VIDYASAGAR UNIVERSITY

INDUSTRIAL CHEMISTRY
(MAJOR)

Under Graduate Syllabus
(3 Tier Examination Pattern)
w.e.f. 2014-2015

REVISED

Vidyasagar University
Midnapore 721 102
West Bengal

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INDUSTRIAL CHEMISTRY (MAJOR)

Each paper consists of 100 marks and each group of each paper are of equal marks. For theoretical paper times is 4 hours and for practical paper time in 5 hours.

B. Sc. Part – I Paper – I F. M. 100 Time – 4 hours

Group – A :
Industrial Aspects of Organic Chemistry

Nomenclature Generic name, trade name.

Raw Material Resources : Cellulose, Starch Properties, Modification, Important Industrial Chemical derived from them, alcohol and alcohol based chemical, Oxalic acid, Furfural.

Group : B
Unit Process in Organic Chemical Manufacture

Nitration : Introduction – Nitrating agents, Kinetic and mechanism of nitration process such as nitration of –

i) Paraffinic hydrocarbons
ii) Benzene to Nitrobenzene and m-dinitrobenzene
iii) Chlorobenzene to O-& P-nitrobenzene
iv) Acetanilide to P-nitroacetanilide
v) Toluene, Continuous vs. batch nitration

Halogenations : Introduction-kinetics of halogenations reactions. Reagents for halogenations, Halogenations of aromatics-side chain and

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nuclear halogenations, Commercial Manufactures-chlorobenzenes, chloral, monochloractic and chloromethane, dichloroflouromethane.

Sulphonation : Introduction-sulophonating agents, Chemical and physical factors in sulphonation, Kinetics and mechanism of sulphonation reaction, commercial sulfonation of benzene, naphthalene, alkyl benzene, Batch vs. continuous sulfonation.

Group : C
Unit Processing in Organic Synthesis

Oxidation : Introduction-Types of oxidation reactions, Oxidizing agents, Kinetics and mechanism of oxidation of organic compounds, Liquid phase oxidation, vapour phase oxidation, Commercial manufacture of benzoic acid maleic anhydride, phthalic anhydride, acrolein, acetaldehyde, acetic acid.

Hydrogenation : Introduction-Kinetics and thermodynamics of hydrogenation reaction, Catalysts of hydrogenation reaction, Hydrogenation of vegetable oil, Manufacture of methanol from carbon monoxide and hydrogen, hydrogenation of acids to alcohols, catalytic reforming.

Alkylation : Introduction, Types of alkylation, alklating agents, thermodynamic and mechanism of alkylation reactions, Manufacture of alkyl benzenes (for detergent manufacture), ethyl benzene, phenyl ethyl alcohol, (N-alkyl anilines mono and di-methyl and ethyl anilines).

Esterification : Introduction, Hydrodynamics and kinetics of esterification reaction, Esterification by organic acids, by addition of unsaturated compounds, esterification of carboxy acid derivatives, commercial

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manufacture of ethyl acetate, dioctyl phthalate, vinylacetate, cellulose acetate.

ANIMATION :

a) By Reduction: Introduction, Method of reduction-metal and acid, catalytic, sulfide, electrolytic, metal and alkali sulfites, metal hydrides, sodium metal and alkali sulfites, metal hydrides, sodium metal, concentrate caustic oxidation, reduction, commercial manufacture of aniline, m-nitro aniline, p-amino phenol.
b) By Aminolysis : Introduction, Animating agents, Kinetics, thermodynamics and mechanism of hydrolysis.

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Paper – II, Full Marks – 100, Time – 4 hours

Group – A :
Material Science

Mechanical properties of materials and change with respect to temperature.

Materials of constructions used in industry.

Metals and alloys : Important metals and alloys, Iron, Copper, Aluminum, Lead, Nickel, Titanium and their alloys phen diagram Mechanical and chemical properties and their applications.

Cement : Types of cement, composition, manufacturing process setting of

Ceramics : Introduction, Types, manufacturing process, applications, refractoriness, concept of bioceramics.

