Savitribai Phule Pune University
Faculty of Science & Technology

Curriculum Details

For
Bachelor of Vocational (Engineering)
RUBBER TECHNOLOGY
(Choice Based Credit System)

(With Effect from Academic Year 2024-25)

1. Course Objectives

After successfully completing the vocational course, the student would have acquired relevant appropriate and adequate technical knowledge together with the professional skills and competencies in the field of Rubber Technology so that he/she is properly equipped to take up gainful employment in this Vocation. Thus he/she should have acquired: -

A. Understanding of

(a) The relevant basic concepts and principles in basic science subjects (Physics, Chemistry and Mathematics) so that the students are able to understand the different vocational subjects.
(b) The basic concepts in engineering drawing.
(c) The concepts, principles of working of basic rubber technology.
(d) The knowledge of testing procedure of components by making use of different test instruments.
(e) The procedure of making rubber compounding.
(f) The concepts and principles used rubber product manufacturing.

B. Adequate Professional Skills and Competencies in

(a) Testing different rubber components.
(b) Testing the performance of rubber.
(c) Locating the fault at component level and at the stage level.

C. A Healthy and Professional Attitude so that the student has

(a) An analytical approach while working on a job.
(b) An open mind while locating/rectifying faults.
(c) Respect for working with their own hands.
(d) Respect for honesty, punctuality and truthfulness

D. NSQF compliant skills in Qualification developed by sector skill council in Rubber sector.

3. Course Structure:

The course will consist of combination of practice, theory and hands on skills in the Rubber sector.

Curriculum:

The curriculum in each of the years of the program would be a suitable mix of general education and skill components.

Skill Development Components:

- The focus of skill development components shall be to equip students with appropriate knowledge, practice and attitude, to become work ready. The skill development components will be relevant to the industry as per its requirements.
- The curriculum will necessarily embed within itself, National

Occupational Standards (NOSs) of specific job roles within the industry. This would enable the students to meet the learning outcomes specified in the NOSs.

- The overall design of the skill development component along with the job roles selected will be such that it leads to a comprehensive specialization in few domains.
- The curriculum will focus on work-readiness skills in each of the year of training.
- Adequate attention will be given in curriculum design to practical work, on the job training, development of student portfolios and project work.

General Education Component:

- The general education component adheres to the normal senior secondary and university standards. It will emphasize and offer courses which provide holistic development. However, theory component will not exceed 40% of the total curriculum.
- Adequate emphasis is given to language and communication skills.

B. Voc Rubber Technology Syllabus for First Year

Structure for Semester-I

Course Code	Course Name	Teaching Scheme (Hours /Week)		Examination Scheme and Marks						Credits		
		Theory	Practical	ISE	ESE	TW	PR	OR	Total	TH	PR	Total
101	Communication Skill	03		50	50				100	03		03
102	Engineering Graphics	03		50	50				100	03		03
103	Polymer Chemistry	03		50	50				100	03		03
104	Engineering Graphics-Lab		02				50	--	50		01	01
105	Basic Science- Lab		02				50	--	50	--	01	01
106	On Job Training		24			200			200		12	12
	Total	09	28	150	150	200	100	--	600	09	14	23

Structure for Semester-II

Course Code	Course Name	Teaching Scheme (Hours/ Week)		Examination Scheme and Marks						Credits		
		Th	Prac	ISE	ESE	TW	PR	OR	Total	TH	PR	Total
201	Rubber Processing	03		50	50				100	03		03
202	Rubber Materials-I	03		50	50				100	03		03
203	Fundamentals of Industrial Management	03		50	50				100	03		03
204	Rubber Materials-I Lab		02				50	--	50		01	01
205	Rubber Processing Lab		02				50		50		01	01
206	On Job Training		24			200			100		12	12
	Total	09	28	150	150	200	100	--	600	09	14	23

*On Job Training should be carried out in any one subject per semester as per NSDC Guide lines for following Skill Sets:

