

SARDAR PATEL UNIVERSITY
FACULTY OF SCIENCE
COURSE OF STUDY
RULES OF DEGREE OF THE MASTER OF SCIENCE
M.Sc. INDUSTRIAL CHEMISTRY

R.PG.Sc.1: A candidate who has obtained the degree of Bachelor of Science of the University or of any other University recognized as equivalent thereto with Industrial Chemistry, Industrial Chemistry(vocational), Chemistry, any branch of chemistry or Chemistry as one of the major subject may, after successful completion of the course work etc. prescribed for the M.Sc. degree examination, for a period of two years subsequent to his passing the B.Sc. degree examination, be admitted to the examination for the degree of M.Sc. in the respective subject as per the regulation prescribed in that behalf.

The degree of Master of Science will be taken by papers and practicals only.

R.PG.Sc.2: The examination of the various theory papers and laboratory work will be conducted under semester system. For this purpose each academic year will be divided into two semesters.

R.PG.Sc.3: Candidates will be examined in each Theory paper for 100 marks and practicals for 200 marks wherever prescribed at the end of each semester. There shall be a viva-voce examination of 50 marks at the end of each semester to be held by the university.

For deciding result of M.Sc. examination in each semester the ratio between the internal assessment and external assessment will be 30:70.

1. Theory:

There are four theory courses in a semester each of 100 marks. Of these 30 marks are assigned to internal assessment. The breakup of these 30 marks of each course shall be as under:

- | | |
|------------------------|----------|
| • Tests | 20 Marks |
| • Quiz | 5 Marks |
| • Seminar + Assignment | 5 Marks |

2. Practicals:

The practical courses in each semester carry 200 marks. Of these 60 marks are assigned to internal assessment.

The breakup of these 60 marks for internal assessment shall be as under

- | | |
|--|----------|
| • Tests | 40 Marks |
| • Weekly attendance, Regularity, Lab. Skill, Journal | 10 Marks |
| • Viva | 10 Marks |

R.PG.Sc.4: Candidate shall be required to attend at least 75% of total theory, lectures and practicals under each of the courses during the semester.

R.PG.Sc.5:

- i) The Head of department in consultation with other teachers if the department will prepare in the beginning of the year a detailed scheme of seminars, home work, quizzes, etc. and the programme for the test examinations and the same will be announced to the candidates.
- ii) The records of the test examinations as well as seminars, home work, quizzes, etc. will be maintained by the department concerned.
- iii) Every candidate shall maintain a regular record of his/her practical work which shall be duly certified by his/her teacher(s) from time to time.

R.PG.Sc.6: Candidates will be required to obtain at least 33% marks in the internal evaluation separately in each head of passing. A candidate who fails to obtain 33% marks in not more than two heads of passing, may be allowed to appear at the university examination by the head of department concerned on the recommendation of the committee appointed by him/her to assess the candidate's overall performance.

(Note: A head of passing will mean a course in theory or practicals)

R.PG.Sc.7: A candidate desirous of appearing at each semester examination may forward his application in the prescribed form to Registrar through the Head of the University Post-Graduate Department concerned on or before the date prescribed for the purpose under the relevant ordinances.

R.PG.Sc.8: The final result for the award of the degree will be declared on the basis of the grand total marks of all the Theory papers, Practicals and viva-voce prescribed for all semesters examinations for the said degree.

R.PG.Sc.9: Only those students who fail in not more than two heads of passing at each semester examination be allowed to keep terms at the next semester. No Candidate will be allowed reappear in course in which he/she has already passed.

R.PG.Sc.10: The standard of passing:

The standard of passing at the M.Sc. degree examination will be as under:

- a) To pass any semester for the M.Sc. degree, a candidate must obtain at least 40% marks at the University Examination and 40% marks in the aggregate of University and Internal examination in each course of theory, practical and 40% marks in viva-voce Examination.
- b) Award of Classes:
 - 1) Those successful candidates will be placed in Second Class if they obtain at least 50% or more marks in the aggregate of all semesters examinations taken together.

- 2) Those successful candidates will be placed in First Class if they obtain at least 60% or more but less than 70% marks in the aggregate of all semester's examinations taken together.
- 3) Those successful candidates will be placed in First Class with Distinction if they obtain 70% or more in the aggregate of all semester's examinations taken together will be declared to have passed the examination in First Class with Distinction.

R.PG.Sc.11:

i) A candidate who fails in more than two courses (any two of the total heads of passing in the particular semester) in a particular semester will not be admitted for further study at a subsequent semester and will be required to repeat the courses in which he/she has failed by joining the department as a regular student in the semester in which these courses are again offered. A candidate failing in not more than two courses at any semester examination will be promoted to the subsequent semester according to the following scheme.

ii) A candidate failing in the First Semester will be permitted to pursue his/her study up to the Third Semester will not be permitted to go to the Fourth Semester even though he/she may have passed in the Second and/or Third Semester. A candidate failing in the Second Semester will be permitted to pursue his studies up to the Fourth Semester.

