Government Polytechnic, Mumbai

(Academically Autonomous Institute, Government of Maharashtra)

Name of the Programme : Diploma In Rubber Technology (Sandwich Pattern)

Learning and Assessment Scheme (P23)		**With Effect from Academic Year: 2023-24**
Duration Of Programme: 6 Semester		**Duration: 16 WEEKS**
Semester: Third		**Scheme: (P23)**

Sr. No	Course Title	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Paper Duration (hrs.)	Assessment Scheme													
					Actual Contact Hrs./Week			Self-Learning (Term Work + Assignment)	Notional Learning Hrs/Week			Theory					Based on LL & TL Practical					Basedon Self Learning		Total Marks
												FA-TH		SA-TH	Total		FA-PR		SA-PR			SLA		
					CL	TL	LL					T1	T2	Max	Max	Min	Max	Min	Max PR	Max OR	Min	Max	Min	
1	Latex Technology	SEC	RT23301	0	5	-	2	1	8	4	2.5	20	20	60	100	40	25	10		-	-	25	10	150
2	Rubber physics	AEC	RT23302		3		2	1	6	3	2.5	20	20	60	100	40	25	10	-	-	-	25	10	150
3	General Purpose Rubber	DSC	RT23303	2	4	-		2	6	3	2.5	20	20	60	100	40	-	-	-	-	-			100
4	Rubber Machinery	DSC	RT23304	0	4	-		2	6	3	2.5	20	20	60	100	40	-	-	-	-	-	-	-	100
5	Specialty Rubber	DSC	RT23305	2	4	-		2	6	3	2.5	20	20	60	100	40			-	-	-	-	-	100
6	Strength of Materials	DSC	AM23306	3	3	-	2	1	6	3	2.5	20	20	60	100	40	25	10	-	-	-	25	10	125
7	UHV II	DSC	UV23302		1		-	1	2	1	-	-	-	-	-	-	-	-	-	-	-	50	-	50
TOTAL				7	24		6	10	40	20		120	120	360	600	240	75	30	-	-	-	100	20	775

Abbreviations: CL- Classroom Learning, TL- Tutorial Learning, LL-Laboratory Learning, FA- Formative Assessments -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination, @$ Internal Online Examination

Note:

1. **FA-TH represents average of two class tests of 30 marks each conducted during the semester.**
2. **If candidate is not securing minimum passing marks in FA-PR of any course, then the candidate shall be declared as "Detained" in that semester.**
3. **If candidate is not securing minimum passing marks in SLA of any course, then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.**
4. **Notional Learning hours for the semester are (CL+LL+TL+SL) hrs.* 15 Weeks**
5. **1 credit is equivalent to 30 Notional hrs.**
6. *** Self learning hours shall not be reflected in the Time Table.**

Course Category : Discipline Specific Course Core (DSC) : 2, Discipline Specific Elective (DSE) : 0, Value Education Course (VEC) : 1, Intern./Apprentice./Project./Community (INP) : 0, Ability Enhancement Course (AEC) : 2, Skill Enhancement Course (SEC) : 2, Generic Elective (GE) : 0

Coordinator, Curriculum Development,
Department of Rubber Technology

Head of Department,
Department of Rubber Technology

In-Charge
Curriculum Development, Cell

Principal

Programme : Diploma in RT													
Course Code:RT23301					**Course Title : Latex Technology**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2.5 Hrs.)**	**FA - PR**	**SA**		**SLA**	**Total**
										PR	**OR**		
5	-	2	1	8	4	20	20	60	25	--		25	150

Total IKS Hrs. for course: 0hrs.

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination, @$ Internal Online Examination

Note:

1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work.
4. SA-PR represents the end term practical examination.

I. Rationale

Since rubber are normally derived from the latex, a student of rubber technology must have understanding of various characteristics of latex, its compounding & processing & testing, physical properties & their application.

II. Industry / Employer Expected Outcome

Natural rubber latex offers several key benefits that make it a highly desirable material choice surgical applications to industrial manufacturing, natural rubber latex tubing can be found in a wide range of diverse applications.

III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1	Understand about Cultivation of Natural Rubber Latex.
CO2	To Know about the different preservation & Concentration systems and their importance in latex
CO3	Analyse the various Characteristics & gelation mechanism of natural rubber latex.
CO4	Design the latex compounding ingredient Formulation.
CO5	Understand about the Solutions, dispersions and emulsions for Latex Compounding & Its Molding & Testing Equipments.
CO6	Diagnose Latex allergies

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1	**TLO 1a** Explain the Principle of rubber tree **TLO 1b.** Conditions required for the growth of Hevea brasiliensis, **TLO 1c**. Regions of the world where Hevea brasiliensis is found	**Cultivation of Natural Rubber Latex:** 1.1 The principle rubber tree: General description, more detailed structure of the mature trunk. 1.2 The Hevea brasiliensis plantations: Conditions required for the growth of Hevea brasiliensis, 1.3 Regions of the world where Hevea brasiliensis is found, outline of the history of the Hevea brasiliensis plantations 1.4 Propagation of Hevea brasiliensis: Introduction, Propagation by seed, Vegetative propagation. **Course Outcome: CO1 Teaching Hours: 4 hrs Marks: 06 (R- 2, U-2, A-2)**
2.	**TLO 2a .** Explain method of tapping **TLO 2b.** Why preservation of latex is required? **TLO 2c.** Properties of Natural latex **TLO 2d.** Factors of Latex yield	**Natural Lattices & Preservation & Concentration of Natural Rubber Latex:** 2.1 Tapping: Introduction, Early tapping system, modern tapping system, factors which affect the yield of latex, other methods of tapping, improvement of latex yield. 2.3 Preliminary considerations, The ideal preservative for natural rubber latex, Ammonia as a preservative, Ammoniation, Low-ammonia preservation system, other preservative for natural rubber latex. 2.5 Preliminary considerations, Concentration by evaporation, creaming, centrifugation and electrodecantation, 2.6 Properties of natural rubber latex concentrates.

		Course Outcome: CO2 Teaching Hours: 6 hrs Marks: 10 (R- 4, U-4, A-2)

3	**TLO 3a.** Explain process of Gelation **TLO 3b.** Concentration relationship .**TLO 3c**..Importance of pH in latex **TLO 3d** Curing system	**Fundamental Latex Characteristics & Its Gelation:** 3.1 Particle size & distribution, 3.2 Stability & destabilization of lattices, 3.3 Viscosity, 3.4 Concentration relationship, 3.5 Surface free energy & wetting behavior, 3.6 zeta- potential, Zinc oxide solubility with pH, 3.7 Significance of Gelation, 3.8 Heat gelling systems, 3.9 Delayed action gelling system, 3.10 Significance of pH/time gelation cure. **Course Outcome:CO3** **Teaching Hours: 6 hrs Marks: 10(R- 4, U-4, A-2)**
4	**TLO 4a.** Latex Ingredient **TLO 4b.**Explain vulcanizing agents, accelerators and activators **TLO 4c.** Name the soap used for dispersion of inorganic filler in water **TLO 4d.** Viscosity-modifiers and macromolecular colloid stabilizers,	**Latex Compounding Ingredients:** 4.1 Introduction, 4.2 Rubber vulcanizing agents, 4.3 Rubber vulcanization accelerators, 4.4 Rubber Vulcanization activators, 4.5 Rubber anti-oxidants, 4.6 Fillers and pigments, 4.7 Surface active substances, 4.8 Viscosity-modifiers and macromolecular colloid stabilizers, 4.9 Other latex compounding ingredients. **CourseOutcome: CO4 Teaching Hours: 8 hrs Marks: 08 (R- 2, U-4, A-2)**
5	**TLO 5a.** Preparation of aqueous solutions for latices **TLO 5b.** List of. compounding ingredients **TLO 5c**. Latex formulations **TLO 5d.** Effect of successive dilution with water in latex **TLO 5e**. Compare ball mill and pearl mill	**Preparation of Solutions, dispersions and emulsions for** 5.1 General considerations. 5.2 Preparation of aqueous solutions for addition to latices, 5.3 Preparation of aqueous dispersions of solid latex compounding ingredients, 5.4 Preparation of oil -in-water emulsions for addition to latices, 5.5 Representation of latex formulations. 5.6 Planetary mixer, turbo mixer, Jar mill, Ball mill or pebble mills. **Course Outcome: CO5** **Teaching Hours: 10 hrs** **Marks: 10 (R- 4, U-4, A-2)**