1. RSC/Q0312 (5) Lab Chemist - Incoming Raw Material Testing
2. RSC/Q0111(5) Mixing Supervisor

B. Voc Rubber Technology Syllabus for Second Year

Structure for Semester-III

Course Code	Course Name	Teaching Scheme (Hours/ Week)		Examination Scheme and Marks						Credits		
		Theory	Practical	ISE	ESE	TW	PR	OR	Total	TH	PR	Total
301	Rubber Material – II	03		50	50				100	03		03
302	Polymer Composite Materials	03		50	50				100	03		03
303	Rubber Testing – I	03		50	50				100	03		03
304	Polymer Science lab		02				50	--	50		01	01
305	Rubber Testing-I Lab		02				50	--	50	--	01	01
306	On Job Training		24			200			200		12	12
	Total	09	28	150	150	200	100	--	600	09	14	23

Structure for Semester-IV

Course Code	Course Name	Teaching Scheme (Hours/ Week)		Examination Scheme and Marks						Credits		
		Th	Prac	ISE	ESE	TW	PR	OR	Total	TH	PR	Total
401	Physical Properties of Polymers	03		50	50				100	03		03
402	Environmental Science	03		50	50				100	03		03
403	Rubber Testing-II	03		50	50				100	03		03
404	CAD Practice Lab		02				50	--	50		01	01
405	Rubber Testing-II Lab		02				50		50		01	01
406	On Job Training		24			200			200		12	12
	Total	09	28	150	150	200	100	--	600	09	14	23

*On Job Training should be carried out in any one subject per semester as per NSDC Guide lines for following Skill Sets:

1. RSC/Q0315 (5) Lab Chemist - Finished Product Testing
2. RSC/Q0403 Manager Quality Assurance (CENEX)
3. RSC/Q0213 (5) Moulding /Curing Supervisor

B. Voc Rubber Technology Syllabus for Third Year

Structure for Semester-V

Course Code	Course Name	Teaching Scheme (Hours/ Week)		Examination Scheme and Marks						Credits		
		Theory	Practical	ISE	ESE	TW	PR	OR	Total	TH	PR	Total
501	Rubber Compounding	03		50	50				100	03		03
502	Mould Design	03		50	50				100	03		03
503	Rubber Materials-III	03		50	50				100	03		03
504	Project Stage-I		04			100		--	100	--	02	02
505	On Job Training		24			200			200		12	12
	Total	09	28	150	150	300		--	600	09	14	23

Structure for Semester-VI

Course Code	Course Name	Teaching Scheme (Hours /Week)		Examination Scheme and Marks						Credits		
		Th	Prac	ISE	ESE	TW	PR	OR	Total	TH	PR	Total
601	Rubber Testing – III	03		50	50				100	03		03
602	Rubber Processing and Product Manufacturing	03		50	50				100	03		03
603	Project Stage-II		04			100			100		02	02
604	On Job Training		24			200			200		12	12
	Total	06	28	100	100	300		--	500	06	14	20

*On Job Training should be carried out in any one subject per semester as per NSDC Guide lines for following Skill Sets:

1. RSC/Q0403 (6) Manager Quality Assurance (CENEX)
2. RSC/Q6112 (6) Factory Manager - TSR

Semester I
Syllabus

Semester: I **Subject Name: Communication skill**	
Course Code: 101	Semester: I
Weekly Teaching Hours: TH: 03	Scheme of Marking TH: 100 ISE: 50, ESE: 50
Credit:3	

Unit I - Communication: **06 Hrs**

Meaning of Communication, Importance of Communication, Types of communication. Process of communication, Communication network in an organization, Barriers to communication, Essentials of good communication.

Unit II - Remedial English Grammar: **08 Hrs**

Articles, agreement between verb and subject, uses of tenses, Modal and their uses, Prepositions. Understanding and applying Vocabulary: One-word substitutes, Synonyms and Antonyms. Word formation: -Prefixes, Bases and Suffixes.

Unit III - Listening Skills: **06 Hrs**

The process of listening, Types of listening, Benefits of effective listening, Barriers to listening, listening to announcements at work place.

Unit IV - Reading Skills: **08 Hrs**

Process and methodologies of reading, Skimming and scanning, Levels of reading, Proofreading, Summarizing, Precise writing, Unseen comprehension passage, Note taking and reviewing, convert the given information into charts and graphs.

Unit V - Writing Skills: **08 Hrs**

Main Forms of Written Communication: Notices, Drafting an E-mail. Correspondence: Personal and Official, Notices, Technical Report Writing, Preparing agenda and minutes of meetings.

