

**Proposed Syllabus Structure for the B.Tech Course Surface coating Engineering & Tech.**

**Semester I**

No.	Subjects	Hours/week (L + T)	Marks	Credits
1	Inorganic Chemistry	2+1	50	3
2	Organic Chemistry-I	3+1	100	4
3	Applied Mathematics-I	2+2	100	4
4	Applied Physics-I	3+1	100	4
	<b>TOTAL</b>	<b>15</b>	<b>350</b>	<b>15</b>
5	Engineering Graphics-I	8	100	4
6	Physics Laboratory	4	50	2
7	Inorganic Chemistry Laboratory	4	50	2
8	Organic Chemistry Laboratory	4	50	2
	<b>Total Practicals</b>	<b>20</b>	<b>250</b>	<b>10</b>
		<b>35</b>	<b>600</b>	<b>25</b>

**Semester II**

No.	Subjects	Hours/week (L + T)	Marks	Credits
1	Organic Chemistry-II	3+1	100	4
2	Analytical Chemistry	2+1	50	3
3	Material & Energy Balance Calculations	2+2	100	4
4	Applied Mathematics-II	2+2	100	4
5	Applied Physics-II	2+1	50	3
	<b>TOTAL</b>	<b>18</b>	<b>400</b>	<b>18</b>
6	Engineering Applications of Computers	4	50	2
7	Organic Chemistry Laboratory	4	50	2
8	Analytical Chemistry Laboratory	4	50	2
9	Communication Skills	4	50	2
	<b>Total practicals</b>	<b>16</b>	<b>200</b>	<b>8</b>
		<b>34</b>	<b>600</b>	<b>26</b>

- #where there are one special subject or practice in specials bracket it should be considered common for both Polymer & Paints students
- \* where there are two special subject or practice in specials bracket first one is for Polymers & second one is for Paints students

### Semester III

No.	Course code	Subjects	Hours/week (L + T)	Marks	Credits
1		Engineering Mechanics and Strength of Materials	3+1	50	3
2		Electrical and Electronics Engineering*	2+1	50	3
3		Physical Chemistry	3+1	100	4
4	PST1C01	Spl 1: Polymer Science & Technology I	3+1	100	4
5	PST1C02	Spl 2: Polymer Science & Technology II	2+1	50	3
6	PST1C03	Spl 3: <u>Materials Technology</u>	2 +1	50	3
		<b>TOTAL</b>	<b>21</b>	<b>400</b>	<b>19</b>
7		Electrical and Electronics Engineering Laboratory	4	50	2
8		Physical Chemistry Laboratory	4	50	2
9	PSP1C04	Pr1: <u>Analysis &amp; Characterization of raw materials &amp; polymers-I</u>	4	50	2
		<b>Total Practicals</b>	<b>12</b>	<b>150</b>	<b>6</b>
			<b>33</b>	<b>550</b>	<b>26</b>

### Semester IV

No.	Course code	Subjects	Hours/week (L + T)	Marks	Credits
1		Transport Phenomena	3+1	100	4
2	PST1C05	Spl 4 Polymer Science & Technology III	3+1	100	4
3	PST1C06	Spl 5 Thermoplastics Polymer Technology I	2+1	50	3
4	PST1C07	Spl 6 Technology of Thermoset Polymers- I	2+1	50	3
5	PST1C08	Spl 7 Colour Physics & colour Harmony	3+1	100	4
		<b>TOTAL</b>	<b>18</b>	<b>400</b>	<b>18</b>
6	PSP1C09	Pr 2: <u>Analysis &amp; Characterization of raw materials &amp; polymers-II</u>	4	50	2
7	PSP1C10	Pr 3: Synthesis & Characterization of resins & polymers-I	4	50	2
8	PSP1C11	Pr 4: Colour Physics	4	50	2
		<b>Total Practicals</b>	<b>12</b>	<b>150</b>	<b>6</b>
			<b>30</b>	<b>550</b>	<b>24</b>

### Semester V

No.	Course code	Subjects	Hours/week (L + T)	Marks	Credits
1		<b>Chemical Engineering Operations</b>	2+1	50	3
2		<b>Chemical Reaction Engineering</b>	2+1	50	3
3	PST1C12	<b>Spl 8:</b> Thermoplastics Polymer Technology II	2+1	50	3
4	PST1C13	<b>Spl 9:</b> Thermoplastics Polymer Technology III	2+1	50	3
5.	PST1C14	<b>Spl 10:</b> Technology of Thermoset Polymers- II	2+1	50	3
6	PST1C15	<b>Spl 11:</b> Technology of Thermoset Polymers- III	2+1	50	3
		<b>TOTAL</b>	<b>18</b>	<b>300</b>	<b>18</b>
7	PSP1C16	<b>Pr 5</b> <i>Analysis , Characterization of raw materials &amp; Synthesis of resins &amp; polymers</i>	4	50	2
8	PSP1C17	<b>Pr 6</b> Synthesis & Characterization of resins & polymers-II	8	100	4
9	PSP1C18	<b>Pr 7</b> Synthesis & Characterization of resins & polymers-III	4	50	2
		<b>Total Practicals</b>	<b>16</b>	<b>200</b>	<b>8</b>
			<b>34</b>	<b>500</b>	<b>26</b>

### Semester VI

No.	Course code	Subjects	Hours/week (L + T)	Marks	Credits
1		<b>Instrumentation</b>	2+1	50	3
2	PST1C19	<b>Spl 12: Pigments &amp; Additives for Polymers</b>	2+1	50	3
3	PST1S01	<b>Spl 13</b> Paints Technology -I	3+1	100	4
4	PST1S02	<b>Spl 14:</b> Paints technology II	2+1	50	3
5	PST1S03	<b>Spl 15:</b> Paints technology -III	2+1	50	3
6	PST1P04	<b>Elective-I:</b> Structure property relationship	2+1	50	3
		<b>TOTAL</b>	<b>19</b>	<b>350</b>	<b>19</b>
7		<b>Chemical Engineering Laboratory</b>	4	50	2
8	PSP1S04	<b>Pr 8:</b> Processing of paints-I	8	100	4
9	PSP1S05	<b>Pr 9:</b> Processing of paints-II	4	50	2
		<b>Total</b>	<b>16</b>	<b>200</b>	<b>8</b>
			<b>35</b>	<b>550</b>	<b>27</b>

