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: Fifth (V)		**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					Based on 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	Metrology and QualityAssurance	DSC	ME23115	1	4	--	2	--	6	3	2.5	20	20	60	100	40	25	10	25#	--	10	--	--	150
2	Industrial Organization & Management	DSC	MG23501	2	2	--	2	2	6	3	2.5	20	20	60@$	100	40	25	10	--	--	--	25	10	150
3	Rubber Products Manufacturing	SEC	RT23501	2	3	--	2	3	8	4	2.5	20	20	60	100	40	25	10	--	--	--	25	10	150
4	Reverse Engg. & Analysis of Rubber Products	DSC	RT23502	2	3	--	2	1	6	3	2.5	20	20	60	100	40	25	10	--	--	--	25	10	150
5	Mould Design	DSC	RT23503	2	3	--	2	1	6	3	--	--	--	--	--	--	25	10	--	25	10	25	10	75
6	Project and Seminar	AEC	RT23504	--	--	--	4	4	8	4	--	--	--	--	--	--	50	20	--	50#	20	25	10	125
TOTAL				9	15	0	14	11	40	20	10	80	80	240	400	160	175	70	25	75	40	125	50	800

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

Department Coordinator	Head of Department	In-Charge	Principal
Curriculum Development Cell	Department of Rubber Technology	Curriculum Development Cell	Government Polytechnic, Mumbai

Programme : Diploma in ME/RT (Sandwich Pattern)	
Course Code: ME23115	**Course Title: Metrology and Quality Assurance**
Compulsory / Optional: Compulsory	

Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2Hrs 30mins.)**	**FA-PR**	**SA**		**SLA**	**Total**
						T1	**T2**			**PR**	**OR**		
4	**--**	**2**	**1**	**6**	**3**	**20**	**20**	**60**	**25**	**25#**	**--**	**--**	**150**

Total IKS hrs. for course: 1

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 total TWO class tests of 20 marks each conducted during the term.
2. SA-TH represents End term exam of 60 marks.
3. FA-PR represents Term work of 25 marks.
4. SLA represents self-learning assessment.

I. Rationale

This course trains students in the selection and use of measuring instruments and quality control tools.
It provides hands-on experience with various measurement techniques.
Students learn to choose appropriate materials for specific applications.
Basic material testing methods are introduced.
The course prepares students for roles in quality control and inspection.

II. Industry / Employer Expected Outcome:

Apply industrial engineering concepts, and managerial skills in industry.

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

CO1	Describe the terminology related with metrology and calibration requirements
CO2	Select and use of suitable measuring instruments for linear measurement and describe construction, working and applications of comparators.
CO3	Use instruments for angle measurement and thread measurement.
CO4	Interpret tolerances, fits and design Go-No Go gauges from given data and perform machine tool alignment testing
CO5	Select and use of suitable measuring instruments for surface roughness and flatness
CO6	Describe the elements of Quality management, TQM, Six Sigma and apply the technique of statistical quality control, acceptance sampling and estimation of process capability

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's.	Topics / Sub-topics
1	TLO 1.1 Define various parameters of Metrology and Measurement. TLO 1.2 Explain characteristics of measuring instruments. TLO 1.3 Explain different types of standards. TLO 1.4 Describe working principle of Linear measuring instruments.	**Basics of Engineering Metrology** 1.1 Disciplines of Metrology: Scientific metrology, industrial metrology and Legal Metrology, measuring characteristics of instruments & their significance: Least count, range, precision, accuracy, repeatability, sensitivity 1.2 Traceability and calibration: Need of Calibration, General requirements for the competence of testing and calibration laboratories (as per ISO 17025 - 2017 and NABL-129 related with dimensional metrology, Types and Sources of errors in measurement, concept of uncertainty **1.3** Types of standards: Line standard, End standard and wavelength standard, their comparison.
Course Outcome: CO1 Teaching Hours: 06 Marks: 10 (R-2, U-4, A-4)		
2	TLO 2.1 Explain construction and working of given comparators. TLO 2.2 Use gauges for given job with justification. TLO 2.3 Select slip gauges for building specific dimensions	**Linear measurement and Comparators** 2.1 Basic Measuring Instruments: Principle, construction and application/operation of Vernier callipers, Micrometres, Height gauge, Feeler gauges, Radius gauges, Screw pitch gauges, Slip gauges: specification, wringing and combination, Applications of slip gauges 2.2 Definition and Classification of comparators, requirements of good comparator **2.3** Working and applications of comparators: Dial indicator, Sigma comparator, Pneumatic Comparator
Course Outcome: CO2 Teaching Hours: 06 Marks: 10 (R-2, U-4, A-4)		
3	TLO 3.1 Select Angular measuring instrument for given component and calculate unknown angle. TLO 3.2 Calculate screw thread parameters using given method. TLO 3.3 Explain procedure of measuring the given parameters of gear TLO 3.4 Describe procedure for examining surface finish of the given component.	**Angular Measurement and Thread Measurement** 3.1 Concept of angle measurements, Working and use of universal bevel Protractor, Sine Bar, Sine Centre, Sine table and Spirit Level 3.2 Principle and Working of Clinometers, Angle Dekker, Angle Gauges: combination for setting required angle 3.3 Definitions and measurement of different thread elements such as major diameter, minor diameter, effective diameter, pitch for external threads 3.4 Construction, working and use of Thread Micrometres, floating carriage micrometre, Errors in threads, Pitch errors
Course Outcome: CO3 Teaching Hours:07 Marks:10 (R-2, U-4, A-4)		

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's.	Topics / Sub-topics
4	TLO 4.1 Explain concept of limits, fits and tolerances. TLO 4.2 Describe procedure of alignment tests for Lathe, milling machine and drilling machine as per IS standard	**Gauge Design and Machine Tool Testing** 4.1 Concept of Limits, Fits, And Tolerances, interchangeability, Hole and Shaft Basis System (IS-919-1993), Tolerance staking: worst scenario method and SD method 4.2 Classification of gauges, Taylor's Principle for gauge design, Design of Go-No Go Gauges from given data 4.3 Concept of Parallelism, Straightness, Squareness, Roundness, Run out 4.4 Alignment Test: Significance of alignment tests, Tools required, Procedure of alignment tests for Lathe, milling machine and drilling machine as per IS standard
Course Outcome: CO4	**Teaching Hours:07**	**Marks: 10 (R-2, U-4, A-4)**
5	TLO 5.1 Explain various techniques of qualitative analysis TLO 5.2 Explain procedure for measurement by CMM.	**Surface Roughness, Flatness Testing and Modern Metrology** 5.1 Terminology as per IS 3073- 1967, CLA, Ra, RMS values and their interpretation, 5.2 Various techniques of qualitative analysis 5.3 Talysurf roughness tester: construction and working 5.4 Principles of interferometry, Use of Optical flat for flatness testing 5.5 Introduction to laser metrology 5.6 Coordinate measuring machines (CMM): Construction, working and industrial applications.
Course Outcome: CO5	**Teaching Hours:05**	**Marks: 10 (R-2, U-4,A-4)**
6	TLO 6.1 Explain ddefinitions of quality and quality control TLO 6.2 State pprinciples and concept of 'Total Quantity Management TLO 6.3 Procedure of plotting Control charts for variables (X & R charts), control charts for attributes (P, C charts) TLO 6.3 Explain the concept of sampling inspection	**Quality Tools and Quality Management** 6.1 Definitions of quality and quality control, Quality characteristics, Quality of design, Quality of conformance, Quality of performance, Quality cost & its components, Comparison between Quality assurance and Quality Control, Inspection: Need, Types of inspection. Inspection stages, 6.2 Principles and concept of 'Total Quantity Management', Quality Audit, and its type, six sigma concept, Needs of quality standards, Introduction of ISO 9001 recent version, Revision of quality standards 6.3 **Statistical Quality Control:** Significance of SQC, Variables and attributes, Population and sample, Causes of variation assignable and random variations. Normal distribution curve. 6.4 Control charts: Plotting of Control charts for variables (X & R charts), control charts for attributes (P, C charts), selection

