

H.B.Technical University, Kanpur-208 002
B.Tech. Chemical Technology (Paint Technology)
Course Structure & Evaluation Scheme
(Recommended by B.O.S.)

Year I Semester I Branch: Common to all branches

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Exam		ESE			
						CT	TA				Total
Theory											
1	IMA101	Mathematics I	3	1	0	30	20	50	100	150	4
2	IPH101/ICY101	Physics/Chemistry	3	1	0	30	20	50	100	150	4
3	IEE101/IET101	Electrical Engg./Electronics & Instrumentation Engg.	3	1	0	30	20	50	100	150	4
4	IME101/ICS101	Engg. Mechanics/ Concepts of Computer and C programming	3	1	0	30	20	50	100	150	4
5	IHU101/ICE101	Professional communication/ Engineering Graphics	3	1	0	30	20	50	100	150	4
6	IHU102/ICE102	Remedial English/Environment and Ecology	2	0	0				50	50	Audit
Practical/Training/Project											
7	IPH151/ICY151	Physics lab/Chemistry Lab	0	0	3	10	10	20	30	50	1
8	IHU151/ICS151	Language Lab/Computer Lab	0	0	3	10	10	20	30	50	1
9	IEE151/IWS151	Electrical Engg. Lab/Workshop Practice	0	1	3	30	20	50	50	100	2
10	IGP101	General Proficiency						50		50	

Year I Semester II Branch : Common to all branches

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Exam		ESE			
						CT	TA				Total
Theory											
1	IMA201	Mathematics II	3	1	0	30	20	50	100	150	4
2	IPH201/ICY201	Physics/Chemistry	3	1	0	30	20	50	100	150	4
3	IEE201/IET201	Electrical Engg./Electronics & Instrumentation Engg.	3	1	0	30	20	50	100	150	4
4	IME201/ICS201	Engg. Mechanics/ Concepts of Computer and C Programming	3	1	0	30	20	50	100	150	4
5	IHU201/ICE201	Professional Communication/ Engineering Graphics	3	1	0	30	20	50	100	150	4
6	IHU202/ICE202	Remedial English/Environment and Ecology	2	0	0				50	50	Audit
Practical/Training/Project											
7	IPH251/ICY251	Physics Lab/ Chemistry Lab	0	0	3	10	10	20	30	50	1
8	IHU251/ICS251	Language Lab/Computer Lab	0	0	3	10	10	20	30	50	1
9	IEE251/IWS251	Electrical Engg. Lab/ Workshop Practice	0	1	3	30	20	50	50	100	2
10	IGP201	General Proficiency						50		50	

Year-II

Semester-III

Branch-Chemical Technology (Paint Technology)

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Exam		ESE			
						CT	TA				Total
Theory											
1	IMA-301	Mathematics - III	3	1	0	30	20	50	100	150	4
2	ICY-301	Modern Analytical Techniques	3	1	0	30	20	50	100	150	4
3	ICH-301	Materials and Energy Balance	3	1	0	30	20	50	100	150	4
4	ICH-304	Fluid Flow & Solid handling	3	1	0	30	20	50	100	150	4
5	IPT-301	Introduction to Surface Coatings and Their Components	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
6	ICY-351	Applied Chemistry Lab	0	0	6	30	20	50	50	100	2
7	IPT-351	Oil based Coating Media Lab	0	0	6	30	20	50	50	100	2
8	IGP-301	General Proficiency						50		50	--

Year-II

Semester-IV

Branch-Chemical Technology (Paint Technology)

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Exam		ESE			
						CT	TA				Total
Theory											
1	IMA-401	Numerical methods & computer programming	3	1	0	30	20	50	100	150	4
2	ICH-402	Heat Transfer Operation	3	1	0	30	20	50	100	150	4
3	ICH-403	Chemical Engg. Thermodynamics	3	1	0	30	20	50	100	150	4
4	IPT-401	Natural Resins & Synthetic Polyesters	3	1	0	30	20	50	100	150	4
	IPT-402	Inorganic Pigments & Extenders	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
6	IMA-451	Numerical Methods & Computer Programming Lab	0	0	3	15	10	25	25	50	1
7	ICH-453	Chemical Reaction Unit Operation Lab.	0	0	3	15	10	25	25	50	1
8	IPT-451	Oleoresinous Media Lab	0	0	6	30	20	50	50	100	2
9	IGP-401	G.P.						50		50	--

Year-III

Semester-V

Branch-Chemical Technology (Paint Technology)

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Exam		ESE			
						CT	TA				Total
Theory											
1	IME-506	Elements of Mechanical Engineering	3	1	0	30	20	50	100	150	4
2	ICH-501	Instrumentation & Process Control	3	1	0	30	20	50	100	150	4
3	ICH-506	Mass Transfer Operations	3	1	0	30	20	50	100	150	4
4	IPT-501	Synthetic Resins & Polymers	3	1	0	30	20	50	100	150	4
5	IPT-502	Organic Pigments & Dyestuffs	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
6	IPT-551	Pigments & Extenders Lab	0	0	6	30	20	50	50	100	2
7	IPT-552	Coating Testing Lab.	0	0	6	30	20	50	50	100	2
8	IGP-501	G.P.						50		50	--

Year-III

Semester-VI

Branch-Chemical Technology (Paint Technology)

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Exam		ESE			
						CT	TA				Total
Theory											
1	IME-604	Machine Design	3	1	0	30	20	50	100	150	4
2	ICH-607	Transport Phenomenon	3	1	0	30	20	50	100	150	4
3	ICH-606	Chemical Reaction Engg.	3	1	0	30	20	50	100	150	4
4	IPT-601	Formulation and manufacture of coatings	3	1	0	30	20	50	100	150	4
5	IPT-602	Analysis and Evaluation of Coatings	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
6	IPT-651	Resins & Emulsion Lab	0	0	6	30	20	50	50	100	2
7	IPT-652	Seminar	0	0	3			50		50	1
8	ICH-653	Instrumentation & Process Control Lab.	0	0	3	15	10	25	25	50	1
9	IGP-601	G.P.						50		50	--

Year-IV Semester-VII

Branch-Chemical Technology (Paint Technology)

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Exam		ESE			
						CT	TA				Total
Theory											
1	ICH-706	Process Equipment Design	3	1	0	30	20	50	100	150	4
2	IPT-701	Industrial & Specialty Coatings	3	1	0	30	20	50	100	150	4
3	IPT-702	Architectural & Eco-friendly coatings	3	1	0	30	20	50	100	150	4
4	IPT-703	Surface Preparation & coating Applications	3	1	0	30	20	50	100	150	4
5	IOE716(Open Elective)	Paint Manufacture & Application	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
6	IPT-751	Coating Preparation and Application Lab	0	0	6	30	20	50	50	100	2
7	IPT-752	Industrial Training Report Presentation	0	0	3			50		50	1
8	IPT-753	Project / Dissertation	0	0	3			50		50	1
9	IGP-701	General Proficiency						50		50	--

Year-IV

Semester-VIII

Branch-Chemical Technology (Paint Technology)

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Exam		ESE			
						CT	TA				Total
Theory											
1	IHU-801	Engg. Economics and Management	3	1	0	30	20	50	100	150	4
2	ICH-806	Process Modelling & Simulation	3	1	0	30	20	50	100	150	4
3	IPT-801	High Polymeric Engg.	3	1	0	30	20	50	100	150	4
4	IPT-802	Technology of Printing Inks	3	1	0	30	20	50	100	150	4
5	Branch Elective IPT-803 → IPT-804 → IPT-805 → IPT-806 →	Corrosion Engg. & Tech. Instrumentation in coating industries Packaging Tech. Industrial & Automotive painting	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
6	IPT-851	Project (Design & Techno-economic feasibility report)	0	0	12	30	20	50	100	200	4
7	IPT-852	Collaborative Industrial Project						50		50	1
8	IPT-852	Educational Tour Evaluation	0	0	3	15	10	25	25	50	Audit
9	IGP-801	G.P.						50		50	--

IPT - 301 : INTRODUCTION TO SURFACE COATINGS AND THEIR COMPONENTS L:T:P::3:1:0

UNIT I: Surface Coatings- Definitions and general classifications; paints, varnishes and lacquers; their components and functions; Coating Binders, media/vehicles, pigmentations, paint making; Coating Applications; mechanism of film formation; Modern Surface Coatings; Properties of Surface Coatings and their films; Film Ageing; Indian and Global picture of Paint Industry; Career in paint technology.

