartition of energies, van der Waals' equation and itsapplication, general cubic equation of state, use of compressibility factor chart, inter molecular interactive forces – London, Debye, Keesom forces.

Thermodynamics

1.*Basic Concepts*: Microscopic and macroscopic points of view: thermodynamic variables of a system, State function, exact and inexact differentials.

2. *First Law of Thermodynamics*: Thermal equilibrium, Zeroth law and the concept of temperature. Thermodynamic equilibrium, internal energy, external work, quasistatic process,

first law of thermodynamics and applications including magnetic systems, specific heats and their ratio, isothermal and adiabatic changes in perfect and real gases.

3. *Second Law of Thermodynamics*: Reversible and irreversible processes, indicator diagram. Carnot's cycles-efficiency, Carnot's theorem.Kelvin's scale of temperature, relation to perfect gas scale, second law of thermodynamics – different formulations and their equivalence, Clausius inequality, entropy, change of entropy in simple reversible and irreversible processes, entropy and disorder; equilibrium and entropy principle, principle of degradation of energy.

4. *Thermodynamic Functions*: Enthalpy, Helmholtz and Gibbs' free energies; Legendre transformations, Maxwell's relations and simple deductions using these relations; thermodynamic equilibrium and free energies.

5. *Change of State*: Equilibrium between phases, triple point: Gibbs' phase rule (statement only) and simple applications. First and higher order phase transitions, Clausius-Clapeyron's equation. Joule Thomson effect.

Course Code-INCA-P1P

Paper-I: Laboratory Practical & Sessional [Full Marks -25]

Inorganic & Analytical Chemistry

*[**Course outcome:** Development of the concept of the detection of acid & basic radicals and quantitative analysis of inorganic samples.]*

A) Detection of some important ions/radicals

Ag^{+}, Pb^{+2}, Cu^{2+}, Cd^{2+}, As^{3+}, Al^{3+}, Fe^{3+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Co^{2+}, Mg^{2+}, Cl^{-}, NO_3^{-}, $SO_4^{=}$, $S_2O_3^{=}$, PO_4^{3-}, F^{-}, BO_3^{3-}

B) Quantitative Chemical Analysis of Ores and Alloys

Ores -Limestone, Dolomite,Pyrolusite.

Alloys - Cu in Brass, Cr and Mn in steel.

Industrial Chemistry: 2nd Semester

Detailed Syllabus

Course Code-INCA-P2T

Paper-II: Industrial Chemistry [Theory] Full Marks: 75

*[**Course outcome:** This course will provide a comprehensive idea about the aliphatic nucleophilic substitution, elimination mechanisms, Nucleophilic addition to carbonyl compound, acid base theory, concept of a redox titration, concept of electrochemical cells.]*

Unit I- Organic Chemistry-II [Marks 25]

Classification of organic reactions based on reaction mechanism:

Part A: Substitution reaction

Aliphatic nucleophilic substitution: i) Sustitution at sp^3centre - Mechanism: S_N1, S_N2, S_Ni mechanisms, effect of solvent, substrate structure, leaving group, nucleophiles including ambident nucleophiles (cyanide & nitrite) substitution involving NGP; ii) Substitution at sp^2 carbon (carbonyl system) - Mechanism: $B_{AC}2$, $A_{AC}2$, $A_{AC}1$, $A_{AL}1$ (in connection to acid and ester).

Aromatic electrophilic substitution: Huckel's rules for aromaticity, mechanisms, orientation and reactivity. Reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reactions, one carbon electrophiles (reactions: Gatterman, Hoesch, Vilsmeier-Haack reaction, Reimer-Tiemann, Kolbe-Schmidt).

Aromatic electrophilic substitution: Addition-elimination mechanism, S_N1 mechanism.

Part B: Elimination reaction

Elimination - Mechanisms: E1, E2 and E1cB; reactivity, orientation (Saytzeff/Hofmann) and stereoselectivity.