**In-Plant Training: 50 marks/2 credits**

### Semester VII

No.	Course code	Subjects	Hours/week (L + T)	Marks	Credits
1		Project Economics	2+1	50	3
2		Industrial Psychology and Human Resource Management	2+1	50	3
3	PST1S06	Spl 16: Corrosion protection Tech.	2+1	50	3
4	PST1S07	Spl 17: Technology of Printing Inks	2+1	50	3
5		Spl 18: Evaluation & testing of Polymers -I	2+1	50	3
6	PST1S08	Elective II : Electrical Insulation Coatings	2+1	50	3
		<b>TOTAL</b>	<b>18</b>	<b>300</b>	<b>18</b>
7	PSP1S09	Pr 10: Processing of Paints-III	8	100	4
8	PST1C20	Seminar	4	50	2
9	PSP1S10	Pr 11: Analysis & Testing of Paints	4	50	2
		<b>Total Practicals</b>	<b>16</b>	<b>200</b>	<b>8</b>
			<b>34</b>	<b>500</b>	<b>26</b>

### Semester VIII

No.	Course code	Subjects	Hours/week (L + T)	Marks	Credits
1		Industrial Management	2+1	50	3
2		Value Education	2+1	50	3
3		Design and Analysis of Experiments	2+1	50	3
4	PST1S12	Spl 19 Advanced Paints technology I	2+1	50	3
5	PST1S13	Spl 20: Pigments & additives for Paints	2 +1	50	3
6	PST1S14	Elective III -Advanced Paints Technology II	2+1	50	3
		<b>TOTAL</b>	<b>18</b>	<b>300</b>	<b>18</b>
7	PSP1S15	Pr 12: Processing & analysis of paints IV	4	50	4
8	PSP1C21	Experimental Project	12	150	6
		<b>Total</b>	<b>16</b>	<b>200</b>	<b>10</b>
			<b>34</b>	<b>500</b>	<b>28</b>

**Total credits of all semesters = 25 (Sem I) + 26 (Sem II) + 25 (Sem III) + 24 (Sem IV) + 26 (Sem V) + 27 (Sem VI) + 2 (IPT) + 27 (Sem VII) + 28 (Sem VIII) = 209**

**Total Marks: 600 (Sem I) + 600 (Sem II) + 550 (Sem III) + 550 (Sem IV) + 500 (Sem V) + 550 (Sem VI) + 50 (IPT) + 500 (Sem VII) + 550 (Sem VIII) = 4450**

- #where there are one special subject or practice in specials bracket it should be considered common for both Polymer & Paints students
- \* where there are two special subject or practice in specials bracket first one is for Polymers & second one is for Paints students

Subject heads	AICTE Norms	Proposed syllabus in %			
		Marks	% Marks	Credits	% Credit
<b>General</b>	<b>5 - 10 %</b>	<b>250</b>	<b>5.68</b>	<b>14</b>	<b>6.73</b>
<b>Basic Sciences</b>	<b>15 – 25 %</b>	<b>1150</b>	<b>26.14</b>	<b>50</b>	<b>24.04</b>
<b>General Engineering + Chemical Engineering</b>	<b>15 – 25 %</b>	<b>650</b>	<b>14.77</b>	<b>31</b>	<b>14.90</b>
<b>Professional courses</b>	<b>55 – 65%</b>	<b>2350</b>	<b>53.41</b>	<b>113</b>	<b>54.33</b>
<b>GRAND TOTAL</b>	<b>--</b>	<b>4400</b>	<b>100</b>	<b>208</b>	<b>100</b>

**Electives to be offered by Polymer Engineering and Technology Department and their prerequisite**

S. No.	Elective	Prerequisite
1	Polymer Science & Technology II(SemIII) <b>Corrosion protection Tech. (SemVII)</b>	<b>No prerequisite</b>
2	<b>Elective-I:</b> Structure property relationship	<b>No prerequisite</b>
3	<b>Elective II:</b> Electrical Insulation Coatings (Sem. VII)	<b>Polymer / Paints /Oils</b>
4	<b>Elective III-</b> Advanced Paints Technology II	<b>Polymer / Paints / Oils</b>

**SEMESTER I** No Special Subjects

**SEMESTER II** No Special Subjects

**SEMESTER III**

**THEORY**

**PST1C01:Special 1: Polymer Science & Technology I (Polymer/ Surface coating)**

(4 h/ week)

Marks 100

Historical developments in polymeric materials, Basic concepts & definitions : monomer & functionality, oligomer, polymer , repeating unites, degree of polymerization, molecular weight & molecular weight distribution. (5),

Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins etc. (9),

Raw material for synthetic polymers: Manufacturing of various fractions of crude petroleum important for polymer industry for (a) Raw Materials such as ethylene, propylene, butadiene, vinyl chloride, vinylidene dichloride, styrene, acrylic monomers like acrylic acid, acrylonitrile, methacrylic acid, methacrylates, acrylamide etc, (c) Polyacids such as phthalic acid, terephthalic acid, isomers and anhydrides etc. (d) phenols, polyols and their modifications, (e) Isocyanates, (f) Amino Compounds, (g) Other petroleum based material

(31)

(b) solvents such as alcohols, toluene, xylene, acetone, ketones, terpenes, chloromethanes etc. Evaluation of raw materials and reactants for synthesis & manufacturing of polymers.

(15)

**Textbooks/Sourcebooks:**

1. Raw Materials for Industrial Polymers by H Ulrich, Hanser Publication 1989.
2. Principles of Polymer Science, by Bahadur and Sastry, Narosa Publishing House 2002.
3. Polymer Science by Gowariker, Johan wiley and Sons 1986.
4. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
5. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
6. Petrochemicals The Rise of an Industry by Peter H. Spitz, Johan Wiley and sons 1988.
7. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.