[8]

UNIT II: Fixed Oils – Essential, Mineral and Fixed oils; sources and composition of glyceride oils; molecular structure of tri-glyceride oils; non-glyceride components of oils; constitution and molecular structure of fatty acids; distribution of fatty acids in oil molecules; extraction of oils; processing of oils; evaluation & characterization of oils – physical and chemical; fatty acid composition and characteristics of individual oils; classification of glyceride oils-drying, semi drying and non-drying oils; properties and uses of glyceride oils; yellowing and non-yellowing oils; chemical properties of oils – oxidation, iodination and hydrogenation, hydrolysis, acidolysis, alcohololysis, saponification, sulphation, sulphonation, epoxidation; fatty alcohols and fatty amines; foreign matter, breaks and foots in oils.[10]

UNIT III: Modifications of Oils : Deficiencies in oil films; chemical modifications of triglyceride oils- heat bodied/thermally polymerized (stand) oils, blown oils, boiled & double boiled oils; solvent segregation; isomerized oils; dehydrated castor oils; maleinized oils & water soluble oils; co-polymerized oils; reconstituted (semi-synthetic) oils; limed oils; catalyzed oils; methyl esters and biodiesel. Refining of oils, Contamination: sources, causes and effects.

[8]

UNIT-IV: Coating Driers: constitution; active & auxiliary, primary and secondary; surface & through driers; metal part and organic acid part of driers; properties and uses of individual driers; mechanism of drier action; manufacture of driers; evaluation of driers; combination of driers; drier dosage; drier substitutes; drier related paint film defects; driers of water based coatings; future trends.

[6]

UNIT V : Volatile Solvents and Other Components: general classes of solvents, properties of solvents e.g. solvent (cutting) power, rate of evaporation, boiling point & vapor pressure, distillation range, flash point, auto ignition temperature, toxicity, aromatic content etc.; chromatographic techniques for solvent analysis; criteria of solubility; thermodynamics of solubility; solubility parameters; solvent mixture (thinners) – true solvents, latent solvents and diluents; evaporation properties of solvent mixtures; azeotropes; activity coefficients; evaporation from polymer films; sources and properties of individual solvents. Water as coating solvent; effect of volatile solvents on film properties; use of supercritical fluids as solvents; uses of solvents with different binder systems; safety, health & environmental aspects.

Chemistry and technology of synthetic polymers, inorganic and organic pigments, Fillers and Extenders: additives.

[8]

References and suggested readings :

1. Organic Coating Technology, Volume I, by Henry Fleming Payne, John Wiley & Sons.
2. Surface Coatings, Volume I, by OCCA Australia (Prepd.), Chapman and Hall
3. Outlines of Paint Technology, III Ed. By W.M.Morgans, Edward Arnold
4. Surface coatings: Science and Technology, by Swaraj Paul, John Wiley and Sons
5. Organic Coatings: Science and Technology, Volume I, by Z.W.Wicks, F.N.Jones and S.P.Pappas, Wiley-Interscience

6. Fatty acid vol. I–V, by Markley
7. Basics of Paint Technology, Part I & II, by V.C.Malshe & Meenal Sikchi
8. websites of PRA, Wikipedia etc.

IPT – 401 : NATURAL RESINS AND SYNTHETIC POLYESTERS

L:T:P::3:1:0

UNIT I : Natural Resins and Their Modifications

(A) Resins and Polymers, Resinous State and Degree of Polymerization, Classification of Resins, Classification of Natural Resins, Sources, availability and properties of Fossil & Semifossil Resins, Processing of Natural Resins- Congo, Copal, Kauri etc.

(B) Rosin/ Colophony : Sources and Recovery of Rosin, Grades of Rosin, composition of oleoresin, composition of rosin, abietic type acids & pimaric type acids, types of rosins (Gum rosin, Wood rosin, Toll Oil rosin), properties of rosins, structure-property relationship, deficiencies of rosin films, Disproportionated rosin, modification of rosins ; polymerized (dimerized) rosin, hydrogenated rosin, limed rosin, rosin esters, maleinized rosin, maleopimaric acid, maleic resins (regular and spirit soluble), water soluble Maleic resins, identification of presence of rosin.

(C) Shellac: Origin and Extraction, Different kinds of Lacs and their properties , Composition of lac(shellac), Properties and Testing of shellac, Chemical modifications of Shellac, French Uses of Shellac in Surface Coatings.

[10]

UNIT II : Natural Polymers and Their Modifications

(A) Cellulosic polymers : Sources, Constitution and Properties of Natural Cellulose, Deficiencies of Natural Cellulose as Coating binder, Chemical modifications of Cellulose, Ethers , Esters and Mixed esters, Nitro cellulose (NC) , Degree of substitution(DS) and Degree of polymerization (DP), Grades of NC based on viscosity, grades of NC based on solubility, Structure-property relationship, Organic thinner composition for NC, Handling & Storage of NC, Water soluble cellulose derivatives; Preparation, Properties, Testing and uses of individual Cellulose derivatives (CA, CAB, EC, HEC, EHEC, MC, CMC, SCMC).

(B) Plasticizers : Definitions, role of plasticizers, internal and external plasticizers- primary and secondary plasticizers, mechanism of plasticization, types of plasticizers – oils, resin type and simple chemicals such as phthalates, sebacates, phosphates, camphor etc. , molecular structure, properties and uses of individual plasticizers, efficiencies of plasticizers, evaluation of plasticizers based on tensile strength, percent elongation, low temperature flexibility, exudation etc.

(C) Rubber Resins: sources & recovery of natural rubber from latex, properties of natural rubber, deficiencies of natural rubbers as coating binder, modifications of natural rubber-chlorinated rubber resins, cyclized (isomerized) rubber resins, grades of modified rubbers resins, properties of chlorinated rubber resins vs cyclized rubber resins and their evaluation, merits and demerits of chlorinated and cyclized rubber resins, specific uses of modified rubber resins., Butadiene- Acrylonitrile Co-polymers, chloroprene rubber, High SBR Co-polymer, Chlorinated Paraffins & Chloro Waxes, Biphenyls & Polyphynyls, Rubber resin Latexes/ Latices.

[8]

UNIT III : Introduction to Synthetic Polymers

(A) Polymerisable monomers Vs. Monomeric chemicals, Functionality of molecules and its determination; Degree of polymerization and molecular weight; Non-convertible and Convertible film-formers

(B) Polyester resins : Saturated Polyesters (Oil-free Alkyds), Unsaturated Polyesters, Components and Formulations of Polyester resins, Curing mechanism, Air inhibition, Properties, Applications of Polyester resins, Hydrolytic stability, Recent trends, Hyper-branched Polyesters, High solids and Radiation cure compositions, Water soluble Polyesters

[8]

UNIT IV: Alkyd Resins

Raw materials & their properties, Non-convertible Oils & Fatty acids for Alkyds, Chemistry and Formulation of various Alkyds, Oil length & its effect on Alkyds and Film properties, Excess hydroxyls, Carother's equation

and its applications, Alkyd constant, Tailor-making of Alkyds, Formula calculation, Manufacturing processes and Commercial plant (Batch & Continuous), Gellation tendency & Safe processing, Classification, Properties and Application of various types of Alkyds, modification of Alkyds such as Co-polymerized Alkyds, Natural and Synthetic resin modified Alkyds, Water soluble Alkyds.[10]

UNIT V: Hydrocarbon and Other Resins

(A) Bitumens and Asphalts , Petroleum bitumens, Natural bitumens, Gilsonite, Albino bitumens (Petroleum resins), Pitches, Gums , Glues, Proteins (Casein), Waxes

(B) Hydrocarbon resins : Coumerone and Indene resins, resins from petroleum products, terpene resins

(C) Miscellaneous resins : Fluoro polymers, Ketonic resins, Polycarbonates, CNSL & BSNL resins etc.[4]

References and other readings:

1. Organic Coating Technology, Volume I; by Henry Fleming Payne, John Wiley & Sons.
2. Surface Coatings, Volume I; by OCCA Australia (Prepd.), Chapman and Hall
3. Outlines of Paint Technology, III Ed.; by W.M.Morgans, Edward Arnold
4. Organic Coatings: Science and Technology, Volume I; by Z.W.Wicks, F.N.Jones and S.P.Pappas, Wiley-Interscience
5. Handbook of coatings additives, by L.J. Calbo (Ed.), Marcel Dekler Inc.
6. Protective and decorative coatings; by J.J. Mattiello.
7. Technology of Paints, Varnishes and Lacquers by C.R.Martin.