6	**TLO 6a.**Ingredients used in latex compounding **TLO 6b.**Types of mould used in latex **TLO 6c**. Difference between processing of latex and milled rubber **TLO 6d**. Explain flex resistance tester	**Latex Moulding & Casting & Testing Equipments**: 6.1 Outline of latex-moulding and casting processes, latex-moulding processes using plaster molds, latex-moulding processes using metal moulds, other latex-moulding and casting processes, after treatments for latex mouldings, castings and compounding. 6.2 Indentation hardness tester for foam, flex resistance tester, Mechanical stability Tester. 6.3 Difference between processing of latex and milled rubber. 6.4 Summary of hints for latex compounding and processing. **Course Outcome: CO5 Teaching Hours: 7 hrs Marks: 10 (R- 4, U-4, A-2)**
7	**TLO 7a.** Which constituent of latex causes allergy to human body? **TLO 7b.** Types of Latex **TLO 7c**. Explain Diagnosis of latex allergy, .	**Latex allergy:** 7.1 Introduction, 7.2 Causes, 7.3 Remedies, 7.4 Types of latex reactions and allergy, 7.5 Diagnosis of latex allergy, 7.6 Management of latex allergies etc. **Course Outcome: CO6 Teaching Hours: 4 hrs Marks: 06 (R- 2, U-2, A-2)**

V. Suggested Micro Project / Assignment/ Activities for Specific Learning / SkillsDevelopment (Self Learning):

1. Perform experiment for Coagulation of NR latex – Determination of pH, Total Solids, Ash
2. Write assignment for determination of DRC/VFA/NH3/KOH number.
3. Write assignment for Preparation of dispersions of Sulphur/ZnO/ZDC/Clay.
4. Write assignment for Film formation from the compounded NR Latex, Measurement of physical properties.
5. Write assignment for Preparation of Emulsion of Antioxidant, plasticizers
6. Write assignment for Compounding of NR latex with Fillers, testing of physical properties
7. Write assignment for Preparation of dipped articles – balloons, gloves etc

VI.Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Cultivation of Natural Rubber Latex**	2	2	2	6
2	**Natural Lattices & Preservation & Concentration of Natural Rubber Latex**	4	4	2	10
3	**Fundamental Latex Characteristics & Its Gelation**	4	4	2	10
4	**Latex Compounding Ingredients**	2	4	2	8
5	**Preparation of Solutions, dispersions and emulsions for Latex Compounding**	4	4	2	10
6	**Latex Moulding & Casting & Testing Equipment's**	4	4	2	10
7	**Latex allergy**	2	2	2	6
	Total	22	24	14	60

Suggested COs - POs Matrix Form

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	2	2	3	3	3	2	2	3	2
CO2	2	3	2	2	2	2	2	3	3
CO3	2	2	3	3	2	2	3	3	2
CO4	2	3	3	2	3	3	2	2	2
CO5	3	3	2	2	3	2	2	3	3
CO6	3	2	2	2	2	2	2	2	2

I. Suggested Learning Materials / Books

Sr. No.	Title	Author, Edition and Year Of publication	Publisher,
1	Natural Rubber Science & Technologies	Roberts	----------
2	Hand book of Rubber Projects, Tech. & Product Formulary. By:	--------	SBP Consultants & Engineers (P) Ltd.
3	Polymer Latices Vol.2	D. C Blackley	------
4	Polymer Latices Vol. 3	D. C Blackley	-------

Learning Websites & Portals

E-References:

- https://www.youtube.com/watch?v=_saC-xe8k80
- https://www.youtube.com/watch?v=O0tK_526PSw
- https://www.youtube.com/watch?v=7pKNnRKSAWA
- https://www.youtube.com/watch?v=tz5fohTXUGw
- https://www.youtube.com/watch?v=NfWuU87pPVY
- https://www.youtube.com/watch?v=nrfRWP1jnJ0

Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr. Ravindra Barde	Industry Expert	Sidhhi Elasto Pvt. LTD
2	Mr. Dharmesh Dhanani	Industry Expert	Elphiepoly
3	Mr. Sahil Ranoliya	Lecturer in Rubber Technology	AIRIA
4	Mr. Sahil Soliya	Lecturer in Rubber Technology	AIRIA

Coordinator,
Curriculum Development,

Department of Rubber Technology

Head of Department
Department of Rubber Technology

I/C, Curriculum Development Cell

Principal

Programme : Diploma in Rubber Technology													
Course Code: RT23302					**Course Title: Rubber Physics**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2.5 Hrs.)**	**FA - PR**	**SA**		**SLA**	**Total**
										PR	**OR**		
3	-	2	1	6	3	20	20	60	25	--		25	150

Total IKS Hrs. for course: 0hrs.

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination, @$ Internal Online Examination

Note:

1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work.
4. SA-PR represents the end term practical examination.

I. Rationale

A rubber technologist must have an understanding of Physics of raw and vulcanized rubber which include Viscosity, Elasticity and Solubility, understand stress-strain & other physical properties of vulcanized rubbers. This will help him to understand the principles governing their elastomeric nature & the mechanics of rubber product design.

II. Industry / Employer Expected Outcome

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Rubber physics involves the study of light and its interactions with matter. It has applications in various engineering fields such as telecommunications , imaging and laser technology.

III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1	Able to learn about Stress & Strain properties of elastomer.
CO2	Learn about the Classification of fluid behavior.
CO3	Understand About viscoelastic behavior.
CO4	Understand the importance of Viscosity for elastomers.
CO5	Details of solution properties of rubber to determine other parameter.
CO6	Learn the Importance of the Properties for designing of the component.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1	**TLO 1a** Definition of Stress, Strain **TLO 1b.**,What is thermoplasticity? **TLO 1c**. Relation Between Bulk modulus(K) & Young modulus (E), **TLO 1d.**:	**Stress and Strain:** 1.1 Elasticity, Stress & strain 1.2 Generalized Hook's Law, 1.3 Modulus of Elasticity, 1.4 Relation Between Bulk modulus(K) & Young modulus (E), 1.5 Deviation from perfect elastic behavior, 1.6 Plasticity and flow **Course Outcome: CO1 Teaching Hours: 4 hrs Marks: 06 (R- 2, U-2,A-2)**
2.	**TLO 2a** Types of time dependency in polymer **TLO 2b.** Various types of viscocity measuring instrument **TLO 2c**. Pascal's law and Pascalion fluid **TLO 2d** Explain process of solubility with the first law of thermodynamics	**Newtonian & Non–Newtonian fluid behaviour:** 2.1 Newton's law, Classification of fluid behaviour, 2.2 non-Newtonian fluid behaviour, 2.3 Time-independent fluid behaviour, 2.4 Viscoplastic fluid behaviour, 2.5 Shear-thickening or dilatant fluid behaviour, 2.6 Time-dependent fluid behaviour, 2.7 Visco-elastic fluid behaviour, 2.8 Dimensional considerations for visco-elastic fluids. **Course Outcome: CO2 Teaching Hours: 10 hrs Marks: 12 (R- 4, U-4, A-4)**

