Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

FACULTY OF ENGINEERING AND TECHNOLOGY

Syllabus Structure- 2014-2015

B. Tech Final Year (Plastics & Polymer Engineering)

Subject Code	SEMESTER-VII	Contact Hrs / Week				Examination Scheme						
	Subject	L	T	P	Total	CT	TH	TW	P	Total	Credits	Duration of Theory Exam
PPE401	Mould and Product Design	3	1	-	4	20	80	-	-	100	4	3 Hours
PPE402	Instrumental Analysis of Polymers	3	1	-	4	20	80	-	-	100	4	3 Hours
PPE403	Advanced Elastomer Technology	4	-	-	4	20	80	-	-	100	4	3 Hours
PPE404	Process Engineering & Plant Design	4	-	-	4	20	80	-	-	100	4	3 Hours
PPE441-444	**Elective-II**	4	-	-	4	20	80	-	-	100	4	3 Hours
PPE421	Laboratory-I :Instrumental Analysis of Polymers	-	-	2	2	-	-	50	50	100	1	NA
PPE422	Laboratory-II : Plant Design	-	-	2	2	-	-	50	50	100	1	NA
PPE423	Laboratory-III: CAE for Plastics	-	-	4	4	-	-	100	-	100	2	NA
PPE425	Project-II	-	-	6	6	-	-	100	100	200	3	NA
	Total of semester-VII	**18**	**02**	**14**	**34**	**100**	**400**	**300**	**200**	**1000**	**27**	-

Sub Code	SEMESTER-VIII	Contact Hrs /week				Examination Scheme						
	Subject	L	T	P	Total	CT	TH	TW	P	Total	Credits	Duration of Theory Exam
PPE471	Inplant Training (IPT)*	-	-	-	-	-	-	300	300	600	27	NA
	Total of semester-VIII	**-**	**-**	**-**	**-**	**-**	**-**	**300**	**300**	**600**	**27**	-
	Grand Total of VII & VIII	**-**	**-**	**-**	**-**	**100**	**400**	**600**	**500**	**1600**	**54**	-

L: Lecture hours per week T: Tutorial hours per week P: Practical hours per week CT: Class Test
TH: University Theory Examination TW: Term Work P: Practical/Oral Examination NA: Not Applicable

Elective-II

1. PPE441 Fiber Technology
2. PPE442 Polymer Nanocomposites
3. PPE443 Adhesive Science and Technology
4. PPE444 Polymer Blends and Composites

After every two weeks of Inplant Training (IPT) student shall apprise the progress of training to the internal guide and get the required inputs.

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Code No: PPE401	**Title: Mould and Product Design**
Teaching Scheme: 04 Hrs/week	**Class Test (Marks): 20**
Theory: 03 Hrs/week	**Theory Examination (Duration): 03 Hrs**
Tutorial: 01 Hr/week	**Theory Examination (Marks): 80**
Credits: 04	

Objectives	**:**	• To impart the knowledge about basic concepts of mold & product design. • To provide knowledge about detailed drawing of molds and various products, bill preparation and Material selection criteria for end use application.
Unit-I	**:**	**Designing of Compression Moulds. [10 Hrs]** ▪ Design of Flash, Positive and Semi-Positive mould with pin ejection, sleeve ejection, stripper plate ejection, systems. ▪ Design of Two-plate and three plate moulds, Split moulds, ▪ Mould Designing for Threaded Articles and inserts, ▪ Types of cooling systems and their selection criteria. ▪ Bill of Material.
Unit-II	**:**	**Designing of Injection Moulds [15 Hrs]** ▪ Design of Two-Three Plate Moulds, Core Side pin Withdrawal, sprue removal and ejection system arrangement. ▪ Cavity balancing, types of gates, gate balancing, types of cooling systems, and gas channels for gas assisted IM, Special feature required for thermoset moulds. ▪ Selection of suitable M/C for suitable Mould, Types of Heating systems available for Moulds. ▪ Mould Designing for Threaded Articles and inserts, Multi-day light mould, troubleshooting. ▪ Bill of Materials and Specification.
Unit-III	**:**	**Design of Transfer, Blow Moulds and Extrusion Dies [5 Hrs]** ▪ Pot, Auxiliary ram, separate pot moulds. ▪ Details of loading chamber, ejection methods, heating systems. ▪ Classification of Dies, and design fetchers, application and working. ▪ Blow mould and their design fetchers.
Unit-IV	**:**	**Basic Product Design considerations [8 Hrs]** ▪ Effect of Wall Thickness, flat surfaces Corners, Radius, Drafts, Fillets, Shrinkage, Warpage, Parting line tolerances.
Unit-V	**:**	**Basic Product Design Features [12 Hrs]** ▪ Rim, Rib, Design, gussets, bosses, radii/fillets holes and its types Under cuts, core outs, collapsible core, types of inserts and threads, types jigs and fits, shapes of male and female inserts Product costing with ref. to No. of cavity, cycle time, material for moldings, and over heads.

Unit-VI	**:**	**Component Design** **[10 Hrs]** Design of components like; i) Engine Gaskets ii) Pipe iii) Gears iv) Plastic bearing v) Over head tanks. **vi)** Chair
Reference Books:	**:**	1. Plastic Product Design by Ronold D. Beck, 2nd edition, published by Van nostrend Reinhold company. 2.Plastics Product design Hand book(part A) by Edward Miller, published by Marcel dekker.inc 3. Plastics Design Hand Book by Dominic & Donald V. Rosato, 2nd Edition, published by Kauwer Academic publisher. 4.Plastic Product Design Manual by Tycoon industries ltd Japan, 1998 design Manual 5.Dies for Extrusion of Plastics by M.V. Joshi, First Publication,1984,published by MacMillan India Limited 6. Injection Mould Design by R.G.W. Pye, 4th edition, published by East-West Press Pvt. Ltd. New Delhi.
E-References: E-Journal References:	**:**	1. Design Analysis methods and Techniques, 7th Edition, F.Rouessac, A.Rouessac, John Wiley and Sons Ltd. 2. Plastics Product design ,2nd Edition Tycon Ind.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI

Pattern of Question Paper:

The six units in the course syllabus shall be divided in two equal parts of 3 units each. Question paper shall be set having two sections; Section A and Section B. The questions of Section A shall be set on first part and questions of Section B on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

1. Set ten questions in all with five questions in each section.
2. Question no. 1 from section A and Question no. 6 from section B should be made compulsory and should cover the entire course syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
3. Two questions of 15 marks each from remaining questions from each section A and B should be asked to solve.