IPT-402 : INORGANIC PIGMENTS AND EXTENDERS

L : T: P::3: 1:0

UNIT I: Introduction to Pigments and Extenders

Definition and classification of pigments. General methods of manufacturing of natural and synthetic inorganic pigments and extenders. General method of synthesis of pigments. Micronisation and surface treatment of pigments. Manufacturing, applications and merits and demerits of Nano pigments and extenders. [8]

UNIT II: Extender Pigments

Source, manufacture, properties and uses of extenders pigments such as carbonates, such as calcium carbonate, dolomite, whiting, calcite, Silicates, such as china clay, Talc, Kaolin, mica, calcium magnesium silicate, silica alumina, Sulphates, such as barytes, blanc fixe, Oxides, aluminates and miscellaneous extenders etc. Extender mixtures, Calcined Pigments and Extenders. [10]

UNIT III : White and Black Pigments

Titanium Dioxide ; Source, manufacturing, properties, chemistry, surface treatment, various grades and their technical characterization, applications and ecology. Manufacturing, properties and applications of zinc oxide, zinc sulphide, zinc phosphate, lithopone, basic lead carbonate, sulphate, silicate, etc. antimony oxide, calcium plumbate, zirconium oxide and silicate, potassium titanate, etc., Source, manufacturing, properties and uses of black pigments : such as Carbon black, furnace Black, Thermal, Gas Channel, Acetylene Black, and their technical characterization e.g. particle size crystal size shape and distribution surface area oil absorption and structure of the aggregate, graphite, copper chrome complex, iron oxide, aniline and logwood, etc. [10]

UNIT IV: Colour Pigments

Source, manufacture, properties and uses of natural and synthetic iron oxides, lead chromates, silico chromates and molybdate, chromegreen, chromium oxide, cadmium pigments, prussian and ultra marine blue, mercuric sulphide, cobalt blue, cadmium pigments, synthetic inorganic complexes and mixed pigments e.g. Sprinel Pigments etc. [10]

UNIT V: Metallic, Functional and Miscellaneous Pigments

Source, manufacture, properties and uses of metallic pigments such as aluminium, zinc, copper alloys, stainless steel etc. anti-corrosive pigments such as micaceous iron oxide, red lead, silicone chromate, zinc and strontium chromates, white molybdates, calcium plumbate etc., Functional and miscellaneous pigments such as cuprous and mercuric oxides, barium metaborate. Special effect pigments e.g. pearlescent, nacreous, phosphorescent, fluorescent and luminescent, IR reflecting pigments, thermochromic pigments, polymeric pigments, invisible pigments, etc.

12

References and suggested readings:

1. Pigment Hand book Vol. I, II and III by T.C.Patton.
2. Basics of Paint Technology, Part I & II, by V.C.Malshe & Meenal Sikchi.
3. Pigments, dyestuffs and Lakes, part six, Paint Technology Manuals.
4. Organic Coating Technology Vol. I & II by H.F.Payne.
5. Outlines of Paint Technology by W.M.Morgan.
6. Paints and Surface Coatings by Lambourne

UNIT I: Formaldehyde Resins:

(A) Phenolic resins : Classification, Pure & Reduced Phenolics, Types of Phenols used, reaction of Phenols and formaldehyde, P/ F Ratio, Phenolic Condensate, Novolacs and Resoles, Oil soluble and Oil reactive Phenolics, Heat reactivity of Phenolics, Resin production, Properties and Applications of various Phenolics, Water soluble phenolics.

(B) Amino resins: Urea-formaldehyde and Melamine-formaldehyde resins, Various Amines, Formulation of Methylol products, HMMM, Alkylation, Curing reaction, Manufacture, Properties, Applications in Surface Coatings, Water soluble and other Amino resins [8]

UNIT II: Epoxy Resins

(A) Epoxy resins : Chemistry, Raw Materials, BPA & BPF Epoxies, Diepoxide resins, Polyepoxide resins, Manufacture of Epoxy resins, Epoxide equivalent, Hydroxyl equivalent, Various Curing agents for Epoxies, phr, Formulation of two pack systems like Solvent based coatings, Solventless, High solids coatings, Single pack Epoxies like Epoxy esters, Degree of Estrification, Thermoplastic Epoxies etc. , Various Epoxy modified resins and their applications, Water borne epoxies

(B) Polyamide resins : Polyamines and acids used, Dimerized fatty acids, Properties and Applications of various Polyamides. [8]

UNIT III: Polyurethane Resins

Various isocyanates, Blocked & Polymeric isocyanates, Polyols, Castor oils, Catalysts,. NCO/ OH ratio, Reactions of isocyanate groups, isocyanate hazards, classification of polyurethanes, urathane oils and uralkyds, properties and applications of various single and two-pack systems, Aqueous PU systems, PUDs.

[8]

UNIT IV: Silicone resins

Silicate binder (Alkali & Alkyl), Synthesis of silicone resins, Silicone oils, Structure-property relationship, Pure Silicones, Modified Silicones, Properties and Applications of silicone resins. [6]

UNIT V: Ethylenic Resins

(A) Vinyl resins: Vinyl monomers, Types of Vinyl resins used in surface coatings, PVC, PVC- PVAc copolymers, Vinylidene chloride copolymers, PE-PVAc copolymers, Polyvinyl esters, PVA, Vinyl acetal resins, Properties and uses of individual Vinyl resins/ copolymers.,

(B) Acrylic resins: Acrylic monomers, Effect of monomers on Polymer & Film properties, ,Thermoplastic and Thermosetting acrylics, Tg & MFFT , Commercial plant for emulsion polymerization, Water borne acrylics, Emulsions/ Latices, Water-reducible TSAs [10]

References and suggested readings

1. Organic Coating Technology, Volume I & II; by Henry Fleming Payne
2. Surface Coatings, Volume I & II; by OCCA Australia
3. Outlines of Paint Technology; by W.M.Morgans
4. The chemistry of organic film-formers, by D.H.Solomon, R.E. Krieger Pub.
5. Introduction to paint chemistry; by G.P.A. Turner, Chapman and Hall
6. A Manual for resins for surface coatings; by P.K.T. Oldring
7. Basics of Paint Technology, Part I & II; by V.C.Malshe & Meenal Sikchi
8. Silicone Resins, by
9. Fluorinated Polymers by

IPT-502 : ORGANIC PIGMENTS AND DYESTUFFS

L : T: P::3: 1:0

UNIT I: General Introduction of Organic Pigments

Properties and evaluation of pigments such as crystal structure, particle size, surface area by BET techniques, Pigment particle shape, refractive index and hiding power, oil absorption, colour, specific gravity and bulking value, UV and IR absorption, light fastness, resistance to heat, water, alkali and acid, corrosion inhibition, toxicity, reducing power, tinting strength, flooding and floating, settling volatile and water soluble matter, residue on sieve, bleeding and other chemical, physico-chemical and mechanical properties of pigments, etc. **[10]**

UNIT II: Colour Phenomena

light spectrum, light sources, selective absorption and scattering of light, primary and complementary colours, colour mixing, dimensions of colour and colour systems, colour measurements, colour blindness etc. Definition of dyes, pigments dyestuffs, toners and lakes. Chemical structures and their colour imparting behaviours. Auxochromes and chromophores. Influence of physical factors.colour psychology, aesthetics and safety standards. **[8]**

UNIT III: Natural Organic Pigments

Comparison of organic and inorganic pigments. Raw materials : coaltar distillation products, mordants and precipitants, bases for colour striking and lakes, miscellaneous salts and chemicals. Chemical reactions for synthesis of various intermediates from benzene, naphthalene and anthracene etc. **[8]**

UNIT IV: AZO Pigments

Classifications and general method of preparation of synthetic organic azo pigments. Classification and description of various types of azo pigments, diazotization and coupling, di-and tetra azo compounds, and other related colourants such as azoic, etc. Basic and acid dyes pigments: permanent and fugitive type of dyes and pigments, anthracene and anthraquinone and vat colour pigment. **[12]**

UNIT V: Phthalocyanine and Miscellaneous Pigments

Phthalocyanine blue and green metal free phthalocyanine ; Quinacridones and other related pigments, miscellaneous organic pigments such as nitro, nitroso etc.,. Introduction to high performance Pigments & dyes, such as azocondensation , quinocridones, perylene, perinone, carbazole, phthalocynines, diketopyrrolo pyrrol (DPP), anthraquinone, and vat pigments. Composit and mixed pigments. Testing and identification of organic pigments. Introduction to colour index name and number. Colour coding systems. **[12]**

References and suggested readings

1. The Chemistry and Physics of Organic Pigments by L.S.Pratt.
2. Pigment Hand book Vol. I, II and III by T.C.Patton.
3. Basics of Paint Technology, Part I & II, by V.C.Malshe & Meenal Sikchi
4. Pigments, dyestuffs and lakes, part six, Paint Technology Manuals.
5. Organic Coating Technology Vol. I & II by H.F.Payne.