Semester 1(Total 650 marks)

Course No	Paper	Hours per week	Credits	Internal Marks	External Marks	Total Marks
PS01CICH01	Unit Operations 1	3+1Seminar= 4hrs	4	30	70	100
PS01CICH07	Organic & Polymer Chemistry	3+1Seminar= 4hrs	4	30	70	100
PS01CICH 08	Industrial Management & Psychology	3+1Seminar= 4hrs	4	30	70	100
PS01EICH 04 PS01EICH 05	Processing of Polymers Technology of essential oils ,surfactants and cosmetic products	3+1Seminar= 4hrs	4	30	70	100
PS01CICH04 PS01CICH05	Industrial Analysis-1 Chem Engg Practicals-1	6 hrs 6 hrs	4+4	60	140	200
PS01CICH06	Viva-Voce				50	50

Semester II (Total 650 Marks)

Course No	Paper	Hours per week	Credits	Internal Marks	External Marks	Total Marks
PS02CICH01	Unit Operations II - & Stoichiometry	3+1Seminar= 4hrs	4	30	70	100
PS02CICH02	Unit Processes	3+1Seminar= 4hrs	4	30	70	100
PS02CICH 03	Polymer Technology	3+1Seminar= 4hrs	4	30	70	100
PS02EICH 01 PS02EICH0 2	Polymer Characterisation Technology of paint manufacturing, printing inks & heavy duty protective coatings	3+1Seminar= 4hrs	4	30	70	100
PS02CICH04 PS02CICH05	Industrial Analysis-2 Chem Engg Practicals-2	6 hrs 6 hrs	4+4	60	140	200
PS02CICH06	Viva-Voce				50	50

Semester III (Total 650 Marks)

Course No	Paper	Hours per week	Credits	Internal Marks	External Marks	Total Marks
PS03CICH01	Chemical Reaction Engineering & Utility Engineering	3+1Seminar= 4hrs	4	30	70	100
PS03CICH02	Spectroscopy & Instrumental Techniques	3+1Seminar= 4hrs	4	30	70	100
PS03CICH 03	Chemical technology I	3+1Seminar= 4hrs	4	30	70	100
PS03EICH 01 PS03EICH0 2	Composites, Blends & Adhesives Processing of oils & fats to utility products	3+1Seminar= 4hrs	4	30	70	100
PS03CICH04	Synthesis Planning 1	6 hrs	4+4	60	140	200
PS03CICH05	Synthesis Planning 2	6 hrs				
PS03CICH06	Viva-Voce				50	50

Semester IV (Total 650 Marks)

Course No	Paper	Hours per week	Credits	Internal Marks	External Marks	Total Marks
PS04CICH01	Industrial Hygiene and Safety	3+1Seminar= 4hrs	4	30	70	100
PS04CICH02	Selected topics in Industrial Chemistry	3+1Seminar= 4hrs	4	30	70	100
PS04CICH 03	Chemical Technology II	3+1Seminar= 4hrs	4	30	70	100
PS04EICH 01 PS04EICH0 2	Petrochemicals Technology of resins for surface coating	3+1Seminar= 4hrs	4	30	70	100
PS04CICH04	Practicals–Project	16 hrs	8	60	140	200
PS04CICH05	Viva-Voce				50	50

**INDUSTRIAL CHEMISTRY DEPARTMENT
STRUCTURE FOR M.Sc. SEMESTER I TO IV**

**Scheme for Internal Assessment
(Effective from June 2012)**

1. Theory:

There are four theory courses in a semester each of 100 marks. Of these 30 marks are assigned to internal assessment. The breakup of these 30 marks of each course shall be as under:

- | | |
|------------------------|----------|
| • Tests | 20 Marks |
| • Quiz | 5 Marks |
| • Seminar + Assignment | 5 Marks |

2. Tests:

- i. There will be 1 test in each course. The course wise schedule of test shall be prepared by the department and circulated to all concerned well in advance.
- ii. Test will be of 1 hour duration and shall comprise 2 questions, each of 10 marks. The total marks of the test will be 20.

3. Quiz:

- i. Each quiz shall carry 5 marks and shall be (normally) of 10 minute duration.
- ii. The quiz examination of the four courses shall be taken in such a manner that the students have not to appear in two quizzes on the same day. The quiz should not be conducted during 'Test weeks'.
- iii. The minimum number of quizzes in a course will be 4. However the concerned teacher can conduct additional quiz if it is necessary.
- iv. The evaluation of student 'Quiz' subhead shall be as follows:

$$\frac{\text{Aggregate marks of quizzes}}{\text{Total number of quizzes}}$$

4. Seminar and Assignment:

- i. There will be a minimum of 1 seminar plus 1 home assignment per course.
- ii. The assignment/seminar shall carry 5 marks. It is suggested that due credit will be given to regular attendance in seminar and punctual submission of assignment
- iii. The evaluation of a student under subhead assignment + seminar shall be done as follows:

$$\frac{\text{Aggregate marks in assignment \& seminar}}{\text{Total number of assignment \& seminar}}$$

Note:

- i. The concerned teacher shall maintain a record of all the marks obtained by a student in various components of internal assessment and shall promptly submit one copy of each to the office, without delay.
- ii. All the concerned teachers shall meet to compute the final 'internal marks' of the students at the end of a semester and shall submit course wise marks to the office.

