CURRICULUM FRAMEWORK AND SYLLABUS
(OUTCOME BASED EDUCATION)

B. TECH. (POLYMER SCIENCE AND ENGINEERING)

(with effect from the academic year 2020–21)

COCHIN UNIVERSITY OF SCIENCE & TECHNOLOGY

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The Department strives develop to a Centre of Excellence in Polymer Technology in the country by strengthening in-house infrastructure and taking up collaborative Research and Development in frontier areas.

Mission

As a Department we are committed to:

- Acquire state-of-the-art infrastructure and take up inter-disciplinary research in frontier areas.
- Achieve academic excellence in the field of Polymer Science and Rubber Technologythrough innovative teaching - learning processes.
- Prepare well-trained human resource in Polymer Science and Rubber Technology who can contribute positively to the developmental efforts of the Nation.
- Promote good academia - industry interaction.

OUTCOME BASED EDUCATION

Programme Educational Objectives (PEO)

PEO1: To mould well-trainedhumanresource in the field Polymer Science and Rubber Technology to support the Nation in its endeavor to be self - reliant and self-sufficient.

PEO2: To instill in students a quest for exploring new knowledge areas, improving academic credentials and acquiring new leadership and entrepreneurial skills

PEO3: To prepare graduates who are morally upright and sensitive to the environmental issues and needs of the society.

Graduate Attributes for Polymer Science and Engineering(GA)

1. Problem Analysis: Identify, formulate, research literature, and solve complex Polymer Science and Engineering problems reaching substantiated conclusions using fundamental principles of Basic Science, Engineering science, and relevant domain disciplines.
2. Design /Development of Solutions: Evaluate Polymer Science and Engineering problems and design products and processes that meet specific needs of the industry with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
3. Conduct Investigations of Polymer Science and Engineering Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

4. Professional Ethics: Understand and commit to professional ethics and cyber regulations, responsibilities, and norms of a professional in Polymer Science and Engineering.
5. Life-long Learning: Recognize the need and have the ability, to engage in independent learning for continuous development as a Polymer Engineer.
6. Project Management And Finance: Demonstrate knowledge and understanding of the Polymer Science and Engineering principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
7. Communication Efficacy: Communicate effectively with the Polymer Science and Engineering community, and with society at large, through academic/ technical reports, proper documentation and effective presentations.
8. Societal and Environmental Concern: Understand and assess societal, environmental, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional Polymer Science and Engineering practice.
9. Individual and Team Work: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary environments.
10. Innovation and Entrepreneurship: Identify a timely opportunity and pursue it to create value and wealth for the betterment of the individual and society at large.

Program Outcomes (POs)

A graduate of this major should be able to:

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, techniques, skills, and modern tools of polymer Science and engineering to the solution of polymer engineering problems.

PO2.Problem Analysis: Identify, formulate, research literature, and analyze engineering problems related to Polymer Science and Engineering to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components, processes to meet the needs of public health and safety, and the cultural, societal, and environmental considerations in the field of Polymer Science and Rubber Technology.

PO4. Conduct investigations of complex Problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the **information to provide valid conclusions for broadly defined polymer science and engineering problems.**

PO5. Modern Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to Polymer Science and Engineering activities with an understanding of the limitations.

PO6.The Engineer and Society: Apply reasoning informed by the contextual knowledge to assesssocietal, health, *safety, legal*, and cultural issues and the consequent responsibilities relevant to Polymer Science and Engineering.

PO7. Environment and Sustainability: Understand the impact of polymer science and engineering solutions in a societal and global context.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice related to Polymer Science and Engineering.

PO9. Individual and team work: Function effectively as a member or leader on a technical team and in multidisciplinary settings.

PO10. Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions regarding broadly defined polymer science and engineering activities.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to polymer engineering related work.

PO12. Life-long learning: Exhibit a commitment to quality and timeliness, and develop the ability to engage in life-long learning for continuous improvement.

Anderson's revised Bloom's taxonomy of cognitive levels

Level	Description	Sample Objectives
Remember	Recognizes students' ability to remember and recall certain facts.	The students will *recall* the four major food groups without error. The students will *list* at least three characteristics peculiar to the Cubist movement.
Understand	Involves students' ability to read course content, understand and interpret important information and put other's ideas into their own words.	The students will *summarize* the main events of a story in grammatically correct English. The students will *describe* in prose what is shown in graph form.
Apply	Students take new concepts and apply them	The students will *apply* previously learned information about socialism to reach an

	to another situation.	answer. The students will *demonstrate* the principle of reinforcement to classroom interactions.
Analyze	Students have the ability to take new information and break it down into parts to differentiate between them	The students will read a presidential debate and *point out* the passages that attack a political opponent personally rather than the opponent‘s political programs. Students will *discriminate* among a list of possible steps to determine which one(s) would lead to increased reliability for a test.
Evaluate	Involves students‘ ability to look at someone else‘s ideas or principles and see the worth of the work and the *value* of the conclusions	Given any research study, *evaluate* the appropriateness of the conclusions reached based on the data presented. The students will *compare* two pieces of sculpture, giving reasons for their positive evaluation of one over the other
Create	Students are able to take various pieces of information and form a whole *creating* a pattern where one did not previously exist	After studying the current economic policies of the United States, student groups will *design* their own goals for fiscal and monetary policies. The students will write a different but plausible ending to a short story.

REGULATIONS FOR B.TECH DEGREE COURSES IN POLYMER SCINECE AND ENGINEERING

UNDER FACULTY OF TECHNOLOGY WITH EFFECT FROM 2020

1. **Effective from:** This regulation of the B. Tech. programme in Polymer Science and Engineering offered by the Department of Polymer Science and Rubber Technology is with effect from 2020-21 admission.The B.Tech (Polymer Science and Engineering) course will follow **OBE system**.

2. Total Credit: The curriculum of the B. Tech. programme shall have a minimum total of **160 credits.**

a) This consists of core subjects, professional electives, open electives and industrial electives.

b) The professional electives may be taken from the Department of from other Departments in the campus. In cases where the elective is from other Departments, the evaluation will be done by them.

c) The **open elective** is to be taken from the courses offered **by NPTEL/ SWAYAM/Edex/Coursera**. The electives from these list will be identified and approved by the Department.

d) The credit obtained from these courses will be transferred to the University

e) The maximum number of open courses will be 20% of the total electives.

f) **The industrial elective** will be offered jointly with an industry. The evaluation will be done jointly with the industry in a method mutually agreed upon.

3. **Mode of Evaluation**: The performance of the students in theory and practical courses will be evaluated based on continuous assessment and end- semester examination. For theory courses and practical courses, continuous assessment and end semester examination will carry 50 % weightage each. The level of difficulty of the questions will be: of 30 % easy, 40 % medium difficulty and 30 % tough.

4. **Assessment**: In each theory courses, the assessment pattern will be as follows:

a) Continuous Assessment:

Sl. No.	**Break up**	Maximum marks
1	I Periodical Test	**15**
2	II Periodical Test	**15**
3	Assignments	**15**
4	Attendance	**5**

b) The marks awarded for attendance will be as follows:

Percentage Attendance	**Marks**
95-100	5
90 to less than 95	4
85 to less than 90	3
80 to less than 85	2
75 to less than 80	1

c) End Semester Examination:

The examination will be of 3 hours duration for which maximum marks will be 50.

d) Practical Courses

In each practical course, assessment pattern will be as follows:

1. Continuous assessment : 50 marks. For continuous assessment, marks may be awarded on the basis of regularity and performance of the student in the laboratory sessions.
2. End semester examination : 50 marks.

e) Normally both question paper setting and valuation of answer papers for all the periodical tests shall be carried out by the teacher who has handled the course. The question paper for the end semester examination for theory papers will be set by an external examiner. The Controller of Examinations will make necessary arrangement for settling the question papers and valuation of answer books for the end semester examination.

f) The continuous assessment in laboratory course will be based on supervision of the students work, their performance in viva voce examinations and the quality of their work. The end semester examination for the laboratory courses shall be conducted internally by the respective department / division with at least two faculty members as examiners.

g) In the case of project work, a committee consisting of the Project Co-coordinator (appointed by the Head of the Department), project guide and at least one senior faculty member will carry out the assessment based on at least two interim reviews and a final review just before the submission of the project report.

h) The Viva voce examination at the end of VIII Semester will be conducted by a panel of examiners consisting of the Head of the Department and one senior faculty of the Department and one external expert.

i) A candidate shall allowed to improve the continuous assessment marks in theory / laboratory courses subject to the following conditions :

1. He / she shall not combine the course work with his / her regular course work.
2. He / she shall repeat the theory/ practical course in a particular course only once and satisfy the minimum attendance requirement of 75 percent in that particular course.
3. He / shall not be allowed to repeat the course work of any semester if he / she has already passed the semester examination in full.

5. Pass requirements.

A candidate has to obtain a minimum of 50 percent marks for continuous assessment and end semester examination put together with a minimum of 45 percent marks in the end semester examination for a pass in both theory and laboratory courses. That is , he / she has to score a minimum of 23 marks out of 50 for the external examination.

6. Promotion to Higher Semesters

A candidate shall be eligible for promotion from one semester to the next semester only if the following conditions are satisfied:

a) He/ she has secured a minimum of 75% attendance.
b) Promotion from one semester to the next semester shall be subject to the condition that the candidate to be promoted to the n^{th} semester should have earned a minimum of (n-2)15 credits. This norm is applicable only from 5^{th} semester onwards.
c) His / her progress and conduct have been satisfactory.

7. Attendance

a) The percentage of attendance of a candidate for a semester shall be indicated by a letter code as given below

Percentage Attendance	Letter Code
90 and above	H
75 to less than 90	N
Less than 75	L

a) A student whose attendance is less than 75% for a semester is not eligible to appear for the end semester examination.
b) The Vice Chancellor shall have the power to condone shortage of attendance up to 10 percent on medical grounds on the recommendations the Head of Division / Department. However such condonation for shortage of attendance shall be given only twice during the entire course.

8. **Grading**

a) Grades shall be awarded to the students in each course based on the total marks obtained in continuous assessment and the end semester examination. The grading pattern shall be as follows:

Marks obtained (Percentage)	**Grade**	**Grade Points**
90-100	S	10
80 to less than 90	A	9
70 to less than 80	B	8
60 to less than 70	C	7
50 to less than 60	D	6
Less than 50	F	0

b) A student is considered to have credited a course or earned credits in respect of a course if he / she secures a grade other than F for that course.

c) Grade Point Average.

The academic performance of a student in a semester is indicated by the Semester Grade Point Average (SGPA)

$$SGPA = \frac{G1C1+O2C2+O3C3+\ldots\ldots\ldots\ldots GnCn}{C1+C2+C3+\ldots\ldots\ldots\ldots\ldots\ldots Cn}$$

Where G refers to the grade point and C refers to the credit value of corresponding course undergone by the student.

d) The cumulative grade point average (CGPA) will be calculated as

$$CGPA = \frac{S1T1+S2T2+S3T3+\ldots\ldots\ldots SnTn}{T1 + T2 + T3 + \ldots\ldots\ldots\ldots\ldots Tn}$$

Where ‘S’ refers to the grade point average, ‘T’ refers to the total credits in that semester.

e) Grade Card

The Grade Card issued at the end of the semester to each student by the Controller of Examinations , will contain the following:

1. The code, title, number of credits of each course registered in the semester, marks (internal, external , total, month & year of pass the subject)
2. The letter grade obtained (grade number)
3. The attendance code
4. The total number of credits earned by the student up to the end that semester and
5. SGPA & CGPA (CGPA for final semester only)

A CGPA of 8.0 and above will be classified as **FIRST CLASS WITH DISTINCTION** and a **CGPA 6.5 above** will be classified as**FIRST CLASS.** The percentage conversion formula isPercentage of marks = (CGPA or SGPA – 0.5) * 10

CURRICULUM

SEMETSER I

Sl. No.	Course Code	Subject	L	T	P	Credits	Marks		
							Internal	External	Total
1	20-214-0101	Engineering Mathematics I	2	1	0	3	50	50	100
2	20-214-0102	Engineering Physics	2	1	0	3	50	50	100
3	20-214-0103	Engineering Chemistry	2	1	0	3	50	50	100
4	20-214-0104	Engineering Graphics	1	2	0	3	50	50	100
5	20-214-0105	Basic Electrical Engineering and Electronics	2	1	0	3	50	50	100
6	20-214-0106	Soft Skill Development	2	0	0	2	50	50	100
7	20-214-0111	Introduction to Industrial Chemical Analysis	0	0	2	1	50	-	50

8	20-214-0112	Basic Electrical Engineering and Electronics	0	0	2	1	50	-	50
9	20-214-0113	Language Lab	0	0	2	1	50	-	50
	20-214-0121	Seminar (Non – Credit)	0	0	3	–			
	20-214-0122	Library (Non – Credit)	0	0	4	–			
		Total	**11**	**6**	**13**	**20**	**450**	**300**	**750**

SEMESTER II

1	20-214-0201	Engineering Mathematics II	2	1	0	3	50	50	100
2	20-214-0202	Engineering Mechanics	2	1	0	3	50	50	100
3	20-214-0203	Environmental Studies	3	0	0	3	50	50	100
4	20-214-0204	Mechanical Engineering	2	1	0	3	50	50	100
5	20-214-0205	Introduction to Macromolecular Science and Engineering	3	0	0	3	50	50	100
6	20-214-0206	Fluid Mechanics	2	1	0	3	50	50	100
7	20-214-0211	Mechanical Engineering Workshop	0	0	3	1	50	-	50
8	20-214-0212	Polymer Synthesis	0	0	2	1	50	-	50
	20-214-0221	Seminar (Non – Credit)	0	0	3	–			
	20-214-0222	Library (Non – Credit)	0	0	4	–			
		Total	**14**	**4**	**12**	**20**	**400**	**300**	**700**

SEMESTER III

1	20-214-0301	Engineering Mathematics III	2	1	0	3	50	50	100
2	20-214-0302	Natural Rubber Production and Technology	3	0	0	3	50	50	100
3	20-214-0303	Strength of Materials	2	1	0	3	50	50	100
4	20-214-0304	Heat and Mass Transfer	2	1	0	3	50	50	100
5	20-214-0305	Organic Chemistry	3	0	0	3	50	50	100
6	20-214-0311	Computer Programming	2	0	3	3	100	-	100
7	20-214-0312	Identification of Polymers	0	0	2	1	50	-	50
8	20-214-0313	Chemical Engineering Lab	0	0	2	1	50	-	50
	20-214-0321	Seminar (Non – Credit)	0	0	3	–			
	20-214-0322	Library (Non – Credit)	0	0	3	–			
		Total	**14**	**3**	**13**	**20**	**450**	**250**	**700**

SEMESTER IV

1	20-214-0401	Applied Statistics	2	1	0	3	50	50	100
2	20-214-0402	Quality Management Systems and Safety	3	0	0	3	50	50	100
3	20-214-0403	Polymer Synthesis and Manufacture	3	0	0	3	50	50	100
4	20-214-0404	Science and Engineering of Rubbers	3	0	0	3	50	50	100
5	20-214-0405	Plastics Materials	3	0	0	3	50	50	100
6	20-214-0406	Review Seminar	0	4	0	1	100	-	100

7	20-214-0411	Polymer Synthesis, Modification and characterization	0	0	4	2	50	-	50
	20-214-0421	Seminar	0	0	3	1	30		30
	20-214-0422	Library (Non – Credit)	0	0	4	–			
		Total	**14**	**5**	**11**	**19**	**430**	**250**	**680**

SEMESTER V

1	20-214-0501	Plastic Processing	3	0	0	3	50	50	100
2	20-214-0502	Polymer Physics	3	0	0	3	50	50	100
3	20-214-0503	Rubber Processing and Products Manufacture	3	0	0	3	50	50	100
4	20-214-0504	Fiber Science and Technology	3	0	0	3	50	50	100
5	20-214-0521-23	Elective I	3	0	0	3	50	50	100
6	20-214-0524-26	Elective II	3	0	0	3	50	50	100
7	20-214-0511	Polymer Characterization and properties	0	0	2	1	50	-	50
8	20-214-0512	Polymer Processing lab	0	0	3	1	50	-	50
	20-214-0521	Seminar	0	0	3	1	30		30
	20-214-0522	Library (Non – Credit)	0	0	4	–			
		Total	**18**	**0**	**12**	**21**	**430**	**300**	**730**

SEMESTER VI

1	20-214-0601	Latex Technology	3	0	0	3	50	50	100

2	20-214-0602	Characterization and Testing Methods	3	0	0	3	50	50	100
3	20-214-0603	Polymer Products Design	3	0	0	3	50	50	100
4	20-214-0604	Polymer Rheology	3	0	0	3	50	50	100
5	20-214-0621-23	Elective III	3	0	0	3	50	50	100
6	20-214-0624-26	Elective IV	3	0	0	3	50	50	100
7	20-214-0605	Minor Project	0	0	3	1	100	-	100
8	20-214-0611	Latex and Dry rubber Technology	0	0	2	1	100	-	100
	20-214-0621	Seminar	0	0	3	1	30		30
	20-214-0622	Library (Non – Credit)	0	0	4	–			
		Total	**18**	**0**	**12**	**21**	**530**	**300**	**830**

SEMESTER VII

1	20-214-0701	Polymer Composites and Blends	3	0	0	3	50	50	100
2	20-214-0702	Introduction to MouId and Design	3	0	0	3	50	50	100
3	20-214-0703	Failure Analysis of Polymers	3	0	0	3	50	50	100
4	20-214-0704	Industrial Management	3	0	0	3	50	50	100
5	20-214-0721-23	Elective V	3	0	0	3	50	50	100
6	20-214-0724-26	Elective VI	3	0	0	3	50	50	100
7	20-214-0711	Polymer Products Testing	0	0	2	1	50	-	50

	20-214-0712	Review paper based on Elective			4	1	60		60
	20-214-0721	Soft skill/ start up workshop (Non – Credit)	0	0	3	–			
	20-214-0722	Library (Non – Credit)	0	0	3	–			
		Total	**18**	**0**	**12**	**20**	**410**	**300**	**710**

SEMESTER VII

1	20-214-0801	Project Work Report and Viva Voce	0	0	22	12	200	200	400
2	20-214-0802	Industrial Training	0	0	4	3	50	50	100
3	20-214-0821	Open Elective I	2	0	0	2	–	50	50
4	20-214-0822	Open Elective II	2	0	0	2	–	50	50
		Total	**4**	**0**	**26**	**19**	**250**	**350**	**600**

Electives	
Elective I	20-214-0521 Adhesives Technology
	20-214-0522 Surface Coatings
	20-214-0523 Disaster Management
Elective II	20-214-0524 Biodegradable Polymers
	20-214-0525 Polymers and Environment
	20-214-0526 Polymers for packaging
Elective III	20-214-0621 Polymers for Electrical & Electronics Applications
	20-214-0622 Footwear Technology
	20-214-0623 Polymer Recycling
Elective IV	20-214-0624 Specialty Polymers
	20-214-0625 Materials Science
	20-214-0626 Introduction to Biomaterials and Medical Devices
Elective V	20-214-0721 Tyre Technology
	20-214-0722 Polymer process modeling and simulation
	20-214-0723 Smart and intelligent polymers
Elective VI	20-214-0724 Polymers in Space

	20-214-0725 Polymer nanocomposites
	20-214-0726 Professional Ethics in Engineering

Credits			
Category	**Theory**	**Lab**	**Total**
Basic Sciences	21	1	22
Eng. Sciences	22	3	25
Humanities/management/computer	14	1	15
Core	52	7	59
Prof. Elective	18	0	18
Open Elective	4	0	4
Project	15	0	15
Seminar&minor project	2	0	2
Total Credits	160		

SYLLABUS

20-214-0101 Engineering Mathematics I

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Recall the methods of differentiation and integration. (Understand)

CO 2: Solve ordinary differential equations and linear differential equations of higher orders with constant coefficient and apply them in engineering problems. (Apply)

CO 3: Explain the concept of partial derivative. (Understand)

CO 4: Estimate the maxima and minima of multi variable functions. (Analyse)

CO 5: Evaluate area as double integrals and volume as triple integrals in engineering applications. (Analyse)

CO 6: Apply multiple integrals in plane area, surface area & volumes of solids. (Apply)

CO 7: Illustrate the application and physical meaning of gradient, divergence and curl. (Apply)

CO 8: Evaluate line, surface and volume integrals. (Evaluate)

Mapping of course outcomes with program outcomes:
Level – Low (1), Medium (2) and High (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	1	1									1
CO 2	1	1	1	1								1
CO 3	1	1	1	1								1
CO 4	1	1	1	1								1
CO 5	1	2	1	1								1
CO 6	1	1	1	1								1
CO 7	1	1	1	1								1
CO 8	1	1	1	1								1

Unit 1. Ordinary differential equations – First order differential equations - exact differential equations. Bernoulli's equations - methods of solution and simple applications. Linear differential equations of higher orders with constant co-efficient - methods of solution of these equations. Cauchy's linear differential equations. Simultaneous linear differential equations : simple applications of linear differential equations in engineering problems - electrical circuits, mechanical systems.

Unit 2. Partial differentiation – Concept of partial derivative, chain rule, total derivative. Euler's theorem for homogeneous functions. Differentials and their applications in errors and approximations. Jacobians: maxima and minima of functions of two variables (proof of the result not required), simple applications.Co-ordinate systems : rectangular co-ordinates, polar co-ordinates - in plane and in space, cylindrical polar co-ordinates, spherical polar co-ordinates.

Unit 3. Integral calculus – Application of definite integrals : area, volume, arc length, surface area. Multiple integral : evaluation of double integrals, change of order of integration, evaluation of triple integrals, change of variables in integrals.Applications of multiple integrals : plane area, surface area & volumes of solids.

Unit 4. Vector calculus – Scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of vector point functions, their physical meaning. Evaluation of line integral, surface integral, and volume integrals. Gauss's divergence theorem. Stoke's theorem (no proofs). Conservative force fields, scalar potential.