Part C: Addition reaction

Electrophilic addition to carbon-carbon multiple bond: Mechanism, reactivity, regioselectivity and stereoselectivity. Reactions: halogenations, hydrohalogenation, hydration, hydrogenation, epoxidation, hydroxylation, ozonolysis, electrophilic and free radical addition to conjugated dienes: 1, 2 versus 1, 4 addition.. Radical addition: HBr addition.

Nucleophilic addition to carbonyl compound: Mechanism, reactivity, equilibrium and kinetic control. Reactions with alcohols, amines, thiols, HCN, bisulfate. Carbonyl Reduction: hydride addition, Wolff-Kishner reduction, dissolving metal (Bouveault-Blanc reduction, Clemmensen Reduction), Cannizzaro reaction, aldol condensation, benzoin condensation. Nucleophilic addition to α,β-unsaturated carbonyl system (general principles).

Unit II- Inorganic Chemistry-II [Marks 25]

Acid Base:

Arrhenius theory, Bronsted and Lowry's concept, relative strengths of acids, hydracids andoxyacids Lewis concepts, acid-baseequilibria in aqueous solution, pH, buffer solution,neutralization curves, choice of acid-base indicators and titrations.

Co-ordination compounds: Double salts and complex salts, Werner's theory of co-ordination,Chelate complexes, stereo chemistry of coordination numbers 4 & 6, IUPAC system ofnomenclature of coordination compounds (upto two metal centres). Stability constants of metalligandcomplexes and their importance in complexometry metal indicators, masking anddemasking reactions.

Redox titration: Feasibility of a redox titration, redox potential at equivalence point, redox indicators

Unit III- Physical Chemistry-II [Marks 25]

Electrochemistry:

Conductance of electrolytic solutions, transport numbers and hydration ions, ion conductance and ionic mobility, basic ideas of interisionic attractions, electrochemical cells, cell e.m.f. and itsthermodynamic significance, standard redox potentials, sign conventions, Nernst equation singleelectrod potentials and its applications, conductometric titrations.

Photochemistry:

Stark-Einstein law of photochemical equivalence and Lambert-Beer's law; quantum yield and its measurement for a photochemical process, actinometry.Photosensitized reactions.Kinetics of HI decomposition, H2-Br2 reaction, dimerisation of anthracene.

Colloids and surface chemistry:

Hydrophobic, hydrophyllic dispersions, stability of dispersions, electrokinetic phenomena, surface energy, surface tension, contact angle, wetting, detergency, miscelle formation.

Chemical kinetics:

Reaction rates, rate constants, order of reaction, overall order, concept of elementary reaction, activation energy, Arrhenius equation, Catalysis, selective catalyst, biocatalysts/ enzymes.

Course Code-INCA-P2P

Laboratory Practical & Sessional [Full Marks -25]

Organic Chemistry

*[**Course outcome:** Development of the concept of the detection of special elements and functional groups of organic samples.]*

Experiment-1. Qualitative analysis of single solid organic compounds

A. Detection of special elements (N, Cl, S) by Lassaigne's test

B. Solubility and Classification (solvents: H_2O, 5% HCl, 5% $NaHCO_3$, 5% NaOH)

C. Detection of the following functional groups by systematic chemical tests:

Aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), Aimdo ($-CONH_2$, including imide), Phenolic –OH, Carboxylic acid (-COOH), Carbonyl (>C=O); only one test for each functional group is to be reported.

Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups in known and unknown (at least 5) organic compounds.

SEMESTER – III

Paper III: Basic Chemistry & Industrial Chemistry

Theory- Full Marks: 75

Course Code-INCA-P3T

Revision vide Dated 03.07.2014

*[**Course outcome:** Students will acquire an idea about the Rotational & Vibrational spectroscopy, concept of lattice, lattice energy. symmetry, crystal class, crystal system, unit cell and concept of Pyrometallurgy, hydrometallurgy & electrometallurgy]*

Unit- 1: Molecular Spectroscopy [Marks 25]

I) Light-matter interaction, transition moment integral, selection rule, Spectroscopic arrangements.

II) Rotational spectroscopy of diatomic molecules: rigid rotor model, selection rules, spectrum, characteristicfeatures of spectral lines (spacing and intensity). Determination of bond length, effect of isotopic substitution.