3	**TLO 3a.** Describe Voight Kelvin model with equation **TLO 3b**. Relaxation property **TLO 3c**.. Four-Parameter Model **TLO 3d. Explain** Maxwell Model with equation	**Mechanical Models for Linear Viscoelastic Response:** 3.1 Maxwell Model, 3.2 The Voight Element, 3.3 The Four-Parameter Model, 3.4 Material Response Time — The Deborah Number, 3.5 Relaxation and Retardation Spectra, 3.6 Superposition Principles. **Course Outcome: CO3** **Teaching Hours: 8 hrs** **Marks: 10 (R- 4, U-4, A-2)**
4	**TLO 4a** Various types of Viscosity measuring instrument – **TLO 4b** Advantages of Rapid Plastimeters **TLO 4c**. Terms of PRI and RPN and its importance in rubber industry	**Mooney Viscosity of Rubbers :** 4.1 Principle & Working of Mooney Viscometer – Explanation and their importance. 4.2 Plastimeters , PRI, RPN & its importance in rubber industry. 4.3 Viscometers & Rheometer. **Course Outcome: CO4** **Teaching Hours: 8 hrs** **Marks: 12 (R- 4, U-4, A-4)**
5	**TLO 5a**. Difference between theta solvent and theta temperature **TLO 5b** Concept of swelling and how it is measured in rubber industry **TLO 5c**. Explain Gibb's free energy equation	**Solution properties of Rubbers**: 5.1 Concept of Solubility parameter, 5.2 Theta solvent, 5.3 Theta temperature, 5.4 Thermodynamic of solubility, 5.5 Gibb's free energy, 5.6 Factors Affecting Swelling of Rubber by Fluids –solvents, oils etc. 5.7 viscosity average molecular Weight: Determination of molecular weight by Intrinsic viscosity method. **Course Outcome: CO5 Teaching Hours: 8 hrs** **Marks: 10 (R- 4, U-4, A-2)**

6	**TLO 6a**. Define Abrasion Resistance ,Permeability **TLO 6b**. Electrical properties of polymer **TLO 6c**. Factors affecting on Temperature, Compression &Tension **TLO 6d**. Explain Rebound resilience with properties **TLO 6e Define terms** Dielectric strength, break down Voltage and Creep.	**Properties of Rubbers:** 6.1 Factors affecting properties under Temperature, Compression &Tension. 6.3 Hysteresis with examples. Importance of Resilience, Tear, Abrasion, Flex & Fatigue Properties in Rubber article. 6.4 Permeability in Polymers. 6.5 Electrical properties of Polymers. 6.6 Dielectric strength and break down Voltage Creepage. 6.7 Time Temperature superposition. 6.8 Boltzmann superposition principle. **Course Outcome: CO6** **Teaching Hours: 7 hrs** **Marks: 10 (R- 4, U-2, A-4)**

V. Suggested Micro Project / Assignment/ Activities for Specific Learning / SkillsDevelopment (Self Learning):

1. Derive Stress, strain & tear properties of vulcanized rubbers.
2. Find out Mooney viscosity of different rubber at different temperatures
3. Derive Swelling of rubber in various fluids.
4. Preform Experiment of Hardness testing & write assignments for its importance in industry
5. Write Assignments for Abrasion Properties of different rubber & its Testing
6. Perform experiment of Flex Resistance Testing – De-mattia & Ross Flex
7. Perform experiment of Rebound Resilience of rubber.

VI. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Stress and Strain**	2	2	2	06
2	**Newtonian & Non – Newtonian fluid behavior**	4	4	4	12
3	**Mechanical Models for Linear Viscoelastic Response**	4	4	2	10
4	**Mooney Viscosity of Rubbers**	4	4	4	12
5	**Solution properties of Rubber**	4	4	2	10
6	**Properties of Rubber**	4	2	4	10
	Total	22	20	18	60

Suggested COs - POs Matrix Form

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3	3	3	3	1	2	1	3	2
CO2	3	2	2	2	2	2	1	3	3
CO3	3	3	3	3	2	2	1	3	2
CO4	3	2	3	3	1	3	1	2	2
CO5	3	3	2	2	1	2	1	3	3
CO6	3	2	2	2	2	2	1	2	2

I. Suggested Learning Materials / Books

Sr. No.	Title	Author, Edition and Year Of publication	Publisher,
1	The Physics of Rubber	Treolar	----------
2	Rubber Engineering	A.L.Gent	Hanser Publisher, Munich & Vienna.
3	Rubber Engineering	Freakley	Plenum press
4	Rubber Processing,	James L. White	----------

Learning Websites & Portals

E-References:

- https://www.youtube.com/watch?v=cZtmvv4R57w
- https://www.youtube.com/watch?v=j1ov7qWfJbM
- https://www.youtube.com/watch?v=imAacRXvOCU
- **https://www.youtube.com/watch?v=P8u2s7s4N3c**

Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr. Ravindra Barde	Industry Expert	Sidhhi Elasto Pvt. LTD.
2	Mr. Dharmesh Dhanani	Industry Expert	Elphiepoly
3	Mr. Sahil Ranoliya	Lecturer in Rubber Technology	AIRIA
4	Mr. Sahil Soliya	Lecturer in Rubber Technology	AIRIA

Coordinator,
Curriculum Development,

Department of Rubber Technology

Head of Department
Department of Rubber Technology

I/C, Curriculum Development Cell

Principal

Programme : Diploma in Rubber Technology													
Course Code: RT23303					**Course Title: General Purpose Rubber**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2.5 Hrs.)**	**FA - PR**	**SA**		**SLA**	**Total**
										PR	**OR**		
4	-	-	2	6	3	20	20	60	-	-	-	-	100

Total IKS Hrs. for course: 2hrs.

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination, @$ Internal Online Examination

Note:
1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work.
4. SA-PR represents the end term practical examination.

I. Rationale

A rubber technologist must have knowledge of various types of rubber like Natural rubber, Synthetic rubber viz. Styrene- butadiene rubber, Poly butadiene rubber, Reclaimed Rubber, Polyisoprene rubber, Butyl rubber etc. Their method of preparation, different grades and their properties and uses. It will help him to select a rubber for the desired application.

II. Industry / Employer Expected Outcome

In Rubber because of its elasticity, resilience and toughness it is the basic constituent of the tires used in automotive vehicles, aircraft and bicycles.

