Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

Revised Syllabus of Third Year (TY) Bachelor of Technology

Plastic and Polymer Engineering

(V & VI Semester)

Under Choice Based Credit System (CBCS)

Under Faculty of Science and Technology

(Effective from 2021-22 and onwards)

FACULTY OF SCIENCE AND TECHNOLOGY

Proposed Syllabus Structure w.e.f. 2021-2022 (Choice Based Credit System)

TY B. Tech (Plastic and Polymer Engineering)

Semester-V

Course Code	Course Name	Teaching Scheme (Hrs/Week)			Examination Scheme and Marks							Credits			
		Theory	Practical	Tutorial	MSE-I	MSE-II	TA	ESE	TW	PR/OR	Total	TH	TW/PR	TUT	Total
PPE301	Elastomer Technology	3	-	-	15	15	10	60	-	-	100	3	-	-	3
PPE302	Polymer Rheology	3	-	-	15	15	10	60	-	-	100	3	-	-	3
BSH303	Managerial Economics, Finance & Costing	3	-	-	15	15	10	60	-	-	100	3	-	-	3
PPE341-343	Professional Elective Course-II	3	-	-	15	15	10	60	-	-	100	3	-	-	3
	Open Elective-I	3	-	-	15	15	10	60	-	-	100	3	-	-	3
PPE321	Lab: Elastomer Technology	-	2	-	-	-	-	-	-	25	25	-	1	-	1
PPE322	Lab: Design Lab-II	-	2	-	-	-	-	-	-	25	25	-	1	-	1
PPE223-225	Lab: Professional Elective Course-II	-	2	-	-	-	-	-	25	-	25	-	1	-	1
PPE326	Minor Project-I	-	2	-	-	-	-	-	25	-	25	-	1	-	1
PPE327	Lab: Materials Synthesis and Testing	-	2	-	-	-	-	-	-	25	25	-	1	-	1
PPE328	Lab: Experiential / Problem Based Learning	-	2	-	-	-	-	-	25	-	25	-	1	-	1
		15	**12**	**-**	**75**	**75**	**50**	**300**	**75**	**75**	**650**	**15**	**6**	**-**	**21**

Semester-VI

Course Code	Course Name	Teaching Scheme (Hrs/Week)			Examination Scheme and Marks							Credits			
		Theory	Practical	Tutorial	MSE-I	MSE-II	TA	ESE	TW	PR/OR	Total	TH	TW/PR	TUT	Total
PPE351	Polymer Processing Technology	3	-	-	15	15	10	60	-	-	100	3	-	-	3
PPE352	Polymeric Materials	3	-	-	15	15	10	60	-	-	100	3	-	-	3
PPE353	Polymer Characterization	3	-	-	15	15	10	60	-	-	100	3	-	-	3
PPE391-93	Professional Elective Course-III	3	-	-	15	15	10	60	-	-	100	3	-	-	3
	Open Elective-II	3	-	-	15	15	10	60	-	-	100	3	-	-	3
PPE371	Lab: Polymer Processing Technology-I	-	2	-	-	-	-	-	-	25	25	-	1	-	1
PPE372	Lab: Polymeric Materials	-	2	-	-	-	-	-	-	25	25	-	1	-	1
PPE373	Lab: Polymer Characterization	-	2	-	-	-	-	-	-	25	25	-	1	-	1
PPE374	Major Project-I	-	4	-	-	-	-	-		50	50	-	2	-	2
PPE375	Lab: CAE for Plastics	-	2	-	-	-	-	-	25	-	25	-	1	-	1
	Mandatory Non-credit Course (Audit Course)	2													
		17	**12**	**-**	**75**	**75**	**50**	**300**	**25**	**125**	**650**	**15**	**6**	**-**	**21**

MSE- Mid Semester Exam, ESE- End Semester Examination, TH-Theory, OR- Oral, TA-Teacher Assessment, TW- Term Work, PR- Practical, Tut-Tutorial

Professional Elective Courses-II (Semester-V)

Group A	Group B	Group C
PPE341: Surface Coating Technology	PPE342: Mass Transfer	PPE343: Membrane Technology

Professional Elective Courses-III (Semester-VI)

Group A	Group B	Group C
PPE391: Fluid Mechanics	PPE392: Biopolymers	PPE393: Advanced Polymer Chemistry

List of Open Elective-I (Semester V)

Sr. No.	Offered by Department	Name of Course	Course Code
1.	Agricultural Engineering	Statistical Methods in Engineering	AED331
2.	Civil Engineering	Environmental Impact Assessment	CED331
3.	Computer Science and Engineering	Artificial Intelligence and its Applications	CSE331
4.	Electrical Engineering	Special Purpose Machines	EED331
5.	Electronics and Telecommunications Engineering	Electronic Product Design	ETC331
6.	Mechanical Engineering	Operations Research	MED331
7.	Plastic and Polymer Engineering	Introduction to Nanotechnology	PPE331

List of Open Elective-II (Semester VI)

Sr. No.	Offered by Department	Name of Course	Course Code
1.	Agricultural Engineering	Fundamentals of Bioenergy	AED381
2.	Civil Engineering	Solid Waste Management	CED381
3.	Computer Science and Engineering	Information & Cyber Security	CSE381
4.	Electrical Engineering	Electrical Materials	EED381
5.	Electronics and Telecommunications Engineering	Internet of Things	ETC381
6.	Mechanical Engineering	Industry 4.0	MED381
7.	Plastic and Polymer Engineering	Polymer Recycling and Waste Management	PPE381

Mandatory Non-Credit Course (Audit Course) (Semester VI)

Sr. No.	Offered by Department	Course	Course code
1.	First Year	German Language	BSH807
2.	First Year	Japanese Language	BSH808
3.	Civil Engineering	Professional Ethics and Constitution of India	CED801
4.	Computer Science and Engineering	Green Computing	CSE801
5.	Electronics and Telecommunications Engineering	Smart Cities	ETC801
6.	Mechanical Engineering	Research Methodology	MED801
7.	Plastic and Polymer Engineering	Industrial Safety and Management	PPE801

<table>
<tr><td colspan="3">Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
(Faculty of Science & Technology)
Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V</td></tr>
<tr><td colspan="2">Course Code: PPE301
Course: Elastomer Technology
Teaching Scheme:
Theory: 3 Hrs/week</td><td>Credits: 3-0-0
Mid Semester Examination-I: 15 Marks
Mid Semester Examination-II: 15 Marks
Teacher Assessment: 10 Marks
End Semester Examination: 60 Marks
End Semester Examination (Duration): 3 Hrs</td></tr>
<tr><td>Prerequisite</td><td colspan="2">• Introduction to polymer engineering.
• Polymer testing.</td></tr>
<tr><td>Objectives</td><td colspan="2">1. To understand different terminologies associated to elastomer technology.
2. To acquire fundamental knowledge about natural and synthetic rubbers, their structures, basic characteristics and applications.
3. To gain knowledge about compounding of elastomers.
4. To acquire knowledge about vulcanization of rubbers.</td></tr>
<tr><td>Unit-I</td><td colspan="2">Introduction to Elastomers
Definitions and terminologies, Gough-Joule effect, molecular structures, classifications (natural and synthetic, general purpose and special purpose, polar and non-polar), basic characteristics and miscellaneous applications of rubbers.
(3 Hrs)</td></tr>
<tr><td>Unit-II</td><td colspan="2">Testing of Rubbery Materials
Brief idea about the principles of tensile strength, tear strength, abrasion resistance, resilience, hardness, compression set, plasticity retention index, heat build-up, flex fatigue, die swell, gas barrier property and crosslink density measurement.
(9 Hrs)</td></tr>
<tr><td>Unit-III</td><td colspan="2">Natural Rubber and Its Derivatives
Brief overview of natural rubber latex, composition, tapping and related notations, coagulation, processing of latex, different grades (RSS, SMR, ISNR), properties and applications. Brief discussion on preparation, properties and applications of oil extended, epoxidized, cyclized, deproteinized, chlorinated natural rubber and ebonite.
(6 Hrs)</td></tr>
<tr><td>Unit-IV</td><td colspan="2">Polar and Non-polar Rubber
Structure, properties and applications of polar (BR, SBR, IIR and EPDM) and non-polar (CR, NBR and silicone) rubbers.
(7 Hrs)</td></tr>
<tr><td>Unit-V</td><td colspan="2">Rubber Compounding
Vulcanization, curing agents, accelerators, fillers (carbon black and silica), vulcanization methods, systems and techniques, roles of different additives, compounding formulation, analysis of rheo-curve. Calculation of scorch time, optimum cure time and cure index. Calculation of density of compound and amounts of components required for a compounding formulation.
(8 Hrs)</td></tr>
</table>

Unit-VI	**Thermoplastic elastomer** Fundamental idea about thermoplastic elastomer (TPE) and thermoplastic vulcanizates (TPV). Methods of preparation (static and dynamic vulcanization), structure, properties and applications of thermoplastic elastomers. **(3 Hrs)**				
Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	Rubber Technology	Maurice Morton	Van Nostrand Reinhold	1987
	2.	Rubber Technology and Manufacture	C. M. Blow	Butterworths for the Institution of the Rubber Industry	1971
	3.	Handbook of Elastomers	Anil K. Bhowmick, Howard Stephens	CRC Press	2nd 2000
	4.	Rubber Engineering	Indian Rubber Institute	McGraw Hill, India	1998
	5.	Physical Testing of Rubber	Roger Brown	Springer	4th

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V	
Course Code: PPE302 Course: Polymer Rheology **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs

Prerequisite	• Introduction to Polymer Engineering. • Physical Chemistry of Polymers. • Polymer Testing.
Objective	1. To understand flow behaviour of polymeric materials.
Unit-I	**Introduction to Rheology** Overview and importance of rheology, power law, Newtonian and non-Newtonian fluids, pseudoplastic and dilatant fluids, thixotropy and rheopexy, viscoelasticity, thermal dependence of viscous flow (free volume), Deborah number, Weissenberg effect, die swell. **(5 Hrs)**
Unit-II	**Viscoelastic Models** Creep and stress relaxation in Maxwell, Voigt-Kelvin and four parameter model, viscoelastic relaxation and retardation, creep compliance, correlations of rheological parameters. **(7 Hrs)**
Unit-III	**Factors Affecting Shear Flow** Effect of temperature, pressure and frequency on rheological behaviour; effect of molecular weight and concentration on viscous flow, melt fracture and irregular flow. **(6 Hrs)**
Unit-IV	**Transition Phenomena** Identification of phase transition temperatures, WLF equation, time-temperature equivalence and superposition. **(5 Hrs)**
Unit-V	**Measurement of Rheological Characteristics** Brief working principle and application of various rheometers: Capillary rheometer, Mooney rheometer, cone and plate rheometer, parallel plate rheometer, Brookfield viscometer, extensional rheometer, moving die rheometer, oscillating die rheometer. **(8 Hrs)**
Unit-VI	**Interpretation of Rheological Characteristics of Polymeric Materials** Analysis of storage modulus, loss modulus, tan δ, glass transition, curing, gelation, interfacial interaction. **(5 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
Text Book/ Reference Books	1.	Polymer melt rheology	F. N. Cogswell	Woodhead Publishing Ltd.	1st 1981
	2.	Rheometry	K. Walters	Chapman and Hall	1st 1975
	3.	Flow properties of polymer melt	Brydson. J. George	George Goodwin Ltd.	1st 1981
	4.	Viscoelastic properties of polymers	John D. Ferry	John Willey & Sons	3rd 1980
	5.	A practical approach to rheology and rheometry	Gebhard Schramm	Gebrueder HAAKE GmbH	2nd 2000
	6.	Rheology of chemists	J. Goodwin, R. Hughes	RSC Publishing	2nd 2008
	7.	Polymer melt rheology	F. N. Cogswell	Woodhead Publishing Ltd.	1st 1981
	8.	Rheometry	K. Walters	Chapman and Hall	1st 1975
	9.	Flow properties of polymer melt	Brydson. J. George	George Goodwin Ltd.	1st 1981

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester V	
Course Code: BSH303 Course: Managerial Economics, Finance & Costing **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs

Prerequisite	• Basic knowledge of concepts of economics.
Objectives	On the completion of this course, the learner will be able to 1. Correlate various micro and macro-economic variables and solve numerical problems 2. Analyze, interpret the financial statements and decide upon the health of a firm. 3. Appreciate and illustrate Economic/Industrial/Trade policies and their implications and Role played by various financial institutions/banks. 4. Apply costing and accounting and costing practices in solving real life problems.
Unit-I	**Managerial Economics Part-I** Introduction- Economics, basic concepts - utility, wealth, welfare, price, markets, and opportunity cost. Micro - and macro- economics, economics of growth and development. **(4 Hrs)**
Unit-II	**Managerial Economics Part-II** Demand and supply analysis: Law and elasticity of demand and supply. Demand function. Market structure - competition, monopoly, oligopoly and imperfect competition. Market imperfections and state interventions. Role of government; monetary, fiscal and trade policies, BOP, industrial policy; instruments of government policy; taxation, incentives, budget. Theory of firm: Production and Cost analysis for short run and long run. Cost-Output Relationship: Cost Function, Cost-Output relationships in Short Run and Long Run. Revenue Analysis and Pricing Policies. **(8 Hrs)**
Unit-III	**Finance Part-I** Introduction, Basic business function, sources of finance and their relative importance. Long and short term finance. Fund allocation, alternative uses of finance. Time value of money. Analysis of financial statements –Ratio analysis using balance sheet, profit and loss account. Capital budgeting decisions- type, nature and evaluation criteria: NPV, IRR, Payback. **(6 Hrs)**
Unit-IV	**Finance Part-II** Working capital management. Financial markets; money markets, bill market, discount houses, call loan market, etc., Capital markets; mutual funds, stock markets, industrial banks, world bank, UTI, IDBI, ICICI, SEBI and state finance corporations. **(6 Hrs)**