5. Practicals:

The practical courses in each semester carry 200 marks. Of these 60 marks are assigned to internal assessment.

The breakup of these 60 marks for internal assessment shall be as under

- | | |
|--|----------|
| • Tests | 40 Marks |
| • Weekly attendance, Regularity, Lab. Skill, Journal | 10 Marks |
| • Viva | 10 Marks |

SEMESTER – I

CORE COURSES

PS01CICH 01: UNIT OPERATIONS 1

Distillation: Enthalpy concentration diagrams, Use of Ponchon Savarit method in the design of multistage tray towers and packed towers. Gas Absorption: Choice of solvent for absorption, Minimum Liquid- Gas ratio for Absorbers, HETP in continuous contact equipments.

Liquid- Liquid Extraction: Choice of solvent for extraction, Binodal solubility curves, Calculations for single stage and multi stage cross & countercurrent extraction, Differential Extractors. Drying: Rate of batch drying, calculations for cross and through circulation drying, Rate of drying for continuous driers, Hold up in rotary driers. Filtration: Theory of Filtration, Filtration Calculations, Filtration in centrifuges.

Boundary layer concept, Calculations for reciprocating and centrifugal pumps, Use of air vessels in pumps, Vapour locking and NPSH, Design of flow meters, Pressure and Vacuum producing devices, Dimensionless analysis using Rayleighs and Buckingham Π method.

Motion of particles through fluids: Terminal settling velocity of particles settling under Stokes, Intermediate and Newton's range in free & hindered settling, Mechanism of fluidization, Design of fluidized bed columns

References:

1. Mass Transfer Operations, Robert Treybal, Mc.Graw Hill Co. 3rd Edition.
2. Unit Operations of Chemical Engineering, W. Mc.Cabe,J.Smith, Mc.Graw Hill Co 7th edition.
3. Chemical Engineering,, Vol. 1 to VI , Coulson & Richardson,Pergamon Press. 3rd edition.
4. Fundamentals of Engg. Heat & Mass Transfer,R.C.Sachieve,Wiley Ltd.
5. Basic Principles and Calculations in chemical engg.,D.Himel Blan,Prentice Hall
6. Chemical Engg. Handbook, Robert Perry. 7th edition.

PS01CICH 07: ORGANIC & POLYMER CHEMISTRY

Preparations and applications of following reagents :

Aluminium tertiary butoxide, BF₃, DCC, Ozone, Per benzoic acid, Pt & Pd, Selenium, Per iodic acid, PPA, Di azo acetic ester.

Selected Name reactions and Rearrangements:

Aldol condensation, Arndt-eistert, Cannizzaro, Darzen, Dakin, Diels-alder, Elbs persulphate, Houben Hoesch, Knoevenagel, Leucarts, Meerwin pondorff verely, Pechmann, Perkin, Wurtz, Reimer tiemann, Wolf kishner, Wurtz-fittig.

Introduction to Polymer Science: Importance of polymers, Basic concepts, Classification of polymers, Thermoplastics, thermosetting behavior, tacticity in polymers, average molecular weight concept, Polydispersity and molecular weight distribution, Crystallization of polymers, degree of crystallinity, glass transition temperature (T_g). Chemistry of polymerization and its techniques: Addition polymerization- free radical, ionic, co-ordination polymerization, Condensation polymerization, Copolymerisation, Polymerization techniques.

Polymer Degradation: Introduction, Types of degradation- thermal degradation, mechanical degradation, degradation by ultrasonic waves, photo degradation, degradation by high-energy radiation, oxidative degradation and hydrolytic degradation and biodegradation.

References:

1. Organic Synthesis based on Name reaction and unnamed reaction, A.Hassner & C.Stummer, Pergamon press. 2nd edition
2. Advanced Organic Chemistry- Reaction Mechanism & Structure, J.March, John Wiley & Sons. 4th edition
3. Organic Chemistry Vol 1 & Vol 2, I.L.Finar, Long man Scientific. 5th edition
4. Reaction mechanism and reagents in organic chemistry, G.Chatwal, Himalaya publishers.
5. Organic chemistry, warren, oxford university press.
6. Polymer Science, V.R.Gowarikar, New age International, Mumbai
7. Introduction to polymer Chemistry, P.J.Flory, Asian Books
8. Polymer Technology, Miles & Briston, J.G.Chemical Publishing Company, New York

PS01CICH08: INDUSTRIAL MANAGEMENT & PSYCHOLOGY

Human Resource Management:Introduction, Acquisition of Human resources, Development of human resources, Motivation of human resources.

