MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
EXAMINATION

SCHEME OF TEACHING AND EXAMINATION

Paper	Subject	Teaching Hrs. per Week				End Term	Mid Term	Total Marks
FIRST SEMESTER		L	T	P	C			
ICH 1.1	Chemical Process Calculation	3	-	-	3	40	35	75
ICH 1.2	Chemical Engineering-I (Fluid Flow & Mechanical Operations)	3	-	-	3	40	35	75
ICH 1.3	Chemical Technology	3	-	-	3	40	35	75
ICH 1.4	Organic synthesis	4	-	-	4	50	50	100
ICH 1.5	Analytical techniques	4	-	-	4	50	50	100
Practicals								
ICH 1.6	Fluid Flow & Mechanical Operation Lab.	-	-	2	1	-	25	25
ICH 1.7	Chemical Technology Lab.	-	-	2	1	-	25	25
ICH1.8	Analytical techniques Lab.	-	-	2	1	-	25	25
ICH1.9	Organic synthesis Lab.	-	-	2	1	-	25	25
	Total	**17**	**-**	**8**	**21**	**220**	**305**	**525**

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).

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
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SCHEME OF TEACHING AND EXAMINATION

Paper	Subject	Teaching Hrs. per Week				End Term	Mid Term	Total Marks
SECOND SEMESTER		L	T	P	C			
ICH 2.1	Chemical Engineering-II (Heat & Mass Transfer)	3	-	-	3	40	35	75
ICH 2.2	Industrial Pollution Control	3	-	-	3	40	35	75
ICH 2.3	Pharmaceutical Chemistry	3	-	-	3	40	35	75
ICH 2.4	Electrochemistry and material chemistry	4	-	-	4	50	50	100
ICH 2.5	Thermodynamic and Chemical Reaction Engineering	3	-	-	3	40	35	75
Practicals								
ICH 2.6	Heat & Mass Transfer Lab	-	-	2	1	-	25	25
	Total	**16**	**-**	**2**	**17**	**210**	**215**	**425**

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
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SCHEME OF TEACHING AND EXAMINATION

Paper	**Subject**	**Teaching Hrs. per Week**				**End Term**	**Mid Term**	**Total Marks**
THIRD SEMESTER		L	T	P	C			
ICH 3.1	Organic Spectroscopy	4	-	-	4	50	50	100
ICH 3.2	Polymer Science & Technology	3	-	-	3	40	35	75
ICH 3.3	Elective*	3	-	-	3	40	35	75
ICH 3.4	Open Elective**	3	-	-	3	40	35	75
ICH 3.5	Organic spectroscopy lab	-	-	2	1	-	25	25
	Total	**13**	**-**	**2**	**14**	**170**	**180**	**350**

*Elective (ICH 3.3)

1. Process Instrumentation
2. Engineering Materials
3. Nano Technology
4. Renewable Energy
5. Numerical Analysis

** Open Elective (ICH 3.4)

1. Research Methodology
2. Industrial Safety & Hazards
3. Waste Management in Industry
4. Industrial Management
5. Chemical Analysis in Agro Food and Pharmaceutical Energy

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SCHEME OF TEACHING AND EXAMINATION

Paper	Subject	Teaching Hrs. per Week			End Term	Mid Term	Total Marks
FOURTH SEMESTER		L	P	C			
ICH 4.1	Thesis	-	24	13	-	-	-
Total		-	**24**	**13**	**-**	**-**	**-**

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.

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
EXAMINATION

SYLLABUS FOR

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)

FIRST SEMESTER(2020-2022)

Paper Title: Chemical Process Calculation (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

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*:**

1. Bhatt, V. I. & Vora, S. M. : Stiochiometry, 3rd Edition, Tata McGraw Hill, 1984.
2. Himmelbleau, D. M. : Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall, 1977.
3. Felder, R. M. & Rousseau R.W. : Elementary Principles of Chemical Processes, 3rd Edition, John Wiley and Sons, 1986.
4. Reklaithis, G. V. : Introduction of Material and Energy balances, John Wiley, 1983.
5. Lubyben, L.W. & Winzel, L. A. : Chemical Process Analysis, 2nd Edition, Prentice Hall, 1988.

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
EXAMINATION

Paper Title: CHEMICAL ENGINEERING-I (Fluid Flow & Mechanical Operations) (Theory)
Paper Code: ICH 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

Fluid Statics and fluid properties: Normal forces in fluids, Pressure Measurements, Newtonian and non-Newtonian Fluids, Flow in Boundary Layers, Basic Equation of Fluid Flow: Bernoulli's Equation.
Flow of Incompressible Fluids: Laminar and Turbulent flow in pipes, Velocity Distribution in Pipes, Frictional Losses in Pipes and Fittings, Fanning friction, Derivation of HAGEN-POISEULLI equations.
Flow Measurements: Pilot tube, Orifice-meter, Venturi-meter, Rotameter and Notches.
Fluid Machinery: Classification and Performance curves of Pumps, Net positive Suction Head, Concept of Cavitation.