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Code No.: PPE402
Teaching Scheme:
Theory: 03 Hrs/ week
Tutorial: 01 Hr/week
Credits: 04

Course Title:-Instrumental Analysis of Polymers
Class Test (Marks): 20
Theory Examination (Duration): 03Hrs
Theory Examination (Marks): 80

Course Objective	**:**	• To give an overview to the students about various instruments used for polymer characterization, their working principle, instrumentation and applications.
Unit-I	**:**	**Introduction, Instruments involved in each method and applications. (5 Hrs)** The purpose of characterization, molecular architecture, crystallizing polymer, survey of characterization techniques. Overview of various analytical methods like Spectral:(UV, IR, NMR, Mass, Raman, ESR), Thermometric (DSC, TGA, DTMA, TMA)
Unit-II	**:**	**X-Ray Diffraction Analysis: (10 Hrs)** Methods of production of x-rays, properties of x-rays, diffraction of x-rays, Bragg's Law, lattice and powder diffraction methods, small angle scattering of x-ray by polymers, Analysis of molecular structure of simple polymers by XRD, determination of crystallinity, size and orientation of crystallites. **Electron microscopy: (5 Hrs)** Overview of AFM, and XPS for polymer analysis (Instrumentation details not required)
Unit-III	**:**	**Electron microscopy: (10 Hrs)** Instrumentation, Working Principle, Applications of SEM and TEM.
Unit-IV	**:**	**Chromatography: (12 Hrs)** Classification, theories of chromatographic paper, column, thin layer, ion exchange, gas and HPLC, GPC.
Unit-V	**:**	**Polarography: (10 Hrs)** Principle and instrumental set-up of polarography, concepts and expressions of diffusion current, half-wave potential, residual current, dropping mercury electrode, current potential curve and reversible reactions.
Unit-VI	**:**	**Atomic absorption method: (8 Hrs)** Atomisation, Atomisers, Radiation sources, Applications.
Text Books	**:**	1. Instrumental Methods of Chemical Analysis, 5th Edition, Galen W. Ewing, McGraw-Hill International Editions. 2. Undergraduate Instrumental Analysis, 6th Edition, James W.Robinson, Eileen Frame, George Frame, CRC Press. 3. Modern Instrumental Analysis, 1st Edition, By. S. Ahuja,N. Jesperson, Elsevier Publications. 4. Spectroscopy of Organic Compounds, 6th Edition, P.S.Kalsi, New Age International Publishers. 5. Spectrometric Identification of Organic Compounds. Silverstein, Robert M John Wiley (2005). 6. Instrumental Methods of Analysis, Will and Merritt, CBS Publisher, New Delhi.

		7. Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler and Timothy A. Nieman, Harcourt Brace Coolege Publishing, Philadelphia.
References e- books, e- Journals	**:**	3. Chemical Analysis-Modern Instrumentation methods and Techniques, 2nd Edition, F.Rouessac, A.Rouessac, John Wiley and Sons Ltd. 4. ASTM, BIS, ISO standards.

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For 80 marks Paper:

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Code No.: PPE403	**Course Title: Advanced Elastomer Technology**
Teaching Scheme:	**Class Test (Marks): 20**
Theory: 04 Hrs/ week	**Theory Examination (Duration): 03Hrs**
Credits: 04	**Theory Examination (Marks): 80**

Course Objective	**:**	• To impart the knowledge about synthesis, properties and applications of various speciality elastomers and to make them understand the manufacturing technology of various elastomeric products. Also to make students aware of environmental issues regarding rubber industry so that in future they can do advancement in rubber technology considering environmental problems.
Unit-I	**:**	**Specialty Rubbers:** **a) Silicones: (3 Hrs)** Introduction, Manufacturing- structure and its influence on properties, compounding, curing, general properties and applications. **b) Epichlorohydrin: (3 Hrs)** Introduction, Manufacturing- structure and its influence on properties, compounding, curing, general properties and applications. **c) Fluoro Elastomers: (3 Hrs)** Introduction, Manufacturing- structure and its influence on properties, compounding, curing, general properties and applications. **d) Polysulphides: (3 Hrs)** Introduction, Manufacturing- structure and its influence on properties, compounding, curing, general properties and applications. **e) Polyurethane Rubbers: (3 Hrs)** Introduction, Manufacturing- structure and its influence on properties, compounding, curing, general properties and applications. **f) Acrylic Rubbers: (3 Hrs)** Ethylene Acrylic copolymer, Introduction, Manufacturing- structure and its influence on properties, compounding, curing, general properties and applications.
Unit-II	**:**	**Latex product manufacturing: (8 Hrs)** Introduction, compounding, Manufacturing, properties and formulation of Household and surgical gloves, electrical gloves, Coir Foam and Mattresses, Latex thread, Latex toys and balloons. Dunlop and Talalay process for Latex foam manufacturing, Latex Allergies.
Unit-III	**:**	**Rubber Industry and Environment: (4 Hrs)** Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) – Guidelines for rubber industry. Rubber Waste Disposal, Pollution Control in Rubber Industry – Effluent generation and effluent treatment, Carbon black recovery from rubber waste.

