### MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
**EXAMINATIONS 2020-2022**

**SCHEME OF TEACHING AND EXAMINATION**

<table>
<thead>
<tr>
<th>Paper</th>
<th>Subject</th>
<th>Teaching Hrs. per Week</th>
<th>End Term</th>
<th>Mid Term</th>
<th>Total Marks</th>
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<tr>
<td><strong>FIRST SEMESTER</strong></td>
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<tr>
<td>ICH 1.1</td>
<td>Fluid Flow &amp; Mechanical Operations</td>
<td>3</td>
<td>-</td>
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<tr>
<td>ICH 1.2</td>
<td>Chemical Technology (Organic)</td>
<td>3</td>
<td>-</td>
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<tr>
<td>ICH 1.3</td>
<td>Process Instrumentation</td>
<td>3</td>
<td>-</td>
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<tr>
<td>ICH 1.4</td>
<td>Analytical Techniques</td>
<td>3</td>
<td>-</td>
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<td>3</td>
</tr>
<tr>
<td>ICH 1.5</td>
<td>Material &amp; Energy Balances</td>
<td>4</td>
<td>-</td>
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<td>4</td>
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<tr>
<td>ICH 1.6</td>
<td>Numerical Analysis</td>
<td>3</td>
<td>-</td>
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| Practical |                                        | L | T | P | C |              |            |
|-----------|----------------------------------------|   |   |   |   |              |            |
| ICH 1.7  | Fluid Flow & Mechanical Operations Lab | - | - | 2 | 1 | - | 25 | 25 |
| ICH 1.8  | Chemical Technology Lab. (Organic)     | - | - | 2 | 1 | - | 25 | 25 |
| ICH 1.9  | Analytical Techniques Lab.             | - | - | 2 | 1 | - | 25 | 25 |

| Total     |                                        | 19 | - | 6 | 22 | 250 | 300 | 550 |

L: Lectures/Week  
P: Practical Hours/Week  
C: Number of Credits

**Note:** Mid Term include: Evaluation towards two minor tests (60% of the marks), Assignments (20% of the marks), Class surprise tests, presentations etc. (20% of the marks).
### SCHEME OF TEACHING AND EXAMINATION

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<tr>
<td>ICH 2.1</td>
<td>Heat &amp; Mass Transfer</td>
<td>3  -  -  3</td>
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<td>35</td>
<td>75</td>
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<tr>
<td>ICH 2.2</td>
<td>Chemical Technology (Inorganic)</td>
<td>3  -  -  3</td>
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<td>35</td>
<td>75</td>
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<tr>
<td>ICH 2.3</td>
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<td>35</td>
<td>75</td>
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<td>ICH 2.4</td>
<td>Organic Chemistry: Strategies in Organic Synthesis</td>
<td>3  -  -  3</td>
<td>40</td>
<td>35</td>
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<td>ICH 2.5</td>
<td>Chemical Reaction Engineering</td>
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<td>Chemical Technology Lab. (Inorganic)</td>
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<td>12  -  8  19</td>
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<td>275</td>
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### Scheme of Teaching and Examination

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<tr>
<td>THIRD SEMESTER</td>
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<tr>
<td>ICH 3.1</td>
<td>Thermodynamics</td>
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<td>Industrial Pollution Control</td>
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<tr>
<td>ICH 3.3</td>
<td>Elective*</td>
<td>3 - - 3</td>
<td>40</td>
<td>35</td>
<td>75</td>
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<tr>
<td>ICH 3.4</td>
<td>Open Elective**</td>
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<td><strong>Total</strong></td>
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<td><strong>160</strong></td>
<td><strong>140</strong></td>
<td><strong>300</strong></td>
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*Elective (ICH 3.3)  **Open Elective (ICH 3.4)*

1. Polymer Chemistry  1. Physical Chemistry
2. Food Processing    2. Industrial Safety & Hazards
SCHEME OF TEACHING AND EXAMINATION

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<tr>
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<tr>
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<td>12</td>
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NOTE:
The student is required to make seminar presentation(s) of the results achieved before the submission of the thesis.

1. No marks are assigned to Thesis evaluation work. On successful completion and presentation of Research Seminars, the candidate will be awarded ‘S’ grade i.e. satisfactory or else ‘X’ grade i.e. unsatisfactory.