III) Vibrational spectroscopy of diatomic molecules: SHO model, selection rule, spectra; anharmonicity and its consequences on energy levels, overtones, hot bands, Raman Effect. Characteristic features and condition of Raman activity with suitable illustraitons. Rotational and vibrational Raman spectra. Rule of mutual exclusion with examples.

IV) Potential energy curves (diatomic molecules), Decay of excited states by radiative and non-radiative paths. Fluorescence and phosphorescence, Jablonsky diagram.

Unit II: Materials Science 25 Marks

1. Introduction of Material Science and Engineering, Classification of materials, Introduction to engineering materials, Materials Design and selection, advanced materials.

2. Structure of crystalline solid: lattice, basis, unit cell, crystal system, point coordinates, crystallographic direction, crystallographic plane. Concept of amorphous, single crystalline and poly crystalline material. Radius ratio rule, Crystal structures of ionic materials. Structural analysis and phase identification using X-ray diffraction technique.Crystal imperfections: point defects, linear defects, surface defects & importance of defects.

Recommended Books

1. Material Science & Engineering – William D. Callister, Jr.

2. Material Science & Engineering – V. Raghaban, prentice hall of India Pvt Ltd.
3. Essentials of Material Science & Engineering – Donald R. Askeland, pradeep P. Fulay.

Unit-III Metallurgy (Marks 25)

- Basic divisions: Pyrometallurgy, hydrometallurgy and electrometallurgy, basic metallurgical operations -Pulverisation ,Calcination, Roasting , Refining, Smelting.

- Meatllurical thermodynamics: Application of thermodynamics in metallurgy. Ellingham and kellog diagram. Gibb's phase rule, Iron Carbon equilibrium diagram for eutectoid and pro-eutectoid phases. Lever rule. Nature of cooling curves for Fe-C system.

- Physico-chemical principles & details of extraction as per Indian context of the following metals; Copper, Lead, Silver, Aluminium, Zinc.

- Production of Iron in blast furnace-Raw materials, charging and sequence of operations, casting ,operation of pig casting machine.

- Production of semi-killed and killed steel in steel melting shop (LD process)- mixing of raw materials, charging sequences, operation in converter, blowing, tapping and testing process, timing in pit side, holding and stripping operations.

- Continuous casting of semi-finished steel products.

Recomended Books:

Metallurgy:

1. Extraction of Nonferrous Metals- H.S.Ray, R. Sridhar, K.P. Abraham, Affiliated East-West Press Pvt. Ltd., New Delhi.

2. Principles of Extractive Metallurgy- H.S. roy and A. Ghosh - New Age International (P) Ltd., Publishers, New Delhi.

3. Engineering Chemistry- P.C. Jain & Moni Jain, Dhanpat Rai PublishningCo.P. Ltd., New Delhi.

4. Industrial Chemistry- B.K.Sharma, Geol Publishing house, Meerut-25001,U.P.

Course Code-INCA-P3P

Paper-I: Laboratory Practical &Sessional [Full Marks-25]

Experiments on Physical chemistry

*[**Course outcome:** Students will gain an idea about the acid base titrations methods, Instrumental method of analysis for Surface tension, viscosity, Partition Coefficient.]*

Lab techniques, Preparation of standard solution, Acid- Base titration, Surface tension, viscosity, Partition Coefficient.

Course Code-INCA-P4T

Revision vide Dated 26.10.2017

Paper IV: Industrial Chemistry

Theory- Full Marks: 75

Group-A

*[**Course outcome:** This course will provide an idea about the_concept of materials balance &energy balance, heat transfer co-efficient and concept of Polymerization methods & their kinetics.]*

Unit I: Chemical Engineering -I *(Marks 10)*

Units and dimensions, Process calculations (materials balance and energy balance, phase equilibria)

Unit II: Chemical Engineering -II (Transport Process and unit operations)

(Marks 40)

(*1*) *Fluid mechanics:* Concepts and definitions, Nature of fluid statics, differential manometer, viscosity, Reynold's no., Laminer flow, Turbulant flow, Hagen Poiseulle equation, Bernoulli equation, Fanning's equation. Fluid friction, Resistance to immersed bodies, Friction in flow through packed bed. Flow measurements, Orifice meter, Venturi meter, Pitot tube , Rotameter. Transporation of fluids, Pumps , valves and Pipe fittings (Basic and qualitative ideas).