Unit-IV	**:**	**Tyre**: **(16 Hrs)** Introduction to tyre, nomenclature of tyres, function of tyres and their components, construction of tyres, function of the tyre components. Types of tyres as per their tread pattern, Construction (Beltings), Application and others. Intelligent or smart tyres, Eco-friendly tyres, Solid tyres. Manufacturing Techniques of Various tyres and Automotive tubes; Principle of designing formulation for various tyre components. Green tyre and their curing method (Bladder Curing), Post Cure Inflation Quality Control test and Performance test of tyre; Plunger Test, Endurance Test, Rolling resistance, Traction and wet skid performance test, Noise test, etc.
Unit-V	**:**	**Manufacturing of transmission systems**: **(7 Hrs)** Manufacturing process, Properties and formulations of Different components of Cables, V-belts, Conveyor belts and Hoses.
Unit-VI	**:**	**Dry Rubber Products:** **(7 Hrs)** Manufacturing and properties of different components of Footwear, Tennis balls, Golf ball, Seals and gaskets.
Text Books	**:**	1. Rubber Product Manufacturing Technology, A K Bhowmik, M M Hall and H A Benaney, Marcel Dekker Inc, Newyork, 1994. 2. Rubber Technology, A S Chraig, Oliver, Boyd, Edinburgh, 1982. 3. Rubber Technology Handbook, C.Hoffman, Hanser Pub. 4. Synthetic rubbers – Chemistry & Technology, D.C.Blakley, Applied science Publishers, 1979. 5. Hose Technology, C W Evans, Elsevier Applied Science Publisher, 1979. 6. Handbook of Elastomers, new developments and technology, A K Bhowmik, H L Stephens, Marcel Dekker Inc., Newyork, 1988.
References e- books, e- Journals	**:**	1. Rubber handbook, Stukcol. 2. Handbook of Specialty Elastomers, Robert C. Klingender. 3. Journal of Rubber Research, Malaysian Rubber Board. 4. Rubber Chemistry and Technology, Rubber Division, American Chemical Society. 5. Chemistry, Manufacture and Applications of Natural Rubber, Woodhead Publishing, Science Direct.

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For 80 marks Paper:

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Code No.: PPE404 | **Course Title: Process Engineering & Plant Design**
Teaching Scheme: | **Class Test (Marks): 20**
Theory: 04 Hrs/ week | **Theory Examination (Duration): 03 Hrs**
Credits: 04 | **Theory Examination (Marks): 80**

Course Objective	:	• To get a basic understanding of chemical equipment design and managerial techniques for designing of polymer plant.
Unit-I	:	**Process Development:** **(7Hrs)** Process selection, literature survey, study of alternate process, development of project from laboratory & pilot plant data **Preliminary Process Design:** Batch versus continuous processes, comparative analysis, fabrication methods and testing
Unit-II	:	**Equipment Design**: **(15 Hrs)** Heat Exchangers, batch reactor, distillation column, plant design of Polyvinyl chloride and polyethylene.
Unit-III	:	**Material Specifications:** **(8 Hrs)** Types and selection of material, mechanical properties, corrosion and resistance, Indian standards on material.
Unit-IV	:	**Piping Auxillaries**: **(10 Hrs)** Plant location and layout, piping standards and color codes, P&I diagrams, selection of piping, supports and temperature effects.
Unit-V	:	**Optimization in design:** **(10 Hrs)** Nature, basic concepts and formulation. PERT and CPM techniques, Introduction to simulation.
Unit-VI	:	**Engineering Economics:** **(10 Hrs)** Elements of project cost , total capital investment and total capital cost, time value of money, depreciation, interest, project financing.
Text Books	:	1. Chemical Engineering Plant Design, by Vibrandt & Dryden E.E, McGraw Hill 2. Plant Design and Economics for Chemical Engineers (5th Ed), by Peters, Max S., K.D. Timmerhaus and R.E. West, McGraw-Hill International 3. Chemical Engineering: Vol.6, by . Coulson J.M. and Richardson J.F, Pergamon Press 4. Optimization of chemical processes, by Thomas Edgar, David Himmelblau, McGraw Hill,2nd Edition 5. Process Modeling Simulation and Control for Chemical Engineers, by Luyben W L, McGraw Hill,2nd Edition
References e- books, e- Journals	:	1. Perry's Chemical Engg. Handbook, 7th Edition , by R.H. Perry & Don W. Gress, McGraw Hill Company 2. Process Design of Equipments, by Dawande S.D, Central Techno Publications 3. Process Equipment Design, by M.V. Joshi and V.V. Mahajan, MacMillan India Ltd.

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Code No.: PPE441
Teaching Scheme:
Theory: 04 Hrs/ week
Credits: 04

Course Title: Elective-II : Fiber Technology
Class Test (Marks): 20
Theory Examination (Duration): 03Hrs
Theory Examination (Marks): 80

Course Objectives	**:**	• To understand the production & Technology of fibre manufacture. • To learn production technologies of synthetic fibres. • To learn Melt spinning, wet spinning, dry spinning methods.
Unit-I	**:**	**Introduction: (14 Hrs)** Classification, sources, essential properties of textile fibre, Characteristics of fibre forming polymers. Methods of fibre formation: - Melt, dry, wet spinning & drawing. Vegetable fibre, protein fibre, silk, wool fibre their structure & properties.
Unit-II	**:**	**Fiber Structure: (8 Hrs)** Arrangement of molecules and crystallites in fibre. Measurement of crystallinity by density, X-ray diffraction, thermal, IR, chemical method. Orientation and its measurement by different methods.
Unit-III	**:**	**Regenerated cellulose fibers: (8 Hrs)** Viscose rayon, spinning process, purification, analysis of spinning process, properties. Modification of viscose rayon: High tenacity, high viscosity, high wet modulus. Cuprammonium rayon: Properties & application. Cellulose acetate fiber: Manufacture, properties, application, modification.
Unit-IV	**:**	**Polyamide fiber: (5 Hrs)** Fiber formation, high tenacity, high oriented and staple fiber, application & properties, aromatic polyamide fibre. **Polyester fiber**: Spinning process, fiber formation, below spinnerette, winding & drawing, continuous process of fibre formation, properties and application.
Unit-V	**:**	**Polyolefin fibre:** Spinning process and properties. **(10 Hrs)** **Vinyl fibre**: PAN fibre methods of spinning/stretching, advantages and disadvantages. **Modacrylic fibre:** Properties and applications. **PVC, Polyvinyl alcohol fibre**: fibre formation, structure, properties and applications. **Elastomeric fibre**: Spandex, Perlon U, lycra, vyrene.
Unit-VI	**:**	**Bleaching Agents: (15 Hrs)** Mechanism, effect of P^H, time, temperature, Oxidative bleaching, reduction bleaching, test for degree of bleaching, bleaching procedure. Processing of fibre:- Twisting, process sequence of twisted yarn, texturisation, its process, staple fibre formation. **Fibre Optics**: Introduction, preparation of optical fibre, optical fibre material, principle of operation of optical fibre, types, loss in optical fibre, concept of numerical aperture, advantages of optical fibre communication.