**PST1C02:Special 2 Polymer Science & Technology II (Polymer/ Surface coating)**

(2 hrs/ week)

Marks 50

Classification of polymers thermoplastic/ thermoset, addition/ condensation, natural /synthetic, crystalline/amorphous, step growth /chain growth, ,commodity...specialty, homochain/ heterochain, confirmation: homo & copolymers (detailed graft ,block alt, ladder etc. & nomenclature), configuration cis/trans; tacticity, branched/ crosslinked, Classification of polymers based on end use etc. (7)

Molecular weight and its distribution determination ( $M_n$  to  $M_z$  & MWD), Carothers equation, states of polymers, transition temperatures such as  $T_g$ ,  $T_c$ ,  $T_m$ , solubility parameter, solution properties, temperature, good/ bad solvent, (12)

Addition, condensation polymerization mechanism (7)

Surface tension/ energy & contact angle measurements of different polymeric systems & their wettability with other substances. (4)

**Textbooks/Sourcebooks:**

1. Principles of Polymer Science, Bahadur and Sastry, Narosa Publishing House 2002.
2. Polymer Science, Gowariker, John Wiley and Sons 1986.
3. Encyclopedia of Polymer Science and Technology, John Wiley and Sons, Inc 1965.
4. Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, Inc 1988.
5. Polymer Chemistry, Malcolm P. Stevens, Oxford University Press, Inc, 1990.
6. Text book of polymer Science, Billmeyer, John Wiley and Sons 1984.
7. Principles of Polymer Systems, Rodriguez, Hemisphere Publishing Corp, 1982.
8. Introduction to Polymer Science and Technology, H. S. Kaufman and J. J. Falsetta, Wiley – Interscience Publication, 1977
9. Polymer Science and Technology of Plastics and Rubbers, P. Ghosh,
10. Tata McGraw-Hill Publishing Company 1990.
11. Textbook of Polymer Science, P. Nayak and S. Lenka, Kalyani Publishers, 1986.
12. Fundamentals of Polymer Science an introductory text, P. Painter and M. Colman, Technomic publishing Co Inc, 1994.
13. Textbook of Polymer Science and Engg Anilkumar and Gupta, Tata McGraw-Hill Publishing Co, Ltd., 1978.
14. Polymer Science and Technology by J. R. Fried, Prentice-Hall, Inc 1995.
15. Polymer chemistry, Seymour and Carraher, Marcel Dekker, 2003.
16. Fundamentals of Polymer Processing, S. Middleman, Houghton Mifflin Company, 1997.

**PST1C03: Spl 3: Materials Technology:**  
**(Polymer/ Surface coating)**

(2 hrs/ week)  
Marks 50

Crystal structure, crystal defects, atomic packing factor, study of different metals iron/steel, Al, brass, copper, nickel, chrom, titanium etc. Their different grades/ compositions of alloys. Annealing, nitriding, carburizing & other treatments etc. corrosion of metals, electrochemistry, corrosion & its prevention. Use of different grades of steel for manufacture of reactors, molds, dies & plastic processing equipments.

**Textbooks/Sourcebooks:**

Mechanical metallurgy

Dieter

**Practicles:**

**PSP1C04:Pr1: Analysis & Characterization of raw materials & polymers-I Marks 50**  
**(Polymer/ Surface coating) 2X4**

- 1) To Check the colour of oil & resins.
- 2) To Check the colour of oils & resins on heating.
- 3) To check the viscosity of oils & resins solution using Ford Cup or Brookfield viscometer.
- 4) To check the melting range of given resin by capillary tube method.
- 5) To find the acid value of given sample.
- 6) To find Aniline point of given solvent.
- 7) To find the distillation large of given solvent.
- 8) To find the evaporation rate of given solvent.
- 9) To find flash point of given solvent.
- 10) To find moisture content of solvent (qualitative analysis)
- 11) To find specific gravity of solvent by pycnometer.
- 12) To find the moisture content of pigment.
- 13) To find the water soluble matter of pigment.
- 14) To check the Acidly & Alkalinity of pigment.
- 15) To check bleeding of pigment.
- 16) To find oil absorption value of pigment.
- 17) To find minimum surfactant demand by Daniel flow-point method

## ***SEMESTER IV***

### **THEORY**

**PST1C05: Spl 4: Polymer Science & Technology III (Polymer)** (4 hrs/ week)  
**(Polymer/ Surface coating)** Marks 100

Techniques of polymerization: bulk, solution, suspension, emulsion, plasma etc. Different initiating systems such as free radicle polymerization, redox, cationic & anionic polymerization ( different terms such as living polymers, inifers, telechelics ). Their kinitics & control over structure of polymer.

(18)

Condensation polymerization, different catalysts used case studies of condensation polymerization, carothers equation, Comparison of these systems with advantages & disadvantages.

(10)

Copolymerization, reactivity ratios & kinitics of copolymerization (copolymer composition equation).

(10)

Rheological concepts of polymer solutions and melts, degradation plasticization operations: Typical agitation system, dissolution

(10)

Different advanced catalyst systems: Ziegglar natta catalyst & metallocene catylysts & their role in polyolefins, ATRP etc.

(12)

#### **Textbooks/Sourcebooks:**

1. Principles of Polymer Science, Bahadur and Sastry, Narosa Publishing House 2002.
2. Polymer Science , Gowarikar, Johan wiley and Sons 1986.
3. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
4. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.