References

1 S.S. Sastry, Engineering mathematics, Vol.1., 4th Edn., PHI Learning (2009).

2 Erwin Kreyzig, Advanced Engineering Mathematics, 10th Edn., John Wiley& Sons (2010).

3 T. Veerarajan, Engineering Mathematics, 3rd Edn., Tata McGraw Hill Publishers (2012).

4 B.S.Grewal, Higher Engineering Mathematics, 43rd Edn., Khanna Publishers (2015).

20-214-0102 Engineering Physics

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Describe the concepts of interference and diffraction of light. (Understand)

CO 2: Explain the polarization of light. (Understand)

CO 3: Interpret modern devices and technologies based on lasers. (Apply)

CO 4: Demonstrate the technologies based on optical fibres. (Apply)

CO 5: Explain the basic principles of crystal physics. (Understand)

CO 6: Describe the types and properties of metallic glasses. (Understand)

CO 7: Discuss the basic concepts of quantum mechanics. (Understand)

CO 8**:** Explain the Schrodinger equation. (Understand)

Mapping of course outcomes with program outcomes:
Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1						1			1
CO 2	1	1	1									1
CO 3	1	1	1	1		1			1	1		1
CO 4	1	1	1									1
CO 5	1	1	1	1								1
CO 6	1	1	1									1
CO 7	1	1	1	1					1			1
CO 8	1	1	1	1								1

Unit 1. Interference of light – Michelson interferometer, applications: interference in thin films, antireflection coatings, interference filters. Fringes produced by air wedge, testing of flat surfaces. Diffraction of light, zone plate: plane diffraction grating, reflection and transmission gratings. Determination of wavelength of light, dispersive and resolving powers. Polarization of light : double refraction, Nicol's prism, quarter and half wave plates, elliptically and circularly polarized light, optical activity, specific rotation, half-shade polarimeter, applications of polarized light.

Unit 2. Laser – Introduction, properties, interaction of radiation with matter, absorption, spontaneous and stimulated emission, principle of laser, Einstein coefficients - conditions for getting laser, population inversion, metastable state. Basic components of a laser, different types of lasers. Construction, working and applications of Ruby laser, Neodymium YAG laser, He-Ne laser. Applications of laser in medicine, industry, science and communication.
Holography - basic principle, comparison with ordinary photography. Recording and reconstruction of holograms, applications.Fibre optics - basic structure of an optical fibre, propagation of light in an optical fibre. Classifications: step-index fibre and graded index fibre, single mode and multimode. Numerical aperture of a step-index fibre and graded index fibre, acceptance angle and acceptance cone, modes of propagation, applications.

Unit 3. Crystallography – Basis, space lattice, unit cell, unit cell parameters, crystal systems, Bravais lattices. Three cubic lattices : SC, BCC, and FCC. Number of atoms per unit cell, co-ordination number, atomic radius, packing factor. Relation between density and crystal lattice constants. Lattice planes and Miller indices. Separation between lattice planes in SC - Bragg's law. Bragg's x-ray spectrometer.Liquid crystals : display systems - merits and demerits. Metallic glasses: types of metallic glasses (metal-metalloid glasses, metal-metal glasses) - properties of metallic glasses (structural, electrical, magnetic and chemical properties). Shape memory alloys, shape memory effect.
Unit 4. Quantum mechanics – Introduction, quantum theory of black body radiation and photoelectric effect (brief ideas only). Matter waves, de Broglie wavelength, wave packet, uncertainty principle, wave function, physical interpretation. Time dependent Schrodinger equation for a free particle, time independent Schrodinger equation.

References

1 S. Mani Naidu, A Text book of Engineering Physics, Pearson (2010).

2 A.S. Vasudeva, Modern Engineering Physics, 6th Edn., S. Chand & Co. (2013).
3 S.O. Pillai and Sivakami, Applied Physics, 2nd Edn., New Age International (P) Ltd. (2008).
4 G.S. Raghuvanshi, Engineering Physics, 3rd Edn., Prentice Hall of India (2016).
5 Prabir K. Vasu and Hrishikesh Dhasmana, Engineering Physics, Ane books Pvt. Ltd. (2010).
6 M.R. Sreenivasan, Physics for Engineers, 2nd Ed., Anshan (2011).
7 J. Jacob Philip, A Textbook of Engineering Physics, 2nd Edn., Educational Distributers and Publishers (2012).

20-214-0103 Engineering Chemistry

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Interpret the basic principles and concepts of quantum mechanics. (Understand)

CO 2: Explain energy level diagrams of diatomic molecules. (Understand)

CO 3: Describe bonding in solids and theories in solid state chemistry. (Understand)

CO 4: Describe solid surface characterisation. (Understand)

CO 5: Explain fundamentals of electrochemistry. (Understand)

CO 6: Describe principles of electrochemical devices. (Apply)

CO 7: Explain the chemistry of a few important engineering materials. (Understand)

CO 8: Discuss the properties and applications of engineering materials. (Understand)

Mapping of course outcomes with program outcomes:
Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1						1			1
CO 2	1	1	1									1
CO 3	1	1	1							1		1
CO 4	1	1	1									1
CO 5	1	1	1									1
CO 6	1	1	1	2	1	1	1	1	1	1		1
CO 7	1	1	1	1		1	1	1	1	1	1	1
CO 8	1	1	1	1		1	1	1	1	1	1	1

Unit 1. Quantum Chemistry – Schrodinger equation : Derivation from classical wave equation, operator form of the equation. Application of Schrodinger equation to 1-D box solutions. Significance of wave functions, probability and energy. Application of 1-D box solutions to conjugated molecules. Forms of hydrogen atom wave functions and the plots of these functions to explore their spatial variations.Energy level diagrams of diatomic molecules, Pi-molecular orbitals of butadiene, and benzene and aromaticity.

Unit 2. Solid state chemistry – Fundamentals, bonding in solids. Born-Haber cycle. Point defects. Methods to improve reactivity of solids. Free electron theory, band theory, Fermi level in semiconductors, molecular field theory of magnetic materials. Conventional and organic superconductors, high temperature superconductors and liquid crystals - applications. Solid surface characterisation : electron spectroscopy for chemical analysis, chemical shift,

BET isotherm - thermodynamics of adsorption.

Unit 3. Electrochemistry – Fundamentals : electrode potentials, types of electrodes, salt bridge, emf measurement, concentration cells, acids and bases, buffer solutions, pH measurements, polarization, overvoltage. Power generation : secondary cells, fuel cells, photovoltaic effect, solar cells. Corrosion : different forms of corrosion, prevention of corrosion.
Phase Rule : terms involved and examples, application of phase rule to one component water system, two-component systems (simple eutectic systems).

Unit 4. Engineering materials – Industrial polymers : Thermoplastics, thermosets, elastomers, fibers, adhesives. Nanomaterials : definition, classification and applications. Nanometals and nanoceramics - examples and properties. Lubricants : classification, functions and properties. Mechanism of lubrication. Refractories : classification and properties. Manufacture, setting and hardening of portland cement, lime and plaster of paris. Chemistry of optical fibres, fullerenes and organoelectronic materials (introduction only).Lubricants : introduction. Mechanism of lubrication, solid and liquid lubricants. Properties of lubricants : viscosity index, flash and fire point, cloud and pour point, aniline value.Refractories : classification and properties.

References

1 Bruce. M. Mahan, R. J. Meyers, University Chemistry, 4th Edn., Pearson publishers (2009).
2 Peter W. Atkins, Julio de Paula, James Keele, Atkin's Physical Chemistry, 11th Edn., Oxford publishers (2018).
3 M. J. Sienko, R. A. Plane, Chemistry: Principles and Applications, 3rd Edn., Mc Graw-Hill publishers (1980).
4 B.L. Tembe, M.S. Krishnan, Kamaluddin, Engineering Chemistry (NPTEL Web Course).
5 Shashi Chawla, A Text book of Engineering Chemistry, Dhanpat Rai & Co. (2017).

20-214-0104 Engineering Graphics

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Prepare drawings as per Indian standards. (Apply)

CO 2: Understand the construction of conic sections. (Understand)

CO 3: Produce orthographic projection of straight lines and planes. (Understand)
CO 4: Draw orthographic projection of solids. (Analyse)

CO 5: Draw the projection of polyhedra and solids of revolution. (Apply)

CO 6: Understand development of surface of different geometric shapes. (Apply)

CO 7: Construct isometric scale, isometric projections and views. (Analyse)

CO 8: Draw different views of simple machine elements. (Apply)

Mapping of course outcomes with program outcomes: Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1		1				1	1		1
CO 2	1	1	1									1
CO 3	1	1	1							1		1
CO 4	1	1	1									1
CO 5	1	1	1									1
CO 6	1	1	1	1	1	1			1	1		1
CO 7	1	1	1	1	1	1			1	1		1
CO 8	1	1	1	1		1						1

Unit 1. Introduction to engineering graphics – Drawing instruments and their use. Familiarisation with current Indian standard code of practice for general engineering drawing. Scales : plain, Vernier, diagonal.Conic sections : construction of ellipse, parabola, hyperbola. Construction of cycloid, involute, Archimedian spiral and logarithmic spiral - drawing tangents and normal to these curves.

Unit 2. Introduction to orthographic projections – Plane of projection, principles of first angle and third angle projections, projection of points in different quadrants.
Orthographic projection of straight lines parallel to one plane and inclined to the other plane, straight lines inclined to both the planes, true length and inclination of lines with reference planes, traces of lines.Projection of plane laminae of geometrical shapes in oblique positions.

Unit 3. Projection of polyhedra and solids of revolution – Frustum, projection of solids with axis parallel to one plane and parallel or perpendicular to other plane, projection of solids with axis inclined to both the planes, projection of solids on auxiliary planes.Section of solids by planes inclined to horizontal or vertical planes - true shape of sections. Introduction to isometric projection, isometric scales. Isometric projections : prisms, pyramids, cylinders, cones and sphere

Unit 4. Development of surface – Cubes, prisms, cylinders, pyramids and cones.Intersection of surfaces, methods of determining lines of intersection, intersection of prism in prism and cylinder in cylinder.Introduction to perspective projections : visual ray method and vanishing point method. Perspective view of circles, prisms and pyramids. Introduction to machine drawing (basic concepts) : different views of hexagonal nut and bolt, square bolt. Conversion from isometric view to orthographic views of simple machine elements.

References

1 K.C. John, Engineering graphics, PHI Learning (2013).

2 N.D. Bhat, Elementary engineering drawing, 53rd Edn., Charotar Publishing House (2014).

3 Gill P.S. Engineering drawing (Geometric drawing), B.D Kataria&Sons (2013).

4 K.C. John, P.I. Varghese, Machine Drawing, V.I.P. publishers (2007).

5 N.D. Bhatt, V. M. Panchal, Machine Drawing, 47th Edn.,Charotar Publishing (2012).

6 P.I. Varghese, Engineering Graphics,Tata McGraw Hill Education (2013).

20-214-0105 Basic Electrical Engineering and Electronics

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Analyse and solve electric circuits. (Analyse)

CO 2: Understand the principles of electromagnetic induction. (Understand)

CO 3: Identify meters for measuring electrical quantities. (Remember)

CO 4: Recognize the basic elements and phases in AC circuits. (Understand)

CO 5: Understand the behaviour of semiconductor junctions and diodes. (Understand)

CO 6: Choose diodes in rectification and regulation. (Apply)

CO 7: Explain special semiconductor devices. (Understand)

CO 8: Describe fundamentals of instrumentation and communication. (Understand)

Mapping of course outcomes with program outcomes:
Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1		1				1	1		1
CO 2	1	1	1									1
CO 3	1	1	1									1
CO 4	1	1	1									1
CO 5	1	1	1									1
CO 6	1	1	1	1	1				1	1		1
CO 7	1	1	1	1	1	1			1	1		1
CO 8	1	1	1	1		1			1	1		1

Unit 1. Basic principles of electric circuits – Review of Ohm's law. Definition of resistance, current, voltage and power. Series and parallel circuits. Constant voltage and current source.

Network Theorems : Kirchhoff's laws, network analysis by Maxwell's circulation currents, superposition theorem, Thevenin's theorem, Norton's theorem, simple illustrative problems on network theorems.Review of electrostatics : Coulomb's Law, electric field strength and electric flux density, capacitance.

Unit 2. Review of electromagnetic induction – Faraday's Law, Lenz's Law. Mutually induced emf. Magnetic circuits, magnetic field of a coil, Ampere turns calculation - magnetic flux, flux density, field strength.Measuring instruments : working principle of galvanometer, ammeter, voltmeter, Watt meter & energy meter (elementary concepts).AC Fundamentals : sinusoidal alternating waveforms, sinusoidal AC voltage characteristics and definitions, general representation of voltage or current, phase relations, average value, effective (root mean square) value.Basic elements and phasors: response of basic R, L and C elements to a sinusoidal voltage or current, phasor diagrams, frequency response of the basic elements, average power and power factor, complex representation of vectors (rectangular & polar forms).

Unit 3. Basic electronics – Passive components : resistor, capacitor, inductor, color coding. Transformer - different types, construction. Semiconductors : energy band diagram, intrinsic & extrinsic semi conductors, doping, PN junction. Diodes - Zener diodes, characteristics, application. Rectifiers : half wave, full wave and bridge rectifiers, ripple factor and regulation. Transistors : PNP and NPN transistors, theory of operation, configurations characteristics, comparison. Special semiconductor devices: PET, SCR, LED and LCD, V-I characteristics, applications.

Unit 4. Fundamentals of instrumentation – Transducers : definition, classification - active & passive. Transducer for position, pressure, velocity, vibration and temperature measurements. CRO : principle of operation, measurement of amplitude, frequency and phase. Fundamentals of communication : analog communication, concept of modulation, demodulation. Types - AM, FM, PM. Block diagram of general communication system. Basic

concepts of digital communication, block diagram.

References

1 B. L. Theraja, Basic Electronics - Solid State, S. Chand & Co. (2016).

2 Leonard S. Bobrow, Fundamentals of Electrical Engineering, 2nd Edn., Oxford University Press (2003).

3 Edward Hughes, Ian McKenzie Smith, Hughes Electrical Technology, Addison Wesley Publication (1995).

4 G.K. Mithal, Ravi Mittal, Electronic Devices & Circuits: Applied Electronics Vol. 1, Khanna Publishers (1997).

5 Robert L. Boylestad, Introductory Circuit Analysis, 13th Edn., Pearson Education (2015).

6 Rajendra Prasad, Fundamentals of Electrical Engineering, 2nd Edn., PHI Learning (2009).

20-214-0106 Soft Skills Development

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the role and importance of verbal communication. (Understand)

CO 2: Read, comprehend and answer questions based on literary, scientific and technological texts. (Apply)

CO 3: Understand the fundamental grammar. (Understand)

CO 4: Practice words and styles used for formal and informal communication. (Apply)

CO 5: Develop presentation skills through oral, poster and power point. (Apply)

CO 6: Improve communication skills through group discussions and debates. (Apply)

CO 7: Develop self-motivation, raised aspiration, belief in one's own abilities and commitment to achieving one's goal. (Apply)

CO 8: Demonstrate emotional maturity and emotional health. (Apply)

Mapping of course outcomes with program outcomes:
Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1								1	1		
CO 2	1								1	1		1
CO 3	1								1	1		
CO 4	1								1	2		1
CO 5	1								2	2		1
CO 6	1								1	1		1
CO 7	1								1	1		1
CO 8	1								1	1		1

Unit 1. Role and importance of verbal communication – Everyday active vocabulary, common words used in transitions, enhancing vocabulary, affixes and changes in pronunciation and grammatical functions, words often confused in pronunciation and usage. Passage comprehension : skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Types of meaning : literal and contextual. Constructive criticism of speeches and explanations.

Unit 2. Fundamental grammar – Simple structures, passivizing the active sentences, reported speech, the judicious use of tenses and moods of verbs, forming questions and conversion from questions to statements and vice versa, forming open-ended and close- ended questions. Words and style used for formal and informal communication. Practice converting informal language to formal, the diction and the style of writing. Dealing with the nuances of ambiguous constructions in language. Learning authoritative writing skills, polite writing and good netiquette. Writing for internships and scholarships.Co-ordinate systems : rectangular co-ordinates, polar co-ordinates - in plane and in space, cylindrical polar co-ordinates, spherical polar co-ordinates.

Unit 3. Communication – Kinesics, proxemics, haptics, and other areas of non-verbal communication, fighting communication barriers, positive grooming and activities on the same.
Different types of interviews and presentation : oral, poster, ppt. Organizing ideas for group discussions, the difference between GD and debates. Effective listening and seeking to understand others' perspectives. Non-violent negotiation and persuasion, communicating across age groups, cultures or identity groups. Higher order thinking and evaluation, information-seeking, research, and independent learning, synthesis, creativity, problem analysis and problem solving. Decision making, self- reflection and learning from experience.

Unit 4. Developing positive self – Understanding oneself, realistic awareness of oneself and one's abilities, strengths and potential, self-esteem, self-efficacy, steps for improvement.
Intra-personal skills : self-control, emotional regulation and self-discipline, conscientiousness, dutifulness, reliability, truthfulness, honesty and trustworthiness. Goal orientation and initiative. Time management - prioritising work.Interpersonal skills : cross cultural competence and valuing diversity of perspectives, respecting and expressing concern for others. Empathy and ability to notice the effect of one's actions on others, tolerance for disagreement, conflict management and resolution.

References

1 Steve Duck, David T. McMahan, Communication in Everyday Life, 3rd Edn., Sage (2017).
2 Gamble Teri Kwal, W.Gamble Michael, The Public Speaking Playbook, 2nd Edn., Sage (2017).
3 Meenakshi Raman, Sangeeta Sharma, Technical Communication: Principles and Practice, 3rd Edn., Oxford University Press (2015).
4 Daniel Goleman, Emotional intelligence: Why it can matter more than IQ, Random House (2012).
5 Devadas Menon, Stop sleep walking through life!, Yogi Impressions Books Pvt. Ltd. (2013).
6 Barun K. Mitra, Personality Development and Softskills, Oxford University Press (2012).

20-214-0111 Introduction to Chemical Analysis (lab)

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Analyse the purity of monomers supplied by industries.

CO 2: Analyse the characteristic properties of natural rubber.

Mapping of course outcomes with program outcomes:
Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	1			1	1	1				1
CO 2	2	1	1			1	1	1	1	1	1	1

Experiments

1. Acidimetry and Alkalimetry: Estimation of Hydrochloric acid, Sodium hydroxide, Hardness of water.

2. Estimation of percentage purity of monomers – glycerol, formaldehyde, methylmethacrylate, urea, phenol.

3. Iodimetry and Iodometry: Estimation of Iodine

4. Determination of iodine value of NR.

5. Determination of saponification value of oil.

References

1 A.O. Thomas, B.Sc. Practical Chemistry

20-214-0112 Electrical Engineering Workshop

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Apply basic electrical engineering knowledge for house wiring practice.

Mapping of course outcomes with program outcomes:
Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	1	1		1	1	1	1	1	1		1

Experiments

1. One lamp controlled by one switch

2. Series and parallel connections of lamps.

3. Stair case wiring.

4. 4. Hospital Wiring.

5. Godown wiring.

6. Fluroscent lamp.

7. Connection of plug socket.

8. Different kinds of joints.

9. Winding of transformers.

10. Soldering practice.

11. Familiarisation of CRO.

20-214-0113 Language Lab

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Test pronunciation skills through stress on word accent, intonation, and rhythm.

CO 2: Use English language effectively for writing business letters, resume, minutes of meeting and reports.

CO 3: Use English language effectively to face interviews, group discussions, and public speaking.

Mapping of course outcomes with program outcomes:
Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	1								1	1	1	1
CO2	2								1	1	1	1
CO3	1								1	1	1	1

Following course content is prescribed for the Language Laboratory sessions:

1. Introduction to the Sounds of English- Vowels, Diphthongs & Consonants.
2. Introduction to Stress and Intonation.
3. Preparing business letters
4. Preparing a resume
5. Conducting a meeting and writing the minutes
6. Writing a report
7. Situational Dialogues / Role Play.
8. Oral Presentations- Prepared and Extempore.
9. 'Just A Minute' Sessions (JAM).
10. Describing Objects / Situations / People.
11. Debate
1. 12. Group discussion

20-214-0201 Engineering Mathematics II

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Compute different operations related to matrix and vector spaces. (Apply)

CO 2: Solve the system of algebraic equations using matrices. (Apply)

CO 3: Solve Fourier series. (Apply)

CO 4: Apply Fourier integrals. (Apply)

CO 5: Solve Laplace equations. (Apply)

CO 6: Use Laplace transforms in the solving initial value problems, unit step functions, impulse functions & periodic functions. (Apply)

CO 7: Deal with vector point functions & Laplacian operators. (Apply)

CO 8: Evaluate line, surface & volume integrals using Gauss Divergence theorem & Stokes Theorem. (Apply)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1	1	1							1
CO 2	1	1	1	1	1							1
CO 3	1	1	1	1								1
CO 4	1	1	1	1								1
CO 5	1	1	1	1								1
CO 6	1	1	1	1								1
CO 7	1	1	1									1
CO 8	1	1	1									1

Unit 1. Matrices and Vector spaces – Rank of matrix, echelon and normal form, solutions of linear systems of algebraic equations, eigen values and eigen vectors, Cayley Hamilton theorem (non proof). Vector Spaces: subspaces, linear independence of vectors, linear span, dimension and basis, linear transformations.

Unit 2. Fourier series and Fourier integrals – Fourier series of periodic functions, Euler formulae for Fourier coefficients, functions having period 2p, arbitrary period, even and odd functions, half range expansions, Fourier integral, Fourier cosine and sine transformations, linearity property, transform of derivatives, convolution theorem (no proof).

Unit 3. Laplace transforms – Linearity property, transforms of elementary functions, laplace transforms of derivatives and integrals, differentiation and integration of transforms, convolution theorem (no proof), use of laplace transforms in the solution of initial value problems, unit step function, impulse function, transform of step functions, transforms of periodic functions.

Unit 4. Vector Algebra – subspaces, linear independence and independence, spanning of a subspace, dimension and basis, inner product, inner product spaces, orthogonal and orthonormal basis, Gram-Schmidt orthogonalization process, linear transformations.

References

1 R.K. Jain, S.R.K. Iyengar, Advanced Engineering Mathematics, 4th Edn., Narosa Publishers (2014).

2 C. Ray Wylie, Louis Barrett , Advanced Engineering Mathematics, 6th Edn., McGraw-Hill Education (1995).

3 N.P. Bali, Manish Goyal, A Textbook of Engineering Mathematics, 9th Edn., Laxmi Publications (2016)

20-214-0202 Engineering Mechanics

Course Outcome

On completion of the course, the students will be able to:

CO 1: Understand the principles of statics, the concept of free body diagrams and resolution of forces. (Understand)

CO 2: Apply the principles of mechanics, concept of free body diagrams and resolution of forces. (Apply)

CO 3: Explain the parallel forces in a plane. (Understand)

CO 4: Ascertain the physical and mathematical meaning of moment of inertia. (Apply)

CO 5: Explain the concept of rectilinear motion. (Analyse)

CO 6: Apply D'Alembert's principle in rectilinear motion. (Apply)

CO 7: Explain the concept of curvilinear translation. (Analyse)

CO 8: Apply D'Alembert's principle in curvilinear translation. (Apply)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1		1				1			1
CO 2	1	1	1		1				1			1
CO 3	1	1	1						1			1
CO 4	1	1	1	1					1			1
CO 5	1	1	1	1								1
CO 6	1	1	1						1			1
CO 7	1	1	1									1
CO 8	1	1	1						1			1

Unit 1. Concurrent forces in a plane – Principles of statics, composition and resolution of forces, equilibrium of concurrent forces in a plane, method of projection, method of moments, friction. Parallel forces in a plane: two parallel forces, general case of parallel forces in a plane, centre of parallel forces and centre of gravity, Pappus theorems, centroids of composite plane figures and curves, distributed forces in a plane.