Text Books	**:**	1. Applied Fibre Science, by F Happey, Academic Press 2. Chemical Technology of Fibrous Material, by F.Sadov, M Korchagin, Mir Publication 3. Fundamentals of fibre formation, by A Ziabicki, John Wiley & Sons 4. Man made fibres science & Technology, by H.Mark, S.M.Atlas, Wiley Interscience 5. Cellulose- Structure, Modification & Hydrolysis, by R.A.Young & Rowell, Wiley International
References e- books, e- Journals	**:**	1. Manufactured Fibre Technology, by V.B.Gupta & V.K.Kothari, Springer 2. A Text book of Fibre Science & Technology, by S.P.Mishra, New Age International 3. Fibre Science & Technology, by V.I.Koshtikov, Springer 4. Fibres & Polymers, Springer 5. Fibre Chemistry, Springer 6. Optical Fibre Technology, Science Direct

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For 80 marks Paper:

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Code No.: PPE442 | **Course Title: Elective-II: Polymer Nanocomposites**
Teaching Scheme: | **Class Test (Marks): 20**
Theory: 04 Hrs/ week | **Theory Examination (Duration): 03Hrs**
Credits: 04 | **Theory Examination (Marks): 80**

Course Objectives	:	1. To study the introduction to nano materials and thefactors affecting it. 2. To study the synthesis methods of nano material. 3. To study the applications of nano materials in polymer composites preparation. 4. To study the different application sectors of nano materials and nano composites.
Unit-I	:	**Introduction: (8 Hrs)** Introduction to Nanotechnology, Conventional and nano-material properties, Role of size in properties of nano-materials, Length scale concept & uniqueness of nanostructured materials, Types of Nano-Materials.
Unit-II	:	**Synthesis: (10 Hrs)** Bottom-up approach and Top-down Approach for nano materials synthesis Methods: Ball Milling, Chemical vapor deposition, pressure vapor deposition, Solvo-thermal, Photochemical, Electrochemical, Sono-chemical synthesis, Precipitation, sol-gel, Micelles and Micro-emulsion, inert gas condensation, Plasma arc techniques and others.
Unit-III	:	**Overview & Effect of Nanoparticles: (12 Hrs)** Different types of nanoparticles: Montmorillonite, Carbon nanofibers – vapour grown carbon fibers, Polyhedral Oligomeric Sisoquioxane, carbon nanotubes, nanosilica, nanoaluminium oxide, nanotitanium oxide, Effect of nanoparticles on mechanical, chemical, electrical, optical, barrier, flame retardant, scratch & mar, & magnetic properties.
Unit-IV	:	**Polymer Nanocomposites Preparation & Characterization: (14 Hrs)** Synthesis methods: Solution intercalation, Melt intercalation, Roll Milling, Emulsion Polymerization, In-Situ Polymerization **Characterization Methods**: X ray diffraction, Transmission Electron microscopy (TEM), Small angle X ray scattering (SAXS), The Cone calorimeter, The Mass loss Calorimeter (MLC)
Unit-V	:	**Rheology of Polymer Nanocomposites: (6 Hrs)** Rheology of composites, Rheology of Nanocomposites with C-nano tubes,Rheology of Nanocomposites with MMT clay, Rheology of colloidal suspension .
Unit- VI	:	**Applications of Nanocomposites: (10 Hrs)** Self cleaning materials, self healing materials, Flame Retardant composites using nano materials, Toughened Plastics, Barrier properties of plastic packaging using Nanomaterials, Nanomaterials in Paints application, Nanomaterials in Rubbers, nanodendrimers in Bio-medical applications, Nanomaterials in cosmetics applications.
Text Books	:	Polymer Nanocomposites : Processing, Characterization & Applications - Joseph H. Koo - McGraw Hill publications.
References	:	1. Encyclopedia of Nanoscience and Nanotechnology - Hari singh Nalwa - American

e- books, e- Journals		Scientific publishers 2. Nanoparticle Technology Handbook - M Hosokawa, K Nogi, M Naito, T Yokoyama - Elsevier 3. The Science of Nanotechnology: An introductory text - LUANNE TILSTRA et al - Nova Science Publishers, Inc. 4. Polymer-Layered Silicate and Silica Nanocomposites - Y.C. Ke, P. Stroeve - ELSEVIER, 2005

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Code No.: PPE443	**Course Title: Elective-II : Adhesive Science & Technology**
Teaching Scheme:	**Class Test (Marks): 20**
Theory: 04 Hrs/ week	**Theory Examination (Duration): 03Hrs**
Credits: 04	**Theory Examination (Marks): 80**

Course Objective	**:**	To impart the knowledge of various adhesives, their mechanisms, characteristics and applications.
Unit-I	**:**	**Basics of Adhesion: (14 Hrs)** Basics of adhesion, surface energy and surface tension, Adhesion mechanism, Theories of adhesion, mechanical interlocking, electrostatic attraction, diffusion, adsorption, chemisorptions, classification and characteristics of adhesives, factors affecting adhesion, Advantages and limitations of adhesive bonding.
Unit-II	**:**	**Polymer Structure and Adhesive behavior: (8 Hrs)** Chemical structure, physical properties of polymers, bond formation, **Bond behavior**: molecular movement, internal stresses, bond separation.
Unit-III	**:**	**Characterization of Adhesives: (8 Hrs)** Need of testing adhesives, viscosity, pot life, tack, cure rate, percent solids, **Joint test:** shear, tensile, peel, impact, strength retention, Non destructive testings.
Unit-IV	**:**	**Types of adhesives: (14 Hrs)** Adhesives based on Phenolic resin , Amino resin, Polyvinyl acetate/alcohol , Plastisols, Epoxides, starch, cellulose ester, cellulose ether, polyurethane.
Unit-V	**:**	**Hot Melt Adhesives: (8 Hrs)** Introduction, advantages and disadvantages of hot melt adhesives, Usage areas, toubleshooting guide, hot melt application equipments.
Unit-VI	**:**	**Other Adhesives: (8 Hrs)** Adhesive papers, general tapes, pressure sensitive adhesives, water based adhesives, animal glue, solvent cementing thermoplastics and thermosets.
Text Books	**:**	1. Adhesion and Adhesives: Science & Technology, By A J Kinloch, Kluwer Publications. 2. Advances in Adhesives, Adhesion Science and Testing, By Denis Damico, ASTM Publications. 3. Handbook of Adhesives, 3rd Edition, By Skeist, Irving, Van Nostrand, New York Publications.
References e- books, e- Journals	**:**	1. Adhesives Technology Handbook, Second Edition, By Sina Ebnesajjad 2. Surface Preparation Techniques for Adhesive Bonding, By Raymond Wegman 3. International Journal of Adhesion and Adhesives, Elsevier 4. Applied Adhesion Science, Springer Open Journal