Financial & Marketing Management:Nature and scope of financial management, financial statement and analysis, funds flow, cash flow, cost concepts, financial planning, investment planning and analysis, budgeting and business plan.Introduction, analyzing marketing opportunities, developing marketing strategies, planning marketing programmes.

Operational Management:Introduction, Organization of manufacturing; Production planning & control; material management,Supervisory and Executive Leadership: Individual differences. Proficiency Personality and pro-social behavior, situational factors affecting pro-social behavior, Recipient interactions.
Types of conflicts and their resolutions

Psychology In Industry: Causation in behavior. Attitude, Frustration, Morale and group processes, Causes of stress, duration and intensity of stress. Stress and job performance, stress threshold, personality and stress. Stress Management.Psychological Tests: Design of jobs. Industrial training. Motivation. Fatigue.

References:

1. Marketing Management, Philip Kotter, Prentice- hall India 9th edition.
2. Personal or Human Resource & Personnel Management, D.A Decenzo, S.P. Robbins, PH India pub. 3rd edition.
3. Industrial Marketing Strategy, Fredrick Webster,3rd edition, John wiley & Sons.
4. N. R. F Maier,Psychology in industry,Oxford and I B H Publishing co.
5. T. W. Harwell.,Industrial Psychology,Oxford and I B H Publishing co.
6. Keith Davis & John . W. Newsyrom,Human Behaviour at work, 8th Edn. McGraw Hill
7. V.O. Jenks,Human Relations in Organizations Haper & Row (1990)
8. M. L. Blum, J. C. Naylor,Industrial Psychology,CBS Publishers

ELECTIVES

PS01EICH 04: PROCESSING OF POLYMERS

Principles of Polymer processing: Introduction to Polymer Processing, Melt processing of thermoplastics and melt processing of thermosetting polymers, Introduction to mixing, Types of mixers- Twin drum tumbler, ribbon blender, high speed mixer, ball mill and Cowles dissolver, two roll mill, Banbary mixer,

Compression & Injection Moulding: Fundamental principles, Melt processing of thermoplastics and melt processing of thermosetting polymers, Materials- factors to be considered while processing, Techniques of preheating, Types of compression & injection moulding, Comparison with transfer moulding, Specifications of injection moulding machine – injection & clamping unit.

Extrusion, Calendering & Blow moulding: Fundamental principles, operation of single screw & twin screw extruder, Extrusion blow moulding, Injection blow moulding and Stretch blow moulding, calendaring process.

Thermofoming, Rotational moulding, Casting processes & Polymer foam: Fundamental principles, Materials, general production method, Types, processes, applications.

Reference Books:

1. Polymer Processing, Morton & Jones, Chapman & Hall.
2. Plastics Engineering, R. J. Crawford, Maxwell Macmillan International.
3. Plastics Engineering Handbook, M.L. Berins, Van Nostrand Reinhold, New York.
4. Plastics Engineering Handbook, Joel Frados, Van Nostrand Reinhold, New York.
5. Plastics Processing Data Hand Book, Dominick. V. Rosato and Donald V. Rosato, Van Reinhold Nostrand, New York.
6. Plastics materials & Process, H. Goodman, Van Nostrand Reinhold Company, New York.
7. Plastics materials and processes, Seymour S. Schwartz and Sidney, H. Goodman, Van Nostrand Reinhold.
8. Principle of Polymer Processing, R.T. Fenner, Maxwell McMillan International Edn, London.
9. Plastics Extrusion Technology Handbook, Sidney Levy and James F. Carley, Industrial Press, New York.1989.
10. Plastics Extrusion Technology, FriedhlmHanser, Hanser Publications, New York.
11. Dies for plastics extrusion, M.V. Joshi, Macmillian India Ltd, India.
12. Mixing in Polymer Processing, Chris Rauwendaal, Marcel Dekker, New York.
13. Blow Moulding Handbook, Dominic Rosato and Donald Rosato, Nostrand Reinhold, New York.

PS01EICH 05: Technology of essential oils, surfactants and cosmetic products

Essential Oils, chemical constituents of essential oils, manufacturing technology, utilization of essential oils

Surfactants, classification & physico chemical properties of surfactants, practical applications of surfactants in various fields, manufacturing of various industrial surfactants

Cosmetics, classification, raw materials for cosmetics, manufacturing of various cosmetic products

Modifications of oils, fats & waxes, Introduction to chemical reactions of oils, fats & fatty acids, manufacturing of DCO, blown, boiled, stand & malenised oils

References:

1. The chemistry of oils & fats, F.D. Gunstone, Blackwell Pub.
2. Baileys Industrial oils & fats products, Vol 1-5, John Wiley & Sons
3. Essential Oils, Vol 1-7, D. Gunther, R.E. Krigger Pub Comp., New York
4. Cosmetic Science & Technology, Vol 1 & 2, Wiley Interscience, New York
5. Cosmetics, Soaps & Perfumes, W.A. Poucher, Chapman Hall, London & New York
6. Handbook of surfactants, Porter, Mc Graw Hill Pub

Practicals

PS01CICH 04- INDUSTRIAL ANALYSIS 1

PS01CICH 05- CHEMICAL ENGINEERING PRACTICALS -1

(Details to be worked out by the department)

SEMESTER 2

CORE COURSES

PS02CICH01- UNIT OPERATIONS II & STOICHIOMETRY

Modes of heat transfer, Three Dimensional heat conduction equation in rectangular and cylindrical co-ordinates, Effect of variable thermal conductivity, Heat transfer from extended surfaces. Calculations for free and forced convection .Application of Plancks distribution law, Stefan Boltzman law and Kirchoffs law,Radiation Shields.