Unit 2. Properties of areas – Moment of inertia of a plane figure with respect to an axis in its plane, polar moment of inertia, product of inertia, principal axes, mass moment of inertia of material bodies. General case of forces in a plane: composition of forces in a plane. Equilibrium of forces in a plane. Plane trusses - Method of joints. Method of sections. Plane frames : Method of members. Principle of virtual work: Equilibrium of ideal systems, stable and unstable equilibrium.

Unit 3. Rectilinear translation – Kinematics of rectilinear motion, differential equation of rectilinear motion, motion of a particle acted upon by a constant force, by a force as a function of time and by a force proportional to displacement, simple harmonic motion, D'Alembert's principle. Momentum and impulse. Work and energy: ideal systems, conservation of energy, Impact.

Unit 4. Curvilinear translation – Kinematics of curvilinear translation. Differential equations of motion: motion of a projectile, D'Alembert's principle in curvilinear motion,moment of momentum, work and energy in curvilinear motion. Rotation of a rigid body: kinematics of rotation, equation of motion of a rigid body rotating about a fixed axis, rotation under the action of a constant moment, compound pendulum, general case of moment proportional to the angle of rotation, D'Alemberts principle of rotation, resultant inertia force in rotation, principle of angular momentum in rotation, energy equation for rotating bodies.

References

1 S. Timoshenko, D. H. Young, Sukumar Pati, J. V. Rao, Engineering Mechanics, 5th Edn., McGraw Hill Education (2013).

2 Ferdinand P. Beer, E. Russell Johnston, David Mazurek, Phillip J. Cornwell, Brian Self, Sanjeev Sanghi, Vector Mechanics For Engineers Statics And Dynamics, 12th Edn., Tata McGraw Hill (2019).

3 H. L. Merram, L. G. Kraige, Engineering Mechanics, Vol. 1: Statics (SI version), 7th Edn., John Wiley and Sons (2013).

4 E. M. S. Nair, N. Biju, A Textbook of Engineering Mechanics, Vol. 1: Statics, Educational Publishers & Distributors (2012).

5 J. Benjamin, A textbook of Engineering Mechanics, 4th Edn., Pentex Book Publishers & Distributors (2015).

6 N. Biju, Theory and Problems in Engineering Mechanics (Dynamics), Educational Publishers & Distributors (2002).

7 R. S. Khurmi, N. Khurmi, Principles of Engineering Mechanics, S. Chand Publishing (2019).

20-214-0203 Environmental Studies

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the importance of environmental studies. (Understand)

CO 2: Identify the natural resources and suitable methods for conservation and sustainable development. (Understand)

CO 3: Realize the importance of eco system for maintaining ecological balance. (Analyse)

CO 4: Explain the importance of biodiversity and its conservation. (Understand)

CO 5: Identify environmental pollutants and abatement mechanisms. (Understand)

CO 6: Comprehend the concept of Disaster management and Environmental protection Act. (Remember)

CO 7: Understand environmental problems arising due to developmental activities and population growth. (Understand)

CO 8: Explain simple ecosystems. (Apply)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1				1	1	1	1			1
CO 2	1	1				1	1		1			1
CO 3	1	1				1	1		1			1
CO 4	1	1				1	1		1			1
CO 5	1	1				1	1	1	1			1
CO 6	1	1	1			1	2	2	1			1
CO 7	1	1	1			1	2	1	1			1
CO 8	1	1										1

Unit 1. Multidisciplinary nature of environmental studies – Definition, scope and importance, need for public awareness. Natural Resources: renewable and non-renewable resources, natural resources and associated problems. Forest resources: use and over-exploitation, deforestation, case studies, timber extraction, mining, dams and their effects on forest and tribal people. Water resources: use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. Land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Unit 2. Ecosystems – Concept of an ecosystem: structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids. Structure and functions of the ecosystems: forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation: introduction, definition of genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local levels. India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Unit 3. Environmental Pollution – Definition. Cause, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards. Solid waste management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides. Environmental legislation: Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation.

Unit 4. Environmental ethics – Issues and possible solutions. Climate change: global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies: waste land reclamation, consumerism, waste products. Social issues and the environment: from unsustainable to sustainable development. Urban problems related to energy: water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people: its problems and concerns. Human population and the environment: population growth, variation among nations, population explosion – family welfare programme, environment and human health, human rights, value education, HIV/AIDS, women and child welfare, role of Information technology in environment and human health, case studies. Field work: visit to a local area to document environmental assets river, forest, grassland, hill, mountains, visit to a local polluted site-urban, rural, industrial, agricultural, study of common plants, insects, birds. Study of simple ecosystems: pond, river, hill slopes, etc.

References

1 R. Rajagopalan, Environmental studies: From Crisis to Cure. Oxford University Press (2005).

2 ErachBharucha, Textbook of Environmental studies and ethics, Universities Press (2005).

3 A. Jayashree, V. M. Parikh. Balsaraf, P.B. Dwivedi, Environmental Studies, Ane Books Pvt. Ltd (2010)

4 AninditaBasak, Environmental Studies, Pearson (2009).

5 S.P.Misra, Essential Environmental Studies, 3rd Edn., Ane Books Pvt. Ltd. (2011).

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20-214-0204 Mechanical Engineering

Course Outcome

On successful completion of the course, the students will be able to:

CO1: Understand the properties of engineering materials. (Understand)

CO 2: Identify various moulding tools and equipment used for material processing. (Remember)

CO 3: Describe different types of boilers. (Understand)

CO 4: Understand various engines. (Understand)

CO 5: Comprehend the machine elements and mechanical power transmission. (Understand)

CO 6: Describe belt and gear drives. (Understand)

CO 7: Gain knowledge on various welding techniques. (Apply)

CO 8: Understand soldering and brazing. (Remember)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1				1			1			1
CO 2	1	1				1			1			1
CO 3	1	1				1	1		1			1
CO 4	1	1				1	1		1			1
CO 5	1	1				1	1		1			1
CO 6	1	1				1	1					1
CO 7	1	1				1	1		1			1
CO 8	1	1										

Unit 1. Material Science – Classification of engineering materials: mechanical, thermal and chemical properties of materials. Fuels: classification, solid, liquid, gaseous and nuclear, calorific values (HCV & LCV), determination of calorific values. Pattern making: types,

materials, allowances. Moulding tools and equipments: sand, preparation of sand, desirable properties, additives, cope, drag, cover, core prints, gating, reserving..

Unit 2. Boilers and Engines – Classification of boilers: sample vertical, cochran, locomotive, Babcox, wilcox and La-mant boilers, boiler mountings and accessories, electric furnaces.
Internal Combustion engines: classification, 2 stroke, petrol and diesel fuel system, simple carburetor, diesel fuel pump, injector petrol fuel pump. Ignition system: battery coil, magnets codling system, lubrication system.

Unit 3. Introduction to machine elements – shafts, fly wheels, bearings, clutches, cone clutches, single plate clutch, shaft couplings. Mechanical Power Transmission: belt, rope, chain, gear drives. Belt drive: open, closed, velocity rates, slip, length of belt power transmitter, stopped pulling. Gear drive: types of gears, types of gear drives, spur gear nomendations, velocity ratio.

Unit 4. Welding – Classification, oxy-acetylene welding, gear welding equipment, arc welding equipment, arc welding, resistance welding, thermal welding, TIG, safety devices. Introduction to soldering and brazing.Metal working-hot and cold working, rolling -extrusion-drawing forging- bending-shearing - punching metal cutting -cutting tools- classification, materials, Cutting fluids-Purpose-desirable qualities, Machine Tools: Lathes- Types of Lathes, Engine Lathe-parts- operations, Milling machine- Planning machine- Drilling machine- Shaping machine-Guiding machine-Main parts.

References

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3 Rajendar Singh, Introduction to Basic Manufacturing Processes and Workshop Technology, New Age International (2006).
4 S. K. Hajra Choudhury, Nirjhar Roy, Elements of Workshop Technology, 13th Edn., Media Promotors & Publishers Pvt. Ltd. (2010).

20-214-0205 Introduction to Macromolecular Science and Engineering

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Explain the global scenario of polymers and polymer industries. (Remember)
CO 2: Identify polymers based on its properties.(Understand)
CO 3: Explain the mechanism of addition polymerization. (Analyse)
CO 4: Comprehend the kinetics of free radical and ionic polymerization.(Understand)
CO 5: Explain the mechanism of condensation polymerization and copolymerization. (Analyse)

CO 6: Describe the kinetics of step reaction polymerization and copolymerization.(Understand)

CO 7: Explain the mechanism of coordination polymerisation. (Analyse)

CO 8: Describe the synthesise of polymers according to the need of polymer industry. (Analyse)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1			1	1	1			1		1
CO 2	1	1	1	1		1			1			1
CO 3	1	1	3	2		1	1					2
CO 4	1	1	1	1		1			1			1
CO 5	1	1	3	2		1	1					2
CO 6	1	1	1	1		1	1					1
CO 7	1	1	3	2		1	1					2
CO 8	1	1	2	2					1			2

Unit 1. Basic concepts of macromolecular science – history, molecular forces and chemical bonding, molecular weight, molecular weight distribution, configuration and conformation. Types of macromolecules: chemistry and classification of polymers, structure and property relationships. Classification of polymers: rubbers, plastics and fibres. Comparison of polymers with other materials-metals and ceramics. Status of polymer industries: global scenario of polymer industry, polymer industries in India.

Unit 2. Chain reaction (Addition) polymerization – Basics. Free radical Polymerization: monomers, generation of initiators, mechanism of free radical polymerization, generation of free radicals, initiation, propagation, termination, chain transfer reactions, inhibition and retardation, kinetics of free radical polymerization. Ionic Polymerization: cationic and anionic, selection of monomers, chain transfer reactions, kinetics.

Unit 3. Step reaction (condensation) polymerization–Basics. Mechanism of condensation polymerisation:general characteristics, addition reactions, substitution reactions, ring versus chain formation, alkyd reactions, interfacial condensation, interchange reactions, poly condensation reaction, network condensation reaction. Kinetics of step reaction polymerization: catalyzed and non catalyzed, Carothers equation, molecular-weight control, prediction of gel point.

Unit 4. Coordination polymerization:basics, stereo regular polymers, tacticity in polymers. Mechanism of coordination polymerization: coordination catalysts, monometallic, bimetallic . Copolymerisation: types of copolymers, mechanism of copolymerization, addition and condensation copolymerization. Kinetics of copolymerization: reactivity ratios, copolymer equation.

Polymerization techniques: homogeneous polymerization techniques-bulk, solution, heterogeneous polymerization techniques- emulsion, suspension, solid phase.

References

1 F.W. Billmeyer, A Text Book of Polymer Science, 3rd Edn., Wiley & Sons (2009).

2 Herman F. Mark (Ed.),Encyclopedia of Polymer Science and Engg., Vol 15, 4th Edn., Wiley & Sons (2014).

3 P.J.Flory, Principle of Polymer Chemistry, Cornell University Press (1986).

4 V. R. Gowariker, N. V. Viswanathan and J. Sreedhar,Polymer science, John Wiley & Sons (2010).

20-214-0206 Fluid Mechanics

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Summarize various properties of fluids and pressure measurements. (Understand)

CO 2: Distinguish different types of flow systems. (Understand)

CO 3: Explain the concepts of flow in boundary layers and basic equations of fluid flow. (Apply)

CO 4: Describe various discharge measuring devices. (Analyze)

CO 5: Identify the pumps used for fluid flow. (Apply)

CO 6: Derive the equation for pressure drop in packed bed. (Apply)

CO 7: Examine the fluidization behaviour. (Apply)

CO 8: Outline the fluid flow around immersed solids and identify the method for separating the solids from the fluid. (Apply)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1		1		1					1
CO 2	1	1	1						1			1
CO 3	1	1	1				1		1			1
CO 4	2	1	1	1					1			1

CO 5	1	1	1						1			1
CO 6	1	1	1									1
CO 7	2	1	1			1	1		1			1
CO 8	1	1	1									1

Unit 1.Fluid Mechanics –Basics. Properties of fluids: density, compressibility and bulk modulus of elasticity, surface tension and capillarity, pressure, viscosity-Newton's law of viscosity, dynamic and kinematic viscosity, rheological classification of fluids. Fluid statics: Pascal's law, variation of pressure with elevation. Pressure measurement: mercury barometer, piezometer tube, U- tube manometer, inclined tube manometer, pressure gauge.

Unit 2.Fluids in motion – Velocity field, velocity gradient, Reynolds experiment, Reynolds number, laminar flow, turbulent flow, transition region. Boundary-layers: flow in boundary-layers, boundary-layer formation in straight tubes, boundary-layer separation and wake formation. Basic equations of fluid flow: stream lines and stream tubes, equation of continuity, Bernoulli equation, Hagen-Poiseulle equation. Fluid friction in pipes: friction loss from sudden expansion and contraction of cross section, effect of fittings and valves.

Unit 3.Transportation and metering of fluids – Pipe and tubing, joints and fittings. Valves: gate valve and globe valve. Discharge measurement: venturi meter, orifice meter, rota meter, pitot tube, weirs. Pumps: reciprocating positive displacement pumps-working principle, rotary positive displacement pumps-working principle of gear and vane pumps, centrifugal pumps-working principle, characteristic curves, NPSH, cavitation, priming.

Unit 4.Flow past immersed bodies – Flow through packed beds: Ergun equation. Drag, drag coefficients, stagnation point, settling under gravity, terminal velocity, hindered settling, Stoke's law range, Newton's law range and intermediate law range. Fluidization: characteristics of fluidization, minimum fluidization velocity, aggregative and particulate fluidization, applications. Gravity settling processes: classifiers, differential settling methods, sedimentation. Centrifugal settling processes. Cyclone separators**.**

References

1 P.E. Irving Granet, Fluid Mechanics for Engineering Technology, 3rd Edn., Prentice Hall (1989).

2 W.L.Badger, J.T.Banchero, Introduction to Chemical Engineering, Mc Graw Hill Inc.(1955).

3 Warren L. Mc Cabe, Julian C. Smith, Peter Harriott, Unit operations of Chemical Engineering, 7th Edn., Mc Graw Hill Higher education (2005).

4 J. R. Backhurst, J H Harker, J.M.Coulson , J.F.Richardson, R.P. Chhabra, Chemical Engineering Volume 1: Fluid Flow, Heat Transfer and Mass Transfer, 6th Edn., Butterworth Heinemann (1999).

5 Victor L.Streeter, E. Benjamin Wylie, K.W. Bedford, Fluid Mechanics, 9th Edn., Tata McGraw Hill (2010).

20-214-0211 Mechanical Engineering Workshop

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Identify and use tools,and make different types of joints used in carpentry, fitting and sheet metal shop

CO 2: Compare basic fabrication techniques of different types of welding

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1	1			1			1
CO2	1				1	1			1			1

Preliminary exercises for beginners in all the following shops. Specific models may be designed by the teachers

1) Fitting shop
2) Sheet metal shop
3) Foundry shop
4) Welding shop
5) Carpentry shop

20-214-0212 Polymer Synthesis

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Synthesise various polymers through addition and condensation polymerisation techniques

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2			1	1	1	1	1			1

1. Polymer Synthesis

a)Washing of monomers using separating funnel
b) Preparation of polymethylmethacrylate through bulk technique
c) Preparation of polystyrene through bulk technique
d) Preparation of polystyrene through Solution technique
e) Preparation of polystyrene through suspension technique
f) Preparation of polystyrene through emulsion technique
g) Preparation of nylon 66 through interfacial condensation technique
h) Regeneration of cellulose
i) Preparation of UF, PF - Novolacs, Resols

References

1 Rabek, Experimental methods in polymer chemistry, John Wilely& sons (1998).

2 D. Braun, H. Cherdron, H. Ritter, Polymer Synthesis: Theory and Practice, Springer Science and Business Media (2001)

3 Stanley R. Sandler, Wolf Karo, Joanne Bonesteel, Eli M. Pearce, Polymer Synthesis and Characterization: A Laboratory Manual, Elsevier (1998)

20-214-0301 Engineering Mathematics III

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Compute different types of complex function. (Apply)

CO 2: Apply conformal mapping to elementary functions. (Apply)

CO 3: Use Cauchy's integral theorem, integral formula & residue theorem to evaluate real integrals. (Apply)

CO 4: Expand functions in terms of Taylor's & Laurent series. (Apply)

CO 5: Identify & formulate partial differential equations. (Understand)

CO 6: Solve different types of partial differential equations. (Apply)

CO 7: Understand the one dimensional wave and heat equations. (Understand)

CO 8: Solve one dimensional wave & heat equations and Laplace equations using method of separation of variables. (Apply)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		1								
CO2	1	1										1
CO3	1	1		1								1
CO4	1	1		1								1
CO5	1	1	1	1								1
CO6	1	1	1	1								1
CO7	1	1	1	1								1
CO8	1	1	1	1								1

Unit 1.Complex, analytic functions and conformal mapping – curves and regions in the complex plane, complex functions, limit, derivative, analytic function,Cauchy - Riemann equations. Elementary complex functions: powers, exponential function, logarithmic, trigonometric and hyperbolic functions. Conformal mapping: Linear fractional transformations, mapping by elementary function like Z^2, e^z, sin z, cos z, sin hz, and Cos hz, Z + 1/Z

Unit 2.Complex integration – Line integral, Cauchy's integral theorem, Cauchy's integral formula, Taylor's series, Laurent's series, residue theorem, evaluation of real integrals using integration around unit circle, around the semi circle, integrating contours having poles, on the real axis.

Unit 3.Partial differential equations – Formulation of partial differential equations. Solutions of equations of the form F (p,q) = 0, F(x,p,q) = 0, F(y,p,q) = 0, F(z,p,q) = 0, F1(x,p) = F2 (y,q), Lagrange's form Pp+Qq = R, Linear homogeneous partial differential equations with constant coefficient.

Unit 4.Vibrating string – one dimensional wave equation, D'Alembert's solution, solution by the method of separation of variables. One dimensional heat equation: solution of the equation by the method of separation of variables, solutions of Laplace's equation over a rectangular region and a circular region by the method of separation of variables.

References

1. R.K.Jain, S.R.K.Iyengar, Advanced engineering mathematics, 5th Edn., Narosa Publishers (2016).
2. Erwin Kreyszig, Advanced Engineering Mathematic, 10th Edn.,John Wiley & Sons, Inc. (2011).
3. James Ward Brown, Ruel V. Churchill, Complex Variables &Applications , 9th Edn., Mc-Graw Hill Education (2014).
4. Merle C. Potter, Jack Goldberg,Edward F. Aboufadel, Advanced Engineering Mathematics, 3 rdEdn., Oxford University Press (2005).
5. B.S.Grewal,Higher engineering mathematics, 44 thEdn., Khanna Publishers (1965).

20-214-0302 Natural Rubber Production Technology

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Explain the history, present and future of natural rubber. (Remember)
CO 2: Understand the various tapping methods (Understand)
CO 3: Distinguish various concentration process. (Understand)
CO 4: Understand the formation of latex by biosynthesis in rubber tree (Understand)
CO 5: Get an insight on the preservation of NR latex. (Understand)
CO 6: Describe the process involved in the production of various forms of dry rubber. (Understand)
CO 7: Explain various modified forms of natural rubber. (Understand)
CO 8: Understand the production process and applications of of skim rubber (understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										1
CO2	1	1										1
CO3	1	1	1									1
CO4	1		1	2	1							1
CO5	1	1	1		1						1	1
CO6	1	1	1	1	1							1
CO7	1	1	1	1	1							1
CO8		1	1	1	1						1	1

Unit 1. Natural rubber – Various sources of natural rubber, history and development of HeveaBrasiliensis, present status, future prospects of rubber plantation industry, propagation of rubber trees - generic method and vegetative method. Tapping - methods, standard of tapability, tapping notation, marking on trees. Yield stimulation, rainguarding.

Unit 2. Natural rubber latex– Biosynthetic pathway of natural rubber production, Role of micro-organisms in latex & latex destabilisation. Preservation : short term and long term. Latex concentration : different methods used for concentration, specification for concentrated latex, grading, packing and despatch. Skim latex: production, properties and uses of skim rubber.

Unit 3. Dry natural rubber – Ribbed smoked sheets, crepe rubber-PLC, EBC, sole crepe, processing, grading, baling and despatch. Technically specified block rubber: processing, specification, grading, baling and despatch.

Unit 4. Modified forms of natural rubber – superior processing rubbers, processing aid rubber, constant viscosity& low viscosity rubber, reclaimed rubber, oil extended natural rubber, epoxidised natural rubber, tyre rubber, chlorinated natural rubber, powdered natural rubber, graft natural rubber, latex carbon black masterbatch.

References

1 P.J. George, C.Kuruvilla Jacob (Eds.), Natural Rubber Agromanagement and Crop processing, Rubber Research Institute of India, Rubber Board (2000).

2 D. C. Blackley, Polymer Latices, Vol.1, 2nd Edn., Chapman &Hallb(1997).

3 M.M.Patel, S.B.Rath, R.M.Sambandam, D.Joseph Francis (Eds.), Rubber Engineering by Indian Rubber Institute, Tata McGraw-Hill (2000).

4 BIS specifications.

5 Steven Blow, Handbook of Rubber Technology, GalgotiaPublications(2004).

6 Rani Joseph, Practical Guide to Latex Technology, Smithers Rapra, (2013).

7 M.R. Sethuraj, Ninan T Mathew (Eds.), Natural Rubber : Biology , Cultivation and Technology, Elsevier (2012)

20-214-0303 Strength of Materials

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Assimilate the fundamentals of stress and strain and their relationships. (Understand)

CO 2: Explain the loads at the ends and in between ends of uniform section. (Apply)

CO 3: Explain the relation between elastic constants. (Apply)

CO 4: Understand the compound stress and importance of principal stress. (Understand)

CO 5: Explain the shear force and bending moment. (Understand)

CO 6: Explain the relation between shear force and bending moment. (Analyse)

CO 7: Describe the stresses and strains in thin cylinders and deflection of beams. (Evaluate)

CO 8: Describe the stress in cantilever in different point load conditions.(Evaluate)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1									1
CO2	1	1	1									1
CO3	1	1	1									1
CO4	1		1	1					1			1
CO5	1	1	1	1								1
CO6	1	1	1	1								1
CO7	2	1	1	1					1			1
CO8	2	1	1	1	2	1			1			1

Unit 1.Stress and Strain – Axially loaded members and loads at the ends and in between ends of uniform section, stepped bars, Composite bars. Hooke's Law: stress - strain diagram, linear strain, lateral strain, Poisson's ratio, Elastic constants: relation between 3 elastic constants, thermal strain energy, simple problems.