5. Polymer Chemistry , Malcolm P. Stevens, Oxford University Press, Inc, 1990.
6. Text book of polymer Science, Billmeyer, John Wiley and Sons 1984.
7. Principles of Polymer Systems, Rodriguez, Hemisphere Publishing Corpn, 1982.
8. Introduction to Polymer Science and Technology, H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
9. Polymer Science and Technology of Plastics and Rubbers, P. Ghosh,
10. Tata McGraw-Hill Publishing Company 1990.
11. Textbook of Polymer Science, P. Nayak and S. Lenka, Kalyani Publishers, 1986.
12. Fundamentals of Polymer Science an introductory text, P. Painter and M. Colman, Technomic publishing Co Inc,1994.
13. Textbook of Polymer Science and Engg Anilkumar and Gupta, tata McGraw-Hill Publishing Co, Ltd., 1978.
14. Polymer Science and Technology by J. R. Fried, Prentice-Hall, Inc 1995.
15. Polymer chemistry, Seymour and Carraher, Marcel Dekker, 2003.
16. Fundamentals of Polymer Processing, S. Middleman, Houghton Mifflin Compony, 1997.

**PST1C06: Spl 5: Thermoplastic Polymer Technology I (Polymer/ Surface coating)**

( 2 hrs/week)

Marks 50

Polyethylenes; modified polyethylenes, Polypropylene and copolymer of PP, modified Polyolefins like crosslinked & filled polyolefins, Polyisobutylene & polyolefin plastomers etc.

(15)

Engineering Polymers Polyesters such as PET, PBT, PTT, Polycarbonates, Polyacetal etc.

(15)

**PST1C07: Spl 6: Technology of Thermoset Resins-I (Polymer/ Surface coating)**

(2 hrs/ week)

Marks 50

Polyester Resins- unsaturated polyesters resins: Raw material: poly-basic acids, polyfunctional glycols. Curing of resins through unsaturation of the resin/polymer backbone. Curing systems, catalysts and accelerators. Polyester based composites & their recipes, Water reducible polyesters, high solid polyesters/ polyesters for powder coatings Moulding compositions, DMC,SMC,fibre and film forming compositions.

(12)

Phenolics: Basic components of the polymer. Different kinds of phenols and their derivatives, different kinds of aldehydes used. Novolacs and Resol: effect of the ratio of phenol to aldehyde on the nature and the property of the polymer. Theory of resinification and effect of pH on the reaction mechanism and the reaction product. Curing of phenolics

Modification of phenolics such as novolac-epoxy oil soluble and oil reactive. Phenolic moulding compounds, ingredients, compounding and applications. (9)

Amino resins: Basic raw materials used like urea/melamine/ aniline/ formaldehyde. Synthesis of UF and MF resins. Theory of resinification and effect of pH on the reaction mechanism and

the reaction product. Properties and application of the UF, MF and AF resins Modification of resins with alcohols and phenols Moulding materials, compounding, processing and applications. (9)

### **Text/ Source Books**

1. Text book of Polymer Science by Billmeyer, John Wiley and Sons 1984.
2. Encyclopedia of Polymer Science and Technology, John Wiley and Sons, Inc 1965.
3. Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, Inc 1988.
4. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
5. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
6. Handbook of Polyethylene, A. J. Peacock, Marcel Dekker Inc, 2000
7. PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co, 1994.
8. Engineering Thermoplastics Polycarbonates Polyacetals Cellulose Esters, L. Bottenbruch, Hanser Publishers, 1996.
9. Composite Polymeric Material, R. P. Sheldon, Applied Science Publishers, 1982.
10. Composites: Design Guide, Industrial Press Inc, 1987.
11. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984.
12. Biopolymers, Wiley, VCH Verlag, 2003
13. Handbook of Thermoplastics, O. Olabisi, Marcel Dekker, 1997.
14. Plastics Materials J. A. Brydson, Butterworth Scientific, 1990.
15. Polymer chemistry, Seymour and Carraher, Marcel Dekker, 2003.
16. Polymer and Resins; Their Chemistry and Chemical Engg, Brage Golding, D. Van Nostrand Company Inc, 1959.
17. Structures of Cellulose, Atlla, American Chemical society, 2003.
18. Styrene Based Plastics and their Modifications, Svec, Ellis Harwood, 1991.
19. Polymer Technology by Miles and Briston
20. Surface Coating, OCCA Publication.
21. Organic Coating Technology by H. F. Payne.
22. Organic Coating: Science and Technology by Z. Wicks.]

### **PST1C08: Spl 7: *Colour Physics and Colour Harmony (Polymer/ Surface coating)*** (2 hrs/week) Marks 50

Introduction-geometric and chromatic attributes; Radiation and illumination; SPD, CT and CCT; Sources and illuminants; Need for artificial sources – various ways of producing light

and different artificial sources; Lamp efficacy and colour rendering properties of sources

(6)

Interaction of radiation with matter – gloss and diffused reflectance, absorption of light in sample; Various transitions in molecule, Beer – Lambert law and its verification, deviation from Beer – Lambert law, Additivity of absorbance, mixture analysis, absorbance and scattering in the sample – Kubelka – Munk theory. (8)

Perception of colour in eye \ brain, various colour theories (3)

Additive – subtractive mixing, colour specification systems – Munsell colour order system, CIE system, colour spaces, colour difference formulae. (6)

Single constant Kubelka – Munk theory of colourant formulation and recipe prediction; Modern computerised methods of colour matching; Finding the dyeing recipes, shade sorting, etc. using the CCM software (3)

Decorative effect using pattern and design theory; Application of CAD for textiles.(4)

**Text/Reference Books :**

1. *Color : A Multidisciplinary Approach*, Zollinger Heinrich Zurich, Verlag Helvetica Chemica Acta, 1999
2. *The color Science of Dyes and Pigments*, R. McLaren Bristol, Adam Hilger Ltd., 1983
3. *Industrial Color Technology*, Johnson R.M., Sartzman M., American Chemical Society Washington D.C., 1971

*Computer Color Analysis : Textile Applications*, Sule A.D., New Age International Ltd., New Delhi, 1997

## **PRACTICES**

**PSP1C09: Pr 2: Analysis & Characterization of raw materials & polymers-II**  
**(Polymer/ Surface coating)**

(2 hrs/ week)  
Marks 50

1. To find polymer content and NVM of emulsion polymer
2. Analysis of carbon black, saw dust etc.
3. To find bulk density of fillers like Tio<sub>2</sub>, Carbon black etc
4. Identification of pigment by spot test
5. To determine Acid value, amine value, iodine value

**PSP1C10:Pr 3: Synthesis & Characterization of resins & polymers-I**  
**(Polymer/ Surface coating)**

**50**  
(2 hrs/ week)  
Marks 50

- 1) To synthesis polymer using Bulk, solution, suspension & emulsion polymerization method.
- 2) To study auto acceleration by solution polymerization method.
- 3) Synthesis of copolymers by emulsion Bulk, solution & suspension and emulsion, Polymerization.