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(Faculty of Engineering & Technology)
Syllabus of Final Year B. Tech. (Plastics & Polymer Engineering) Semester-VII

Code No: PPE444	**Course Title: Elective-II: Polymer Blends and Composites**
Teaching Scheme: Hrs/week	**Class Test (Marks): 20**
Theory: 04 Hrs/week	**Theory Examination (Duration): 03 Hrs**
Credits: 04	**Theory Examination (Marks): 80**

Course Objective	**:**	• To impart the knowledge of polymer blends and composites along with Nanocomposites.
Unit-I	**:**	**Introduction to polymer blends: [8 Hrs]** Definition, Classification, Advantages of blends over conventional polymers, Selection of blend components, Significance of blend technology, Methods of blending, Economy of blending, Relevance of thermodynamics in blend preparation, Applications of polymer blends in different fields.
Unit-II	**:**	**Compatibilization of polymer blends and Interpenetrating network: [12 Hrs]** Types of compatibilizers and their importance in polymer blend preparation, Compatibilization mechanism and methods, Merits of compatibilization. Introduction to Interpenetrating network, Types of Interpenetrating network, Methods of preparation and applications of Interpenetrating network.
Unit-III	**:**	**Morphology and Rheology of polymer blends: [10 Hrs]** Factors affecting morphology of polymer blends, Homologous blends, Miscible and Immiscible blends, Flow behavior of miscible and immiscible polymer blends, Polyolefin blends- PE/PP, PE/PE blends.
Unit-IV	**:**	**Polymer Composites: [10 Hrs]** Introduction, Definition, Classification, Effect of properties of matrix on its composites, Reinforcing material- Definition, Classification (particulate, fibrous, laminar with examples), Effect of shape and size of fibrous reinforcement on properties of composites.
Unit-V	**:**	**Processing Techniques and design consideration of composites: [12 Hrs]** Injection molding, Reaction injection molding, compression molding, Blow molding, Thermoforming, Hand Lay-up, Filament winding, Pultrusion, Spray-up etc. Coating process of composites. Design consideration, material and product consideration. Applications of polymer composites.
Unit-VI	**:**	**Nanocomposites: [8 Hrs]** Introduction, Methods of synthesis of nanoparticle, Advantages of Nanocomposites over conventional polymer composites, Effect of size and shape of nanoparticle on properties of Nanocomposites. Applications in different fields.

Text Books	**:**	1. Polymer Blends, D.R.Paul & Newmann. 2. Polymer Alloys & Blends, Folkes. 3. Polymer Alloys & Blends, L.A.Uttracki, Hanser Pub, New York. 4. FRP Technology, R.A.Weatherhead, Applied science pub, London. 5. Fiber Reinforced Composites, P.K.Mallide, Marcel Dekker Inc,New York. 6. Handbook of Composites, George Lubin. 7. Plastics Engineering Handbook, J.L.Fradoz, Van Nostrand Reinhold Co, New York. 8. Engineering Materials Handbook of Composites, Volume – 1, Cyrill.A.Dostal. 9. Composite Material Handbook, Schwastz. 10. Nanoparticle Technology Handbook, M Hosokawa, K Nogi, M Naito, T Yokoyama, Elsevier.
References e- books, e- Journals		1. Biodegradable Polymer Blends and Composites from Renewable Resources, Long Yu (Editor), Wiley.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI

Pattern of Question Paper:

The six units in the course syllabus shall be divided in two equal parts of 3 units each. Question paper shall be set having two sections; Section A and Section B. The questions of Section A shall be set on first part and questions of Section B on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

1. Set ten questions in all with five questions in each section.
2. Question no. 1 from section A and Question no. 6 from section B should be made compulsory and should cover the entire course syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.

Two questions of 15 marks each from remaining questions from each section A and B should be asked to solve.

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Code No: PPE421	**Course Title: Laboratory I: Instrumental Analysis of Polymers**
Teaching Scheme:	**Term Work (Marks): 50**
Practicals: 02 Hrs/week	**Practical Examination (Marks): 50**
Credits: 01	

Course Objective	:	• To give an overview to the students about various instruments used for polymer characterization, their working principle, instrumentation and applications.
List of Practicals	:	1. Study of IR and FTIR for characterization of the structure of the polymers and interpretation of an IR spectrum obtained from the instrument. 2. To find Tg, Tc, and Tm of given resin by DSC. 3. Study of X-Ray scattering and X-Ray diffraction methods to determine crystallinity and orientation in polymers and analysis of a X-Ray diffraction pattern. 4. Identification of polymer components by Chromatography. 5. Study of differential scanning calorimetry to determine thermal behaviour of polymers and interpretation of a melting curve. 6. Interpretation of a crystallization (cooling) curve on DSC. 7. Interpretation and analysis of a DSC scan taken for isothermal crystallization. 8. Study of G.P.C. to determine MW and MWD of polymer and analysis of a result sheet obtained from GPC instrument. 9. To find molecular weight & PDI of given resin urging GPC. 10. To study the thermal property of given sample using Thermo Gravimetric Analyzer. 11. Study of scanning electron microscopy and interpretation of a SEM photograph.