Unit 2**.** Graphical – Compound stress, stresses on inclined planes, principal planes. Principal stresses: Mohr's circle, design of riveted joints, checking for shearing of plane, shearing of rivet, crushing of rivet.
Unit 3.Shear force & Bending Moment – SF & BM diagram. Cantilever. Beam: simply supported beams, over hanging beams. Loads: transverse and inclined loads, point loads, uniformly distributed loads, triangular loads. Relation between SF & BM, Simple problems.

Unit 4. Thin cylinders under internal pressure: stresses, changes in dimensions and volume, simple problems. Deflection of beams: Differential equation for deflection, derivation, assumptions,- simply supported beams. Point load: Uniformly distributed load, cantilever point load at the end, not at the end, u d load throughout the span and part of the span, Simple problems.

References

1 S. Ramamrutham, Strength of Materials, 5th Edn., Dhanpat Rai Publising Co. Ltd. Pvt. (2017).

2 R.S. Khurmi, N. Khurmi, A Textbook of Strength of Materials (Mechanics of solids), 26thEdn., S. Chand Publishing (2019).

3 R.K. Banzal, A Text Book of Strength of Materials, 6th Edn., Laxmi Publications (2017).

4 S.P.Timoshenko, D.H.Young, Elements of Strength of Materials, 5th Edn., East-West Press (2003).

20-214-0304 Heat and Mass Transfer

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Explain different modes of heat transfer. (Understand)

CO 2: Calculate rate of heat conduction through flat plate, cylindrical wall and hollow sphere. (Analyze)

CO 3: Describe typical heat exchange equipments. (Understand)

CO 4: Explain the concept of overall heat transfer coefficient. (Apply)

CO 5: Outline the concepts of evaporation and various types of evaporators. (Evaluate)

CO 6: Assess number of theoretical stages required in distillation column by Mc-Cabe Thiele method. (Evaluate)

CO 7: Impart fundamental concepts of mass transfer operations like diffusion, distillation,absorption, drying, filtration. (Understand)

CO 8: Understand the equipments needed for various mass transfer operations. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	2	1									2	
CO3	1											
CO4	1	1	1									
CO5	1	1				1					1	
CO6	2	2	1	2								
CO7	1	1	1								1	
CO8	2	1	1	1		1					1	

Unit 1.Introduction to heat transfer – Modes of heat transfer. Concept of heat conduction: Fourier's law, one dimensional steady-state heat conduction equation for flat plate, hollow cylinder and hollow sphere, heat conduction through a series of resistances, numerical problems. Principles of heat flow in liquids:Typical heat exchange equipments-single pass tubular condenser, and double pipe heat exchanger-counter current and cocurrent flows, energy balance in exchangers and condensers. Concept of logarithmic mean temperature difference, derivation of expression for LMTD.

Unit 2.Concept of overall heat transfer coefficient – Individual and over all heat transfer coefficients, derivation of expression for overall heat transfer coefficient, fouling factors, determination of overall heat transfer coefficient with and without fouling. Evaporators:Principle, types, material and energy balance, single effect calculations, performance, capacity and economy. Factors affecting the performance of evaporators. Multiple effect evaporators:different feeding arrangements.

Unit 3.Distillation– Vapour-liquid equilibria, ideal solutions, Raoults and Henrys laws , boiling point diagram from Raoults Law, simple distillation, flash distillation, steam distillation. Relative volatility. Continuous binary rectification : number of ideal plates by Mcabe Thiele method, total and minimum reflux, plate efficiency, rectification columns-constructional details.

Unit 4.Mass transfer operations – Principles. Diffusion : Fick's law, steady state molecular diffusion in gases and liquids, mass transfer coefficients. Gas absorption: absorption towers. Drying: drying equipments. Filtration: filtration equipments- plate and frame presses, rotary-drum filter.

References

1 BinayK.Dutta, Heat Transfer Principles and Applications, PHI Learning Pvt Ltd. (2018).

2 W.L.Badger, J.T.Banchero, Introduction to Chemical Engineering, Mc Graw Hill Inc.(1955).

3 Warren L. Mc Cabe , Julian C. Smith, Peter Harriott,Unit operations of Chemical Engineering,7th Edn., Mc Graw Hill Higher education (2005).

4 J. R. Backhurst, J H Harker, J.M.Coulson , J.F.Richardson, R.P. Chhabra, Chemical Engineering Volume 1: Fluid Flow, Heat Transfer and Mass Transfer,6th Edn., Butterworth Heinemann (1999).

5 K.V. Narayanan, B. Lakshmikutty, Mass Transfer Theory and Applications, CBS Publishers & Distributors Pvt Ltd (2014).

20-214-0305 Organic Chemistry

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Explain the phenomenon of hybridization and orbital overlap to form molecules. (Understand)

CO 2: Identify the stereoisomerism in various compounds. (Analyse)

CO 3: Explain the mechanism of synthesis of special reagents and its applications. (Understand)

CO 4: To understand the chemistry of heterocyclic compounds (Understand)

CO 5: Understand the classification of various organic reactions. (Understand)

CO 6: Analyse the structure and properties of carbohydrates and lipids. (Analyse)

CO 7: Analyse the structure and properties of proteins, peptides and nucleic acids. (Analyse)

CO 8: Explain various chromatographic techniques and its applications. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	1	1										1
CO2	2	1										1
CO3	2	1	1									1
CO4	1	1										
CO5	2	1	1									1
CO6	1	1	1			1			1			
CO7	2	2	1			1			1			1
CO8	1		1			1			1		1	

Unit 1. Covalent bond - Hybridisation and orbital overlap in molecules like ethane, ethylene, acetylene, benzene and cyclohexane, their geometry. Stereo isomerism: optical isometrism in lactic and tartaric acids, explanation, elements of symmetry and chirality, D.L. Configuration, fischer and Newman projection formula, racemisation, recemic mixture, methods of resolution.

Unit 2. Grignard reagent and related compounds: Introduction,grignard reagent, alkyl lithium, synthetic applications. Ethers: reactions of epoxides, claisen rearrangement mechanism, Zeisel's method of estimation of alkoxy groups. Heterocyclic compounds: structure, preparation and properties of furan, pyrrole, pyridine, indole, pyrimidine and purine. Reaction mechanism: polarity of bonds, inductive mesomeric and electromeric effects, resonance, hyper conjugation, steric effects, classification of organic reactions, bond fissions, reaction intermediates, carbocations, their stability and rearrangements, carbanions, free radicals.

Unit 3.Carbohydrates, proteins and lipids – Carbohydrates: reaction and structure elucidation of glucose and fructose, structure of sucrose and maltose, elementary study of starch and cellulose, industrial uses of cellulose. Amino acids, proteins and nucleic acids: L-amino acids as building block of proteins, zwitter ion property, synthesis of polypeptides, primary, secondary, tertiary, quaternary structure of proteins, Nucleic acids: structure of DNA and RNA, Genetic code, protein synthesis. Lipids: biological functions and types of lipids, oils and fats**,** occurrence in foods, composition, industrial oils of vegetable origin, common fatty acids present in fats and oils, extraction, refining and hydrogenation of fats and oils,identification of fats and oils, physical and chemical properties, saponification value, acid value and iodine number, flavour changes in oils and fats, reversion and rancidity.
Unit 4.Chromatography – Classification, principle of differential migration, adsorption phenomena, Rf value. Chromatographic techniques: parturition chromatography -theory and applications, thin layer, paper and ion exchange chromatography, liquid chromatography-HPLC, applications, gas chromatography-theory and application.

References

1 Arun Bahl, B.S. Bahl, Advanced Organic Chemistry, 2nd Edn., S. Chand Publishing (2012).
2 K.S.Tewari, N.K.Vishnoi, A Textbook of Organic Chemistry, 4th Edn.., Vikas Publishing (2017).
3 Robert Thornton Morrison, Robert Neilson Boyd, SaibalKanti Bhattacharjee, Organic Chemistry, 7th Edn., Pearson (2011).
4 Michael Smith, Jerry March, Advanced Organic Chemistry, 6th Edn., John Wiley & Sons, Inc. (2007).

20-214-0311 Computer Programming

Course Outcome

On successful completion of the course, the students will be able to:

CO1: Understand the basics of computer programming C. (Understand)
CO 2: Explain the commands and its applications in computer programming. (Analyse)
CO 3: Understand the programming using C. (Understand)
CO 4: Identify the control structures & pointers, searching & sorting. (Understand)
CO 5: Understand the creation and use of databases in a suitable database package. (Remember)
CO 6: Write C programs using basic commands and run using a compiler. (Understand)

CO 7: Apply the function command in practical programs using C. (Apply)
CO 8: Write C program involving pointers and searching. (Apply)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1			1					1		
CO2	2	1	1	1	1							
CO3	1	1	1	1	1					1		
CO4	1		1	1	1					1	1	
CO5	1	1	1		1							
CO6	2	2	1	1	1					1	1	
CO7	2	1		1	1							
CO8	2	1		1	1					1	1	

Unit 1. Introduction to programming in C – Fundamental data types: integer, floating point, and enumerated data types. Expressions: arithmetic, relational and logic operators.Type conversion: simple and compound statement, access to standard library, standard I/O-getchar, putchar, formatted I/O, scanf, printf, error handling, line input and out put, control structures, selection statement, IF, SWITCH, WHILE, DO WHILE, FOR, BREAK, CONTINUE, GOTO, RETURN statements.

Unit 2. Functions – Declarations and functions, parameter passing mechanism, storage classes, scope, visibility, and life time of variables, AUTO, EXTERN, STATIC and REGISTER modifiers, Recursion.

Unit 3. Arrays – Single and multi dimensional arrays, sorting, selection sort, search-linear search and binary search, structures and union.

Unit 4. Pointers – Pointers and addresses, pointer arrays, function returning pointers, pointers to function, pointer arithmetic, pointers to structures, array of structures, preprocessor directive, command line arguments, typedef.

References

Priti Sinha, Pradeep K.Sinha, Computer Fundamentals, BPB publications (2004).
1

2 Byron S. Gottfried, Schaum's Outlines Programming with C, McGraw Hill Education (2018).

3 Varghese Paul, Computer Fundamentals, Educational Publishers and Distributors (2003).

20-214-0312 Identification of Polymers

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Identify the plastics and rubbers used in various unknown polymeric products.

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1							1			2

1. Identification of rubbers -NR, SBR, PB, IR, IIR, EPDM, Hypalon,Thiokol, Silicone, CR, NBR.
2. Identification of plastics-PE, PP, PS, PVC, PVA, PF, UF, MF, Polyester
3. Identification of thermoplastic elastomers -SIS, SBS, SEBS, Hytrel

References

1 K.J.Saunders , Identification of Plastics and Rubber, Chapman and Hall

20-214-0313 Chemical Engineering Lab

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Measure the flow rate & viscosity of fluid, friction developed within the tube and plot the characteristic curves of centrifugal pump.

CO 2: Conduct experiments to find characteristics of some heat and mass transfer operations.

Mapping of course outcomes with program outcomes:

Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1				1			1			1
CO2	1	1				1			1			1

1. Fluid flow measurement using orifice meter and venturimeter.
2. Weirs and notches.
3. Friction in straight pipes, bends and fittings.
4. Viscosity measurements by terminal setting velocity.
5. Characteristic curves of a centrifugal pump.
6. Calculation of heat transfer and mass transfer coefficients.
7. Simple distillation and steam distillation.

20-214-0401 Applied Statistics

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Get a brief idea about collection, classification & properties of large data sets. (Understand)

CO 2: Fit a curve to the given data using regression lines & least square method. (Apply)

CO 3: Understand addition and multiplication theorems. (Understand)

CO 4: Identify & solve problems dealing with probability using Binomial, Poisson and Normal distributions. (Apply)

CO 5: Test hypothesis related to mean, standard deviation, variance, correlation coefficient and fitting using different statistical testing procedures. (Apply)

CO 6: Infer whether a process or product is under statistical control or not using control charts and Acceptance sampling procedures respectively. (Evaluate)

CO 7: Analysis variance using one way and two way data classifications. (Analyze)

CO 8: Get an idea about concepts of quality assurance like total quality control, company wide quality control & quality control circles. (Understand)

	Mapping of Course Outcomes with Programme Outcomes: Level – Low (1), Medium (2) and High (3)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1				1	1		1
CO2	1											
CO3	1											
CO4	1											
CO5	2	1	1	1					1			1
CO6	2	1	1	1					1			1
CO7	2	1										1
CO8	2	1	1	1					1			1

Unit 1.Introduction to Statistics – Collection and classification, measures of central tendency, dispersion, skewness and kurtosis. Correlation & Regression: curve fitting by method of least squares, correlation coefficient and regression lines.

Unit 2.Probability – Introduction, addition and multiplication theorems, Baye's theorem, expectation, probability density functions and distribution functions, moment generating functions, binomial, Poisson and normal distribution (Theorems without proof).

Unit 3. Sampling – Sampling distribution, standard error. Testing of hypothesis: large sample and small sample tests, test for correlation coefficient, test for goodness of fit. Statistical quality control: control chart for variables and attributes,acceptance sampling, single sampling, double sampling, multiple sampling, sequential sampling plans, curves.

Unit 4.Design of experiments – Introduction, randomization, replication and local control, analysis of variance-one way and two way classification, CRD, RBD, LSD. Quality control: concepts of quality assurance, total quality control, company wide quality control, quality control circles, and simple statistical tool for quality circles.

References

1 S.P.Gupta, Statistical Methods, 43rd Edn., Sultan Chand (2014).

2 E.L.Grant, Fundamentals of Statistical Quality Control, 7th Edn., McGraw Hill Education (2000).

3 S.C.Gupta, V.K.Kapoor, Fundamentals of Applied Statistics, Sultan Chand & Sons-Tb (2014).

4 S.C.Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons-Tb (2018).

20-214-0402 Quality Management Systems and Safety

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the basics of organisational management. (Understand)

CO 2: Describes the concepts of Quality and Quality management. (Understand)

CO 3: Describes on the basics of various ISO certification and Quality practices in the industry level. (Understand)

CO 4: Understand the concept and practice of six sigma (Understand)

CO 5: Describes on the various customer related concepts. (Understand)

CO 6: Discuss performance appraisal and CPI. (Understand)

CO 7: Describes on the safety concepts and techniques used in the industry. (Understand)

CO 8: Explain the principles and methods of hazard identification and risk assessment. (Understand)

	Mapping of Course Outcomes with Programme Outcomes: Level – Low (1), Medium (2) and High (3)	

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1					1			1	1	1	
CO2	1					1			1	1	1	1
CO3	1					1			1	1	1	1
CO4	1											1
CO5	1					1			1	1	1	
CO6	1					1			1	1	1	
CO7	1					1			1	1	1	1
CO8	1					1			1	1	1	1

Unit 1. Quality management – Basis of organisational management, basis of quality management and quality concepts, terminology, quality Policy, quality management principles, quality system, quality assurance, quality control, quality characteristics, total quality management, quality cost, role of senior management, continual improvement.

Unit 2. Quality systems – ISO 9000: 2000 systems, ISO 14000, 17025 and others as applicable, quality auditing, introduction to internal auditing, concept and practice of six sigma, interaction between quality management system and other management systems in an organization.
Good laboratory practices, OECD principles of GLP.

Unit 3.Corrective and preventive actions – Customer satisfaction, customer perception of quality, customer complaints, quality of service, customer retention, performance appraisal, benefits, continuous process improvement.

Unit 4. Introduction to Safety – Laboratory safety, concepts of occupational health hazard and risks, system engineering approach to safety, causes of accidents, accident analysis and aontrol, techniques used in safety analysis, safety management and organization, principles and methods of hazard identification and risk assessment, risk management, training, human behavioral approach in safety.

References

1 Dale H. Besterfiled, et al., Total Quality Management, 4th Edn., Pearson Education Ltd. (2015).

2 James R. Evans, William M.Lindsay, The Management and Control of Quality, 8th Edn., South-Western; International ed. (2010).

3 John S. Oakland. Total Quality Management - text with cases, 4th Edn.,New York Routledge (2013).

4 N S Sreenivasan, V Narayana. Managing Quality - Concepts and Tasks, New Age International(P) Ltd. (2005).

5 M. Zairi. Total Quality Management for Engineers, Wood Head Publishing (1991).

6 David Hoyle. ISO 9000 Quality Systems Handbook, 4th Edn., Butterworth-Heinemann (2001).

7 D.H. Stamatis, Six Sigma Fundamentals: A Complete Guide to the System, Methods and Tools, Productivity Press (2004).

8 VlastaMolak, Fundamentals of Risk Analysis and Risk Management, Lewis Publishers (1997).

9 Roger L. Brauer, Safety and Health for Engineers,3rd Edn., Wiley-Blackwell (2016).

20-214-0403 Polymer Synthesis

Course Outcome

On completion of the course, the students will be able to:

CO1: Design the synthesis route of polymers based on the structure of monomers. (Understand)

CO 2: Describe various types of reactors used for industrial polymerization. (Understand)

CO 3: Design the synthesis strategy for specialty polymers. (Analyse)

CO 4: Understand the type of reactors used for polymer synthesis. (Understand)

CO 5: Determine the molecular weight of polymers. (Analyse)

CO 6: Understand the techniques of molecular weight determination. (Understand)

CO 7: Comprehend on the degradation of polymers under different environments. (Understand)

CO 8: Understand the concept of polymer dissolution. (Understand)

	Mapping of Course Outcomes with Programme Outcomes: Level – Low (1), Medium (2) and High (3)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1							1		1
CO2	1		1	1	1	1					1	
CO3	3	1	1	2		1			1			1
CO4	1	1		1	1				1		1	

CO5	2	1	1						1			
CO6	2	1	2	1	1						1	1
CO7	2		1	1			1	1		1		
CO8	1	1	1					1	1			1

Unit 1. Polymer synthesis – Synthesis and properties of polyethers, polyacetals, polylactones, polylactams, polyesters, polycarbonates, polyamides. Type of reactors: batch reactors, tubular flow reactors, stirred tank reactors.

Unit 2. Specialty polymers: synthesis of heteroatomic polymers, poly (ether ketone), poly (ether ether ketone), polyphenyleneoxide, polyphenylenesulphide, polysulphones, polysiloxanes, liquid crystalline polymers, conducting polymers, photoconducting polymers.

Unit 3. Molecular characterization of polymers– average molecular weight, molecular weight distribution, determination of molecular weight - end group analysis, colligative property measurement, light scattering, ultra centrifugation, solution viscosity and gel permeation chromatography.

Unit 4. Polymer degradation and stabilization –Thermal, oxidative, photochemical and ozone degradation, degradation under special environments, commonly used anti-degradants, mechanism of degradation and stabilization.

References

1 F.W. Billmeyer, A Text Book of Polymer Science, 3rd Edn., Wiley & Sons (2009).

2 R.B. Seymour, C.F.Carrher, Polymer Chemistry, 6th Edn., Marcel Dekker Publications (2003).

3 Hans - George-Elias, Macromolecules, Vol.1, Springer (1986).

4 G. Odian, Principles of Polymerization, 4th Edn., Wiley-Interscience (2007).

5 V. R. Gowariker, N. V. Viswanathan and J. Sreedhar, Polymer science, John Wiley & Sons (2010).

6 Andrew Peacock, Allison Calhoun, Polymer Chemistry – Properties and Applications, Hanser Publishers (2006).

20-214-0404 Science and Engineering of Rubbers

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Explain the importance and functions of different rubber compounding additives and their normal dosages. (Understand)

CO 2: Design formulations based on different rubbers and additives. (Apply)

CO 3: Understand the chemistry of vulcanization process (Understand)

CO 4: Describe vulcanisation process, techniques to assess the state of cure. (Understand)

CO 5: Compare different cure systems and vulcanizate properties. (Analyse)

CO 6: Explain the classification of elastomers, preparation, properties, processing and applications of various general purpose elastomers. (Understand)

CO 7: Understand the structure, properties and applications of speciality rubbers. (Understand)

CO 8: Understand the properties and applications of thermoplastic elastomers and ionomers. (Understand)

	Mapping of Course Outcomes with Programme Outcomes: **Level – Low (1), Medium (2) and High (3)**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1		1							1
CO2	3	1	2		1	1						1
CO3	1	1	1									1
CO4	2		1	1	1	1				1		1
CO5	1	2	1	1								1
CO6	2	2	1	1	1						1	

CO7	2	1	1	1	1				1			
CO8	1	1	1	1	1				1			1

Unit 1. Compounding ingredients – Preparation, properties and uses of carbon black. Structure and properties: non-black fillers, plasticizers, antidegradants, accelerators, activators, cross linking agents, reclaimed rubber, factice and special purpose additives.

Unit 2. Rubber vulcanization – Chemistry and technology of vulcanization, sulphurvulcanisation systems: conventional, semi- efficient, efficient, sulphur linkages: monosulphidic, disulphidic, polysulphidic. Accelerator types- ultra, semi ultra, delayed action, slow. Non-sulphur curing systems: peroxides, metal oxides, sulphur donors, amines, quinone dioxime curing, resins, sulphur chloride, radiation. Effect of state of cure and cure systems on properties of rubbers, crosslink density of vulcanisates.

Unit 3. Synthetic Rubbers – General purpose rubbers: Manufacture, structure, vulcanization, properties and applications of SBR, polybutadiene and polyisoprene rubber. Special purpose rubbers: Manufacture, structure, properties and applications of Neoprene rubber, EPDM, butyl rubber, nitrile rubber.

Unit 4. Specialty rubbers – Manufacture, properties, vulcanization and applications of EVA, polyurethanes, hypalon rubber, silicone rubber and Fluorocarbon rubber. Thermoplastic elastomers: classification, preparation, properties and applications of thermoplastic elastomers based on blends, polyurethane and polyesters. Ionomers: different types, preparation and properties.

References

1 Werner Hofmann, Rubber Technology Handbook, Hanser Gardner Publications (1990).

2 C. M. Blow, C. Hepburn, Rubber Technology and Manufacture, 2nd Edn., Butterworth Scientific (1982)

3 Maurice Morton, Rubber Technology, 3rd Edn., Springer Science Business (1999).

4 Frederick R Eirich, James E. Mark, BurakErman, (Eds.), Science and Technology of Rubber, 2nd Edn., Elsevier (2014).

5 J. M. Martin, W. K. Smith, S. C. Bhatia, Handbook of Rubber Technology, Volume 1-Natural, Synthetic Rubber and Technology of Vulcanisation, CBS Publishers and Distributers (2007).