2. The thesis will be evaluated by Post Graduate Student Research Committee (PGRC) of the Institute. The constitution of the committee is as under:
   a. Chairperson of the institute
   b. Senior professor of the institute
   c. Supervisor(s)
   d. External examiner

3. The PGRC will evaluate the final thesis based on an open house presentation by the student, which will be attended by the faculty members, PG students and other research scholars of the institute.

4. Requirement for the award of M.Sc.(Industrial Chemistry) is 65 credits with a minimum of CGPA of 6.0 and successful completion of thesis work.
SYLLABUS

FIRST SEMESTER

Paper Title: FLUID FLOW & MECHANICAL OPERATIONS (Theory)
Paper Code: ICH 1.1   Max. Marks 40       Credits: 3              Time: 3 hours
Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A


Flow of Incompressible Fluids: Laminar and Turbulent flow in pipes, Velocity Distribution in Pipes, Frictional Losses in Pipes and Fittings, Fanning’s equation, Derivation of HAGEN-POISEULLI and \( f=16/Re \) equations.


Fluid Machinery: Classification and Performance of Pumps, Net positive Suction Head.

SECTION-B

Filtration: Plate and frame filter press, continuous rotary vacuum filter, filter aids, theory of filtration for non-compressible cakes.

Fluidization: Aggregate and particulate fluidization. Ergun’s and Carman-Kozeny equations.

Books Recommended:

Paper Title: CHEMICAL TECHNOLOGY (ORGANIC) (Theory)

Paper Code: CHE 1.2  Max. Marks 40  Credits: 3  Time: 3 hours

Course Duration: 35 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

*Oils & Fats:* Introduction, Extraction of oils from vegetable oils, refining of oils and fats, hydrogenation of oils.

*Soaps and Detergents:* Introduction, Raw materials, Manufacture of soap, Classification of deterdents, finishing of detergents.

*Water:* Sources and Constraints, Consumption patterns; Impurities: dissolved, suspended, colloidal; Hardness of water; Water softening; Lime soda, Ion exchange.

*Desalination:* Classification of processes; Evaporative processes, Multieffect evaporation, multistage flash, vapour compression; Membrane processes, Reverse osmosis, electrodialysis.

**SECTION-B**


*Sugar:* Introduction; Sugar extraction, defacation, sulphitation, carbonation, concentration, crystallization, drying, refining; Uses of molasses and bagasse.

*Carbon Technology:* Introduction, Classification of activated carbons, raw materials and manufacture of activated carbons, precursors for carbon fibres, manufacture of carbon fibres from polyacrylonitrile, manufacture of carbon black by furnace black process, applications.

*Nanotechnology:* Introduction and synthesis of nano particles by RF plasma process.

**Books Recommended**

Paper Title: PROCESS INSTRUMENTATION (Theory)
Paper Code: ICH 1.3 Max. Marks 40 Credits: 3 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Importance of instrumentation in industry. Elements of instruments.

**Static and Dynamic Characteristics of Instruments:** Desirable and undesirable

**Temperature measurement:** Expansion thermometers– bimetallic thermometers, pressure spring thermometers. Thermocouples, resistance thermometers, optical and radiation pyrometers.

**Liquid level measurement:** Direct measurement of liquid level, level measurement in open vessels: Bubbler system, diaphragm box system, air trap system, level measurement in pressure vessels: Differential pressure manometer, use of liquid seals with a manometer, displacement float liquid level gauge.

**Density measurement:** Liquid level method, displacement meter and hydrometer

**Viscosity measurement:** Float viscometer, rotational viscometer

SECTION-B

**Humidity measurement:** Psychrometer method and hygrometer method for moisture in gases, dew point method

**Conductivity measurement** with and without electrodes

**Pressure measurement:** Bourdon gauge, bellows type gauge. Measurement of pressure in corrosive fluids: Diaphragm seal, liquid seal and purge system. Vacuum measurement: Mcleod gauge, Pirani vacuum gauge.

**Quantity meters:** Tilting trap meter, reciprocating-piston meter, nutating disk meter, rotary vane meter, sealed drum meter

**Measurement of weight:** Spring scale, pneumatic force meter and hydrostatic force meter. Conveyer weighing for measuring flow of dry materials

**Process Instrumentation**–Recording instruments: circular and strip charts, control centre, indicating and signaling instruments, transmission of instrument reading, instrumentation diagrams-importance and symbols used.