Design of Heat transfer equipments LMTD correction factors, Effectiveness and number of transfer units for heat exchangers.

Mass balance calculation_for processes with and without chemical reactions, recycle & purge operations

Energy balance calculation for processes with and without chemical reactions

References

1. Unit Operations of Chemical Engineering, W.Mc.Cabe,J.Smith, Mc.Graw Hill Co 7th edition
2. Chemical Engineering, Vol 1 to VI, Coulson & Richardson,Pergamon Press. 4th edition
3. Engineering Heat Transfer,C.P.Gupta, R.Prakash, Nomchand & Bros.,Roorkee. 7th edition.
4. Process Heat Transfer, D.Q.Kern, Mc.Graw Hill Co.
5. Fundamentals of Engg. Heat & Mass Transfer, R. C. Sachieve, Wiley Ltd.
6. Basic Principles and Calculations in chemical engg.,D.Himel Blan,Prentice Hall
7. Stoichiometry, H. T. Bhatt, S. M. Vora, Tata Mc.Graw Hill Co. 3rd edition.
8. Chemical Process Principles,Vol I, Houghen, Watson, Asian Pub. House.

PS02CICH 02 – INDUSTRIAL PROCESS CHEMISTRY

Study of following processes with special emphasis on chemistry & chemical engineering principles of following processes:

Halogenation, Alkylation,

Oxidation, Hydrogenation, Nitration, Sulphonation,

Hydrolysis , Esterification,Hydration.

Synthesis Based On Carbon Monoxide and Hydrogen.

References:

1. Unit processes in organic synthesis, Groggins, Tata Mgraw Hill pub. 5th edition
2. Chemistry of petrochemical processes, Sami Mater,Lewis Hatch, Gulf Professional pub. 2nd edition
3. Industrial Organic Chemistry, K.Weissermal, H.J.Arpe,Wiley VCH. 4th edition
4. Chemistry and technology of basic organic and petrochemical synthesis, N.N. Lebedev, Mir pub.

PS02CICH 03: POLYMER TECHNOLOGY

Thermoplastics materials: Synthesis of monomers, Polymerization, Structure related properties, general properties and applications of various thermoplastics materials like polyolefin's, viz. Polyethylene, Polypropylene, olefinic copolymers, Vinyl polymers, Fluorine-containing Polymers, Poly(vinyl acetate) and its derivatives, Acrylic plastics, plastics based on Styrene and Cellulose plastics.

Engineering thermoplastics: Intermediates for Polyamides, polymerization of aliphatic polyamides, their structure and applications, Polyimide. Structure, properties and applications of Polyacetals and Polycarbonates.

Thermosetting materials: Manufacture, curing and application of Epoxide resins, Unsaturated Polyester resins, Polyurethanes, Phenolic resins, Urea-formaldehyde resins, Melamine-formaldehyde resins, Furan resins.

Thermoplastics elastomers: Introduction, Structure related properties, general properties and applications of various TPE like styrenics, polyesters, thermoplastics poly urethanes (TPU), polyamides and thermoplastics olefinic elastomers (TPO).

Reference books:

1. Fundamental principles of polymer materials practices for engineers, Plastics Materials, Stephen L. Rosen, Barnes & Noble, New York.
2. Plastics Materials, J. A. Brydson, Butterworths, London.
3. Polymer Technology, Miles & Bristol, J. G, Chemical Publishing company, Inc, New York.
4. Plastics Materials and Processes, Seymour S. Schwartz S.H. Goodman, Van Nostrand Reinhold, New York.
5. Plastics Technology, R. V. Milbey, McGraw Hill, Book Company New York,
6. Polymer science and Technology of Plastics and Rubber, P. Ghosh, McGraw hill, New York.
7. Engineering Plastics, R.W. Dyson, Chapman & Hall, New York.

ELECTIVES

PS02EICH01-- POLYMER CHARACTERIZATION

Importance of Quality control and Characterization of molecular weight: Importance of specification & standards in quality control of polymers, Preparation of polymer test specimens and conditioning, determination of molecular weight by Ultra Centrifugation, Gel Permeation Chromatography. End Group Analysis, Ebulliometry, Cryoscopy, Osmometry, and viscometry.

Material Characterization test: Introduction, Melting point, Softening point, Thermal conductivity, Shrinkage, Melt Flow Index test, Particle size, Density, and bulk factor, Water and Moisture absorption.