6 Steven Blow, Handbook of Rubber Technology, Galgotia Publications Pvt. Ltd. (1998).

20-214-0405 Plastics Materials

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the advantages, disadvantages and general classification of polymers. (Understand)

CO 2: Understand the various types of additives and their uses in plastic, (Understand)

CO 3: Summarise the production, properties and uses of various engineering thermoplastics. (Understand)

CO 4: Know the manufacture, properties and uses of thermosetting resins based on phenol (Understand)

CO 5: Know the manufacture, properties and uses of thermosetting resins based on urea and melamine. (Understand)

CO 6: Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU. (Understand)

CO 7: Know the manufacture, properties and uses of PS and styrene containing polymers and copolymers. (Understand)

CO 8: Know the manufacture, properties and uses of flurocarbon polymers, vinyl polymers and cellulose derivatives. (Understand)

Mapping of Course Outcomes with Programme Outcomes:

Level – Low (1), Medium (2) and High (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1								1
CO2	3	1	2	1								1
CO3	2	2	2		1	1					1	
CO4	2	1	1	1	1	1	1			1	1	
CO5	2	1	1	1	1	1	1			1	1	
CO6	2	1	1	1	1	1	1			1	1	
CO7	2	1	1	1	1	1	1				1	
CO8		1	1	1	1	1	1			1	1	

Unit 1. Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. Additives for plastics: antioxidants, fillers, plasticisers, lubricants, fire retardants, blowing agents. General purpose thermoplastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation.

Unit 2. Engineering thermoplastics – Aliphatic polyamides: manufacture, structure, properties and uses of Nylon6, Nylon66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA.

Unit 3. Thermosetting Plastics **–** Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

Unit 4. Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN , poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly(vinyl acetate), poly(vinyl carbazole), cellulose acetate.

References

1 Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8th Edn., Elsevier (2017).

2 J.A.Brydson, Plastics Materials, 7th Edn., Butterworth Heinemann (1999).

3 Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4th Edn., CRC press (2006).

4 A. Brent Strong, Plastics: Materials and Processing, 3rd Edn., Pearson Prentice Hall (2006).

5 Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2nd Edn., CRC press (2016).

20-214-0411 Polymer Synthesis, Modification and Characterisation

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Estimate molecular weight of polymers by different techniques.

CO 2: Modify natural rubber.

CO 3: Prepare specialty polymers.

	Mapping of Course Outcomes with Programme Outcomes: Level – Low (1), Medium (2) and High (3)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										1
CO2	2	1	1		1	1	1	1	1			2
CO3	2	1	1		1	1	1	1	1			2

1.Estimation of polymer molecular weights
a) Viscometry
b) Gel permeation chromatography
c) End group analysis

2**. Polymer modification**
a) Cyclised natural rubber
b) Chlorinated natural rubber
c) Liquid natural rubber

3. Preparation of Specialty polymers
a) Preparation of cured epoxy resins.
b) Preparation of cured unsaturated polyester resin.
c) Prepration of polyaniline and its conductivity studies
d) Grafting of NR

References

1 Rabek, Experimental methods in Polymer Chemistry, John Wilely& sons (1998)

2 D. Braun, H. Cherdron, H. Ritter, Polymer Synthesis: Theory and Practice, Springer Science and Business Media (2001)

3 Stanley R. Sandler, Wolf Karo, Joanne Bonesteel, Eli M. Pearce, Polymer Synthesis

and Characterization: A Laboratory Manual, Elsevier (1998)

20-214-0501 Plastic Processing

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Acquire knowledge on additives for plastic compounding and methods employed for the same. (Understand)

CO 2: Understand major processing techniques employed for plastics by moulding (injection, blow, compression and transfer), extrusion, thermoforming and casting. (Understand)

CO 3: Familiarize the machinery and ancillary equipment related to different plastic processing techniques. (Understand)

CO 4: Predict suitable additives for plastics for the intended application. (Apply)

CO 5: Choose appropriate processing technique for the manufacture of a plastic product. (Apply)

CO 6: Establish correlation between various processing techniques with product properties. (Apply)

CO 7: Evaluate process variables against functional properties of the plastic products. (Evaluate)

CO 8: Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques. (Create)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1					1	1		1
CO2	3	1	1		2	2			1		1	
CO3	2	1	1	1	1	1					1	
CO4	2	1	1	1								1
CO5	2	1	1		1	2			1		1	
CO6	1	1	1	1	1	1						1
CO7	3	1	2	1	2	2					1	1
CO8	2		1	1	1	1						1

Unit 1. Introduction to plastic processing – Principles of plastic processing: processing of plastics vs metals and ceramics. Factors determining efficiency of plastics processing: molecular weight, viscosity and rheology, plastic machining techniques. Difference in approach for thermoplastic and thermoset processing. Additives for plastics: antioxidants, light stabilizers, UV stabilizers, lubricants, relative auxiliaries, processing aids, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization pelletization.

Unit 2. Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects, exit instabilities. Defects: melt fracture, shark skin, bambooing. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Dies and take off equipment. Latest developments in extrusion assisted plastic processing.

Unit 3. Injection molding – Principles, machinery, accessories and functions, process outline, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Cylinder nozzles. Basic mould types. Reciprocating vs plunger type injection moulding. Thermoplastic vs thermosetting injection moulding. Injection moulding vs other plastic processing techniques. State-of-the art injection moulding techniques.

Unit 4. Compression moulding – Working principles, bulk factor, flow properties, moulding materials, process cycle. Moulding parameters: cure time, temperature and pressure. Preforms and preheating. Types of moulds: positive, semi-positive and flash. Transfer moulding: working principle, equipment, moulding cycle, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding. Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming, mechanical forming. Casting: working principle, types and applications.

References

1 S. S. Schwart, S. H. Goodman, Plastics Materials and Processes, Van Nostrad Reinhold Company Inc. (1982).

2 W. S. Allen and P. N. Baker, Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors (2004).

3 M. Chanda, S. K. Roy, Plastic Technology handbook, 4th Edn., CRC Press (2007).

4 I. I. Rubin, Injection Molding Theory & Practice, Society of Plastic Engineers, Wiley (1973).
5 D.V. Rosato, M. G. Rosato, Injection Molding Hand Book, Springer (2012).
6 M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012).
7 B. Strong, Plastics: Material & Processing, A, Pearson Prentice hall (2005).
8 D.V Rosato, Blow Molding Hand Book, Carl HanserVerlag GmbH & Co (2003).
9 F. Hensen (Ed.), Plastic Extrusion Technology, Hanser Gardner (1997).

20-214-0502 Polymer Physics

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Correlate the molecular and structural aspects of polymers in predicting crystallinity in polymers and thereby its influence on the functional properties. (Apply)

CO 2: Understand theories of crystallisation and methods of estimating degree of crystallisation. (Understand)

CO 3: Acquire the concepts of glass transition process and the theories, other thermal properties. (Understand)

CO 4: Understand theories of glass transition and factors affecting Tg. (Understand)

CO 5: To define and calcuate size of polymer chain in solution- ideal case and real polymers. (Understand)

CO 6: Understand theories of polymer solutions and its application in osmotic pressure calculations(Apply)

CO 7: Understand structure- property relationship in polymers. (Understand)

CO 8: Understand influence of structural and environmental factors on mechanical properties. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1						1	1	1
CO2	3	1	1	2						1		1
CO3	3	1	1	2						1		1
CO4	2		1	1						1	1	1
CO5	2	1	2	1							1	1
CO6	2	1	1	1			1					1
CO7	2	1	1	1			1				1	
CO8	1	1	1	1			1				1	

Unit 1. Crystalline and amorphous structure of polymers – crystallization tendency, structural regularity, chain flexibility, polarity, bulky substituents. Crystal structure of polymers: theories of crystallization, kinetics of crystallization, degree of crystallinity, determination of crystal structure by X-Ray diffraction, crystallinity Vs polymer properties.

Unit 2. Thermal transitions in polymers – glass transition temperature and its measurement. Factors affecting glass transition temperature: chain flexibility, geometric factor, inter-chain attractive forces, co-polymerization, crosslinking, branching, crystallization, plasticization. Theories of glass transition: kinetic, equilibrium and free volume. Melting - Intermolecular bonding, effect of structure and chain flexibility

Unit 3. Solution properties of polymers – End - to - end dimensions, freely jointed chain, real polymer chain, thermodynamics of polymer solutions and blends: Flory-Huggins theory. Flory-Krigbaumtheory, osmotic pressure of polymer solutions. Phase diagrams, theta solvents, solubility parameter.

Unit 4. Structure-property relationships: Stress-strain behaviour, creep, stress relaxation, dynamic mechanical analysis, impact, elastic stress-strain relation, deformation of solid polymers. Effect of structural and environmental factors in mechanical properties: molecular weight, cross-linking, crystallinity, co-polymerization, plasticizers, polarity, steric factors, temperature, strain rate, pressure. Mechanical tests: compression vs. tensile

References

1 R.P. Brown, Physical testing of Rubbers, Chapman & Hall (1996).

2 R.P. Brown, Handbook of plastics test methods, Harlow, Longman Scientific and Technical (1988).

3 J.M.G Cowie, Polymers: Chemistry and Physics of Modern Material, 2nd Edn., Chapman & Hall (1991).

4 L.H. Sperling, Introduction to Physical Polymer Sciences, John Wiley (1993).

5 R.T. Crompton, Molecular Motions in High Polymers, Pergmon Press (1989).

20-214-0502 Polymer Physics

CourseOutcome

On successful completion of the course, the students will be able to:

CO 1: Correlate the molecular and structural aspects of polymers in predicting crystallinity in polymers and thereby its influence on the functional properties. (Apply)

CO 2: Understand theories of crystallisation and methods of estimating degree of crystallisation. (Understand)

CO 3: Acquire the concepts of glass transition process and the theories, other thermal properties. (Understand)

CO 4: Understand theories of glass transition and factors affecting Tg. (Understand)

CO 5: To define and calculate size of polymer chain in solution- ideal case and real polymers. (Understand)

CO 6: Understand theories of polymer solutions and its application in osmotic pressure calculations(Apply)

CO 7: Understand structure- property relationship in polymers. (Understand)

CO 8: Understand influence of structural and environmental factors on mechanical properties. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1						1
CO2	3	1	1	2						1
CO3	3	1	1	2						1
CO4	2		1	1						1
CO5	2	1	2	1						
CO6	2	1	1	1			1			
CO7	2	1	1	1			1			
CO8	1	1	1	1			1			

Unit 1. Crystalline and amorphous structure of polymers – crystallization tendency, structural regularity, chain flexibility, polarity, bulky substituents. Crystal structure of polymers: theories of crystallization, kinetics of crystallization, degree of crystallinity,

determination of crystal structure by X-Ray diffraction, crystallinity Vs polymer properties.

Unit 2. Thermal transitions in polymers – glass transition temperature and its measurement. Factors affecting glass transition temperature: chain flexibility, geometric factor, inter-chain attractive forces, co-polymerization, crosslinking, branching, crystallization, plasticization. Theories of glass transition: kinetic, equilibrium and free volume. Melting - Intermolecular bonding, effect of structure and chain flexibility

Unit 3. Solution properties of polymers – End - to - end dimensions, freely jointed chain, real polymer chain, thermodynamics of polymer solutions and blends: Flory-Huggins theory. Flory-Krigbaumtheory, osmotic pressure of polymer solutions. Phase diagrams, theta solvents, solubility parameter.

Unit 4. Structure-property relationships: Stress-strain behaviour, creep, stress relaxation, dynamic mechanical analysis, impact, elastic stress-strain relation, deformation of solid polymers. Effect of structural and environmental factors in mechanical properties: molecular weight, cross-linking, crystallinity, co-polymerization, plasticizers, polarity, steric factors, temperature, strain rate, pressure.Mechanical tests: compression vs. tensile

References

1 Robert O. Ebewele, Polymer Science and Technology, CRC Press (2002)

2 Paul C. Hiemenz, Timothy P. Lodge, Polymer Chemistry, 2nd Edn., CRC Press (2007)

3 J.M.G Cowie, Ploymers: Chemistry and Physics of Modern Material, 2nd Edn., Chapman & Hall (1991).

4 L.H. Sperling, Introduction to Physical Polymer Sciences, John Wiley (1993).

5 Manas Chanda, Introduction to Polymer Science and Chemistry - A Problem Solving Approach, CRC Press (2006)

6 Joel Fried, Polymer Science and Technology, CRC Press (2006)

7 Alfred Rudin, The Elements of Polymer Science & Engineering, 2nd Edn., Academic Press (1999)

8 Herman S. Kaufman, Joseph J. Falcetta (Eds), Introduction to Polymer Science and Technology, John Wiley & Sons (1999)

9 Ulf W. Gedde, Polymer Physics, Chapman & Hall (1995)

10 Ulrich Eisele, Introduction to Polymer Physics, Springer-Verlag (1990)

20-214-0504 Rubber Processing and Product Manufacture

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the machineries used for rubber compound preparation. (Understand)

CO 2: Understand the process of calendering and the machineries used. (Understand)

CO 3: Understand the process of moulding and the machineries used. (Understand)

CO 4: Understand the process of extrusion and the machineries used. (Understand)

CO 5: Appreciate recent status and future prospects of rubber product industries in India. (Understand)

CO 6: Learn the manufacture of foot wears, belts, hoses cables etc (Understand)

CO 7: Learn the manufacturing process of various rubber products such as tyres,seals, sports goods and surgical products. (Understand)

CO 8: Learn the manufacturing process of various rubber products such as bonded articles, rubber covered rollers, tank lining etc . (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	1							1
CO2	2	1	1	1	2	1			1			1
CO3	2	1	1	1	2	1			1			1
CO4	2	1	1	1	2	1			1			1
CO5	2	2				1		1	1	1		
CO6	3	2	1	1	2	2					1	1
CO7	3	2	1		2	1					1	
CO8	2	1	1									1

Unit 1. Rubber compounding – Machinery used for mixing: two roll mills, internal mixers and continuous mixers. Master batching and blending. Calendering technology: principle, processing, defects, defects, types of calenders, fabric coating and spreading.

Unit 2. Moulding techniques – Machineries, process method, advantages &disadvantages: compression, transfer, injection moulding of rubbers, flashlessmoulding, finishing of moulded articles, calculation of mould shrinkage, moulding defects and its remedies. Machinery used for extrusion: ram and screw extruders, extrusion technology, crosshead extruders and strainers. Vulcanisation methods other than moulding: batch curing, continuous curing, open

steam autoclaves, hot air, fluidized bed, LCM, molten salt bath and high energy radiation curing.

Unit 3. Manufacture of rubber products I – Present status and future prospects of rubber product industries in India. Manufacture of foot wears, conveyor belts, power transmission belts, hoses, tubings, cables, wires, cellular rubber products and hard rubber products.

Unit 4. Manufacture of rubber products II – Cycle tyres and tubes, solid tyres, mechanical seals, sports goods, surgical products. Rubber to metal bonded articles: rubber covered - rollers, tank, pipe and valve lining, shock absorbers and anti-vibration mountings.

References

1 C. M. Blow, C. Hepburn, Rubber Technology and Manufacture, 2nd Edn., Butterworth Scientific (1982).

2 Werner Hofmann, Rubber Technology Handbook, Hanser Gardner Publications (1990).

3 P. K. Freakly, Rubber Processing and Production Organisation, Springer Science & Business Media (2012).

4 M.M.Patel, S.B.Rath, R.M.Sambandam, D.Joseph Francis (Eds.), Rubber Engineering by Indian Rubber Institute, Tata McGraw-Hill (1998).

5 J. M. Martin, W. K. Smith, S. C. Bhatia, Handbook of Rubber Technology, Volume 1- Natural, Synthetic Rubber and Technology of Vulcanisation, CBS Publishers and Distributers (2007).

6 J. M. Martin, W. K. Smith, S. C. Bhatia, Handbook of Rubber Technology, Volume 2- Processing, Compounding, Manufacturing and Uses of Rubber, CBS Publishers and Distributers (2007).

7 Steven Blow, Handbook of Rubber Technology, 1st Edn., Galgotia Publications Pvt. Ltd (1998).

8 Robert F. Ohm (Ed.), The Vanderbilt Rubber Handbook, 13th Edn., R. T. Vanderbilt Company, Inc. (1990).

20-214-0505 Fibre Science and Technology

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Describe the structural principles of fibres. (Understand)

CO 2: Explain the different types of spinning processes. (Understand)

CO 3: Summarise the production and properties of general purpose fibers. (Understand)

CO 4: Summarise the production and properties of high performance fibers. (Understand)

CO 5: Understand different types of tests done on fibers (Understand)

CO 6: Understand different post processing of fibers including dyeing. (Understand)

CO7: Learn different chemical treatments for modifying surface chemistry. (Understand)

CO 8: Identify the fibres suitable for reinforcing rubber products. (Analyse)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1								1
CO2	2	1	1	1	1	1	1					1
CO3	2	1	2	1	1	1			1			1
CO4	2	1	2	1	1	1			1			1
CO5	3	2	1	1			1		1			1
CO6	1	1	1						1			1
CO7	2	1		1		1	1				1	1
CO8	3	1	1			1					1	

Unit 1. Fibre basics – Definition of textile terms, use of fibres in rubber and plastic industries, classification of fibres. Structural principles of polymeric fibres: orientation, crystallinity, methods of measurement. Spinning processes: melt, dry and wet spinning, spin finishes, drawing. Natural fibres: chemical composition, production, cotton, coir, flax, jute, sisal, hemp, wool,silk, properties and uses.

Unit 2. Synthetic fibres – Manufacture, properties and application areas of viscose rayon, nylon 6, nylon 66, PET, acrylics, spandex fibres, polypropylene. High performance fibres: Manufacture, properties and application areas of aramid, carbon, glass, gel-spun high performance polyethylene.

Unit 3. Testing of fibres – Man-made fibres: crimp, fineness, tensile properties, eveness, shrinkage, entanglement, frictional properties. Post processing of fibres: fibre-to-fabric formation,weaving, knitting, non-woven fabrics. Dyeing of fabrics and types of dyes.

Unit 4. Surface modification of fibres: chemical treatments, grafting, bleaching. Fibre-matrix adhesion: adhesive treatments for rayon, nylon, polyester, aramid, in-situ bonding system, mechanism of adhesion. Requirements of textile for reinforcement of rubber products. Application

of man madefibres: textile, agriculture, biomedical applications.

References

1 V.B. Gupta, V.K. Kothari (Eds.), Manufactured Fibre Technology, Chapman & Hall (1997).

2 Premamoy Ghosh, Fibre Science and Technology, Tata McGraw-Hill (2004).

3 JorgMussig (Ed.), Industrial Applications of Natural Fibres, John Wiley & Sons (2010).

4 J. W. S. Hearle (Ed.), High-performance Fibres, 1st Edn.,Woodhead Publishing Limited (2001).

5 Bernard P. Corbman, Textiles: Fiber to Fabric, 6th Edn., McGraw-Hill (1985).

6 David B.Wootton, The Application of Textiles in Rubber, RAPRA Technology Ltd. (2001).

7 S.P. Mishra, A Text Book of FibreScience and Technology, New Age International (2000).

8 H.V.Sreenivasa Murthy, Introduction to Textile Fibres, Taylor & Francis (2015).

20-214-0511 Polymer Characterisation and properties

Course Outcome

On successful completion of the course, the students will be able to:

CO1: Demonstrate the working of equipments used for polymer testing and characterisation.

CO 2: Understand the characteristic behaviour of polymer raw materials.

CO 3: Prepare samples for testing.

CO 4: Determine the mechanical and thermal properties of polymers.

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3								1	1		1
CO2	2	2							1			1
CO3	2	1							1			1
CO4	3	1	1						1			1

1. Demonstration of equipment like UTM, TGA, DSC, ODR, UV etc.

2. Determination of MFI of plastic materials
3. Determination of viscosity using Brookfield viscometer
4. Determination of MST, HST, and ZST of latex.
5. Preparation of test pieces
6. Determination of tensile strength and tear strength of rubber and plastic samples.
7. Determination of Resilience, Abrasion Resistance, Flex, Crack Resistance, Compression set, Heat build up, Heat deflection temperature, Hardness.

References

1 BIS, ASTM, ISO Standards

20-214-0512 Analysis of Compounding Ingredients and Rubber Compounds

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Analyze the raw materials used for dry rubber compounding.

CO 2: Analyze the filler and sulphur content in rubber compounds / vulcanizates.

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2				1			1			1
CO2	1	2	2			1			1			1

1. Estimation of percentage purity of MBT, DPG, ZnO
2. Determination of acid value of stearic acid
3. Determination of Iodine Adsorption number of Carbon black.

4. Analysis of rubber compounds – Carbon black content, Free sulphur content, Total inorganic filler and silica content, Total sulphur content, Bound rubber content, Determination of mooney viscosity, scorch time and cure time

5. Estimation of flash point and fire point of oils.

6. Estimation of Aniline point of oils.

7. Estimation of pour point of wax.

Factory visits: Visit to rubber factories producing extruded and mouldedarticles. Visit to units manufacturing FRP products

References

1 BIS, ASTM, ISO Standards

2 C. M. Blow, C. Hepburn, Rubber Technology and Manufacture, 2nd Edn, Butterworth Scientific (1982).

20-214-0601 Latex Technology

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Describe the characteristics of NR latex. (Understand)

CO 2: Explain the significance and methods of latex specification tests. (Understand)

CO 3: Explain the basic principles of latex stability and destabilization. (Understand)

CO 4: Get an insight on the various ingredients used for latex compounding. (Understand)

CO 5: Summarise the different types of dipping techniques. (Understand)

CO 6: Identify the role of latex in miscellaneous applications. (Analyse)

CO 7: Design suitable formulations for different latex based products. (Apply)

CO 8: Illustrate and compare various latex product manufacture methods. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1			1						1
CO2	3	2	2			1	1			2		2
CO3	2	2	1	1			1			1		1
CO4	3	2	1			1	1		1	1		1

CO5	2	1	2						1		1	1
CO6	1	1	1			1	1		1	1	1	1
CO7	2	2	2	1		2	2	1	1	1	2	1
CO8	2	1	1			1	1		1	1	1	1

Unit 1. Introduction to Natural rubber latex – fundamentals, comparison of natural and synthetic latices, comparative study of rubber goods manufactured from latices and solid elastomers, polymer solution vs polymer latices, viscosity-concentration relationship, latex stability and destabilization.

Unit 2. Latex test methods and compounding – Total solids, dry rubber content, total alkalinity, coagulum content, sludge content, KOH number, mechanical and chemical stability, VFA number, zinc oxide stability. Latex compounding: de-ammoniating of latex, vulcanising agents, accelerators, antioxidants, fillers, dispersing and emulsifying agents, stabilisers, thickening agents, special ingredients, solutions, dispersions and emulsions, compounding and vulcanisation, pre-vulcanised latex, radiation vulcanisation.