III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1	Understand about Natural Rubber its properties & processing
CO2	Understand chemistry & manufacturing process Synthetic Isoprene rubbers.
CO3	To know about Styrene-Butadiene Rubber (SBR) manufacturing process & Properties & Different grades.
CO4	To know about Polybutadiene Rubber (PBR) manufacturing process & Properties & Different grades.
CO5	Understand about Isobutene-Isoprene (Butyl) Rubbers manufacturing process & Properties & Different grades.
CO6	Understand about Reclaimed Rubber manufacturing process & Properties & Different grades.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1	**TLO 1a.** Explain about Natural rubber, its advantages and limitations **TLO 1b.** Why NR sheets keeps in smoke house **TLO 1c**. List different sources of NR **TLO 1d.**: Classification of SMR, ISNR	**Natural rubber (NR):** 1.1 Production of NR, 1.2 Conventional Grades- Pale crepe, Ribbed Smoked Sheets, Air-dried sheets, Michelin Sheets, Sole crepes, Brown and Blanket Crepes. 1.3 Technically Specified Rubbers (TSR) - SMR, ISNR, Countries producing TSRs. 1.4 Other Forms Of Natural Rubber – Technically Classified Rubbers, Oil-extended Natural Rubber, Tire Rubber, Deproteinized Rubber, Peptized Rubber, Powdered Rubber, Skim Rubber, Superior Processing Rubber, Heveaplus MG Rubbers, Epoxidized Natural Rubber and Thermoplastic Natural Rubbers. 1.5 Sources of natural rubber- Hevea brasiliensis, Guayule, Gutta Percha & Ballata. 1.6 Structure: - Property relationship in NR strain Induced Crystallization, Mastication. 1.7 Special Properties 1.8 Advantages & limitations. 1.9 End use Application of Natural Rubber **Course Outcome: CO1 Teaching Hours: 10 hrs** **Marks: 12 (R- 4, U-4, A-4)**

2	**TLO 2a.** Manufacturing process of polyisoprene rubber **TLO 2b.** Different isomerism of polyisoprene **TLO 2c**.Applications ofIR	**Synthetic Polyisoprene (IR) Rubbers:** 2.1 Preparation of Synthetic Polyisoprene (IR) Rubbers, Types of polymerization for Polyisoprene Rubber 2.2 Structure: - Property relationship 2.3 Special Properties 2.4 IISRP Numbering System, 2.5 Processing, 2.6 End use Applications **Course Outcome: CO2 Teaching Hours: 5 hrs Marks: 08 (R- 4, U-2, A-2)**
3	**TLO 3a.** Effect on glass transition temperature of SBR **TLO 3b** Process of cold and hot SBR **TLO 3c.**Contrast structure property between solution and emulsion SBR **TLO 3d.** End use Applications of SBR	**Styrene-Butadiene Rubber (SBR):** 3.1 Source and Manufacture of Emulsion SBRs & Emulsion SBRs , 3.2 Structure and Variations of Emulsion SBRs, 3.3 Structure and Variations of Solution SBRs, 3.4 IISRP Numbering System, 3.5 Special Properties 3.6 Comparison of Solution and Emulsion SBRs, 3.7 End use Applications **Course Outcome: CO3 Teaching Hours: 8 hrs Marks: 10 (R- 4, U-4, A-2)**
4	**TLO 4a.** Role of different catalyst used for PBR **TLO 4b.** List of homopolymer rubber **TLO 4c**. Chemical structure of PBR with applications properties	**Polybutadiene Rubber (PBR):** 4.1 Manufacture of Polybutadiene. 4.2 Structure and Properties of Polybutadienes, 4.3 IISRP Numbering System, 4.4 Classifications, 4.5 Special Properties 4.6 End use Applications. **Course Outcome: CO4 Teaching Hours: 6 hrs Marks: 10 (R- 4, U-4, A-2)**
5	**TLO 5a.** Grades of IIR **TLO 5b.**.Explain halogenation process of butyl with reaction **TLO 5c.** Determination of isoprene content in polyisobutylene	**Isobutene-Isoprene (Butyl) Rubbers:** 5.1 Manufacture of Isobutene-Isoprene Rubber 5.2 Structure-Property Relationships, 5.3 Grades, 5.4 Special Properties, 5.5 End use Applications of Unmodified Butyl Rubbers, 5.6 Halo butyl Rubbers (Chloro butyl & Bromo butyl), 5.7 End use Applications, **Course Outcome: CO5 Teaching Hours: 8 hrs Marks: 10 (R- 4, U-4, A-2**

6	**TLO 6a.** Process of making crumb rubber **TLO 6b.** Difference between crumb and reclaim rubber **TLO 6c.**Gases used in cryogenic process **TLO 6d.** Uses of Reclaimed rubber	**Reclaimed Rubber:** 6.1 Introduction, 6.2 Reclaiming Processes 6.2.1 Scrap-rubber Preparation 6.2.2 Digester Process 6.2.3 Heater or Pan Process 6.2.4 Reclaimator Process 6.2.5 Millroom Operations 6.3 The Advantages of using Reclaimed Rubber 6.4 Major Uses of Reclaimed Rubber 6.5 Rubberized Asphalt & Its End use application **Course Outcome: CO6 Teaching Hours: 8 hrs Marks: 10 (R- 4, U-4, A-2)**

V. Suggested Micro Project / Assignment/ Activities for Specific Learning / SkillsDevelopment (Self Learning):

1. Assignment on Reclaim and crumb rubber.(Constituents of polymer/ringforcing filler/process oil)
2..Requirement of zinc oxide /stearic acid in crumb rubber and reclaim rubber.
3. Particle size of crumb rubber and its effect on mechanical properties when added as an organic filler in rubber compound.

VI.Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Natural Rubber(NR)	04	04	04	12
2	Synthetic Polyisoprene (IR) Rubbers	04	02	02	08
3	Styrene-Butadiene Rubber (SBR)	04	04	02	10
4	Polybutadiene Rubber (PBR)	04	04	02	10
5	Isobutene-Isoprene (Butyl) Rubbers	04	04	02	10
6	Reclaimed Rubber	04	04	02	10
	Total	24	22	14	60

Suggested COs - POs Matrix Form

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3	2	3	3	3	1	2	3	2
CO2	3	2	2	2	2	1	2	3	3
CO3	3	2	3	3	2	1	3	3	2
CO4	3	2	3	3	3	1	2	2	2
CO5	3	2	2	2	3	1	2	3	3
CO6	3	2	2	2	2	1	1	2	2

I. Suggested Learning Materials / Books

Sr. No.	**Title**	**Author, Edition and Year Of publication**	**Publisher,**
1	Synthetic Rubbers, Their Chemistry & Technology	D.C. Blackley	
2	Handbook of Elastomers	Anil K. Bhowmick, Howard L. Stephenes	-------
3	Rubber Technology	Maurice Morton	-------

Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr. Ravindra Barde	Industry Expert	Sidhhi Elasto Pvt. LTD
2	Mr. Dharmesh Dhanani	Industry Expert	Elphiepoly
3	Mr. Sahil Ranoliya	Lecturer in Rubber Technology	AIRIA
4	Mr. Sahil Soliya	Lecturer in Rubber Technology	AIRIA

Coordinator,
Curriculum Development,

Department of Rubber Technology

Head of Department
Department of Rubber Technology

I/C, Curriculum Development Cell

Principal

Programme : Diploma in Rubber Technology													
Course Code: RT23304					**Course Title : Rubber Machinery**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2.5 Hrs.)**	**FA - PR**	**SA**		**SLA**	**Total**
										PR	**OR**		
4	-	-	2	6	3	20	20	60	--	--	--	--	100

Total IKS Hrs. for course: 2hrs.

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination, @$ Internal Online Examination

Note:

1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work.
4. SA-PR represents the end term practical examination.

I. Rationale

A Rubber Technologist must have an understanding of various machinery used in Rubber industry for conversion of raw rubber into finished rubber product.