Books:

1. Sethi, J & et al -A Practice Course in English Pronunciation, Prentice Hall of India, New Delhi.
2. Sen, Leena., Communication Skills; Prentice Hall of India, New Delhi.
3. Prasad, P., Communication Skills; S.K. Kataria & Sons.
4. Bansal, R.K. and J.B. Harrison., Spoken English; Orient Language.
5. McCarthy, Michael; English Vocabulary in Use; Cambridge University Press.
6. Dr. Ashok Kumar Singh, One Word Substitution; Arihant Publications (India) Pvt, Ltd
7. Rajinder Pal and Prem Lata., English Grammar and Composition; Sultan Chand Publication.

Semester: I **Subject Name: Engineering Graphics**	
Course Code: 102	Semester: I
Weekly Teaching Hours: TH: 03	Scheme of Marking TH: 100 ISE: 50, ESE: 50
Credit:3	

Unit I- Introduction to drawing, lines and lettering **07 Hrs**

- Definition and classification of drawing
- Drawing instruments such as; drawing board, drawing sheets, drafter.
- Types of pencils, sheets, eraser etc.
- Different types of lines (Straight line, inclined line and curved lines)
- Practice engineering style for letters and numbers as BIS: SP:46-2003

Unit II - Dimensioning and scale 0**6 Hrs**

- Importance of dimensioning
- Types (i.e. chain, parallel and progressive etc.) and methods of placing dimensioning, Principles of dimensioning and practice dimensioning technique as BIS: SP: 46-2003, Free hand sketching of straight lines, circle, square, Polygons

Unit III -Introduction to Projection **07 Hrs**

- Introduction to first and third angle projection,
- Introduction to projection of point, line and plane, Sectioning of solids

Unit IV- Isometric and Orthographic projection **09 Hrs**

- Orthographic projection of simple geometric solids
- Isometric drawing of simple geometric solids

Unit V- Geometric and dimensioning Tolerance **07Hrs**

- Component Drawing and interpretation
- Geometric dimension and Tolerance
- Introduction to CAD software used in drawing

Books

1. N.D. Bhatt and V.M. Panchal Enginering Drawing Plane and Solid Geometry Forty-Fourth Edition2002, Charotar Publishing House
2. Laxmi Narayan and Vaishwanar Engineering DrawingCharotar Publishing House
3. P.S. Gill Engineering Graphics and Drafting Milenium Edition S.K. Kataria and Sons
4. Jolhe, D. A., (2015), "Engineering Drawing with introduction to AutoCAD", Tata McGraw Hill, New Delhi

Semester: I **Subject Name: Polymer Chemistry**	
Course Code: 103	Semester: I
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: 100 ISE: 50, ESE: 50
Credit:3	

CONTENT:

Unit 1. Introduction: Monomer, Oligomer, Polymer, Molecular weight-average, MWD, Poly-diversity, Functionality: Terms & Definition, Classification of Polymers: Rubbers, Plastics, Fibers, Paint Initials Catalyst, Emulsifier. **8 Hrs**

Unit 2. Catalysts and catalytic reaction, Redox initials, Ziggler Natta Catalyst and other common catalyst. Free Generators and initials eg.H_2O_2, $K_2S_2O_8$. Anionic, cationic, Neonic, Emulsifier- Principle, example and use. **7 Hrs**

Unit 3. Polymer Structures: **7 Hrs**
Homopolymers, Copolymers, Terpolymers.
Linear, Branched, cross linked Polymers.

Unit 4. Random, Block copolymers, Graft copolymers, Geometrical isomers- Tacticity. **7 Hrs**
Explanation as above with example.

Unit 5. Types of polymerizations: **8 Hrs**

a. Free radical polymerization.
b. Ionic Polymerization: Anionic, Cationic
c. Condensation Polymerization

Books:

1. A Textbook of Engineering Chemistry Jain and Jain Dhanpat Rai 16th
2. A Textbook of Engineering Chemistry S.S. Dara S. Chand 12th
3. Engineering Chemistry Prasanth Rath Cengage Learning 15th
4. Applied Chemistry H.D. Gessar Springer Publication
5. Polymer Chemistry Malcolm P. Stevens Oxford University Press 3 rd

Semester: I **Subject Name: Engineering Graphics Lab**	
Course Code: 104	Semester: IV
Weekly Teaching Hours: PR: **02**	Scheme of Marking PR: **50**
Credit:01	

CONTENT:

Practical No. 1-

- Prepare drawing sheet by using different types of lines
- Prepare drawing sheet by Bisection of line, angle, arc.