- ***(2) Heat Transfer:***

(a) Basic Laws (For e.g. Fourier's law), Definitions (Thermal conductivity and thermal diffusivity) . Heat transfer in solids and fluids. Heat transfer co-efficient, Driving force,

Radiative heat transfer: Basic laws and definitions.

(b) Simple heat exchangers: Double pipe heat exchanger.

(c) Equilibrium limited separation process and rate limited separation process

(d) Basic ideas on (Physical description only) different types of heat transfer situation like natural convection , boiling and condensation.

- ***(3) Mass Transfer and separation process:***

(a) Basic laws (Fick's law) , Concepts of mass transfer co-efficients, interface mass transfer.

(b) Brief physical / qualitative description of different separation processes and equipments.

Group-B

Unit-III Polymer Science & Technology [Marks 25]

Chemistry of high polymers: Monomer, functionality, degree of polymerisation, classification of polymers, Polymerization methods: addition and condensation , cationic and anionic polymerisation, copolymerisation , monomer reactivity ratios and its significance , Polymerisation techniques: bulk , solution, suspension, emulsion.

Brief introduction to the following polymers with respect to synthesis, properties and applications: Thermosetting Polymers: Phenol-formaldehyde resin, Urea-formaldehyde and Melamineformaldehyderesins , Epoxy resin.

Commodity and general purpose thermoplastics: Polyethylene, Polypropylene, Polystyrene, Polyvinyl Chloride, Polyesters, Acrylic, PU polymers .

Engineering Plastics: Nylon , Polycarbonate, Polyphenylene oxide.

Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, Styrene -Butadiene rubber, Polychloroprene rubber, Nitrile rubber, Butyl rubber, Ethylene-propylene-Diene Terpolymer, Silicone, Thermoplastic Elastomer.

Course Code-INCA-P4P

Paper-IV: Laboratory Practical & Sessional [Full Marks-25]

Materials Science

*[**Course outcome:** Students will acquire an idea about the synthesis approach and characterizations tools of materials.]*

A. Synthesis of pure and rare earth doped oxide materials through sol-gel technique.
B. Characterization of synthesized materials by XRD, FTIR and FESEM/HRTEM
C. Photoluminescence study of rare earth doped materials for solid state lighting applications.

SEMESTER – V

Paper V: Ceramic Technology, Petroleum & Unit Process

Theory- Full Marks: 100

Course Code-INCA-P5T

Revision vide Dated 03.07.2014

*[**Course outcome:** Concept of the white wares, refractoriness, glass formation technology & petroleum Refinery.]*

Group-A: Ceramic Technology 50 Marks

Unit I: Introduction of Ceramics 10 Marks

1. Ceramics:Historical development, Raw materials-their composition, occurrence, properties and classification. Ceramic industries in India.
2. Manufacture of white ware, drying and firing of ceramic products. Ceramic products-whiteware, porcelain, sanitaryware, glazes; advanced polymer based ceramic products, ceramic coating.
3. a. Conventional Process – Dry and semi-dry pressing, Slip casting, Extrusion
   b. Advanced Process – Cold Isostaticpressing& Hot Isostatic pressing, Injection moulding, Hot-pressing.
4. Sintering: Solid-state sintering,Liquid Phase sintering and vitrification, Driving force ofSintering, controlling factors for sintering of ceramic system.

Reference Book-

1. Introduction of ceramics- W.D. Kingery, H. Kent Bowen, D.R. Uhlmann
2. Handbook of ceramic technology
3. Whiteware by sudhirsen

Unit II:Refractories Technology 15 Marks

Definition and classification of Refractories; Manufacturing process, Properties and applications of the following refractories- Acidic Refractories (Silica Refractories), Basic Refractories (Magnesite), High alumina refractories, Alumino-silicate Refractories, special refractories, Non-Oxide Refractories: Silicon Carbides.