SECTION-B

Size Reduction: Crushers and Grinders: jaw crusher, Gyratory Crusher, crushing rolls, roller mill, pin mill, ball mill, Hammer mill and Fluid energy mill. Laws of crushing.
Size Separation by Screening: Stationery screens, Grizzlies, Trommel and Vibrating screens. Standard Screens, Screening Analysis-differential and cumulative.
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*:**

1. McCabe, Warren L., Smith, Juluain C. and Harroit, Peter : Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill, New York, 2005.
2. Foust, Alan S., Wenseli, Leonard A., Clump, Curtis W., mans, Louis and Anersen, L. Bryce : Principles of Unit Operations, John Wiley & Sons Inc., New York, 2nded, 1980.
3. Coulson, J.M. and Richardson, J.F. : Unit Operations (Volume 2 of Chemical Engineering) 5thed, Elsevier, New Delhi, 2003
4. Badger, Walter L. and Banchero, Julius T. : Introduction to Chemical Engineering, McGraw-Hill, International edition 1955.
5. Brown, C.G. : Unit Operations, CBS Publishers and Distributors, New Delhi, 2005.

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
EXAMINATION

Paper Title: CHEMICAL TECHNOLOGY (Theory)
Paper Code: CHE 1.3 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

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 detergents, finishing of detergents.

Pulp & paper: Introduction, Raw Materials, types of pulp, Manufacture of paper.

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

SECTION-B

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

Cement & Glass: Cement-Types of cement, Constituents of cement, Manufacture of Portland cement. Glass-Introduction, Types of glass, Raw materials, Manufacture of glass.

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.

Fertilizers: Nitrogeneous fertilizers- Manufacture of Ammonia, Nitric acid, Urea, CAN, Ammonium Sulphate. Phosphatic fertilizers- superphosphate and triple superphosphate.Potassic fertilizers- Potassium Chloride and Potassium Sulphate, Safety aspects.

Books Recommended

1. Shreev, R.N. & Brink, J.A. : Chemical Process Industries, 5th Edition, McGraw Hill, 1987.
2. Austine, G.T. : Shreeves Chemicals Process Industries, 5th Edition, McGraw Hill, 1984.
3. Dryden, C.E., Rao M.G. & Silting, M. : Outlines of Chemical Technology, 3rd Edition, Affiliated East West Press Pvt. Ltd., N. Delhi, 2008.

4. Pandey, G.N. : Chemical Technology, Volume-II, Lion Press, Kanpur.
5. Donnet J. B., Bansal R. C. : Carbon Fibres, Marcel Dekker Inc.
6. Donnet J. B., Bansal R. C., Wang M. J. : Carbon Black, Marcel Dekker Inc.
7. Bansal R. C., Donnet J. B., Stoeckli F. : Active Carbon, Marcel Dekker Inc.

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
EXAMINATION

Paper Title: Organic Synthesis (Theory)
Paper Code: ICH 1.4 Max. Marks 50 Credits: 4 Time: 4 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

Reagents in Organic Synthesis:

Use of following reagents in Organic Synthesis and functional group transformations: Complex metal hydrides, Stereoselectivity in hydride reduction, Catalytic hydrogenation(Homogenous and Heterogeneous) and dissolving metal reductions, Lithium diisopropyl-amide (LDA), dicyclohexylcarbodiimide, Umpolung of reactivity (dipole inversions), trimethylsilyl iodide, trin-butyltin hydride, Oxidation of alcohols to carbonyl. Phenols to quinones, Osmium tetraoxide, selenium dioxide, phase transfer catalysis, Crown ethers, conversion of alkene to epoxides and diols, Oxidative bond cleavages.

Aliphatic Nucleophilic Substitution

The SN2, SN1, mixed SN1 and SN2 and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by π and σ bonds, Classical and non-classical carbocations, norbornyl system. common carbocation rearrangements. The SNi mechanism. Nucleophilic substitution at an allylic, aliphatic, trigonal and a vinylic carbon.

Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis, ambident nucleophile, regioselectivity.

SECTION B

Aromatic Substitution Reaction (Electrophilic &Nucleophilic)

(i) **Aromatic Electrophilic Substitution**

The arenium ion mechanism, Evidences for arenium ion mechanism, role of π –σ complexes orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Fries rearrangement, Diazonium coupling, Vilsmeyer reaction.

(ii) Aromatic Nucleophilic Substitution

The SNAr, SN1, benzyne and SRN1 mechanisms, Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Bucherer reaction, Sommelet-Hauser and smiles rearrangements.

Pericyclic reactions: Concerted reactions, unimolecular rearrangement and elimination, Electrocyclic sigmatropic and cycloaddition reactions, Correlation diagrams and FMO theory, Diels-Alder reactions, general feature, Dienophiles, Diene (2+2) cycloadditions, Cope and Claisen rearrangement, Ene reaction.

Books Recommended:

1. Caruthers, W. Some Modern Methods of Organic Synthesis, 4th edition, Cambridge University Press, 2004.
2. Smith, M.B. Organic Synthesis, Chapters 1, 3, 4 & 5, McGraw International edition, 1994. 3. Corey, E.J.; Cheng, X.M. The Logic of Organic Synthesis, Chapters 1 & 2, John Wiley and Sons, 1989.
4. House, Herbert O.; Benjamin, W.A. Modern Synthetic Reactions, 2nd edition, Benjamin Inc., 1972.
5. Wills, Christine; Wills, Martin Organic Synthesis, Oxford University Press, 1995.
6. House, Herbert O. Modern Synthetic Reactions, 2nd edition, the Benjamin/Cummings Publishing Company, 1972.
7. Smith, D.M.; Mackie, R.K. Guide Book to Organic Synthesis, 3rd edition, Longman, 1999.