II. Industry / Employer Expected Outcome

Rubber products machine operators are responsible for operating machines that are used to knead, blend, calender, mould, extrudes and cure rubber products from natural and synthetic rubber.

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III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1	To know the techniques of mixing different polymer.
CO2	Understand the process of Calendering.
CO3	Understand the process of Extrusion.
CO4	Compare the different molding techniques used for manufacturing of rubber products.
CO5	To know about Hand Building & Forming Equipments
CO6	Select the appropriate vulcanizing equipment for specific rubber product

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1	**TLO 1a** Working principle of two roll mill **TLO 1b.**,Difference between Banbury and kneader mixing **TLO 1c**. Explain Tandem mixing	**Mixing Mill:** 1.1 Two Roll mixing mill: Construction of mixing mill-cooling system, concept of friction ratio. Various size, 1.2 Single geared & double geared mills- relative advantage & disadvantage. 1.3 Ancillary Equipments for mixing mills- Apron, stock blender, cutting knives, Collector, safety devices on the mill. 1.4 Size of mill, how to calculate mill capacity, output of production. 1.5 Mastication on mill, Compound mixing, mixing sequence, Precaution with different rubber. 1.6 Energy & economic consideration, 1.7 Kneaders, 1.5 Transfer mix, 1.6 Banbury mixer, 1.7 Tandem mixing. **Course Outcome: CO1 Teaching Hours: 8 hrs Marks: 12 (R- 4, U-4, A-4)**

2	**TLO 2a.** Explain coating and frictioning in calendaring process **TLO 2b.** advantages and disadvantages of cross axis in calendering .**TLO 2c.** Roll bending in calendering	**Calenders:** 2.1 Types & sizes of typical machines, 2.2 Roll configurations, 2.3 Roll cambering, 2.4 Single trip & double rip arrangements for sheeting, 2.5 Equipments for coating of textile fabrics, 2.6 Friction coating, 2.7 Axis crossing devices, roll bending etc. **Course Outcome: CO2 Teaching Hours: 4 hrs Marks: 8 (R- 4, U-2, A-2)**
3	**TLO 3a.** What is Die swell in extruder **TLO 3b** L/D ratio of cold feed extruder and hot feed extruder **TLO 3c** Various parts of extruder along its function	**Extruders:** 3.1 Principle & Function, Construction of Ram type & screw type extruders, 3.2 Hot & cold feed extrusion di extruders, 3.3 Pin Barrel and Dual feed extruder. 3.3 Effects of screw length/dia. ratio, temp. 3.4 Control & ancillary equipment, 3.5 Extruder drives & power rating, 3.6 Machine selection. 3.7 Types of Heads **Course Outcome: CO3 Teaching Hours: 8 hrs Marks: 10 (R- 4, U-4, A-2)**
4	**TLO 4a.** Explain compression moulding process **TLO 4b.** Types of Injection moulding **TLO 4c**. Why surface treatment is required for moulding **TLO 4d.** Advantages and disadvantages of Transfer moulding **TLO 4e**. Heating methods	**Moulding Machine:** 4.1 Moulding, Review of Moulding Methods, 4.2 Compression Moulding, Transfer Moulding, Injection Moulding, 4.3 Materials handling & Mould Stripping 4.4 Mould lubricants, Surface treatments & Cleaning 4.5 Deflashing & Finishing of Moldings, 4.6 Blank preparation for moulding , Blank heating methods, 4.7 Injection moulding machine, types, screw & ram type machines, vertical injection moulding machines ejection techniques, 4.8 Compression moulding machines, 4.9 Transfer moulding machine. **Course Outcome: CO4 Teaching Hours: 12 hrs Marks: 12 (R- 4, U-4, A-4)**

5	**TLO 5a.** What is rubber lining **TLO 5b.** Roller covering	**Hand Building & Forming Equipments:** 5.1 Equipments for tank & pipe lining, 5.2 Roller covering, 5.3 Low pressure unreinforced hoses making. **Course Outcome: CO5 Teaching Hours: 5 hrs Marks: 06 (R- 2, U-2, A-2)**
6	**TLO 6a.**.Priciple of microwave vulcanization **TLO 6b.**.Curing methods **TLO 6c**. Different types of vulcanization equipment **TLO 6d** LCM vulcanization with reference to fluid	**Vulcanization Equipments:** 6.1 Autoclave, 6.2 Curing methods 6.3 Equipments for continuous vol. hot air tunnel, 6.4 Molten salt bath, 6.5 Fluidized bed, 6.6 Microwave curing, 6.7 New developments. **Course Outcome: CO6 Teaching Hours: 8 hrs Marks: 12 (R- 4, U-4, A-4)**

I. Suggested Micro Project / Assignment/ Activities for Specific Learning / SkillsDevelopment (Self Learning):

1. Components of mixing mill(2 roll)
2..latest version of its component and comparision with older one
3. Extent of lubrication for various part of 2 roll mill and its consistency for high mean time between failure use

I. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Mixing Mill**	4	4	4	12
2	**Calenders**	4	2	2	8
3	**Extruders**	4	4	2	10
4	**Moulding Machine**	4	4	4	12
5	**Hand Building & Forming Equipments**	2	2	2	6
6	**Vulcanization Equipments**	4	4	4	12
	Total	22	20	18	60

Suggested COs - POs Matrix Form

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3	2	3	3	2	2	1	3	2
CO2	3	2	3	3	2	2	1	3	3
CO3	3	1	3	3	2	2	1	2	3
CO4	3	2	3	3	2	3	1	2	2
CO5	3	1	3	3	2	2	1	3	3
CO6	3	2	2	2	2	2	1	2	3

I. Suggested Learning Materials / Books

Sr. No.	Title	Author, Edition and Year Of publication	Publisher,
1	Rubber Technology & Manufacturing	C.M Blow.	Butterworth Scientific, London.
2	Rubber Engineering	Freakley	Plenum Press

Learning Websites & Portals

E-References:

- https://www.youtube.com/watch?v=8SaYTtrz8y4
- https://www.youtube.com/watch?v=5TsvYGZ5dSE
- https://www.youtube.com/watch?v=YGXWYXd4LS8
- https://www.youtube.com/watch?v=3iU2MfWRLR8
- https://www.youtube.com/watch?v=YVYTx0Cnwv0

Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr. Ravindra Barde	Industry Expert	Sidhhi Elasto Pvt. LTD
2	Mr. Dharmesh Dhanani	Industry Expert	Elphiepoly
3	Mr. Sahil Ranoliya	Lecturer in Rubber Technology	AIRIA
4	Mr. Sahil Soliya	Lecturer in Rubber Technology	AIRIA

Coordinator,
Curriculum Development,

Department of Rubber Technology

Head of Department
Department of Rubber Technology

I/C, Curriculum Development Cell

Principal

GOVERNMENT POLYTECHNIC MUMBAI
GPM
ESTD. 1960
TRANSFORM KNOWLEDGE INTO WORK

Programme : Diploma in Rubber Technology													
Course Code: RT23305					**Course Title : Specialty Rubber**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2.5 Hrs.)**	**FA - PR**	**SA**		**SLA**	**Total**
										PR	**OR**		
4	-	-	2	6	3	20	20	60		--			100

Total IKS Hrs. for course: 2hrs.

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination, @$ Internal Online Examination

Note:

1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work.
4. SA-PR represents the end term practical examination.