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's.	Topics / Sub-topics
		of appropriate type of chart, Process capability: estimation (Cp & Cpk), interpretation: Statistically capable and in capable processes. 6.5 Acceptance Sampling: Concept of sampling inspection, Comparison with 100% inspection, Different types of sampling plans, IS 4905-1968, working of various sampling plans, factors affecting on selection of sampling plan, Operating Characteristic Curve. consumer's risk and producer's risk
Course Outcome: CO6	**Teaching Hours:14**	**Marks: 10 (R-2, U-4, A-4)**

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Sr. No.	Laboratory Learning Outcome **(LLO)** aligned to CO's.	**Laboratory Experiment / Practical Titles / Tutorial Titles**	**Number of hrs.**	**Relevant COs**
1	LLO 1.1 Learning about laboratory safety, care and maintenance	Know your laboratory (Safety, care and maintenance)	2	CO1
2	LLO 2.1 Measure dimensional parameters by using linear measuring instruments.	Calibration Procedure for Vernier Calliper and micrometre	2	CO1,CO2
3	LLO 3.1 Operate various types of gauges for different applications	Use of basic measuring instruments: Surface plate, V-block, feeler gauge, radius gauge, thread gauge and height gauge	2	CO2
4	LLO 4.1 Check the geometrical parameters of a component with the help of pneumatic comparators.	Inspection of components using Pneumatic comparator	2	CO2
5	LLO 5.1 Operate dial indicator as mechanical comparator.	Use of dial indicator as mechanical comparator	2	CO2
6	LLO 9.1 Use sine bar for measurement of angle or taper of given component.	Angle measurement using Sine bar	2	CO3
7	LLO 7.1 Measure dimensional parameters by using various types of micrometers.	To measure major diameter, minor diameter, effective diameter, using floating carriage diameter measuring machine/thread micrometre.	2	CO3
8	LLO 8.1 Measure dimensional parameters by using Tool Maker's Microscope	To measure major diameter, minor diameter, pith, depth of thread and thread angle using profile projector/ Tool Maker's Microscope	2	CO3

9	LLO 9.1 Describe the procedure of designing gauge.	Assignment on Gauge Design	2	CO4
10	LLO 10.1 Describe alignment testing methods on machine tools	Alignment testing on centre lathe / drilling machine	2	CO4
11	LLO 11.1 Use different optical flats for measurement of surface flatness.	Surface flatness characterization using optical flats	2	CO5
12	LLO 12.1 Construct control chart for given variable (X,R chart)	Construct X,R chart and interpret the results/ Plotting of control chart for variables	2	CO6
13	LLO 13.1 Construct control chart for given attributes (P/C- chart)	Construct P/C- chart and interpret the results/ Plotting of control chart for attributes	2	CO6
14	LLO 14.1 Working of various sampling plans, factors affecting on selection of sampling plan	Sampling Inspection	2	CO6

VI. Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Basics of Engineering Metrology	2	4	4	10
2	Linear measurement and Comparators	2	4	4	10
3	Angular Measurement and Thread Measurement	2	4	4	10
4	Gauge Design and Machine Tool Testing	2	4	4	10
5	Surface Roughness, Flatness Testing and Modern Metrology	2	4	4	10
6	Quality Tools and Quality Management	2	4	4	10
	Total	**12**	**24**	**24**	**60**

Suggested COs - POs Matrix Form

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

VI. Suggested Learning Materials / Books

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Engineering Metrology	R. K. Jain, Khanna Publisher, Delhi, 22nd Ed; 2015	978-8189-4012-69
2	Text Book of Metrology	M. Mahajan, Dhanpat Rai & Co; 4th Ed, 2012	978-8177-0005-11
3	Text Book of Metrology	I.C. Gupta, Dhanpat Rai & Co; 4th Ed, 2018	978-8189-9284-52
4	Statistical Quality Control	M. Mahajan, Dhanpat Rai & Co.4th Ed, 2016	978-8177-0006-58
5	Statistical Quality Control	Douglas C Montgomery, Students' Resource Manual, Wiley India Pvt. Ltd. 5th Ed; 2002	978-0471-6781-06

VII. Learning Websites & Portals

Sr. No	Link / Portal	Description
1	boltdepot.com>fastners>information>measuring	Measuring instuments
2	mahr.com/ear/tester	Testing methods
3	openoregan.pressbook.pub>manufacturing process	Manufacturing process
4	support.minitab.com>en.os>acceptance sampling	Sampling inspections.
5	www.mitutoyo.co.jp	Sampling inspections.
6	www.nabl-india.org	Sampling inspections.

VIII. Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr. Malvankar Pundalik	Director	Sacardande Engg. Pvt. Ltd.,Mumbai
2	Mr. Mohanish Puralkar	Manager, R & D	Miles Ahead Tech Pvt. Ltd Mumbai
3	Mr. Rao V. B.	Assistant Professor	Fr. CR. College of Engg Mumbai
4	Mr. Moizuddin M.	Lecturer in Mech. Engg.	M.H.S.S. Polytechnic, Mumbai
5	Mr. Kiran Z. Dhangare	Lecturer in Mech. Engg.	Government Polytechnic, Mumbai
6	Mrs.A.N.Naik	Lecturer in Mech. Engg.	Government Polytechnic, Mumbai

Coordinator,
Department of Mechanical Engineering

Head of Department
Department of Mechanical Engineering

I/C, Curriculum Development Cell

Principal

Programme : Diploma in Rubber Technology (Sandwich Pattern)													
Course Code: MG23501					**Course Title: Industrial Organization & Management**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2Hours. 30mins.)**	**FA-PR**	**SA**		**SLA**	**Total**
						T1	**T2**			**PR**	**OR**		
2	**--**	**2**	**2**	**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:

This curriculum equips students with **essential business and operational skills** specific to rubber manufacturing, covering production planning, supply chain management, and quality control systems. It bridges technical knowledge with **industry-relevant management practices**, preparing graduates to optimize efficiency, costs, and sustainability in rubber-related enterprises

II. Industry / Employer Expected Outcomes:

Students will be able to understand and demonstrate the process flow and manufacturing technologies of various rubber-based industrial and consumer products.