Unit-V	**Costing Part-I** Cost classification: Cost ascertainment; allocation, apportionment, absorption of overheads and non-production cost; overhead analysis, absorption methods, general considerations. Job costing; factory job costing, contract cost. Unit costing; output and operating cost, simple process costing, normal and abnormal losses in process, waste, scrap, bye-and joint products. Marginal costs and breakdown charges. **(6 Hrs)**				
Unit-VI	**Costing Part-II** Cost planning and control, standard cost and budgetary control, setting standards, variance analysis. Cost reduction; tools, techniques and productivity. Depreciation; causes and significance, methods of providing for depreciation, book values, taxes and depreciation. **(6 Hrs)**				
Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	Economics	Paul Samuelson and William Nordhaus	Tata McGraw Hill.	2005
	2.	Financial Management	Prasanna Chandra	McGraw Hill.	10th
	3.	Cost Accounting	Jawaharlal	Tata McGraw Hill (TMH).	3rd
	4.	Finance Sense - Text and Cases	Prasanna Chandra	Tata McGraw Hill	4th
	5.	Managerial Economics	Varshney and Maheshwari	Sultan Chand and Sons, New Delhi	22nd
	6.	Indian Economy	Ruddar Datt and Sundaram	S.Chand Publication	72nd
	7.	Financial institutions and markets	L.M. Bhole and Jitendra Mahakud	McGraw Hill Education.	6th
	8.	Managerial Economics	Paul Keat, Philip Young and Sreejata Banerjee	Pearson Publication	7th
Website	1.	www.nptel.ac.in			

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V	
Course Code: PPE341 Course: Professional Elective Course-II (Surface Coating Technology) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Objectives	1. To make the students aware of the essential components of paints and coatings. 2. To make the students familiar with the basic and recent advancements in coating technologies.
Unit-I	**Introduction** Concepts & terminologies, classification of coatings interfacial tension, basic components of surface coating, free energy changes, wetting, dispersion, cohesive and adhesive forces, chemistry and technology of surfactants. **(4 Hrs)**
Unit-II	**Technology of Water-based Paints and Coatings** Preparation of latex for paints, chemistry and technology of emulsion and latex paints, developments in waterborne coatings. **(6 Hrs)**
Unit-III	**Various Surface Coatings** Preparation and characteristics of Coil Coating, UV curable coating, Anti-corrosive coatings, Non Stick coatings, Smart Coatings, Super hydrophobic coatings, Hygienic Coatings, Protective coatings, Marine coatings, Automotive and Aerospace coatings, Self cleaning and self healing coatings. **(8 Hrs)**
Unit-IV	**Powder coatings, Varnishes and Lacquers** Powder Coatings, dry distempers, cement paints, oil based distempers and paints, other stiff paints, putties, Technology of manufacturing varnishes, lacquers and their applications. **(7 Hrs)**
Unit-V	**Technology of Construction Chemicals** Adhesives & Sealants, Waterproofing compounds, Polymeric Additives for Concrete admixtures. **Specific application Paints and Coatings** Wood Finishes, Road Marking Paint, Novelty Finishes. **(4 Hrs)**
Unit-VI	**Study of Important Characteristics of Surface Coating** Rheological properties, optical properties, adhesion and mechanical properties, corrosion and chemical resistance properties, film thickness, liquid paint analysis according to ASTM, BIS and BS Standards, characterization of varnishes according to ASTM, BIS and BSS standards. **(7 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
Text Book/ Reference Books	1.	Chemistry, Materials and Properties of surface coatings	Gungor Gundoz	Destech Pub	-
	2.	Surface Coating Technology Handbook	NPCS Board	Asia Pacific Business Press	-
	3.	Modern Technology of Paints, Varnishes & Lacquers	NIIR Board	National Institute Of Industrial Research	January, 2005
	4.	Paints and Surface Coatings	R.Lambourne,TA Strivens	Elsevier	2nd 1999
	5.	Testing of paints : technical analysis of paints and paint raw materials	Shreekant Patil	Colour Pub	2009
	6.	Basics of Paint Technology, Part-I	V.C.Malshe	Sevak Printers	1st 2002

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V	
Course Code: PPE342 Course: Professional Elective Course-II (Mass Transfer) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Objectives	1. To understand the fundamental concepts of mass transfer principles and apply these concepts to real engineering problems 2. To get acquainted with the design of continuous contact and stage wise operations. 3. To provide theoretical understanding of various mass transfer operations such as diffusion, vapor-liquid, gas-liquid systems and drying 4. To understand industrial, polymeric-membrane materials.
Unit-I	**Introduction to Mass Transfer and Molecular Diffusion** Introduction and various mass transfer operations, classification of mass transfer operations, Ficks law, molecular diffusion in gases and liquids, types of diffusion. **(6 Hrs)**
Unit-II	**Interphase Mass Transfer and Mass Transfer Coefficients** Equilibrium, diffusion between phases, local and average phase /overall mass transfer coefficients, mass transfer coefficients in laminar and turbulent flow, theories for mass transfer: film theory, penetration theory, boundary layer theory. **(6 Hrs)**
Unit-III	**Absorption** Introduction, ideal liquid solutions, material balance for one component transferred in countercurrent, equipment for gas liquid operations. **(6 Hrs)**
Unit-IV	**Distillation** Vapor – liquid equilibria, Raoult's law, differential distillation and equilibrium distillation, Fractionation, graphical methods for estimation of number of stages required in distillation column by Mccabe Thiele method, minimum reflux ratio, optimum reflux ratio, effect of feed conditions on number of plates for separation, concept of HETP. **(8 Hrs)**
Unit-V	**Drying** Constant rate and falling rate periods, equilibrium moisture contents, mechanism of batch drying continuous drying, time required for drying, drying equipments: rotary dryers, drum dryers. **(4 Hrs)**
Unit-VI	**Membrane Separation Processes** Introduction, types and classification of membrane separation processes, membrane materials, membrane modules, transport in membrane, reverse osmosis and ultrafiltration. **(6 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
Text Book/ Reference Books	1.	Mass Transfer Operation	R. E. Trybel	Mcgraw Hill Company	3rd
	2.	Chemical Engineering Vol I & II	Richardson & Coulson	Mcgraw Hill Company	6th
	3.	Unit Operations of Chemical Engineering	McCabe & Smith	Mcgraw Hill Company	7th
	4.	Principles of mass transfer and separation processes	Binay Dutta	PHI learning Pvt.Ltd, New Delhi	-
	5.	Unit Operations of Chemical Engineering vol 1 & 2	Chattopadyay P.	Khanna Publishers, New Delhi	-
	6.	Separation Process Principles	J. D. Seader, Ernest Henley	John Wiley & Sons	2nd
Website	1.	http://nptel.ac.in/courses/103103034			

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Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V</td></tr>
<tr><td colspan="2">Course Code: PPE343
Course: Professional Elective Course-II
(Membrane Technology)
Teaching Scheme:
Theory: 3 Hrs/week</td><td>Credits: 3-0-0
Mid Semester Examination-I: 15 Marks
Mid Semester Examination-II: 15 Marks
Teacher Assessment: 10 Marks
End Semester Examination: 60 Marks
End Semester Examination (Duration): 3 Hrs</td></tr>
<tr><td>Prerequisite</td><td colspan="2">• Basic knowledge of chemistry and polymer science.</td></tr>
<tr><td>Objectives</td><td colspan="2">1. To provide a general overview on Advanced Separation Technology.
2. To provide idea through understanding and knowledge of Membrane Technology.
3. To be able to understand the preparation and characterization of membranes for different applications.</td></tr>
<tr><td>Unit-I</td><td colspan="2">Overview of Membrane Science and Technology
Historical development of membrane, type of membrane, Basics of membrane science, introduction to membrane separation process, osmosis, reverse osmosis, membrane separation and transport mechanism, cross flow and pressure filtration, selective and permeability of membranes.
(6 Hrs)</td></tr>
<tr><td>Unit-II</td><td colspan="2">Membrane, its Modules and Techniques of Membrane Preparation
Isotropic membrane, Inorganic membrane, liquid membrane, hollow fibre membrane, membrane module, membrane with symmetric structure: track etching, precipitation from vapor phase, membrane with asymmetric structure: dry wet phase inversion technique, thermally induced phase separation method.
(6 Hrs)</td></tr>
<tr><td>Unit-III</td><td colspan="2">Membrane Transport Theory and Membranes for Separation Processes
The solution-diffusion model, structure-permeability relationship in solution-diffusion membrane, pore-flow membrane, classification of membrane process: microfiltration, ultrafiltration, nanofiltration, reverse osmosis, pervaporation.

Ion Exchange Membrane Process
Electrodialysis, fuel cell membrane, membrane in chlor-alkali processes, membrane distillation and membrane reactors.
(6 Hrs)</td></tr>
<tr><td>Unit-IV</td><td colspan="2">Membrane Characterization
Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Raman Spectroscopy.
(6 Hrs)</td></tr>
<tr><td>Unit-V</td><td colspan="2">Testing of Membrane
Integrity testing method (destructing and non-destructing), bubble point test, diffusion test, spray testing, capacitance testing, pore size testing, distribution testing.
(6 Hrs)</td></tr>
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Unit-VI	**Applications of Membranes and Its Maintenance** Application of membranes in bio separation, gas separation, membrane distillation, Biomedical application of membranes and industrial applications (RO, UF, ED, MF). Membrane fouling, filtration/fouling mechanisms filter cakes, types of foulants and scalants, prevention of fouling, fouling control, backwashing, chemically enhanced backwash cleaning optimization, water recovery. **(6 Hrs)**				
Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	Chemical Engineering (Vol. 2)	Richardson and Coulson	Butterworth Heinemann Titles	2nd
	2.	Industrial Membrane Separation Technology	K. Scott and R. Hughes	Blackie Academic & Professional Londan	1st 1981
	3.	Separation Processess	C. J. King	Tata McGraw Hill	-
	4.	RO/UF Process, Principle	S. Sourirajan and Matsuura	National Research Council, Canada	-
	5.	RO and Synthetic Membrane Theory, Technology & Engineering	S. Sourirajan	National Research Council, Canada	-
	6.	Handbook of Industrial Membrane Technology	M. C. Portor	Crest Publishing House	2005
	7.	Membrane Technology and Application	R.W. Baker	John Wiley and Sons Ltd.	2004

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester V	
Course Code: AED331 Course: Open Elective-I (Statistical Methods in Engineering) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• Statistical analysis and types of data.
Objectives	1. To introduce different techniques involved in statistical analysis. 2. To learn and practice various statistical methods for data analysis.
Unit-I	**Introduction** Definitions of Statistics and its applications in Engineering, Limitations, Types of data, Classifications, Tabulation and Frequency distribution, graphical presentation. **(6 Hrs)**
Unit-II	**Measures of Central Tendency** Arithmetic Mean, Median, Mode, GM, HM, Weighted average, Quartile, Deciles, Percentiles, Characteristics of ideal measure, Merits and Demerits of various measures. **(6 Hrs)**
Unit-III	**Correlation** Definition of Correlation, Types, Scatter diagram. Karl Pearson's Coefficient of Correlation and its test of significance. Spearman's Rank Correlation coefficient. **(6 Hrs)**
Unit-IV	**Regression** Linear Regression equations, definition & properties of Regression coefficient, constant, fitting of Regression lines, its test of significance, comparison of Regression and Correlation coefficients. **(6 Hrs)**
Unit-V	**Introduction to Test of Significance** Null and Alternate Hypothesis, Types of errors, One tailed and Two tailed test, degrees of freedom, Level of Significance, Critical region, Steps in testing of hypothesis, One sample, Two sample, Paired 't' test and 't' test for testing significance of correlation coefficient. **(6 Hrs)**
Unit-VI	**ANOVA** Introduction to analysis of variance, Basics, Assumptions of ANOVA, analysis of one way classification, numericals on ANOVA. **(6 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
Text Book/ Reference Books	1.	A Text book of Agriculture Statistics	R. Rangaswami	New Age International (P) Limited, Hyderabad	1st
	2.	Statistics for Agriculture Sciences	Nageshwar Rao G	BS Publications	1st
	3.	Statistical Methods	Snedecor GW. & Cochran WG	Iowa State University Press	1st

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<tr><td colspan="2">Course Code: CED331
Course: Open Elective-I (Environmental Impact Assessment)
Teaching Scheme:
Theory: 3 Hrs/week</td><td>Credits: 3-0-0
Mid Semester Examination-I: 15 Marks
Mid Semester Examination-II: 15 Marks
Teacher Assessment: 10 Marks
End Semester Examination: 60 Marks
End Semester Examination (Duration): 3 Hrs</td></tr>
<tr><td>Prerequisite</td><td colspan="2">• Environmental Engineering.</td></tr>
<tr><td>Objectives</td><td colspan="2">1. Student would overview the concepts, methods, issues and various forms and stages of EIA process.
2. Student will be able to examine the development of EIA in India and highlight the diversity of approach and impact of the EIA process.</td></tr>
<tr><td>Unit-I</td><td colspan="2">Introduction and Evolution of EIA
Introduction to Environmental Impact Assessment, Origin of EIA, Stages in EIA, thorough discussion of steps in EIA.
Establishments of Procedure: Legislative Option, Project Screening for EIA, Public Participation in EIA process.
(6 Hrs)</td></tr>
<tr><td>Unit-II</td><td colspan="2">Impact assessment
Background information, IA methods, environmental impact assessment methodology, documentation and selection process, environmental indices and indicators for describing affected environment, Life cycle assessment.
(6 Hrs)</td></tr>
<tr><td>Unit-III</td><td colspan="2">Air and noise environment
Prediction and assessment of impact for air and noise environment, Basic information of air quality, identification of type and quantity of air pollutant, existing air quality and air quality standards, impact prediction and assessment, mitigation. Basic information of noise, existing noise levels and standards, prediction of noise levels and assessment of impact, mitigations.
(6 Hrs)</td></tr>
<tr><td>Unit-IV</td><td colspan="2">Water and soil environment
Prediction and assessment of impact for water and soil environment, Basic information of water quality (Surface water and ground water), water quality standards, identification of impact, prediction of impact and assessment, mitigations. Background information of soil environment, soil and ground water standards, prediction and assessment of impact for ground water and soil, mitigations.
(6 Hrs)</td></tr>
<tr><td>Unit-V</td><td colspan="2">Decision Methods for Evaluation of Alternative
Public participation in environmental decision making, Regulatory requirements, environmental impact assessment process, objectives of public participation, verbal</td></tr>
</table>

	communication in EIA studies. **(6 Hrs)**
Unit-VI	**Environmental Impact Assessment Report** Rapid and Comprehensive EIA, general structure of EIA document, Environmental management plan; post environmental monitoring. Latest EIA notification by Ministry of Environment and Forest (Govt. of India): Provisions in the EIA notification, Procedure for public hearing, post environmental monitoring, Procedure for obtaining Environmental clearance for construction projects. **(6 Hrs)**