**Books Recommended:**
1. Eckman, Donald P. : Industrial Instrumentation, CBS Publisher and Distributors
Paper Title: ANALYTICAL TECHNIQUES (Theory)

Course Duration: 35 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B. Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

Section A
1. Complexometric titrations: Complexes-formation constants; chelates – EDTA, Chelon Effect, EDTA equilibria, effect of pH on EDTA equilibria, EDTA titration curves, end point–detection and indicators; Importance of complexometric titrations.
2. Solvent Extraction: Distribution law, extraction process, factors effecting extraction, technique for extraction, quantitative treatment of solvent extraction equilibria, classification of solvent extraction systems. Advantages and applications of solvent extraction.

Section B
7. NMR: Principle, chemical shift, spin-spin coupling shift reagents, instrumentation, spectra and molecular structure, identification of organic compounds on the basis of NMR.

Books Recommended:
Paper Title: MATERIAL AND ENERGY BALANCES (Theory)
Paper Code: ICH 1.5 Max. Marks 50 Credits: 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
Review: Stoichiometric and composition relationship gas laws; Gaseous mixtures, vapor pressure, humidity, etc.
Material Balances for Non-reaction systems including balances involving recycle and bypass streams.

SECTION-B
Material Balances for Reacting systems including balances involving recycle and purge streams.
Combustion Calculations.
Energy balances on nonreactive and reactive systems.

Books Recommended:
Paper Title: NUMERICAL ANALYSIS (Theory)
Paper Code: ICH 1.6     Max. Marks 40    Credits: 3     Time: 3 hours

Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

SECTION-B

Books Recommended:

Paper Title: FLUID FLOW & MECHANICAL OPERATIONS LAB (Practical)
Paper Code: ICH 1.7  Max. Marks 25  Credits: 1  Time: 2 hours

1. General study of pipe fittings, valves and other equipments in the Chemical Engineering Lab.
2. Pressure drop for flow through pipelines, valves and fittings.
3. Characteristic curves of centrifugal pump.
4. Flow measurement by the use of orifice meter, venturimeter, rotameter and pitot tube.
5. Flow over weirs and notches.
6. Pressure drop in fluidized beds.

Paper Title: CHEMICAL TECHNOLOGY LAB (ORGANIC) (Practical)
Paper Code: ICH 1.8  Max. Marks 25  Credits: 1  Time: 2 hours

1. Oils & Fats: Determination of Acid value, Iodine value, Saponification value.
2. Carbohydrates: Reducing and non reducing sugars by (i) Fehlings method (ii) Pavy’s method.
3. Soaps: Determination of free and combined alkali, total fatty matter, moisture and insoluble.

Paper Title: ANALYTICAL TECHNIQUES LAB (Practical)
Paper Code: ICH 1.9  Max. Marks 25  Credits: 1  Time: 2 hours

1. Determination of viscosity of NaCl/Sugar at different concentrations. Calculation of partial molal volume of NaCl/Sugar at infinite dilution from density.
2. a) Verification of Lambert – Beer Law.
   b) Colorimetric determination of the composition of Fe-Salicylate complex by Job’s method of continuous variation.
3. a) R_f of organic compounds by TLC
   b) Analysis of analgesic drugs (APC) by TLC.
   c) Separation of o- & p-nitroaniline by column chromatography.
4. Determination of degree of dissociation and dissociation constant conductometrically.
5. Titration of week acid – strong base pH metrically and determination of the ionization constant of weak Acid.
6. Complexometric titration (EDTA) for determination of Ca^{+2} and Zn^{+2} ions.
7. Thermal analysis of Pb (OOCCH_3)_{4}& CaC_2O_4\cdot H_2O
8. 

Books Recommended:
SYLLABUS

SECOND SEMESTER

Paper Title: HEAT & MASS TRANSFER (Theory)
Paper Code: ICH 2.1       Max. Marks 40       Credits: 3       Time: 3 hours
Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Conduction: Steady state conduction in one dimensional system, general conduction equation in Cartesian coordinates, conduction through a plain wall, composite wall, cylindrical wall, effect of variable thermal conductivity,
Convection: Free and forced convection, concept of heat transfer co-efficient, dimensionless numbers in free and forced convection, Dimensional analysis methods and simple problems.
Condensation and Boiling: Condensation heat transfer phenomenon, film condensation on vertical plates, turbulent film condensation, convective coefficient for film condensation on tubes, boiling, boiling regimes, bubble growth and nucleate boiling
Evaporation: Types of Evaporators, single and multiple effects, single effect calculations, methods of feeding.
Heat Exchangers: Construction and application of double pipe heat exchanger, 1,1 and 1,2 shell and tube heat exchangers