Mechanical, Electrical and Flammability test: Introduction, Hardness, Tensile strength, Compression strength, Flexural strength, Impact strength, Dielectric strength, Dielectric constant, Insulation resistance and arc resistance, Ignition properties, Oxygen index test and smoke generation tests.

Chemical and Weathering properties: Immersion test, Stain resistance test, Solvent stress cracking resistance test, Environmental stress cracking resistance test, Accelerated weathering test, Outdoor weathering of polymers.

Reference Books:

1. Handbook of plastics test method, R. P. Brown, Longman Scientific and Technical.
2. Handbook of plastics testing technology, Vishu Shah, John Wiley & Sons, New York.
3. ASTM, BIS, ISO standards.
4. Instrumental methods of Analysis, Will and Merritt, CBS Publisher, New Delhi.
5. Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler and Timothy A. Nieman, Harcourt Brace Coolege Publishing, Philadelphia.
6. Encyclopedia of Polymer science and Engineering, Wiley Inter science, New York.

PS02EICH02- TECHNOLOGY OF PAINT MANUFACTURING, PRINTING INKS & HEAVY DUTY PROTECTIVE COATINGS

Principles of paint formulation, concept of pigment volume concentration, theory of pigment wetting & dispersion, dispersion technology

Coating manufacturing equipments-ball mill, sand mill, basket mill, attritor, High speed disperser

Different types of inks, manufacturing of inks ,different printing processes

Corrosion & Technology of heavy duty protective coatings, technology of marine coatings

References

1. Surface coating technology, Vol 1 & 2,OCCA,Chapman & Hall, London & New York
2. Paints & surface coatings, theory & practice, second edition, R.Lambourne & T.A.Stevens,William Andrew Publishers
3. Technology of printing inks, E.A.Apps
4. Protective Print coatings for metals, Fraun Hofer & Boxaln, Particullis Press, England
5. Basics of Paint Technolgy, first edition, V.C.Malshe

PRACTICALS

PS02CICH04- INDUSTRIAL ANALYSIS-2

PS02CICH05- CHEMICAL ENGG PRACTICALS-2

(Details To Be Worked Out By The Department)

SEMESTER 3

CORE COURSES

PS03CICH 01: Chemical Reaction Engineering & Utility Engineering

Kinetics of Homogeneous reactions: Single and Multiple Reactions, Elementary and Non-elementary reactions, Molecularity and order of reactions, Kinetic models for non-elementary reactions, Temperature dependency and reaction rate prediction from Arrhenius, transition and collision theories. Integral and Differential analysis for constant volume and variable volume reactors-irreversible & reversible.

Design of reactors: Design of Ideal batch, CSTR and plug flow reactors, determination of the best system for a given conversion, residence time distribution- determination of exit age curve.

Kinetics of Heterogeneous reactions: Global rate of reaction, Effect of transport processes on selectivity in series and parallel reactions, Rate equations for surface reactions, Three phase reactors – Slurry and Trickle bed reactors. Determination of surface area, porosity, density and particle size of catalyst

Steam & Steam generation: Introduction and thermodynamics of steam generation, steam generators, Indian boiler act, Oil heating (furnace oil).calculations for boilers

References:

1. Chemical Reaction Engineering, Octave Levenspiel, Wiley Eastern Ltd. 3rd edition.
2. Chemical Engineering Kinetics, J.M.Smith, Mc.Graw Hill Book Co.3rd edition.
3. Chemical Kinetics, S. K. Jain, Vishal Publication, Jallander.
4. Fundamentals of Chemical reaction Engineering., Holland & Anthony
5. Chemical Reactor Theory, Lenbigh & Turner, University of Cambridge.
6. Reaction Engg. Through solved problems, G.M.Pande & S.M. Shrivastava
7. Chemical Engg. Handbook, Robert Perry. 7th edition.
8. A text book of plant utilities, D. B. Dhone,Nirali Prakasan 6th edition

PS03CICH02- SPECTROSCOPY & INSTRUMENTAL TECHNIQUES

Elementary principles, Instrumentation, sampling methods and application of FTIR, ¹H NMR, ¹³C NMR ,

Mass Spectrometry for the structural elucidation of organic compounds. Introduction to 2D-NMR and LC-MS/MS

Theory, Instrumentation and applications of HPLC, HPTLC

Introduction and instrumentation of Atomic Absorption spectroscopy, XRD & SEM with special emphasis on polymer and pharmaceutical products

References:

1. Organic Spectroscopy, William Kemp, ILBS 3rd edition
2. Spectrometric identification of organic compounds, Silverstein, John Wiley pub. 6th edition.
3. Applications of absorption spectroscopy of organic compounds, J.R. Dyer. 10th reprint.
4. Instrumental methods of chemical analysis, B.K. Sharma, Goel pub., 26th edition.
5. Instrumental Methods of analysis, Willard and Dean, CBS, 7th edition.
6. Spectroscopy of organic compounds, P.S. Kalsi. Wiley eastern ltd.
7. HPTLC, D. Sethi, CBS 2nd edition.

