GOVERNMENT POLYTECHNIC MUMBAI

(Academically Autonomous Institute, Government of Maharashtra)

Teaching and Examination Scheme (P22)with

effect from AY 2022-23

Programme: Diploma in Rubber Technology (Sandwich Pattern) **Term / Semester - III**

Course Code	Course Title	Teaching Hours/Contact Hours				Credits	Examination Scheme (Marks)						
							Theory			PR	OR	TW	Total
		L	P	TU	Total		TH	TS1	TS2				
RT22301	Latex technology	3	2		5		60	20	20	25*		25	**150**
RT22302	Rubber physics	3	2		5		60	20	20	25*		25	**150**
RT22303	General Purpose Rubber	3			3		60	20	20				**100**
RT22304	Rubber machinery	3			3		60	20	20				**100**
RT22305	Specialty Rubber	3			3		60	20	20				**100**
AM22306	Strength of materials	3	2		5	S	60	20	20	25		25	**150**
UV19R103	UHV III		2	-	2		-	-	-				-
	Total	**18**	**8**		**26**		**360**	**120**	**120**	**75**	**-**	**75**	**750**
Student Centered Activity (SCA)					**03**								
Total Contact Hours					**29**								

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 assessment, **#** indicates self, on- line learning Mode, **@** indicates on line examination

Note: Duration of Examination--TS1&TS2 -1hour, TH- 2:30 hours, PR/OR – 3 hours per batch, SCA- Library - 1 hour, Sports- 2 hours, Creative Activity-2 hours Self, online learning Mode through MOOCS /Spoken Tutorials / NPTEL / SWAYAM / FOSSEE etc.

Coordinator, Curriculum Development,

In-Charge Curriculum Development Cell

Head of Departments Department of Rubber Technology

Principal

Department of Rubber Technology

Equivalence Courses for Rubber Technology Programme

The following courses represent the equivalence courses for P-18 to P-22 scheme as follows:

Sem	Sr. No.	P-18 Scheme				P-22 Scheme			
		Course code	**Course Title**	**Mode of Exam**	**Credits**	**Course code**	**Course Title**	**Mode of Exam**	**Credits**
I	1	HU18101	Basics of communication	TH	3	HU22105	Business Communication	TH, TW	4
	2	HU18103	Generic Skill	OR	2	**No Equivalence**			
	3	HU18104	Environmental studies	OR, TW	2	**No Equivalence**			
	4	SC18104	Engg. Physics	TH, TW	5	SC22109	Engg. Physics	TH, PR, TW	5
	5	SC18105	Engg. Chemistry	TH, TW	5	SC22106	Engineering Chemistry	TH, PR , TW	5
	6	SC18107	Mathematics - I	TH	4	SC22107	Basic Mathematics - I	TH	4
	7	ME18201	Engg. Drawing I	PR, TW	6	ME22204	Engg. Drawing I	PR, TW	6
	8	RT18101	Basics of Organic Chemistry	TH	3	RT22103	Basics of Organic Chemistry	TH	3
	9	NC18101	Yoga		2	**No Equivalence**			
	10	NC18102	Social Work		2	**No Equivalence**			
II	11	CO 18201	Computer Fundamentals	TW	2	**No Equivalence**			
	12	HU18102	Communication skills	OR	2	**No Equivalence**			
	13	SC18108	Mathematics -II	TH	4	SC22108	Basic Mathematics -II	TH	3
	14	ME18301	Machine Drawing	TH, OR, TW	7	ME22207	Machine Drawing & Computer Aided Drafting	PR, TW	5
	15	ME18203	Basic of Mechanical Engg.	TH, TW	6	ME22206	Basic of Mechanical Engg.	TH, OR, TW	5
	16	EE18204	Basic of Electrical Engg.	TH, TW	5	EE22202	Basic of Electrical Engg.	OR, TW	4