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
EXAMINATION

Title	**ANALYTICAL TECHNIQUES**		**Credits**	04
Code	ICH 1.5	**Semester:-**1st	**L TP**	4 - -
Max.Marks	**End term- 50**	**Mid term- 50**	**Elective**	N
Pre requisites			**Contact Hours**	60
THEORY				
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,Which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.			
Course Objectives	1. To give an insight about various chromatographic techniques:principle, instrumentation and application 2. To introduce the thermoanalytical methods and their basic applications. 3. To give advanced knowledge about the Photochemical processes using Jablonski diagram and to introduce the photochemical reactions of common organic compounds. 4. To gain an insight to the interpretation of infrared and electronic spectra of common organic compounds and to get an exposure to the instrumentation of I R and UV- Vis spectroscopy. 5. To study the electronic and magnetic properties of transition metal complexes and to introduce the Orgel diagrams and Tanabe Sugano diagrams to calculate the Dq and B values 6 To give an introduction about the X-Ray diffraction methods.			
Course Outcomes	CO1.The students would be able to understand the applicability of important chromatographic methods. CO2. Understand the principal of thermoanalytical methods and be able to analyse the data from these techniques CO3. Understand the mechanism of the different types of photochemical reactions of common organic compounds.. CO4.would be familiar with the instrumentation of Infrared and UV_Vis spectroscopic methods and be able to interpret the spectra. CO5Would be able to understand term symbols ,Orgel diagrams and calculate the values of Dq and B for transition metal complexes. CO6 Would be able to understand the basics of X-Ray diffraction methods.			

Section A

Chromatography: Recapitulation of the basic concepts of chromatography---(Introduction to chromatography, principles, classification of chromatographic techniques, common terms used in chromatography and their relation, thin layer and paper chromatography – principle and technique)Column Chromatography : Factors affecting column efficiency and applications. Gas –liquid chromatography : theory, instrumentation and applications.*HPLC* – instrumentation andapplications.

10hrs

Thermo-analytical methods: Principle, classification of methods. TGA – Instrumentation, factors affecting results and analysis of data, applications. DTG – Instrumentation, analysis of data and applications. DTA – Principle,

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Instrumentation and applications 7hrs

Photochemistry: Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence. Jablonsky diagram.Photochemistry of alkenes, dienes and polyenes ,photochemistry of carbonyl compounds – photoreductions, photooxidations and photorearrangement reactions - photochemistry of aromatic compounds.
15hrs

Section B

Vibrational Spectroscopy: Infrared Spectroscopy:- Linear Harmonic Oscillator, Vibrational energy of diatomic molecule zero point energy, force constants & bond lengths anharmonicity, morse potential energy diagram. Selection rules Normal modes of vibration, group frequencies,fundamental frequencies and overtones, combination bands and Fermi resonance. Instrumentation and sample handling. Characteristics vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols ,ethers phenols and amines . Effect of hydrogen bonding of solvent,isotope effect.FT-IR of gaseous, solid and polymeric materials
7hrs

UV-Vis Spectroscopy: Recapiculationof Beer-Lambert law,Principle of electronic spectroscopy , types of transitions and selection rules of UV Vis spectroscopy.
UV spectral absorptions of carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls,effect of solvent on electronic transition. Basic instrumentation (Choice of source, monochromator and detector) for single and double beam instrument.
7hrs

Electronic Spectra and Magnetic Properties Of Transition Metal Complexes-Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d1 -d9 states), calculations of Dq, B and β parameters, charge transfer spectra. 7 hrs
X-ray crystallography-Fundamentals: X-ray and their properties. Use of X-ray diffraction to find atomic arrangements. Point group, space group and unit cell. Combining waves to obtain an image: Elementary treatment of Structure factor and Fourier synthesis. Crystals and intensity data collection: Fundamental concepts.
7 hrs

Books Recommended:

1. Skoog, D. A. & West D. M. : Principles of Instrumental Analysis, 5th Edition, Saunders College Publishers, USA.
2. Skoog, D. A. & West D. M. : Fundamentals of Analytical Chemistry, 7th Edition, Saunders College Publishers, USA.
3. Willard, Meritt, Dean &Settle, : Industrial Methods of Analysis, 7th Edition.
4. Galen W. Ewing. : Industrial Methods of Chemical Analysis, 5th Edition.
5. Silverstein R. M. &Webster F.X.: Spectrometric identification of Organic Compounds, 6thEdition, John Wiley and Sons, Inc., USA.
6. Rohatgi Mukherjee K K , Fundamentals of Photochemistry, Wiley Eastern Ltd., 1992.
7. Turro, N. J., Scaiano, J. C., and Ramamurthy, V., Modern Molecular Photochemistry of Organic Molecules, University Science Books, 2010.
8. S.M Khopkar Basic concepts of Analytical Chemistry ,SecondEdition,New Age International Publishers ,New Delhi,2008.

Paper Title: FLUID FLOW &

MECHANICAL OPERATION LAB. (Practical)

Paper Code: ICH 1.6 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.
7. Measurement of drag force, Stoke's law, Filtration.

Paper Title: CHEMICAL TECHNOLOGY LAB (Practical)

Paper Code: ICH 1.7 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.

4. Fertilizers (i) Determination of N-P-K Values

   (ii) Determination of micronutrients

5. Cement: Loss of ignition, silica, insolubles, estimation of Mg, Ca, Fe.

Paper Title: ANALYTICAL TECHNIQUES LAB (Practical)
Paper Code: ICH 1.8 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 $Pb(OOCCH_3)_4$ & $CaC_2O_4 \cdot H_2O$

***Books Recommended*:**

1. Vogel : Practical Organic Chemistry, 3rd Edition, ELBS, 1989.
2. Vogel : Textbook of quantitative analysis, 5th Edition, ELBS, 1989.
3. Lavitt, B. P. : Findlay's Practical Physical Chemistry edited by Lavitt, B. P., Longman group, 9th rev. Edition, 1978.