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

CO1	Understand types of business, globalization, IPR, and basic management principles.
CO2	Know different organizational structures and ownership types used in industries.
CO3	Learn HR functions like recruitment and training in the rubber industry.
CO4	Understand industrial safety, laws, and dispute handling.
CO5	Know basic finance, costing, and inventory management in rubber production.
CO6	Apply project planning tools and lean methods in rubber operations.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1.	TLO 1.1**:** Define types of businesses and explain the concept and impact of globalization. TLO 1.2**:** Describe functions of management and outline Henri Fayol's principles.	**Unit 1: Introduction to Business & Management** Definition & Types of Business: Service, Manufacturing, Trade Globalization: Meaning, Importance, Pros & Cons Intellectual Property Rights (Patent, Copyright, Trademark) Definition of Management vs Administration Henri Fayol's Principles Functions of Management
Course Outcome: CO1 Teaching Hours 6 hours, Marks: 6 (R-2, U-0, A-4)		
2	TLO 2.1: Compare different organizational structures used in industries. TLO 2.2: Differentiate types of business ownership and apply suitable models to rubber industries.	**Unit 2: Organizational Structure & Ownership** Types of Organizational Structures: Line, Staff, Functional, Project Ownership Types: Proprietorship, Partnership, Joint-Stock Designing Organization for Rubber Industry
Course Outcome: CO2 Teaching Hours 6 hours, Marks: 6 (R-2, U-0, A-4)		
3	TLO 3.1: Explain HRM functions including recruitment and training. TLO 3.2: Identify training needs and HR challenges specific to the rubber industry.	**Unit 3: Human Resource Management** HRM Functions: Recruitment, Training Developing Training Programs for Rubber Technicians HR Challenges in Rubber Industry
Course Outcome: CO3 Teaching Hours 8 hours, Marks: 6 (R-2, U-2, A-4)		
4	TLO 4.1: Identify causes of industrial accidents and suggest preventive measures. TLO 4.2: Explain major industrial legislations relevant to manufacturing sectors.	**Unit 4: Industrial Safety & Legal Framework** Causes of Accidents, Safety Precautions Industrial Legislations: Factory Act, ESI, GST Industrial Dispute Resolution
Course Outcome: CO4 Teaching Hours 8 hours, Marks: 6 (R-2, U-2, A-4)		
5	TLO 5.1: Analyze basic financial documents and cost elements in rubber production. TLO 5.2: Apply inventory control models and explain the purchase process for rubber chemicals.	**Unit 4: Financial & Materials Management** Production Budget, Balance Sheet Analysis Cost Element Calculations for Rubber Compounding ABC & EOQ Inventory Models Purchase Process for Rubber Chemicals
Course Outcome: CO5 Teaching Hours 8 hours, Marks: 6 (R-2, U-4, A-4)		
6	TLO 6.1: Develop project plans using CPM/PERT and conduct break-even analysis. TLO 6.2: Implement lean manufacturing tools like Kaizen and 5S in rubber industry operations.	**Unit 6: Project & Operations Management** CPM/PERT Networks for Project Planning Break-even Analysis Lean Tools: Kaizen and 5S in Rubber Industry
Course Outcome: CO6 Teaching Hours 8 hours, Marks: 6 (R-2, U-4, A-4)		

Note: Any one unit from the above five units, has to be preferably taught by alumni of Govt. Polytechnic

Mumbai.

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	**Sr. No**	**Laboratory Experiment / Practical Titles / Tutorial Titles**	**Number of hrs.**	**Relevant COs**
Understand different types of businesses and management roles	1	Case study on service, manufacturing, and trade businesses	4	CO1
Identify key organizational structures and ownership types	2	Prepare organizational charts for different ownership types	4	CO2
Develop a basic training plan for rubber industry workers	3	Design a training schedule for new rubber technicians	4	CO3
Explain causes of accidents and legal safety norms	4	Prepare a safety checklist for rubber industry operations	4	CO4
Analyze components of a sample balance sheet	5	Balance sheet interpretation activity	4	CO5
Apply inventory control models to rubber raw materials	6	EOQ/ABC analysis exercise using sample data	4	CO5
Construct a basic CPM/PERT network for a rubber project	7	Draw and evaluate a CPM/PERT chart for plant setup	4	CO6
Implement lean tools for process improvement	8	Conduct a 5S audit or Kaizen suggestion plan for a rubber manufacturing scenario	2	CO6
		Total	**30**	

VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning):

Note: Student are required to complete any four micro projects from the suggested list given below. Similar micro projects could be added or given to the students by the concern faculty.

1. **Prepare a Comparative Report on Business Types**
   Activity: Select one example each of service, manufacturing, and trading businesses and compare their objectives, operations, and market scope.
   Related CO: CO1
2. **Design an Organizational Structure for a Rubber Product Unit**
   Activity: Develop a chart showing reporting hierarchy and department functions for a small-scale rubber manufacturing firm.
   Related CO: CO2
3. **Create a Training Module for New Rubber Industry Recruits**
   Activity: Prepare a simple training module including objectives, content, duration, and assessment method for workers.
   Related CO: CO3
4. **Develop a Safety Awareness Poster / Handbook**
   Activity: Design an informative poster or safety manual highlighting common hazards and precautions in rubber industries.
   Related CO: CO4
5. **Prepare a Mini Financial Plan with Break-even Analysis**
   Activity: Using assumed data, create a simple cost sheet, budget, and perform break-even analysis

for a small rubber product.
Related CO: CO5 & CO6

V. Specification Table:

Unit No	Topic Title	R	U	A	Total Marks
1	Introduction to Business & Management	2	0	4	6
2	Organizational Structure & Ownership	2	0	4	6
3	Human Resource Management	2	2	4	8
4	Industrial Safety & Legal Framework	2	2	4	8
5	Financial & Materials Management	2	4	4	10
6	Project & Operations Management	2	4	4	10
Total		**12**	**12**	**24**	**48**

VI.Suggested COs - POs Matrix Form

Course Outcome s (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PSO-1	PSO-2
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

VII.Suggested Learning Materials / Books:

Sr. No.	Title	Author, Edition, and Year	Publisher (India)	ISBN
1	Principles of Management	P.C. Tripathi & P.N. Reddy, 6th Ed., 2022	Tata McGraw-Hill	9789352607123
2	Human Resource Management	K. Aswathappa, 8th Ed., 2017	McGraw Hill Education	9789352607611
3	Industrial Engineering and Management	O.P. Khanna, Revised Ed., 2019	Dhanpat Rai Publications	9788177000209
4	Financial Management for Non-Financial Managers	H. V. Jhamb, Latest Ed., 2020	Everest Publishing House	9788186314944
5	Industrial Safety and Environment	A. K. Gupta, 1st Ed., 2014	Laxmi Publications	9789380386503
6	Operations Management	S. Anil Kumar & N. Suresh, 2nd Ed., 2015	New Age International Publishers	9788122438121

VIII. Learning Websites & Portals:

1. https://swayam.gov.in
   Free online courses by Indian institutes (IITs, IIMs) on management, HR, finance, and operations.
2. https://nptel.ac.in
   Government of India portal offering video lectures on Industrial Management, Safety, and Business.
3. https://www.coursera.org
   Offers global certification courses on Business, Project Management, HRM, and Operations.
4. https://www.udemy.com
   Affordable courses on Lean, Kaizen, 5S, GST, and financial analysis.
5. https://www.mygov.in
   Provides resources and awareness on Indian laws, ESI, GST, and safety norms.
6. https://www.investopedia.com
   Comprehensive portal for financial terms, budget analysis, and cost management.

XI. 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. Sunil Kumar Shrivastava	Expert in Rubber Technology	Arizona Techzeal
4	Mr. E. C. Dhembare	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of Rubber Technology

Head of Department
Department of Rubber Technology

I/C, Curriculum Development Cell
Government Polytechnic Mumbai

Principal
Government Polytechnic Mumbai

Programme : Diploma in Rubber Technology (Sandwich Pattern)													
Course Code: RT23501					**Course Title: Rubber Products Manufacturing**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2Hours. 30mins.)**	**FA-PR**	**SA**		**SLA**	**Total**
						T1	**T2**			**PR**	**OR**		
3	**--**	**2**	**3**	**8**	**4**	**20**	**20**	**60**	**25**	**--**	**--**	**25**	**150**

Total IKS Hrs. for course: 2hours.

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:

This course equips students with knowledge and practical experience in the manufacturing of rubber products, aligned with industry needs for professionals skilled in design, processing, and quality control in rubber technology.

II. Industry / Employer Expected Outcomes:

Students will be able to understand and demonstrate the process flow and manufacturing technologies of various rubber-based industrial and consumer products.

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

CO1	Understand cellular rubber products and their manufacturing processes.
CO2	Explain the production of rubber gaskets, washers, seals & rubber to metal bonded products.
CO3	Describe vibration isolators and mounts, including design and compounding.
CO4	Demonstrate knowledge of hoses and tubing manufacturing.
CO5	Explain manufacturing processes of rubber rollers, printing blankets, and conveyor belting.
CO6	Understand footwear manufacturing processes.

