## 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>Chemical Engineering-I</td>
<td>3</td>
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<td>ICH 1.2</td>
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<tr>
<td>ICH 1.5</td>
<td>Material &amp; Energy Balances</td>
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<td><strong>Practicals</strong></td>
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<tr>
<td>ICH 1.7</td>
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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 (2018-2019)

<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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## MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
### EXAMINATIONS 2018-2019

### SCHEME OF TEACHING AND EXAMINATION (2018-2019)

<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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<td>L  T  P    C</td>
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* *List of Open Elective (ICH 3.4)  
1. Research Methodology  
2. Project Management  
3. Optimization Techniques  
4. Safety & Hazards  

* Elective* (ICH 3.3)  
1. Oils and Fats Technology  
2. Paper Technology  
3. Paints & Varnish Technology  
4. Sugar & Starch Technology  
5. Fertilizers  
6. Food Processing
Master of Science (Industrial Chemistry)  
Examinations 2018-2019

Scheme of Teaching and Examination (2018-2019)

<table>
<thead>
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<th>Paper</th>
<th>Subject</th>
<th>Teaching Hrs. per Week</th>
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<th>Mid Term</th>
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<td>-</td>
<td>24 13</td>
<td>-</td>
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</tbody>
</table>

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 Σ grade i.e. satisfactory or else Ξ 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.
MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)  
EXAMINATIONS 2018-2019

SYLLABUS FOR  
MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)  
FIRST SEMESTER (2018-2019)

Paper Title: CHEMICAL ENGINEERING-I (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


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

Soaps and Detergents: Introduction, Raw materials, Manufacture of soap, Classification of detergents, 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)

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

General Concept: Need and classification of measurements and instruments, Basic and auxiliary functional elements of a measurement system.

Static and Dynamic Characteristics of Instruments:

Static Characteristics: Range and span, accuracy and static error, reproducibility and drift, sensitivity and dead zone.

Dynamic Characteristics: Speed of response and lag, fidelity and dynamic error, dead time.

Temperature measurement:


Thermocouples, metal resistance thermometers and thermistors, optical and radiation pyrometers, radiation receiving elements.

Pressure measurement:

Use of manometers, Bourdon gauge, bellows type gauge. Vacuum measurement – Mcleod gauge, thermoionic type ionization gauge, pirani vacuum gauge. Measurement of pressure in corrosive fluids: Diaphragm seal, liquid seal and purge system.

SECTION-B

Liquid level measurement:

Direct measurement of liquid level – Float & tape liquid level gauge, float and shaft liquid level unit, hydraulic remote transmission 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.

Measurement of viscosity, conductivity, humidity and pH.

Density measurement – liquid level method, displacement meter and hydrometer.

Measurement of weight – spring scale, pneumatic force meter and hydrostatic force meter.

Process Instrumentation - Recording instruments, indicating and signaling instruments, control centre, transmission of instrument reading, instrumentation diagrams.

Books Recommended:

1. Eckman, Donald P.: Industrial Instrumentation, CBS Publisher and Distributors, Indian Reprint 2004.
Paper Title: ANALYTICAL TECHNIQUES (Theory)
Paper Code : ICH 1.4  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.

Section A
1. **Complexometric tiritations**: Complexes-formation constants; chelates ï EDTA, Chelon Effect, EDTA equilibria, effect of pH on EDTA equilibria, EDTA titration curves, endpoint ï detection and indicators; Importance of complexometric tiritations.
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.
3. **Chromatography**: Introduction to chromatography, principles, classification of chromatographic techniques, thin layer and paper chromatography ï principle and technique. Column Chromatography ï Factors affecting column efficiency and applications. Gas ï liquid chromatography ï theory, instrumentation and applications. HPLC ï instrumentation, method, column efficiency and applications.
4. **Thermoanalytical methods**: Principle, classification of methods. TGA ï Instrumentation, factors affecting results and analysis of data. applications. DTG ï Instrumentation, analysis of data and applications. DTA ï Principle, Instrumentation and applications.

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: 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
Review: Stoichiometric and composition relationship gas laws; Gaseous mixtures, vapor pressure, humidity, etc.
Material Balances for Non-reaction systems including balances involving recycle and by-pass 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: CHEMICAL ENGINEERING LAB.-1 (Practical)**

**Paper Code : ICH 1.7**

Max. Marks 25  
Credits : 1

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

3. *Soaps*: Determination of free and combined alkali, total fatty matter, moisture and insoluble.