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

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1) Quantitative analysis and function group detection of unknown organic compounds containing multiple functional groups (nitrobenzaldehyde, nitroaniline, aminobenzoic acid)

2) Organic preparations:

(i) Preparation of dibenzal acetone (dibezylidine acetone) from benzaldehyde (Claisen- Schmidt reaction)
(ii) Synthesis of asprin from acylation of Salicylic acid.
(iii) Oxidation of ethanol / isopro panol/acetone (Iodoform reaction)
(iv) Preparation of phenylazo-p-naphthol from aniline (Diazocoupling reaction) and its synthetic application.
(v) Preparation of benzopinacol from benzophenone (photoreduction)
(vi) Preparation of benzanilide from aniline (Schotten –Baumann reaction)
(vii) Aldol condensation
(viii) Semicarbazone of any one of the following compounds: acetone,ethyl methyl ketone, cyclohexanone,bezaldehyde.

SYLLABUS FOR MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)

SECOND SEMESTER

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
EXAMINATION

Paper Title: CHEMICAL ENGINEERING-II (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:

1. McCabe, W.L., Smith, J.C. and Harriot H.P. : Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill,2005.

2. Holman, J.P. : Heat Transfer, McGraw Hill Publication Co.Ltd., New Delhi, 9th Edition, 2008

3. Chapman, A.J. : Heat Transfer, McMillan Publishing Co., 4th Edition, 1984

4. Kern, D.Q. : Process heat Transfer, Tata McGraw Hill Publishing Co., New Delhi, Edition 1997, 2006

5. Kreith, F. : Principles of Heat Transfer, Harper & Row Pub., London.

6. Geankoplis, C.J. : Transport Processes and Unit Operations, Prentice Hall of India Pvt. Ltd., 3rd Edition, 1999.

7. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition, McGraw-Hill, 1981.

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
EXAMINATION

Paper Title: INDUSTRIAL POLUTION CONTROL (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

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

- Tertiary treatment systems: Brief review about Coagulation and Filtration, Adsorption on Activated carbon, Ion exchange, Reverse osmosis, Electrodialysis, Nitrogen and Phosphorous removal.

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:

1. Rao, C. S. : Environmental Pollution Control Engineering, New Age Int. (P) Ltd. Publishers, 2006.

2. Rao, M.N. and Rao, H.V.N. : Air Pollution, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.

3. Zajic, J.E. : Water pollution, Marcel Dekker, Inc. New York, 1971.

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EXAMINATION

4. Davis, M.L. and Cornwell, D.A. : Introduction to Environmental Engg. McGraw-Hill International Editions, 1991.

Title	PHARMACEUTICAL CHEMISTRY		**Credits**	03
Code	ICH 2.3	**Semester:-**1st	**L TP**	3 --
Max.Marks	**End term- 40**	**Mid term- 35**	**Elective**	N
Pre requisites			**Contact Hours**	45
THEORY				
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,Which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.			
Course Objectives	1. To provide an overview about the discovery and catergories of drugs 2. To make the students aware of the various considerations in design of drug dosage forms 3. To give an introduction to the field of natural product chemistry in order to identify different types of natural products 4. To discuss the use of natural products as starting materials for medicines 5. To provide an exposure to the design, development,synthesis, structure and medicinal effects as well as adverse effects of some common classes of drugs.			
Course Outcomes	1: The students would be able to identify the different types of drugs 2. Would be aware of the usage of the drug dosage forms 3.would be able to understand and identify natural products and their use as precursors for medicinal use 4. Understand the chemistry of drugs with respect to their pharmacological activity.			

Section A

Discovery, Classification and categorization of drugs in Pharmacology **4 hrs**

Different dosage forms for drugs and Advantages and disadvantages of the various dosage forms **5hrs**

Chemistry and Medicinal properties of Natural Products
Classification,occurrence, isolation, structure and medicinal properties of some natural products i)Terpenoids and Carotenoids---citral, geraniol, α -terpineol, menthol, farnesol, zingiberene, santonine, longifolene,abietic acidand vitamin A .ii)Steroids--cholesterol, bile acids, and testosterone, estrone, progesterone. iii) Alkaloids---ephedrine, Nicotine, atropine, quinine, morphine, chloroquin, **12 hrs**

Classification, pharmacology, drug discovery, design and development, mode of action, adverse effects and Retrosynthetic approach for Synthesis and structure activity relationship of the representative drugs of the following classes of drugs:
Antipyretic drugs: Paracetamol , acetanilide and aspirin.
Analgesic drugs: Morphene Sulphate and codeine
Non **Steroidalanti inflammatory drugs:** Indomethacine , Ibuprofen and Neproren.
Central Nervous System agents: Phenobarbital, Diazepam,
Cardiovascular: Glyceryl trinitrate **24 hrs.**