Practical No. 2-

- Prepare drawing sheet

a) To divide line of length 120mm into 9equal parts

b) To divide a circle into 12 equal parts by using engineering compass

c) To divide a circle into 8 equal parts by using set square

Practical No. 3-

- Prepare drawing sheet of projection of point, line & plane.

Practical No. 4-

- Prepare drawing sheet of orthographic projection
- Prepare drawing sheet of isometric projection.

Practical No. 5-

Prepare drawing sheet by using any CAD software on any topic mentioned above.

Semester: I **Subject Name: Basic Science Lab**	
Course Code: 105	Semester: I
Weekly Teaching Hours: PR: **02**	Scheme of Marking PR: **50**
Credit:01	

LIST OF EXPERIMENTS:

1. Lee's disc Determination of thermal conductivity of a bad conductor
2. Potentiometer-Determination of thermo emf of a thermocouple
3. a) Optical fiber -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
4. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.

Semester II
Syllabus

Semester: II **Subject Name: Rubber Processing I**	
Course Code: 201	Semester: II
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

Unit :1. Mixing: Description and comparison of mixers and compounding equipment, introduction to safe working practice . **8 Hrs**

Unit:2. Extrusion: description of general mechanical construction of a single screw extruder. Screw design and feed arrangement. **7 Hrs**

Unit: 3. Description of die construction, die swell. Description of the function and layout of ancillary equipment for standard extrusion operations. **7 Hrs**

Unit:4. Different type of rubber extruders, viz, hot feed, cold feed, pin barrel, cross head, co extrusion, etc. **7 Hrs**

Unit: 5. Calendaring- Description of the construction, function and use of calendaring machinery and general layout of calendaring, other methods of textile coating, viz, spreading. **7 Hrs**

REFERENCES

1. Blow.C.M. andHepburn.C. Rubber Technology and manufacture, Butterworths
2. Evans.C.W., Practical Rubber Compounding and processing, Applied SciencePublishers, London
3. Whelan.A., Injection Moulding Machines, Elsevier
4. Stevens.M.J., Extruder Principles and Operations, Elsevier Applied Science, NewYork
5. White.J.L., Rubber Processing Technology Materials, Principles, Hanser Publication,New York, 1995.
6. Richard F.Grossman,The Mixing of Rubber, Chapman & Hall,1997.
7. Kleemann, Weber, Elastomer Processing, Hansar, 2005.

Semester: II **Subject Name: Rubber Material I**	
Course Code: 202	Semester: II
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: 100 ISE: 50, ESE: 50
Credit:3	

Unit 1. Source, manufacture (in outline), grading, types, basic mix design, **8 Hrs**

Unit 2. Processing, vulcanization and properties of NR, SBR, CR, IIR, EPDM, NBR. **7 Hrs**

Unit 3. Main characteristics- of BR, IR, EPR, Silicon, fluorocarbon, acrylate, polyurethane, epichlorohydrin **7 Hrs**

Unit 4. Halo butyl, solution polymerized PBR **7 Hrs**

Unit 5. Oxysulphides, chlorosulphonated polythene. **7 Hrs**

TEXT BOOK:

1. Kothandaraman B, Rubber Materials, Ane Books, New Delhi, 2007

REFERENCES

1. Brydson, J.A., Rubber Chemistry, Allied science Publishers, London, 1978.
2. Morton.M., Rubber Technology, Chapman Hall, 1995.
3. Franta, Elastomers and Rubber Compounding materials, Elsevier, 1989.
4. Klingender R.C, Handbook of speciality elastomers, CRC Press, 2008.