I. Rationale

A rubber technologist must have a knowledge of various types of rubber like Ethylene- Propylene Rubbers, Chloroprene Rubber, Acrylonitrile Butadiene Rubber, Silicone Rubber, Specialty Rubbers etc. Their method of preparation, different grades and their properties and uses. It will help him to select a rubber for the desired application.

II. Industry / Employer Expected Outcome

In specialty rubber the silicone rubber products are highly versatile and are used in various applications. This type of rubber can sell in the form of sheets, mold and cut into pieces to form gaskets or rubber strips.

III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1	Identify chemistry & manufacturing process of Ethylene-Propylene Rubbers (EPM & EPDM).
CO2	To know about Acrylonitrile Butadiene Rubber (NBR) manufacturing process & Properties & Different grades.
CO3	Classify different Properties of Chloroprene Rubber (CR & its importance.
CO4	Identify properties of different grades of Silicones/Silicone Rubber.
CO5	Understand about Fluorocarbon Elastomers manufacturing process & Properties & Different grades
CO6	Understand about other specialty elastomers manufacturing process & Properties & Different grades.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1	**TLO 1a** Specific gravity of EPDM **TLO 1b.**,Importance of diene moomer **TLO 1c**. Rebound resilience of EPDM rubber **TLO 1d.**Applications of EPDM :	**Ethylene-Propylene Rubbers (EPM & EPDM):** 1.1 Manufacture of Ethylene-Propylene Rubber 1.2 Polymer Variables and Properties, 1.3 Variables between Grades, 1.4 Special Properties, 1.5 End use application of EPDM **Course Outcome: CO1 Teaching Hours: 8 hrs Marks: 10 (R- 4, U-4, A-2)**
2	**TLO 2a.** Chemical structure of acrylonitrile of NBR **TLO 2b.** Properties and applications of NBR **TLO 2c**..Effect of CAN content on NBR	**Acrylonitrile Butadiene Rubber(NBR):** 2.1 Manufacture of Acrylonitrile Butadiene Rubber 2.2 Structure and Properties Relationships 2.3 Special Grades of Nitrile Rubber, 2.4 Special Properties, 2.5 End use Application of NBR **Course Outcome: CO2 Teaching Hours: 8 hrs Marks: 10 (R- 4, U-2, A-4)**

3	**TLO 3a.** Trade name of chloroprene rubber **TLO 3b** Difference between NBR and CR **TLO 3c** Effect of polymerization on CR **TLO 3d** Applications	**Chloroprene Rubber(CR):** 3.1 Production of Polychloroprene, 3.2 Structure and Properties Relationships 3.3 Grades of CR 3.4 Special Properties, 3.5 End use of Application CR **Course Outcome: CO3 Teaching Hours: 8 hrs Marks: 10 (R- 4, U-4, A-2)**
4	**TLO 4a.** Operational temperature range and specific gravity of Silicone rubber **TLO 4b.** Rubber tubes used in food industry **TLO 4c**.Classification of silicone rubber **TLO 4d** Limitations of Silicone rubber	**Silicone Rubber :** 4.1 Nomenclature of Organosilicone Compounds & Elastomers 4.2 Manufacture of Silicone Elastomers, 4.3 Structure & Properties of Silicone Elastomer Polymers 4.4 Special Properties, 4.5 Liquid Silicone Rubbers 4.6 Room Temperature Vulcanizing Rubber(RTV), 4.7 End use Application. **Course Outcome: CO4** **Teaching Hours: 8 hrs** **Marks: 10 (R- 4, U-4, A-2)**
5	**TLO 5a.** Definition **TLO 5b.**.List of different fluorocarbon elastomer **TLO 5c**.Properties **TLO 5d Applications**	**Fluorocarbon Elastomers :** 5.1 Commercial Fluorocarbon rubbers 5.1.1 Manufacturing Process 5.1.2 Commercial Types 5.2 Structure and Properties Relationships 5.3 Special Properties, 5.4 End use Application **Course Outcome: CO5 Teaching Hours: 6 hrs Marks: 10 (R- 4, U-2, A-4)**
6	**TLO 6a.**. Full form of EVA, PTEE,PNR **TLO 6b.**.Structure of polyurethane and its properties **TLO 6c**. Grades, Types, Special Properties of EVA, PTEE,PNR **TLO 6d** Applications, Advantages and Disadvantages	**Other Specialty Rubbers:** 6.1 Polyurethanes 6.1.1 Grades, Types, Special Properties, 6.1.2 Vulcanization & Compounding 6.1.3 Special Application 6.1.4 Advantages & Disadvantages. 6.2 EVA 6.2.1 Grades, Types, properties 6.2.2 Special Properties, 6.2.3 Special Application 6.2.4 Advantages & Disadvantages. 6.3 Polynorbornenes Rubber (PNR) 6.3.1 Grades, Types, Special Properties, 6.3.2 Vulcanization & Compounding 6.3.3 Special Application 6.3.4 Advantages & Disadvantages.

		Course Outcome: CO6 Teaching Hours: 7 hrs Marks: 10 (R- 4, U-4, A-2)

V. Suggested Micro Project / Assignment/ Activities for Specific Learning / SkillsDevelopment (Self Learning):

1.Solubility of different chemicals limit in medium ACN nitrile rubber
2..Priority of sulphur in mixing sequence
3. Particle size ,coating of magnesium carbonate and polybutadine and PH value, acid value and impurities found in sulphur used for nitrile rubber
4. Effect of Acrylic rubber with compatibility of carbon silica and calcium carbonate.

VI.Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Ethylene-Propylene Rubbers (EPM & EPDM):**	04	04	02	10
2	**Acrylonitrile Butadiene Rubber**	04	02	04	10
3	**Chloroprene Rubber(CR)**	04	04	02	10
4	**Silicones/Silicone Rubber**	04	04	02	10
5	**Fluorocarbon Elastomers**	04	02	04	10
6	**Other Specialty Rubbers**	04	04	02	10
	Total	24	20	16	60

Suggested COs - POs Matrix Form

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3	2	3	3	3	2	2	3	2
CO2	3	2	1	2	2	2	2	3	3
CO3	3	2	3	3	2	2	3	3	2
CO4	3	2	3	2	3	3	2	2	2
CO5	3	2	1	2	3	2	2	3	3
CO6	3	2	1	2	2	2	1	2	2

I. Suggested Learning Materials / Books

Sr. No.	Title	Author, Edition and Year Of publication	Publisher,
1	Synthetic Rubbers, Their Chemistry & Technology	D.C. Blackley	
2	Handbook of Elastomers	Anil K. Bhowmick, Howard L. Stephenes	-------
3	Rubber Technology	Maurice Morton	-------
4	Rubber Materials & Their Compounds	J.A Brydson	

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Head of Department
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I/C, Curriculum Development Cell

Principal

GOVERNMENT POLYTECHNIC MUMBAI
GPM
ESTD. 1960
TRANSFORM KNOWLEDGE INTO WORK

Programme : Diploma in Rubber Technology													
Course Code: RT23306					**Course Title : STRENGTH OF MATERIAL**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2.5 Hrs.)**	**FA - PR**	**SA**		**SLA**	**Total**
										PR	**OR**		
3	--	2	1	6	3	20	20	60	25	--	--	25	150

Total IKS Hrs. for course: 2hrs.

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination, @$ Internal Online Examination

Note:

1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work.
4. SA-PR represents the end term practical examination.