Text Book/ Reference Books

Sr. No.	Title	Author	Publication	Edition
1.	Environmental Impact Assessment	Canter R.L.,	Mc Graw Hill International	1997
2.	Environmental Impact Assessment Theory and Practice	Peter Watten (Eds.)	Unwin Hyman	1988
3.	Environmental Impact Assessment	R.R. Barthwal	New Age International Publishers	1st
4.	Environmental Impact Analysis Handbook	John G. Rau and David C. Wooten	McGraw Hill Book Company	1st

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester V	
Course Code: CSE331 Course: Open Elective-I (Artificial Intelligence and its Applications) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• Data Structures and Algorithms.
Objectives	1. To introduce different techniques involved defining and simulating an intelligence. 2. To learn and practice various Artificial Intelligence methods, algorithms, and knowledge representation schemes.
Unit-I	**Introduction** Artificial Intelligence, AI Problems and AI techniques, solving problems by searching, Problem formulation. Application of AI techniques in different branches of engineering, Basic Sciences, Medical Science and equipment, Economy and Finance **.** **(6 Hrs)**
Unit-II	**Searching techniques in AI** DFS, BFS, Uniform cost search, Depth Limited Search, Iterative Deepening, Bidirectional search, Comparing Different Techniques. **(6 Hrs**)
Unit-III	**Heuristic functions** Hill Climbing, Simulated Annealing, Best First Search, A*, IDA*, SMA*, Crypto-Arithmetic Problem. **(6 Hrs)**
Unit-IV	**Agents and Environments** Structure of Intelligent agents, Types of Agents, Agent Environments PEAS representation for an Agent. A Knowledge Based Agent, Environment, Types of Environments WUMPUS WORLD Environment, **Case Study: Automated Taxi, Vacuum Cleaner.** **(6 Hrs)**
Unit-V	**Expert Systems** Concept of an Expert System. Characteristics of an Expert System, Components of expert System, Concept of Knowledge Base, Components of Knowledge base, Knowledge Representation methods. **Case Study : DENDRAL, MYCIN, PXDES, CaDeT.** **(6 Hrs)**

Unit-VI	**Propositional Logic** Introduction, First Order Predicate Logic, Forward and Backward Chaining, Resolution., Introduction to PROLOG and LISP. **(6 Hrs)**				
Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	Artificial Intelligence: A Modern Approach	Stuart Russell and Peter Norvig	Pearson Education	2nd
	2.	Artificial Intelligence	Elaine Rich, Kevin Knight, Shivshankar B Nair	McGraw Hill,	3rd
	3.	Artificial Intelligence	Elaine Rich, Kevin Knight	Tata McGraw Hill	2nd

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester V	
Course Code: EED331 Course: Open Elective-I (Special Purpose Machines) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• They should have basic knowledge about all basic laws and construction / working principle of DC and AC motors and generators,
Objectives	1. To differentiate between generalized machines and control machines. 2. To understand principle and working of different control machines. 3. To be able to identify and implement control machines.
Unit-I	**Hysteresis Motors** Magnetic field production & nature of torque, Applications. **Reluctance Motors** F. H. P. Reluctance motors, switched reluctance motors, Principle of working & operation, Applications. **(6 Hrs)**
Unit-II	**Control Motors** D C servomotors, transfer function of Armature and field-controlled motors their applications, Construction of F. H. P. Induction two-phase servomotors, production of torque, Torque-speed curves-characteristics & features-dynamic equations, Methods of control, Applications. Numerical on DC and AC servos. **(6 Hrs)**
Unit-III	**Eddy Current Devices** Construction & operation of eddy current couplings & dynamometers, merits & limitations. **(4 Hrs)**
Unit-IV	**Tacho-Generators** Basic requirements of tacho-generators, Ideal characteristics, classification. i) D.C. Tacho Generators: Output characteristics, Deviation from no load Characteristics, Dead-zone, Tooth ripples, Temperature effect, Accuracy class. ii) Induction Tacho-generators: Operating principle, Output characteristics, Equivalent circuit, Reasons for deviation from desired characteristics, Corrective means, Advantages. iii) A. C. Tacho-generators: Construction & operation, Output characteristics, non-linearities & tooth ripples, Advantages over other tacho-generators. Dynamic characteristics of techno-generators, Applications of tacho-generators. **(8 Hrs)**
Unit-V	**Synchro & Synchro Transformers** Different types of single phase & three-phase synchro, Differential synchro, Synchro-indicators, Their constructional features, Characteristics & applications, Synchro

	transformers principle, Characteristics error, applications of synchro transformers. **(6 Hrs)**
Unit-VI	**Linear Motors** Construction, Theory of operation of a linear induction motor, System with two-dimensional & three-dimensional field patterns, Performance of linear induction motors, Effect of variation in the air gap, Effect of width & thickness of the reaction plate, Thrust of linear induction motors, Applications. **(6 Hrs)**

Text Book/ Reference Books

Sr. No.	Title	Author	Publication	Edition
1.	Electrical Machine and Power Electronics	Bhimbhra P. S	Tata McGraw Hill Publication.	2nd
2.	Modem control Engineering	Ogata K.	Prentice Hall	2nd
3.	Principles of Electrical Machines	V.K. Mehta	Chand Publication	2nd
4.	Electrical Machines	Ashfaq Hussain	Dhanpat Rai	3rd
5.	Electrical Machines	Nagnath Kothari	TATA McGraw Hill	5th
6.	Electrical Technologies	Edward Hughes Elbs	Pearson Education	2nd

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester V	
Course Code: ETC331 Course: Open Elective-I (Electronic Product Design) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• Students should be familiar with Circuit design and PCB design.
Objectives	1. To understand the stages of product (hardware/ software) design and development. 2. To be acquainted with methods of PCB design and different tools used for PCB design. 3. To understand the importance of testing in product design cycle. 4. To understand the processes and importance of documentation.
Unit-I	**Introduction to Electronic product Design** Product development basics, Product development stages, Redundancy, Ergonomics and Aesthetic Design consideration. **(6 Hrs)**
Unit-II	**Packaging, Noise and Heat Management** Introduction to product packaging ,Noise in electronic circuits, Grounding, Shielding, Enclosure Sizing ,Thermal management **(6 Hrs)**
Unit-III	**Fundamentals of PCB and PCB Design** Important terms related to PCB, Types of PCBs, PCB Design elements, PCB design Steps, Requirements of artwork, Layout rules, Grounding, Shielding, Design issues related to supply and ground conductors **(6 Hrs)**
Unit-IV	**Software Design** \Waterfall model of software development, Phases of Software design, Goals of software design, Design of structured program, Testing and debugging of program **(6 Hrs)**
Unit-V	**Product Testing** Environmental Testing, Temperature testing Humidity testing, Various test on enclosures, EMI and EMC related testing, Importance of standards, Classification of standards, IEC standards **(6 Hrs)**
Unit-VI	**Product Documentation** Need of documentation**,** Types of documentation, Manual, Types of manual, Study of one typical manual, Bill of Material-examples, **(6 Hrs)**

Text Book/ Reference Books	Sr. No.	Title	Author	Publication	Edition
	1.	Electronic Product Design	R.G.Kaduskar	Wiley-India	2nd
	2.	Integrated Circuits	K.R.Botkar	Khanna Publisher	10th
	3.	Embedded System: A contemporary design Tool	James Peckol	Wiley	2nd

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester V	
Course Code: MED331 Course: Open Elective-I (Operations Research) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• Fundamental knowledge and understanding of Engineering mathematics. • Understanding of concepts of costing and management concepts.
Objectives	1. To familiarize the students with formal quantitative approach to problem solving. 2. To formulate real life engineering problems. 3. To solve engineering problems using various Operations Research Techniques.
Unit-I	**Introduction to Operations Research** Basics definition, scope, objectives, phases, models, applications, and limitations of Operations Research. **(2 Hrs)**
Unit-II	**Linear Programming Problem** Formulation of LPP, Graphical solution of LPP, Simplex Method, Artificial variables, Big-M method, two-phase method, degeneracy and unbound solutions. **(8 Hrs)**
Unit-III	**Transportation Model** Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method, and Vogel's approximation method. Optimality test – the steppingstone method or MODI method. Degeneracy in Transportation Problem. Assignment Problem: Hungarian Method to solve Assignment Problem, Travelling Salesman as an Extension of Assignment Problem. **(8 Hrs)**
Unit-IV	**Inventory Control, Replacement Analysis and Theory of Games** Inventory Models: Economic Order Quantity Models, Quantity Discount Models, Stochastic Inventory Models, Multi Product Models, Inventory Control Models in Practice. Replacement Analysis: Replacement of Items that Deteriorate, Replacement of Items that Fail Suddenly. Theory of Games: Introduction, Minimax and Maximin Principle, Solution of Game with Saddle Point, Solution by Dominance. **(6 Hrs)**
Unit-V	**Queuing Model and Sequencing Model** Queuing Systems and Structures, Notation Parameters, Single Server and Multi Server Models, Poisson Input, Exponential Service, Constant Rate Service, Infinite Population Sequencing Model: Introduction, n jobs through two machines, n jobs through three

	machines, two jobs through m machines and n jobs through m machines. **(6 Hrs)**				
Unit-VI	**Network Models** Fulkerson‘s rule, concept and types of floats, float calculations, CPM and PERT, Crashing cost and crashing Network. **(6 Hrs)**				
Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	Operations Research	Taha H.A.	Prentice Hall of India.	9th
	2.	Introduction to Operations Research	Frederick S. Hillier and Gerald J. Lieberman	Tata McGraw-Hill	7th
	3.	Operations Research	P.K. Gupta, D.S Hira	S. Chand & Co.	4th
	4.	Operations Research	Man Mohan, P. K. Gupta, Kanti Swarup	S. Chand & Co.	12th
	5.	Operations Research Principles and Practice	Ravindran, Phillips and Solberg	Mc. WSE Willey	2nd
	6.	Operations Research: Applications and Algorithms	Wayne L. Winston, Jeffrey B. Goldberg	Thomson Brooks	4th
	7.	Operations Research: Theory, Methods & Applications	S. D. Sharma, Himanshu Sharma	Kedar Nath Ram Nath	4th
	8.	PERT and CPM: Principles & Applications	L. S. Srinath	East-West Press Private Limited,	3rd
	9.	Project Planning & Control with PERT & CPM	Dr. B.C. Punmia & K.K. Khandelwal	Firewall Media	4th

<table>
<tr><td colspan="3">Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
(Faculty of Science & Technology)
Syllabus of Third Year B. Tech. (All) Semester V</td></tr>
<tr><td colspan="2">Course Code: PPE331
Course: Open Elective-I (Introduction to Nanotechnology)
Teaching Scheme:
Theory: 3 Hrs/week</td><td>Credits: 3-0-0
Mid Semester Examination-I: 15 Marks
Mid Semester Examination-II: 15 Marks
Teacher Assessment: 10 Marks
End Semester Examination: 60 Marks
End Semester Examination (Duration): 3 Hrs</td></tr>
<tr><td>Objectives</td><td colspan="2">1. To study the introduction to nanomaterials and the factors affecting it.
2. To study the types and synthesis methods of nanomaterials.
3. To study the characterizations and properties of nanomaterials.
4. To study the different applications of nanomaterials.</td></tr>
<tr><td>Unit-I</td><td colspan="2">Introduction
Introduction to nanotechnology, conventional micro vs. nano-material properties, role of size in properties of nano-materials, length scale and surface to volume concept, and uniqueness of nanostructured materials; health hazards and handling of nanomaterials.
(4 Hrs)</td></tr>
<tr><td>Unit-II</td><td colspan="2">A) Synthesis
Bottom-up and top-down approach for nano materials synthesis, methods: ball milling, chemical vapor deposition, pressure vapor deposition, ultrasound assisted, minimulsion, microemulsion, nanoemulsion, hydrothermal, sol-gel, miscellaneous techniques.
(4 Hrs)
B) Types of Nano-Materials
Natural and synthetic clays – Montmorillonite and layered double hydroxide (LDH); carbon nanofibers (CNFs), carbon nanotubes, graphene nanosheets, nanosilica, nanoaluminium oxide, nanotitanium oxide, nano-hybrids.
(4 Hrs)</td></tr>
<tr><td>Unit-III</td><td colspan="2">Properties of Nanomaterials in terms of Structure Property Relationship
Thermal properties, mechanical properties, gas barrier properties, flame retardant properties, electrical and electrochemical properties, electronic properties, optical properties, magnetic properties, biodegradable properties, antimicrobial properties, catalytic properties.
(6 Hrs)</td></tr>
<tr><td>Unit-IV</td><td colspan="2">Preparation of Polymer Nanocomposites
Solution intercalation, melt intercalation, roll milling, emulsion polymerization, in-situ polymerization.
(6 Hrs)</td></tr>
<tr><td>Unit-V</td><td colspan="2">Characterization of Nanomaterials and Nanocomposites
X-ray diffraction (XRD), dynamic light scattering (DLS), scanning electron microscopy (SEM), Transmission electron microscopy (TEM), energy dispersive X-ray spectroscopy (EDS), atomic force microscopy (AFM), small angle X-ray scattering (SAXS), differential</td></tr>
</table>

	scanning calorimetry (DSC), thermo gravimetric analysis (TGA). **(6 Hrs)**				
Unit-VI	**Application of Nanomaterials and Nanocomposites** Biomedical-drug delivery, bone replacement; sensors – gas sensor, metal adsorption and recovery, bio-molecule detectors; energy storage and conversion - super capacitors, solar cells, energy generators; electronics; self-cleaning and self-healing paints, nano-engineering of cement-based materials, agricultural nanotechnologies. **(6 Hrs)**				
Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	Polymer Nanocomposites Processing, Characterization, and Applications	Joseph H. Koo	McGraw-Hill Nanoscience and Technology Series	1st 2006
	2.	Encyclopedia of Nanoscience and Nanotechnology	Hari singh Nalwa	American Scientific publishers	-
	3.	Chapter: Advanced Hybrid Nanostructures: Preparation, Properties and Applications, Book: Encyclopedia of Nanoscience and Nanotechnology	Aniruddha Chatterjee et al	American Scientific publishers	2018
	4.	Nanoparticle Technology Handbook	M Hosokawa, K Nogi, M Naito, T Yokoyama	Elsevier	-
	5.	The Science of Nanotechnology: An introductory text	Luanne Tilstra et al	Nova Science Publishers, Inc.	-
	6.	Polymer-Layered Silicate and Silica Nanocomposites	Y.C. Ke, P. Stroeve	Elsevier	2005
	7.	Nanotechnology in concrete – A review (24, 2010, 2060-2071)	Florence Sanchez, Konstantin Sobolev	Construction and Building Materials, Elsevier	-
	8.	Agricultural Nanotechnologies: What are the current possibilities?	Claudia Parisi et al	Nano Today, Elsevier	2014