6. Outlines of Paint Technology by W.M.Morgan.
7. Industrial organic pigments by Klaous Hüngrer and Hürbst

IPT- 601 : FORMULATION AND MANUFACTURE OF COATINGS

L:T:P::3:1:0

UNIT I: Coating Additives and Principles of Coating Formulation

Coating Additives: Definition, nomenclature, role, scope of incorporation , dosage, side/adverse effects of use of additives

(i)For solvent thinned paints : Wetting and dispersing agents, anti settling , anti sag, bodying agents/ thickeners, anti skinning agents, anti flood & anti-float agents, biocides (bactericides and fungicides), thixotropic agents, leveling and flow control, mar and slip aids, adhesion promoters, heat and light stabilizers , driers

(ii)For water- thinned /latex (emulsion) paints : surface active agents (dispersing agents and stabilizers), anti foam agents/defoamers , protective colloids and thickeners, preservatives, pH buffers, coalescing aids, wet-edge extenders, freeze-thaw stabilizers, sequestering agents, miscellaneous- organoclays and silicone additives.

Prerequisites, Mathematics & Steps; PVC, CPVC, LCPVC, RCPC, % Volume solids, Relationship between PVC and film properties, Theoretical Covering Capacity, P/B ratio; Typical formulations of dry distempers, cement Paints and skim coats.

Typical formulations of solvent base Primers, Undercoats, Intermediate coats and Finish coats.

Typical formulations of water base Primers, Acrylic washable distempers, Plastic emulsion Paints- Interiors & Exteriors.

[10]

UNIT II: Principles of Coating Manufacture

Steps in Paint manufacturing, Phenomenon of Mixing, Soaking, wetting, grinding, dispersion and stabilization.

Dispersion processes, Daniel wet & flow point, Composition of grinding vehicle, Classification of grinding equipments, important considerations in pigment dispersion and stabilization.

Dispersion for aqueous media, high solids coatings.

Mill Base Composition, Rheology of Mill base, Daniel Flow Point, Concept of F(PVC), MBC (Mill base concentration), RTM (Ratio of Total Paint volume to Mill base volume), let down vehicle, Let down troubles, Optimum let down conditions, Stabilization of Mill base.

[8]

UNIT III: Heavy Duty Machines and Ball Mills

Heavy duty mixtures, double blade mixers, sigma mixture, Warner & P'flauder sigma kneaders, pug mills, edge runner roller mills, Hammer mills, jet mills.Rotostator.

Roll mills: Two roll mills, Triple roll mills; Vertical and horizontal construction, material balance, power input, Mill base compositions, Major uses.

Ball and Pebble mills: Advantages & disadvantages, physical factors affecting the performance of ball mill, critical & optimum speed of ball mill.

Types of grinding media and practical considerations for ball mills and other mills

[8]

UNIT IV: Attritors and High Speed Machines

Attritors and Bead Mills

Sand Mills: Vertical and Horizontal type (Pressurized and Normal) ; description, types of sand, selection of grinding media, impeller unit, mill base composition, production rates & economic considerations, advantages a& disadvantages of sand mill, Dyno Mill.

High speed disc disperser: description; size, positioning & speed of disperser blades, mill base rheology, power input, advantages & limitations of sand mill, Basket Mill, Twin shaft disperser, Cowles dissolvers, Kady Mills .

High speed stone and colloid mill: Description, stone grit size, mill base composition.

High speed impingement mill: Description, mill base composition, order of addition.

[8]

UNIT V: Production planning, Factory Layout and Safety, Health & Environment

Human resource Planning: Importance and processes, Job analysis and Engagements, Training need analysis and Training of staff,

Factory lay out: Principles, general considerations, typical flow diagrams, single & multi storied buildings, different sections of a paint factory and their locations, Instrumentation and automation.

Safety considerations in storage of hazardous, and inflammable raw materials.

Fire Protection and safety: Sources, types, Fire & explosion index, safety measures for protection.

Health and Hazards: Resources, competence & regulations, systems & tools, HAZOP guidelines,

Environment: Eco-friendly, waste minimization & waste disposal, system efficiency, respiratory protective equipments,

[6]

References and suggested readings:

1. Organic Coating Technology, Vol. I & II, By: H.F.Payne
2. Outlines of Paint Technology, By: W.M.Morgan
3. Paint Flow and Pigment Dispersions, By: T.C.Patton
4. Basics of Paint Technology, Part I & II, by V.C.Malshe & Meenal Sikchi
5. A.
6. A
7. A
- 8.

IPT- 602 : ANALYSIS AND EVALUATION
OF COATINGS

L:T:P::3:1:0

UNIT I: Analysis of Coatings

Pigment content, binder or solid vehicle content (% NV), water content, ash content, pigment, binder and solvent analysis, [6]

UNIT II: General properties of Coatings

Classification of coating properties: Properties and evaluation of raw materials used in coating formulations. Adhesion and cohesion properties, factors affecting adhesion, wetting power, optical properties; colour, gloss, hiding, Concept of Kubelka-munk equation etc, physical, chemical and mechanical properties of paint films, Newtonian and non Newtonian flow behaviours, factors affecting viscosity and influence on rheological behaviour. [10]

UNIT III: Objectives of Paint Testing

Quality control and quality assurance procedures, Standard specifications and test methods, test on liquid paints, density, dispersion, viscosity, consistency, application of films, spreading capacity, wet opacity, dry hiding, spreading time, drying time, wet and dry film thickness, etc. Optical properties- colour, gloss, haze & clarity, opacity, orange peel/ DOI (distinctiveness of image) transparency, hiding power [8]

UNIT IV: Mechanical Properties of Coatings

Adhesion, flexibility, impact resistance, hardness, mar resistance, abrasion resistance, tensile strength, slip resistance and stress phenomenon in organic coatings. water and moisture resistance; water vapour transmission, PAC and salt spray test, chemical resistance of coatings, resistance to heat and fire, air permeability etc. Electrical resistance properties-conductivity, dielectric constant etc. [8]

UNIT V: Environmental resistance and ageing properties of coatings

Natural & accelerated outdoor weathering tests, weather-o-meter, defects observed in paint film on exposure & its evaluation, evaluation of water based paints, Exterior test protocol, in-can preservation and dry film preservation, Hygiene surfaces, biological effects on water based paint films.

Concept of quality circles, introduction of ISO and other quality standards, Six sigma methodology.

Specific product testing (traffic paints, can & coil coatings, automotive paints, pipeline coatings, marine coatings, aircraft coatings, radiation resistant coatings etc.) [8]

References and suggested readings:

1. Organic Coating Technology, Vol, I & II by H.F. Payne
2. Surface Coatings, Vol, I & II by, OCCA, Australia
3. Outlines of Paint Technology by W. M. Morgan
4. Testing of Organic Coatings by Norman I. Gaynes
5. Paint Testing Manual-Gardener
6. Organic Coatings Analysis by Konstandt
7. -----by Jones, Wicks and Pappas

IPT-701: INDUSTRIAL AND SPECIALITY COATINGS

L : T : P
3 1 0

UNIT I:

Clear finishes for metals and woods. Furniture finishes e.g. sanding sealers, lacquers and cold cure finishes. Automotive coatings: primers, primer-surfacer, fillers, base coats, top coats, clear coats, refinishing, etc. Air craft finishes, Marine coatings: Dock and harbour installations, offshore structures , ships paints, fouling, organisms, leaching rate, types of antifouling paints, recent developments.

Industrial structures and industrial buildings (chemical plants): Primers undercoats, finish coats. Inhibitive primers. Non-convertible and convertible red oxide-zinc chromate, zinc phosphate, zinc rich primers(inorganic and organic) Etch primers, conversion coatings, Colour aesthetics and Standards.