**Paper Title: ANALYTICAL TECHNIQUES LAB. -1 (Practical)**

**Paper Code : ICH 1.9**

Max. Marks 25  
Credits : 1

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’s 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 weak acid with 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$_2$O$_4$·H$_2$O
8. 

Books Recommended:

SYLLABUS FOR
MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
SECOND SEMESTER (2018-2019)

Paper Title: CHEMICAL ENGINEERING – II (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: ENGINEERING MATERIALS (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 co-ordination, structures of common metallic, polymeric, ceramic, amorphous and partly crystalline materials.
**SECTION-B**

*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.

*Phase Diagrams and phase transformation:* binary phase diagrams (Fe-Fe₃C, Cu-Ni, Pb-Sn), microstructure development, TTT diagrams, heat treatment processes—hot and cold working, hardening and softening processes.

*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

**Paper Title:** INDUSTRIAL MANAGEMENT (Theory)

Paper Code : ICH 2.4 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.

**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:**


**Paper Title: Mathematics (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**


**SECTION-B**


**Books Recommended:**


**Paper Title: CHEMICAL ENGINEERING LAB – II (Practical)**

**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 plot for solutions involving nonvolatile solutes.

Mass transfer coefficients for naphthalene-air system.

Drying rate curves for different wet materials.

Verification of Rayleigh 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    Credit: 1
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. (INORGANIC) (PRACTICAL)
Paper Code: ICH 2.8   Max. Marks 25  Credit: 1
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.

Books Recommended:
   India Pvt. Ltd., New Delhi.
   Wiley.

Paper Title: COMPUTERS APPLICATIONS (PRACTICAL)
Paper Code: ICH 2.9   Max. Marks 25  Credit: 1
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 FOR
MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
THIRD SEMESTER (2018-2019)

Paper Title: CHEMICAL ENGINEERING – III (Theory)
Paper Code : ICH 3.1
Max. Marks 40
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

Thermodynamics
- The First law of thermodynamics and other basic concepts-
  Joule experiment, internal energy, the first law of thermodynamics, energy balance for closed system, thermodynamics state and state function equilibrium, phase rule, the reversible process, constant volume and constant pressure process, enthalpy, heat capacity, mass and energy balance for open system.
- Volumetric properties of pure fluids-PVT behavior of pure substance, Equations of states.
- Heat effects.
- The Second law of thermodynamics.

SECTION-B

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

Reaction Kinetics:
Kinetics of homogenous reactions, analysis of reversible, irreversible, series, parallel reaction schemes, Introduction to different types of reactors.

Books Recommended:


Paper Title: INDUSTRIAL POLUTION CONTROL (Theory)
Paper Code : ICH 3.2
Max. Marks 40
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 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. Oils and Fats Technology

SECTION-A

Introduction, Properties and classification of oils, manufacture of vegetable oils by expression and solvent extraction.

SECTION-B

Processing of fats (alkali refining, bleaching deodorization), Fatty acids and glycerol, hydrogenation of oils, soap and its manufacture, waxes.

Books Recommended:

2. Paper Technology

SECTION-A
Introduction, raw materials, pulping processes, sulphate pulp, soda pulp, sulphite pulp, beating, refining, filling, sizing and colouring.

SECTION-B
Manufacture of paper, calendaring, pollution problem, recovery of chemicals from spent liquor from sulphate and sulphite process.

Books Recommended:

3. Paints and Varnish Technology

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

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

Books Recommended:

4. Sugar and Starch Technology:

SECTION-A
Sugar: Introduction, manufacture of cane sugar, extraction of juice, purification of juice, concentration, crystallization, drying and separation of crystals, refining of sugar, recovery of sugar from molasses, bagasse.

SECTION-B
Starch: Introduction, manufacture of starches and corn syrup from corn, utilization of molasses, bagasse, corn cob etc.

Books Recommended:

5. **Fertilizers:**

   **SECTION-A**
   Introduction, classification of fertilizers, mixed fertilizers, fixation of nitrogen, manufacture of ammonia based fertilizers.
   Phosphatic fertilizers: Raw materials, single superphosphate, triple superphosphate.