Unit 3. Dipping technology – straight dipping, coagulant dipping, different types of formers, dipping process, after treatments. Manufacture of dipped goods: rubber band, medical, household, and industrial gloves, dipped fabric gloves, balloon, nipples, prophylactics, defects in dipped goods. Latex impregnation and spreading. Latex cement and adhesives. Latex based surface coatings. Latex in road rubberisation. Rubber-fibre composite products: coir foam, latex treated rugs and carpet backing.

Unit 4. Latex foam, thread and mouldings – compounding, mechanical frothing by beating, processing methods, vulcanisation, washing and drying. Gelling: merits and demerits. Continuous foam production. Latex thread: extrusion, typical thread formulation. Latex castings and mouldings: principles and production of hollow articles, solid articles, use of porous moulds in casting.

References

1 D.C. Blackley, Polymer Latices: Science and Technology, Vol 1, 2 and 3, Springer Science (1997).
2 D. C. Blackley, High Polymer Latices, Vol 1 and 2, Maclaren (1966).
3 Rani Joseph, Practical Guide to Latex Technology, Smithers Rapra (2013).
4 R. F.Mausser (Ed.), The Vanderbilt Latex Handbook, R.T. Vanderbilt Company (1987).
5 David Eaves, Handbook of Polymer Foams, Smithers Rapra Publishing (2004).

20-214-0602 Characterization and Testing Methods

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Explain the relevance of standards and specifications. (Understand)

CO 2: Distingush the processability tests used for thermoplastics, thermosets and elastomers. (Analyse)

CO 3: Discuss the thermal, electrical & optical properties of plastics and rubbers. (Understand)

CO 4: Summarise the various test methods for evaluating the mechanical properties of the polymers. (Understand)

CO 5: Outline various techniques used for charactersing polymers. (Understand)

CO 6: Distinguish polymer, blends & composites using the test results of characterisation. (Analyse)

CO 7: Explain the test procedures for latex and dry rubber products. (Understand)

CO 8: Summarise the specification test methods of various plastics products. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1					1						
CO2	3	2	1			1	1			1	1	1
CO3	2	2	1	1		1	1		1	1	1	1
CO4	3	2	2	2			1		1	1	1	1
CO5	2	2	1	1					1			1
CO6	2	2	1	1		1			1			1
CO7	3	2	2	1		1	1		1			1
CO8	2	1	1			1	1		2	1	1	1

Unit 1. Introduction – Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and specifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on dry rubber: processability parameters of rubbers - plasticity, Mooney viscosity, scorch time, cure time, cure rate index Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.

Unit 2. Mechanical properties of plastics and rubber: Tensile, compressive, flexural, tear strength, dynamic stress-strain, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties.Thermal properties: specific heat, thermal conductivity, thermal expansion, heat deflection temperature, Vicat softening point.Electrical properties: resistivity, dielectric strength, dielectric constant.Optical properties: transparency, refractive index, haze, gloss.Tests for chemical resistance. acids, alkalies. Flammability tests- oxygen index test. Tests for weather resistance. Gas permeability.

Unit 3. Characterisation of polymers, blends and composites – X-Ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Ultraviolet-Visible Spectroscopy, Differential Scanning Calorimetry (DSC), Thermogravimetric Analysis (TGA), Scanning Electron Microscopy (SEM), and Transmission Electron Spectroscopy (TEM), Atomic Force Microscopy (AFM).

Unit 4. Testing of latex products: dipped goods - gloves (surgical, examination, household, industrial), prophylactics, balloons, foam, latex thread. Testing of dry rubber products: footwear, hose, belts (conveyor & power transmission).Testing of plastic products: containers, pipes, films, laminates.

References

1 ISO, BIS, ASTM, BS and DIN standards.
2 R.P.Brown, Plastic test methods, 2nd Edn., Harlond, Longman Scientific, (1981).
3 Vishu Shah, Handbook of Plastic Testing Technology, 3rd Edn., John Wiley & Sons (2007).
4 R.P.Brown, Physical Testing of Rubbers, 4th Edn., Chapman Hall (2006).
5 J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons (1980).
6 M.M.Woolfson, An Introduction to X-Ray Crystallography, 2nd Edn., Cambridge University Press, Vikas Publishing House (1997).
7 F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher (1977).

20-214-0603 Polymer Products Design

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the various steps involved in plastic products design process.

(Understand)

CO 2: Understand general relationships between polymer structure and properties. (Understand)

CO 3: Understand the fundamentals of designing plastic beam and plates. (Understand)

CO 4: Analyse the stress on plastic beams and plates. (Analyse)

CO 5: Understand the fundamentals of various plastic products design features. (Understand)

CO 6: Understand the principles of designing walls, tapers, blind holes, gate and undercuts. (Understand)

CO 7: Understand the different terms and parts of a plastic gear. (Understand)

CO 8: Understand the candidate materials and various design features of plastic gear. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1				1					
CO2	2	1									1	
CO3	2	1	1			1				1		1
CO4	1	3	2						1			1
CO5	3	1	1						1		1	1
CO6	2	1	1			1			1		1	1
CO7	2	1										1
CO8	2	1	1						1		1	1

Unit 1. Product design – Principles, functional design, aesthetic design, plastics structure, physical and chemical properties, effect of fillers on properties and performance.

Unit 2. Beams and plates – Structural design, dynamic load response, cyclic loading, design for stiffness, processing limitations, design of products for static and dynamic loads, cost estimation, cost reduction methods.

Unit 3. Design features – Inside sharp corners, ribs, tapers or draft angles, weld lines, gate size and location, wall thickness, tolerance, internal plastic threads, blind holes, undercuts, thermoplastic hinge and snap fitting.

Unit 4. Plastic gears – raw materials, advantages and disadvantages, glossary of gearing terms, design, backlash, working clearance, lubricating additives, frictional and wear properties, strength and durability, moulded v/s cut plastic gearing.

References

1 E. Miller, Plastics Products Design Handbook, Marcel Dekker (1983).

2 C. Hepburn, Elastomers: Criteria for Engineering Design, Applied Science Publishers (1979).

3 P. Tres, Designing Plastic Parts For Assembly, Hanser Publishers (2000).

4 J.B. Dym, Product Design with Plastics - Industrial Press Inc. (1983).

5 D. Beck Ronald, Plastic Product Design, Van Nostrand Reinhold Company (1980).

20-214-0604 Polymer Rheology

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the different models used to represent viscoelastic materials. (Understand)

CO 2: Analyse the models mathematically to derive appropriate governing equations and predict the behaviour of the system. (Analyse)

CO 3: Understand the effect of time and temperature on viscoelastic materials. (Understand)

CO 4: Summarise the effect of temperature and frequency on the dynamic mechanical properties of polymers. (Understand)

CO 5: Understand the different types of fluids. (Understand)

CO 6: Analyse the flow under different shear conditions. (Analyse)

CO 7: Understand the flow behaviour of fluids through simple geometries. (Understand)

CO 8: Understand the principles of different types of viscometers. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1										1
CO2	2	3										1
CO3	2	1							1			1

CO4	1	2	1						1	1		
CO5	3	1	1						1	1		1
CO6	1	2	1			1					1	1
CO7	2	1	1		1	1		1	1		1	1
CO8	3	2	1			1			1		1	1

Unit 1. Polymer viscoelasticity – Ideal elastic response, pure viscous flow, viscoelasticity, mechanical models for linear viscoelastic response, Max well and Voigt models, four parameter model, material response time-Deborah number, Maxwell-Weichert model, generalized Voight element, Problems.

Unit 2. Superposition principles: Boltzmann superposition, time temperature superposition, WLF equation, shift factor. Rubber elasticity: ideal rubber, entropy elasticity. Dynamic measurements: storage, loss modulus, loss tangent and complex modulus, fatigue, hysteresis, rebound resilience.

Unit 3. Polymer flow behaviour – Newtonian flow, non - Newtonian flow, pseudoplastic, Bingham, dilatant, thixotropic and rheopectic behaviour. Factors influencing flow behaviour: molecular weight and distribution, chain branching and temperature.

Unit 4. Flow properties – Power-law fluids, drag flow and pressure flow of power-law fluids in simple geometries. Measurement: capillary viscometers, Rabinowitsch correction, Bagley correction, melt fracture, normal stress and die swell, coaxial cylinder viscometer, cone and plate viscometer, extensional viscometers, Problems.

References

1. Robert O. Ebewele, Polymer Science and Technology, 1st Edn., CRC Press (2000).
2. R. J. Crawford, P. J. Martin, Plastics Engineering, 4th Edn., Butterworth-Heinemann (2020).
3. R.P. Chhabra, J.F. Richardson, Non-Newtonian Flow and Applied Rheology: Engineering Applications, 2nd Edn., Butterworth-Heinemann (2008).
4. J. A. Brydson, Flow properties of polymer melts, 2nd Edn., Godwin (1981).
5. B.R. Gupta, Applied Rheology in Polymer Processing, Asian Books Private Limited (2006).
6. John M. Dealy, Kurft F. Wissbrun, Melt Rheology and its Role in Plastics Processing, Springer (1999).
7. F. N. Cogswell, Polymer Melt Rheology – A guide for Industrial Practice, Woodhead Publishing (1981).
8. Lawrence E. Nielsen, Robert F. Landel, Mechanical properties of Polymers and Composites, 2nd Edn., Marcel Dekker, Inc. (1994).

20-214-0611 Dry Rubber and Latex Technology

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Test natural rubber (dry & latex) as per the specification.

CO 2: Prepare different natural rubber products (dry and latex).

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1								1		
CO2	3		1						1		1	1

1. Preparation of dispersions and emulsions.

2. Dry Rubber Testing - Homogenization, volatile matter, ash content, initial plasticity and PRI, dirt content, nitrogen content.

3. Latex Testing - DRC, TSC, total alkalinity, VFA number, MST, coagulum content, Magnesium content, sludge content, KOH number, Cu content, Manganese content.

4. Determination of Mooney viscosity and cure time of natural rubber compound.

5. Creaming of natural rubber field latex.

6. Effect of viscosity modifier on thickness of latex deposits.

7. Preparation of rubber bands, balloons, finger caps, household and surgeons gloves, latex foam, latex based adhesives.

8. Preparation of rubber products like play balls, injection bottle caps, teats, tea-mats, M.C.Sheet, Vstraps, sponge.

Factory visits:

Visit to units producing dipped goods, latex foam, carpet backing, latex thread and other latex products.

References

1 BIS, ASTM, ISO Standards

2 D.C.Blackely, High Polymer Latices, Vol. I & II, Applied Science Publishing

20-214-0701 Polymer Composites and Blends

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Summarise the resins used in the manufacture of FRP. (Understand)

CO 2: Understand the manufacture and properties of fibres used for FRPs. (Understand)

CO 3: Derive the properties of the composites theoretically. (Understand)

CO 4: Compare the predicted properties with the experimentally measured properties of composites. (Analyse)

CO 5: Summarise the various techniques used for the manufacture of FRPs. (Understand)

CO 6: Compare the advantages and limitations of the different manufacturing process of FRPs. (Analyse)

CO 7: Outline the basic concepts of the different types of blends. (Understand)

CO 8: Interpret the polymer blends based on its characterisation. (Apply)

Mapping of Course Outcomes with Programme Outcomes:

Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	1	1			1	1		1	1		1
CO2	3	1	1			1	1		1	1		1
CO3	2	2	1			1			1		1	1
CO4	1	2	2						1			1
CO5	2	1	1			2	1		1	1		1
CO6	1	2	1			1	1		1			
CO7	2					1	1			1		
CO8	1	2	1						1		1	1

Unit 1. Introduction to composite materials– Classification: particulate, flake, fibrous, laminates, advantages and disadvantages. Reinforcing fibres: composition, manufacture, properties of glass, carbon (PAN & Pitch-based), kevlar, boron, silicon carbide, surface treatment, coupling agents. Matrix materials: production, properties and applications of unsaturated polyester, epoxy, vinyl ester, phenolic resins.

Unit 2. Theory of composite materials– Prediction of composite properties: rule of mixtures. Continuous fibre composites: longitudinal strength and modulus, minimum and critical fibre content, transverse strength and stiffness, shear modulus, Poisson's ratio, Halpin -Tsai equation. Factors affecting the strength of composites. Short fibre composites: mechanism of load transfer, load transfer length, critical fibre length, average strength of composites, Problems.

Unit 3. Fibre Reinforced Plastics (FRP) – processing machinery, operation, advantages and disadvantages, hand lay-up, spray up, centrifugal casting, bag moulding-vacuum bag, pressure bag, autoclave, resin transfer moulding (RTM), Vacuum assisted RTM (VARTM), reinforced reaction injection moulding (RRIM), compression moulding, injection moulding, filament winding, pultrusion.

Unit 4. Polymer blends – classification, criteria for blending, advantages of blending. Preparation techniques: melt blending, solvent blending, latex blending, in-situ polymerization. Compatibilising agents. Methods of determining miscibility / compatibility, plastic-plastic, rubber-rubber and plastic-rubber blends.

References

1 P. K. Mallick, Composites Engineering Handbook Part-1&2, CRC Press (2016).

2 Ever J. Barbero, Introduction to Composite Materials Design, 2nd Edn., CRC Press (2011).

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20-214-0702 Introduction to Mould and Die Design

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Get an insight into the materials used for the manufacture of the various components of moulds and dies. (Understand)

CO 2: Identify the right materials for the components of moulds and dies. (Analyse)

CO 3: Gain knowledge about the conventional & advanced machinery and techniques used for machinining and production of the components of moulds and dies. (Understand)

CO 4: Learn the modern computer based systems for the design, production and quality assurance of moulds and dies. (Understand)

CO 5: Comprehend and envisage the processes involved in the design and production of various types of injection moulds. (Analyse)

CO 6: Understand the basic designs used for feed and ejection system. (Understand)

CO 7: Get an insight into the design and manufacture of moulds for compression and transfer moulding processes. (Understand)

CO 8: Learn the design and manufacture of various types of dies and extrudate calibration systems. (Understand)

Mapping of Course Outcomes with Programme Outcomes:

Level – Low (1), Medium (2) and High (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2					1	1					
CO2	1	1				1	1					1
CO3	3	1	1		1				1	1		
CO4	2	1	1						1	1		
CO5	2	1	1		1	1	1		1	1		1
CO6	2	1			2	1	1		1	1	1	1
CO7	2	1	1		2	1	1		1			
CO8	3	1			2	1			1			1

Unit 1. Materials for moulds and dies – Selection, steels-hardening, nitriding, corrosion resistant steels, aluminium alloys-surface treatment and coating, bronzes, zinc alloys. Materials for prototype moulds: natural materials, metals, synthetic materials.

Unit 2. Mould manufacturing processes – Machineries used: cutting, turning, milling, grinding and welding. Electrical discharge machining (EDM). Electroforming. Hobbing. Polishing. Surface structuring. Design: Introduction to computer aided mould design (CAD), computer aided manufacturing (CAM), computer integrated manufacturing (CIM) and computer integrated quality assurance (CAQ).

Unit 3. Injection mould design – Basic injection mould construction, feed system in injection moulds -design of sprue, runners and gates. Non solidifying runners. Ejection system. Mould venting, cooling, guiding and locking. Stack moulds. Moulds for threaded products. Moulds for thermosets and rubbers.

Unit 4. Compression moulds: general types, components of compression moulds and design. Transfer moulds : types of moulds, components of transfer moulds, advantages and design. Extrusion dies: General rules for die design, extrusion dies for discharge of single melt. Types of dies:basic, pipe, sheet, blown film and wire coating . Automatically adjustable dies. Profile dies. Dies for extruding nets. Dies for co-extrusion. Systems for sizing and calibration of extrudates.

References

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8 Chris Rauwendaal, Understanding Extrusion, 2nd Edn, Hanser Publications (2010).

20-214-0703 Failure Analysis of Polymers

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the different modes of failure occurring in polymers and composites. (Understand)

CO 2: Explain the fundamentals of fracture mechanics. (Understand)

CO 3: Understand the fracture mechanics during impact tests. (Understand)

CO 4: Explain fracture mechanics in long-term tests. (Understand)

CO 5: Summarise the effect of various environmental factors on the degradation behaviour of polymers. (Understand)

CO 6: Explain the strategic weakness leading to failure of polymers. (Understand)

CO 7: Outline the environmental stress cracking phenomenon in polymers. (Understand)

CO 8: Discuss degradation mechanisms in polymers. (Understand)

Mapping of Course Outcomes with Programme Outcomes:

Level – Low (1), Medium (2) and High (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1							1			
CO2	2	1										
CO3	2	1										
CO4	2	1				1	1			1		
CO5	2	1				1	1			1		
CO6	2	1										
CO7	1	1				1	1		1			
CO8	1	1				1	1			1		1

Unit 1. Fundamentals of fracture – molecular failure process. Failure modes: brittle failure, ductile failure, ductile-brittle transitions, toughened polymers, mechanisms of rubber toughening, failure of highly filled systems/composites. Fracture mechanics: linear elastic fracture mechanics (LEFM), fracture predictions based on stress concentration and stress intensity factor, fracture predictions based on an energy balance.

Unit 2. Fracture mechanics – Short term and long term test methods and analysis: impact strength, impact failure, creep rupture, fatigue, friction and wear.

Unit 3. Failure analysis and degradation of polymers – Identification of strategic weakness, stability of polymer structures,environmental effect on polymer failure - weather, thermal, photo and oxidation.

Unit 4. Degradation mechanisms- Ionizing radiation, hydrolysis, environmental stress cracking-crazing and cracking, electrical treeing and water treeing, chemical degradation, electrochemical degradation, biodegradation, physical ageing.

References

1 David C. Wright, Failure of Plastics and Rubber Products, RAPRA Technology Ltd. (2001).

2 Tim A. Osswald, Georg Menges, Material Science of Polymers for Engineers, 3rd Edn., Hanser Publications (2012).

3 R. J. Young, P. A. Lovell, Introduction to Polymers, 3rd Edn., CRC Press (2011).

4 R.J. Crawford, Plastics Engineering, 3rd Edn., Elsevier Butterworth-Heinmann (2002)

20-214-0704 Industrial Management

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Summarise the basic concepts of management. (Understand)

CO 2: Explain the theories and the functions of management. (Understand)

CO 3: Differentiate personnel management & human resource management and Recruitment & Selection. (Understand)

CO 4: Describe the various concepts in HRM (like absenteeism, transfers ,promotions and T&D. (Understand)

CO 5: Describe different concepts in Production management and Materials management. (Understand)

CO 6: Outline the basic concepts of Quality management. (Understand)

CO 7: Describes Marketing management and consumer behaviour. (Understand)

CO 8: Analyse Accounting concepts and principles and financial accounting concepts. (Apply)

Mapping of Course Outcomes with Programme Outcomes:

Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1								1	1	1		
CO2						1		1	1	1	1	
CO3						1		1	1	1		
CO4						1		1	1	1		1
CO5						1	1	1	1	1	1	
CO6						1	1	1	1	1	1	
CO7						1			1	1		
CO8						1			1	1		

Unit 1. Introduction to management **–** Definition of management, characteristics of management, levels of management, management skills. Theories: evolution of management theory, scientific management, principles of scientific management, administrative management, modern management theories. Functions of management: planning, forecasting, organizing, staffing, directing, motivating, controlling, coordinating, communicating, decision making.

Unit 2.Personnel management – definitions, objectives, characteristics, functions, principles, recruitment and selection of manpower, scientific selection, transfers, promotion, absenteeism, labour turnover, training and development of manpower, need, objectives, benefits, methods.

Unit 3.Production management: manufacturing systems, product design and development, plant location and layout, balancing production lines. Materials management: purchasing, stores and store-keepinginventory control. Quality management: definition, QC function, quality systems, quality control, quality cost, accounting for quality cost and loss, quality audit.

Unit 4.Marketing management – Evolution of marketing, modern concept of marketing-marketing functions, marketing systems, marketing mix, consumer behaviour, products mix, product line, advertising, pricing, market research, sales forecasting. Functions of financial management : cost accounting and control, fundamentals of accounting, balance sheet, source of finance, financial institutions, profit/loss account, cost of sales taxes, financial ratio, capital classification of capital, working capital, need for working capital, assessment of working capital, factors affecting working capital. Breakeven analysis, depreciation, equipment replacement policy.

References

1 Lawrence L. Bethel, Franklin S. Atwater, George H.E. Smith, Harvey A. Stackman Jr., James L. Riggs (Ed.), Industrial Organisation and Management, 6th Edn., Mc Graw Hill Inc. (1979).

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4 W J Reddin, Denis Ryan, Handbook of management by objectives, Tata Mcgraw-Hill (1988).

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11 Dennis Lock, The essentials of Project Management, Ashgate Publishing Ltd. (2014).

20-214-0711 Polymer Product Testing

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Test latex products, dry rubber products and plastic products as per specification.

Mapping of Course Outcomes with Programme Outcomes:

Level – Low (1), Medium (2) and High (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2							1	1		1

1. Testing of Latex products – gloves, thread, foam
2. Testing of Dry Rubber Products – sponge, MC sheet, cycle tyres and tubes, rubber to metal bonded products, hoses, belting
3. Testing of Plastic Products – films, sheets, pipes, laminates, blow moulded containers

References

1 BIS, ASTM, ISO Standards

20-214-0801 Project Work Report and Viva Voce

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Perform literature survey and analyse the recent technology developments in the field of polymer engineering. (Analyse)

CO 2: Design experiments related to the development of polymer products (Create)

CO 3: Perform experiments related to a research problem. (Apply)

CO 4: Analyse and solve problems related to polymer industries. (Analyse)

CO 5: Assess the experimental data generated during the experimental work. (Analyse)

CO 6: Develop components, products, processes or technologies in the polymer engineering field. (Create)

CO 7: Interpret results and make reports based on the project work. (Analyse)

CO 8: Apply knowledge gained in solving real life engineering problems. (Apply)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	2	1	2	1	1	1	1	1	1	1
CO2	3	2	2	1	2	1	1	1	1	1	1	1
CO3	3	2	2	1	2	1	1	1	1	1	1	1
CO4	3	2	2	1	2	1	1	1	1	1	1	1
CO5	3	2	2	1	2	1	1	1	1	1	1	1
CO6	3	2	2	1	2	1	1	1	1	1	1	1
CO7	3	2		1	2	1	1	1		1	1	1
CO8	3	2	2	1	2	1		1	1	1	1	1

Project Plan:

Do through literature survey to aquireindepth knowledge on the research topic assigned by the company/ institution. Finalization of the objectives and methodology relating to the assigned topic, preparing a detailed work plan for conducting the project work, including team work. Detailed Analysis/ Modelling/ Simulation/ Design/ Problem Solving/ Experiment as needed. Final development of product/process, testing, results, conclusions and future directions. Preparing a paper for Conference presentation/Publication in Journals, if possible. Preparing a report in the standard format for being evaluated by the assessment board. Final project presentation and viva voce by the assessment board including external expert.