**PSP1C11:Pr4: Color Physics (Polymers) (Term Work)**  
**(Polymer/ Surface coating)**

(1x 4hrs/week)  
Marks 50

1. Determination of unknown concentration of a dye in solution by Dubosque colorimeter.
  2. Verification of B-L law ( dependence of absorbance on concentration ) by spectrophotometer.
  3. Mixture analysis using spectrophotometer.
  4. Determination of gloss of various samples using gloss meter
  5. Determination of color of various textile samples in terms of Lovibond primaries and chromaticity co-ordinates using Lovibond tintometer
  6. Specification of color of a textile sample in terms of 'Lab' at using color computer.
  7. Finding color differences( $\Delta E$ ) between set of samples vis a vis dye solution concentration.
  8. Finding color differences( $\Delta E$ ) between set of samples vis a vis time of exposure.
  9. Determination of colors of samples in terms of Munsell color system using Munsell Color Tree.
  10. Recipe prediction and matching of colored samples using CCM
- Suitable number of experiments from the above list will be performed

## ***SEMESTER V***

### **THEORY**

**PST1C12: Spl 8: *Thermoplastic Polymer Technology (Polymer) II*** ( 2 hrs/week)  
*(Polymer/ Surface coating)* Marks 50

Styrenic polymers - Polystyrene, HIPS, SAN, ABS, important copolymers of styrene maleic anhydride and styrene acrylics copolymers, toughening mechanism of impact modified plastics

(12)

Polymamides- Nylon 6, Nylon 6,6, Nylon 11, aromatic polyamide such as Kevlar (10)

Acrylic polymers & copolymers, Polyacrylamide, PMMA, ASA, Polyacrylonitrile etc.  
 (7)

**PST1C13: Spl 9: *Thermoplastic Polymer Technology (Polymer) III*** ( 2 hrs/week)  
*(Polymer/ Surface coating)* Marks 50

Polyvinyl chloride & its copolymers, Poly vinyl acetate, Polyvinyl alcohol etc. (8)

Modified cellulose: Cellulose esters and ethers such as Ethyl cellulose, CMC, HPMC, cellulose acetals etc., Liquid crystalline polymers; speciality plastics- PES, PAES, PEEK, PEAK etc.  
 (15)

Developments in new polymers such as dendrimers, biopolymers & biodegradable polymers, thermoplastic PU etc.  
 (7)

**PST1C14: Spl 10: Technology of Thermoset Resins-II (Polymer)** (2 hrs/ week)  
**(Polymer/ Surface coating)** Marks 50

Epoxy resins: Basic raw materials like epichlorohydrin and di hydroxy phenol. Different di hydroxy phenolic compounds which can be used. Classification of epoxy resins. Synthesis of epoxy resins. Ratios of reaction components and their effect on the properties of reaction product and molecular weight in particular. Curing of the resin: curing agents like amines, acids, anhydrides, etc. Epoxy compositions and their ingredients, like diluents, flexibilizers, etc. Epoxy adhesives along with their recipes. Novolac epoxy, epoxy acrylates, Modified epoxides & epoxy resins for advanced applications.

(12)

Polyurethanes- Thermoset: Basic components: diisocyanates and diols, different diisocyanates and diols used. Reactions of isocyanates with various other functional groups. Synthesis of polymers. Polyurethane foams, polyester and polyether foams. Processes like one-shot process, Polyether pre-polymers, Quasi-pre-polymer polyether foams, etc. Difference between thermoset & thermoplastic PU. Flexible foams. Polyurethanes in Coatings. Polyisocyanates IPN using polyurethanes-acrylic blends

(10)

Silicones Thermoplastic and Thermoset: Preparation of intermediates, Grignard's method, direct method, olefin addition method, sodium condensation method, rearrangement of organo chlorosilanes. Nature and effect of Si-H, Si-O, Si-Si, and Si-C bond. Effect of different functional groups on properties, Silicone fluids, resins, elastomers, RTV silicones. Their compounding, processing and applications. Silicone modified resins.

(8)

**PST1C15: Spl 11: Technology of Thermoset Resins-III (Polymer)** (2 hrs/ week)  
**(Polymer/ Surface coating)** Marks 50

Thermosetting acrylics: Synthesis of acrylic polymers and co-polymers, different techniques. Structure property relationship application of thermosetting acrylics, like anaerobic adhesives, laminating resins, etc.

(6)

Alkyd resins: Basic components like polyfunctional alcohols, poly-basic acids, vegetable oils/fatty acids. Different types of drying oils: drying, semi-drying and non-drying with examples. Influence of all these components in the synthesis and properties of the final alkyds obtained. Modification of alkyds: modification with rosin, maleic anhydride, acrylics, vinyls, imides etc.

(15)

Miscellaneous thermosetting polymers:

Polyimides, plasma-polymers & other thermoset polymers

(9)

**Text/ Source Books**

- 1) Text book of Polymer Science by Billmeyer, John Wiley and Sons 1984.
- 2) Encyclopedia of Polymer Science and Technology, John Wiley and Sons, Inc 1965.
- 3) Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, Inc 1988.
- 4) Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.