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V		
Course Code: PPE321 Course: Lab: Elastomer Technology **Teaching Scheme:** Practical: 2 Hrs/week		Credits: 0-0-1 Practical: 25 Marks
Objectives	**:**	1. To understand flow behaviour of polymeric materials.
List of Practical/ Assignments	**:**	1. To identify rubbers through spot test. 2. To determine total solid content (TSC) and dry rubber content (DRC) of rubber latex. 3. To determine total alkalinity of rubber latex. 4. To masticate rubber in two-roll mill. 5. To formulate rubber compounds for different vulcanization systems. 6. To mix a rubber compound using different ingredients. 7. To determine minimum torque, maximum torque, induction time (t_s2), scorch time (t_s5), optimum cure time (t_c90) and cure rate index from rheometer curve). 8. To analyze rheocurve of rubber compounds with different vulcanizing systems. 9. To determine carbon black content in rubber composite.
(Any 8 number of practical to be performed from the given list)		

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V		
Course Code: PPE322 Course: Lab: Design Lab-II **Teaching Scheme:** Practical: 2 Hrs/week		Credits: 0-0-1 Practical: 25 Marks
Objectives	**:**	1. To understand CAD – 3D modelling, Surface modelling, assembly modelling and drafting of different engineering parts. 2. To enable students to design and model the objects as per defined dimensions & features. 3. To enable students to simulate the models of different assemblies.
List of Practical/ Assignments	**:**	1. Introduction to 3D CAD software along with the user interface. 2. To study and practice solid modelling concepts including 3D modelling, extrude, revolve, sweep, sketching constraints. 3. To study and practice profile editing tools including edge blend, shell, pattern, mirror. 4. To study and practice surface modelling, freeform modelling ruled through curves, swept and swept blend. 5. To study and practice trim sheet, face blend, surface through points, X-form, and curve on surface. 6. To study and create basic assembly modelling concepts, bottom-up approach, and top-down approach**.** 7. To study and practice assemblies, assembly constraints, components, assembly explosion. 8. To study and practice drafting, drawings and views, linear dimensions, radial dimensions, notes and labels, section views, detailed view, half-section, broken view. 9. To study and practice additional drafting symbols like thread, weld, surface finish, and annotation edit. 10. To study and practice motion simulation of assemblies with bill of materials.
(Any 8 number of practical to be performed from the given list)		

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V		
Course Code: PPE323 Course: Lab: Professional Elective Course-II (Surface Coating Technology) **Teaching Scheme:** Practical: 2 Hrs/week		Credits: 0-0-1 Term Work: 25 Marks
Objectives	**:**	1. To make the students aware of the basic components of paint and coatings. 2. To make the students aware of the recent advancements in coating technology.
List of Practical/ Assignments	**:**	1. To determine the opacity of paint film. 2. To determine the drying time of a paint film. 3. To determine the temperature stability of paint film. 4. To determine the washability and cleanability of paint film. 5. To analyze a synthetic enamel based on its cross-cut adhesion test and pencil hardness test. 6. To determine the viscosity of a synthetic enamel using B-Ford cup. 7. To test the solvent, acid, alkali and light resistance of pigments. 8. To analyze an emulsion paint for its non-volatile matter, % solids content.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V		
Course Code: PPE324 Course: Lab: Professional Elective Course-II (Mass Transfer) **Teaching Scheme:** Practical: 2 Hrs/week		Credits: 0-0-1 Term Work: 25 Marks
Objectives	**:**	1. To understand the fundamental concepts of mass transfer principles and apply these concepts to real engineering problems. 2. To get acquainted with the design of continuous contact and stage wise operations. 3. To provide theoretical understanding of various mass transfer operations such as diffusion, vapor-liquid, gas-liquid systems and drying.
List of Practical/ Assignments	**:**	1. Determination of diffusivity of volatile liquid vapor into air. 2. Determination of mass transfer coefficient of naphthalene balls in air. 3. Verification of Rayleigh's equation for differential distillation. 4. Preparation of boiling point diagram and plot of T-X-Y diagram for binary system at equilibrium. 5. Determination of HETP for packed column. 6. Determination of mass transfer coefficient in gas absorption column. 7. Determination of number of theoretical stages in distillation column. 8. Determination of rate of drying in batch dryer.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V		
Course Code: PPE325 Course: Lab: Professional Elective Course-II (Membrane Technology) **Teaching Scheme:** Practical: 2 Hrs/week		Credits: 0-0-1 Term Work: 25 Marks
Objective	**:**	1. To understand the preparation and determination of different characteristics of membranes.
List of Practical/ Assignments	**:**	1. To synthesize a membrane by phase inversion process. 2. To synthesize a membrane by solution casting process. 3. To synthesize a membrane by track etching/template leaching process. 4. To synthesize proton exchange membrane. 5. Determination of ion exchange capacity of proton exchange membrane. 6. Fabrication of polymeric membrane. 7. To determine water uptake of polymeric membrane. 8. Destructive testing of membranes: a) Ductility test. b) Ultimate tensile strength. 9. Study of membrane fouling.
(Any 8 number of practical to be performed from the given list)		

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
(Faculty of Science & Technology)
Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V

Course Code: PPE326	Credits: 0-0-1
Course: Minor Project-I	Term Work: 25 Marks
Teaching Scheme:	
Practical: 2 Hrs/week	

Objectives	**:**	• To plan for various activities of the project and distribute the work amongst team members. • To develop the ability to define and design the problem and lead to its accomplishment with proper planning. • To understand the importance of document design by compiling Technical Report on the Minor Project work carried out. • To develop student‘s abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Minor Project.
Guidelines	**:**	1. Students should select a problem which addresses some basic home, office or other real-life applications. 2. Projects which will address the social issues will be given due weightage. 3. It is desirable that the systems developed by the students have some novel features. 4. The batch size shall not exceed TWO students per batch. 5. The students have to select a suitable problem, design, prepare the drawings, produce the components, assemble and commission the project. 6. Institute may arrange demonstration with poster presentation of all minor projects developed by the students at the end of semester. 7. At the end of the semester, the students have to prepare and present 20-25 pages project report. 8. Final evaluation shall be based on continuous internal assessment followed by Viva-Voce.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V		
Course Code: PPE327 Course: Lab: Materials Synthesis and Testing **Teaching Scheme:** Practical: 2 Hrs/week		Credits: 0-0-1 Practical: 25 Marks
Objectives	**:**	1. To understand synthesis, processing, characterization and properties of materials. 2. To enable students to design and conduct experiments in materials synthesis as well as analyze and interpret the data. 3. Understand the structure-property relationship in materials.
List of Practical/ Assignments	**:**	1. Synthesis of Hot-Melt Adhesive using Autoclave Reactor. 2. Synthesis of nanomaterial using Ultrasonicator. 3. To synthesize a copolymer using Autoclave Reactor. 4. Determination of K-value of PVC. 5. Determination of the Particle size of the given material by DLS. 6. Determination of the Zeta potential of the given material by Nano-ZS Zetasizer. 7. To determine the density dynamic and kinematic viscosity of a polymer by Brookfield Viscometer of a given material using density meter. 8. To determine the molecular weight of polymer by end group analysis.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
(Faculty of Science & Technology)
Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester V

Course Code: PPE328	Credits: 0-0-1
Course: Lab: Experiential / Problem Based Learning	Term Work: 25 Marks
Teaching Scheme:	
Practical: 2 Hrs/week	

Course Objectives:

On completion of the course, learner will be able to –

- To develop positive attitude, new skills or new ways of thinking.
- To introduce independent and group learning by solving real world problem with the help of available resources.
- To be able to develop systematic approach in technical documentation.
- To select and utilize appropriate Software tools/Equipment/Problem solving tools to solve real life problems.

Guidelines:

The students plan, manage and complete a activity which addresses the stated problem.

1. The students must work in group to solve real life problem.
2. Open ended problems from course teachers can be considered from any course related to engineering field. (It can be domain/specific/ multidisciplinary but the emphasis on Plastic and Polymer Engineering)
3. A mentor to be assigned to 3-4 groups / one batch.
4. The steps to be followed for problem based learning are as mentioned below:

Step 1: Explore the issue.

Gather necessary information; learn new concepts, principles, and skills about the proposed topic.

Step 2: State what is known.

Individual students and groups list what they already know about the scenario and list what areas they are lacking information.

Step 3: Define the issues.

Frame the problem in a context of what is already known and information the students expect to learn.

Step 4: Research the knowledge.

Find resources and information that will help create a compelling argument.

Step 5: Investigate solutions.

List possible actions and solutions to the problem, formulate and test potential hypotheses

Step 6: Present and support the chosen solution.

Clearly state and support your conclusion with relevant information and evidence.

Step 7: Review your performance.

Often forgotten, this is a crucial step in improving the problem-solving skills. Students must evaluate their performance and plan improvements for the next problem.

Recommended parameters for assessment, evaluation and weightage:

1. Identification of the Problem. (20%)

<table>
<tr><td colspan="4">2. Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents). (30%)
3. Demonstration (Poster Presentation/Model Exhibition etc). (20%)
4. Awareness /Consideration of - Environment/ Social /Ethics/ Safety measures/Legal aspects. (10%)
5. Outcome (Participation in technical events / publication in national international conference journal/copyright/patent/prototype). (20%)</td></tr>
<tr><td rowspan="4">Reference Books/ Research Articles:

Web Resources:</td><td>Sr. No.</td><td>Title</td><td>Author</td></tr>
<tr><td>1.</td><td>A new model of problem based learning</td><td>Terry Barrett</td></tr>
<tr><td>2.</td><td>Research Methodology: Methods and Techniques</td><td>C. R. Kothari</td></tr>
<tr><td></td><td colspan="2">1. Problem-Based Learning: https://www.coursera.org/lecture/university-teaching/problem-based-learning-i-pbl-in-practice-SMXol
2. Problem-Based Learning: https://onlinecourses.swayam2.ac.in/ntr20_ed29/preview</td></tr>
</table>

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI	
Course Code: PPE351 Course: Polymer Processing Technology **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• Knowledge of Polymer materials, additives and compounding, rheology, heat transfer.
Objective	• To impart the understanding of various polymer processing techniques considering the equipment, material, processing parameters etc.
Unit-I	**Injection Molding** Introduction, basic components and processes, molding materials, drying, molding cycle, co-injection molding, gas/water assisted injection molding, foam injection molding, advantages and limitations of the process, troubleshooting and safety measures, process parameters and their effects on product quality. **(10 Hrs)**
Unit-II	**Compression Molding** Introduction, basic process, molding cycle, molding materials, process parameters, types of molds, advantages and limitation of process, troubleshooting. **(4 Hrs)**
Unit-III	**Transfer Molding** Introduction, basic process, molding cycle, molding materials, types of machines, process parameters and their effect on product quality, troubleshooting. **(4 Hrs)**
Unit-IV	**Extrusion** Introduction, extrusion and extruder screw, process, molding materials, extruder output, extrusion blown film, sheet extrusion, pipe extrusion, process parameters & their effects on product quality, co-extrusion, twin screw extruder, troubleshooting. **(10 Hrs)**
Unit-V	**A) Rotational Molding** Introduction, molding material, cycle time, types of machines, process parameters & their effects on product quality, advantages & disadvantages, troubleshooting. **(2 Hrs)** **B) Calendering** Introduction, molding material, process, types of calendar roll, process parameters, Advantages, disadvantages, troubleshooting. **(2 Hrs)**
Unit-VI	**Blow Molding** Introduction, molding materials, Extrusion blow molding, Injection blow molding, stretch blow molding, process parameters and their effects on quality of product, advantages &

	disadvantages, troubleshooting. **(4 Hrs)**				
Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	Plastics Engineering Handbook	J. Frados	Van Nostrand Reinhold Company	4th
	2.	Plastics Processing Handbook	A. S. Athalye	Colour Publications (Pvt.) Ltd.	1st
	3.	SPI Plastics Engineering Handbook	Michael Berins	Springer	5th
	4.	Principles of Polymer Processing	A. Tadmor and C. G. Gagos	John Wiley & Sons, New York	2nd

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI	
Course Code: PPE352 Course: Polymeric Materials **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs

Prerequisite	• Introduction to Polymer Engineering. • Physical Chemistry of Polymers. • Polymer Synthesis and Manufacturing. • Polymer Testing. • Polymer Additives and Compounding.
Objectives	To provide a general overview of 1. Different polymeric materials, their types. 2. General properties, processing behavior and applications of different class of polymeric materials. 3. Structure-property relationship of different classes of polymer.
Unit-I	**Natural Polymers** Properties and applications of natural polymers - shellac resin, cellulosics – Regenerated cellulose, cellulose nitrate, cellulose acetate, ethyl cellulose. **(4 Hrs)**
Unit-II	**Commodity Plastics** Properties and applications of polyethylene – LDPE, LLDPE, HDPE, HMWHDPE, UHMWHDPE, crosslinked polyethylene, chlorinated polyethylene, polypropylene – homo- and co-polymer, polyvinyl chloride. **(6 Hrs)**
Unit-III	**Phenolic and Amino Resins** Properties and application of phenol formaldehyde (PF) resins (Novolac, Resol, Phenolic laminates), melamine formaldehyde (MF) and urea formaldehyde (UF) resins. **Epoxies** Structure-properties relationships and application of epoxies. **(8 Hrs)**
Unit-IV	**Unsaturated Polyester Resins** Types of unsaturated polyester resins, properties and applications. **Alkyd Resins** Structure-properties relationship and application of alkyd resins. **(4 Hrs)**
Unit-V	**Engineering Plastics and Its Applications** Properties and applications of styrene copolymers: high impact polystyrene (HIPS), acrylonitrile butadiene styrene (ABS), Styrene acrylonitrile (SAN), acrylic plastics –

<table>
<tr><td></td><td>polymethyl methacrylate, polyacrylonitrile, ethylene vinyl alcohol (EVA).
Properties and applications of polyamides: Nylons 6, (6,6), (6,10), polyesters – Polyethylene terephthalate, polybutylene terephthalate, polycarbonate, polyacetals.
(6 Hrs)</td></tr>
<tr><td>Unit-VI</td><td>A) Liquid Crystalline Polymers
Concept of liquid crystalline (LC) phase, liquid crystalline polymers and their classification, characteristics of LC state and LCPs, blends of LCPs, applications of LCPs
B) Conducting Polymers
Basic concept (requirements for polymer to work as conductor, types of conducting polymers - doping of polymeric systems). Brief idea about polyacetylene, polyaniline, polypyrrole, polythiophene and poly-paraphenylene based conducting polymers.
C) High Temperature Resistance Polymers
Requirements for heat resistance, structure-property relationships, applications of heat resistant polymers like polyamides, polyimide. Brief idea about polymers for high temperature resistant-PES, PPS, PPO, PEEK, fluro polymers, ultrahigh fibres – aramid – carbon fibres.
(8 Hrs)</td></tr>
<tr><td>Text Book/ Reference Books</td><td colspan="2"><table>
<tr><th>Sr. No.</th><th>Title</th><th>Author</th><th>Publication</th><th>Edition</th></tr>
<tr><td>1.</td><td>Polymer Science and Technology</td><td>P. Ghosh</td><td>Tata McGraw Hill</td><td>2nd</td></tr>
<tr><td>2.</td><td>Plastics Materials</td><td>J Brydson</td><td>Butterworth Hienemann</td><td>7th</td></tr>
<tr><td>3.</td><td>Introduction to Polymers</td><td>Young, R. J., and P. A. Lovell</td><td>CRC Press</td><td>2nd</td></tr>
<tr><td>4.</td><td>Polyesters and polyamides</td><td>B. L. Deopura, R. Alagirusamy, M. Joshi, B. Gupta</td><td>Woodhead Publishing in Textiles</td><td>1st</td></tr>
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Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI	
Course Code: PPE353 Course: Polymer Characterization **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs

Prerequisite	• Chemical structure, formulae, crystal lattice types.
Objectives	1. To understand about the mechanisms of different instrumental analysis methods. 2. To acquire fundamental knowledge about structural characteristics of polymers and correlation to the analysis methods.
Unit-I	**Introduction to Instrumental Analysis of Polymers** Significance of instrumental analysis of polymers, molecular architecture of polymers, overview and classifications of various characterization techniques in terms of application. **(4 Hrs)**
Unit-II	**Spectroscopy** Introduction, basic working principle, strategy of analysis with examples and applications of FTIR (including ATR mode), UV-VIS, NMR (including molecular weight determination from NMR) and Raman spectroscopy. **(8 Hrs)**
Unit-III	**Chromatography** Introduction, basic working principle, strategy of analysis with examples and applications of HPLC, GPC (with reference to different types of detectors and columns used) and GC-MS. **(6 Hrs)**
Unit-IV	**X-ray Analysis** Introduction, basic working principle, strategy of analysis with examples and applications of XRD (including determination of crystallinity, crystal size and indexing), SAXS and XPS. **(7 Hrs)**
Unit-V	**Thermal and Thermomechanical Analysis** Introduction, basic working principle, strategy of analysis with examples and applications of DSC, TGA (including reverse engineering techniques, isothermal and non-isothermal degradation, isothermal DSC in correlation to crystallization characteristics) and DMA (Insight to loss modulus, storage modulus and tan delta). **(6 Hrs)**
Unit-VI	**Morphology Analysis** Introduction, basic working principle of OM, SEM (including EDS analysis and mapping), TEM (including brief introductory idea about SAED, cryo-TEM, tomography), AFM (including examples of current sensing atomic force microscopy). **(5 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
Text Book/ Reference Books	1.	Undergraduate Instrumental Analysis	James W. Robinson, Eileen M. Skelly Frame, George M. Frame II	Marcel Dekker	2005
	2.	Modern Instrumental Analysis	S. Ahuja, N. Jesperson	Elsevier	2005
	3.	Polymer characterization - laboratory techniques and analysis	Nicholas P. Cheremisinoff	Noyes Publications	1996
	4.	Analytical Methods for Polymer Characterization	Rui Yang	CRC Press	2018
	5.	Characterization of Solid Polymers: New techniques and developments	S.J. Spells	Chapman & Hall	1994
	6.	Spectroscopy of Polymers	Jack L. Koenig	Elsevier	2nd
	7.	Polymer Characterization by Liquid Chromatography	Gottfried Glockner	Elsevier	1986
	8.	Thermal Analysis Fundamentals and Applications to Polymer Science	Joseph D.Menczel, R.Bruce Prime	John Wiley & Sons	2009
	9.	Polymer Microscopy	Linda C. Sawyer, David T. Grubb, Gregory F. Meyers	Springer	3rd

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI	
Course Code: PPE391 Course: Professional Elective Course-III (Fluid Mechanics) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• Knowledge of basic calculations, basic units and dimensions.
Objective	1. To understand the basic concepts of fluid flow and its applications in upstream and downstream industry.
Unit-I	**Introduction** Units and dimensions, introductory concepts about fluids, properties of fluids, classification of fluid, Newton's law of viscosity and based numerical, rheological classification of fluids, types of flow. **(6 Hrs)**
Unit-II	**Fluid Pressure and Measurement** Pascal law, hydrostatic equilibrium for compressible and incompressible fluid. Concept of gauge pressure, vacuum pressure and absolute pressure, U tube manometer, inclined manometer, differential manometer, inverted U manometer. **(6 Hrs)**
Unit-III	**Fluid Flow Equations and Flow Measuring Devices** Continuity equation for fluid flow (in differential form for three dimension and integral form for one dimension), Bernoulii's equation, equation of motion, concepts of friction factor. Measurement of fluid flow: orificemeter, venturimeter, rotameter, Pitot tube. **(6 Hrs)**
Unit-IV	**Dimensional Analysis** Fundamental dimensions of quantities, dimensional homogeneity, dimensional analysis by Rayleigh's method and Buckingham's method, dimensionless numbers. **(6 Hrs)**
Unit-V	**Single Multiphase Flows** Flow of incompressible fluid in circular pipe, Hagen Poiseuille equation, friction factor, fanning and Darcy equation, frictional losses in flow through pipes, pipe fittings, laminar and turbulent flow in pipe, boundary conditions and its significance, concept of drag and drag coefficient. Flow through packed bed, loading and flooding point, fluidised bed. **(6 Hrs)**
Unit-VI	**Fluid Transporting Machines** Classification of fluid flow machinery as fans, blower, compressor and pumps, their types and applications. centrifugal pump : working principle, construction, head developed by pump, cavitation, N.P.S.H., priming, performance and characteristics curves. **(6 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
Text Book/ Reference Books	1.	Coulson, Richardson, Chemical Engineering. Vol-1	J.M.Coulson and J.F.Richardson	Butterworth-Heinmann	**7th**
	2.	Unit Operations of Chemical Engineering	Mc cab, Smith and Harriot	Mc Graw Hill Pub.	7th
	3.	Fluid Mechanics	R.K. Bansal	Laxmi Publications	10th
	4.	Fluid Mechanics	R.P. Vyas	Denett & Co.	3rd

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI	
Course Code: PPE392 Course: Professional Elective Course-III (Biopolymers) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Objectives	1. To gain an understanding on the chemical structure of biopolymer, their classification and nomenclature. 2. To acquire acknowledge about the resources and preparation involved in the production and the recovery of biopolymers. 3. To acquire the knowledge about the basic properties of biopolymers and their various applications.
Unit-I	**Introduction** Biopolymers, difference between polymer and biopolymer, origin of natural biopolymers, classification of biopolymers, advantages and disadvantages of biopolymers. Applications of Biopolymers. **(4 Hrs)**
Unit-II	**Structure, Synthesis, Properties and Applications of Biopolymer** Technology, production and application of biopolymer based on starch, cellulose, chitosan, gelatine, keratin, fatty acids, lipids, aliphatic polyesters (PLA, PHB). **(8 Hrs)**
Unit-III	**Biodegradability** Natural biodegradable polymer, synthetic and modified biodegradable polymers, biodegradation processes, measuring of biodegradation of polymers. Effects of recycling, applications, economics and future prospectus. **(6 Hrs)**
Unit-IV	**Bioplastics and Biocomposites: Processing, Properties and Applications** Introduction of bioplastics and biocomposites, processing of bioplastics and biocomposites, properties and applications of bioplastics and their composites. Bio-nanocomposites: Properties, characteristic and applications. **(8 Hrs)**
Unit-V	**Feedstock for Biopolymer and Surface Modification** Introduction, first and second generation crops, productivity and availability of arable land to grow feedstock for biopolymer. Surface modification of biomaterials for improved functionality: enhancement of biocompatibility by the use of corona discharge and plasma processes**.** **(6 Hrs)**

Unit-VI	**Characterization and Testing of Biopolymers** Bulk analysis methods applied to the study of biopolymers (XRD, FTIR, DSC, TGA, etc.). Surface analysis methods applied to the study of biopolymers (SEM, TEM, AFM, etc.). Mechanical test: wear, friction, flexibility, fatigue, etc**.** **(4 Hrs)**				
Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	Bio-Based Plastics	Stephan Kabasci	Wiley	1st 2014
	2.	Handbook of Biopolymer-Based Material	Sabu Thomas, Dominique Durand, Christophe Chassenieux, P. Jyotishkumar	Wiley	1st 2013
	3.	Chemistry and Technology of Biodegradable Polymers	G.J.L. Griffin Blackie	Academic & Professional London	1st 1994
	4.	Handbook of Biodegradable Polymers	Abraham J.Donb and others	Harwood Academic Publishers	1st 1998
	5.	Green Polymer Composite Technology Properties and Applications	Inamuddin	Taylor & Francis CRC Press	1st 2016
	6.	Biopolymer Nanocomposites Processing,Properties and Applications	Alain Dufresne, Sabu Thomas, Laly A. Pothan	Wiley	1st 2013
	7.	Polymeric Biomaterials	Piskin, A.S. Hoffinann	Martinus Nijhoff Publishers	2nd 1986
	8.	Biomaterials:An Introduction	J.B. Park	Plenum Press	2nd 1979
	9.	The intersection of Biology and Materials Science	G.M. Whitesides, A.P. Wong	MRS Bulletin	-
	10.	Biomaterials	Sujata V.Bhat	Alpha Science Int.	-

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI	
Course Code: PPE393 Course: Professional Elective Course-III (Advanced Polymer Chemistry) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs

Prerequisite	• The students should have a clear concept of the traditional polymers, their processing techniques, their properties and applications.
Objectives	1. This course is intended to update the students about various modern polymerization techniques, synthetic polymers made by newer techniques, new class of additives being used for polymer processing. 2. The student will have a basic knowledge of the advancements taking place in the field of plastics.
Unit-I	**Polymerization Techniques and Property Relationship** Linear and crosslinked polymers, effect of process of polymerization on the properties of the polymer in addition polymers (bulk, suspension, solution, emulsion and precipitation polymerization). **(5 Hrs)**
Unit-II	**Monomer Recovery Techniques for Condensation Polymers** Pyrrolytic GCMS, polyesters, polyamides, polyurethanes depolymerization for identification of monomers. **(6 Hrs)**
Unit-III	**Polymer Chemistry and Nature** Life, DNA, reproduction with seeds, sperms. **Modified natural polymers** CA, CAP, CAB, ethyl cellulose, hydroxyethyl cellulose, methyl cellulose, CMC, micro crystalline cellulose. Modified Guar gum. **(7 Hrs)**
Unit-IV	**Structurally Modified Polymers** Orientation of polymers, fibre forming polymers, conditions for fibre formation, wire enamels, wire varnishes, castables, PVC compounds for cables. **(6 Hrs)**
Unit-V	**Polymer Architecture and Advanced Polymerization Techniques** a) Techniques of polymer architecture b) Advanced polymerization techniques i. Cationic and anionic polymerization ii. Nitrite mediated polymerization iii. ATRP iv. RAFT

	v. GTP vi. Precipitation polymerization as a tool to get very low poly dispersity factor. **(6 Hrs)**
Unit-VI	**Additives for Polymers** a. Stabilization, anti oxidants b. Degradation c. Anti static additive d. UV and heat stabilization with special reference to PVC e. Anti bacterial f. Anti rodent and anti termite g. Fire retardant h. Reduction of permeability i. Increasing electrical conductivity j. Colour masterbatches. **(6 Hrs)**