Polymeric Materials : Commodity polymers, blends and composites their constitution, chemical and physical properties, industrial applications.

Glass : Types, composition, manufacture, physical and chemical properties, Industrial applications.

Corrosition : Various types of corrosion relevant to chemical industry-mechanism, preventive methods.

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Group-B
Effluent Treatment and Waste Management

Principles and equipments for aerobic, anaerobic treatment, absorption, filtration, sedimentation.

Bag filters, electrostatic precipitator, mist eliminators, wet scrubbers. Absorbers .

Solid waste Management.

Industrial Safety Laws.

Group-C:
Industrial Aspects of Inorganic Chemistry

Basic Metallurigical Operations : Pulverization, Calcinations, Roasting, Refining.

Physicochemical principles of extraction of Iron, Copper, Lead, Silver, Sodium, Aluminum, Magnesium, Zinc, Chromium.

Inorganic Materials of Industrial Importance : Their availability, forms, structure and modification, Alumuna, Silica , Silicates, Clays, Mica, Carbon, Zeolites.

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Part-II
Paper-III (3rd) F.M: 100

Group-A:
Industrial Aspects of Physical Chemistry

Surface Chemistry and Interfacial phenomenon : Absorption isotherm, sols, Gels, Emulsions, Micro emulsion, Micelles, Aerosols, Effects of surfactants, hydrotropes.

Catalysis : Introduction Types – Homogeneous and Heterogeneous. Basic principles, mechanism, Factors affecting the performance, Introduction to phase. Transfer catalysis. Enzyme catalyzed reactions rate model, Industrially important reactions.

Group-B :
Material and Energy Balance

Dimensions and units : Basic chemical Calculations – Atomic weight, molecular weight, equivalent weight, mole, composition of (i) Liquid mixtures, and (ii) gaseous mixtures.

Materials Balance Without chemical Reactions: Flow diagram for materials balance, simple materials balance with or without recycle or by-pass for chemical engineering operations such as distillation, absorption, crystallization, evaporation, extraction, etc.

Material Balance involving Chemical Reactions : Concept of limiting reactant, conversion, yield, Liquid Phase reaction, gas Phase reaction with or without recycle or bypass.

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Energy Balance : Heat capacity of pure gases and gaseous mixtures at constant pressure, sensible heat changes in Liquids, Enthalpy changes.

Group-C:
Unit operations In Chemical Industry

Distillation: Introduction, batch and continuous distillation separation of azeoteopes, plate columns and packed columns.

Absorption: Introduction, Equipments'-packed columns, spray columns, bubble columns, packed bubble columns, mechanically agitated contractors.

Evaporation: Introduction, Equipments short tube(standard) evaporator forced circulation evaporators, falling film evaporators, climbing film(Upward flow) evaporators, wiped(agitated) film evaporator.

Filtration: Introduction, Filter media and filter aids, equipments, plate and frame filter press, nutch filter, rotary drum filter, sparkler filter, candle filter, bag filter, centrifuge.

Drying: Introduction, free moisture, bound moisture, drying curve, equipments-tray dryer, rotary dryer, flash dryer, drum dryer, fluid bed dryer, spray dryer.

Crystallization: Introduction, solubility, super saturation, nucleation, crystal growth, Equipments- tank crystallizer, agitated crystallizer, evaporator crystallizer, draft tube crystallizer.

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Extractions: Introduction, selections of solvents, equipments spray column, packed column, rotating disk column, mixer-settler.

Mixing: Introduction, mixing of liquid-liquid, solid-solid, liquid-solid systems.

Group-D:
Utilities & Fluid Flow & Heat Transport in Industry

Utilities in Chemical Industry:

Fuel : Types of fuels- advantages and disadvantages combustion of fuels composition of fuels. Calorific value, Specifications for fuel oil orate number, cetane number.

Boilers : Specifications for industrial use, various water treatments.

Steam : Generation and use.

Air : Specifications for industrial use. Processing of air.

