4.1 RESIN TECHNOLOGY - 1

L	T	P
4	-	2

RATIONALE

This subject is designed for students who will be involved in development of coatings in their daily professional life. This involves the chemistry, raw materials, formulations and applications of various resins which are important component of the coatings.

DETAILED CONTENTS

1. Fundamentals of film formers, monomers, functionality and its determination, degree of polymerization, molecular weight, Convertible and non-convertible film former - linear, branched and cross linked film former, natural and synthetic film former, homopolymers and copolymers. (12 hrs)

2. Classification and properties of natural resins, processing of natural resins like copal congo etc. Rosin sources, oleoresin and its composition. Recovery of resin and turpentine from oleoresin, properties and deficiencies of rosin film, modification of rosin-calcium rosinate, zinc and polymerized rosin, maleopimaric acid from rosin etc. Identification of rosin, Shellac origin, extraction of lac, Different kinds of lac and their properties, Composition of Lac, Chemical modification of shellac for use in coatings, French polish, leather finishes, oleo resinous varnishes etc. from shellac. (12 hrs)

3 Bitumen, pitches, gums and glues, natural bitumens like gilsonite and petroleum in Bit Pitches, general properties and uses of gums and glues. Cellulose; source, properties, modification of cellulose for use in surface coatings like cellulose esters, ethers, water soluble cellulose derivatives, their properties, testing and uses in lacquers, putties etc. Rubber resins sources of natural rubber, properties and modification of rubber like chlorinated rubber, cyclised rubber or isomerised rubber, their properties and uses. (12 hrs)

4. Alkyd resins, raw materials, chemistry and formulation of various alkyds, Carothers equation and its application, alkyd constant, manufacturing processes, classification, properties and application of various type of alkyd, modification of alkyds such as copolymerized alkyds, natural and synthetic resin modified alkyds, water soluble alkyds. Polyester resin-saturated polyesters components and formulation of unsaturated polyester resin, curing mechanism. Properties and application of polyester resin, water soluble polyesters. Phenolic Resins, classification, types of phenols used, reaction of phenol and formaldehyde, novolacs and cresol resin production, properties and application of various phenolics, water soluble phenolics. (14 hrs)

5. Polyurethanes: Chemistry of PU coatings, raw materials; Isocynates, monomeric isocynats, polyisocynats, blocked isocynates, Polyols (polyster polyols, polyether polyols and hydroxy terminated polyols), one component and two component coatings.

(14 hrs)

LIST OF PRACTICALS

1. To test softening point of natural resins
2. To determine acid value of natural resins
3. To prepare limed rosin and test the acid value
4. To prepare ester gum and test the acid value and softening point
5. To prepare penta ester gum and test the acid value and softening point
6. To prepare long oil alkyd resin and test the acid value

INSTRUCTIONAL STRATEGY

As the subject is completely theoretical, it involves synthesis of various resins used in paint industry. It can be made more interactive by showing various paint samples (automotive, wall coatings, high duty coatings etc). so that students can appreciate different types of resins and their properties.

RECOMMENDED BOOKS

1. Organic Coating Technology, Vol. II by H.F. Payne; Wiley Publishers, New York
2. Surface Coating, Science and Technology, Ed. 2, Swarj Paul(john Wiley)
3. Outlines of Paint Technology by W.M. Morgans; John Wiley & Sons
4. Orgnic Coatings Wicks W; Jones FN.; Pappas S.P. & Wicks D.A. (John Wiley 3rd Edn.)

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	20
2	12	20
3	12	20
4	14	20
5	14	20
Total	**64**	**100**

4.2 PAINT TECHNOLOGY- II

L	T	P
3	-	2

RATIONALE

The subject prepares the student for industry as it specifies all application techniques in surface treatments. These are commonly used in all the paint related industries.