Semester: II **Subject Name: Fundamentals of Industrial Management**	
Course Code: 203	Semester: II
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: 100 ISE: 50, ESE: 50
Credit:3	

CONTENT:

Unit – I **Concept of Quality** **8 Hrs**

- Quality: Definition, History, Importance
- Approaches to define Quality, Cost of Quality, Hierarchy of Quality Management
- Introduction to Quality Control.

Unit – II **Organizational Aspects of Quality Assurance** **7 Hrs**

- Quality Assurance (QA): Introduction, Definition, Management principles in QA, QA in different stages, Quality Planning.
- ISO: Introduction, ISO 9000 series of standard, Benefits of ISO.
- ISO 9001, Benefits of ISO 9001.
- Quality survey: Scope, Types of audits, inspection methods, Quality budget, Vendor Quality Rating

Unit – III **Problem solving tools and techniques:** **7 Hrs**

- Definition of a problem
- Type of problems, classification of problems
- What is problem solving, barriers to problem solving
- Problem solving tools: Cause and effect diagram, Histogram, flow charts, Check sheets, Histogram, Brain-storming, Pareto charts, Control charts, Scatter Diagram

3.5 Problem solving techniques: Brain storming, Flow diagram, PDCA Cycle etc

Unit – IV **Total Quality Management:** **7 Hrs**

- Basic concept of TQM, features of TQM
- principles of TQM
- leadership concepts
- Quality statements
- Barriers to TQM implementation
- Concept of TPM
- Quality allied concept: KAIZEN, Poke yoke, JIT, KAPA

Unit – V **5 S and Safety:** **7 Hrs**

- Detailed concept of 5S and safety used in Industries
- Integrated Management system.

Books

Name of Authors	Title of the Book	Publisher
1. L.Sganthi & Anand A. Samuel,	Total quality Management	PHI Publication.
2. Poornima M Charantimath,	Total quality Management	Pearson Publication.

Semester: II **Subject Name: Rubber Materials-I Lab**	
Course Code: 204	Semester: II
Weekly Teaching Hours: PR: **02**	Scheme of Marking PR: **50**
Credit:1.5	

LIST OF EXPERIMENTS:

1. Determination of Total Solids Content, Dry Rubber Content., KOH number of naturalrubber Latex
2. Estimation of total alkalinity of the latex
3. Determination of volatile matter, dirt, ash content in Rubber from Natural sources
4. Estimation of Cu, Fe and Mn in rubber by colorimetry

Semester: II **Subject Name: Rubber Processing-I Lab**	
Course Code: 205	Semester: II
Weekly Teaching Hours: PR: **02**	Scheme of Marking PR: **50**
Credit:1.5	

LIST OF EXPERIMENTS:

1. Mixing behavior of NR on two roll mills
2. Mixing study of carbon black filled NR
3. Mixing study of carbon black filled SBR
4. Mixing study of carbon black filled SBR & NR blend

Semester III

Syllabus

Semester: III **Subject Name: Rubber Materials- II**	
Course Code: 301	Semester: III
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

Unit:1. Awareness about polymer blends and the properties of PVC and thermosetting phenol formaldehyde resins. **7Hrs**

Unit:2. Function and example of: activators, peptizes, blowing agents, softness, extruders pigment, tackifiers, and release against reclaim rubber, factice, ground crumb, mineral rubber, retarders **7 Hrs**

Unit:3 Curing systems- Conventional, Semi-EV, EV systems, Classification of accelerators, peroxides, metal oxides and resins. **7 Hrs**

Unit:4 Filler-reinforcing and extending fillers: black and nonblack outline of the manufacturer of carbon black, classification of carbon black. **7 Hrs**

Unit:5. Mix design and selection of polymers- NR, SBR, NBR, IIR, CR and EPDM compound for: low cost: high strength, high elongation, high and low hardness and modulus, maximum resistance to hydrocarbon oils and solvents, Maximum resistance to heat ageing, weathering and ozone, electrical insulation, conduction and antistatic, process ability high resilience, low set, flex cracking resistance, microcellular and multicellular structure, flame resistance, low temperature , flexibility, non-toxicity for food stuff and applications. **8 Hrs**

TEXT BOOK:

1. Kothandaraman B, Rubber Materials, Ane Books, New Delhi, 2007

REFERENCES

5. Brydson, J.A., Rubber Chemistry, Allied science Publishers, London, 1978.
6. Morton.M., Rubber Technology, Chapman Hall, 1995.
7. Franta, Elastomers and Rubber Compounding materials, Elsevier, 1989.
8. Klingender R.C, Handbook of speciality elastomers, CRC Press, 2008.