I. Rationale

Rubber Diploma holders are required to analyze reasons for failure of different components and select the required materials for different applications in rubber industries. For this purpose, it is essential to teach them concepts, principles, applications and practices covering stress, strain, bending moment, shearing force. Hence this subject has been introduced. It is expected that efforts will be made to provide appropriate learning experiences in the use of basic principles to the solution of applied problems to develop the required Compentencies.

II. Industry / Employer Expected Outcome

.Strength of material is crucial in designing mechanical Components and structures that can withstand stress and load. With this knowledge, engineers can select appropriate materials and determine their sizes and shapes for specific applications.

III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1	Calculate simple stresses, strain and deformation in components.
CO2	Evaluate material properties & elastic constants.
CO3	Compute Moment of Inertia of simple & composite sections.
CO4	Draw shear force and bending moment diagrams in beams subjected to different types of loads.
CO5	Calculate stresses in shafts under twisting moments.
CO6	Calculate direct and bending stresses.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1	**TLO 1a** Definition of stress, strain, elastic, plastic and rigid bodies, **TLO 1b.**, Hooke's Law, Young's modulus, **TLO 1c**. . Concept of temperature stresses and strains, simple **TLO 1d.** : Advantages and limitations, numerical on modulus	**Simple Stresses and Strains** 1.1 Definition of elastic, plastic and rigid bodies, concept of deformation, stresses and strains, 1.2. Axial tensile and compressive load, Hooke's Law, Young's modulus, axial stress, axial strain, , modulus of elasticity, , problems on bars of uniform and stepped cross section. 1.3. Behavior of mild steel under tensile loading, stress-strain curve along with important points such as limit of proportionality, yield stress, ultimate stress, breaking stress. Factor of safety, safe stress, working stress for ductile and brittle materials. 1.4. Concept of composite section, advantages and limitations of composite section (Simple numerical problems). 1.5. Concept of temperature stresses and strains, nature of stresses, simple problems on temperature stresses on homogenous sections only. **Course Outcome: CO1,Teaching Hours:10 hrs,Marks:12 (R-2, U-4, A-6)**

2	**TLO2a.** Mechanical properties of elastic, definition of principal stress, principal plane **TLO2b.** Bulk modulus, modulus of rigidity& volumetric strain **TLO2c**.. Factor of Safety, Poisson's ratio **TLO2d.** Simple numerical problems	**Mechanical Properties and Elastic Constants** 2.1 Mechanical properties: Elasticity, Plasticity, Ductility, Brittleness, Malleability, Fatigue, Creep, Toughness, Hardness. 2.2 Strength. Factor of Safety, Stiffness and flexibility. 2.3 Linear and lateral strain, Poisson's ratio, changes in lateral dimension. 2.4, Bulk modulus, modulus of rigidity& volumetric strain. 2.5 Relation between three moduli. (Simple numerical problems). 2.6 Stress due to Gradual. Sudden and Impact load, corresponding deformation. Strain Energy, Resilience, Proof Resilience and Modulus of resilience. (Simple numerical problems). **Course Outcome: CO2,Teaching Hours: 10hrs, Marks:12 (R-2, U-4, A-6)**
3	**TLO3a.** Concept of moment of inertia, **TLO3b.** Parallel axis, perpendicular axis theorem **TLO3c.** Numerical problems on Moment of inertia	**Moment of Inertia** 3.1 Concept of moment of inertia for plane bodies, radius of gyration, section modulus, expression for moment of inertia about centroidal axes for regular plane figures such as rectangular, square, triangular, circular, semicircular and quarter circular sections. 3.2 Parallel axis theorem, perpendicular axis theorem, polar moment of inertia, Numerical problems on Moment of inertia of standard basic sections and composite sections such as I and T section. **Course Outcome: CO3, Teaching Hours: 07hrs, Marks:10(R-2, U-4, A-4)**
4	**TLO4a.** Concept and definition of shear force and bending moment **TLO4b.** Types of beams **TLO4c**. Simple numerical problems on point of contra flexure.	**Shear Force and Bending Moment** 4.1 Types of beams, supports & loads, Concept and definition of shear force and bending moment, sign convention, relation between bending moment, shear force and rate of loading. 4.2 Shear force and bending moment diagram for simply supported, cantilever and overhanging beams subjected to concentrated load, uniformly distributed load and couple, point of zero shear, point of contra flexure. (Simple numerical problems.) **(No numerical on External moment or couple)** **Course Outcome:CO4,Teaching Hours: 07 hrs, Marks:10(R-2, U-4, A-4)**

5	**TLO5a.** Torsion: Concept, field applications **TLO5b.**.Torsional resistance for hollow and solid circular shafts	**Torsion** 5.1Torsion: Concept, field applications (Shaft, flange couplings, shear bolts), torsional rigidity, torsional equation its derivation and assumptions. 5.2 Torsional resistance for hollow and solid circular shafts, Power transmitted by shaft, replacement of section. **Course Outcome:CO5,Teaching Hours: 06 hrs, Marks:8 (R-2 , U-2, A-4)**
6	**TLO6a.**. Axial and eccentric load, effects of eccentricity **TLO6b.**. Limiting eccentricity **TLO6c**. Axial stress and bending stress	**Direct and Bending Stresses** 6.1 Axial and eccentric load, effects of eccentricity, Field cases (Hook, clamp. Bench Vice, Frame etc). 6.2 Axial stress and bending stress, resultant stress intensities. resultant stress variation (Eccentricity about one axis only). 6.3 Limiting eccentricity, Core of section. 6.4 No tension condition. **Course Outcome:CO6,Teaching Hours: 05 hrs, Marks:8 (R-2 , U-2, A-4)**

V. Suggested Micro Project / Assignment/ Activities for Specific Learning / SkillsDevelopment (Self Learning):

1. List the various parts and their functions of Universal Testing Machine along with brief introduction of other test to be conducted on UTM
2. Tensions test on Mild steel/ Aluminium specimen plotting of stress strain curve and indicating significant points.
3. Shear test — Single and double shear for mild steel bar.
4. Compression test on timber cube.
5. Izod impact test on aluminium, copper, mild steel, brass, cast iron. (Any two metals).
6. Hardness test on various metals. (Brinell Hardness)
7. Assignment on Moment of Inertia
8. Assignment on direct and bending stresses.

VI.Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Simple Stresses and Strains	2	4	6	12
2	Mechanical Properties and Elastic Constants	2	4	6	12
3	Moment of Inertia	2	4	4	10
4	Shear Force and Bending Moment	2	4	4	10
5	Torsion	2	2	4	08
6	Direct and Bending Stresses	2	2	4	08
	Total	**12**	**20**	**28**	**60**

Suggested COs - POs Matrix Form

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	--	3	2	2	3
CO2	3	2	2	2	2	1	2	3	2	3
CO3	2	3	3	3	2	1	2	2	2	2
CO4	3	2	3	2	--	--	3	3	2	2
CO5	3	3	3	3	--	--	2	2	2	3
CO6	3	3	3	3	--	--	3	2	3	2

I. Suggested Learning Materials / Books

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Strength of Materials	S. Timoshenko, (D. Van Nostntnd Company Inc.)	978-1124155098
2	Strength of Materials	R.K, Bansal . (Laxmi Publication pvt ltd.)	978-8131808146
3	Strength of Materials	R. K. Rajput . (S. Chand & Company Ltd.)	9789352533695
4	Strength of Materials	S. Rarnamrutham. (Dhanpat Rai and sons Publishing House)	9789384378264

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1	Mr. Ravindra Barde	Industry Expert	Sidhhi Elasto Pvt. LTD
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Coordinator,
Curriculum Development,

Department of Rubber Technology

Head of Department
Department of Rubber Technology

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in ME/CE/EE/CO/IF/IS/EC/RT/LT/LG (Sandwich Pattern), AIML**										
Course Code: UV19R102				Course Title: Universal Human Values-II						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total (Credit)	TH (2 Hrs 30min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
--	**--**	**-**	**02**	**-**	**-**	**-**	**--**	--	**--**	**--**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination

Note: For Minimum passing marks under various heads, refer, examination rule AR26.Two practical skill tests are to be conducted. First skill test at mid-term and second skill test at the end of the term.