DETAILED CONTENTS

1 Objective of surface preparation and the phenomena, mechanical surface preparation, flame cleaning, blast cleaning etc. chemical surface preparation, solvent wiping and degreasing, alkali cleaning, emulsifiable solvent cleaning, steam cleaning, acid cleaning, pickling, phosphoric acid, electrolytic pickling. (10 hrs)

2 Chemical paint removal such as alkaline and solvent type removers etc. pretreatment chemical conversion coatings based on zinc manganese iron and chromium etc., cromate and other treatments, substrates and their specific preparations. (10 hrs)

3 Common application techniques, importance of rheological behavior in paint application, brush application, conventional air spray, airless spray. Hot spray, duel component spray, electrostatic handgun and high speed disc systems dipping roller and coil coating, powder coating, electrode position principles, miscellaneous application techniques, vacuum impregnation, curtain coating, flow coating, silk screen slush coating, knife coating, calendar coating, centrifugal coating etc. (16 hrs)

4: Curing of wet film paint shop services, paint shakers or tumblers, paint and distribution system, waste treatment, paint shop troubles, inspection and service complains, finishing of specific items, motor, body, refrigerator and domestic appliances, machinery and casting. (06 hrs)

5: Paint defects, sources, leveling, sagging, drip marks, crawling, cratering, wrinkling, peeling, classification, defects in the liquid paint, defects during application, defects during drying or curing, defects in the dry film in use, causes and rectification of defects and preventive measures refinishing and maintenance finishing. (06 hrs.)

INSTRUCTIONAL STRATEGY

Practical aspects of surface treatment and application of techniques should be shown by visits to paint auto shop plants.

LIST OF PRACTICALS

1. Study of different surfaces and their preparation for coatings.

   i) Wood
   ii) Metals
   iii) Plastics
   iv) Concrete/cement/bricks

2. Removal of paints from different substances:

   i) use of sand paper
   ii) use of solvents
   iii) double coating layers

3. Oil and Cup viscometer, measurements of flow of different formulations vis-à-vis:

   i) for different applications
   ii) effect of additives
   iii) effect of pigments
   iv) effect of resins
   v) Gardner Tube method Viscosity (A+OZ)

4. Various application techniques:

   i) Brush
   ii) Spray-gun
   iii) Applicator (thin film)
   iv) Rollers
   v) Dip coating
   vi) Knife coating

5. Analysis of defects in coatings.

   Different defects: leveling, sagging, etc. use of microscopy and visual observation.

6. To find the grindness of Paint/Primer

RECOMMENDED BOOKS

1. Organic Coating Technology, Vol. I & . II by R.F. Paync; Wiley Publishers, New York
2. Outlines of Paint Technology by W.M. Morgans; John Wiley & Sons
3. Good painting Practices by Joseph Bijos
4. Surface coatings Science and Technology by Swaraj Paul; Wiley Publishers.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	20
2	10	20
3	16	40
4	06	10
5	06	10
Total	**48**	**100**

4.3 HEAT TRANSFER

L	T	P
4	-	3

RATIONALE

The subject enables the students to apply the understanding of heat transfer mechanisms such as conduction, convection and radiation for understanding the performance of various heat transfer equipment such as heat exchangers, condensers, boilers, evaporators etc. used in almost all chemical and related industries.

DETAILED CONTENTS

1. Modes of Heat Transfer (32 hrs)

a) Conduction (12 hrs)

Fourier's law, Thermal conductivity, Conductance, Flat wall, Multilayer flat wall, Hollow cylinder, Multilayer cylinder, log mean area, geometric mean area and Arthmatic mean area, Introduction to unsteady state conduction, Simple numerical problems in S.I. Units.

b) Convection (12 hrs)

Natural and forced convection, dimensional analysis, Pi theorem, physical significance of dimension less number. Reynolds No, Prandlt No., Nusselt No., Stanton No., Peclet No., Grashoff No., Dittus Boelter's equation-simple numerical problems using Dittus Boelter equation. Fouling factor. Individual heat transfer coefficient and over, all heat transfer coefficient.

c) Radiation (8 hrs)

Reflection, absorption and transmission of radiation, Kirchoff;s law, Emissive power, Wein's displacement law, Stefen Boltman law, heat transfered by radiation, exchange of energy between two parallel planes of different emissivity, Radiant heat transfer coefficient, Solar radiation, grey surfaces or grey body.

2. Heat Exchanger (12 hrs)

Log.-Mean-Tempature.-Difference(L.M.T.D.) for parallel or concurrent -flow, counter-current-flow, cross -flow, construction and description of

i) Double pipe heat exchangers.
ii) Shell & Tube heat exchanger
iii) Finned tube heat exchangers.
iv) Scale formulation and cleaning devices, Wilson's plot (Simple Numerical Problems).
iv) Overall heat transfer coefficient

3. Evaporators (12 hrs)

Construction and description of
i) Horizontal tube types
ii) Standard vertical type or calendria type.
   (a) Natural and forced circulation type.
   (b) Entrainment and foam formation.
   (c) Method of feeding evaproators-Forward,Backward & cross, mixed multi effect evaproation.