	17	WS18201	Workshop Practices	TW	4	WS22208	Workshop Practices	PR, TW	4
	18	RT18201	Introduction to Polymer Science	TH	3	RT22201	Polymer Science	TH	3
III	19	AM18204	Strength of Materials	TH, TW	5	AM22206	Strength of Materials	TH, PR	5
	20	ME18205	Basic Thermodynamics	TH, OR, TW	6	**No Equivalence**			
	21	RT18301	Mould Design	PR,TW	6	RT22301	Latex Technology	TH,PR,TW	5
	22	RT18302	Rubber Physics	TH,PR,TW	5	RT22302	Rubber Physics		5
	23	RT18303	Rubber Chemistry	TH	3	RT22303	General Purpose Rubber	TH	3
	24	RT18304	Rubber and Its Compounding Ingredients	TH,OR,TW	8	RT22304	Rubber Machinery	TH	3
	25	--				RT22305	Specialty Rubber	TH	3

Program: Diploma in Rubber Technology (Sandwich Pattern)										
Course Code: RT22303				Course Title: General Purpose Rubber						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2.30 Hrs.)	TS1 (1 Hr)	TS2 (1 Hr)	PR	OR	TW	Total
3	**0**	**--**	**3**	**60**	**20**	**20**	**--**	**---**		**100**

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.

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.

Course Outcomes: Student should be able to

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.

Course Content Details:

Unit No	Topics / Sub-topics
1	**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	**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	**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	**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	**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	**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)**

Suggested Specifications Table (Theory):

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

References/ 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	-------

CO Vs PO and CO Vs PSO Mapping (Rubber Technology)

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

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

Program: Diploma in Rubber Technology (Sandwich Pattern)										
Course Code: RT22301				Course Title: Latex technology						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2.30 Hrs.)	TS1 (1Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	**2**	**--**	**5**	**60**	**20**	**20**	**25***	**---**	**25**	**150**

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.

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.

Course Outcomes: Student should be able to

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

Course Content Details:

Unit No	Topics / Sub-topics
1	**Cultivation of Natural Rubber Latex:** 1.1 The principal 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	**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	**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	**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. **Course Outcome: CO4 Teaching Hours: 8 hrs Marks: 08 (R- 2, U-4, A-2)**
5	**Preparation of Solutions, dispersions and emulsions for Latex Compounding:** 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	**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	**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)**

Suggested Specifications Table (Theory):

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

List of experiments/Assignments:

Sr. No.	Unit	CO	Experiments/Assignments	Approx. Hours
1	3	CO3	Write assignments for Mechanical stability of latex	02
2	3	CO3	Write assignments for Performance of various stabilizers of M.S.T of latex.	02
3	3	CO3	Perform experiment for Coagulation of NR latex – Determination of pH, Total Solids, Ash	04
4	3	CO3	Write assignment for determination of DRC/VFA/NH3/KOH number.	04
5	4	CO4	Write assignment for Preparation of dispersions of Sulphur/ZnO/ZDC/Clay.	04
6	5	CO5	Write assignment for Film formation from the compounded NR Latex, Measurement of physical properties.	04
7	5	CO5	Write assignment for Preparation of Emulsion of Antioxidant, plasticizers.	02
8	5	CO5	Write assignment for Compounding of NR latex with Fillers, testing of physical properties	04
9	6	CO5	Write assignment for Preparation of dipped articles – balloons, gloves etc.	04
			Total	**30**

References/ 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	-------

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

CO Vs PO and CO Vs PSO Mapping (Rubber Technology)

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

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

Program: Diploma in Rubber Technology (Sandwich Pattern)										
Course Code: RT22304				Course Title: Rubber machinery						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2.30 Hrs.)	TS1 (1Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	0	--	3	60	20	20	--	---		100

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.

Rationale:

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

Course Outcomes: Student should be able to

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

Course Content Details:

Unit No	Topics / Sub-topics
1	**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	**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	**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	**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: 10 (R- 4, U-4, A-4)**
5	**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	**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)**

Suggested Specifications Table (Theory):

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

References/ 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

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

CO Vs PO and CO Vs PSO Mapping (Rubber Technology)

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

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Coordinator,
Curriculum Development,
Department of Rubber Technology

Head of Department
Department of Rubber Technology

I/C, Curriculum Development Cell

Principal

Program: Diploma in Rubber Technology (Sandwich Pattern)										
Course Code: RT22302				Course Title: Rubber Physics						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2.30 Hrs.)	TS1 (1Hr)	TS2 (1Hr)	PR*	OR	TW	Total
3	2	--	5	60	20	20	25	---	25	150

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests,
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Note: For Minimum passing marks under various heads, refer, examination rule AR26.