- 5) Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
- 6) Handbook of Polyethylene, A. J. Peacock, Marcel Dakker Inc, 2000
- 7) PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co, 1994.
- 8) Engineering Thermoplastics Polycarbonates Polyacetals Cellulose Esters, L. Bottenbruch, Hanser Publishers, 1996.
- 9) Composite Polymeric Material, R. P. Sheldon, Applied Science Publishers, 1982.
- 10) Composites: Design Guide, Industrial Press Inc, 1987.
- 11) Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984.
- 12) Biopolymers, Wiley, VCH Verlag, 2003
- 13) Handbook of Thermoplastics, O. Olabisi, Marcel Dekker, 1997.
- 14) Plastics Materials J. A. Brydson, Butterworth Scientific, 1990.
- 15) Polymer chemistry, Seymour and Carraher, Marcel Dekker, 2003.
- 16) Polymer and Resins; Their Chemistry and Chemical Engg, Brage Golding, D. Van Nostrand Company Inc, 1959.
- 17) Structures of Cellulose, Atlla, American Chemical society, 2003.
- 18) Styrene Based Plastics and their Modifications, Svec, Ellis Harwood, 1991.
- 19) Polymer Technology by Miles and Briston
- 20) Surface Coating, OCCA Publication.
- 21) Organic Coating Technology by H. F. Payne.
- 22) Organic Coating: Science and Technology by Z. Wicks.]

### **PRACTICES**

**PSP1C16: Pr 5 : Analysis , Characterization of raw materials & Synthesis of resins & Polymers (Polymer/ Surface coating)** (2x2 hrs/ week)  
Marks 50

- 1.) Analysis of formalin, phenol, substituted phenol, epichlorohydrine, plasticizer..
- 2) Determination of Hydroxy value, K-Value , carboxyl value, epoxy value, ester value, sap value etc. RI of solvent and plasticizer, color and viscosity by Gardeners tube etc.

**PSP1C17: Pr 6 : Synthesis & Characterization of resins & polymers-II** (4X4 hrs/ week)  
(Polymer/ Surface coating) Marks 100

- 1.) Synthesis of novolac, Resol, epoxy, amino, unsaturated polyester resin and their analysis
- 2). Manufacturing of molding powder of phenolic resin & Amino resin
- 3.) Making paper laminate of resol resin. To find free phenol & free formaline content of phenolic resin etc.

**PSP1C18:Pr 7 :Synthesis & Characterization of resins & polymers-III** (2x2 hrs/ week)  
(Polymer/ Surface coating) Marks 50

- 1.) Aqueous polymerization of acrylamide.
- 2.) Synthesis of modified amino, epoxy, modified phenolic resin. etc

- 3.) Core and shell polymer  
 4.) Manufacturing of Plastisol ,organosol, Polyaniline synthesis. Etc.

## SEMESTER VI

### THEORY

#### **PST1C19:Spl 12: 1 Pigments & additives for Polymers (Polymer/ Surface coating)**

(4 hrs/ week)  
 Marks 100

- Properties required in a pigment and extender (4)  
 Pigment dispersion basics (2)  
 Inorganic pigments such as titanium dioxide, zinc oxide, carbon black, chromate pigments, molybdate orange, chrome green, ultramarine blue, iron blue, cadmium red, pearlescent and other effect pigments (15) corrosion inhibiting pigments, such as zinc phosphate, zinc and barium chromate pigments, ceramic pigments, metal flake pigments, extenders (9)  
 Theory of color formation in organic compounds, effect of auxiliary groups on the shade and hue of the pigment (Bathochromic and hyper chromic shift) (3)  
 Manufacture of Carbon black different grades such as furnace & channel black  
 Additives such as dispersion aids, UV stabilizers, antioxidants & antiozonents, processing/flow modifiers, different fillers such as calcium carbonate, mica, talc & others etc. (12)

#### **PST1S01:Spl 13: Paints Technology- I (Paints)**

(4 hrs/ week)  
 Marks 100

- Colloidal chemistry of coatings, surface chemistry of pigments (6)  
 Pigment dispersion and wetting, flushing of pigments, effect of pigment volume concentration on paint properties (4)  
 Paint additives, solvents (12)  
 Basics of Paint formulations (4)  
 Machinery for grinding of pigments and extenders (4)  
 Paint manufacturing machinery for pigment dispersion (Ball mill, Sand mill, Attritor mills, Drais mill, basket mill, kaddy mills, twin shaft dispenser, alpine mills, horizontal V/S vertical mills (6)

#### **Recommended Books**

- |  |                        |
|--|------------------------|
| (1) Paint and Surface Coatings                     | Lambourne and Strivens |
| (2) Organic Coatings Science and Technology        | Zeno Wicks et al       |
| (3) Surface Coatings Science and Technology        | Swaraj Paul            |
| (4) Introduction to Paint Chemistry                | Turner                 |
| (5) Pigment Hand Book Part 1, 2,3                  | Patton                 |
| (6) Encyclopedic Hand book of Emulsions Technology | Sjoblom                |
| (7) Paint Film Defects                             | Hess                   |
| (8) Industrial Organic Pigments                    | W. Herbst              |

## **PST1S02:Spl 14: Paints Technology II**

**(Paints)**

(2hrs/ week)  
Marks 50

Special effect pigments (IR Reflective, anticorrosive, thermo chromic, pearlescent etc), Incan corrosion preventor, rheology modifiers, biosides, antisetling, antiskinning, antisagging additives, odourants, masking agenrts, Additives for water based coatings

### ***Text Books/Source***

- |                                       |               |
|---------------------------------------|---------------|
| 1) High performance pigments          | Huge M. Smith |
| 2) Pigment Hand Book Part 1, 2,3      | Patton        |
| 3) Application properties of Pigments | A. Karnik     |

## **PST1S03:Spl 15: Paints technology III**

(2hrs/ week)  
Marks 50

Manufacture of Powder Coatings, dry distempers, cement paints, oil based distempers and paints, other stiff paints, putties, Manufacturing of alkyds, emulsions and hard resins, filtration of resins, paints, ultra filtration of ED resins, forming of hard resins, marking and labeling of packaged products, Utilities in paint plant (steam, hot oil, cooling water, chilled water, compressed air)

Plant layout, Inventory control, use of computers in paint industry, interphasing with R&D