4. Insulation (08 hrs)

Purpose of insulation, common insulators, critical thickness of insulation for cylinder and spheres, optimum thickness of insulation, Heat loss from a pipe.

LIST OF PRACTICALS

1. To determine the over all heat transfer coefficient for an open pan evaporator in steady and unsteady state conditions.

2. To determine the amount of steam required in evaporating the solution in open pan evaporator.

3. To determine 'U' for a double pipe heat exchanger in steady state conditions and also to determine efficiency of heat utilization for parallel current

4. To determine 'U' for a double pipe heat exchanger in steady state conditions and also to determine efficiency of heat utilization for counter current

5. To determine 'U' for a shell and tube heat exchanger in steady state conditions and also to determine efficiency of heat utilization for parallel current

6. To determine 'U' for a shell and tube heat exchanger in steady state conditions and also to determine efficiency of heat utilization for counter current

7. To determine steam economy of a single and double effect evaporator

8. Measurement of emissivity of test surfaces

9. To determine the rate of evaporation for a given sample

10 To determine thermal conductivity of metal

11. To determine the rate of evaporation in a an open jar evaporator

INSTRUCTIONAL STRATEGY

Since this is an important subject, it is very essential for the teacher to make the students very clear about the fundamentals of heat transfer, numerical problems and various heat transfer equipment.

RECOMMENDED BOOKS

1. Unit Operation of Chemical Engineering by McCabe and Smith, McGraw Hill Publication
2. Heat Transfer by Chapman, McMillan Publication
3. Heat Transfer by NC Adams, McGraw Hill Publication
4. Heat Transfer by Kern by McGraw Hill Publication
5. Principles of Heat Transfer by Kreith, Harper and Raw Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	32	50
2	12	20
3	12	20
4	08	10
Total	64	100

4.4 MASS TRANSFER

L	T	P
4	-	3

RATIONALE

In this subject the basic concepts of mass transfer are covered to enable the students to understand working of various mass transfer equipments like distillation column, gas absorption columns, dryers, cooling towers and extraction columns etc which are used in industries for purification of products

DETAILED CONTENTS

1. Introduction to Mass Transfer Operations and Classification (02 hrs)

2. Diffusion (10 hrs)

   Definition of diffusion and its classification viz diffusion under concentration, pressure and thermal gradient, forced diffusion and eddy diffusion.

   Role of diffusion in mass transfer, fick's law, diffusion in the gas phase equimolar counter diffusion, diffusion through stationary gas, Mass transfer coefficient, film theory and penetration theory of mass transfer, diffusion in solids, relation between film and overall mass transfer coefficient.

   Simple numerical problems based on Flick's law definition and physical meaning of mass transfer coefficient. Important correlations (no derivation), meaning of each term

3. Distillation (12 hrs)

   Relative volatility, vapour liquid equilibrium, various distillation methods, flash distillation, continuous, fractionating column with details and identification of different parts, flash distillation, steam distillation, introduction to azeotropic, extractive distillation, different types of distillation columns, concept of flooding, weeping, entrainment and loading in distillation columns

   (Qualitative treatment only, final expressions and the physical meaning of terms therein – derivations excluded)

4. Gas Absorption (12 hrs)

   Condition of equilibrium between gas and liquid, mechanism of absorption, material balance and design equation, operating line. Concept of transfer unit (HTU and NTU) height of column based on condition-gas film, based on condition-liquid film, height of column based on overall coefficient. HETP for packed column of distillation, equipment used, types of tower packing, properties of tower packing, problems encountered like flooding, channeling, and weeping, loading, choice of solvent, Raoult's law and Henry's law.