PS03CICH03- CHEMICAL TECHNOLOGY I

Study of following group of Industries with respect to their classification, raw materials, manufacturing process of at least one product with special emphasis on chemistry and engineering principles, structural features and product analysis:

Pigment Industry

Surface coating Industry-Binders

Surface Coating- Solvents & additives

Oils & oleo chemical industries

References

1. Handbook of Industrial Chemicals, Vol. 1 & II, K. M. Shah, Multitech Pub. House. 2nd edition.
2. Encyclopedia of chemical technology, Kirk & Othmer..
3. Perfumes, cosmetics & Soaps, vol: 1, 2 & 3, W.A. Poucher, Chapman & Hall 8th edition.
4. Surface Coatings, Vol. I & II , Oil & Color Chemists association, Australian Chapman and hall, London/ New York, 8th edition.
5. Hand Book of pigments, K. M. Shah 2nd edition.
6. Chemistry and Technology of surfactants, R.J. Farn, Blackwell pub. 1st edition.

ELECTIVES

PS03EICH01-- COMPOSITES, BLENDS & ADHESIVES

Composites: Introduction to composite materials, definitions, classifications, applications, advantage and disadvantages of composites, types of mold for composites and preparation of molds, release agents, core materials, coupling agents, fillers and pigments, gel coats, equipments and tools used for preparation of composites, Sheet moulding compounds (SMC), Dough moulding compounds (DMC) and Prepregs.

Processing of composites: Composites processes like Hand layup, Spray layup, Vacuum bag, Pressure bag, Autoclave moulding, Cold press, Hot press moulding, Resin injection, Resin transfer moulding, Foam reservoir, Filament winding, Centrifugal casting, Pultrusion, continuous laminations, Troubleshooting and remedies for composite processing.

Compatibilization Practical compatibilization, factors affecting miscibility, compatibilization by Physical processes, Physical additives, polymer modifications for physical compatibilization, reactive compatibilizers and reaction mechanism.

Adhesives: Concepts and terminology, Classification of adhesives, advantages and disadvantages of adhesives bonding, joint design, adhesive selection, adhesive properties surface preparation and bonding process. Solvent cementing of thermoplastics, cementing of thermosetting Polymer, Welding of thermoplastics, Ultrasonic assembly.

Reference Books:

1. Polymer blends and Composites, L.H. Sperling, Published by Plenum Press.
2. Handbook of Plastics Elastomers and Composites, Charles A Harper, McGraw Hill, New York.
3. Plastics Engineering, R.J. Crawford, Maxwell Macmillan International, New York.
4. FRP technology- Fiber reinforced Resin systems, Weatherhead, Applied Science, and London.
5. Handbook of Reinforcements for plastics, Milewski Katz, Van Nostrand Reinhold, New York.
6. Polymer Engineering Composites, M.C. W Richardson, Published by Applied science, London.
7. Multi component polymer systems, I.S. Miles and S. Rostami, Chapman & Hall, New York.
8. Polymer blends and Alloys, G.O. Shonaike and G.P. Simon, Marcel Dekker Inc, New York.

9. Polymer Blends, Vol 1& 2, D.R. Paul and Seymour Newman, Published by Academic Press, New York.
10. Adhesives Handbook, Butterworth's, J. Shields.

PS03EICH02- Processing of oils & fats to utility products

Processes and plants employed for hydrogenation of oils, chemistry of hydrogenation of oils, catalyst for hydrogenation of oils, hydrogen production for hydrogenation of oils

Fat splitting, hydrolysis of oils & fats, glycerine manufacturing

Raw materials for soap industries, plant & process employed in soap manufacturing

Raw materials for detergents, plants & processes employed for detergents, detergent additives

References:

1. Continuous processing of fats, M.K. Schwitzer, Chem Pub Comp., New York
2. Baileys Industrial Oils & fats products, Vol 1-5, John Wiley & Sons
3. Manufacture of soaps, detergents & glycerine, Edgar, Norwood Limited
4. Treaties on fats, fatty acids & oleo chemicals, O P. Narulla, Indl Consultants India Ltd., New Delhi
5. Soaps & Detergents, Parsuram K.S., Tata McGraw Hill Pub, New Delhi
6. Soaps, their chemistry & technology, J G. Kane, Indian central oil seeds comp, Hyderabad

PRACTICALS

PS03CICH04- SYNTHESIS PLANNING -1

PS03CICH05- SYNTHESIS PLANNING -2

(Details to be worked out by the department)

SEMESTER 4

CORE COURSES

PS04CICH01- INDUSTRIAL HYGIENE AND SAFETY

Concept of Industrial safety, Accident causes & prevention, Safety committee and policies, Accident Investigation and Analysis.

Types of chemical hazards and control, Control techniques, Process flow chart and its importance for safety inspection, Interpretation, use and training of MSDS, UN, HAZCHEM classification of chemicals, chemistry of fire.