Evaluation

Exam	**Mark Distribution**		
	Report	presentation & viva	Total Marks
Internal Assessment	50	150	200
External Assessment	50	150	200
Total Marks	100	300	400

20-214-0802 Industrial Training

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Identify the vaious processes involved in the manufacture of polymer products. (Analyse)
CO 2: Understand various machineries used for the manufacture of polymer products. (Understand)
CO 3: Analyse and solve problems related to polymer industries. (Apply)
CO 4: Make reports based on the industrial training. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	2	2	1	2	1	1	1	1	1	1	1
CO2	2	2	2	1	2	1	1	1	1	1	1	1
CO3	2	2	2	1	2	1	1	1	1	1	1	1
CO4	2	2	2	1	2	1	1	1	1	1	1	1

One month training in various polymer engineering industries like tyre industries, dry rubber product industries, latex industries, dipped goods industries, paint industries, adhesive industries, plastic product industries etc.

Evaluation

Exam	**Mark Distribution**		
	Report	presentation & viva	Total Marks
Internal Assessment	20	30	50
External Assessment	20	30	50
Total Marks	40	60	100

ELECTIVES

20-214-0521 Paints and Surface Coatings

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the different components of paint. (Understand)

CO 2: Explain the various resins used in paints. (Understand)

CO 3: Summaries the various types of pigments and its properties. (Understand)

CO 4: Generate appropriate paint formulations. (Apply)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1			1			1		1	
CO2	3	2	1			1	1		1		1	1
CO3	2	1	1			1	1		1		1	1
CO4	1	1	1	1		1	1	1	1		1	1

Unit 1. Paint basics – Significance of paint, Components of paint: binders, pigments, solvents, various additives. Binders: industrial resins- Alkyd, polyester, silicone, epoxy, acrylic, hydrocarbon, vinyl, formaldehyde based polymers, chlorinated rubber, polyurethanes, fluoro polymers. Hard resins and varnishes.

Unit 2. Ingredients – inorganic and organic pigments. Pigment dispersion: properties of pigments, factors affecting dispersions, preparation of pigment dispersion, grinding equipment, solvents, extenders, other additives. Formulations.

Unit 3. Painting processes – Surface preparation: mechanical cleaning, solvent cleaning, alkali cleaning, and acid pickling. Chemical conversion treatment. Paint application: mechanism of film formation. Applying processes: brushing, dip coating and flow coating, curtain coating, roller coating and spraypainting. Curing- Physical, chemical and oxidative curing.

Unit 4. Properties of Paints – mechanical, optical, rheological, flammability and environmental properties. Applications.

References

1 R.Lambourne, T.A.Strivens, Paint and Surface Coating: Theory and Practice, 2nd Edn., William Andrew Publishing (1993).
2 Arthur A.Traction, Coatings materials and surface coatings, CRC Press (2007).
3 Rodger Talbert, Paint Technology Handbook, CRC Press (2008).
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5 Philip A. Schweitzer, P.E. Paints and coating: Applications and Corrosion Resistance, CRC Press (2005).

20-214-0522Adhesives Technology

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the basics and theories of adhesion. (Understand)

CO 2: Summarise the different types of resins used as adhesives. (Understand)

CO 3: Design different adhesive joints (Analyse)

CO 4: Identify suitable adhesive formulation for various applications. (Analyse)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					1			1		1	
CO2	3	2	2			1	1		1		1	
CO3		2	2			1			1		1	
CO4		1	2			1	1		1			

Unit 1. Introduction to Adhesives – Adhesive bonding, characteristics and functions of adhesives. Adhesive and cohesive failure. Structural and non-structural adhesives. Classification of adhesives. Theories of adhesion: Adsorption, mechanical, diffusion and weak boundary layer theories. Wettability. Surface energy. Contact angle. Work of adhesion and cohesion.

Unit 2. Performance of adhesives – Types of stresses acting on adhesive joints: Tension/compression, shear, cleavage and peel stresses. Factors affecting stress distribution. Factors affecting adhesive performance. Adhesive composition. Design of adhesive joints. Testing of adhesives and adhesive joints.

Unit 3. Classification and types of adhesives – Classification based on origin, function, chemical composition, and method of reaction: single-part, multi-part, hot-melt, pressure sensitive etc. Epoxy, urethane, acrylic, phenolic, cyanoacrylate, silicone, water based adhesives etc.

Unit 4. Adhesive compositions and applications – Adhesive compounding additives: binders, hardeners, solvents, fillers, plasticizers etc. Formulations. Adhesives for special environments-high/low temperature, thermal cycling, vacuum, UV, ozone and corrosive atmosphere. Adhesives for specific substrates.

References

1 Edward M. Petrie, Handbook of Adhesives and Sealants, McGraw Hill Handbook, 2nd Edn. (2007).

2 A. Pizzi, K.L. Mittal, Handbook of Adhesive Technology, Marcel and Dekker Inc., 2nd Edn. (2003).

3 I. Skeist (Ed.), Handbook of Adhesives,Chapman and Hall, 3rd Edn. (1990).

20-214-0523 Disaster Management

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Differentiate the types of disasters, causes and their impact on environment and society. (Understand)

CO 2: Tell the Do's and Don'ts during various types of disasters. (Apply)

CO 3: Assess vulnerability and various methods of risk reduction measures as well as mitigation. (Analyse)

CO 4: Understand the relationship between disaster and development. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1			2			1	1	1	1	1	1	
CO2			2			2	2	1	2	3		
CO3		2				2	2	1	1	1	1	
CO4			1			1	1	1	1	1		

Unit 1. Introduction to Disasters – Definitions: disaster, hazard, vulnerability, resilience, risks. Types of disasters: earthquake, landslide, flood, drought, fire. Classification and causes of impacts including social, economic, political, environmental, health, psychosocial. Differential impacts- in terms of caste, class, gender, age, location, disability. Global trends in disasters: urban disasters, pandemics, complex emergencies, climate change. Dos and Don'ts during various types of disasters.

Unit 2. Approaches to Disaster Risk Reduction (DRR) – Disaster cycle, phases, culture of safety, prevention, mitigation. Preparedness for community based DRR: structural and nonstructural measures. Roles and responsibilities of community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), State Government, Central Government, and other stake-holders. Institutional processess and framework at State and Central Level: State Disaster Management Authority (SDMA), Early warning system, Advisories from appropriate agencies.

Unit 3. Inter-Relationship between Disasters and Development – Factors affecting vulnerabilities, differential impacts, impact of development projects such as dams, embankments, changes in land-use. Climate change adaptation: IPCC scenario and scenarios in the context of India. Relevance of indigenous knowledge, appropriate technology and local resources.

Unit 4. Disaster Risk Management in India – hazard and vulnerability profile of India, components of disaster relief: water, food, sanitation, shelter, health, waste management, institutional arrangements (mitigation, response and preparedness). Disaster Management Act and Policy: other related policies, plans, programmes and legislation. Role of GIS and Information technology components in preparedness, risk assessment, response and recovery, phases of disaster. Disaster damage assessment. Management of industrial disasters.

References

1 J. P. Singhal, Disaster Management, Laxmi Publications (2019).

2 Tushar Bhattacharya, Disaster Science and Management, McGraw Hill India Education Pvt. Ltd. (2012).

3 K.Gupta Anil, Sreeja S. Nair, Environmental Knowledge for Disaster Risk Management, NIDM (2011).
4 Kapur Anu, Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers (2010).
5 Govt. of India: Disaster Management Act , Government of India (2005).
6 Government of India, National Disaster Management Policy (2009).

20-214-0524 Biodegradable Polymers

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Get insight into various kinds of biodegradation, factors affecting biodegradation and environmental cues determining mechanism of biodegradation. (Understand)

CO 2: Predict biodegradability of polymers based on structure. (Analyze)

CO 3: Evaluate degree of biodegradation as per standard test protocols. (Evaluate)

CO 4: Obtain know-how on synthesis of various biodegradable plastics. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	2			1	1	1	1	1	1	2
CO 2	3	2	1						1			2
CO 3	1	1	1			1	1	1	1			1
CO 4	2	2	2	1		1	1	1	1			1

Unit 1 Biodegradation of Polymers- Biochemical and Environmental factors, Biodegradability- definition, criteria, Biodegradable polymers: Classification based on origin, structure, Physical, mechanical and chemical variations in properties, Surface and bulk erosion, Environmental cues: microorganisms and their role, Microbial degradation, Enzymes: enzyme nomenclature, specificity, factors affecting activity, mechanism of enzymatic degradation, Chemical degradation, Chemically initiated biodegradation: Hydrolysis of natural and synthetic biodegradable polymers

Unit 2 Biodegradable Plastics - Biodegradable plastics: Natural and Synthetic, examples, Biodegradable composites- Types, preparation, properties of of starch; starch- polymer films: fabrication, properties and testing. Biodegradable plastics and composites for packaging applications: pre-requisite properties and challenges, Evaluation of biodegradation by laboratory, environmental and accelerated test methods, Recycling: Methods and Challenges, Alternatives for starch based biodegradable plastic films

Unit 3 Biodegradable polyesters- Introduction, History, Biosynthesis properties and applications of synthetic and bacterial polyesters: crystal structure, morphology, biodegradation: thermal, hydrolytic, environmental and in vivo degradation.

Unit 4 Standards and test methods: Standards for evaluation of biodegradability, Criteria for selecting appropriate test standard, screening tests for ready biodegradability, tests for inherent biodegradability, tests for simulation studies, environmental tests, soil burial tests.

References

1 G.J.L Griffin Blackie (Ed.), Chemistry & Technology of Biodegradable Polymers Academic & Professional London (1994).
2 Yoshiharu Doi, Kazuhiko Fukuda (Ed.), Biodegradable Plastics & Polymers Elsevier (1994).
3 Abraham J.Donb& Others (Ed.), Handbook of Biodegradable polymers.
4 Harvard Academic Publishers Australia (1997).

20-214-0525 Polymers and Environment

Course Outcome

On sucessful completion of the course, the students will be able to:

CO 1: Aacquire in depth knowledge on the environmental issues related with polymeric materials. (Understand)

CO 2: Understand the polymers used in agriculture and packaging applications. (Understand)

CO 3: Dispose or reuse or recycle the polymeric materials. (Apply)

CO 4: Identify the carcinogenic and noncrcinogenic polymeric materials and chemicals used in polymer industries. (Analyse)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1	1		1	1	1	1	1	1	2
CO 2	2	2	1			2	2	2	2			2
CO 3	3	2	2	1		2	2	2	2	1	1	3
CO 4	3	2	2	1	1	1	1	1	1	1		2

Unit 1. Polymers and Environment – Environmental issues related to polymer industries, design for environment life cycle approach, contribution to energy, feed stock, transport, gross and net calorific value. Effectof plastic waste on wild life, aquatic life and water pollution, positive impact of plastic on environment. Effluent treatment at latex and rubber industries.

Unit 2. Polymers in agriculture – Green house films, Plastics in mulch films, plastics in silage, drip irrigation system. Polymers in packaging – Common packaging plastics.

Unit 3. Recycling – PET bottles and thermocol, disposal of waste plastics films. Energy recovery from waste polymer products. Disposal of plastics goods, Reuse and recycling of house hold plastic, recycling of e-waste, disposal and recycling of biodegradable plastics and food waste, biogas production, production of cooking gas from waste plastics. Tyre recycling, recycling of dipped goods and non-tyre products.

Unit 4. Flammability of polymers – Release of polymer vapours, ignition, combustion of polymer vapours. Fire propagation, fire resistant polymers. Methods to improve the fire resistance of polymers. Carcinogenic polymers and rubber chemicals.

References

1 Anthony L. Andrady, Plastics and environment, Wiley Inter Science (2003).

2 PrasanthRaghavan, Recycling of Natural Rubber based Waste Tyres – A Green Environment for the Future Recycled Polymers, Chemistry and Processing, Volume 1, Smithers RAPRA (2015).

3 Ian Hamerton, Polymers, the environment and sustainable, JohnWley and Sons (2003).

20-214-0526 Polymers for Packaging

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Compare various bioplastics suitable for packaging. (Understand)

CO 2: Discuss various processing techniques. (Understand)

CO 3: Explain fundamental properties of packaging materials. (Understand)

CO 4: Identify various packaging methods for raw as well as cooked food materials to increase shelf life. (Apply)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	1			1	1	1	1	1		2
CO 2	2	1	1			1	1		1			1
CO 3	2	1	1			1	1	1	1	1		1
CO 4	3	2	1		1	1	1	1	1	1		2

Unit 1. Edible and biobased food packaging materials – introduction, advantages & disadvantages. Edible films and coatings : polysaccharide based coatings, lipid based coatings and protein based coatings. Biodegradable packaging materials-first, second and third categories, comparison with commercial packaging materials.

Unit 2. Processing of thermoplastic packages – extrusion, calendaring, coating and laminating, stretch blow molding, foamed plastics, closures and sealing systems, vapour deposition, orientation and microperforation. Printing processes.

Unit 3. Properties of packaging materials – optical, tensile, bursting strength, impact strength, crease or flex resistance, coefficient of friction, blocking, orientation and shrinkage. Permeability: single and multilayer materials, gas permeability, water vapour permeability, factors affecting the diffusion & solubility coefficients.
Unit 4. Food packaging – Packaging materials: microwaveable foods, flesh foods, dairy products, cereals, snack foods & confectionary, beverages. Comparison of polymer packaging with paper, metal and glass materials. Aseptic packaging of foods. Active and intelligent packaging. Modified atmospheric packaging

References

1 Gordon.L Robertson, Food Packaging: Principles and Practices, CRC Press (2012).

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3 Stanley Sacharow, Roger C. Griffin, Jr., Basic Guide to Plastics Packaging, MassachusettsCahners (1973).

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20-214-0621 Polymers for Electrical and Electronics Applications

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Describe the structure, theory and properties of organic and inorganic semiconductors. (Understand)

CO 2: Explain the different preparation methods of conducting polymers. (Understand)

CO 3: Outline the properties and processing of conducting polymers. (Understand)

CO 4: Identify the application and device fabrication of conducting polymers. (Analyse)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3				2		1					1
CO2	2	1		2								1
CO3	3	1				1				1		1
CO4	2	1	1	1			1				1	1

Unit 1. Basics on inorganic and organic semiconductors – Classification of materials based on electrical conductivity. Basic laws on electrical conductivity: Ohms law and Coulomb's law. Valance band theory-basic concept of band model. Concept of doping. p-type and n-type doping and doping mechanism. p-n junctions. oxidative and reductive dopants. Inorganic and organic dopants. Type of doping technique. Charge carriers polarons, bipolarons and solitons. Effect of doping on the properties of organic and organic semi conductors. Effect of temperature on conductivity of inorganic and organic semiconductors.

Unit 2. Historical development and synthesis of important conducting polymers – Historical development of organic conductors. Basic structural characteristics of organic conductors. Methods of preparation of conducting polymers: chain growth polymerization, step growth polymerization, electrochemical polymerization. Synthesis of organic conductors: polyacetylene, poly(para phenylene), polyaniline, polypyrrole, poly(phenylene vinylene) and poly(vinyl carbazole). Conduction mechanism in organic conductors. Interchain and intrachain

conduction.

Unit 3. Properties and Processing of conducting polymers – Important properties of conducting polymers: electrical conductivity, photoconductivity, charge storage capacity, photoluminescence and electroluminescence. Dielectric constant, dielectric loss and absorption properties. Processing of conducting polymers. Methods to enhance the processability of conducting polymers. Advantages and disadvantages of conducting polymers

Unit 4. Applications of conducting polymers and device fabrication methods – Applications of conducting polymers. Electroactive applications polymer rechargeable batteries, supercapacitors, sensors, electrochemical actuators. Conductivity applications: antistatic coatings and conductive adhesives. Electronic applications: EMI shielding and Frequency selective surface. Space applications.

References

1. Tony Blythe, David Bloor, Electrical Properties of Polymers, 2nd Edn, Cambridge University Press. (2005).
2. H.S. Naiwa, Organic conductive molecules and polymers, John wiley and sons; vol. 2, (1977).
3. Prasanth Raghavan, Jabeen Fatima (Eds.), Polymer and ceramic electrolytes for energy storage devices, First Edition, Taylor and Francis, CRC Press (2020).
4. Neethu T. M. Balakrishnan, Prasanth Raghavan (Eds.), Electrospinning for advanced energy storage applications, Springer-Nature (2020).
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6. Pradip Kar, Doping in Conjugated Polymers, Scivener Publishing (2013).
7. J. Margolis, Conducting Polymers and Plastics, Chapman and Hal (1993).
8. M.E.O.Lyons (Ed.), Electroactive polymers, Plenum Press (1994).

20-214-0622 Footwear Technology

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the operations involved in footwear manufacture. (Understand)
CO 2: Select required adhesives and synthetic fabrics for footwear. (Analyse)
CO 3: Identify various footwear components and processes. (Apply)
CO 4: Understand the process of specialty footwear manufacture. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		1		1	1					1	1
CO2	3	1	2		1	1						1
CO3	2		1		1	1				1		1
CO4	2				1	2		1		1	1	2

Unit 1. Production of Footwear – Operations involved in making footwear. 'Built-up' footwear: DVP/DIP (Direct Vulcanising / Direct injection Moulding) process. Non-rubber materials used for footwear manufacture.

Unit 2. Adhesives and Synthetic Fabrics in Footwear – Adhesive formulations involving starch, glue, latex, rubber solutions, chloroprene, polyurethane (PU) etc. Properties of adhesives & their choice for different purposes and in construction as in DIP, DVP, cemented etc. Mechanism of adhesion. Fabrics used: cotton, rayon, nylon, polyester. Treatment of textiles for combining with rubber.

Unit 3. Cellular and Microcellular Materials – Natural and synthetic rubber based microcellular materials: PU, polyvinyl acetate (PVC), ethylene vinyl acetate (EVA) in microcellular soling; Direct vulcanizing / injection processes.
Unit 4. Specialty and moulded footwears – Footwear's for sports: Relation between surface, activity and footwear, materials and method of construction, preparation of uppers, sequence of operations. Sponge rubber moulded on slippers. Soled rubber moulded on footwear. Thermoplastic injection moulded on footwear. Cellular PU moulded on footwear. Mountaineering / hiking shoes, fireman, and oil refinery shoes.

References

1 J.H. Thornton, Text Book of Footwear Manufacture, National Trade Press Ltd., 3rd Edn. (1970).

2 J. Blakeman, An Introduction to Applied Science for Boot and Shoe Manufacture, The Anglo American Technical Co.Ltd. (1935).

3 R. Goontilleke, Science of Footwear, CRC Press, (2013).

4 I.A. Skoggard, Modern Shoe Making– Lasting, SATRA Publication, (1996)

5 A. J. Harvey, Footwear Materials and Process Technology, LASRA Publications,2nd Edn. (1982).

20-214-0623 Polymer Recycling

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Explain the need and benefits of polymer recycling. (Understand)

CO 2: Describe primary and secondary recycling aspects. (Understand)

CO 3: Explain tertiary and quaternary recycling routes. (Understand)

CO 4: Understand the recycling of commingled plastic and rubber wastes (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	1	1				2					
CO2	3	2	1			2	2					1
CO3	3	2	1			2	2					1
CO4	2	1	1			2	1	1			1	1

Unit 1. Introduction to polymer recycling – Need, benefits. Sorting and Separation Techniques: manual, density based, optical, advanced spectroscopic based, electrostatic. Recycling methods : primary, secondary, tertiary and quarternary.

Unit 2. Primary / secondary recycling (mechanical recycling) – Stages of recycling :pre sorting, size reduction, separation - separation of non-plastics, light contaminants, plastic-plastic separation. Cleaning and conversion into products.Recycling of polyolefins, polystyrene, PVC, acrylics, PET, PBT, ABS, Nylons, polyacetals, PC, PPO.

Unit 3. Tertiary recycling – Modes of decomposition. wet process : PET - glycolysis, methanolysis, hydrolysis, PMMA - catalytic cracking, PU - glycolysis, hydrolysis and alcoholysis, Nylon - hydrolysis. Dry process - pyrolysis and gasification. Catalytic cracking of polyolefins. Feedstock recycling of plastic wastes: chemical depolymerisation, gasification and partial oxidation, thermal process, catalytic cracking and reforming, hydrogenation. Quarternary recycling: energy recovery from plastic waste, incineration.

Unit 4. Recycling of commingled plastics, thermosets and rubber – Commingled plastics recycling : problems, methods, applications. Recycling of thermoset waste : problems, recycling technologies - mechanical, thermal & chemical recycling process, and uses of recyclates. Rubber recycling : crumb rubber , reclaimed rubber - devulcanization techniques, compounding with devulcanized rubber, properties and applications. Pyrolysis of waste rubber - conversion of used tire to carbon black and oil.

References

1 John Scheirs, Polymer Recycling: Science, Technology and applications, John Wiley and Sons Ltd. (2001)

2 G. Akovali, C. Bernardo, J. Leidner, L. A. Utracki, M. Xantho (Eds.), Frontiers in the Science and Technology of Polymer Recycling, 2nd Edn., Spriger Science and Business media (2013).

3 R. J. Ehirg (Ed.), Plastics Recycling: Products and Processes, Hanser Publications (1992).

4 Sadhan K. De, AvraamIsayev, KlementinaKhait (Eds.), Rubber Recycling, CRC Press (2005).

5 J. Aguado, D. Serrano, James H. Clark (Ed.), Feedstock Recycling of Plastic Wastes, The Royal Society of Chemistry (1999)

6 A. L. Andrady, Plastics and the Environment, John Wiley and Sons (2003).

7 J. Brandrup, M. Bittner, W. Michacli, G. Menges, Recycling and Recovery of plastics, Hanser Publications (1996).

20-214-0624 Specialty Polymers

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Summarise the different types of high temperature resistant polymers. (Understand)

CO 2: Understand the synthesis and properties of ionic polymers. (Understand)

CO 3: Develop polymers possessing novel properties. (Apply)

CO 4: Get an insight of the polymers used in concretes, propellants and explosives. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3		1			1					1	1
CO2	2	3			1	1						1
CO3	2	1	1	2	1							1
CO4	1	1		1	1		2				1	1

Unit 1. High temperature and fire resistant polymers – fluoropolymers, aromatic polymers, hydrocarbon polymers, polyphenylene sulphide, polysulphones, polyesters, aromatic polyamides, polyketones, heterocyclic polymers, fire resistant polymers, flame retardants.