SECTION-B

Mass transfer: Introduction to mass transfer and diffusion, molecular diffusion in gases and liquids, diffusion coefficients for gases and liquids.
Mass transfer coefficients: Concept and types of mass transfer coefficients, theories of mass transfer.
Interphase mass transfer, concept of overall mass transfer coefficient.
Distillation: differential distillation for binary systems, Fractionation of binary mixtures using McCabe – Thiele method,

Books Recommended:


Paper Title: CHEMICAL TECHNOLOGY (INORGANIC) (Theory)

Paper Code: ICH 2.2 Max. Marks 40 Credits: 3 Time: 3 hours

Course Duration: 35 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Chlor-Alkali Industry: Voltage efficiency, Current efficiency, Current density, Decomposition efficiency, Manufacture of soda ash by Solvay and Modified Solvay process, Manufacture of caustic soda.

Sulphuric Acid: Introduction, Manufacture of sulphuric acid by Chamber and Contact process, Material of construction, Storage and handling.


SECTION-B

Ceramics: Introduction, Properties of ceramics, Classification of refractories, Important steps involved in the manufacture of refractories.

Industrial gases: Manufacture and uses of carbon dioxide, oxygen and nitrogen, acetylene.

Paints: Introduction, Classification of paints, Manufacture of paints, Requirement of a good Paint.


Books Recommended:

Paper Title: MATERIALS SCIENCE (Theory)
Paper Code: ICH 2.3 Max. Marks 40 Credits: 3 Time: 3 hours
Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Atomic Structure: Review of bonding in solids, structure –property-processing Relationships
Crystal Structure: Space lattice, crystal systems, Miller indices, effect of radius ratio on coordination, structures of common metallic, polymeric, ceramic, amorphous and partly crystalline materials.
Imperfections in atomic arrangement: various defects in atomic arrangement, diffusion phenomenon in solids, Fick’s first and second law of diffusion, solid solution, slip systems, various methods of strengthening materials, Schmid’s law.

SECTION-B


Materials: Standards and specifications, unified alloy numbering system, ferrous metals and alloys, non-ferrous metals and alloys; overview of ceramic, polymeric and composite materials;

Mechanical tests: standard test procedures for mechanical property determination-strength, toughness, fracture toughness, hardness, deformation, fatigue, creep etc.

Corrosion: Types and mechanism of corrosion, factors influencing corrosion, combating corrosion, selection of materials of construction for handling different chemicals.

Books Recommended:

4. Raghavan, V. : Material Science & Engineering, Prentice Hall of India

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Organometallic Reagents:

**Electrophilic additions to carbon-carbon multiple bond:**

**SECTION B**

**Carbanions and other nucleophilic carbon species and their reactions**
Acidity of hydrocarbons, Carbanions stabilized by functional groups, Generation of carbon nucleophiles by deprotonations, alkylation, Michael addition, Aldol condensations, Robinson annulation, Amine catalysed condensations, Mannich reactions, acylation of carbanions, wittig and related reaction, sulphur ylides Darzen condensation, Stevens wittig and Favorskii rearrangements.

**Books Recommended:**

Paper Title: CHEMICAL REACTION ENGINEERING (Theory)

Course Duration: 35 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

*Kinetics of Homogeneous Reactions*: Rate equation, Concentration Dependent Term of a Rate Equation, Temperature Dependent Term of a Rate Equation.

*Interpretation of Batch Reaction Data*: Constant – Volume Batch Reactor, Varying volume Batch Reactor, Temperature and Reaction Rate.

*Introduction to Reactor Design*

*Ideal Reactors for a Single Reaction*: Ideal Batch Reactors, Steady State Mixed Flow Reactors, Steady – State Plug Flow Reactors

*Evaluation of laboratory reactors*: fixed bed, stirred batch reactor, stirred contained solids reactor, continuous-stirred tank reactor, straight-through transport reactor, recirculating transport reactor.

SECTION-B

*Multiple Reactions*: Conditions for maximizing the desired product in parallel reactions. Maximizing the desired product in series reactions.

*Non-Isothermal Reactor Design*: Energy balances: basic ideas about constant or mean and variable heat capacities, heat added to the reactor. Non-isothermal continuous flow reactors at steady state: application to the CSTR, adiabatic tubular reactor

*Catalysis and Catalytic Reactions*: Steps in a catalytic reaction, synthesizing a rate law, mechanism and rate limiting steps, design of reactors for gas-solid reactions, heterogeneous data analysis for reactor design.