UNIT II:

- (a) Appliance finishes. Coatings for swimming pool, can coatings, coil coatings, coatings for metal containers, papers, plastics, leathers, textiles, etc.
- (b) Heavy duty coatings: Coatings for nuclear power plants, radiation resistant coatings,

UNIT III:

Novelty finishes: Wrinkle, Hammertone, multicolour, Stipple, polychromatic, Crystal crackle, Flamboyant etc. Special purpose coatings : anti corrosive , heat resistant, fire retardant, electrical resistant (insulating), temperature indicating , etc.

06

UNIT IV:

Electrodeposition: Principles of anodic and cathodic electrodeposition, coating compositions based on alkyds, epoxies, polybutadienes, acrylics polyurethanes, etc. application methods , cure machanisms, operating conditions, Throwing Power, merits and demerits, uses.

04

UNIT V:

Miscellaneous coatings : Polyurea, high visibility, phosphorescent, fluorescent, intumescent, putrescent coatings, traffic/road marking paints, rail road coatings, coatings for electronic appliances, aerosols , Anti skid Coatings, Self-stratifying Coatingsetc.

- **NOTE: All above Coatings are required to be discussed covering the following aspects:**
 - (a) **Composition/ Formulation**
 - (b) **Requirements & Specifications**
 - (c) **Specialities in Formulation, Manufacturing and Testing**
 - (d) **Specific end use areas**
 - (e) **Recent Advances**

Reference Book

1. Basics of Paint Technology, Part I & II, by V.C.Malshe & Meenal Sikchi.
2. Surface coatings vol I & II by OCCA, Australia.
3. Surface coatings science and technology Swaraj Paul

4. Organic Coating Technology Vol. I & II by H.F.Payne.
5. Outlines of Paint Technology by W.M.Morgan.

IPT-702 : ARCHITECTURAL AND ECO-FRIENDLY COATINGS

L:T:P::3:1:0

UNIT I:

Introduction To Eco-Systems :Fundamental aspects of environmental protection related to coating industries (Ozone layer, renewable resources, Green coating, Carbon neutral products, Biodegradability of materials). Eco-friendly coatings: aspects of environmental pollution (volatile organic compounds, VOC and hazardous air pollutants, HAP) with reference to conventional coatings & organic solvents, water as a substitute for organic solvents, merits & demerits of water as a solvent, water borne/based/thinnable/reducible coatings, aqueous dispersions Vs. non aqueous dispersions. Substrate type, and aggressiveness of environment for architectural coatings. **[8]**

UNIT II:

Architectural Coatings, Eco-Friendly Coatings. Selection of raw materials for architectural and ecofriendly coatings, effect of solvent(s) on paints and coatings, Drying mechanism of paint. Green building concept , GS 11- 2008 , Green engineering and Green chemistry principles in paint formulation. VOC and its calculation as per BIS and ASTM. International initiatives updates on green paints. **[8]**

UNIT III:

Architectural Coating Systems : Primer-surfacer/ Surfacer, undercoats, putties, sound deadeners, underseal. Decorative/ Tradesale/Architectural paints: Sealers for wood, plasters, primers, surfacers, flat oil paints, synthetic enamels. Water base coatings: Lime wash, Lime colours, Dry distempers, Cement paint, Oxide floor colours, Skim coats, water thinnable primers, oilbound distempers, acrylic washable distempers. Plastic emulsion paints: interior and exteriors; properties and uses. **[8]**

UNIT IV:

Eco-Friendly Coatings: Designing, mechanism, application and merits & demerits of high solids coatings. High solids coatings: Considerations, influence of solvents, temperature, pigments, additives, cross-linkers etc.Radiation curable coatings: Types of radiations, UV curing, fundamental of photopolymerisation, photoinitiators, photo sensitizers, oligomers, monomers, problems associated with radcure cure systems, electron beam curing: EB generators, factors affecting EB generation and curing, uses / areas of application of EB curing and other curing systems. **[8]**

UNIT V:

Powder and Speciality Coatings: Thermoplastic and thermoset; Manufacture of powders, powder classifications, types of powder coatings, application methods; electrostatic, fluidization,/ electrofluidisation, flame spraying, uses, performance affecting parameters. Miscellaneous coatings: Wood coatings, Melamine wood finish, Floor paints, concrete paints, road marking paints. **[8]**

References and suggestive readings :

1. Surface Coatings, Vol. II, By: OCCA, Australia
2. Outlines of Paint Technology, By: W.M.Morgan
3. Surface Coating Technology, By: Swaraj Paul
4. Basics of Paint Technology (Part II), By: Malshe & Sikchi
5. Organic coating technology vol. II By H.F.Payne
6. Powder coatings vo.-1 and vol. -2, by Hester

IPT - 703 : SURFACE PREPARATION, TREATMENT AND COATING APPLICATIONS

L:T:P::3:1:0

UNIT I

Objectives of surface preparation, Surface preparation methods: Hand cleaning, Power cleaning, Abrasive blasting; classification, selection & equipments,

Chemical cleaning: Solvent, Acidic, Alkaline , Emulsion Cleaning

Equipments for surface preparation: Immersion, vapour, wiping & spray, operating conditions, bath analysis & control.

Surface preparation for new & previously painted surfaces.

UNIT II

Pretreatments of ferrous metal substrate: Degreasing, de-rusting, pickling; compositions, operating conditions, bath analysis & control.

Pretreatments of non-ferrous metal substrates: Anodizing

Chemical conversion coatings: Phosphate coatings; classification, advantages & disadvantages of Zn and Fe phosphating, Bath make-up & maintenance, operating parameters, Tricationic treatment, nano technology in surface treatment.

Chromate conversion coating: classification, coating process.; Rinsing, Accelerator, and Passivation.

UNIT III

Coating application: Brush, Roller, Curtain, Dip, Flow, Silk screen, Knife coating, Calendar coating, Powder coating application, Coil coating application

Spray Application: Conventional air spray, Airless spray, HVLP spray, Dual-feed spray, Electrostatic spray, Bell application, Robot Painting, Transfer efficiency, , Overspray disposals.

Electro-deposition: Anodic/ Cathodic deposition, Commercial ED installation, Throwing Power, Bath control, Ultra-filtration, variables, advantages & disadvantages, Bath Parameters, Line Monitoring, common Paint film defects in CED

Plasma coating, Chemical vapour deposition.

UNIT IV

Curing of wet film. Spray Booth (Preparation Zone, Spray Zone, Flash-off Zone), Paint Circulation Systems(Need, Flow diagram, Construction of Paint Containers, Filters, Pressure gauges & Regulators, Pumps, Pipelines & Insulations, CCV, Flushing Line, Air Supply & Exhaust Systems), Promix (Definition, need, Construction & Working principle, Paint-Hardener ratio, Promix Calibration), Air Handling Units (Definition, Importance, Construction & Working Principle, Flow diagram., Humidifier, Filtration System, Eliminator, Plenum, Dampers), Ovens (Types, Zones & Temperature Curves), Conveyors (Need, Types, I beam type, Enclosed tack, Floor Conveyor, Selection of Conveyor, Elements of Conveyor, Lubrication Unit, Drive Unit, Safety Mechanism, Tension Take up Unit, Anti back Mechanism, Drive Synchronisation, Point Load Conveyor Pitch), Jigs & Trollys (Guidelines for Jig designing & its Construction, Importance of Jig Maintenance Jig Utilization) Water in pretreatment shop: control of quality, economy, (DM/ RO Plants) Effluent treatment & waste disposal, Paint circulation systems (Need, Flow diagram, Air velocity & balance, dust level, Filter pressure drop) spray booth management

UNIT V

Paint shop troubles inspection and services

Paint defects: classification, causes & remedies

Paint and Varnish Removers: Solvent & chemical paint removers, mechanism, methods.