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Books recommended

1. Aulton M.E.:Aulton Pharmaceutics: The design and manufacture of medicines -5th ed., Elsevier
2. George Mathew : Textbook of Pharmaceutical Chemistry ISBN: 9788130912608,9788130912608
3. Beale J.M. & Block J.H.:Wilson&Gisvold textbook of organic medicinal and pharmaceutical chemistry, 12th ed., Wolters kluwer business.
4. 1. Finar l. L , Organic Chemistry, Vol.1, 2, 5th ed. Pubs: ELBS (1975
5. Aggrawal, O.P., Chemistry of natural products , Vol 1&2.
6. Mann J.; Davidson ,R.S.;Hobbs, J.B.;Banthrope,D.V.;Harborne,J.B., .Natural Products :Chemistry and biological siginificance , Longman,Essex
7. Rahman, Att-ur ;Choudhary, M.I., New trands in Natural products Chemistry , HarwoodAcademic Publishers
8. Akhrem, A.A.Total Steroids Synthesis, Pubs: Plenum Press, New York, (1970

Paper Title: Electrochemistry and Materials Chemistry (Theory)

Paper Code : ICH 2.4

Max. Marks 50 **Credit 4** **Time: 3 hours**

Course Duration: 35 Lectures of one hour each.

Instructions for paper setters and candidates: I. Examiner will set total of NINE questions comprising TWO questions from each unit and ONE compulsory question of short answer type covering whole syllabi. II. The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question. III. All questions carry equal marks.

Section A

Electrochemistry-I

Ionic Interaction: Non-ideal behaviour of electrolyte solutions. Electrochemical potential. Derivation of Debye-Huckel limiting law. Extended Debye-Huckel Law Structure of solutions. Detailed treatment of ion-solvent interactions (Ion solvation), Solvation number, Energy considerations. Ion-ion interactions (Ion association). Bjerrum theory of ion association. Quantitative aspects of the Debye-Huckel- Onsager treatment of ion transport in solution and its extension. Elementary treatment of membrane electrochemistry

Electrochemistry-II

Interfacial Phenomena: Thermodynamic treatment of electrode-solution interface Surface charge density. Electrical double layer, Structure of the double layer : Helmholtz-Perrin, GouyChapman, and Stern models. Mathematical treatment of electrocapillarity. Surface excess. Derivation of Lippmann equation. Significance of electrocapillary curves Electrode Kinetics: Overpotentials, Exchange current density, Derivation of Butler-Volmer equation and its implications, Tafel plot Electrochemical techniques: Chronoamperometry, cyclic voltammetry, chronopotentiometry, coulometry, ac impedance spectroscopy Electrocatalysis

Section B

Nanomaterials: Definition, historical perspective and effects of nanoscience and nanotechnology on various fields. Classification of nano-structured materials, top-down and bottom up 33 approaches, Synthesis of

nanoparticles by chemical routes, Thermodynamics and kinetics of nucleation; Growth of polyhedral particles by surface reaction, Ostwald ripening, size distribution; Properties of nanostructured materials: Optical properties; magnetic properties; chemical properties and mechanical properties. Overview of applied chemistry of nanomaterials and their toxic effects. Determination of surface structure: Principle, working and applications of Powder X_ray diffraction (XRD);X_ray photoelectron spectroscopy (XPS); Auger Spectroscopy;Scanning electron microscopy (SEM); Transmission electron microscopy (TEM); Low-energy electron diffraction (LEED); Atomic Force Microscopy (AFM)and Dynamic light scattering (DLS) techniques.

Suggested Books

ESSENTIAL:

1. Reiger P.H., Electrochemistry, Pubs. Prentice-Hall,New Jersey (1994).

2. Crow D.R., Principles and Applications of Electro-chemistry, Blackie academic, Glasgow (1988).

3. Brett C.M.A. and Brett A.M.O., Electrochemistry: Principles, Methods and Applications, Pubs: Oxford Uni. Press (1993).

4. Bockris J.O'M. and Reddy A.K.N., Modern Electro-chemistry, Vols. 1,2, Pubs: Plenum Press, New York (1970).

FURTHER READING:

1. Bard &. Faulkner, Electrochemical Methods: Fundamentals and Applications, Second Edition

2. Scholz. F, Electroanalytical methods: Guide to Experiments and Applications, Springer

3.D.A. Skoog, F.J. Holler and T.A. Nieman, Principles of Instrumental Analysis, 5th Edition (1998)Saunders College Publishing, Harcourt Brace & Company, U.S.A.

4. West, A.R., Solid State Chemistry and its Applications, John Wiley and Sons,2007.

5. Azaroff, L.V., Introduction to Solids, McGraw Hill Education Private Ltd.,1997.

6. Rao, C.N.R., Chemistry of Advanced Materials, Blackwell Scientific Publications, 1993.

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
EXAMINATION

Paper Title: THERMODYNAMICS AND CHEMICAL REACTION ENGINEERING – III (Theory)

Paper Code : ICH 2.5 **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:

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

Books Recommended:

1. Smith, J.M. and Van Ness, H.C. : Introduction to Chemical Engg. Thermodynamics, McGraw Hill Book Co., London.

2. Stiener, L.E. : Introduction to Chemical Thermodynamics, McGraw Hill Book Co.

3. Levenspial, D. : Chemical Reaction Engineering, John Wiley.

4. Narayanan, K.V. : A Textbook of Chemical Engineering Thermodynamics, PHI Learning Pvt. Ltd., 2004.

Paper Title: Heat & Mass Transfer (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. Wilsonplots.
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.

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SEMESTER THIRD

Paper Title: ORGANIC SPECTROSCOPY
Paper Code: ICH 3.1
Max. Marks 50 **Credits: 4** **Time: 2 hours**

Instructions for paper setters and candidates: I. Examiner will set total of NINE questions comprising TWO questions from each unit and ONE compulsory question of short answer type covering whole syllabi. II. The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question. III. All questions carry equal marks.