IV. Course Content Details:

UnitNo.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1.	1. Explain the concept of sponge and expanded rubber. 2. Understand compounding ingredients used in cellular rubber. 3. Describe manufacturing techniques for sponge and expanded rubber.	**Unit 1: Cellular Rubber** 1.1 Introduction 1.2 Difference between sponge & expanded rubber 1.3 Compounding of sponge rubber 1.4 Manufacture of expanded rubber
Course Outcome: CO1,Teaching Hours :8 , Marks: 10		
2.	1) Understand the function and selection of rubber for sealing applications. 2) Describe methods of manufacturing rubber-to-metal bonded items.	**Unit 2: Gaskets, Washers, Seals & Rubber to Metal Bonded Products** 2.1 Properties of gasket, washer & seal materials 2.2 Selection of rubber for oil seals 2.3 Types of seals 2.4 Manufacturing methods 2.5 Metal surface preparation for rubber to metal bonding. 2.6 Rubber to metal bonded product manufacturing.
Course Outcome: CO2 Teaching Hours 7 hours, Marks: 10		
3	1. Define and explain vibration and shock principles. 2. Understand isolation and damping systems. 3. Explain compounding for vibration and manufacturing methods.	**Unit 3: Vibration Isolators and Mountings** 3.1 Vibration & Shock 3.2 Principles of Isolation & Damping 3.3 Design & Compounding 3.4 Manufacturing methods
Course Outcome: CO3 Teaching Hours:8 hours , Marks: 10		
4	1) Explain hose design, construction and various types. 2) Describe the manufacturing process and testing.	**Unit 4: Hoses & Tubing** 4.1 Hose design and construction 4.2 Manufacturing Process 4.3 Fittings and Couplings 4.4 Hydraulic assemblies 4.5 Testing & Maintenance
Course Outcome: CO4,Teaching Hours:8 hours , Marks: 10		
5	1. Understand roller design and manufacturing. 2. Explain belt structure and manufacture.	**Unit 5: Rubber Rollers, Printing Blankets & Conveyor Belting** 5.1 Rubber rollers - types, design & manufacturing. 5.2 Printing blankets 5.3 Conveyor belts - functions, design, manufacturing
Course Outcome: CO5 Teaching Hours: 07 hours Marks: 10		

6	1) Identify components and processes in footwear manufacturing. 2) Understand adhesive use and testing.	**Unit 6: Footwear** 6.1 Manufacturing processes 6.2 Types of adhesives 6.3 Testing adhesives 6.4 Component manufacturing
Course Outcome: CO6 Teaching Hours: 07 hours Marks: 10		

Note: Any one unit from the above five units, has to be preferably taught by alumni of Govt. Polytechnic Mumbai.

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	**Sr. No**	**Laboratory Experiment / Practical Titles / Tutorial Titles**	**No. of hours.**	**Relevant Cos**
Formulate and test a rubber compound to achieve specified hardness.	1	Preparation of a Rubber Compound to Achieve Required Hardness	4	CO1
Produce sponge rubber using blowing agents and curing methods.	2	Manufacturing of a Sponge Rubber Sample	4	CO1
Prepare expanded rubber with controlled cellular structure.	3	Preparation of an Expanded Rubber Sample	4	CO1
Bond rubber to metal and assess adhesion strength.	4	Fabrication of a Rubber-to-Metal Bonded Item	2	CO2
Fabricate and test a rubber vibration isolator.	5	Preparation of a Vibration Isolator Model	4	CO3
Manufacture a rubber hose/tube with proper dimensions and durability.	6	Fabrication of a Rubber Tube/Hose	4	CO4
Apply and evaluate a functional coating on rubber rollers/belts.	7	Coating of a Rubber Roller or Belt	4	CO5
Mold and test a rubber sole for wear resistance and flexibility.	8	Preparation of a Rubber Footwear Sole Sample	4	CO6
		Total	**30**	

VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning):

Note: Student are required to complete any five micro projects from the suggested list given below. Similar micro projects could be added or given to the students by the concern faculty.

1. **Compare Sponge vs. Expanded Rubber** – Create samples, analyze porosity/density differences.
2. **Test Oil Resistance of Seal Materials** – Immerse NBR/FKM/EPDM in oil, evaluate swelling/hardness.
3. **Fabricate Rubber-Metal Bonded Washer** – Bond rubber to metal, test adhesion strength.
4. **Design a Rubber Vibration Isolator** – Build and test a mount for motor vibration reduction.
5. **Measure Hose Burst Pressure** – Inflate reinforced hoses until failure, compare strengths.
6. **Analyze Conveyor Belt Ply Structure** – Cut cross-sections, count plies, link to durability.
7. **Map Rubber Roller Hardness** – Measure Shore hardness at multiple points, assess consistency.
8. **Test Footwear Tread Slip Resistance** – Carve treads, measure slip angles on wet/dry surfaces.
9. **Evaluate Shoe Sole Adhesives** – Compare peel strength of PU/latex/contact cement bonds.
10. **Abrasion Test for Rubber Soles** – Rub against sandpaper, track weight loss over time.

VII. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Cellular Rubber	2	4	4	10
2	Gaskets, Seals & Rubber-Metal Bonding	3	4	3	10
3	Vibration Isolators and Mounts	2	5	3	10
4	Hoses & Tubing	3	3	4	10
5	Rubber Rollers, Printing Blankets & Belts	2	5	3	10
6	Footwear	3	4	3	10
	Total	**15**	**25**	**20**	**60**

VIII. Suggested COs - POs Matrix Form

Course Outcome s (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PSO-1	PSO-2
CO1	2	1	1	3	1	--	1	3	2
CO2	2	2	2	3	2	--	1	3	2
CO3	2	3	3	2	1	--	1	3	1
CO4	2	2	2	3	2	--	1	3	2
CO5	2	2	2	3	1	--	1	3	2
CO6	2	1	1	3	3	--	1	2	3
Legends: - High:03, Medium:02, Low:01, No Mapping: --									

IX. Suggested Learning Materials / Books:

Sr. No.	Title	Author, Edition, and Year	Publisher (India)	ISBN
1	Rubber Technology: Compounding and Testing for Performance	John S. Dick, 2nd Ed. (2001)	Hanser Gardner	978-1569903071
2	Handbook of Rubber Bonding	B. Crowther (2003)	Rapra Technology	978-1859574403
3	Engineering with Rubber: How to Design Rubber Components	A.N. Gent, 3rd Ed. (2012)	Hanser India	978-3446427678
4	Rubber Products Manufacturing Technology	A.K. Bhowmick et al. (1994)	Marcel Dekker	978-0824791172
5	The Science and Technology of Rubber	J.E. Mark et al., 4th Ed. (2013)	Academic Press	978-0123945846
6	Conveyor Belts: Principles, Calculations & Design	G. Lodewijks (2015)	Vulkan Verlag	978-3433031596
7	Rubber to Metal Bonding	C.M. Roland (2010)	Smithers Rapra	978-1605950214
8	Footwear Technology	K. Bhaskaran (2005)	CBS Publishers	978-8123906545

X. Learning Websites & Portals

Sr. No	Link / Portal	Description
1	Rubber World Magazine	Industry-leading articles on rubber compounding, manufacturing trends, and case studies.
2	ASTM International	Global standards for rubber testing (e.g., D2000 for materials, D1052 for abrasion).
3	NPTEL (IIT Courses)	Free courses like Polymer Engineering (IIT Kharagpur) covering rubber technology fundamentals.
4	Smithers Rapra	Technical reports on rubber bonding, vibration isolators, and conveyor belts.
5	Rubber Board India	Official Indian rubber industry updates, training programs, and sustainability guidelines.
6	ScienceDirect (Elsevier)	Research papers in Polymer Testing and Rubber Chemistry and Technology journals.
7	The Rubber Group (YouTube)	Practical videos on sponge rubber production, footwear sole manufacturing.
8	Google Scholar	Open-access research on rubber compounding, isolator design, and adhesives.