5. Humidification and Dehumidification (10 hrs)

Definition of humidity, saturated gas, relative humidity, percentage humidity, humid heat, humid volume, dew point, total enthalpy, Dry bulb and wet bulb temperature, meaning and principle only
Gas liquid contact operation: names of adiabatic and non-adiabatic equipment – natural draft cooling tower, humidifier and dehumidifier, different cooling tower arrangements, spray chambers, spray ponds

6. Leaching and Extraction (8 hrs)

Importance of leaching and extraction, leaching equipment, boll man extractor, plate tower, packed tower, spray tower, mixer settler extraction system

7. Drying (10 hrs)

Definition, industrial application, moisture content, wet and dry basis, equilibrium moisture, bound, unbound, free moisture, batch drying; direct driers, tray driers, two track driers, rate of drying curve, continuous drying, turbo type drier, rotary driers

LIST OF PRACTICALS

1. To study the rate of drying in a vacuum dryer
2. To determine the pounds of volatile compounds distilled per unit pounds of steam distlled in a steam distillation operation
3. To study the rate of drying in rotary dryer
4. To determine drying rate for a wet material
5. To study packed tower in various industries
6. To study various extractors in solvent extraction plant
7. To study a spray pond in a sugar and other industries for cooling system
8. To find out the drying characteristics of given sample and draw drying rate curve by infra-red moisture meter and rapid moisture meter.

INSTRUCTIONAL STRATEGY

Field visit will make the students familiar with different types of column (packed/tray) and different types of packings/trays used in the column. This will also make the students aware of auxiliary equipment/models/supports used for the columns. Along with the theoretical part, emphasis should be given to problem solving and practices especially for distillation column, absorption and humidification.

RECOMMENDED BOOKS

1. Mass Transfer Operations by Trey bal, Kogakusha Publication
2. Introduction to Chemical Engineering by Badger and Banc hero, McGraw Hill Publication
3. Unit Operation of Chemical Engineering by Mc Cab and Smith; McGraw Hill Publication
4. Mass Transfer by Sherwood Pigford and Wilke, McGraw Hill Publication
5. Chemical Engineers Handbook by Perry and Chilton, McGraw Hill Publication
6. Mass Transfer Operations by Kiran D. Patil, Nirali Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	02	05
2	10	15
3	12	20
4	12	15
5	10	15
6	08	15
7	10	15
Total	64	100

4.5 CHEMICAL ENGINEERING THERMODYNAMICS

L	T	P
4	-	-

RATIONALE

It is a core subject of chemical engineering and is essential for understanding basic concepts, thermodynamic properties of fluids and performance of thermal systems used in industry.

DETAILED CONTENTS

1. Introduction and Basic Concepts (16 hrs)

   Systems, processes, surroundings, homogeneous and heterogeneous systems, closed, open and isolated systems, intensive and extensive properties, state and path functions, concept of internal energy, enthalpy, entropy, free energy and equilibrium, equation of state, ideal gas law, Vanderwaal's equation, Amagat's law, Dalton's Law, Henry's law, Raoult's law, zeroth law of thermodynamics

2. First law of thermodynamics for open, closed and cyclic systems, Joules experiments. Calculation of internal energy, enthalpy, heat and work for ideal gas undergoing reversible isometric, isothermal, isobaric, adiabatic and polytropic process (16 hrs)

3. Second law of thermodynamics, limitations of first law, general statement of second law of thermodynamics, heat engine, entropy change for reversible and irreversible process, calculations of entropy change and ideal gases adiabatic and isothermal mixing process, carnot cycle, heat engine and its efficiency, thermodynamics temperature scale. (16 hrs)

4. Third law of thermodynamics: third law of thermodynamics and its applications, application of the laws of thermodynamics: heat pumps, refrigerations, coefficient of performance, properties of reorients, vapour compression refrigeration cycle, absorption refrigeration cycle, commonly used refrigerants. (16 hrs)

INSTRUCTIONAL STRATEGY

Emphasis should be given to numerical aspect to give in-depth knowledge of the subject. This will make the subject interesting and improve student's involvement in the subject.

RECOMMENDED BOOKS

1. Introduction to Chemical Engineering Thermodynamics by Smith and Vanness, Mc Graw Hill.

2. Chemical Engineering thermodynamics by K.V. Narayanan, Prentice Hall India.

3. Chemical Engineering Thermodynamics by Dodge, Mc Graw Hill.

4. Chemical Engineering Thermodynamics by YVC Rao

5. Engineering Thermodynamics by PK Nag

6. Thermal Engineering by Ballaney

7. Chemical Engineering Thermodynamics by K.A. Gavhane, Nirali Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	25
2	16	25
3	16	25
4	16	25
Total	**64**	**100**

4.6 PIGMENT TECHNOLOGY

L	T	P
4	-	2

RATIONALE

Pigments are an integral part of decorative, protective and functional coatings. This subject deals with pigments belonging to different groups and the properties which they impart to various coating systems.