UNIT-I

NMR-Spectroscopy Nuclear spin states, Nuclear magnetic moments, Absorption of energy, Mechanism of absorption, Population densities of nuclear spin states, Chemical shift and shielding, NMR spectrometer, Chemical equivalence, Integrals and integration, Chemical environment and chemical shift, Local diamagnetic shielding, Magnetic anisotropy, Spin-spin splitting, Origin of spin-spin splitting, Coupling constant.

UNIT-II

Carbon-13 nucleus, Carbon-13 chemical shifts, Calculation of Carbon-13 chemical shifts, Proton-coupled 13C spectra, Proton-decoupled 13C spectra, NOE, Cross-polarisation: Origin of NOE, Problems with integration in 13C spectra, Molecular relaxation processes, Off-resonance decoupling, DEPT, Two-dimensional NMR spectroscopy, Heteronuclear coupling of carbon to fluorine-19, Heteronuclear coupling to Phosphorous-31, Heteronuclear coupling to Boron-10 and Boron-11.

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UNIT-III

Coupling constants: Symbols, Mechanism of coupling, 1 J, 2 J, 3 J, Long-Range couplings, Magnetic equivalence, Non-equivalence within a group, measuring coupling constants from firstorder spectra, Mechanism of coupling in alkenes-allylic coupling, Measuring coupling constantsanalysis of allylic system, Second-order spectra-strong coupling, Coupling in heteroaromatic systems, Long range coupling, Homotopic enantiotopic and diastereotopic systems, Chemical shift reagents, Chiral resolving agents, NMR imaging, Chemically induced dynamic polarisation (C.I.D.N.P)

UNIT-IV

Mass Spectrometry 10 Theory of mass spectrometry, Instrumentation, Electron and chemical Ionization (EI and CI), Metastable peaks, Isotope peaks, Index of hydrogen deficiency, Nitrogen Rule. Fragmentation patterns of some functional group in organic molecules: alkanes, alkenes, alcohols, ketones, carboxylic acids, amides, aromatic hydrocarbons, phenols, Mclafferty rearrangement. Introduction of modern techniques used in Mass Spectrometry: Principle and application: Fast atom bombardment Ionization (FAB-MS), Liquid in Secondary ion mass spectrometry (LSIMS), Matrix assisted laser desorption/ ionization (MALDI), Electron Spray Ionization (ESI-MS). Application of mass spectrometry in solving structural problems of simple organic molecules.

Suggested Books

1. Drago R.S., Physical Methods for Chemistry, Pubs: Saunders College Publishing. NewYear (1992). 2. Ebsworth E.A.V., Rankin D.W.H. and Cradock S., Structural Method in Inorganic Chemistry, Pubs: Blackwell Scientific Publications (1987).

3. Parish R.V., NMR, IR., NQR., ESR & Mossbauer Spectroscopy in Inorganic Chemistry, Pubs: Ellis Horwood, New York (1990).

4. Silverstein R.M. and Bassler G.S., Spectroscopy Identification of Organic Compounds, 5th Edition, Pubs: John Wiley (1991).

5. Willard R.M. Merrit I. and Dear J. A., Instrumental Methods of Analysis, 7th Edition, Pubs: Van Nostrand-Reinhold (1988).

6. Kemp W., Organic Spectroscopy, 2nd Edition, Pubs: E.I.B.S (1987).

7. Akitt J.W., NMR and Chemistry, Pubs: Chapman and Hall New York (1983).

8. Williams D. and Fleming I., Spectroscopic Methods in Organic Chemistry, Pubs: TMH (1988).

9. Atta-U-Rahman, Nuclear Magnetic Resonance, Pubs: Springer-Verlag, New York (1986).

10. Narrow C.M., Molecular Spectroscopy, Pubs: McGraw-Hill (1964).

11. Drago R.S., Physical Methods in Chemistry, Pubs: Van Nostrand-Reinhold (1977).

12. Banwall C.N., Fundamental of Molecular Spectroscopy, Pubs: Tata McGraw-Hill (1983).

MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY)
EXAMINATION

Paper Title: Polymer Science and Technology
Paper Code: ICH 3.2
Max. Marks 40 **Credits: 3** **Time: 3 hours**
Course Duration: 35 Lectures of one hour each

SECTION-A

Polymers, Functionality and Degree of Polymerization, Mechanism of Polymerization, Molecular Weights of Polymers, Methods of polymerization, Functional Polymers, Industrial applications of Polymers
Polymerization reaction kinetics for polycondensation, addition polymerization, copolymerization, ziegler-Natta Polymerization, emulsion polymerization reactions, most probable molecular weights and distributions. Control of molecular weight and distributions, gelation phenomena, techniques of polymerization, and design of reactors for polymerization reactions, viscosity build up and heat and mass transfer effects in polymer reactors.

SECTION-B

Basic principles, description of different processing techniques such as extrusion, blow molding, wire coating, calendering including equipment, detailed discussions of parameters affecting the processing, problems and troubleshooting during processing, compounding and mixing of polymers and additives.