Solvent emission, recovery and disposal, environmental, health and safety issues

- |  |                        |
|--|------------------------|
| 1) Paint and Surface Coatings              | Lambourne and Strivens |
| 2) Basics of Paints Technology             | V.C.Malshe             |
| 3) Surface Coatings Science and Technology | Swaraj Paul            |

## **Elective I**

### **PST1P04:Structure property Relationship (Polymers/ Surface coatings)**

(2hrs/ week)  
Marks 50

General structural features of polymers: Effects of atoms types of bonds, bond dissociation energy and functional groups on properties of polymers (3)

Configuration and conformation and structure properties of polymers (2)

Molecular mass heterogeneity and structure properties (1)



Polymers solutions: thermodynamics of dissolution, factors effecting dissolution and swelling of polymers, phase equilibrium of polymer-solvent systems, polymer solution, Florry-Huggins theory (6)

Polymer chain flexibility: concept of flexibility, various factors deciding flexibility of polymers with case studies, properties of polymers affected by flexibility (6)

Intermolecular orders: Amorphous, crystalline and oriented forms of polymers, crystallinity in polymers, factors affecting crystallinity, properties affected by crystallinity of polymers (6)

Thermal properties of polymers: fire retardant polymers, factors affecting glass transition (T<sub>g</sub>) temperature, heat stability etc. with case studies (4)

Degradation and stabilization: various stresses acting on polymers and their influence, method of improving the stability of polymers with case study (6)

#### **Text/Source Books**

1. Polymer Structure, Properties and application, R.D. Deanin, American Chemical Society, 1974.
2. Relating Materials, Properties to Structure; Handbook and Software for Polymer calculations and Materials Properties, D. J. david and Ashok Mishra, Technical Publishing Componey, Inc, 1999.
3. Properties of Polymer; Correlations with Chemical Structures and their numerical Estimation and Predication from Additive Group Contribution van Krevelen, Elsevier Publication Company, 1990.
4. Relating Materials Properties to structure, D. J. David, Technical Publishing Company Inc, 1999.
5. Polymer Chemistry, C. E. Carrshar, Marcel Dakker Inc, 2003.
6. Physical chemistry of Polymers, A. Tager, Mir Publishers, 1978.
7. Polymer Association Structures M. A. EL-Nokally, American Chemical Society, 1989.
8. Polymer Solutions; Introduction to Physical Properties, Teraoka, Iwao, John Wiley and Sons. Inc, 2002.
9. Polymer Chemistry; An Introduction, M. P. Stevens, Oxford University Press, 1990.

### **PRACTICES**

#### **PSP1S04:SEM VI Pr 8 Processing of Paints-I (Paints)**

(2x4hours/week)

Marks100

Synthesis of pigments like

1. Iron oxide, Iron blue etc
2. Lemon chrome
3. Middle chrome
4. Zinc phosphate and Zinc Chromate
5. Para red
6. Toluidine red
7. Hansa Yellow
8. Lithol red
9. Pthalocyanine blue
10. Precipited barium sulphate
11. Charecterisation and testing of pigments like moisture content, hiding power, yield, bulk density etc.
12. Use of Muller and Pigment Flusher for dispersion

**PSP1S05: SEM VI Pr 9 Processing of Paints-II (Paints)**

(2hrs/ week)  
Marks 50

Qualitative analysis of Pigments & Pigment mixtures

***SEMESTER VII***

**THEORY**

**PST1S06: Spl 16: Corrosion Protection Technology**

(2Hrs/week)  
Marks 50

Theory of corrosion, action of corroding environment, mechanism of corrosion & detection of corrosion, fouling, pigments, binders & additives for corrosion prevention, recent developments in corrosion protection materials etc.

**References:**

Naval electrician's text book volume 1  
William Hannum, Grubb Bullard  
Electrical Insulation Coatings

**PST1S07: Spl 17 Technology of Printing Inks (Paints)**

(2 hrs / week)  
Marks 50

Manufacture of paper: qualities and properties of paper (2)  
Letterpress printing: Process- characteristics- raw materials- formulations for different substrates- ink related problem and their solution, latest developments (3)  
Screen printing: Process- characteristics- raw materials- formulations for different substrates- ink related problem and their solution, latest developments (4)  
Flexography: Process- characteristics- raw materials- formulations for different substrates- ink related problem and their solution, latest developments (5)  
Gravure: Process- characteristics- raw materials- formulations for different substrates- ink related problem and their solution, latest developments (5)  
Lithography: Process- characteristics- raw materials- formulations for different substrates- ink related problem and their solution, latest developments (5)  
Non impact printing (4)  
Other than above printing method: pad printing, transfer printing and latest development

**Elective II**

**PST1S08: Paints Elective:**

(2 hrs / week)

**Insulating & Intumescent coatings:**

Various insulating resins & polymers used for heat & electrical insulations. Their additives methods of coatings & their properties & Testing

**PRACTICES**

**Sem VII**

**PSP1S09:Pr. 10 Processing of Paints (Paints)**

(4hrs/ week)

Marks 100

1. Evaluation of paints as per IS 1012
2. Preparation of
  - a. Alkyd Resin and its evaluation (Long, medium and Short by different groups)
  - b. acrylic/vinyl acetate emulsion
  - c. Plastic emulsion paint and evaluation ( To include determination of surfactant demand by Daniel Flow Point method and evaluation of final properties of the prepared paint. Scrub resistance, stain resistance , detergent and soap resistance to be evaluated)
  - d. Polyester polyol from Aliphatic and aromatic dibasic acids, aliphatic diol, triols and its characterization (A.V. and Hydroxyl value)
  - e. Suspension polymer from MMA and Butyl methacrylate
  - f. Cement paint and application on exterior surface
  - g. Alkyd paint for base coat and top coat at different PVC
  - h. high gloss coating from the polyol and evaluation of the coating properties
  - i. varnishes for wood finishing

**SEM VII**

**PSP1S10:Pr 11 Processing & Analysis of Paint -II**

(4hrs/ week)