Term Work assessment shall be done on the basis of

- Performing the experiments in the laboratory and
- Continuous assessment

Practical Examination, if applicable, shall be conducted on the syllabus and term work mentioned above.

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Code No: PPE422 | **Course Title: Laboratory- II: Plant Design**
Teaching Scheme: | **Term Work (Marks): 50**
Practicals: 02 Hrs/week | **Practical Examination (Marks): 50**
Credits: 01

Course Objective	**:**	• To get knowledge of designing the equipments using instrumentation and control diagrams.
List of Practicals	**:**	1. Different instrumentation diagrams showing measurement & control of various parameters like temperature, pressure level, flow etc. 2. Design of jacketed batch reactor using CAD software. 3. Design of distillation column for binary system using CAD software. 4. Plant layout of at least one polymer industry using CAD software. 5. Design of Double pipe heat exchanger using CAD software. 6. Design of Shell & Tube heat exchanger. 7. Various pipe fittings & bends. 8. Design of cooling Towers. 9. Design of contacting column. 10. Piping and instrumentation diagram of Polymer Plant.

Term Work assessment shall be done on the basis of

- Performing the experiments in the laboratory and
- Continuous assessment

Practical Examination, if applicable, shall be conducted on the syllabus and term work mentioned above.

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Code No: PPE423 **Course Title: Laboratory-III: CAE for Plastics**
Teaching Scheme: **Term Work (Marks): 100**
Practicals : 04 Hrs/week
Credits: 2

Course Objective	**:**	• To impart the knowledge of design analysis using computer aided engineering packages and to enhance injection mould and product design capabilities.
List of Practicals	**:**	**1. Introduction** to CAE, packages used, Benefits of CAD, CAM, CAE, applications to plastics mould and product design. **2. Flow Analysis:** Gate Location, filling, Fill Pattern: Weld line position, Air trap locations, Position of vents, Over packing, Shoot Filling. **3. Flow Analysis:** Pressure distribution, Pressure required to fill, Clamp force required, Over packing, sticking in mold. **4. Flow/Fill Analysis:** Temperature: Poor surface finish, Weak weld lines, Distortion due to differential cooling. Shear stress distribution: Quality of part: tendency to distort, Quality of part: tendency to crack, Cycle time. **5. Flow/Fill Analysis:** Shear rate cooling time, degradation of material, tendency to distort due to uneven cooling, Quality of part: molecular orientation. Quality of part: molecular orientation, packing pressure, volumetric shrinkage. **6. Cooling Analysis:** Mold surface Temperature, Freeze time, **7. Cooling Analysis:** Coolant temperature and flow rate. **8. Warpage Analysis:** Warped shape, Single variant Warpage shape: fundamental causes of warpage. **9. Mould Assembly:** Core Cavity Extraction / Molding, Mold Base development Manual/Auto, **10.** Introduction to Mold Wizard.
Reference Books	**:**	1. Plastics Design Handbook by D V Rosato, Kluwer Academic Publisher 2. Injection Mould Design by R G W Pye 3. Mould Flow by Sham Tickoo

Term Work assessment shall be done on the basis of

- Performing the experiments in the laboratory and
- Continuous assessment
- Practical Examination, if applicable, shall be conducted on the syllabus and term work mentioned above.

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Code No: PPE425	**Title: Project-II**
Teaching Scheme	**Term Work (Marks): 100**
Practical: 06 Hrs./week	**Practical Examination (Marks): 100**
Credits: 03	

Course Objectives	:	1. The practical implementation of theoretical knowledge gained during the study to till date is important for engineering education. The student should be able implement their ideas/real time industrial problem/ current application of their engineering branch which they have studied in curriculum. 2. To motivate students for creativity. 3. To create awareness regarding latest technology 4. To have common platform for interaction about emerging technology. 5. To inculcate qualities of team work. 6. To explore related information using books, research papers, journals & websites. 7. To improve presentation and communication skills.
		Guidelines For Students And Faculty: 1. Students shall complete the Project-II in continuation of the work planned in third year under the course Project-I 2. Each student/group is required to- a. Submit a report with latest status of the project work. b. Give a 10 minutes presentation through OHP, PC, and Slide projector followed by a 10 minute discussion in the second week of their academic semester. c. Submit a report on the project topic with a list of required hardware, software or other equipment for executing the project in the third week of their academic semester. d. Start working on the project and submit initial development and CPM/PERT planning drawing in the fourth week of their academic semester. e. Preparation of PCB layout, wiring diagram, purchase of components, software demo, flowchart, algorithm, program/code, assembling, testing, etc. should be submitted by student/s within next five/Six weeks and minimum one page report should be there for each major activity. f. Overall assembling, wiring, code writing, testing, commissioning along with performance analysis, should be completed within next two weeks. g. In the last week, student/group will submit final project report to the guide. 3. Every assigned faculty/s should maintain recordof progress of each student or group. The format and other guidelines for the purpose of the Project Submission in hard

		bound copies should be as follows, **REPORT STRUCTURE** Index/Contents/Intent List of Figures List of Tables List of Symbols / Abbreviations 1. Introduction 2. Literature survey 3. System development 4. Performance analysis 5. Conclusions References Appendices Acknowledgement
		1. INTRODUCTION 1.1 Introduction 1.2 Necessity 1.3 Objectives 1.4 Theme 1.5 Organization 2. LITERATURE SURVEY Literature Survey Related information available in standard Books, Journals, Transactions, Internet Websites *etc.* till date (More emphasis on last three to five years) 3. SYSTEM DEVELOPMENT Model Development • Mechanical / Fabricated

- Analytical
- Computational
- Experimental
- Mathematical
- Software

(out of above methods at least one method is to be used for the model development)
Some mathematical treatment or related information is required to be embodied

4. PERFORMANCE ANALYSIS

- Analysis of system developed either by at least two methods depending upon depth of standard
- These methods normally used are Analytical /Computational/Statistical/Experimental/ or Mathematical
- Results at various stages may be compared with various inputs
- Output at various stages with same waveforms or signals or related information/parameters
- Comparison of above results by at least two methods and justification for the differences or error in with theory or earlier published results

5. CONCLUSIONS

5.1 Conclusions

5.2 Future Scope

5.3 Applications

Contributions (if any,)

The innovative work/invention/new ideas generated from the analysis of the work which can be taken from the conclusions

REFERENCES

- Author, "Title", Name of Journal/Transactions/ Book, Edition/Volume, Publisher, Year of Publication, page to page (pp.__).