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.

Course Outcomes: Student should be able to

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.

Course Content Details:

Unit No	Topics / Sub-topics
1	**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	**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	**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	**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	**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	**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)**

Suggested Specifications Table (Theory):

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

List of experiments/Assignments:

Sr. No.	Unit	CO	Experiments/Assignments	Approx. Hours
1	1	CO1	Derive Stress, strain & tear properties of vulcanized rubbers.	4
2	4	CO4	Find out Mooney viscosity of different rubber at different temperatures.	4
2	5	CO5	Derive Swelling of rubber in various fluids.	4
4	6	CO6	Preform Experiment of Hardness testing & write assignments for its importance in industry	4
5	6	CO6	Write Assignments for Abrasion Properties of different rubber & its Testing	4
6	6	CO6	Perform experiment of Flex Resistance Testing – De-mattia & Ross Flex.	6
7	6	CO6	Perform experiment of Rebound Resilience of rubber.	4
			Total	**30**

References/ 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	----------

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**

CO Vs PO and CO Vs PSO Mapping (Rubber Technology)

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

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

Program: Diploma in Rubber Technology (Sandwich Pattern)										
Course Code: AM22306				Course Title: **Strength of Material**						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2.30 Hrs.)	TS1 (1 Hr)	TS2 (1 Hr)	PR	OR	TW	Total
3	**2**	**--**	**5**	**60**	**20**	**20**	**25**	**-**	**25**	**150**

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.

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 require Competencies.

Course Outcomes: Student should be able top

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.

Course Content Details:

Unit No	Topics / Sub-topics
1	**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	**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: 10 hrs,Marks:12 (R-2, U-4, A-6)**
3	**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. 3.3 **Course Outcome: CO3, Teaching Hours:07hrs, Marks:10(R-2, U-4, A-4)**
4	**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	**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	**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)**

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**

List of experiments: (All experiments are compulsory.)

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	List the various parts and their functions of Universal Testing Machine along with brief introduction of other test to be conducted on UTM.	02
2	1	CO1	Tensions test on Mild steel/ Aluminium specimen plotting of stress strain curve and indicating significant points.	04
3	1	CO1	Shear test — Single and double shear for mild steel bar	02
4	1	CO1	Compression test on timber cube.	04
5	2	CO2	Izod impact test on aluminium, copper, mild steel, brass, cast iron. (Any two metals).	04
6	2	CO2	Hardness test on various metals. (Brinell Hardness)	02
7	3	CO3	Assignment on Moment of Inertia	02
8	4	CO4	Bending test on timber.	04
9	5	CO5	Torsion test on metal bar	04
10	6	CO6	Assignment on direct and bending stresses	02
Total				**30**

References/ 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

CO-PO and CO-PSO Mapping

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

Industry Consultation Committee:

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1	Mr. Ravindra Barde	Industry Expert	Sidhhi Elasto Pvt. LTD
2	Mr. Dharmesh Dhanani	Industry Expert	Elphiepoly
3	Mr.E.C.Dhembare	Lecturer in Mechanical Engg Dept.	Govt. Polytechnic Mumbai
4	Mr.M.A.Jadhav	Lecturer in Applied Mechanics Dept.	Govt. Polytechnic Mumbai

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

Program: Diploma in Rubber Technology (Sandwich Pattern)										
Course Code: RT22305				Course Title: Specialty Rubber						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2.30 Hrs.)	TS1 (1 Hr)	TS2 (1 Hr)	PR	OR	TW	Total
3	**0**	**--**	**3**	**60**	**20**	**20**	**--**	**---**		**100**

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.

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.

Course Outcomes: Student should be able to

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.

Course Content Details:

Unit No	Topics / Sub-topics
1	**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	**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	**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	**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	**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	**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)**

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

References/ 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	

CO Vs PO and CO Vs PSO Mapping (Rubber Technology)

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

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I/C, Curriculum Development Cell

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