References :

1. Surface Coatings, Vol. I & II; by: OCCA, Australia
2. Outlines of Paint Technology; by: W.M.Morgan
3. Surface Coating Technology,; by: Swaraj Paul
4. Basics of Paint Technology (Part II); by: Malshe & Sikchi
5. Phosphating of metals by Warner Rausch
6. Hess's Paint film defects by -----

IPT - 716: Paint Manufacture and Application

L:T:P::3:1:0

UNIT I: Basics

(A) Aspects and Concepts

Paints and their general ingredients, Functions of ingredients, Classifications of paints

(B) Film-formers

Drying Oils, Modified Drying Oils, Natural Resins, Synthetic Resins

UNIT II: Other Raw Materials

Extenders & Prime pigments, Inorganic & Organic Pigments, Lakes & Toners, Dyes & Pigments, True Solvents, Latent Solvents & Diluents, Chemical Composition & Properties of Solvents, Effects of Volatile Solvents on Film properties, Drying Catalysts (Driers), Plasticizers, Additives for Solvent-borne & Water-borne Paints

UNIT III: Formulation & Manufacture of Coatings

Formulation Principles for Organic Coatings (Paints, Varnishes & Lacquers), Calculations involved in Paint Formulations, Steps in Paint Manufacture Dispersion Equipments & Machinery used in Paint manufacture

UNIT IV: Testing of Raw Materials & Paints

Testing of Pigments, Extenders, Oils, Resins, Solvents, Testing of Liquid Paints, Evaluation of Paint Films for Physical, Mechanical, Optical Properties; Chemical Resistance and Corrosion Resistance

UNIT V: Surface Preparation & Paint Application

Different Steps involved in Preparation and Chemical Pre-treatment of surfaces, Different Application techniques, Electrostatic Spraying, Electrodeposition, Common Paint Defects and their Prevention & Cure, Recent Trends in Paints & Paint Application, Safety & Health hazards in Paint Industries

References:

1. Organic Coating Technology, Vol. I & II; by H.F.Payne
2. Outlines of Paint Technology; by W.M.Morgan
3. Surface Coatings, Vol. I & II; by OCCA, Australia
4. Basics of Paint Technology (Part I & II); by Malshe & Sikchi

IPT- 801 : High Polymeric Engineering

L:T:P::3:1:0

UNIT-1 :

Basic concept of polymeric engineering, classification of polymers; polymerisation techniques such as bulk, solution, emulsion and suspension; mechanism and kinetics of chain polymerisation, effect of temperature, pressure, initiator Concentration monomer concentration; mechanism and kinetics of step growth polymerization molecular weight control; ionic polymerisation anionic polymerisation and cationic polymerisation coordination polymerization.

Copolymerisation mechanism and kinetics, copolymer equation monomer reactivity ratios and their determination, types of co-polymerization, instantaneous composition of feed and polymer, azeotropic: copolymerisation, study state kinetics.

Molecular weight of polymer, molecular weight average and degree of polymerisation, polydispersity and molecular weight distribution practical significance of polymer molecular weight determination of molecular weight by cryoscopy ebulliometry, isometry, end group analysis, viscometry, light scattering and ultracentrifugation fractionation of polymers precipitation extraction gradients elution gel permeation chromatographic technique.

Polymer degradation, types of degradation thermal, mechanical ultrasonic waves photodegradation, high energy radiation, oxidative and chemical degradation.

Physical and mechanical properties of polymers, glass transition temperature its importance, amorphous and crystalline polymers and their properties and influence on surface coatings. Optical properties, colour properties, thermal and radiation stability, electrical resistivity, electrical conductivity, fibre forming properties, orientation and its effect on the properties of polymers, chemical reactivity and products derived from polymers, oxidation stability of polymers.

References :

1. Organic Coating Technology, Vol, I & II by H.F. Payne
2. Principles of Polymer Chemistry by P. J. Flory
3. Text Book of Polymer Science by F. W. Billmeyer
4.by Gowariker

IPT - 802 : Technology of Printing Inks

UNIT I :

L:T:P::3:1:0

Nature of printing inks, nature of print, methods of drying of printing inks, classification of printing inks. Printing Processes- offset lithographic process, flexographic process, gravure process, letterpress process, screen printing process, inkjet printing, intaglio printing process, toner printing systems, other printing processes e.g.digital inks, plastisol inks, sublimation inks, MICR inks, fugitive inks and security inks, print recognition, substrate selection and need for communication,

UNIT II

Testing and evaluation of raw materials for use in printing inks: Pigments, Dyestuffs, Oils, Resins (Natural and Synthetic), Solvents, Plasticizers, Waxes, Driers, Miscellaneous additives (Chelating agents, anti-oxidants, surfactants, deodorants, Defoaming agents, Laking agents), Raw materials for radiation curing systems (pigment selection, prepolymers, reactive diluents, photo-initiators, additives and inhibitors).

UNIT III

Letterpress inks: General characteristics, Types of presses, Letterpress ink formulation, Inks for packaging, Ink-related problems and their possible solution, Lithographic inks: General characteristics, offset ink formulations, Inks for packaging, metal decorating inks, Ink-related problems and their possible solution, Web-offset inks for paper and board, Dry offset inks, formulating principles of two-piece can decoration inks, multi colour process printing and hexachrome inks.

UNIT IV

Gravure inks, General characteristics, Formulating principles, Inks and varnishes for specific end-use applications, Printing ink faults, Flexographic inks, General characteristics of the inks, Formulating principles, flexible packaging inks for different applications, Screen inks, General characteristics, screen Inks for paper, plastics, textile, leather, wood, glass etc. Daylight fluorescent inks, Speciality screen inks, Inks for the electronics industry, Ultra-violet and electron-beam curing inks,

UNIT V

Manufacture of inks, Mixing and Milling equipments, Handling storage and manufacture of UV inks, Modern production trends and innovations in printing inks, edible and soluble packaging inks, Rheology of printing inks, Testing and quality control and Analysis of printing inks, Health, safety and the environment,

References :

1. Printing Ink Manual; by R. H. Leach & R. J. Pierce
2. Ink Technology for Students & Printers; by E.A. Apps
3. Water based inks by Laden

IPT – 803 : CORROSION ENGINEERING AND CONTROL

L:T:P::3:1:0

UNIT-I :Introduction To Corrosion : Definitions: corrosion science and corrosion engineering; consequences of corrosion, cost of corrosion; inter-disciplinary nature of corrosion; corrosive environment; functional aspect of corrosion; classifications of corrosion processes; corrosion quantification and corrosion rate expressions; electrochemical aspects to affect corrosion rate - polarization and passivity; environmental factors to affect the corrosion rate.

UNIT II: Fundamentals Of Corrosion Science : atom, atomic aggregation, electrolytes, oxidation and reduction reactions, acids, bases and salts, neutralization and hydrolysis, pH and pOH, metallurgy; metals and alloys and solid solutions, crystal imperfections, surface heterogeneity, macroscopic defects, heat treatment and slag inclusion in steel. Electrochemistry: electrical conduction, electrolysis, electrochemical (voltaic or galvanic) cell, electromotive force, electrode potentials, emf vs galvanic series. potential-pH (pourbaix) diagram, thermodynamics - free energy. surface chemistry: electrified interface and electrical double layer. Differential couples: galvanic, concentration and electrolytic cells. Passivity: characteristic parameters for passivation, mechanism of passivation, passivators and inhibitors, theories of passivation , mechanism of passivation, mechanical passivity.

UNIT III : Corrosion Processes: Mechanism of corrosion processes-chemical and electrochemical corrosion. Nature of the environment-atmospheric corrosion, marine corrosion, underground corrosion, biological corrosion hydrogen cracking, radiation cracking, liquid-metal corrosion, molten salt corrosion, acid corrosion, alkali corrosion, corrosion in electrolytes. Type of corrosion deterioration-micro and macro corrosion, surface corrosion, local corrosion, intercrystalline corrosion, Type of corrosion reaction-film free chemical reactions, electrochemical reactions (inseparable and separable anode/cathode type, interfacial anode /cathode type). Mechanical forces on and within the metal-stress corrosion, corrosion fatigue, erosion corrosion, cavitation corrosion, fretting corrosion. Low temperature and high temperature corrosion. Corrosion in non metals- rubber/elastomers properties, plastics (thermoplastics and thermosets) , ceramics, carbon & graphite, wood; their properties and behavior towards corrosion.

UNIT IV : Forms of Corrosion :Chemical vs. electrochemical corrosion, uniform corrosion, non-uniform/localized attack - Galvanic/Bimetallic, Crevice & Filiform , Pitting , Inter granular corrosion, Selective leaching-dezincification & graphitization , Erosion corrosion - impingement attack, cavitation damage, fretting corrosion, Stress corrosion cracking & corrosion fatigue, Filiform (under film) corrosion, Selective corrosion or selective leaching, De-alloying corrosion, Exfoliation, Hydrogen damage, Radiation damage, stain corrosion, Pin point corrosion, caustic embrittlement. Animal body (in vivo) corrosion, aerospace, electronic equipments, dew point corrosion, high temperature corrosion, dry oxidation & Pilling-Bedworth ratio, catastrophic oxidation; iron pillar and statue of liberty.