Binary phase diagrams of refractory oxide systems (Al_2O_3–SiO_2 system & Al_2O_3–MgO system); Testing of important properties of refractories: A.P, B.D, CCS, Total Porosity, Cold MOR, Hot MOR, PCE, RUL, Compressive Strength, Spalling Resistance, Corrosion resistance.

Difference between Shaped and Unshaped Refractories; Advantages of Monolithic Refractories; Classification of Unshaped Refractories,introductory idea of Castables, classification of castables: Conventional Castables, Low cement Castables, Ultra low cement Castables, No or zero cement Castables, and Gel bonded Castables. Types of bonding in Castables.Installation techniques and application of Monolithic/ CastablesRefractories.Refractoryindustries in India.

Reference Book-

1. Refractories Handbook by Charles A. Schacht.
2. Monolithic Refractories by Subrata Banerjee.
3. The Technology of ceramics and refractories – P. P. Budnikov

Unit III: Glass Science & Technology 10 Marks

Definition of glass; non-crystalline solids and glasses; Structural theory of glass (Zachariasen model). Kinetic theory of glass; structure of glass; Ion exchange & network breakdown processes; viscosity – Temperature characteristics of glasses; glass transformation.

Various types of glasses: soda lime silica, boro-silicate, lead special and optical glasses; Glass production, processes of glass making; Raw materials selection, Batch house and mixing, Glass Tank furnace; Annealing; Batch calculation of the glass and determination of the oxide composition of the glass; introduction of glass ceramics. Testing of glasses.Glassindustries in India.

Reference Book-

1. Introduction of ceramics- W.D. Kingery, H. Kent Bowen, D.R. Uhlmann
2. Introduction to Glass Science and Technology- James E. Shelby
3. Handbook of ceramic technology
4. Glass ceramics, P.W. McMillan

Unit IV: Cement Technology 15 Marks

Historical developmentofPortland cement, definition, chemistry of cement, Raw materials, manufacturing process of cement: dry process, semi-dry process, wet process, sequence of operations-winning of raw materials, size reduction, storage of crushed materials, grinding of raw mix. Burning the ground mix to clinker, cooling of hot clinker, grinding the clinker mixed with gypsum, cement making Rotary kilns, reactions occurs in the different zones of rotary kiln, Refractory used in Rotary kiln.

Hydration of cement, Heat of Hydration, Setting and hardening of Portland cement, Flash set and False set of cement. Pozzolana Cement, Blast Furnace slag cement, Quick setting cement, White Portland Cement, High Alumina Cement, Testing of cement.Cementindustries in India.

Reference Book-

1. Chemistry of cement by F.M. Lea

Group-A
Unit I : Petroleum Industries [Marks 30]

(1) Composition of Petroleum, introduction to crude oil, exploratory methods, oil reservoirs, Evaluation of oil stocks, Physical properties of a petoleum oil- Specific Heat, Latent Heat, Critical point & other properties, coefficient of Expansion, Detonation Characterisitics.

(2) Introduction to processing and Refinery Products.

(3) Refinery and Distillation Processes : Boiling Range of Stock, Arrangement of Towers, Flow diagram and operating conditions, Vacuum distillation, Desulphurisation, Refining by adsorption, Preliminary ideas of treating equipments and extraction processes, Dewaxing.

(4) Meaning of terms such as - Pour point depressants, drag reducers, viscosity reducers, ignition point, flash point, octane number, doctor solution types of hydrocarbon fuels and their characteristics.

(5) Basic ideal about the following operations with respect to process, mechanism, catalysts used and applications:Cracking - Catalytic cracking, Hydrocracking, Isomerization, Reforming, Isomerization, Alkylation.Sulphur, hydrogen, petroleum coke and nitrogen compounds from petroleum.

(6) Various catalysts used in petrochemical industry, preparation structure, applications and selectivity.