DETAILED CONTENTS

1. Definition and classification of pigments (organic and inorganic pigments) , properties and evaluation of pigments such as crystal structure, particle size and shape, refractive index and Hiding power, oil absorption, colour, specific gravity and bulking value, UV and IR absorption, light fastness, resistance to hot water, alkali and acid, corrosion inhibition, toxicity, reducing power, tinting strength, flooding and floating, settling, volatile and water soluble matter, residue on sieve, bleeding, Dispersability, Intensity etc. (10 hrs)

2. White pigments such as titanium dioxide, zinc oxide, zinc sulphide and lithopone basic lead carbonate, sulphate, silicate etc (08 hrs)

3. Color pigments - natural and synthetic, iron oxides, lead chromates, silico chromates, Prussian and ultramarine blue etc., Black pigments, Colour pigments such as carbon black graphite. (08 hrs)

4. Metallic pigments such as aluminum, zinc, copper alloys, stainless steel etc. anti corrosive pigments such as red lead silicon chromate, calcium plumbate etc. (08 hrs)

5. General method of preparation and classification of synthetic organic pigments, flushed pigments, Azo Pigments, diazotisation and coupling, di-and tetra azo compounds, classification, description of various types of azo pigments and other related colourants such as azoic, etc. . (11 hrs)

6. Basic and acid dye pigments, permanent and fugitive type of dyes and pigments anthene and anthraquinone and vat colour pigment, Phthalocyanin blue and green metal free phthalocyanin. Quinacridones and other related pigments, miscellaneous organic pigments such as nitro, nitroso etc. Testing and identification of organic pigments. (11 hrs)

7 . Extenders: Definition, Type of Extender (Sulphate, Carbonates & Oxides). (08 hrs)

LIST OF PRACTICALS

1. To check the form and condition of pigment
2. To test the colour of pigment
3. To compare the tinting strength of pigment
4. To compare the reducing power of pigment
5. To determine oil absorption value of pigment
6. To determine residue on sieve of pigment
7. To determine moisture content of pigment
8. To determine water soluble matter of pigment
9. To prepare sample of middle chrome pigment
10. To prepare sample of prussian blue pigment

INSTRUCTIONAL STRATEGY

Field visits should be organized to a paint industry especially to pigment mixing/tinting section so that students can appreciate the colour effect and hiding power of various pigments used in coating industry.

RECOMMENDED BOOKS

1. Organic Coating Technology, Vol. II by H.F. Payne, Wiley Publishers
2. Outlines of Paint Technology by W.M. Morgans, John Wiley & Sons
3. Paint Flow and Pigment Dispersion, Indersciena Publishers – Vol. AX & 111 by T.C. Patton
4. Chemistry and Physics of Organic Pigments by L.S. Pratt; John Wiley Publishers
5. Chemistry of Pigments by PEJ Perry; Scott Greenwood.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	18
2	08	12
3	08	12
4	08	12
5	11	18
6	11	18
7	08	10
Total	**64**	**100**

INDUSTRIAL TRAINING OF STUDENTS

(during summer vacation after IV Semester)

It is needless to emphasize further the importance of Industrial Training of students during their 3 years of studies at Polytechnics. It is industrial training, which provides an opportunity to students to experience the environment and culture of industrial production units and commercial activities undertaken in field organizations. It prepares student for their future role as diploma engineers in the world of work and enables them to integrate theory with practice. Polytechnics have been arranging industrial training of students of various durations to meet the above objectives.

This document includes guided and supervised industrial training of a minimum of 4 weeks duration to be organised during the semester break starting after second year i.e. after IV Semester examinations. The concerned HODs along with other teachers will guide and help students in arranging appropriate training places relevant to their specific branch. It is suggested that a training schedule may be drawn for each student before starting of the training in consultation with the training providers. Students should also be briefed in advance about the organizational setup, product range, manufacturing process, important machines and materials used in the training organization.

Equally important with the guidance is supervision of students training in the industry/organization by the teachers. A minimum of one visit per week by the teacher is recommended. Students should be encouraged to write daily report in their diary to enable them to write final report and its presentation later on.

An internal assessment of 50 and external assessment of 50 marks have been provided in the study and evaluation scheme of V Semester. Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations. The formative and summative evaluation may comprise of weightage to performance in testing, general behaviour, quality of report and presentation during viva-voce examination. It is recommended that such evaluations may be carried out by a team comprising of concerned HOD, teachers and representative from industry.