Books Recommended:

Paper Title: HEAT & MASS TRANSFER LAB (Practical)
Paper Code: ICH 2.6       Max. Marks 25       Credits: 1       Time: 2 hours

General study of heat and mass transfer equipment in the Chemical Engineering Lab.
Determination of heat transfer co-efficient for different types of heat transfer equipment. Wilson plots.
Correlation of instantaneous heat transfer coefficients with time, study of deposition of scale on a heating surface.
Heat losses for insulated pipes
Duhring’s plot for solutions involving nonvolatile solutes.
Mass transfer coefficients for naphthalene-air system.
Drying rate curves for different wet materials.
Verification of Rayleigh’s equation for differential distillation. Flooding velocities in packed columns. Determination of HETP for packed distillation columns.

Paper Title: CHEMICAL TECHNOLOGY LAB. (INORGANIC) (PRACTICAL)
Paper Code: ICH 2.7       Max. Marks 25       Credits: 1       Time: 2 hours

1. Fertilizers (i) Determination of N-P-K Values
   (ii) Determination of micronutrients
2. Cement: Loss of ignition, silica, insolubles, estimation of Mg, Ca, Fe.
3. Water

Paper Title: MATERIALS LAB. (PRACTICAL)
Paper Code: ICH 2.8       Max. Marks 25       Credits: 1       Time: 2 hours

1. To study and calculate MFI (Property)
   a) Conduct experiment of MFI as property and processing parameters.
   b) Relation between molecular weight – structure and MFI.
2. To calculate and analyse the tensile strength of materials.
   a) Films – idea of necking.
   b) Polymers/Plastics.
3. To understand the processing techniques for various applications of materials
   a) Compression moulding
   b) Injection moulding
   c) Film blow moulding – extrusion
   d) Rotational moulding
4. To study and analyse tear/burst strength in packaging.
5. To analyse impact strength of materials especially polymers/composites
6. Processing of composites (glass fibre) and advanced materials
   a) Glass fibre
   b) Nano composites etc.
Paper Title: COMPUTERS APPLICATIONS (PRACTICAL)
Paper Code: ICH 2.9    Max. Marks 25    Credits: 1    Time: 2 hours

1. Introduction to computers, principles and operation of various types of computers, concept of higher level language and compilers, line editing, compiling and running of a small sample problems.
2. Use of internet.
3. C++ Fundamentals: Character set, identifiers, keywords, data types, constants, variables, arrays, declarations, expressions, statements.
4. Operators and expressions.
5. Data input and output.
6. Writing of complete program and compiling.
7. Control statements.
8. Functions.

Books Recommended:

SYLLABUS

THIRD SEMESTER

Paper Title: THERMODYNAMICS (Theory)
Paper Code: ICH 3.1   Max. Marks 40   Credits: 3   Time: 3 hours

Course Duration: 35 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Brief review of the terms: state functions, types of systems, internal energy, heat and work and reversible and irreversible processes.

First Law of Thermodynamics and its Applications i.e. constant volume processes, constant pressure processes, isothermal and adiabatic processes. Joule-Thomson Coefficient, liquefaction of gases, thermochemistry includes a brief review of heat capacities and their measurement, standard heat of reaction, standard heat of formation, standard heat of combustion, flame temperature, H-x diagrams, heat of solution, partial, molar enthalpies, enthalpy for phase change etc.

Equation of state for real gases and their mixtures. Principle of corresponding states and generalized compressibility factor.

Second law of thermodynamics.

SECTION-B

Third Law of thermodynamics and its applications. Free energy functions and their significance in phase and chemical equilibria, Clapeyron’s equation and some important correlations for estimating vapor pressures. Estimation of thermodynamic properties by using graphs and tables.

Thermodynamic properties of fluids-properties relation for homogenous phases, residual properties, residual properties by equation of states.

Partial molar properties, partial molar Gibbs free energy, Chemical potential and its dependence on temperature and pressure Ideal solutions (Lewis-Randel Rule).

Books Recommended:


Paper Title: INDUSTRIAL POLLUTION CONTROL (Theory)
Paper Code: ICH 3.2 Max. Marks 40 Credits: 3 Time: 3 hours
Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Water pollution
Types of waste water, and sources of pollutants.
Basic concept of Industrial Wastewater Treatment:
- Primary treatment: Sedimentation, Flotation
- Secondary treatment: Activated Sludge process, Trickling Filters, Oxidation pond, Rotating Biological Cyclone (RBC) and Anaerobic digester

SECTION-B

Air Pollution
Classification and properties of major air pollutants, Effects of air pollution on human, plants and materials.
Basic concept of Air pollution control methods for Particulate emission control: Gravitational settling chambers, Cyclone separators, Fabric filters, Electrostatic precipitators, Wet scrubbers.