Fluid flow : Basic equation of fluid flow, fans, blowers, compressors, vacuum pumps, ejector.

Pumps: Reciprocating pumps, gear pump, centrifugal pumps.

Heat transfer : Basic Equation of Heat Transfer, Heat Exchangers- shell and tube type, finned tube heat exchangers, plate heat exchangers, refrigeration cycles.

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Paper-IV Full Marks – 100 Time – 5 hours

Industrial Chemistry Laboratory

1. Simple laboratory techniques: Crystallization, fractional, crystallization, distillation, fractional distillation, boiling point diagram.
2. Extraction processes: Phase diagram, partition, co-efficient
3. Preparation of standard solution: Primary & Secondary standards, determination of H_2SO_4 & H_3PO_4 in a mixture.
4. Calibration of thermometers.
5. Acquittance with safely measures in a laboratory, Hazard Chemicals.
6. Depression and elevation in B.P./M.P. of solids and liquids.
7. Chromatography: Column, Paper, Thin layer
8. Ore analysis: Dolomite, Limestone, Calcite, Analysis of alloys such as cupronickel.
9. Determination of Physical constants: Refractive index, surface tension, Effect of surfactants of surface tension, viscosity-fluids, polymer solutions, effect of additives on viscosity, optical rotation.
10. Study experiments / demonstration experiments.

Industrial Chemistry Laboratory

Unit Process : One or two Examples of each of the following unit process Nitration, Sulphonation, Friedel-Crafts, reaction, esterification, hydrolysis, oxidation, halogenations, chlorosulphoneation reduction, Polymeryzation, reaction of diazonium salts.

Instrumental Methods of Analysis : Use of calorimeter, pH meter, potentiometer, conductometer, refractometer, polarimeter, Material testing: Testing of alloys identification of plastic/rubber, estimation of

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yield point, Young's modulus, flaredness, optical, thermal and electrical properties.

Process Instrumentation : Transducers for measuring flow control, Determination of Flash point and ignition points of liquids.

Water Analysis : Solid content, hardness, COD and other tests as per industrial specifications.

Flow Measuring Device : Floats monographs of representative raw material such as sulphuric acid, toluence, sodium, carbonate, sodium hydroxide, carbon tetrachloride benzoic acid (5-6 compounds), Limit tests for heavy metals Pb, Mg, Fe and ash content.

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Paper-V (5^{th}) Full Marks – 100 Time – 4 hours

Group A:
Industrial Chemical Analysis

Industrial Analysis: Sampling procedures, sampling of bulk materials, techniques of sampling solids, liquids and gases collecting and processing of data.

Chromatography, paper Chromatography, TIC, GLC, GPC, HPLC.
Particle size determination.

Rheological properties of liquids, plastics and their analysis.
Modern instrumental methods of analysis.
UV – Visible spectroscopy
IR – Spectroscopy and non-dispersive IR.
NMR – Spectroscopy
Atomic absorption, flame photometry.
Neutron diffraction.
X-Ray fluorescence.
Ion-selective electrodes, Ion-chromatography.

Group B:
Process Instrumentation

Concept of instrument and accuracy principles, construction and working of following measuring instruments.

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Temperature: Glass thermometers, bimetallic thermometer pressure, spring thermometers, vapor filled thermometers, resistance thermometers, radiation pyrometers.

Pressure: Manometers, barometers, bourdon pressure gauge, below type, diaphragm type pressure gauge, Mcleod gauges, Pirani gauges etc.

Liquid Level Direct: Indirect liquid level measurement, float type liquid level gauge, ultrasonic level gauges, bubbler system density measurement, Viscosity measurement.

Group C:
Petrochemicals

Carried concept about:

Manufacture of the following from propylene: Isopropanol, cumene, glycerin, acrylonitrile, acetaldehyds.

Manufacture of the following from C-4, hydrocarbons: Butadiene, isobutene, isobutene, butanediols, oligomers.

Manufacture of aromatic compounds: Benzene, toluene, xylenes, naphthaiene, linear alkyl benezene and their sulphonates, detergents.