Text Book/ Reference Books

Sr. No.	Title	Author	Publication	Edition
1.	Recent Advances in Polymer Chemistry	James Archer	Random Publications	2013
2.	Advances in Polymer Science	Vikas Mittal	Central West Publishing	2019
3.	Polymer Chemistry(Advances in Polymer Science)	Akihiro Abe, Ann Christine Albertsson	Springer	2013
4.	Advances in Sustainable Polymers Synthesis, Fabrication and Characterisation	Katiyar, Vimal, Kumar, Amit, Mulchandani, Neha	Springer	2020

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester VI	
Course Code: AED381 Course: Open Elective-II (Fundamentals of Bioenergy) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• Biomass sources and waste to energy recovery.
Objectives	1. Understand bioenergy technologies, processes, reactions and energy conversion rates for anaerobic Digestion, gasification, pyrolysis and combustion. 2. Know what constitutes a suitable feedstock for bioenergy applications.
Unit-I	**Introduction to Bioenergy** Introduction ,Unit of Energy and Introduction of Bioenergy, How Biomass Formed on the Earth, Road Map of Bioenergy, Basic Biomass Technology (Resources and Production) Exploration of Photosynthesis Process **(6 Hrs)**
Unit-II	**Biogas** Basic concept in anaerobic digestion and biogasification, mechanism of anaerobic digestion, Biochemical methane potential assay and calculations for biogasification feasibility analysis, Biogas utilization, Biomass production System and their Categorization, Components of biogas plants **(6 Hrs)**
Unit-III	**Bioethanol** Basic concept of Cellulosic Bioethanol Process, Pretreatment and Enzyme treatment of Cellulosic Bioethanol Process, Fermentation and Distillation in Cellulosic Bioethanol Production, characteristics of bioethanol **(6 Hrs)**
Unit-IV	**Biodiesel** Biodiesel production processes, Biodiesel characterization , Biodiesel feedstocks, biodiesel characteristics, Environmental permitting and safety considerations for biodiesel production **(6 Hrs)**
Unit-V	**Thermo Chemical Processes** Basic concepts in gasification and pyrolysis, Gasification and pyrolysis systems, Gasification Types - Up Drift Gasifier, Down Draft and cross flow gasifier, operation and performance of gasifier. **(6 Hrs)**
Unit-VI	**Bioenergy Distribution and End Use for a Sustainable Future** Biological root of gasification, non-conventional energy sources, waste-to-energy recovery **(6 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
Text Book/ Reference Books	1.	Introduction to Bioenergy (Energy and the Environment)	Vaughn C. Nelson (Author), Kenneth L. Starcher	CRC press	-
	2.	Bioenergy: Biomass to Biofuels	Anju Dahiya	AP Publications	-
	3.	Bioenergy: Principles and Applications	Yebo Li and Samir Kumar Khanal	Wiley Publications	1st

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester VI	
Course Code: CED381 Course: Open Elective-II (Solid Waste Management) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs

Prerequisite	• Environmental Engineering.
Objective	• To get introduced to the generation, collection and management of the various types of solid waste and different waste management techniques.
Unit-I	**Introduction to Solid Waste Management (SWM)** Need and Objectives, Waste Management Hierarchy, Functional elements, Environmental impact of mismanagement. Solid waste: Sources, types, Composition, Quantities, Physical, chemical and Biological properties. **(6 Hrs)**
Unit-II	**Generation of Solid Waste** Factors affecting. Storage and collection: General considerations for waste storage at source, Types of collection Systems, Transfer station: Meaning, Necessity, Transportation of solid waste: Means and Methods, Routing of vehicles. **(6 Hrs)**
Unit-III	**Segregation and Material Recovery** Objectives, Stages of segregation, sorting operations, Guidelines for sorting for materials recovery, E waste management, Biomedical waste management. **(6 Hrs)**
Unit-IV	**Waste Processing : Processing Technologies** Composting, thermal conversion technologies incineration, treatment of biomedical wastes. Energy recovery from solid waste: Parameters affecting energy recovery, Bio-methanation, Fundamentals of thermal processing, Pyrolysis, Incineration, Advantages and disadvantages of various technological options. **(6 Hrs)**
Unit-V	**Disposal** Landfills and its introduction, Definition, Essential components, Site selection, Land filling methods, Leachate analysis and landfill gas management, treatment & disposal, Determination of capacity of landfill disposal site. **(6 Hrs)**
Unit-VI	**Hazardous waste management (HWM)** Types of hazardous waste (such as nuclear, biomedical and industrial waste), problems and issues related to HWM, Need for HWM, Legislations on management and handling of HW, Hazardous Characteristics, reduction of wastes at source, Recycling and reuse, labeling and

<table>
<tr><td></td><td colspan="5">handling of hazardous wastes, incineration, solidification & stabilization of hazardous waste.
(6 Hrs)</td></tr>
<tr><td rowspan="6">Text Book/ Reference Books</td><td>Sr. No.</td><td>Title</td><td>Author</td><td>Publication</td><td>Edition</td></tr>
<tr><td>1.</td><td>Integrated Solid Waste Management</td><td>Hilary Theisen and Samuel A, Vigil, George Tchobanoglous</td><td>McGraw- Hill, New York</td><td>1993</td></tr>
<tr><td>2.</td><td>Manual on Municipal Solid waste management</td><td>CPHEEO, Central Public Health and Environmental Engineering Organization</td><td>Government of India, New Delhi</td><td>2000</td></tr>
<tr><td>3.</td><td>Environmental Resources Management and Hazardous waste Management,</td><td>Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans</td><td>Mc-Graw Hill International edition, New York</td><td>2001</td></tr>
<tr><td>4.</td><td>Solid waste Engineering</td><td>Vesilind P.A., Worrell W and Reinhart</td><td>Thomson Learning Inc., Singapore</td><td>2002</td></tr>
<tr><td>5.</td><td>Hazardous Waste Management</td><td>Charles A. Wentz</td><td>McGraw Hill International Edition,New York</td><td>2nd 1995</td></tr>
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Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester VI	
Course Code: CSE381 Course: Open Elective-II (Information & Cyber Security) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• Knowledge of Computer Networking is necessary to understand the concepts.
Objectives	1. To understand the foundations of Information Security. 2. To learn various types of algorithms and its applications of Cyber Security. 3. To identify insights on how to apply Cyber Security.
Unit-I	**Introduction** The History of Information Security, Balancing Information Security and Access, Introduction and Security Trends, General Security Concepts and introduction to what is an "infosphere", Operational Security and People's Role in Information Security. **(6 Hrs)**
Unit-II	**Security Needs** The Need for Security, Business Needs, Needs to protect against Threats and Attacks, Security in Emails.Secure Software Development. Essential Terminologies: CIA, Risks, Breaches, Threats, Attacks, Exploits. **(6 Hrs)**
Unit-III	**Cryptography Concepts** Concepts of Data encryption, Introduction, Plaintext & Cipher text, Substitution Techniques, Transposition Techniques, Encryption & Decryption, Symmetric & Asymmetric key Cryptography. Public Key Infrastructure (PKI), Different attacks on Cryptosystems. **(6 Hrs)**
Unit-IV	**Internet Standards and Authentication** Basic concepts of Internet Standards and Physical Security, Network Security and Infrastructure, Authentication Basics, Password, Authentication Token, Certificate based Authentication, Basics of authentication in Wireless Networks, Need of authentication in Wireless Communication. **(6 Hrs)**
Unit-V	**Security in Evolving Technology** Biometrics, Mobile Computing and Hardening on android and ios, IOT Security, Web server configuration and Security. Introduction, Basic security for HTTP Applications and Services, Basic Security for Web Services like SOAP, REST etc., Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges. Open Source/ Free/ Trial Tools: adb for android, xcode for ios, **(6 Hrs)**

Unit-VI	**Cyber Security Vulnerabilities & Safe Guards** Vulnerabilities-Overview, vulnerabilities in software, System administration, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, IT Audit, Authentication. Open Web Application Security Project (OWASP), Web Site Audit and Vulnerabilities assessment .Open Source/ Free/ Trial Tools: WinAudit, Zap proxy (OWASP), burp suite, DVWA kit. **(6 Hrs)**

Text Book/ Reference Books

Sr. No.	Title	Author	Publication	Edition
1.	Cryptography and Network Security	William Stallings	Pearson Education/PHI	2006
2.	Cryptography and Network Security	V.K. Jain	Khanna Publishing House.	-
3.	Principles of Information Security	Michael E Whitman and Herbert J Mattord	Vikas Publishing House, New Delhi.	-
4.	Handbook of Information Security Management	Micki Krause, Harold F. Tipton,	CRC Press LLC	-
5.	Information and Cyber Security	Gupta Sarika	Khanna Publishing House, Delhi.	-
6.	Cryptography and Network Security	Atul Kahate	McGraw Hill.	-

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester VI	
Course Code: EED381 Course: Open Elective-II (Electrical Materials) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• Basics of Electrical and Electronics Engineering, Physics, Chemistry.
Objectives	1. To understand Basic electrical and electronics engineering. 2. To understand Electromagnetism and its laws. 3. To study the conducting and superconducting materials. 4. To study the dielectric and nano materials.
Unit-I	**Crystallography** Crystal directions and planes, Diatomic Crystal (CsCl, NaCl, Diamond, BaTiO3) Crystal imperfection, Point defects, Line defects, Surface and Volume defects, Structure properties relationship, structure determination by X-ray diffraction. **(8 Hrs)**
Unit-II	**Magnetic Materials** Origin of magnetization using atomic theory, classification of magnetic materials and properties, Laws of magnetism, comparison of electrical and magnetic circuits theory of Día, Para and ferromagnetism, Soft and Hard magnetic materials and their uses, Domain theory of ferromagnetism, Hysteresis loss, Antiferromagnetic and Ferrimagnetic materials, Ferrites and Garnets. **(5 Hrs)**
Unit-III	**Conducting and Superconducting Materials** Band theory of solids, Classical free electron theory of metals, Quantum free electron theory, Density of energy states and carrier concentration, Fermi energy, Temperature and Fermi energy distribution, Superconductivity, Factor affecting Superconductivity, Meissner effect, Type-I and Type-II superconductors, BCS theory, Josephson effect, High temperature superconductors, Application of superconductors. **(5 Hrs)**
Unit-IV	**Semiconducting Materials** Band structure of semiconductor, Charge carrier concentration, Fermi level and temperature, Electrical conductivity, Hall effect in semiconductors, P-N junction diode, Preparation of single crystals, LED, Photovoltaic cell. **(6 Hrs)**
Unit-V	**Dielectric Materials** Dielectric constant and polarizability, types of polarization, temperature and frequency dependences of Dielectric parameter, internal fields in solids, Clausius-Mosotti equation,

	dielectric loss, dielectric breakdown, ferroelectric, pyroelectric and piezoelectric materials, applications of dielectric materials. **(6 Hrs)**
Unit-VI	**Nano Materials** Nanomaterials: Introduction and properties, synthesis of nanomaterials, Carbon Nano Tubes, Characterization techniques of nanomaterials- SEM, TEM, EDAX, FMR, XRD. Applications of nanomaterials. **(6 Hrs)**

Text Book/ Reference Books

Sr. No.	Title	Author	Publication	Edition
1.	Electrical engineering materials	A.J. Dekkar	McGraw Hill Publication	2nd
2.	Science of Engineering Materials and Carbon Nanotubes	C.M. Srivastava and C. Srinivasan	New Academic Science	3rd
3.	Material Science and Engineering	V.Raghavan	PHI Learning	5th
4.	Solid State Physics	A.J. Dekkar	Laxmi publication	3rd

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester VI	
Course Code: ETC381 Course: Open Elective-II (Internet of Things) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs

Prerequisite	• Python Fundamentals, basics of electronics, Networking fundamentals, WWW Terminology.
Objectives	1. To understand IOT value chain structure (device, data cloud), application areas and technologies involved. 2. To understand IOT sensors and technological challenges faces by IoT devices. 3. Explore and learn about Internet of things with the help of projects.
Unit-I	**Introduction to IoT** Industry 4.0., Definition of IOT- Evolution of IOT and related terms, hardware, software, network stack for IoT, SAAS Model. **(6 Hrs)**
Unit-II	**Elements of IoT** Introduction to elements of IOT, Basic Architecture of an IOT application sensors, and Actuators, WPAN and LPWAN, 6LoPAN, Sigfox. **(6 Hrs)**
Unit-III	**IoT Sensors** Node MCU ESP 8266- hardware specification, GPIO programming, WIFI connectivity programming, Access Point Programming, Introduction to basis looping and conditional statements, basics of HTML. **(6 Hrs)**
Unit-IV	**Communication and Connectivity Technologies** Introduction to: TCP/IP, UDP, NTP, MQTT, Network and Sockets, Cloud Computing in IOT, IOT Communication Model. **(6 Hrs)**
Unit-V	**Data Analytics and IOT Platforms** Basics of statistics, Descriptive statistics and probability distributions. Big Data Analytics, Hadoop, Data Visualization, IOT Platforms Things speak, Microsoft Azure and Amazon Web Services, IBM Watson, Google Home and Amazon's Alexa. **(6 Hrs)**
Unit-VI	**Preparing IoT Projects** Creating the sensor project with Node MCU ESP 8266, Sensor libraries, Internal representation of sensor values, External representation of sensor values, Exporting sensor data, Creating the actuator project. **(6 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
Text Book/ Reference Books	1.	The Internet of Things: Applications and Protocols	Oliver Hersent, David Boswarthick, Omar Elloumi	Wiley publications	-
	2.	Architecting the Internet of Things	Dieter Uckelmann, Mark Harrison, Florian Michahelles	Springer publications.	-
	3.	Internet of Things with Arduino	Marco Schwatrz	Cookbook, Packt Publications	-
Website	1.	Introduction to internet of things - Course (nptel.ac.in)			

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester VI	
Course Code: MED381 Course: Open Elective-II (Industry 4.0) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs

Prerequisite	• Computer fundamentals and understanding of basics of information technology. • Understanding of basic concepts of production and manufacturing technology.
Objectives	1. To make students aware of the structure and role of Industry 4.0, in current evolving industrial environment. 2. To give learners overview of Industry 4.0 technologies and their integration.
Unit-I	**Introduction** Four industrial revolutions, Digital transformation of Industry and the fourth industrial revolution, Scope of Industry 4.0, Automation pyramid and Industry 4.0, Principles of Industry 4.0. **(6 Hrs)**
Unit-II	**Internet of Things (IoT)** Concept of IoT, IoT Architecture – Sensing layer, Network layer, Data processing layer, Application layer, Applications of IoT – for automobiles, homes, etc. Internet of Service (IoS), Internet of Energy (IoE). **(6 Hrs)**
Unit-III	**Technologies in Industry 4.0 (1)** Augmented reality and Virtual Reality, 3D Printing, Collaborative robots, Smart material handling, Smart sensors, Concept of smart products. **(6 Hrs)**
Unit-IV	**Technologies in Industry 4.0 (2)** Machine learning, Introduction to Cyber Physical Systems (CPS), Components of Cyber Physical Systems, Digital twins, Machine vision, Smart factory, Artificial intelligence. **(6 Hrs)**
Unit-V	**Data in Industry 4.0** Big Data, Data Mining, Data Analytics, Cloud computing, Data – anew resource of organization, Data analysis for optimal decision making, Digitalization of the entire value chain. **(6 Hrs)**
Unit-VI	**Applications of Industry 4.0** Industry 4.0 in Manufacturing – Predictive maintenance, Real-time supply-chain optimization, Digital performance management, Smart energy consumption, Challenges in implementing Industry 4.0. **(6 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
Text Book/ Reference Books	1.	Industry 4.0_ the Industrial Internet of Things	Industry 4.0_ the Industrial Internet of Things	Industry 4.0_ the Industrial Internet of Things	-
	2.	Industry 4.0_ Managing The Digital Transformation	Alp Ustundag, Emre Cevikcan	Springer	-
	3.	Automated Manufacturing System	Hugh Jack	-	-
	4.	Industry 4.0_Opportunities Behind The Challenge	Dr. Mirjana Stankovic, Ravi Gupta and Dr. Juan E. Figueroa	UNIDO General Conference 2017	-

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester VI	
Course Code: PPE381 Course: Open Elective-II (Polymer Recycling and Waste Management) **Teaching Scheme:** Theory: 3 Hrs/week	Credits: 3-0-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
Prerequisite	• Basic knowledge of polymeric materials, additives and their properties. • Basic knowledge of polymer rheology and processing.
Objective	• To learn the basic concepts used in the recycling of polymers along with learning about solid waste management.
Unit-I	**Significance of Recycling** Introduction and classification of waste. Global polymer production and consumption, Global polymer waste composition, quantities and disposal, Identification of polymer for recycling. Recycling Process: collection, sorting and segregation of waste, Use of advanced technologies such as artificial intelligence in sorting, Recycling methods: primary, secondary, tertiary and quaternary recycling, landfilling. **(6 Hrs)**
Unit-II	**Recycling Equipment/Machinery** Equipment for primary and secondary recycling: shredder, granulator, pulverizer, shredder, cutter, Classification and types of reactors for tertiary recycling, Case study on waste to energy conversion plant. **(5 Hrs)**
Unit-III	**Recycling of Plastics from Urban Waste** Physiochemical, mechanical and rheological characteristics of recycled plastics, hydrolytic treatment of plastics waste containing paper, mixed plastic waste and its processing, recycling extrusion and additives used in polymer recycling, wood plastic composites, use of x-ray photoelectron spectroscopy (XPS) in recycling, international standards in recycling. **(7 Hrs)**
Unit-IV	**Recycling Techniques** PE/PP packaging films and woven sacks, PET bottles and films, PVC products, fiber reinforced plastics (FRP), and rubber products. **(6 Hrs)**
Unit-V	**Municipal Solid Waste Management and Treatment Techniques** Collection, storage, transportation and disposal of municipal solid waste, sorting of MSW, vehicles and equipment for primary collection, secondary collection and transport. a) Sanitary landfilling: Requirements, layout, leachate management, waste placement and inspection. b) Composting: windrow, aerated static pile, in vessel, decentralized, bin, box and

	vermicomposting. c) Biomethanation and refuse derived fuel. **(7 Hrs)**
Unit-VI	**Tools for Combating Polymer Waste** Combating tools for waste management: Case studies on extended producer responsibility, product stewardship, usage of green products and usage of biodegradable or environmentally degradable polymers, plastic roads. **(5 Hrs)**

Text Book/ Reference Books

Sr. No.	Title	Author	Publication	Edition
1.	Plastics Fabrication and Recycling	Manas Chanda and Salil K. Roy	CRC Press	4th 2007
2.	Introduction to Plastics Recycling	Vannessa Goodship	Smithers Rapra	2nd 2006
3.	Recycling of Polymers	Raju Francis	Wiley-VCH	1st 2016
4.	Recycling of Plastic Materials	Francesco Paolo La Mantia	Chemtec Publishing	2nd 1993
5.	Feedstock Recycling and pyrolysis of waste plastics	John Schiers & W. Kaminsky	John Wiley and Sons	1st 2006
6.	Mixed Plastic Recycling Technology	B. Hegberg, G. Brenniman	Noyes Data Corporation	1st 1992
7.	Plastics Waste: Recovery of Economic value	Jacob Leidner	Marcel Decker Inc.	2nd 2001
8.	Management of municipal solid waste	T. V. Ramchandra	TERI Press	1st 2009
9.	Waste Management	Martin F. Lehmann	I. A. Publishers	1st 2008
10.	Environmental Waste Management	Ram Chandra	CRC Press	1st 2015
11.	Plastic Waste	Jacob Leidner	Marcel Decker Inc.	1st 1981

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI		
Course Code: PPE371 Course: Lab: Polymer Processing Technology-I **Teaching Scheme:** Practical: 2 Hrs/week		Credits: 0-0-1 Practical: 25 Marks
Objective	**:**	1. Practical exposure of working on polymer processing machines.
List of Practical/ Assignments	**:**	1. To produce an article from hand operated injection molding machine. 2. To set up the reciprocating screw type injection molding machine for processing. 3. To produce an article from reciprocating screw type injection molding machine 4. To identify and troubleshoot defects in an injection molded product along with estimation of the product cost. 5. To perform compounding of a thermoplastic material with filler. 6. To perform recycling of a thermoplastic material. 7. To study the construction and working of blown / cast film extrusion. 8. To study the construction and working of pipe / profile extrusion.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI		
Course Code: PPE372 Course: Lab: Polymer Materials **Teaching Scheme:** Practical: 2 Hrs/week		Credits: 0-0-1 Practical: 25 Marks
Objective	**:**	1. To synthesize various polymers.
List of Practical/ Assignments	**:**	1. To synthesize polystyrene by suspension polymerization technique. 2. To synthesize polystyrene by bulk polymerization technique. 3. To synthesize PMMA by solution polymerization technique. 4. To prepare expanded polystyrene. 5. To synthesize a copolymer by emulsion/ bulk/ solution/ suspension polymerization. 6. To synthesize plastisol/ organosol. 7. To synthesize polyaniline by interfacial polymerization. 8. To synthesize polyvinyl alcohol from polyvinyl acetate. 9. To study auto-acceleration by bulk polymerization method.
		(Any 8 number of practical to be performed from the given list)

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI		
Course Code: PPE373 Course: Lab: Polymer Characterization **Teaching Scheme:** Practical: 2 Hrs/week		Credits: 0-0-1 Practical: 25 Marks
Objective	**:**	1. To give an overview to the students about various instruments used for polymer characterization, their working principle, instrumentation and applications.
List of Practical/ Assignments	**:**	1. To characterize a polymer through FTIR and interpret the spectrum. 2. To characterize a polymer solution through UV-VIS and analyze the spectrum. 3. To determine T_g and T_m of a polymer through DSC analysis. 4. To study thermal degradation of a polymer through TGA and DTG analysis. 5. To determine crystallinity, crystallite size and lattice strain of a polymer from X-ray diffractogram. 6. To index the peaks of an X-ray diffractogram of a polymer. 7. To analyze scanning electron micrographs of a polymer, polymeric blend and composite. 8. To analyze transmission electron micrographs of a polymer and polymeric composite. 9. To analyze purity of solvent using GC-MS. 10. To analyze purity of solvent using HPLC.
(Any 8 number of practical to be performed from the given list)		

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
(Faculty of Science & Technology)
Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI

Course Code: PPE374	Credits: 0-0-2
Course: Major Project-I	Practical: 50 Marks
Teaching Scheme:	
Practical: 4 Hrs/week	

Objective	**:**	1. The Projects in the undergraduate study of engineering aims at developing in the student, knowledge and skills to match the current and projected needs of industry, society or user systems and to create social awareness and professional attitudes. Apart from monitoring the engineering processes and maintenance of engineering work, machines and equipment, an engineer has to do investigate survey, collect data, refer handbooks/datasheets, prepare estimates and design the systems.
Guidelines	**:**	• The completion of project is to be carried out in two semesters i.e. in Third Year Sem. VI and Final Year B. Tech Sem. VII. • The students shall form project group of maximum 3 students for within department projects and maximum of 6 students in case of interdisciplinary projects of their choice. • The students groups shall collect the information on the topic/area of interest and submit brief synopsis to Project Coordinator. • The Project Coordinator shall allot the Project Guide depending upon the area or specialization of eligible faculty members from the department. • The individual student from the project group shall maintain the project diary and update weekly by taking remark of respective guide. • The industry sponsored projects and inter departmental projects shall be encouraged and in case of inter departmental projects, students of maximum 3 different departments/disciplines shall work together by forming the group. The guide allotment and internal/external assessment of such groups shall be done by the respective departments. • The projects addressing issues related to environmental, rural development and societal issues shall be preferred. • The selected project shall help to promote participation in government approved schemes like Unnat Maharashtra Abhiyaan (UMA) and Unnat Bharat Abhiyaan (UBA). • The students shall aim to promote their project work in project exhibitions/competitions, paper presentation/publication in reputed journals and conferences. • The relevance of project and implementation including details of attainment of POs and PSOs addressed through the projects with justification must be clearly stated. **Phases of Major Project - I:** **Phase I:** Problem Identification, Literature survey, data collection, deciding scope

		of topic and objectives and Methodology of the project. **Phase II:** Confirmation of block diagram or layout of the proposed project. **Phase III:** Submission of report of project work

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (Plastic and Polymer Engineering) Semester VI		
Course Code: PPE375 Course: Lab: CAE for Plastics **Teaching Scheme:** Practical: 2 Hrs/week		Credits: 0-0-1 Term Work: 25 Marks
Objective	**:**	1. To impart the knowledge of design analysis using computer aided engineering packages and to enhance injection mold and product design capabilities.
List of Practical/ Assignments	**:**	1. Introduction to CAE for Plastics and software startup with user interface. 2. To practice fill analysis for given plastics product for single cavity mold. 3. To practice fill analysis for given plastics product for multi cavity mold. 4. To practice packing analysis for given plastics product for single cavity mold. 5. To practice packing analysis for given plastics product for multi cavity mold. 6. To practice cooling analysis for given plastics product for single cavity mold. 7. To practice cooling analysis for given plastics product for multi cavity mold. 8. To practice warping analysis for given plastics product for single cavity mold. 9. To practice warping analysis for given plastics product for multi cavity mold. 10. To create a report based on analysis results.
(Any 8 number of practical to be performed from the given list)		

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
(Faculty of Science & Technology)
Syllabus of Third Year B. Tech. (All) Semester VI

Course Code: BSH807 Course: Mandatory non-credit audit course (German Language) **Teaching Scheme:** Theory: 2 Hrs/week	Credits: 0-0-0 Total Marks: 50 (Continuous Assessment)

Objectives	1. Students will be able to apply communicative German Grammar in communication. 2. Students will be able to enhance the level of German vocabulary. 3. Students will be able to pronounce and articulate words as well as sentences accurately. 4. Students will be able to understand and apply German language eventually. 5. Students will be able to develop German language skills. 6. Students will be able to manage situational communication in German.
Unit-I	**Introduction** - Self –Introduction - Nos. up to 10,000 - Weekdays, Months - Date and Time - Greetings **(6 Hrs)**
Unit-II	**Vocabulary** - My house - My family - Daily routine - Hobbies - Food **(6 Hrs)**
Unit-III	**Grammar** - Verb forms (Present Tense) - Articles - Possessive pronouns - Auxiliary verbs - Wh-Questions / Yes-No Questions - Past-Tense of haben and sein **(12 Hrs)**

Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	German Made Simple: Learn to speak and understand German quickly and easily	Arnold Leitner PhD	Namrata's Amazon.in	-

	2.	The Everything Learning German Book: Speak, write, and understand basic German in no time	Edward Swick	Adams Media	-
	3.	Langenscheidt German in 30 Days	Von Angelika G. Beck	Langenscheidt	-
	4.	Complete German Beginner to Intermediate Book and Audio Course: Learn to read, write, speak and understand a new language with Teach Yourself	Heiner Schenke	The McGraw Hill	-
	5.	German: How to Speak and Write It (Beginners' Guides)	Joseph Rosenberg	Repro Books	-
	6.	Collins Easy Learning – Collins Easy Learning German Grammar and Practice	Collins	Collins	-

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
(Faculty of Science & Technology)
Syllabus of Third Year B. Tech. (All) Semester VI

Course Code: BSH808 Course: Mandatory non-credit audit course (Japanese Language) **Teaching Scheme:** Theory: 2 Hrs/wee	Credits: 0-0-0 Total Marks: 50 (Continuous Assessment)