Transportation of hazardous chemicals, storage hazards and controls, hazards & control in unit processes and unit operations. safety work permit, safety of pipe lines, transportation of hazardous chemicals, safe start up & shut down procedures, emergency shutdown.

Personnel protective equipments, housekeeping, toxicology. Safety in Chemical Industry: General; Type of chemical hazards

References:

1. Accident prevention manual for industrial operations, national safety council, Chicago, 10th edition.
2. Safety and accident prevention in chemical operation, 2nd edition, Howard H.,
3. Handbook of occupational safety and health, Lawrence S.
4. MSDS, your guide to chemical safety
5. Engg design for control of work place hazards, Richard A.
6. Safety managers Handbook, J.J.Keller and Associates Inc. USA.
7. Supervising safety for Hazardous Processes, Dr.K.U.Mistry, Safety Health and Environment Association, 1st edition.

PS04CICH02- SELECTED TOPICS IN INDUSTRIAL CHEMISTRY

Medicinal Chemistry

Green Chemistry: Principles, tools and examples of green chemistry

Metabolism of carbohydrates, lipids and protein molecules

Forensic Science chemistry: Introduction, forensic chemistry, illicit drugs, forensic toxicology

References:

1. Green Chemistry: Theory and Practice, Anastas, Warner, Oxford Univ. Press
2. Forensic Science-the basics, Jay Siegal
3. Good manufacturing practices for pharmaceuticals, Willing, S.H., Marce Dekker Pub., 1st edition
4. Modern Organic Chemistry, Sharma & Jain, Goel Publishers

PS04CICH03- CHEMICAL TECHNOLOGY II

Study of following group of Industries with respect to their classification, raw materials, manufacturing process of at least one product with special emphasis on chemistry and engineering principles, structural features and product analysis:

Pharmaceuticals

Fertilizers and agrochemicals

Adhesives

Petrochemicals

References:

1. Handbook of Industrial Chemicals, Vol 1 & II , K.M.Shah, Multitech Pub. House. 2nd edition
2. Industrial Chemistry, B.K.Sharma, 2nd edition.
3. Remington's Pharmaceutical Science, Mac Pub. comp.
4. Industrial Microbiology, A.H.Patel, Mac Millian India Ltd.
5. Handbook on Fertilizer Technology, B.K.Jain, B.Swaminathan, The fertilizer assn. Of India, N.Delhi.

ELECTIVES

PS04EICH01— PETROCHEMICALS

Introduction: Petrochemical, Development of petrochemical industry, Petroleum refining, Petrochemical feed stocks from petroleum refining, The basic building block processes, Petrochemical process technology, Costs in chemical processing, Primary raw materials for Petrochemicals like Natural gas, Crude oils, coal, oils shell, tar sand and gas hydrates.

Crude Oil Processing and Production of Hydrocarbon: Introduction, Physical separation Processes, Conversion Processes, Production of Olefines, Paraffinic hydrocarbon, olefins hydrocarbons, dienes, aromatic hydrocarbons, liquid petroleum fraction and residues.

Alkanes and higher Paraffin based Chemicals: Introduction, Chemical based on synthetic gases, Chemical based on direct reaction of methane, ethane, propane and naphtha based chemicals from high molecular weight n-paraffin.

Chemicals based on olefin diolefin and aromatic hydrocarbon: Introduction, Chemicals from n-butenes, isobutylenes, butadiene, benzene, toluene, xylene.

Reference Books:

1. Chemistry of Petrochemical Process, Sami Matar, Lewis F. Hatch, Gulf Professional Publishing, Boston.
2. Fundamental of Petroleum Chemical Technology, P. Belov, Mir Publications, Moscow.
3. Advanced Petroleum Refining, G. N. Sarkar, Khanna Publishers, Delhi
4. Petrochemicals, Peter Wisheman, John Wiley & Sons, New York.

PS04EICH 02- TECHNOLOGY OF RESINS FOR SURFACE COATING

Raw materials for these resins,chemistry of synthesis,processing techniques,properties & applications of the following resins:

natural resins like rosin, shellac,bitumen,asphalts & coal tar

synthetic resins,alkyds,polyester,phenolics,polyamides

acrylic & vinyl resins

epoxy & polyurethane resins

References:

1. Surface Coatings,OCCA,Vol 1,Chapman & Hall,New York
2. Resins for Surafce Coatings,Vol 1,2 & 3,P.K.T. Old ring, SITA technology
3. Resins for Coatings,Chemistry,properties & applications,Stoye.D,Hanser Pub.
4. Surface coatings,science & technology,Swaraj Paul Second Ed.,,John wiley & Sons
5. The chemistry of organic film formers,Solomon,B.F.Wiley,New York

PS04CICH 04: PROJECT

A project report based on literature survey and laboratory work conducted on topics related to chemical engineering and/or chemistry is to be submitted and presented as a seminar by each student to the institute.