Unit 2. Ionic polymers – Synthesis and physical properties: Ion-exchange, hydrophilicity, applications, ionomers based on polyethylene, elastomeric ionomers, ionomers based on polystyrene, PTFE, ionomers with polyaromatic backbones. Polyelectrolytes: ion exchangers, polyelectrolytes based on carboxylates, polyelectrolyte complexes.

Unit 3. Polymers with novel properties – Liquid crystalline polymers (LCPs): concept of liquid crystalline (LC) phase, liquid crystalline polymers and their classification, main chain LCPs and side chain LCPs, structure-property relationship, applications of LCPs. Conducting polymers: charge carriers, doping, synthesis of polyacetylene, polyaniline, polypyrrole, polythiophene. Photoconducting polymers. Polymers with peizoelectric, pyroelectric and ferroelectric properties.

Unit 4. Polymers for special applications – Polymer concretes, polymer binders for propellants, polymer-bonded explosives. Polymeric materials used in telecommunication and power transmission. Polymers in agricultural applications: green houses, mulches, control release of agricultural chemicals.

References

1 Manas Chanda, Salil K. Roy, Industrial Polymers, Specialty Polymers, and their Applications, CRC Press (2009).
2 Faiz Mohammad (Ed.), Specialty Polymers: Materials and Applications, I.K. International Pvt. Ltd, (2008).
3 Manas Chanda, Salil K.Roy, Plastics Technology Hand book, 5th Edn., CRC press (2018).
4 Jiri George Drobny, Polymers for Electricity and Electronics - Materials, Properties and Applications, 1st Edn., John Wiley & Sons (2012).
5 Pardip Kar, Doping in Conjugated Polymers, John Wiley & Sons (2013).
6 Robert William Dyson (Ed.), Specialty Polymers, Springer (2012).

20-214-0625 Materials Science

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Analysethe structure and size of the crystals. (Analyse)
CO 2: Explain the magnetic, optical and mechanical properties of the materials. (Understand)
CO 3: Select the appropriate polymer and ceramic materials for different engineering processes and applications. (Evaluate)
CO 4: Understand the conducting, semiconducting and superconducting behaviour of materials. (Understand)

Mapping of course outcomes with program outcomes:

Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	1								1
CO2	3		1		1		1					1
CO3	2	1	2		1		1			1		1
CO4	2	2				1	1	1				1

Unit 1. Crystal systems – Fundamental concepts, anisotropy, unit cell, structure, planes - Miller indices, symmetry. Single crystal and polycrystalline materials. Bonding in crystals: ionic, covalent, metallic and molecular bonds, bond energies. Recrystallisation techniques. Structure determination: X-ray and neutron diffraction, analysis of XRD spectra. Crystallinity and crystal size analysis- TEM vs XRD.

Unit 2. Magnetic properties – magnetic moment of a body, atomic magnetic moment, alignment of atomic magnetic moments in solids, ferromagnetism, temperature dependence of magnetisation, soft magnetic materials, hard/permanent magnetic materials. Optical properties: Absorption spectroscopy, electronic absorption in insulators, metals and semiconductors.Optical fibres. Luminescence. Principles of lasers.

Unit 3. Ceramics and composites – Classification of ceramics, structure, mechanical and thermal properties. Composites- mechanical properties of continuous and discontinuous fibre composites. Refractories and glasses, Comparison of physico-chemical, mechanical and thermal propertiesof polymer, ceramic and metal matrix composites.

Unit 4. Mechanical properties – Elastic, anelastic, viscous and plastic deformations, strength-tensile, compressive, shear and torsional. Hardness, ductility, fracture, fatigue and creep. Electrical properties of metals – role of valence electrons. Electron motion in applied electric field. Resistivity, superconductivity. Semiconductors- energy gaps, intrinsic and extrinsic, semiconductor materials, semiconductor devices, superconductors and their uses.

References

1. S.K.Hajra Choudhury, Materials Science & Processes, India Book Distributing Company (1978).
2. Materials Science and Engineering: A first course, V. Raghavan, 6th Edn., PHI Learning Pvt. Ltd. (2015).
3. William D. Callister, Jr., David G. Rethwisch, 8th Edn., Materials Science and Engineering-An introduction, John Wiley & Sons Inc. (2009).
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5. J.C.Anderson, K.D. Leaver, R. D. Rawlings, J. M. Alexander, Materials Science, 5th Edn., CRC press (2003).

20-214-0626 Introduction to Biomaterials and Medical Devices

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Obtain a comprehensive knowledge on fundamentals of biomaterials and its real demand in medical field (Understand)

CO 2: Apply the know-how as a criterion to predict tissue - biomaterial interactions and associated inflammatory reactions in our body (Apply)

CO 3: Validate the performance of a biomaterial in vitro as per the international standards based on the in vitro results (Evaluate)

CO 4: Design of simple biomaterials for biomedical applications (Create)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	2	1		1		2					1
CO2	2	1	2				1	1				1
CO3	1	1	1	1	2		1	1				1
CO4	1		1	1	3	2						1

Unit 1.. Biomaterials - Definition, Contemporary demand and clinical implications, Classification: based on origin, material, functionality, degradation and duration of implantation. Prerequisites of a biomaterial, Concept of biocompatibility, Bioactive, Bioinert and Bioresorbable biomaterial, Biodegradation and its mechanisms, Typical examples for polymers used as biomaterials: ultrahigh molecular weight polyethylene, poly(methyl methacrylate), hydrogels, silicone, polyurethanes, polylactic acid, polyglycolic acid and its copolymers, polycaprolactone, chitosan.

Unit 2. Tissue Engineering (TE) - Principles of TE, Biomimetics: Concept and its role in the advancement of tissue engineering, polymeric tissue engineering scaffolds, Surface functionalization of polymers and techniques employed, Tissue-biomaterial interactions, Inflammatory responses associated with implantation of a biomaterial. Sterilization of biomaterials, Different methods of sterilization: dry heat, UV irradiation, autoclave, ethylene oxide, gamma radiation, selection of suitable sterilization method for biomaterials.

Unit 3. Biomaterials Characterizations - Physicochemical Characterizations, *In vitro* cytocompatibility tests: trypan blue dye exclusion, MTT, live/dead assay, *In vitro*biofunctional assays, *In vivo* assays: importance and evaluation in animal models, Requirement of standards for validation of biomaterials: ISO and ASTM standards followed for biomaterials and medical devices. Pre-clinical evaluation.

Unit 4. Biomedical Devices – Definition, design of a typical medical device, Medical devices: extracorporeal devices (hemodialysis, apheresis, ultrafiltration), Oxygenators, Vascular grafts, Implants: soft tissue implants and hard tissue implants, Bone cement, Advanced drug delivery devices.

References

1 Joon Park, R. S. Lakes, Biomaterials: An Introduction , 3rd Edn, Springer Science, New York (2007)

2 Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, Biomaterials Science: An Introduction to Materials Science, 3rd Edn, Elsevier Academic Press (2004)

3 Medical Biomaterials by Prof. Mukesh Doble, IIT Madras, https://nptel.ac.in/courses/102106057/, available from 13/03/2017

4 Biomaterial for Bone Tissue Engineering Applications, Coordinated by IISc Bangalore https://nptel.ac.in/courses/113108071/#, available from 22/08/2016

5 Biomedical Nanotechnology, Coordinated by IIT Roorkee https://nptel.ac.in/courses/102107058/ available from 08/06/2016

6 Introduction to Biomaterials, Coordinated by IIT Kanpur https://nptel.ac.in/courses/113104009/#, available from 04/07/2012

7 Biomaterial-Tissue Interactions Instructors - Prof.IoannisYannas and Prof. Myron Spector
MIT Course Number 20.441J / 2.79J / 3.96J / HST.522J

8 J. C. L. Schuh, K. A. Funk, Compilation of International Standards and Regulatory Guidance Documents for Evaluation of Biomaterials, Medical Devices, and 3-D Printed and Regenerative Medicine Products. ToxicolPathol. 2019; 47(3):344-357. doi: 10.1177/0192623318804121.

20-214-0721 Tyre Technology

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Gain familiarity with the design of various types of tyres and their functions. (Understand)

CO 2: Get an insight into the materials used for the manufacture of tyres and tubes. (Understand)

CO 3: Comprehend and envisage the processes involved in the design and production of the components of various types of tyres and tubes.(Apply)

CO 4: Learn the non-destructive and destructive tests done on tyres and tubes. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1			1						1
CO2	2	1			1	1	1			1	1	1
CO3	1	1	2	1	1	1					1	1
CO4	2	1	1	1	1		1					1

Unit 1. Introduction to the history and development of tyres. Indian and global status of tyre industry. Types of tyres : bias, bias belted and radial. Basic functions of pneumatic tyres. Comparison of the performance of various types of tyres. Advantages of radial tyres. Tubed and tubeless tyres. Components of bias and radial tyres. Construction of bicycle tyres. Aircraft tyres. Benefits of filling nitrogen in tyres. Role of Indian Tyre Technical Advisory Committee. Tyre size designation. Winter tyres.

Unit 2. Introduction to the materials used in tyre manufacture–Ingredients of rubber compounds for tyres, tubes and tyre curing bladders. Typical formulations for tyre components. Compounding for radial tyres. Textiles used in tyre manufacture. Treatment of textiles - RFL dipping.

Unit 3**.** Manufacture of tyres: two wheelers, cars, trucks, OTR, farm and aircrafts. Calendaring process. Bias cutting. Extrusion of tread, side wall and other components. Dual extrusion of cap and base. Bead construction. Tyre building: machines for bias and radial tyres, components of tyre building machines. Inputs for tyrebuilding : inner liner, plies, bead assemblies, tread, breakers, belts and side walls. Sequence of building. Green tyre preparation. Awling. Shaping and curing in Bag-O-matic press. Typical cure cycle. Post cure inflation. Determination of optimum cure time by thermocouple studies. Cured tyre inspection. Tyre finishing. Design and manufacture of bicycle and automobile tubes.

Unit 4. Evaluation of tyres – Raw materials analysis, in-process tests and tests on finished products. Tyre dimension and size. Endurance test. Plunger test. Noise measurements, tyre balancing, mileage evaluation. Non-destructive tests such as X-ray and holography. Tyre maintenance. Retreading of tyres. Need for tyre re-treading. Hot and cold retreads. Tyre design: Tyre structure, tyre shape. Tread design. Tyre performance analysis: tyre stresses and deformations, tyre noise, rolling resistance, acquaplaning, tyre wear. Features and operations of tyre building machines: bead winding machines, wire belt processing machines, bias cutters and curing presses. Valves used in tyres. Recent developments in tyre technology.

References

1 John F. Purdy, Mathematics Underlying the Design of Pneumatic Tires, University of Michigan (1963 – Digitized on 25 Jul 2011).
2 ITTAC Standards Manual, Indian Tyre Technical Advisory Committee, New Delhi (2018).
3 L. J. K. Setright, AutomobileTyres, Chapman and Hall (1972).
4 Tom French, Tyre Technology, Taylor & Francis (1989).
5 Dr. S.N. Chakravarthy, Introduction to Tyretechnology, Polym Consultants- New Delhi (2012).
6 Samuel Kelly Clark, Mechanics of Pneumatic Tires, U.S. Department of Transportation, National Highway Traffic Safety Administration (1981 - Digitized on 17 Dec 2007).
7 F.J. Kovac, Tyre Technology, Goodyear Tyre& Rubber Company (1973).
8 Tyre Condition Guides, Indian Tyre Technical Advisory Committee, New Delhi (2018).

20-214-0722 Polymer Process Modelling and Simulation

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the mechanism of flow and leakage in film blowing process.(Understand)
CO 2: Analyse the flow pattern in injection moulding and estimate mould cooling time and flow length.(Analyse)
CO 3: Analyse the flow in compression moulding, rotational moulding and calendaring.(Analyse)
CO 4: Model the polymer melt flow through various channels of uniform cross section.(Create)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1			1						
CO2	2	1	2	1	1						1	
CO3	1	1	2	1	1						1	
CO4	1	1	1		1	1		1	1			1

Unit 1. Extrusion – General features: mechanism and analysis of flow, leakage power requirements, analysis of film blowing and blow moulding.

Unit 2. Injection moulding – General features: screws, nozzles and moulds, mould clamping force, heat transfer in polymers. Estimation of mould cooling time and flow length.

Unit 3. Analysis – Compression moulding, thermoforming, rotational moulding and calendering.

Unit 4. Modelling of polymer melt flow – Isothermal flow of Newtonian and power law fluids through different channels of uniform cross-section.

References

1 J. R. A. Pearson, S. M. Richardson (Eds.), Computational Analysis of Polymer Processing, Applied Science publisherrs (1983).
2 D. H. Morton-Jones, Polymer processing, Chapman and Hall (1989).
3 Tim A. Osswald, Polymer Processing: Modeling and Simulation, Hanser Publications (2006).

20-214-0723Smart and Intelligent Polymers

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Explain the basic concepts of smart materials and its working principles. (Understand)
CO 2: Outline the concept of various shape memory systems. (Understand)
CO 3: Explain the principles of various chromogenic materials. (Understand)

CO 4: Describe the properties of various smart polymers. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1								1	1
CO2	2	2	1	1			1				1	1
CO3	2	1		1		1	1					1
CO4	1	1	1	1		1	1					1

Unit 1. Smart materials and structures – System intelligence : components, classification of smart structures, common smart materials and associated stimulus-response, applications. Ferroelectric materials. Piezoelectric materials : piezoelectric effect, direct and converse, parameter definitions, piezopolymers, piezoelectric materials as sensors and actuators.
Unit 2. Shape memory materials – Shape memory effect (SME), Martensitic transformation, one way and two-way SME, rubber like effect. Shape memory alloys (SMAs), binary and ternary alloy systems, functional properties of SMAs. General applications of SMAs and smart materials.
Chromogenic materials: thermochromic, photochromic, electrochromic, chemochromic, mechanochromic- principle and applications.

Unit 3. Smart polymers – thermoresponsive, pH-responsive, photo-responsive, magnetically responsive polymers, synthesis, properties and applications. Smart hydrogels: types- thermoresponsive, pH responsive, light responsive, electroresponsive, synthesis, properties and application.

Unit 4.Self healing polymer systems: principle, types and applications. Smart polymers in medical devices, texiles and optical storage devices- applications.

References

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2 M. Addington, D.L. Schodek, Smart Materials and New Technologies in Architecture, Elsevier(2005).
3 K. Otsuka, C.M. Wayman (Eds.), Shape Memory Materials, Cambridge University Press(1998).
4 Maria Rosa Aguilar, Julio San Román (Eds.), Smart Polymers and their Applications, Elsevier (2014)
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9 Marinella Ferrara, Murat Bengisu, Materials that change Colour - Smart materials, Intelligent Design, Springer Science & Business Media (2013)

20-214-0724 Polymers in Space

Course Outcome

On successful completion of the course, the students will be able to:

CO1: Synthesise high temperature polymers used for space applications. (Understand)

CO 2: Understand the polymers used for thermal protection systems in space research. (Understand)

CO 3: Explain the properties of composites for satellites and launch vehicles. (Understand)

CO 4: Understand the types and propeties of polymers used for launch vehicles and Human in Space programme. (Remember)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1				1	1				1
CO2	1	1	2		1		1	1				1
CO3	2	1	1		1	1		1	1			1
CO4	2	1	1	1		1		1	1		1	1

Unit 1. High temperature polymers for space research – Synthesis, properties and processing of advanced thermoplastics, polyethers, poly (ether sulphones), poly (ether ether ketones) (PEEK), aromatic liquid crystalline polyesters, bismaleimide, polycarbonates.

Unit 2. Polymers for thermal protection systems – Synthesis and processing, high temperature resistant resins-epoxy, phenolic and polyimides. High temperature resistant polymers with metals in their back bone - boron, silicon and phosphorous containing polymers.

Unit 3. Composites for satellites and launch vehicles – Types: fibre composites, particulate composites, foam composites. Polymer matrix :desired properties of a matrix, thermosets,

thermoplastics. Fiber reinforced polymer (FRP): types of fibers-glass, carbon, aramid, metal, alumina, boron, silicon carbide and silica.

Unit 4. Propellant binders – Classification of propellants: solids, liquids, hybrids. Solid propellants: homogeneous, smokeless and heterogeneous (composite). Materials for space environment (HIS) : radiation shielding materials, atomic oxygen resistant materials, space suit materials and materials for life support systems. Materials for cryogenic applications:cryo insulation materials, polymers and adhesive for cryo temperature applications

References

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3 S.K. Mazundar, Composites manufacturing materials, product and process engineering, CRC press (2002).
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5 Urbensky, Chemistry and Technology of Explosives, Vol.2, Vol.3 and Vol.4, Pergamon Press (1985).

20-214-0725 Polymer Nanocomposites

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Understand the structural features and modification of nanomaterials. (Understand)

CO 2: Explain the various preparation methods for the synthesis of nanomaterials and nanocomposites. (Understand)

CO 3: Explain the various processing techniques of nanomaterials. (Understand)

CO 4: Explain the applications of polymer nanocomposites. (Understand)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1				1					1
CO2	2	1	2	1		1						1
CO3	3	2	1				1					1
CO4	21		1	1	1				1		1	1

Unit 1. Introduction to nanomaterials–History of nanomaterials, size and shape dependent properties, their uniqueness. Quantum confinement : zero dimensional, one dimensional, two dimensional nanostructures. Carbon based nano materials: fullerene, carbon nanotube, single walled and multi walled CNT, graphene, carbon onion, nanodiamond and films, modification with carbon nanotubes. Inorganic nanomaterials: nano silica, nano clay, organically modified layered clays, LDH, nanoZnO, nano TiO_2. Hybrid nanomaterials : core-shells, nanoshells, self-assembled nanostructures, POSS.
Unit 2. Nanoparticle synthesis – Introduction to nanoparticle synthesis: topdown and bottom up approaches, wet chemical methods for metal nanoparticles, quantum dots, nanoclusters, nanowires and rods, thin films. Physical nanofabrication techniques: introduction to PVD, MBE, CVD, self-assembly, lithographic techniques.

Unit 3. Processing of nanomaterials – Various methods used for the incorporation of nano fillers in polymer matrix: solution mixing, latex stage mixing, melt mixing, in-situ polymerization and precipitation. Dispersion and nucleating effects: Intercalation, exfoliation. Modification of polymers: layered and non-layered nano and micro particles.

Unit 4. Applications of nanomaterials– healthcare, biosenors, coatings, environment, catalysis, agriculture, automotives, electronics, photonics, information technology, quantum computing, energy sector, and aerospace sector.

References

1 K. Friedrich, S.Fakirov, Z. Zhang (Eds.), Polymer Composites – from Nano to Macro scale, Springer Science and Business Media Inc. (2005).
2 R. Krishnamoorti, R.A. Vaia, Polymer nanocomposites: Synthesis characterization and modelling, Americal Chemical Society (2002).
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5 T. Pradeep, Nano: The Essentials, McGraw-Hill (India) Pvt Limited (2008).

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7 Anke Krueger, Carbon Materials and Nanotechnology, Wiley-VCH Verlag GmbH & Co. KGaA (2010).

20-214-0726 Professional Ethics in Engineering

Course Outcome

On successful completion of the course, the students will be able to:

CO 1: Get fundamental insights into diverse kinds of ethics to be practiced self and in society. (Understand)
CO 2: Practice Self-ethics and professional ethics as an engineer (Apply)
CO 3: Realize the responsibilities and rights as an individual in the society (Analyze)
CO 4: Learn to be a good professional in corporate sector (Apply)

Mapping of course outcomes with program outcomes:
Level - Low (1), medium (2) and high (3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1			1		2		1		
CO2	2	1	1			1		2	1	1	1	
CO3	2	1	1			2		2	1	1		1
CO4	2	1	1			1		2	1	1		1

Unit1 Human Qualities and values- Honesty, Integrity, Courage, Self-awareness and wholeheartedness. Character -Character traits, Self- respect and self-confidence, Caring and sharing, Respect for others. Morals and ethics- Morals, Work ethics, Environmental ethics and Computer ethics, Service learning, Respect for others. Societal values: Humanity, Caring, Sharing, Valueing time, Cooperation, Commitment and Empathy. Professional excellence and stress management.

Unit 2Engineering Ethics- Senses of 'Engineers Ethics', Decision making: Black & white and grey areas, Emotional intelligence, Knowledge, experience and Wisdon Types of inquiry, Moral dilemmas, Moral Autonomy, Principles of obligation, Hierarchy of ethical obligations- primary secondary and tertiary. Professional competence: acquiring, maintaining. Confidentiality - significance and preservation, Misconduct and fraud, Fraud management.
Unit 3.Social Responsibilities and Rights- Engineers as responsible Experimenters, Codes of Ethics, Rights- Professional rights, employee Rights and intellectual Property Rights (IPR), Safety and Risk: Assessment, benefit analysis and methods for reducing risk, Respect for authority, Confidentiality, Conflicts of Interest, Occupational Crime, Discrimination.

Unit 4. Engineers as Leaders: Engineers as managers, consultants, experts and advisors: Eligibility and practices. Motivation- Gaining and giving, Leadership qualities for engineers. Professional excellence and human values. Social responsibilities- Principles and practices. Obeying law. Model Engineers for society

References

1 Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, NewDelhi, 2003.

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4 Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.

5 John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi(2003).

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കൊച്ചി ശാസ്ത്ര സാങ്കേതിക സർവ്വകലാശാല
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No.Conf.II/2941/2/2020 (12)

Dated: 15.01.2021

NOTIFICATION

In exercise of the powers conferred by Section 24(ii) read with Section 42(1) of the CUSAT Act 1986, the Academic Council at its meeting held on 08.07.2020 resolved to approve the revised Regulation and Course Structure for B.Tech in Polymer Science and Engineering offered at the Department of Polymer Science and Rubber Technology with effect from 2020 admissions as in Appendix.

The Syndicate at its meeting held on 21.12.2020 vide Item No.682.07 considered and approved the above resolution of the Academic Council.

Dr. MEERA V.
REGISTRAR

To

1. Dr. C.K. Aanandan, Dean, Faculty of Technology and Professor (Retd.), Department of Electronics, CUSAT, Kochi – 22.
2. Dr. Sunil K. Narayanankutty, Chairman, Board of Studies in Polymer Science and Rubber Technology, Professor, Department of Polymer Science and Rubber Technology, CUSAT, Kochi – 22
3. The Head, Department of Polymer Science and Rubber Technology, CUSAT, Kochi – 22
4. The Controller of Examinations/Joint Registrar (Academic/Exam)/ Assistant Registrar (Academic/Exam IV)/Deputy Registrar (Exam II).
5. Academic A,C/Exam. E.V/IRAA (Directorate of Admissions)/Exam Confidential Sections
6. Day File/Stock File/File Copy