XI. 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. Sunil Kumar Shrivastava	Expert in Rubber Technology	Arizona Techzeal
4	Mr. E. C. Dhembare	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of Rubber Technology

Head of Department
Department of Rubber Technology

I/C, Curriculum Development Cell
Government Polytechnic Mumbai

Principal
Government Polytechnic Mumbai

Programme : Diploma in Rubber Technology (Sandwich Pattern)													
Course Code: RT23502					**Course Title: Reverse Engineering & Analysis of Rubber Products**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2Hours. 30mins.)**	**FA-PR**	**SA**		**SLA**	**Total**
						T1	**T2**			**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:

This curriculum equips students with essential reverse engineering skills for rubber products, combining chemical, analytical, and thermal techniques to meet industry demands for material analysis and quality control.

II. Industry / Employer Expected Outcomes:

Diploma Graduates will be proficient in identifying rubber formulations, analyzing material properties, and optimizing product performance, addressing industry needs for quality assurance and innovation in rubber manufacturing and recycling. Employers can expect professionals capable of troubleshooting production issues and developing sustainable rubber solutions.

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

CO1	Explain rubber reverse engineering concepts and perform basic material characterization.
CO2	Apply chemical methods to analyze rubber additives and polymers.
CO3	Utilize analytical techniques to characterize rubber composition.
CO4	Analyze rubber's thermal properties using standard methods.
CO5	Evaluate additive functions through thermal analysis.
CO6	Demonstrate polymer synthesis and characterization techniques.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1.	**TLO1.1**: Explain the purpose and steps of reverse engineering in rubber products. **TLO1.2**: Describe solvent extraction and ash content determination techniques. **TLO1.3**: Interpret chemical digestion methods for rubber analysis.	**Unit 1: Introduction to Reverse Engineering Concepts Related to Rubber:** 1.1 General Concepts 1.2 Solvent Extraction & Digestion. 1.3 Ash Content Determination. 1.4 Carbon black extraction.
Course Outcome: CO1 ,Teaching Hours :5 , Marks: 06		
2.	**TLO2.1**: Classify chemical techniques for polymer comminution and additive separation. **TLO2.2**: Perform qualitative/quantitative analysis of additives and isolated polymers.	**Unit 2: Principle Chemical Methods used in Rubber Reverse Engineering:** 2.1 Polymer identification 2.2 Chemical Methods, Introduction, Chemical Analysis, 2.3 Comminution of the polymer sample, 2.4 Separation of additives, 2.5 Qualitative and quantitative investigation of the additives, 2.6 Identification and quantitative analysis of isolated polymer samples
Course Outcome: CO2 Teaching Hours 8 hours, Marks: 10		
3	**TLO3.1**: Compare chromatography methods (GC, HPLC, GPC) for polymer analysis. **TLO3.2**: Apply spectroscopy (FTIR) to determine acrylonitrile content in NBR. **TLO3.3**: Evaluate microscopy	**Unit 3: Analytical Methods used in Rubber Reverse Engineering** 3.1 Spectroscopy: Introduction, Infrared Spectroscopy, Fourier Transform Infrared Spectroscopy(FTIR), Carbon Type Analysis (CA, CP, and CN) of the Rubber Process Oil by Fourier Transform Infrared (FTIR) 3.2 Microscopy and Image Analysis: Introduction, : Applications & Principle of Optical Microscope, Scanning

	(TEM/SEM) for carbon black and blend morphology.	Electron Microscope, Transmission Electron Microscope, Identification of Carbon Black Type, Carbon Black Identification by Transmission Electron Microscopy (TEM), Elastomer Blend Morphology by TEM, Microtomy, Staining, and TEM Analysis, TEM Image Analysis—Examples, X-ray Diffraction Techniques (WAXS, SAXS)
Course Outcome: CO3 Teaching Hours:10 hours , Marks: 14		
4	**TLO4.1**: Explain DSC and DTA principles for rubber thermal behavior. **TLO4.2**: Interpret TGA results for rubber composites and evolved gas analysis.	**Unit 4: Thermal Gravimetric Analysis of Rubber: (TGA)** 4.1Introduction, Some Important Technical Terms Related to Thermal Analysis, % composition of formulation. 4.2Principle of Thermogravimetric(TG), Evolved Gas Detection (EGD) and Evolved Gas Analysis (EGA). 4.3 Principle of Differential Scanning Calorimetry (DSC) Operation, Application of DSC. Oxidation, reduction, exothermic and endothermic reaction. Glass transition and melting temperature.
Course Outcome: CO4 , Teaching Hours:8 hours , Marks: 10		
5	**TLO5.1**: Relate thermal data to additive functions (plasticizers, vulcanizing agents).	**Unit 5: Thermal Analysis of Additives in Polymers** 5.1: Introduction 5.2: Antioxidants, Antidegredants, Plasticizers, Accelerators, Vulcanizing Agents, Other Additives etc.
Course Outcome: CO5 Teaching Hours: 07 hours Marks: 10		
6	**TLO6.1**: Assess polymer flammability using thermal analysis.	**Polymer Flammability** 6.1 Polymer Flammability, 6.2 Thermal Analysis & Flammability Evaluation
Course Outcome: CO6 Teaching Hours: 07 hours Marks: 10		

Note: Any one unit from the above five units, has to be preferably taught by alumni of Govt. Polytechnic Mumbai.

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr. No	Laboratory Experiment / Practical Titles / Tutorial Titles	No. Of hours.	Relevant Cos
LLO1: Perform basic rubber characterization through extraction and combustion methods	1	Quantitative Solvent Extraction and Ash Content Determination of Rubber Compounds	4	CO1
LLO2: Separate and analyze rubber additives using standard techniques	2	Soxhlet Extraction and Gravimetric Analysis of Rubber Additives	4	CO1, CO2
LLO3: Identify rubber composition using spectroscopic methods	3	FTIR Spectroscopic Identification of Rubber Types and Process Oils	4	CO1, CO3
LLO4: Characterize polymer molecular weight distribution	4	Molecular Weight Characterization of Rubber Polymers by GPC	2	CO2, CO3
LLO5: Analyze thermal properties of rubber compounds	5	Thermal Behavior Analysis of Rubber Compounds Using DSC/TGA	4	CO3, CO4
LLO6: Quantify vulcanization additives chromatographically	6	Reverse Engineering of Vulcanization Accelerators via HPLC	4	CO4, CO5
LLO7: Evaluate filler dispersion morphology	7	Morphological Characterization of Carbon Black Using TEM	4	CO3, CO5
LLO8: Synthesize and characterize synthetic rubber	8	Synthesis and Fractionation of SBR by Emulsion Polymerization	4	CO6
		Total Hours	**30**	

VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning):

Note: Student are required to complete any five micro projects from the suggested list given below. Similar micro projects could be added or given to the students by the concern faculty.

1. Rubber Product Teardown Report
Task: Dissect a common rubber product (e.g., hose, seal) and document material layers/components.
Deliverable: Diagram + 500-word report on suspected formulation.
2. DIY Solvent Extraction Demo
Task: Extract polymer from rubber bands using acetone; compare yields.
Deliverable: Lab notes + yield calculation spreadsheet.
3. Additive Spot Test Challenge
Task: Use TLC/spot tests to identify sulfur/ZnO in provided rubber samples.
Deliverable: Photo journal of test results.
4. FTIR Spectral Library
Task: Create a reference library of IR peaks for 5 rubber types (NBR, SBR, etc.).
Deliverable: Annotated spectra + cheat sheet.
5. Thermal Analysis Case Study
Task: Analyze provided DSC/TGA data to diagnose a rubber failure (e.g., overheating).
Deliverable: 1-page technical memo with conclusions.
6. Accelerator Quantification Simulation
Task: Use open-source HPLC software (e.g., Open Chrom) to quantify CBS in a virtual chromatogram.
Deliverable: Screenshots + concentration report.
7. Carbon Black Morphology Poster
Task: Research and compare TEM images of 3 carbon black grades.