Rationale:

Universal Human Values-I course helped students to discover themselves and comfortably connect with their peers. Students experienced living in harmony with nature by visiting a nature park and participating in activities like tree plantation, beach cleaning and institute cleaning.

Universal Human Values-II course is more focused on helping students to create health consciousness and experience living in harmony with their bodies. It will help to create a holistic perspective based on self-exploration about themselves, family, society and nature.

Interactions with underprivileged sections of society will help to inculcate values like empathy, accountability and social gratitude. Patriotic values will be imbibed by learning about the constitution of India. Through experiential learning, an ideal personality will be developed to excel in the field of work. It is the journey of thought process from ‘my family’ to ‘world family’.

Course Outcomes: On completion of this course, student should be able to

CO1	Develop empathy for others.
CO2	Understand and appreciate duties and civic responsibilities.
CO3	Develop health consciousness
CO4	Develop respect and recognition for others work.
CO5	Understand the importance of living in harmony with nature and society.

Course Content Details:

Sr. No	Activity	Related Value/s	Methodology of Implementation	Student's Role	Mentor's role	Resources Required
01	Essay writing i)Role of engineer in development of nation ii)Global warming and its remedies iii)My favorite book iv)Bad and good of social media v)My best friend Mentor can add more essay topics related to mentioned values.	Social gratitude, Harmony in behavior, Accountability	Selecting a topic from the list and writing an essay on it	Thoughtfully write the essay on a selected topic.	Display the best essays on the notice board.	Notice board, panel of judges
02	Visiting under-privileged children of less or same age group - understand their life, difficulties, compare with your life, ' give ' them what you can i)Blind school ii)Slums iii)Physically handicapped schools iv)Adiwasi pada	Empathy Compassion Accountability Joy of Giving Social Gratitude	Students to arrange visit under supervision of mentor. Identify and impart technical skills needed to improve their lives.	Interact with the children, Observe their life pattern. Make them aware about technologies used in daily life.	Verify the visit plan and arrangements done by students see that discipline and safety is maintained during visit.	Traveling facilities, food and sufficient drinking water
03	Read preamble of constitution and list down duties and responsibilities of a citizen	Patriotism Integrity Loyalty Harmony Righteousness	Read preamble of constitution of India from internet website	Brainstorm to understand importance of preamble.	Motivate students to present different stories related to Indian constitution	https://www.constitutionofindia.net/constitution_of_india/preamble
04	To visit war memorial/ Hutatma smarak in city	Patriotism Respect	Students to arrange activity under supervision of mentor	List available war memorial/ Hutatma smarak in nearby area	Scrutinize and monitor the visit plan made by students	Traveling facilities, food and sufficient drinking water
05	Prepare your own SWOT Analysis	Self-exploration, Honesty	Analysis and report writing	Thoughtfully analyze self	Explain process of SWOT analysis	Case studies

06	Student will prepare a diet chart, analyze food consumption habit-List food consumed during last 3 days and identify its nutritional effects on body	Health consciousness	Balanced diet chart preparation	Find out the ways to maintain balanced diet chart	Provide information resources	Internet websites, Professiona l dietician
07	Identify 5 personalities from the areas like sports, defence, politics,, businesses and social work who have demonstrated great spirit of integrity in their life and write a report. e.g. **Rajendra singh**- Water man of india, **Dr. A P J Abdul kalam**-scientist and former president of india. **Mohammed Yunus**-Bangladeshi social entrepreneur, **Kapil Dev**-Cricketer of the century. **David Packard**-Chairman of Hewlett-Packard (HP)	Integrity , respect	Information collection and analysis	Identify personalitie s and study their extra-ordin ary work	Guide students to identify various dimensions of the personality	Internet websites, Institute Library
08	Spend an hour with the local municipal corporation disaster management cell.	Recognition of others' work	Visit disaster management cell of local municipal corporation in groups	Interact with the officers and staff	Distribute different groups of students in different local municipal corporations	List of local municipal corporations
09	Spend a day in a local housing society to spread awareness about efficient use of energy while using elevators and home appliances as well as during transportation	Environment Conservation	Interaction with society residents and office bearers	Identify local housing society, interact with people and write report	Make students aware about energy audit	Energy auditor

10	Study the Sustainable Development Goals of the United Nations for peace and prosperity of people and the planet, now and into the future by visiting the following website: https://sdgs.un.org/goals	Social Gratitude, Empathy, Compassion, Accountability	Visit the website, study history and List 17 sdgs	Study the sdg in detail (assigned to your group by mentor), prepare presentation	Assign 17 sdgs to different groups of students	Local NGOs working for UN

Methodology:

1. The course is Non Examination, Credit Course.
2. The course will be introduced during the student induction programme (orientation programme) of one week duration. Most of the activities are to be completed during induction programme and to be continued throughout the term during SCA hours under the guidance of mentor.
3. The mentor will be assigned to the student for a group of 20 students each.
4. In consultation and under supervision of a mentor, the student/ Group of students has to complete the activity.
5. Activities no.2, 7, 8 and 10 can be performed in collaboration with related government organizations or industries (under CSR activity).
6. All events will be organized and managed by students. The mentor will work as a facilitator/ advisor.
7. The strategies to learn the course is "Self- Exploratory" and "Experiential Learning"
8. The onus of responsibility for completing the activities is with students.
9. The student has to complete at least **five** no. of activities throughout the term to earn the credits.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	A Foundation Course in Human Values and Professional Ethics	R.R. Gaur, R. Sangal, G.P. Bagaria, Excel Books, New Delhi, 2010	978-8-174-467 81-2
2	Human Values	A.N. Tripathy, New Age International Publishers, 2003	978-8-122-425 89-5
3	Teacher's Manual - A Foundation Course in Human Values and Professional Ethics	R.R. Gaur, R. Sangal, G.P. Bagaria, Excel Books, New Delhi, 2010	-
4	Science and Humanism, Towards a Unified World View	PL Dhar, RR Gaur, Commonwealth Publications, 1992	978-8-171-692 22-4
5	Education for values in schools- a framework	NCERT	
6	Value oriented education	E N Gawande	

E-References:

1) https://youtu.be/kOJu1vj_BVk **(The 10 MostImportant Human Values)**
2) **Dr. Prakash Baba Amte- Movie**
3) https://youtu.be/QeogOlzG2ls **(Value of Education -short film)**
4) https://www.constitutionofindia.net/constitution_of_india/preamble
5) https://slidemodel.com/personal-swot-analysis-quick-guide/
6) **https://possible.in/balanced-diet-chart.html**

E-References for mentors:

1) **https://www.edutopia.org/**
2) **https://sdgs.un.org/goals**

Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Dr. L.A. Patil	Principal (Retired)	Pratap College, Amalner
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