UNIT V : Corrosion In Industries: chemical industries- pulp & paper, fertilizer, paint manufacture & application industries; petroleum refineries and petrochemical industries; building industry and rebar corrosion; boiler plants; automobile industry; nuclear power plants. Corrosion testing : Planning and preparation; destructive and non-destructive methods; physico-chemical methods-immersion, humidity, salt spray, special property tests for SCC, IGC etc.; electrochemical methods-E-Icurves/Evans diagrams/polarization diagrams; electrode potential measurements, polarization measurements-Tafel's extrapolation, linear polarization, polarization break, impedance measurement, cyclic voltametry; merits and demerits of various test methods; electronic instrumentations, NACE test methods; Performance evaluation of paints and protective coatings; corrosion of plastics and elastomers; nomographs for corrosion rates. Methods of corrosion control and corrosion prevention: Selection of materials of construction; alteration of corrosion environment; corrosion inhibitors; change in design; coatings (metallic, inorganic & organic coatings); cathodic protection and anodic protection

References and suggestive Readings:

1. Corrosion engineering, by Mars G. Fontana, McGraw-Hill Book Company
2. An introduction to science of corrosion and its inhibition, by S.N.Banerjee, Oxonian Press Pvt. Ltd.
3. Corrosion and corrosion protection handbook , by Philip A. Schweitzer (Ed.), Marcel Dekker Inc.
4. Corrosion and corrosion control by H.H.Uhlig & R.V.Revie Wiley-Interscience
5. Uhlig, H.H., The Corrosion Handbook, John Wiley and Sons, Inc. London, 1961
6. Shreir, L. L., Basic Concepts of Corrosion volume 1, pp 1:3–1:15, _ 2010 Elsevier B.V.
7. Frnkel, S. Gerald, Electrochemical Techniques in Corrosion: Status, Limitations, and Needs, Journal of ASTM International, Vol. 5, No. 2, Feb. 2008 (paper ID JAI101241.
8. Corrosion inhibitors by

IPT-804: Instrumentation in Coating Industry

L:T:P::3:1:0

UNIT I Chromatographic Techniques : Theory practice and application of paper chromatography, thin layer chromatography (TLC), Gas liquid chromatography (GLC) High pressure (Performance) liquid chromatography (HPLC) in coating industry for the analysis of oils, resins, solvents and plasticizers. Microscopy in coatings and coating ingredient: Microscopical examination of pigments, paints and paint films. Scanning electron microscopy (SEM): Principle and practice.

UNIT II Infra Red (IR) spectroscopy : Theory, instrumentation, qualitative analysis, monitoring chemical changes in coating materials, internal reflection spectroscopy, fourier transform infra red (FTIR) and quantitative analysis. Near Infrared (NIR) Spectroscopy.

UNIT III: Nuclear magnetic resonance (NMR) spectroscopy : nuclear spin MNMR equation, relaxation, The NMR instrument, chemical shift, spin-spin coupling, application of NMR to coatings and polymers.

UNIT IV : X-ray analysis : analysis based on X-ray diffraction and X-ray emission, use of DSC (Differential Scanning Calorimetry) and TGA (Thermo Gravimetric Analysis) in characterization of coatings.

UNIT V : Computer in coating Industry: Resin/polymer design, product formulation and costing, colour matching, raw material and formula file data bases for non technical applications, future trends.

References :

1. Organic Coating Technology, Vol, I & II by H.F. Payne
2. Testing of Organic Coatings by Norman I. Gaynes
3. Paint Testing Manual-Gardener
4. Treatise on Coatings-Meyer & Long

IPT-805 : Packaging Technology

L:T:P::3:1:0

UNIT I : Elements of packaging, concepts, function, entities, status, scope, biotic and abiotic, natural packaging, packaging values, Professional approach to development of package for food products, general

consumables, cosmetics, pharmaceuticals, engineering materials and other utilities.

UNIT II : Packaging materials and their forms. Paper and paper board, folded cartons and setup boxes, corrugated board, box construction, interior packings, moulded forms, paper composites, tetra pack, wood containers, glasswares.

UNIT III: Plastic as packaging material in different forms: Extrusion, moulding and thermoforming, flexible polymeric films, metallic foils, orientation and metallization.

UNIT IV: Metal containers, tin plate cans, tin free steel cans and tempers, coatings and linings, aluminum cans, collapsible tubes, fiber tubes, Aerosols-principle, valves, spray pattern, metering valves. Closures, applicators, fasteners.

UNIT V: Coatings and lamination, paper films and foils for lamination, adhesives, labels and labeling, heat transfer labels, coding and holograms etc. cushioning, straps, clips, nuts, nails, laws and regulations, Test methods, quality control, machinery and equipments. Package printing importance, Package disposal, Eco-Friendly packings, Innovations in packaging: Active packaging, anti microbial containers, RFID technologies.

References :

1. Handbook of Package Engineering by Joseph F. Hanlon
2. Edible Coatings & Soluble Packaging by Roger Daniels

IPT 806 : Industrial Painting Practices

L:T:P::3:1:0

UNIT I :Selection of industrial paints for different end uses. Type of surfaces and paint application techniques for large surfaces

UNIT II : Surface Preparation

- (a) Mechanical - Hard cleaning, power tool cleaning, flame cleaning, Blast cleaning, cleaning & welds
- (b) Chemical - Solvent wiping & degreasing alkali cleaning, emulsifiable solvent cleaning, steam cleaning, acid cleaning, pickling, phosphating Zn & Fe Paint removers

UNIT III: Practical aspects use & application of paints

Quality control of paints

Shop Painting of steel in fabricating plants

UNIT IV: Painting of Rail board bridges & structures

Painting of Highway bridges & structures

The Painting of steel vessels for fresh water service

Painting of steel tanks

Painting of steel in hydraulic structures

Unit-V

Protection of Pipelines & other underground structures Painting of industrial plants

- (a) Water sewage works structures
- (b) Maintenance painting of steel coke oven plants
- (c) Petroleum refineries
- (d) Chemical plants
- (e) Colour in industrial plants

Metallizing

Causes & prevention of paint failure

References :

1. Good Painting practices by J, Bigos

IPT- 351 : Oil Based Coating Media Lab

L:T:P::0:0:6

I. Physical examination of glyceride oils:

Colour, Specific Gravity, Refractive index, Viscosity, Solubility, Drying Time

II. Chemical Examination/ Characterization of glyceride oils :

Acid Value, Iodine Value, Saponification Value, Hydroxyl Value

III. Preparation and testing of modified oils :

Heat-bodied (stand) oils, Boiled oils, Dehydrated castor oils, Oil-Splitting and Reconstituted oils, Co-polymerized oils, Maleinized oils, Water-soluble oils

IV. (A) Preparation of Driers: Salts of Lead/ Cobalt/ Manganese, as Naphthenates and Octoates

(B) Analysis of driers : Non-volatile Content, Metal content

V. Evaluation of Volatile Solvents: Colour, Acidity, Moisture Content (K&F), Solvent (Cutting) Power, Distillation Range, Relative Evaporation Rate, Flash Point, Aniline Point, Aromatic Content, Refractive Index, Copper Corrosion Test, Density, Surface Tension, Electrical Conductivity, Purity by Gas Chromatography.

VI. (A) Preparation of different Types of Oil-based Coating Media: By using various Drying Oils/ Natural resins combinations

(B) Testing of Oil-based Coating Media: Colour, Specific Gravity, Refractive index, Viscosity, Drying Time (with Various Driers), Non- volatile (Solids) Content

NOTE: Evaluation / Testing/ Analysis/ Characterization is to be done by using **MODERN INSTRUMENTS**.

References :

1. BIS Specifications, No. 74, 548 Part (I)
2. AOCs Specification , No , ,
3. ASTM Specification No. , ,

IPT- 451 : Oleo-resinous media lab

L:T:P::0:0:6

I. Physical Examinations of natural resins: Softening point, Solubility in solvents of varying polarity, Viscosity & non volatile contents of resin solutions

II. Chemical examination of natural resins: Acid value, Iodine Value, Hydroxyl value, Infra red spectroscopy, Molecular weight (viscosity method, Gel Permeation Chromatography)

III. Preparation and testing of rosin modifications:

- (i) Lime, Zinc oxide, Magnesium oxide hardened rosin
- (ii) Rosin esters (ester gum and penta ester gum)
- (iii) Rosin-maleic adduct (normal)
- (iv) Rosin-maleic adduct (water-soluble)
- (v) Maleic Resin (normal)
- (vi) Maleic Resin (spirit soluble)
- (vii) Maleic Resin (water soluble)
- (viii) Rosin modified phenolics
- (ix) Lime, zinc, magnesium hardened maleic adduct.
- (x) Methyl-esters of rosin.