These references must be reflected in text at appropriate places in square bracket

In case of web pages complete web page address with assessing date has to be enlisted

List of references should be as per use in the text of the report

APPENDICES

		Related data or specifications or referred charts, details computer code/program, *etc*. **ACKNOWLEDGEMENTS** Expression of gratitude and thankfulness for helping in completion of the said task with name& signed by the candidate
		• General Guidelines Text should be printed on front and correct side of the watermark on quality bond paper Paper size- A4, 75 to 85 gsm paper Left Margin-1.5” Right Margin-3/4” Top Margin-1” Bottom Margin-1” • Pagination First page of every chapter need not be printed but counted,second page onwards page number to printed at bottom center place. All Greek words must be italic Report Heading -ALL CAPITAL—16 Font Chapter heading -ALL CAPITAL—14 Font Subchapter –Title Case-12 Font Sub-Subchapter –First Alphabet Capital case-12 Font Page numbers for Index/Contents/Intent should be in roman All text should be in times new roman Cover page should have complete symbol of institute Suitable flap (bookmark) with name of the candidate, Department and Institute name and symbol can be used with nylon strip.
		For more information and sample of hard copy please contact the respective Head of the Department.

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Syllabus: B. Tech. (PPE) **Semester-VIII**
Code No.: PPE471 **Title: Inplant Training (IPT)**
Credits: 27 **Examination Scheme**
Term work (Marks): 300
Practical (Marks): 300

(a)	**Rationale:** The techniques and processes of production of goods and services do not demand only technical skills, but also a cluster or conglomerate of skills. A significant part of which is related to the total humanistic growth of the man. Such conglomerate skills technical and humanistic cannot obviously be acquired through pure academic learning of concepts in formalized and institutional courses and in isolation of the actual work situation. It, therefore, naturally follows that no technical education will be complete till it has two components, one learning of concepts vis-a vis acquiring conceptual skill and other application of the concepts in real work situation vis-a vis acquiring manipulative or practicing skills. Technical education needs to have a complement of learning of the techniques of applying the concepts within the industry and business.
(b)	**Objectives:** 1) The students of B.Tech course shall get an opportunity to work on live problems of the industry. 2) He/She shall apply learning concepts in the real work situation. 3) He/She shall get an exposure to the industrial environment and thereby enable himself/herself to appreciate the other related aspects of industry viz. human, economic, commercial and regulatory. 4) He/She shall identify career paths taking into account their individual strengths and aptitude. 5) He/She shall contribute for the achievement of economic goals and aspirations of the industry and our country as a whole.
(c)	The curriculum for B.Tech students of Final Year Course of Part-II shall consist of; • Inplant training for a period of one full term, and the period of the term shall be as prescribed by the university from time to time. • A project on live problems of the industry shall be undertaken by the student/group of students undergoing training in the same establishment. • The term work shall consist of the inplant training record-daily diary, work diary, progress report, a record containing the literature survey in the field of appropriate branch of Engineering, a preliminary report related to project work etc. • Seminars will be arranged after successful completion of period specified in the scheme of semester VIII of B.Tech. The date and times will be decided according to the convenience of guide and student.

(d)	**General Provisions, Rules and Regulation of Inplant Training** 1. **Definition** • In-plant training (IPT) means a course of training in any industry or establishment undergone in pursuance of memorandum of understanding between industry and institute and under the prescribed terms and conditions of Dr.Babasaheb Ambedkar Marathwada University, Aurangabad. • Institute means an academic Institution of higher learning associated and admitted under the privileges of university, i.e. Maharashtra Institute of Technology, Aurangabad affiliated to Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. • Industry means any industry or business in which any trade, occupation or subject field in engineering or technology may be specified as a designated trade. • Establishment includes research organizations (like IITs, NITs, National Laboratories or research center/organization as recognized by Central Govt. / State Govt. / University) or any other organization of repute with the permission of Head of the institute. • University means any of the universities mentioned in the schedule of Maharashtra University Act, 1994 i.e. Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. • Collaboration means collaborative academic activity of the Institute with industry. • Student means a B.Tech. Course student.
	2. **Memorandum of understanding:** Maharashtra Institute of Technology, Aurangabad will enter into an agreement with the industry through 'Memorandum of Understanding' for creating facilities of inplant training in the appropriate branch of Engineering according to the Course Curriculum and keep this agreement for a period of 10 years to foster a healthy industry- institute interaction for mutual benefits of both.
	3. **Admission to inplant training:** No student will be deputed for inplant training unless he/she produces testimonial of having kept one term for the subject under B.Tech. of final year course satisfactorily in Maharashtra Institute of Technology, Aurangabad.
	4. **Period of inplant training:** The period of Inplant training will be the period of one term for the subject under B.Tech. course semester-VIII, which will be notified by Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
	5. **Contract of Inplant Training :** • The student of Maharashtra Institute of Technology shall enter into a contract of inplant training with the employing industry. • The inplant training shall be deemed to have commenced on the date, on which the contract of inplant training has been entered into. • Every contract of inplant training will contain the Terms and Conditions to be agreed by both the parties. • Every contract of inplant training shall be registered with the Maharashtra Institute of Technology within 15 days from entering into the contract.
	6. **Violation of contract:** Where an employer, with whom a contract for inplant training has been entered into, is for any reason, unable to fulfill his obligation under the contract, the contract end with the consent of Maharashtra Institute of Technology. It is agreed between the employer, the student and any other employer that the

student shall be engaged as an "inplant trainee" under the other employer till the expiry period of the inplant training. The agreement on registration with Maharashtra Institute of Technology shall be deemed to be the contract of inplant training between the student and other employer, and from the date of such registration, the contract of inplant training with the first employer shall terminate and no obligation under that contract shall be enforceable at the instance of any party to contract against the other party thereto.