Objectives	1. Students will be able to apply communicative Japanese Grammar in communication. 2. Students will be able to enhance the level of Japanese vocabulary. 3. Students will be able to pronounce and articulate words as well as sentences accurately. 4. Students will be able to understand and apply Japanese language eventually. 5. Students will be able to develop Japanese language skills. 6. Students will be able to manage situational communication in Japanese.
Unit-I	**Introduction** - Introduction - Numbers - Days, Months, Dates **(8 Hrs)**
Unit-II	**Grammar** - Verb and verb forms - Present and Past Tense **(8 Hrs)**
Unit-III	**Communication** - Introduction of Japanese script - Dialogues (Shopping, in the restaurant) - Themes: Family, my city, my country, my friend **(8 Hrs)**

Text Book/ Reference Books

Sr. No.	Title	Author	Publication	Edition
1.	Japanese Kanji for Beginners	Timothy G. Stout and Kaori Hakone	Tuttle Publishing	-
2.	Essential Japanese Grammar: A Comprehensive Guide to Contemporary Usage	Masahiro Tanimori and Eriko Sato Ph.D.	Tuttle Publishing	-
3.	15-Minute Japanese: Learn in Just 12 Weeks	D.K. Goel and Rajesh Goel	Amazon.in	-

	4.	Oxford Japanese Grammar and Verbs (Dictionary)	Bunt Jonathan	Oxford Publication	-
	5.	Read and write Japanese scripts: Teach yourself	Helen Gilhooly	Teach Yourself	-
	6.	Complete Japanese Beginner to Intermediate Book and Audio Course: Learn to read, write, speak and understand a new language with Teach Yourself	Helen Gilhooly	Teach Yourself	-

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester VI	
Course Code: CED801 Course: Mandatory non-credit audit course (Professional Ethics and Constitution of India) **Teaching Scheme:** Theory: 2 Hrs/week	Credits: 0-0-0 Total Marks: 50 (Continuous Assessment)
Prerequisite	• Knowledge of the basic structure of constitution of India.
Objective	1. To create awareness of Engineering Ethics and human values, instil moral social values, loyalty and ethical issues. It will allow the students to assimilate with basic information about Indian Constitution, know its salient features and thus functioning of democracy in India.
Unit-I	**Professional Ethics** Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift v/s Bribery, Environmental breaches, Negligence, Deficiencies in state of-the-art; Vigil Mechanism, Whistle blowing, protected disclosures. **(4 Hrs)**
Unit-II	**Engineering and Professionalism** Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism, and Professional Responsibility. Clash of Ethics, Conflicts of Interest. **(4 Hrs)**
Unit-III	**Responsibility and reliability in Engineering** Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering. **(4 Hrs)**
Unit-IV	**Introduction to Indian Constitution** The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building. **(4 Hrs)**
Unit-V	**Decision Methods for Evaluation of Alternative** Public participation in environmental decision making, Regulatory requirements, environmental impact assessment process, objectives of public participation, verbal communication in EIA studies.

	(4 Hrs)
Unit-VI	**Union Executive and State Executive** Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Articles 370.371,371J) for some States. **(4 Hrs)**

Text Book/ Reference Books

Sr. No.	Title	Author	Publication	Edition
1.	Engineering Ethics (Including Human Values)	Govindrajan.M, Natrajan S, Senthilkumar V.S	PHI publication	-
2.	Ethics, Integrity and Aptitude	Reddy.N H, Ajmera, Santosh,	Tata McGraw Hill	Latest
3.	Introduction to the Constitution on India	Durga Das Basu	Prentice –Hall EEE, 19th / 20th Ed.	2008 and latest
4.	Constitution of India and Professional Ethics	Shubham Singles, Charles E. Haries, and Et al	Cengage Learning India Private Limited	2018
5.	An Introduction to Constitution of India	M.V.Pylee	Vikas Publishing	2002

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (Faculty of Science & Technology) Syllabus of Third Year B. Tech. (All) Semester VI	
Course Code: CSE801 Course: Mandatory non-credit audit course (Green Computing) **Teaching Scheme:** Theory: 2 Hrs/week	Credits: 0-0-0 Total Marks: 50 (Continuous Assessment)
Objectives	1. To learn the fundamentals of Green Computing. 2. To understand the concepts related to Green IT, Green devices and hardware along with software methods, green enterprise activities. 3. To study the various laws, standards, protocols for regulating green IT 4. To study various case studies related to the application of Green IT strategies.
Unit-I	**Green IT: An Overview** Introduction, Environmental Concerns and Sustainable Development, Environmental Impacts of IT, Green IT, Holistic Approach to Greening IT, Applying IT for enhancing Environmental sustainability, Green IT Standards and Eco-Labelling of IT. **(4 Hrs)**
Unit-II	**Green Devices and Hardware with Green Software** Green Devices and Hardware: Introduction, Life Cycle of a device or hardware, Reuse, Recycle and Dispose. Green Software: Introduction, Energy-saving software techniques. **(4 Hrs)**
Unit-III	**Green Enterprises and the Role of IT** Introduction, Organization and Enterprise Greening, Information systems in Greening Enterprises, Greening Enterprise: IT Usage and Hardware, Inter-Organizational Enterprise activities and Green Issues. **(4 Hrs)**
Unit-IV	**Managing Green IT** Introduction, Strategizing Green Initiatives, Implementation of Green IT, Information Assurance, Communication and Social media. **(4 Hrs)**
Unit-V	**Regulating the Green IT: Laws, Standards and Protocols** Introduction, The regulatory environment and IT manufacturers, Non regulatory government initiatives, Industry associations and standards bodies, Green building standards, Green data centers, Social movements and Greenpeace. **(4 Hrs)**
Unit-VI	**Case Studies** The Environmentally Responsible Business Strategies (ERBS) – Case Study Scenarios for Trial Runs – Case Studies – Applying Green IT Strategies and Applications to a Home, Hospital. **(4 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
Text Book/ Reference Books	1.	Harnessing Green IT Principles and Practices	San Murugesan, G.R. Gangadharan	Wiley Publication	-
	2.	Green IT Strategies and Applications-Using Environmental Intelligence	Bhuvan Unhelkar	CRC Press	June, 2014
	3.	The Greening of IT	John Lamb	Pearson Education	2009
	4.	Green Home computing for dummies	Woody Leonhard, Katherine Murray	-	2012

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
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Syllabus of Third Year B. Tech. (All) Semester VI

Course Code: ETC801 Course: Mandatory non-credit audit course (Smart Cities) **Teaching Scheme:** Theory: 2 Hrs/week	Credits: 0-0-0 Total Marks: 50 (Continuous Assessment)

Prerequisite	• Nil
Objectives	1. To identify urban problems. 2. To study effective and feasible ways to coordinate urban technologies. 3. To study models and methods for effective implementation of Smart Cities.
Unit-I	**Smart Cities** Ideal Smart City loop, Socio-economic and environmental issues, Implications of Urbanization, Urbanization models and global trends, Urbanization in India. **(4 Hrs)**
Unit-II	**Criteria for Smart Cities** Smartness - Citizens, Living, Environment, Mobility, Economy, Governance Pillars of Smart cities, Buildings, Utilities, Transportation and road Infrastructure, Health Care, Sustainability issues. **(4 Hrs)**
Unit-III	**Fundamental Technologies** Ubiquitous computing, Big Data, Networking, Internet of Things, Cloud computing, Cyber security architectures. **(4 Hrs)**
Unit-IV	**ICT for Smart Cities** Complex Urban systems ICT Infrastructure modelling, Typical Edge Environment, Smart Cities as Systems of Systems, IoT Centric approach, IoT technologies: WiFi, 6LowPAN, Cellular, NFC, LoRa, Bluetooth, RFID, Zigbee. **(4 Hrs)**
Unit-V	**Smart City** Smart Street lighting, Smart Parking, Environmental pollution monitoring, Vehicular tracking, Smart Traffic Control, Waste Management, Smart Grid, Amenity availability, Heritage Information portal, Mobile application design, development and Visualization. **(4 Hrs)**
Unit-VI	**Case Studies of Smart Cities** National and International smart cities, their model, Clusters and Urbanization, Environmental Issues: The Role of Local and Global Climate Change. **(4 Hrs)**

Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	The City of Tomorrow: Sensors, Networks,	Carlo Ratti and Matthew Claudel	Yale University Press	-

		Hackers, and the Future of Urban Life (The Future Series)			
	2.	The Responsive City: Engaging Communities Through Data-Smart Governance	Stephen Goldsmith, Susan Crawford	Jossey Bass – Wiley	1st

<table>
<tr><td colspan="3">Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
(Faculty of Science & Technology)
Syllabus of Third Year B. Tech. (All) Semester VI</td></tr>
<tr><td colspan="2">Course Code: MED801
Course: Mandatory non-credit audit course (Research Methodology)
Teaching Scheme:
Theory: 2 Hrs/week</td><td>Credits: 0-0-0
Total Marks: 50 (Continuous Assessment)</td></tr>
<tr><td>Objectives</td><td colspan="2">1. To introduce students to quantitative and qualitative methods for conducting meaningful inquiry and research.
2. Prepare a preliminary research design for projects in their subject matter areas
3. Accurately collect, analyze, and report data.
4. Present complex data or situations clearly.</td></tr>
<tr><td>Unit-I</td><td colspan="2">Research Problems and Research Design
Meaning of research, objectives of research, motivation in research, types of research, steps in involved in research process, criteria of good research, significance of research, research methods versus methodology, selection of research problem, steps involved in defining research problem, research process, need for research design, types of research designs, basic principles of experimental design, formal and informal experimental design.
(5 Hrs)</td></tr>
<tr><td>Unit-II</td><td colspan="2">Sampling Design
Need for sampling, steps in sampling design, different types of sampling designs, sampling distributions, concept of central limit and standard error, sources of errors, population mean and proportion, sample size calculations, tests of measurements for validity, reliability, and practicality.
(5 Hrs)</td></tr>
<tr><td>Unit-III</td><td colspan="2">Data Collection, Processing and Analysis
Methods for collection of data, selection of data collection method, data processing operations, statistics in research, confidence level, measures of central tendency, dispersion, asymmetry and relationship. Spearman’s and Pearson’s coefficient of correlation, simple & multiple regression analysis, analysis of variance (ANOVA), factor analysis methods.
(8 Hrs)</td></tr>
<tr><td>Unit-IV</td><td colspan="2">Hypothesis Test
Concept of research hypothesis, concept of testing of hypothesis, Procedure for hypothesis testing, Flow diagram for hypothesis testing, Measuring the power of a hypothesis test, Parametric tests (z, t, F and chi-square tests), Hypothesis testing of means and correlation coefficient, Limitations of the tests of hypotheses.
(7 Hrs)</td></tr>
<tr><td>Unit-V</td><td colspan="2">Report Writing
Interpretation: Meaning of Interpretation, Why Interpretation? Technique of Interpretation, Precaution in Interpretation.
Report Writing: Significance of Report Writing, Different Steps in Writing Report,</td></tr>
</table>

	Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions. **(6 Hrs)**				
Unit-VI	**Ethics** Ethical Issues, Ethical Committees, Commercialization, copy right, royalty, Intellectual Property rights and patent law, Reproduction of published material, Plagiarism, Citation and Acknowledgement, Reproducibility, and accountability. **(5 Hrs)**				
Text Book/ Reference Books	**Sr. No.**	**Title**	**Author**	**Publication**	**Edition**
	1.	Research Methodology: Methods & Techniques	C. R. Kothari and G. Garg	New Age International	4th 2019
	2.	Research Methodology	R. Pannerselvam	PHI Learning,	2nd 2014
	3.	Research Methods and Statistics	Bernard C. Beins & Maureen A. McCarthy	Pearson Education Inc.	2012
	4.	Research Methods Handbook	Stuart MacDonald & Nicola Headlam	CLES	-
	5.	Intellectual Property Rights--Unleashing the Knowledge Economy,	Ganguli Prabuddha.	Tata McGraw-Hill,	2001
	6.	Intellectual Property Rights	Neeraj Pandey and Khushdeep Dharni.	PHI Learning	1st 2014
	7.	Fundamentals of Intellectual Property Rights,	Ramakrishna B.	Notion Press	1st 2017
	8.	The Indian Patents Act 1970 (as amended in 2005)	-	-	-

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
(Faculty of Science & Technology)
Syllabus of Third Year B. Tech. (All) Semester VI

Course Code: PPE801 Course: Mandatory non-credit audit course (Industrial Safety and Management) **Teaching Scheme:** Theory: 2 Hrs/week	Credits: 0-0-0 Total Marks: 50 (Continuous Assessment)

Objectives	1. To understand the fundamental concepts, and methods in Industrial Safety. 2. To understand the impact of safe industrial operations, its benefits and safety management.
Unit-I	**Introduction to Industrial Safety** Introduction, key concepts, terminologies, Need for safety, Safety information system. **(4 Hrs)**
Unit-II	**Safety Management** Safety inspection, procedure, checklist, safety sampling, safety audit, safety survey, accident prevention, training for safety. **(4 Hrs)**
Unit-III	**Safety in Process** Safety in material handling and equipments used, design for safety in process. **(4 Hrs)**
Unit-IV	**Fire Safety** Classification of fires. Common causes of industrial fires. Fire protection systems. **(4 Hrs)**
Unit-V	**Hazards** Occupational health hazards, physical and chemical hazards. **(4 Hrs)**
Unit-VI	**Hazard Analysis** Fault tree and event tree analysis, hazard identification techniques (e.g., HAZOP, HAZAN, OSHAS 18001). **(4 Hrs)**

Text Book/ Reference Books

Sr. No.	Title	Author	Publication	Edition
1.	Industrial Safety, Health and Environment Management Systems	R.K.Jain and Sunil S.Rao	Khanna Publishers, New Delhi	2006
2.	Industrial Safety Management	Deshmukh L M	Tata McGraw-Hill	-
3.	Handbook of Occupational Safety and Health	Slote.L	John Willey and Sons, New York	-

	4.	Safety at Work	Ridley J and Channing J	Butterworth-Heinemann UK	-
	5.	Loss of prevention in Process Industries , Vol. 1 and 2	Frank P. Lees	Butterworth-Heinemann Ltd., London	1991
	6.	Safety Management	Grimaldi and Simonds	AITBS Publishers, New Delhi	2001
Website	https://nptel.ac.in/courses/110/105/110105094/				