***Books Recommended*:**

1. Odian, G.: Principles of Polymerization, McGraw Hill Book Co., 1970.
2. Throne, J.L.: Plastics Process Engineering, Marcel Dekker Inc., New York, 1979
3. Reichert, K., and Geiseler, W.: Polymer Reaction Engineering, Huthing&Wepf. Basel, 1986

4. Bernhardt, E.C.: Processing of Thermoplastic Materials, Reinhold Pub., New York.
5. Middleman, S.: Fundamentals of Polymer Processing, McGraw Hill Book Co., 1977.

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. **PROCESS INSTRUMENTATION**
   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:
Thermal expansion methods – bimetallic thermometers, liquid-in-glass thermometer and filled-in-system thermometers.
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.
2. Singh, S.K. : Industrial Instrumentation and Control, 2nd Edition, Tata McGraw – Hill, 2007.
3. Considine, D.N. : Process Instruments and Controls Handbook 2nd Edition, McGraw Hill, 1974.
4. Fribance, A.E. : Industrial Instrumentation Fundamentals, Tata McGraw – Hill Publishing Co. Ltd., 1962.
5. Patranabis, D. : Principles of Industrial Instrumentation, 2nd Edition, Tata McGraw Hill Publishing Co. Ltd., 1999**.**

2. ENGINEERING MATERIALS

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.

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

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.

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***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*:**

1. Askelland, Donald R. : The Science & Engineering of Materials, PWSKENT.
2. Shackleford, J.F. : Introduction to Material Science for Engineers, Mc Millan.
3. Van-Vlack, L.H. : Elements of Material Science & Engineering, Addison Wesley
4. Raghavan, V.: Material Science & Engineering, Prentice Hall of India
5. Callister Jr. William D. : Materials Science and Engineering- An Introduction, Wiley.

3. Nanotchnology

Section A

Overview of Nanostructures and Nanomaterials: classification . Crystalline nanomaterials and defects therein. Hybrid nanomaterials.

Multiscale hierarchical structures built out of nanosized building blocks (nano to macro).Nanomaterials in Nature: Nacre, Gecko,Teeth.

Nanostructures: Carbon Nanotubes, Fullerenes, Nanowires, Quantum Dots. Applications of nanostructures. Reinforcement in Ceramics, Drug delivery, Giant magnetoresistance, etc. Cells response to Nanostructures.

Surfaces and interfaces in nanostructures. Ceramic interfaces, Superhydrophobic surfaces, Grain boundaries in Nanocrystalline materials, Defects associated with interfaces.

Pre-requisites: Materials Science and Engineering.

Section B

Thermodynamics of Nanomaterials.

Overview of properties of nanostructures and nanomaterials. How the performance of nanomaterials come about: sizestructureMechanism-property-performance pathway.

Overview of characterization of nanostructures and nanomaterials.

Focus on: Brunauer-Emmett-Teller (BET) technique, Transmission Electron Microscopic techniques, Auger Electron Spectroscopy, Xray Photoelectron Spectroscopy. Electron Energy Loss Spectroscopy.

Deformation behaviour of nanomaterials. Fracture and creep. Nanomechanics and nanotribology. Electrical, Magnetic and Optical properties.

Books Recommended

1. Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects, D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009.

2. Handbook of Nanophase and Nanostructured Materials (in four volumes), Eds: Z.L. Wang, Y. Liu, Z. Zhang, Kluwer Academic/Plenum Publishers, 2003.

3. Handbook of Nanoceramics and their Based Nanodevices (Vol. 2) Edited by Tseung-Yuen Tseng and Hari Singh Nalwa, American Scientific Publishers.

4. Additional Reading: Encyclopedia of Nanoscience and Nanotechnology, Ed.:Hari Singh Nalwa, American Scientific Publishers, 2004.

4. RENEWABLE ENERGY

SECTION A

Renewable energy resources

Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources.

Wind energy

Power in the Wind – Types of Wind Power Plants (WPPs) – Components of WPPs-Working of WPPs- Sitng of WPPs-Grid integration issues of WPPs.

Solar Photo voltaic and thermal systems

Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds.- Thermal Energy storage system with Phase Change Materials (PCM)- Solar Photovoltaic (PV)systems : Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells,

Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.

SECTION B

Biomass energy

Introduction-Bio mass resources, Energy from Bio mass, Conversion process, Environmental Benefits.

Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.

Other energy sources

Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC)- Hydrogen Production and Storage- Fuel cell :Principle of working- various types – construction and applications. Energy Storage System- Hybrid Energy Systems.

Books Recommended

1. Rai G.D. , Non-Conventional Energy Sources, Khanna Publishers, 2011
2. Twidell and Wier, Renewable Energy Resources, CRC Press (Taylor and Francis), 2011

5. NUMERICAL ANALYSIS

SECTION-A

Errors in Numerical Calculations, Solution of Algebratic and Transcendental Equations: The Bisection Method, The method of False Position, The Iteration Method, Newton-Raphson Method. Interpolation: Finite Differences, Differences of a Polynomial, Newton's Formulae for Interpolation, Central Difference Interpolation Formulae, Interpolation with Unevenly Spaced Points, Divided Differences and their Properties, Inverse Interpolation, Curve Fitting, Least-Squares Curve Fitting Procedures.

SECTION-B

Solution of Linear Systems, Gaussian Elimination Method, Gauss-Jordan Method, Jacobi Iteration Method, Gauss-Seidel Iteration Method. Numerical Differentiation and Integration: Trapezoidal Rule, Simpson's 1/3 –Rule, Simpson's 3/8-Rule, Weddle's Rules and Romberg Integration. Numerical Solution of Ordinary Differential Equation: Taylor's Series Expansion Method, Picard's Method, Euler's Method, Runga-Kutta Methods, Predictor-Corrector Methods, Simultaneous and Higher Order Equations.