Unit II - Unit process [Marks 20]

Unit processes such as, Nitration, Halogenation, Sulfonationetc with Engineering Basics and Commercial Applications.

Paper VI: Practical & Sessional

Course Code-INCA-P6P

Full Marks: 100

*[**Course outcome:** Students will acquire an idea about the Nitration, Oxidation, Partial reduction, Esterification, Polymerization & chemical analysis methods of cement.]*

Unit I- Cement testing Laboratory [Marks 25]

Estimation of Lime by Rapid Lime Method, Total Carbonate of Sample, Full analysis (SiO_2, Al_2O_3, Fe_2O_3, CaO and MgO) of Cement & Clinker.

Physical testing of Cement: Compressive testing, Specific surface area analysis etc.

Unit II- Unit Process Laboratory [Marks 25]

One example of: Nitration, Oxidation, Partial reduction, Esterification, Polymerization.

Unit III: Industrial/Plant training& reporting [Marks 25]

Detailed report on Industrial training.

Unit IV- Project Work [Marks 25]

SEMESTER – VI

Paper VII: Industrial Chemistry

Theory - Full Marks : 100

Course Code-INCA-P7T

Revision vide Dated 26.10.2017

*[**Course outcome:** Concept of Heavy Inorganic chemicals & Petrochemicals and the concept of industrial pollution, water pollution & solid waste management.]*

Unit I - Heavy Inorganic chemicals [Marks 20]

i) Manufacture of Sulphuric Acid, Hydrochloric acid, Nitric acid, Phosphoric acid.

ii) Fertilizer Industries: Phosphorus Fertilizers - phosphorus, phosphoric acid, ammonium phosphate, superphosphate, triple superphosphate, Nitrogen Fertilizers - Urea, other fertilizers like ammonium nitrate and ammonium sulphate. Inorganic disinfectant chemicals.

Note: Physico-Chemical Principles, Major equipment's, material of construction to be emphasized in all the above topic.

Unit II: Petrochemicals [Marks 20]

Crackers-isolation of different chemicals:

i) C_1 chemicals: Methanol, Formaldehyde, Chlorinated Methanes.

ii) C_2 ,C_3 and C_4 chemicals: Ethyl Chloride, Vinyl Chloride, Ethylene oxide, Ethylene Glycol, Ethanolamines, Acetaldehyde, Acetic acid, Isopropanol, Oxo-synthesis, Acrylonitrile.

iii)A**romatic compounds**- Production and isolation of BTX, monobasic and di-basic acid and its ester, Styrene, Napthalene, Linear Alkyl Benzenes and their sulphonates.

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Basic Drugs such as Anti-malarials, Anti-ambeobies, Analgesic and Anti-pyretic, Broad Spectrum Anti-biotics -Ampicelling, Chloromycetine.

Unit III – Industrial & Environmental pollution [Marks 20]

1. Industrial & Environmental pollution - An overview

Pollution and pollutants-sources, types and consequences.Air and Water pollution, solid wastes.Imbalance in atmosphere, Hydrosphere and Lithosphere.Industrial Effluents. Industrial Episodes of hazards and pollution: Minamata, Love canal, Flixborough, Bhopal , Chernobyl.

***2.* Water as Environmental Resources**: Hydrological cycle. Water quality, criteria of pollution suspended solids; physical chemical and biological; dissoloved solids-organics, Bio-degradable and Nonbiodegradable; Inorganic heavy metal and others.

Assement of water quality- sampling and analysis- Dissoloved oxygen(DO), Bio- chemical oxygen demand (BOD), Chemical oxygen demand(COD), Industrial methods for total organic carbon(TOC), Colorimetric and gas chromatographic methods; Analysis of toxic inorganic pollutants- as fluoride, Hg, Cd, Pb, Sb, Coliform test.

Drinking water standards (India and WHO), Industrial discharge Standards -Minimum National Standards (MINAS).