   **SECTION-B**
   Potassic fertilizers: Manufacture of potassium chloride and potassium sulphate, compound and complex fertilizers, bulk blended fertilizers, fluid fertilizers and pollution problems.

   **Books Recommended:**

6. **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:**

**Paper Title: OPEN ELECTIVES (Theory)**
**Paper Code : ICH 3.4** Max. Marks 40 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. **RESEARCH METHODOLOGY**

   **SECTION-A**
   **Introduction:** Meaning, Features, Objectives/Motives & types of Research; Attributes of good Research, Research Methods and Research Methodology; Research Process, Significance of Research in Managerial decision making.

   **Research Design:** Meaning, Characteristics and various concepts relating to research design and classification of research design, Importance.

   **Measurement and Scaling:** Data Types Nominal, Ordinal and Ratio scale; scaling techniques.

   **Formulation of Hypothesis:** Meaning, Characteristics and concepts relating to testing of Hypothesis (Parameter and statistic, Standard error, Level of significance, type-I and Type-II errors, Critical region,
one tail and two tail tests); Procedure of testing Hypothesis. Numerical problems based on chi-square test and Ftest (variance ratio test only).

SECTION-B

Data Collection: Sources of Data-Primary/Secondary Methods of collecting data; direct personal interview, indirect oral interview, information through local agencies, mailed questionnaire method, schedule sent through enumerators; questionnaire and its designing and characteristics of a good questionnaire.

Sampling Design: Meaning and need of Sampling, Probability and non-probability sampling design, simple random sampling, systematic sampling, stratified sampling, cluster sampling and convenience, judgment and quota sampling (non-probability), determination of sample size.

Data Analysis & Interpretation: Introduction to Multivariate analysis- Multiple and partial correlation, multiple regression analysis (with two independent variables), specification of regression models and estimation of parameters, interpretation of results. Analysis of Variance (ANOVA)-One way and Two way ANOVA. Introduction to discriminant analysis and Factor Analysis (Numerical not to be asked)

Report writing: Style/format, contents and essential steps for report writing.

Books Recommended:
2. Ranjit Kumar:Research Methodology, Pearson Education 2009-02-20
3. Donald R. CooperPamela S. Schindler: Business Research Methods, Tata McGraw Hill
5. R. Pannerselvam: Research Methodology, Parentice Hall of India Limited.
7. William G.Zikmund :Business Research Methods, Thomson South Western Publication

2. PROJECT MANAGEMENT

SECTION-A

Project Management: concept of project management, project management systems, responsibilities and qualities of a project manager, project management team-composition, functions and responsibilities, co-ordination procedures. Manpower planning; recruitment and selection job description, specification and evaluation, performance appraisal, basis of remuneration and incentives, Project Identification: Principles of project identification, importance of capital investment, decision making industrial policy resolution, industrial development and regulation act, supply and demand analysis, incentives for industrially backward areas and small scale industries, foreign collaboration and foreign exchange regulations. Appraisal criteria and selection of investment: Non discounting criteria, discounting criteria, appraisal and selection in practice.
SECTION-B
Feasibility studies: Preparation of techno-economic feasibility report, feasibility analysis technical economic, commercial and financial planning: Network analysis, PERT/CPM Bar chart.
Preconstruction Planning. Project Scheduling control and Monitoring: Resource Scheduling, manpower scheduling, multi project scheduling, cost scheduling, PERT/Cost scheduling optimisation, crash costing and updating and leveling of resources, Implementation of Project schedules. Financial Control: Budgeting and cost control, sources of long term funds for business, Planning and capital structure, problems of working capital management and liquidity.

Books Recommended:

3. OPTIMIZATION TECHNIQUES
SECTION-A

SECTION-B
Geometric Programming: as applied to chemical Engineering problems with degree to difficulty equal to zero and one , with and without constraints; Search Methods: Sequential Search method, Golden Section method, Dichotomous Search method; Introduction to Dynamic Programming as applied to discrete multistage problems like Cascade of CSTR, Train of Head exchangers etc.

Books Recommended:
3. Hadley : Linear Programming.

4. SAFETY & HAZARDS
SECTION-A
Definitions, identifications, Classifications and assessment of various types of hazards in work-place 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.

SECTION-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:*