IV. Chemical modifications of shellac

V. Preparation of clear lacquers (NC and Acrylics), and determination of their viscosity, solids content and drying time

VI. Evaluation of plasticizers for their efficiency

VII. Evaluation of effectiveness of anti-settling agents, anti-skinning agents, dispersing agents, anti-foam agents, thixotropic agents

VIII. Preparation and application (brush/spray) of varnishes based on rosin esters, and testing them for viscosity, non-volatile (solids) content and drying time

IX. Preparation and testing of oleoresinous media for paints, and film application (brush/spray)

X. Preparation of paints (primers/top-coat), and testing them for viscosity, non-volatile (solids) content, weight per liter, drying time

XI. Water solubility of casein, HEC, SCMC

XII. Evaluation of various grades of NCs, chlorinated rubbers and cyclized rubbers by their solubility behaviors, solids content and viscosity of solutions.

References:

1. BIS Specifications, No. , ,
2. AOCS Specification, No , ,
3. ASTM Specification No. , ,
4. B.S.Specification, No. , ,
5. DIN

IPT-551: PIGMENTS AND EXTENDERS LAB

L:T:P::0:0:6

A. TESTING AND EVALUATION OF GENERAL PROPERTIES OF PIGMENTS AND EXTENDERS :

- TEXTURE
- COLOUR

- TINTING STRENGTH/REDUCING POWER
- OIL ABSORPTION
- DANIEL'S FLOW POINT
- RESIDUE ON SIEVE
- BULKING VALUE/BULKING DENSITY
- SP. GRAVITY
- MOISTURE CONTENT
- WATER SOLUBLE MATTER
- BLEEDING
- LIGHT FASTNESS (1-8 BLUE WOOL SCALE)
- WEATHER FASTNESS (1-5 BLUE WOOL SCALE)
- ETC.

B. PREPARATION OF PIGMENTS

1. INORGANIC PIGMENTS

- LEAD CHROME
- ZINC CHROME
- CHROMIUM OXIDE GREEN
- CHROME GREEN
- PRUSSIAN BLUE
- YELLOW OXIDE OF IRON
- RED OXIDE OF IRON
- BLACK OXIDE OF IRON

2. ORGANIC PIGMENTS

- Pigment Yellow 1,
- Pigment Yellow 3,
- Pigment Yellow 12,
- Pigment orange 13,
- Pigment red 3,
- Pigment Red 4,
- Pigment Red 8,
- Pigment Red 170,
- Pigment Blue

3. EXTENDERS : e.g. Calcium carbonate, barium sulphate, silica etc.

References:

1. B.S.Specification, No.. .. ,
2. AOCs Specification, No,
3. ASTM Specification No. ,
4. BIS Specifications, No,

NOTE: The modern instrumentation techniques should also be used in Evaluation , Testing, Analysis and Characterization is to be done by using modern instrumentations.

IPT - 552 : Coating Testing Lab

L:T:P::0:0:6

Evaluation of Physical Properties of Paints/Varnishes and Lacquers

1. Density
2. Bulking value by Wt/ litre cup
3. Non volatile matter
4. Fineness of grind by Hegman Gauge
5. Viscosity by Brookfield, Bubble Tube and Cone & Plate Viscometer
6. Application of films by Automatic Film Applicator and Bar Applicator
7. Determination of Wet Film and Dry Film Thickness
8. Drying Time
9. Surface Roughness by Surface Profile Gauge

Evaluation of Optical Properties of Coating Films

1. Opacity by Digital Opacity Meter
2. Hiding Power by Black & White Cryptometer
3. Gloss by Digital Glossometer
4. Color by Color Matching Cabinet
5. Analysis of Colour by Color Spectrophotometer
6. Distinction of Image by DOI Meter

Evaluation of Mechanical Properties of Coating Films

1. Scratch Hardness by Automatic Scratch Hardness Tester
2. Pencil Hardness by Pencil Hardness Tester
3. Hardness by Pendulum Hardness Tester
 - Adhesion by Pull off Adhesion Tester
 - Adhesion by Cross Cut Adhesion Tester
 - Mechanical Strength by Cupping Tester
4. Flexibility by Conical & Cylindrical Mandrel Tester
5. Impact Resistance by Tubular Impact Tester
6. Abrasion Resistance by Wet Abrasion Tester & Taber Abrasion Tester
7. Bond Strength of Coatings by Digital Bond/Heat Seal Strength tester

Evaluation of Electrical Resistance Properties of Coating Films

1. Electrical Strength of Coatings by Digital Voltage Breakdown Tester
2. Resistivity of Paints by Paint Resistivity Meter
3. Pinhole Testing by Holiday Detector (Pinhole Tester)

Evaluation of Chemical Resistance Properties of Coating Films

1. Salt Spray Test using Salt Spray Cabinet
2. Corrosion Resistance by Digital Corrosion Cabinet
3. Exterior Durability by Accelerated UV Weathering Cabinet

Paint Analysis Including Analysis of pigments, Binder and Solvents

IPT - 651 : Resins and Emulsion Lab

L:T:P::0:0:3

1. Preparation of Oil-in-Water & Water-in-Oil Type Emulsions
2. Preparation of Water Reducible & water Dispersible Media
3. Preparation and Testing of Water Soluble Alkyds
4. Preparation and Testing of Water Soluble Epoxies
5. Preparation and Testing of Bitumen Emulsion, CNSL Emulsion
6. Preparation and Testing of Rubber Emulsion
7. Preparation and Testing of Emulsions based on Acrylics, Vinyl Acetate,
8. Preparation and Testing of PUD
9. Preparation and Testing of Micro Emulsions
10. Preparation and Testing of Secondary Alkyd Emulsion
11. Preparation and Testing of Homopolymers and Copolymers by Emulsion Polymerisation
12. Preparation of all type of alkyds (solvent and water based) and testing of their acid value, colour ,drying and film properties.
13. Preparation of alcohol and oil soluble phenolic resins and their testing.
14. Preparation of butylated and Methylated UF and MF resin
15. preparation of epoxy resins and epoxy esters and its characterization.
16. preparation of saturated and unsaturated Polyester resins
17. preparation of acrylic resins
18. preparation of polyurethane resins

NOTE: Evaluation/Testing/ Analysis/ Characterization is to be done by using **Modern Instruments**.

References:

1. BIS Specifications, No. , ,
2. AOCS Specification, No , ,
3. ASTM Specification No. , ,
4. B.S.Specification, No. , ,

IPT - 751 : Coatings Preparation and application Lab

L:T:P::0:0:6

1. To prepare a sample of Dry distemper.
2. To prepare a sample of Cement Paint
3. To prepare a sample of Oxide floor colour.
4. To prepare a sample of Skim coat (Wall Putty)
5. To prepare a sample of White Primer (Solvent base)
6. To prepare a sample of Red oxide Primer
7. To prepare a sample of Synthetic Enamel
8. To prepare a sample of Air drying cum stoving Enamel
9. To prepare a sample of Road Marking Paint
10. To prepare a sample of Zinc Rich Primer
11. To prepare a sample of N.C. Lacquer
12. To prepare a sample of chlorinated rubber paint
13. To prepare a sample of Oil bound distempers.
14. To prepare a sample of Acrylic washable distemper.
15. To prepare a sample of Interior plastic emulsion paint
16. To prepare a sample of Exterior plastic emulsion paint.
17. To prepare various types of coatings by vibroshaker.
18. To prepare the surface of wood for application of coatings.
19. To prepare the surface of glass for application of coatings.
20. To prepare the surface of concrete for application of coatings.
21. To prepare the surface of plastic for application of coatings (adhesion promoter).
22. To prepare the surface of ferrous metal for application of coatings.
23. To prepare the surface of non-ferrous metal for application of coatings.
24. To prepare the previously painted surface for application of coatings.
25. To apply a sample of coating by brush application.
26. To apply a sample of coating by spray application.
27. To apply a sample of coating by powder coating plant.
28. To apply a sample of coating by electro-deposition method.
29. To characterize the converted coating structure on treated surface by imaging microscope.