Marks 100

1. Analysis Of Linseed Oil (IV, Sap Value, Colour, Refractive Index, Viscosity)
2. Analysis Of A Synthetic Enamel (Black, Red, White) Zinc Chrome Primer, Red Oxide Primer, Intermediate Coat, (NVM, Viscosity, WPL, Grind, Hiding, Drying Time, Scratch Hardness, Impact Test, Flexibility, Gloss, Dry Film Thickness, Acid , Alkali, and Water Resistance, Adhesion As Per IS101, Corrosion Resistance By Salt Spray And Humidity Cabinet, Accelerated Exposure Of Paints In Q UV And Atlas Apparatus
3. Analysis of Emulsion Paint (NVM, % Solids, Scrub Resistance, Stain Resistance)
4. Analysis Of Cement Primer
5. Colour Matching Of Synthetic Enamel, Plastic Emulsion Paint And Distemper
6. Analysis Of An Alkyd (Oil Length, Acid Value, Hydroxyl Value, Phthalic Content
7. Analysis Of Pigments (Solvent Bleed In About 10 Different Solvents, Resistance to acids, alkalis, light)

**PSP1S11:Processing of Paints III**

(2hrs/ week)

Marks 50

Preparation of different solvent & water based coatings powder coatings. Paints such as alkydbased, acrylic emulsion based, lacquers, PU based clear coats/ dispersions, washable distempers, preparation of inks testing & application of these coatings.

**PST1C20:3 Seminar (Term Work)**

(2hrs/ week)

Marks 50

Students will be required to prepare critical reviews of selected topics in Chemical Technology and Allied subjects and submit in the form of standard typed report. The students will also be required to make an oral presentation of the review.

***SEMESTER VIII***

**THEORY**

**PST1S12:Spl 19: Advanced Paints Technology I: (Paints)**

(2hrs/ week)

Marks 50

Paint rheology & different rheology modifiers, Analysis & testing of paints & Paint film. Paint film defects causes & remedies. Painting & printing of different plastic substances.

- |  |      |
|--|------|
| 1. Coil coatings   | (2)  |
| 2. Wood Finishng   | (4)  |
| 3. Strippable coatings, lacquers                         | (1)  |
| 4. Treatment of air for paint application                | (1)  |
| 5. Surface treatment and paint application methods       | (2)  |
| 6. Treatment of over sprays                              | (1)  |
| 7. Reworking of painted products                         | (1)  |
| 8. Paint application and curing machinery                | (1)  |
| 9. Formulation and application of sealants and adhesives | (10) |

**Text books/ References**

- |  |                        |
|--|------------------------|
| (1) Paint and Surface Coatings                     | Lambourne and Strivens |
| (2) Organic Coatings Science and Technology        | Zeno Wicks et al       |
| (3) Surface Coatings Science and Technology        | Swaraj Paul            |
| (4) Introduction to Paint Chemistry                | Turner                 |
| (5) Pigment Hand Book Part 1, 2,3                  | Patton                 |
| (6) Encyclopedic Hand book of Emulsions Technology | Sjoblom                |
| (7) Application properties of Pigments             | A. Karnik              |
| (8) Paint Film Defects                             | Hess                   |
| (9) Industrial Organic Pigments                    | W. Herbst              |

- (10) High performance pigments  
 (11) Printing ink Formulations principles

Huge M. Smith  
 Ronal Todd

**PST1S13: Spl:20 Pigments & additives for paints (paints )**

(2hrs/ week)  
 Marks 50

Organic pigments such as monoazo pigments, copper Phthalocyanine blue, green and other Phthalocyanine pigments, anthraquinone pigments, diarylid yellows, Naphthol pigments, BONA lakes, Benzimidazolone, diazo condensation pigments, azo metal complex pigments, dioxazine violet, violet 23, di keto pyrrolopyrrol pigments, rhodamine phosphotungstic acid complex pigments, quinophthalone pigments, thio indigo polycyclic pigments, perlin and iso indoline pigments, solvent soluble colors, polymeric pigments iron oxide pigments, micaceous iron oxide etc (30)

**Elective III**

**PST1S14: Advanced Paints technology II (paints)**

(2hrs/ week)  
 Marks 50

1. Paint industry overview, problems and prospects (1)
2. Formulation of primers, zinc rich epoxy, Micaceous iron oxide, zinc chromate and tetraoxy chromate, zinc phosphate based primers, wash primers, (8)
3. Anti fouling coatings (3)
4. Paints for marine environments, vinyl paints (1)
5. Road marking paints (2)
6. Cement paints (2)
7. Automotive protection products, paints, finishing and refinishing (4)
8. Electrodeposition coatings (2)
9. UV curable coatings (1)
10. Coatings for high temperature (2)
11. Coatings for aerospace and aircrafts (2)
12. Electrical conducting coatings (1)
13. Thermal sensitive paints (1)
14. Insulating paints (1)
15. Metallic paints (1)

**PRACTICALS**

**100  
 4Xhrs**

**PSP1S15: Pr 12: Processing of paints –IV (Paints) (Term Work)**

1. Synthesis of Alkyds like Drying And Non Drying Alkyds, Long, Medium, Short oil length Alkyds, Modified alkyds (Styrenated, Acrylated)

2. Synthesis of Reduced phenolics like Phenol ( M.P120-240° C), P-Tert Butyl Phenol Bisphenol
3. Synthesis of polymers by Emulsion, Solution polymerization like S-BA,S-MMA
4. Synthesis of Water Dispersible Polyester
5. Synthesis of Cationic Polymer For Electrodeposition And Application
6. Synthesis of Water Soluble Melamine, Urea Formaldehyde, Butylated Melamine Formaldehyde
7. Paint formulation using various PVC values.
8. Paint Application & Curing, Shade matching

**PSP1C21:2 *Project Work (Term Work)***

***12hrs/week***

***Marks:150***

Every student will be required to submit a project report in a typed standard format on a topic set by one or more faculty members. The object of the project work is to test the ability of the student to tackle an investigational problem in his field of specialization. Every student will be orally examined in the subject incorporated in his project report.