Semester: III **Subject Name: Polymer Composite Materials**	
Course Code: 302	Semester: III
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

UNIT- I INTRODUCTION **8 Hrs**

Historical Development- Concept of Composite- Basic Definitions and Classifications of Composites - MMC, CMC and PMC- Advantages and Limitations of Composites Materials

UNIT- II MATRIX MATERIALS - THERMOSETS-I **7 Hrs**

PF, UF and MF Resins – Preparation properties and uses – Moulding powders – AdditivesEpoxy-Preparation properties and uses Unsaturated Polyester, Vinyl Ester

UNIT-III MATRIX MATERIALS - THERMOSETS-II

Cyanate Ester, Furan resins, Polyimides and BMI's - preparation, properties and applications phthalonitrile resins, Benzoxazine resin – Preparation properties and applications

UNIT IV FIBROUS REINFORCEMENTS **7 Hrs**

Reinforcements-Classification-Role and Selection of fibers - Glass fiber -classification, Manufacture and properties, Carbon fiber -classification, Manufacture and properties, Aromatic polyamides, PE fibers, Boron Fibers, Natural Fibers

UNIT – V ADDITIVES FOR COMPOSITES **7 Hrs**

Cross linkers, coupling agents, Fillers -particulate, Whiskers, Nano fillers - carbons based, silica based, cellulose based, self-reinforcing composites

REFERENCES

1. Weatherhead, R., "FRP Technology", Fibre Reinforced Resin Systems, Applied SciencePublishers Ltd., London, 1990.
2. Krishan Kumar Chawla, "*Fibrous Materials"*, Cambridge University Press, 1998
3. Michel Biron, " Thermosets and Composites: Technical Information for Plastics Users,Elsevier Advanced Technology, UK, 2004

Semester: III **Subject Name: Rubber Testing-I**	
Course Code: 303	Semester: III
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

Unit: 1 Specification and standardization. **8 Hrs**

Unit: 2. Stress/ strain properties- Tensile strength, elongation, tear, abrasion, compression set under constant stress/ strain, original and after ageing. **7 Hrs**

Unit :3. Effect of environment and ageing of rubbers- Swelling, oxidation agency and ozone cracking tests. **7 Hrs**

Unit 4. Electrical properties of rubber- Determination of resistivity, relative permittivity, **7 Hrs**

Unit 5 Power factor and die -electrical strength. **7 Hrs**

TEXT BOOKS:

1. Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons. Inc.New York, 1998.
2. R.P. Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London,1981

REFERENCES:

1. ASTM test standards for plastics Vol.8.01 to 8.04, 9.01 & 9.02, 2002.
2. ISO test standards, 1998.

Semester: III **Subject Name: Polymer Science Lab**	
Course Code: 304	Semester: II
Weekly Teaching Hours: PR: **02**	Scheme of Marking PR: **50**
Credit:1.5	

LISTOF EXPERIMENTS

1. Synthesis of Polymers.
2. Bulk polymerization - Preparation of Polymethyl methacrylate.
3. Solution Polymerization - Preparation of polyacrylamide
4. Preparation of Phenol-Formaldehyde, UF and MF resins.

Semester: III **Subject Name: Rubber Testing-I Lab**	
Course Code: 305	Semester: III
Weekly Teaching Hours: PR: **02**	Scheme of Marking PR: **50**
Credit:1.5	

LISTOF EXPERIMENTS

RUBBER COMPOUND TESTING

1. Determination of Mooney Viscosity of Raw and Compounded rubber
2. Determination of Scorch and Cure parameters of Compounded rubber

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Semester IV
Syllabus

Semester: IV **Subject Name: Physical Properties of Polymers**	
Course Code: 401	Semester: IV
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

UNIT I STATES OF AGGREGATIONS IN POLYMERS 7 Hrs

Glassy and rubbery states - Segmental mobility and glass transition Temperature - Thermodynamics and significance - Factors affecting transitions - Multiple transitions– Semi crystalline state - Requirements for crystallization - Crystallization from polymer solutions and melts-Crystal nucleation and growth-