Deliverable: Infographic on structure-property relationships.
8. Rubber Recycling Feasibility Study
Task: Propose a method to reverse engineer and recycle scrap rubber.
Deliverable: 10-slide PowerPoint + cost estimate.
9. Virtual Polymer Synthesis Lab
Task: Simulate SBR synthesis using free tools (e.g., Nano HUB).
Deliverable: Screencast video explaining key steps.
10. Industry Standard Comparison
Task: Contrast ASTM D3182 (rubber testing) with ISO 37; summarize key differences.
Deliverable: Comparison table + 300-word analysis.

VII. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Introduction to Reverse Engineering Concepts	1	3	2	**6**
2	Chemical Methods for Rubber Analysis	2	5	3	**10**
3	Analytical Methods for Rubber Characterization	3	7	4	**14**
4	Thermal Gravimetric Analysis of Rubber: (TGA)	2	5	3	**10**
5	Thermal Analysis of Additives	2	5	3	**10**
6	Experimental Polymer Methods	2	5	3	**10**
	Total	**12**	**30**	**18**	**60**

VIII. Suggested COs - POs Matrix Form

Course Outcome s (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PSO-1	PSO-2
CO1	2	2	1	3	--	--	1	3	2
CO2	3	3	2	2	--	--	1	3	2
CO3	3	3	2	3	--	--	1	3	2
CO4	2	2	1	3	1	--	--	2	1
CO5	2	2	1	3	1	--	--	2	1
CO6	3	3	3	2	2	--	2	3	2
Legends: - High:03, Medium:02, Low:01, No Mapping: --									

IX.Suggested Learning Materials / Books:

Sr. No.	Title	Author, Edition, and Year	Publisher (India)	ISBN
1	Rubber Technology: Manufacture, Processing, and Applications	M. Morton, 3rd Ed., 1999	CBS Publishers	978-8123907989
2	Handbook of Rubber Technology	A.C. Klingender, 1st Ed., 2001	Khanna Publishers	978-8174091548
3	Polymer Science and Technology	Joel R. Fried, 3rd Ed., 2014	Pearson India	978-9332535373
4	Rubber Engineering: Principles and Applications	A.K. Bhowmick & A.N. Gent, 1st Ed., 2001	McGraw-Hill Education (India)	978-0074637404
5	Characterization of Polymers: Thermal, Mechanical, and Rheological Methods	Dan Campbell & Richard A. Pethrick, 1st Ed., 2017	CRC Press (Taylor & Francis India)	978-1138076211

X. Learning Websites & Portals

Sr. No	Link / Portal	Description
1	https://pubs.acs.org/journal/rcted7	Peer-reviewed articles on rubber formulations, additives, and analysis techniques
2	https://www.rubberstudy.com/	Industry reports and technical documents on rubber materials and applications.
3	https://www.rubberworld.com/	Practical articles on rubber compounding, testing, and case studies.

4	https://www.nist.gov/mml/materials-science-and-engineering-division/polymer-chemistry	Guidelines for polymer analysis, including chromatography and spectroscopy.
5	https://www.tainstruments.com/resources/learning-center/	Webinars and guides on DSC, TGA, and DMA for rubber testing.

XI. 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. Sunil Kumar Shrivastava	Expert in Rubber Technology	Arizona Techzeal
4	Mr. E. C. Dhembare	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of Rubber Technology

Head of Department
Department of Rubber Technology

I/C, Curriculum Development Cell
Government Polytechnic Mumbai

Principal
Government Polytechnic Mumbai

Programme : Diploma in Rubber Technology (Sandwich Pattern)													
Course Code: RT23503					**Course Title: Mould Design**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2Hours. 30mins.)**	**FA-PR**	**SA**		**SLA**	**Total**
						T1	**T2**			**PR**	**OR**		
3	**--**	**2**	**1**	**6**	**3**	**--**	**--**	**--**	**25**	**--**	**25**	**25**	**75**

Total IKS Hrs. for course: 2 hrs.

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:

This curriculum equips students with essential reverse engineering skills for rubber products, combining chemical, analytical, and thermal techniques to meet industry demands for material analysis and quality control.

II. Industry / Employer Expected Outcomes:

Diploma Graduates will be proficient in identifying rubber formulations, analyzing material properties, and optimizing product performance, addressing industry needs for quality assurance and innovation in rubber manufacturing and recycling. Employers can expect professionals capable of troubleshooting production issues and developing sustainable rubber solutions.

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

CO1	Explain rubber material behavior and moulding fundamentals
CO2	Illustrate mould construction for compression/transfer/injection processes
CO3	Design single/multi-cavity compression moulds with allowances
CO4	Develop transfer mould components (pot, punch)
CO5	Create extrusion dies for rubber profiles
CO6	Estimate mould costs and select fabrication methods

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1.	**TLO1.1:** Explain the relationship between rubber elasticity, flow properties, and moulding behavior. **TLO1.2:** Describe the curing process and calculate mould shrinkage for a given rubber compound.	**Unit 1: Fundamentals of Rubber & Moulding** Introduction to rubber materials (elasticity, flow properties). Curing process, mould shrinkage calculation. Overview of compression, transfer, and injection moulding. **Activity:** Calculate shrinkage for a given rubber compound.
Course Outcome: CO6 Teaching Hours: 7 hrs Marks: 10 (R- 2, U-4, A-4)		
2.	**TLO2.1:** Identify the functions of core, cavity, guide pins, and ejection systems in rubber moulds. **TLO2.2:** Compare material feeding mechanisms for compression, transfer, and injection moulding.	**Unit 2: Mould Construction** Mould construction for different processes (compression/transfer/injection). Core, cavity, guide pins, bushes, and moving parts. Material feeding and component ejection. **Activity:** Sketch a single-cavity compression mould with labeled parts.
Course Outcome: CO6 Teaching Hours: 9 hrs Marks: 10 (R- 2, U-4, A-4)		
3	**TLO3.1:** Differentiate between positive, semi-positive, and flash-type compression moulds. **TLO3.2:** Justify the selection of flash/shrinkage/draft allowances for a given rubber product.	**Unit 3: Compression & Transfer Mould Design** Positive mould design (single/multi-cavity). Allowances (flash, shrinkage, draft). Transfer pot and punch design. **Activity:** Design a 2-cavity compression mould with allowances.
Course Outcome: CO6 Teaching Hours: 9 hrs Marks: 10 (R- 2, U-4, A-4)		
4	**TLO4.1:** Explain the role of land length and entry angle in rubber pipe die design. **TLO4.2:** Outline key considerations for designing profile extrusion dies.	**Unit 4: Extrusion Die Design** Pipe die design (land length, entry angle). Profile die basics. **Activity:** Sketch a pipe die with critical dimensions.
Course Outcome: CO6 Teaching Hours: 7 hrs Marks: 10 (R- 2, U-4, A-4)		
5	**TLO5.1:** Select appropriate mould steels and heat treatments for core/cavity components. **TLO5.2:** Compare machining processes (EDM vs. CNC) based on tolerance, cost, and surface finish.	**Unit 5: Mould Fabrication** Material selection for rubber mould. heat/surface treatments. Machining (lathe, EDM, polishing) and cost-time tradeoffs. **Activity:** Compare spark erosion vs. CNC for a cavity block.
Course Outcome: CO6 Teaching Hours: 9 hrs Marks: 10 (R- 2, U-4, A-4)		

6	**TLO6.1:** Calculate mould cost components (material, labor, machining). **TLO6.2:** Prepare a mould manufacturing quotation with justified pricing.	**Unit 6: Costing & Quotation** Cost calculation (material, labor, machining). Quotation preparation. **Activity:** Prepare a quote for a mould.
Course Outcome: CO6 Teaching Hours: 4 hrs Marks: 10 (R- 2, U-4, A-4)		

Note: Any one unit from the above five units, has to be preferably taught by alumni of Govt. Polytechnic Mumbai.