3. Waste water treatment methods: Physical chemical and biological , Primary, secondary and tertiary, Removal of Biodegradable Organics- Activated Sludge Methods , Fixed Film methods- Trickling Filter, Rotating Biological Contractor(RBC), Design criteria of Bio-reactor, Pond Treatment and soil treatment systems. Bioremediation. Concepts of recycling and zero discharge industries.

4. Air composition and quality: Chemical and photochemical reactions in the atmosphere. Ozone formation and depletion, green house effect.

Unit IV: Fuels & Furnaces [Marks 20]

- ***Fuels: Solid fuels***-Wood, Charcoal, Origin of Coal and its types, Formation of peat, lignite, bituminous, anthracite. Properties and Grading of Coal. Destructive distillation processes/pyrolysis & carbonisation- coke and by products, coal tar.

- ***Gaseous fuels:*** Natural gas, LPG and other fuel gases-water gas, producer gas, coke oven gas, combustion calculations.

- ***Furnaces:*** Fuel, Fired and Electric; uses in different industry, control of Furnace and waste heat utilisation, waste heat boiler. Heat balance computation.

Unit- V: Analytical Chemistry [Marks 20]

A) Primary and secondary standard substances in acid base, redox ,complexometricargentometric(precipitation) titrations.

B) Principle and application of redox estimation (titrimetric, using $KMnO_4$, $K_2Cr_2O_7$, $Na_2S_2O_3$ (iodometry) / Iodimetry, Estimation of Vitamin C.

C)Principle of Complexometric titration, EDTA titration, Metal ion indictors (with structures), masking agents and demasking agents , Role of buffer in complexometry, Estimation of Cu^{2+} - Zn^{2+}; Fe^{3+}-Al^{3+}; Ca^{2+}-Mg^{2+} , complexometrically.

D) Principles of argentometric titration, requirements ,Estimation of Cl- using adsorption indicatior , Mercurometry.

E) Principles of estimation of i) Dolomite , II) Pyrolusite, III) Portland cement , iV) Basic slag ,V) Brass , VI) Steel , VII) Chalcopyrites , VIII) Type metals ,

F) Principle of Gravimetric estimations , requirements ,co-precipitations , post precipitations, gravimetric estimation of Cl^- , Al^{3+} , Zn^{2+}, Ni^{2+}, SiO_2, PO_4^{3-},

G) Errors in chemical analysis

H)Accuracy , Precision , absolute errors , and relative errors, systematic error and random errors,

I) Standard deviations, Gausse curve for distribution, confidence limit.

SEMESTER – VI

Paper VIII: Practical & Sessional

Full Marks: 100

Course Code-INCA-P8P

*[**Course outcome:** Development of the concept of the Flow measurement & analysis of fuels and during these course students will expand their idea on research.]*

Group A: Practical & Sessional

Unit I- Chemical Engineering Laboratory [Marks 25]

1)*Study the Flow measurement*:Venturimeter, Orifice meter, Pitot tube, Rotameter, Water-meter.

2) *Double pipe Heat Exchanger*:

3) *Temperature measurement set-up* : Study of Temperature sensors (Mercury in glass, Bimetal, RTD, Thermistor, Thermocouple), Characteristics of RTD, Thermistor and Thermocouple, Study & calibration of temperature indicator and temperature transmitter, Study of Seebeck effect, Time constant of glass thermometer and bimetal thermometer . Time constant of RTD, Thermistor, Thermocouple.

4) *Study the various kind of pressure gauge:*

Unit II- Fuels& Furnace Lab [Marks 25]

Determination of Flash Point, Fire Point ,Kinetic Viscosity of oil, Proximate analysis of coal, Calorific value of Solid Fuel.

Unit III: Project work [Marks 25]

Outlines:

D. Synthesis & characterization of nanomaterials
E. Submission of project report

Unit IV: Presentation of Seminar [Marks 25]

Topic for presentation will be different from the topic highlighted in the industrial/Plant visit report. Evaluation will be based upon the following points:

(i) Contents;
(ii) Mastery of the subject;
(iii) Delivery & Gesture;
(iv) Contact with Audience;
(v) Handling of the questions.

The presentation will be evaluated by one internal and the external examiner of the paper concerned.