7. **Termination of Contract:**

The contract of inplant training shall terminate on the expiry of the period of inplant training.

Either party to the contract of inplant training make an application to Maharashtra Institute of Technology, Aurangabad for the termination of the contract.

After considering the content of the application, and objection, Maharashtra Institute of Technology by order in writing, will terminate the contract, if it is satisfied that the parties to the contract have/has failed to carry out the Terms and Conditions of the contract.

Provided that where a contract is terminated-

- For the failure on the part of the Employer, Maharashtra Institute of Technology will depute students to another Employer for providing facilities of inplant training to the remaining period of training.
- For the failure on the part of the student, the student will not be allowed to continue his/her inplant training in that term. The student shall be deputed for inplant training in the next coming term.

8. **Expectation from the Employer / Industry / Establishment:**

The following expectations are derived for effective inplant training.

- To provide legitimate facilities for the training and learning of all the processes.
- To guide the student for understanding a project of immense importance to industry and to help him/her for his/her career advancement.

9. **Obligation of Students:**

- Student must maintain a minimum attendance of 90% of total working days for the period of Inplant Training.
- To learn his/her subject field in Engineering or Technology consciously and diligently at his place of training.
- To carry out all orders of his/her Employer and the Superior in the establishment.
- To abide by the Rules and Regulations of the Industry/Establishment in all matters of conduct and discipline.
- To carry out the obligation under the contract of inplant training.
- The student shall maintain a report of his work during the period of his inplant training in a proforma (form no: 2) made available in Annexure.
- Except in case of extreme urgency, the B.Tech. student shall submit an application for all other leaves except the medical leave to the Manager/Gen. Manager (Personnel) of the concerned industry, where he is undergoing an inplant training and obtain sanction before the leave is taken. In case of Medical Leave, he shall submit an application to Maharashtra Institute of Technology, Aurangabad. The shortage in attendance will be subjected to extending the period of inplant training in which case, the student may not be allowed to appear for the test, project seminar and assessment of term work etc. which will be held immediately after successful completion of the inplant training.

10. **Maintenance of Record:**
Every student of B.Tech. course shall maintain a daily record of the work done by him/her relating to the inplant training in the proforma (Annexure).

11. **Industry Sponsored Student Projects:**
The scheme envisages working out suitable programme for B.Tech. students. They are required to complete their inplant training in a given period. During this period, they shall be familiar with the understanding of the shop process and activities. The students can be asked to solve the mini-shop problem, which will make them think and try out short experiments as an improvement in the process, tools and equipment.

The students in a group alone can undertake a project of immense importance for the benefit of the industry and also useful for the students for their advancement of career. Industry staff and Maharashtra Institute of Technology faculty can plan in advance to effectively complete the practical training with the project for preliminary studies on the floor.

The projects should aim mainly-

- Cost reduction
- Enhancing productivity
- Develoment/Improvement/ Effective use of Softwares/ Systems
- Energy conservation measures
- Process Improvement technique
- Apllication Development
- Plastic and Polymer working
- Hardware/ Software
- Agroengineering and so on.

12. **What will form a good project?**
Through the project, it is hoped to provide the students an exciting experience in solving line problems under practical constraints. Hence it is desired that the project should be a well-defined problem, which can be completed and implemented within the project period. It may be a problem, evolving analysis, design, fabrication and / or testing.

13. **Time Schedule for the Project:**
The following time schedule should be planned by each student or groups of students, who undertake the project.

- Proposal to be received before specified date.
- Project acceptance before.
- Commencement of the project.
- Completion of the project.

14. **Commitment on the part of the Institute:**
- Providing a faculty member to supervise the project.
- Providing the Institute facilities to complete the project.
- Coordinator from industry will be invited to participate in the stage wise assessment of the students performance.

15. **Assistance for completion of the Project:**
All the projects undertaken by the students are time bound. Although, every attempt results may not be achieved within the period available for the student. In such cases, the services of the associated faculty members can be sought for the completion of the same on mutually agreed terms.

16. **Monitoring of Inplant Training:**
The B.Tech. students are expected to follow all the rules and discipline of the industry. However, because of other academic requirements and the nature of the project, the student may have to work in other places outside the industry. The faculty and Industry supervisor will work out a suitable arrangement to review the progress of the work from time to time. Maharashtra Institute of Technology, Aurangabad will monitor the progress of inplant training in association with industry authority.

17. **Conduct and Discipline:**
In all matters of the conduct and discipline, B.Tech. student shall be governed by the rules and regulations (applicable to employees of the corresponding category) in the Establishment, where he/she is undergoing a training.

18. **B.Tech. Students are Trainees and not Workers:**

- Every B.Tech. student undergoing an inplant training in the respective branch of Engineering & Technology in any Establishment shall be treated as a trainee and not a worker and-
- The provision of any law with respect to labour will not apply to such a trainee.

19. **Settlement of Disputes:**
Any disagreement or dispute between an industry and a B.Tech. student trainee arising out of the contract of inplant training shall be resolved both by Maharashtra Institute of Technology and the industry with mutual cooperation. The decision of both Maharashtra Institute of Technology and the industry shall be final.

20. **Holding of Test and Grant of Certificate:**
The progress in inplant training of every student shall be assessed by the industry and Maharashtra Institute of Technology faculty from time to time.

Every B.Tech. student undergoing an inplant training shall be issued a certificate of Proficiency on completion of his/her training to the satisfaction of the industry.

21. **Offer of Stipend / Other Welfare Activities and Employment:**
It shall not be obligatory on the part of the Employer / Industry to offer any stipend and other welfare amenities available, if any, to the students of B.Tech. courses undergoing an inplant training. However, if the industry desirous to do so will be a privilege for the students and also for Maharashtra Institute of Technology in view of the bonding of better understanding and cooperation forever.

(e)	**PRACTICAL EXAMINATION** The Practical examination will be conducted after successful completion of the inplant training for which guide will be internal examiner and external examiner will be appointed by the university. The date of practical examination will be same for the students of a branch and will be notified by the university. The assessment of the practical examination shall consist of 1. Seminar Performance 2. An oral on the project work done. 3. Assessment of the term work / report.