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	**Sr. No**	**Laboratory Experiment / Practical Titles / Tutorial Titles**	**No. of Hours**	**Relevant COs**
Calculate cavity dimensions considering shrinkage factors for rubber products	1	Calculation of cavity dimensions for cylinder, tube, and sheet rubber items	04	CO1, CO3
Determine projected area and volume of moulded rubber components	2	Calculation of projected horizontal/vertical area and volume for given rubber moulded items	04	CO1, CO3
Estimate hydraulic pressure for a mould using ram diameter and platen size	3	Hydraulic pressure calculation for moulding press based on given specifications	04	CO1, CO6
Design symmetrical multi-cavity injection mould and calculate runner length	4	Design of an injection mould layout on an 18×18 inch platen and total runner length calculation	04	CO2, CO3, CO6
Compute extrusion speed in metres and grams based on extruder capacity and profile dimensions	5	Speed of extrusion calculation in m/min and g/min for a given rubber profile and extruder capacity	02	CO5
Create a detailed drawing of a rubber-to-metal bonded product	6	Preparation of part drawing for rubber-metal bonded items like engine mounting or oil seal	02	CO1, CO2
Develop a drawing of a hard-build rubber component like a hose or expansion bellow	7	Drafting of sectional view of hose or expansion bellow using rubber materials	02	CO1, CO5
Draw a single-cavity compression mould and a mould for metal-to-rubber bonded rubber articles	8	Mould design drawings for a simple rubber article and a rubber-metal bonded part	04	CO2, CO3
Prepare a mould layout drawing for rubber bellow manufacturing	9	Design and drawing of a mould used to manufacture rubber bellows Total	04 30	CO2, CO5

VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning):

Note: Student are required to complete any five micro projects from the suggested list given below. Similar micro projects could be added or given to the students by the concern faculty.

1. Micro-Projects (Group/Individual)

A. Design & Simulation-Based

1. **CAD Modelling of Compression Mould**
   - *Task*: Design a single-cavity compression mould for a rubber gasket with draft angles, flash allowance, and ejection system.
   - *Tools*: AutoCAD/SolidWorks.
   - *Outcome*: 3D model + technical drawing with tolerances.
2. **Moldflow Analysis for Rubber Flow**
   - *Task*: Simulate rubber flow in an injection mould using software (e.g., Autodesk Moldflow) to identify air traps/short shots.
   - *Outcome*: Report on optimization of gate location and cooling channels.
3. **Cost Estimation for Mould Fabrication**
   - *Task*: Calculate cost for a 2-cavity transfer mould (material, machining, heat treatment).
   - *Outcome*: Quotation sheet with breakdown.

B. Hands-On Fabrication

4. **Prototype Mould from 3D-Printed Tooling**
   - *Task*: 3D print a simple compression mould (using high-temp resin) and test with silicone rubber.
   - *Outcome*: Physical prototype + observations on dimensional accuracy.
5. **Machining a Mould Component**
   - *Task*: Machine a core/cavity insert on a lathe/milling machine (under supervision).
   - *Outcome*: Finished component + surface finish measurement.

2. Assignments (Theory + Application)

A. Case Studies

6. **Defect Analysis**
   - *Task*: Investigate a real-world rubber part defect (e.g., warpage) and propose mould design fixes.
   - *Deliverable*: 5-page report with diagrams.
7. **Material Selection Justification**
   - *Task*: Compare P20 steel vs. aluminum for a high-volume rubber seal mould.
   - *Deliverable*: Presentation with cost vs. durability analysis.

B. Calculations

8. **Shrinkage Compensation**
   - *Task*: Calculate cavity dimensions for a rubber O-ring (given shrinkage rate: 1.5%).
   - *Deliverable*: Excel sheet with formulas.
9. **Cycle Time Optimization**
   - *Task*: Analyze curing time vs. cooling channel design for a rubber boot mould.
   - *Deliverable*: Graph of time vs. temperature trade-offs.

3. Skill-Building Activities

A. Industry-Oriented

10. **Virtual Factory Tour**
    - *Activity*: Watch a video of a rubber moulding plant (e.g., Michelin) and summarize key design takeaways.
11. **Guest Lecture Reflection**
    - *Activity*: Attend a webinar by a mould designer and write a 300-word reflection.

B. Creative Tasks

12. **Mould Design Poster**
- *Activity*: Create an infographic on "Key Steps in Transfer Mould Design."

13. **DIY Extrusion Die**
- *Activity*: Sketch a profile die for a rubber hose and explain land length selection.

VII. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Fundamentals of Rubber & Moulding	2	4	4	**10**
2	Mould Construction & Components	2	4	4	**10**
3	Compression & Transfer Mould Design	2	4	4	**10**
4	Extrusion Die Design	2	4	4	**10**
5	Mould Fabrication & Machining	2	4	4	**10**
6	Costing & Quotation	2	4	4	**10**
	Total	**12**	**24**	**24**	**60**

VIII. Suggested COs - POs Matrix Form

Course Outcome s (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PSO-1	PSO-2
CO1	2	2	1	3	--	--	1	3	2
CO2	3	3	2	2	--	--	1	3	2
CO3	3	3	2	3	--	--	1	3	2
CO4	2	2	1	3	1	--	--	2	1
CO5	2	2	1	3	1	--	--	2	1
CO6	3	3	3	2	2	--	2	3	2
Legends: - High:03, Medium:02, Low:01, No Mapping: --									

IX.Suggested Learning Materials / Books:

Sr. No.	Title	Author, Edition, and Year	Publisher (India)	ISBN
1	Rubber Mould Design Handbook	Peter R. Horn, 2nd Ed., 2018	Smithers Rapra	978-1910243823
2	Handbook of Mold, Tool and Die Repair Welding	Steve Thompson, 1st Ed., 2013	Elsevier	978-0857094599

Sr. No.	Title	Author, Edition, and Year	Publisher (India)	ISBN
3	Injection and Compression Molding Fundamentals	Avraam I. Isayev (Ed.), 1st Ed., 1987	CRC Press	978-0824776643
4	Plastics and Rubber Moulding: A Practical Guide	P.K. Mallick, 1st Ed., 2010	Khanna Publishers	978-8174092101
5	Design and Manufacturing of Plastic Components	Vannessa Goodship, 1st Ed., 2004	McGraw-Hill Education (India)	978-0070588141
6	Mold Making Handbook for the Plastics Engineer	Hans Gastrow, 3rd Ed., 2018	Hanser Publishers	978-1569905974
7	Rubber Processing and Products Design	A.K. Bhowmick, 1st Ed., 2008	CRC Press (Taylor & Francis)	978-0849333440
8	Computer-Aided Injection Mold Design and Manufacture	J.Y. Fuh et al., 1st Ed., 2004	Marcel Dekker	978-0824749364
9	Extrusion Dies for Plastics and Rubber	Chris Rauwendaal, 4th Ed., 2014	Hanser Publishers	978-1569905233
10	Thermal and Rheological Measurement Techniques for Rubber Compounds	J.G. Sommer, 1st Ed., 2003	Oxford University Press	978-0195141663
11	Practical Cost Estimating for Molds and Dies	Robert E. Wade, 1st Ed., 2006	Society of Manufacturing Engineers	978-0872638425
12	CAD/CAM for Mould Design	T. Jagadeesha, 1st Ed., 2012	I.K. International (India)	978-9380578736

X. Learning Websites & Portals

Sr. No	Link / Portal	Description
1	Plastic Engineers	Rubber/plastic mould design.
2	Rubber News (Crain Communication	Industry trends, mould technology updates, and rubber

		processing innovations.
3	Hanser Publications (Mould Design Resource)	Free articles and book excerpts on mould fabrication and material selection.
4	Moldflow Help Center	Tutorials and simulation guides for rubber flow analysis in moulds.
5	Tooling U-SME	Online courses on mould design, costing, and CNC machining for rubber.
6	NEPTL (Mould Design Lecture)	Free video lectures on mould engineering from IITs (India).