Books Recommended:

1. Hildebrand, F.B. : Introduction to Numerical Analysis.
2. Scarborough, J.B. : Numerical Mathematical Analysis, Oxford and ISH Pub. Co.
3. Chopra, S.C., & Canale, R.P. : Numerical Methods for Engineers.
4. Sastry, S. S. : Introductory Methods of Numerical Analysis, 4th Edition, Prentice Hall.

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:

1. K.N. Krishna Swamy Appa Lyer Siva Kumar M. Mathirajan: Management Research Methodology,
Pearson Education, 2009
2. Ranjit Kumar:Research Methodology, Pearson Education 2009-02-20

3. Donald R. CooperPamela S. Schindler: Business Research Methods, Tata McGraw Hill
4. Michael Riley et.al: Researching & Writing dissertation in Business & Management, Thomson Learning.
5. R. Pannerselvam: Research Methodology, Parentice Hall of India Limited.
6. R. Nandagopalet.al.:Research Methods in Business, ExcelBooks.
7. William G.Zikmund :Business Research Methods, Thomson South Western Publication
8. C.R. Kothari:Research Methodology-Methods &Techniques.
9. K.V. Rao:Research Methodoloty in Commerce &Management.

2. INDUSTRIAL 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

Explosive and inflammable substances. Radioactive hazards. Fire prevention. Good housing keeping in industrial environment. 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:

1. Wells, G.L : Safety in process

3. WASTE MANAGEMENT IN INDUSTRY

SECTION-A

INTRODUCTION

Types of industries and industrial pollution – Characteristics of industrial wastes – Population equivalent – Bioassay studies – effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health – Environmental legislations related to prevention and control of industrial effluents and hazardous wastes

CLEANER PRODUCTION

Waste management Approach – Waste Audit – Volume and strength reduction – Material and process modifications – Recycle, reuse and byproduct recovery – Applications.

POLLUTION FROM MAJOR INDUSTRIES

Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants – Wastewater reclamation concepts

SECTION-B

TREATMENT TECHNOLOGIES

Equalisation – Neutralisation – Removal of suspended and dissolved organic solids - Chemical oxidation – Adsorption - Removal of dissolved inorganics – Combined treatment of industrial and municipal wastes – Residue management – Dewatering - Disposal

HAZARDOUS WASTE MANAGEMENT

Hazardous wastes - Physico chemical treatment – solidification – incineration – Secured land fills

Books Recommended:

1. M.N.Rao & A.K.Dutta, "Wastewater Treatment", Oxford - IBH Publication, 1995.
2. W .W. Eckenfelder Jr., "Industrial Water Pollution Control", McGraw-Hill Book Company, New Delhi, 2000.

4. 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:

1. Koontz & O'Donnel : Essentials of Management, New York, McGraw Hill Publishing Company, 1990. MASTER OF SCIENCE (INDUSTRIAL CHEMISTRY) EXAMINATIONS 2018-2019 15
2. Newman & Summer : Process of Management.
3. Terry, George, R. : Principles of Management Homewood Richards, D. Irwin INC, 1990
4. Davar, R.S. : The Management Process, Bombay, Progressive Corporation, 1980.
5. Rathermund, Dietimar : An Economic History of India from precolonical Times to 1986, Manohar Press, New Delhi, 1988.

5. CHEMICAL ANALYSIS IN AGRO FOOD AND PHARMACEUTICAL INDUSTRY

SECTION A

Analysis of soil:

Moister, pH, total nitrogen, phosphorous, silica, lime, Magnesia, Manganese, sulfur and alkali salts. Fuel analysis: Solid, liquid and Gas , ultimate and proximate analysis heating values , grading of cool , liquid fuels , flasks points , aniline point , octane number and carbon residue , gaseous fuels – producer gas and water gas – calorific value.

Clinical Chemistry: Composition of blood collection, andpreparation of samples, clinical analysis – serum electrolytes, blood glucose, bloodurea nitrogen, uric acid, albumin, globulin, barbiturates, acidic and alkaline phosphates,Immunoassay , principals of radiimmunoassy and applications. The blood- gas analysis –trace elements in the body.

SECTION-B

Drug analysis: Narcotics and dangerous drugs, classification of drugs, screening by gas m thin layer chromatography and spectrophotometric analysis. Introduction to Fluorescence, instrumentation and its application in Biological, Medical and Drug Development.

Food analysis : Moister, ash, crude protein, fat, crud fiber, carbohydrate, calcium,potassium, sodium, and phosphates, food adulteration – common adulteration in food,contamination of food stuffs, microscopic examination of foods for adulterants,Pesticide analysis in food products, Extraction and purification of sample, HPLC, gas chromatography for organo – phosphates, thin layer chromatography for identification ofchlorinated pesticides in food products

Books Recommended:

1. Fundamentals of analytical chemistry by D. A. Skoog , D. M. West and F. J. Honer, W. B. Saunders.
2. Chromic phenomenon , The Technological application of color chemistry Peter,Bamfield

Paper Title: ORGANIC SPECTROSCOPY LAB (Practical)
Paper Code: ICH 3.5 Max. Marks 25 Credits: 1 Time: 2 hours

This laboratory work involves; Manual skills; studies on Organosilicon complexes, Schiffs bases and their characterization with IR, 1H, 13C, Mass Spectrometry.