Solid Waste Management
Types of solid wastes and sources.
Methods of solid waste management: Sanitary landfill, Incineration and Concept of Recycling.
Books Recommended:


Paper Title: ELECTIVE (Theory)
Paper Code: ICH 3.3 Max. Marks 40 Credits: 3 Time: 3 hours
Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. POLYMER CHEMISTRY

SECTION A

Introduction to polymeric materials:
Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. Molecular weights of polymers: Number average and weight average molecular weights, Molecular weight distribution and its significance, Introduction to different methods for determination of molecular weights. Polymer chain flexibility in terms of Configuration and conformation.

Basic Concept of Polymerization:
Kinetics of Polymerization: Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization.

SECTION B

Morphology and Physical Chemistry of Polymers:
Crystallization and crystallinity: Morphology of crystalline polymers, Factors affecting crystalline melting point. Glass transition temperature (Tg) and determination of Tg, Factors affecting glass transition temperature (Tg).
Polymer Solution: Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

**Structures and Properties of Polymers:**
Nature and structure of polymers- Structure Property relationships. Properties of Polymers (Physical, thermal, Flow & Mechanical Properties) Brief introduction to preparation, structure, properties and application of polymers for example: 61 polystyrene and styrene poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, Phenol formaldehyde resins (Bakelite, Novalac), Conducting Polymers, [polyacetylene, polyaniline, poly(pphenylene sulphide polypyrrole, polythiophene).

**Books Recommended:**


2. **FOOD PROCESSING**

**SECTION-A**
Introduction to food processing industry, food preservation, additives, different techniques of food preservation and processing for vegetables and fruits.

**SECTION-B**
Different types of unit operations involved in food processing, food packaging and aging problems.

**Books Recommended:**

3. PAINTS AND VARNISH TECHNOLOGY

SECTION-A
Importance of paints & varnishes, inorganic and organic pigments, natural and synthetic resins, thinners and solvents, dying, semi-dying.

SECTION-B
Modified synthetic oils, manufacture of paints and varnishes, formulation calculations, analysis and testing.

Books Recommended:

Paper Title: OPEN ELECTIVE (Theory)
Paper Code: ICH 3.4 Max. Marks 40 Credits: 3 Time: 3 hours
Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. PHYSICAL CHEMISTRY

SECTION-A
Surface Chemistry
Adsorption:
Surface tension, capillary action, pressure difference across curved surface (Laplace eqn), vapour pressure of droplets, (Kelvin eqn), Gibb’s adsorption isotherm, estimation of surface area (BET eqn), surface films on liquids (electro kinetic phenomenon), catalytic activity at surfaces.
Micelles:
Surface active agents, classification of surface active agents, micellisation, hydrophobic interactions, critical micellar comcentration, factors affecting CMC of surfactants, counter ions
binding to micelles, thermodynamics of micellization-phase separation & mass action models, solubilization, microemulsion, reverse micelles.

SECTION B

Electrochemistry

Electrocatalysis
Introduction to polarography theory; Ilkovic eqn, (excluding derivation),hydrogen electrode, Half wave potential & its significance, electrocardiography

Books Recommended:


2. INDUSTRIAL SAFETY & HAZARDS

SECTION-A
Definitions, identifications, Classifications and assessment of various types of hazards in workplace environment. Protective and preventive measures in hazard control. Toxic chemicals: Maximum allowable concentrations and other standards. Biological threshold limit values. Mechanical and electrical hazards, personal protective equipments.
SELECTION-B

Standard safety procedures and disaster control. Indian legislation on safety and prevention of hazards and safety code.
Case study of typical hazardous industry.

Books Recommended:


3. INDUSTRIAL MANAGEMENT

SECTION-A

Process of decision making, elements in decision making nature and framework of planning short and long range planning policy formulation organisation structure and behaviour, decentralisation and delegation. line-staff relationship motivation and morale, communication, inter-personal and group behaviour, coordination and direction.

SECTION-B

Purpose, processes and areas of control; control standards, control reports, budget as control device.
Economic planning and policy in India, industrial policy, industrial development in India. Position and problems of chemical industries in India.

Books Recommended:


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