XI. 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. Sunil Kumar Shrivastava	Expert in Rubber Technology	Arizona Techzeal
4	Mr. E. C. Dhembare	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of Rubber Technology

Head of Department
Department of Rubber Technology

I/C, Curriculum Development Cell
Government Polytechnic Mumbai

Principal
Government Polytechnic Mumbai

Programme : Diploma in Rubber Technology (Sandwich Pattern)													
Course Code: RT23504					**Course Title: Project Work and Seminar**								
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Assessment Scheme**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2Hours. 30mins.)**	**FA-PR**	**SA**		**SLA**	**Total**
						T1	**T2**			**PR**	**OR**		
--	--	4	4	8	4	--	--	--	50	--	50#	25	125

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:

Project Work enables students to apply theoretical knowledge to practical rubber industry problems. It develops skills in problem-solving, material selection, testing, quality control, teamwork, and communication. The course bridges academics with industry needs, preparing students for employment or further technical education.

II. Industry / Employer Expected Outcomes:

Diploma students should apply practical rubber technology skills and solve industry problems effectively. They must also demonstrate teamwork, reporting, and presentation abilities aligned with industry needs.

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

CO1	Identify and solve rubber technology problems.
CO2	Prepare structured project reports.
CO3	Improve communication through problem analysis.
CO4	Submit complete reports and present project outcomes.
CO5	Plan and complete project tasks efficiently.
CO6	Use effective presentation skills for project delivery.

IV. Course Content Details:

Unit No.	Topics / Sub-topics
1	**Unit 1: Methodology** 1. The project work will be undertaken in the **5th semester** of the Diploma in Rubber Technology. 2. **Course registration** is required at the start of the semester. 3. Students will work in **batches of up to four members**. 4. Each student must maintain a **project diary**, recording weekly activities such as planning, execution, testing, and data collection—this must be regularly reviewed by the project guide. 5. A detailed **project report** (50–70 pages, approx. 5000 words) must be prepared, including relevant drawings, graphs, tables, and photos. Use **Times New Roman** font: Heading – 16 pt, Subheading – 14 pt, Text – 12 pt. 6. Activities such as **batch formation, topic selection, industry interaction, literature survey, model preparation, and presentations** should be completed within the 5th semester.
2	**Unit 2: Suggested Topics for Project Work in Rubber Technology** 1. Design and fabrication of **rubber testing equipment** or lab-scale machines 2. Development of **rubber product prototypes** (e.g., seals, gaskets, tyres, hoses) 3. Formulation and testing of **rubber compounds** 4. Industry-sponsored projects related to rubber processing or product improvement 5. Literature review on **advancements in rubber materials or processing techniques** 6. Investigative projects on **failure analysis** of rubber products 7. Projects on **maintenance and troubleshooting** of rubber processing machinery 8. **Process optimization** in rubber mixing, extrusion, or molding 9. Development of **low-cost rubber compounding or processing setups** 10. Projects focusing on **recycling or sustainable use** of rubber waste 11. **Market survey** on rubber product applications 12. **Environment-focused projects** such as green rubber or biodegradable elastomers 13. Recent trends in **tyre technology, silicone rubber, or TPEs** 14. Application of **appropriate rubber technologies** for rural or MSME sectors.
3	**Unit 3: Project Report Format** Each project group should prepare a structured report including: • **Title Page** (with names of students and guide) • **Certificate** • **Acknowledgment** • **Abstract** • **Table of Contents**

	Chapters: 1. Introduction and Project Definition 2. Literature Survey (focused on rubber technology) 3. Project Planning and Scheduling 4. Design and Modelling (where applicable) 5. Fabrication / Formulation / Processing 6. Trials, Testing, and Evaluation 7. Costing and Economic Feasibility 8. Conclusion and Future Scope 9. Appendix (if needed) 10. References and Bibliography (as per standard format)

V. Suggested Micro Project / Assignment / Activities for Specific Learning / Skills Development (Self-Learning):

As part of self-directed learning and skill development, students of Rubber Technology shall complete **any one** of the following micro-projects or activities related to their Capstone Project:

1. **Technical Paper Writing** – Prepare a research/technical paper based on the Capstone project. *(Refer to Science Direct or similar journals for format and style)*
2. **Paper Presentation** – Present a technical paper related to the Capstone project in an academic or industry seminar.
3. **Patent Filing** – Prepare and file a patent draft for any innovative product, process, or formulation developed in the project.
4. **Theoretical Analysis** – Perform theoretical analysis or complete an assignment on **design and solid modeling** related to the project.
5. **Cost Estimation & Budgeting** – Prepare a detailed cost analysis and budget plan for the proposed project or product.
6. **Uncertainty Analysis** – Carry out uncertainty or risk analysis related to material selection, testing, or project outcomes.

VI. Rubric 1: For Project Oral

No.	Criterion	COs	Marks	1–4 (Not Satisfactory)	5–6 (Satisfactory)	7–8 (Good)	9–10 (Excellent)
1	Literature Survey	CO1, CO2, CO3	10	One basic source used	Few sources used	Multiple sources used	Multiple research-based sources used
2	Presentation Structure	CO2	10	No clear flow	Some jumps in sequence	Logical flow	Logical and engaging flow
3	Use of PPT/Graphics	CO4	10	Poor visuals, unclear	Relevant but basic visuals	Clear and useful visuals	Strong visuals enhancing content

4	Speaking & Eye Contact	CO2, CO4	10	Mumbles, no eye contact	Inconsistent voice, little eye contact	Clear voice, good eye contact	Confident, clear, regular eye contact
5	Question Handling	CO1–CO6	10	Cannot answer	Answers few questions	Answers most questions	Answers all confidently

VII. Rubric 2: For Project TW

No.	Criterion	COs	Marks	Not Satisfactory (1–4)	Satisfactory (5–6)	Good (7–8)	Excellent (9–10)
1	Problem Identification	CO 1	10	No clear background or purpose	Some background given, purpose mentioned	Clear background, with explanation	Strong background, well-explained and relevant
2	Literature Review	CO 1, CO 2	10	Few or irrelevant sources	Few relevant sources	Relevant info from multiple sources	Well-researched from multiple, quality sources
3	Planning & Team Structure	CO 3, CO 4	10	Poor planning, uneven work distribution	Plan exists but not followed	Plan followed, but some imbalance	Clear plan, well followed, proper task distribution
4	Testing	CO 5	10	Testing incomplete or incorrect	Single test, no improvements	Multiple tests, but no improvements	Proper testing with improvements done
5	Project Report	CO 6	10	Not in format, poor references	In format, some mistakes in references	Proper format, references present but not clear	Correct format, references well-written and cited

VIII. CO Vs PO and CO Vs PSO Mapping:

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

CO5	3	3	3	3	2	3	3	3	3
CO6	3	3	2	2	2	2	3	3	2

IX. Academic Consultation Committee/Industry Consultation Committee:

Sr. No.	**Name**	**Designation**	**Institute/Organization**
1	Mr. Ravindra Barde	Industry Expert	Sidhhi Elasto Pvt. LTD
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3	Mr. Sunil Kumar Shrivastava	Lecturer in Rubber Technology	Arizona Techzeal
4	Mr. E.C.Dhembare	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator, Head of Department
Curriculum Development, Department of Rubber Technology
Department of Rubber Technology

I/C, Curriculum Development Cell Principal