Various catalysts used in petrochemical industry: Preparation, structure, applications and selectivity, Importance of petroleum and petroleum industry in the context of Indian economy.

Indian petrochemical industry Indian reserves, quality and petroleum distribution, future.

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Part-III
Paper-VI (6^{th}) Full Marks 100, Time – 4 hours

Group-A:
Petrochemicals (Elective-I)

Crude oil, oil reservoirs, Crude oil characteristics, transportation of crude oil, constitution of crude oil.

Naturals gas – constituents.

Distillation of crude oil, separation of natural gas and different fractions based on relative volatilities. Composition of different distillates.

Meaning of terms such as : Pour point, depressants, drag reducers, viscosity reducers, ignition point, flash point, octance number, doctor solution.

Types of hydrocarbon fuels and their characteristics detailed discussion of the following operations with respect to process mechanism, catalysts used and applications.

Cracking: Catalytic Cracking, Hydrocracking, reforming, isomerization, Alkylation.

Group-B:
Petrochemicals (Elective-II)

Sulphur, Hydrogen, Petroleum coke and Nitrogen compounds from petroleum.

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General discussion of the following reactions with respect to mechanism and applications – oxidation, amonidation, hydroformylation hydration.

Industrial manufacture of the following compounds.

Methene, ethylene, acetylene, propylene, C-4 hydrocarbons, higherolefins.

Industrial preparation of the following from methane – methanol, carbon black, hydrogen cynids, chlorinated methanes, carbon disulphides.

Industrial preparation of the following from Ethylene – Ethylchoride, ethanol, ethylene oxide, ethylene glycol, acetaldehyde, acetic acid, styrene, vinyl acerate, ethanolamines, vinyl chloride, acrlonitrile.

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Paper-VII & VIII
Full Marks – 100 x 2 = 200

Industrial Chemical Analysis – Lab

Industrial Analysis: Analysis of common raw materials as per industrial specifications, such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, epodixe, olefins, oil. etc.

Synthesis of common industrial compounds involving two-step reactions – for example 4 – Bromoaniline, 3-nitroaniline, Sulphanilamide, 4-aminobezonic acid, 4-nitrobenzoic acid, Dihalobenzenes, nitrohalobenzene.
Flow measuring device: Venturimeter & Orifice meter.

Flow management in pipes of different materials – effect of drag reducers.
Measurement of flash point, ignition point, pour point-effect of pour point depressants.
Determination of calorific value fuels.
Preparation of few catalysts used in petrochemical industry, like doped silica get, alumina, treatment of silica gel and alumina with acids.
Characterization of coke.
Characterization of bitumen.
Characterization of petrol, kerosene, diesel, furnace oil, with respect of flash point viscosity, surface tension, composition, distillation fractions.
Hydration of olefins – styrene.
Dehydration of alcohols – tert-butanol.
Sulphonation of aromatics and preparation of the sodium salt of

Comp. Lab: i) DOS/WINDOWS – 2007
ii) D-BASE / FOX PRO (DEF) & (PRG)

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including algorithm & Flow Chart

iii) MS-OFFICE (2000)

In plant Training and Seminar F. M. – 100

Each student will have to undergo about six weeks, raining in chemical process industry and submit a report to the head of the department. The assessment of the student would be made in a viva voce being the final examination where the head of the department and an external expert would consticute abroad for such viva voce examination.

Each student would be assigned a topic, of industrial importance on which the student will submit a report to the head of the department and or his/her guide. He would be required to deliver a lecture on the topic. The assessment of the student would be made by the guide and the head of the department on the basis of the report and the seminar lecture.

Marks distribution of Paper VII & VIII

Paper-VII	1. Practical and Viva	60 Marks
	a. Experimental →	40
	b. Notebook →	5
	c. Viva →	5
	d. Sessional →	10
	2. Project	40 Marks
Paper VIII	1. Inplant training	40 Marks
	2. (i) Writing report	20 marks
	(ii) Viva-voce	20 marks
	3. Seminar	20 marks

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