UNIT II DEFORMATION & FAILURE IN POLYMERS 7 Hrs

Stress — strain properties of polymers - Comparison with conventional materials - short term mechanical properties - Flexural strength - Impact strength - Fatigue endurance - Ductile andBrittle failure - Ductile-Brittle transitions - Long term mechanical properties - Creep and Stress relaxation - Boltzmann Superposition principle

UNIT III TRIBOLOGICAL PROPERTIES OF POLYMERS 7 Hrs

Theory of Friction – surface and bulk material characteristics affecting coefficient of friction- Static and Dynamic Coefficient of friction – Factors affecting Friction in polymers – Elasticdeformation – single contacts – multiple contacts – Rolling friction – sliding friction of rubbersand rigid polymers – lubrication by fluids – solid lubricants -

UNIT IV ELECTRICAL AND OPTICAL PROPERTIES OF POLYMERS 7 Hrs

Volume and surface resistivity - Polar and Non-polar polymers - Polarization - Dielectric properties of polymers - Factors affecting dielectric properties - Dielectric relaxation spectroscopy in polymers - Dielectric breakdown- Anti static and conducting polymers - Optical applications of polymers - Reflection - Refraction - Light scattering - Light transfer and Absorption - Rheoptical properties - Photoelastic effects and analysis in polymers - Birefringence and orientation in polymers

UNIT V ENVIRONMENTAL AND SPECIALITY PROPERTIES 8 Hrs

Barrier properties: Sorption, Diffusion and Permeation - Chemical resistance, Thermal stability and photo degradation in Polymers - Flammability Characteristics - magneto-rheological behaviour in polymer systems - Properties and applications of polyelectrolytes - properties and applications of hydrogels - Piezoelectric properties of polymers - Shape memory polymer systems - Ablative plastics and their applications

REFERENCES:

1. Ulrich Eisele, Introduction to Polymer Physics Springs – Verlag, New York, 1990.
2. Bill Meyer.F.W. Text Book of Polymer Science, Wiley Interscience Publications, 1994.
3. L.H.Sperling, Introduction to Physical Polymer Science, 4th edition, WileyInterscience, 2006

Semester: IV Subject Name: Environmental Science	
Course Code: 402	Semester: IV
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 7 Hrs

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids

UNIT II ENVIRONMENTAL POLLUTION 7 Hrs

Definition — causes, effects and control measures of: (a) Air pollution (b) Water pollution (c)Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards– soil waste management: causes, effects and control measures of municipal solidwastes — role of an individual in prevention of pollution — pollution case studies — disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 8 Hrs

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people — Water resources: Use and overutilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies — Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water 45 logging, salinity, case studies — Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7 Hrs

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental

organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. –wasteland reclamation – consumerism and waste products – environment production act– Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act

– Wildlife protection act — Forest conservation act — enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 7 Hrs

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS
– women and child welfare – role of information technology in environment and human health — Case studies.

TEXT BOOKS:

1. Benny Joseph, "Environmental Science and Engineering" , Tata McGraw-Hill,New Delhi, 2006
2. Gilbert M. Masters, "Introduction to Environmental Engineering and Science" ,2nd edition, Pearson Education 2004

REFERENCES:

1. Cunningham, W.P. Cooper, T.H. Gorhani, "Environmental Encyclopedia",JaicoPubl., House, Mumbai, 2001.
2. Dharmendra S. Sengar, "Environmental law" , Prentice hall of India PVT LTD,New Delhi, 2007.
3. Rajagopalan, R, '" Environmental Studies-From Crisis to Cure", Oxford UniversityPress 2005.
4. Trivedi.R.K., 'Handbook of Environmental Laws, Rules, Guidelines, Compliancesand Standard" , Vol. I and II, Enviro Media
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses"Orient Blackswan Pvt. Ltd. (2013).

Semester: IV Subject Name: Rubber Testing- II	
Course Code: 403	Semester: IV
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

CONTENT:

Unit 1. Time dependent properties- Determination of rebound resilience, effect of temperature and resilience, **7 Hrs**

Unit 2. Determination of heat buildup by Goodrich thermometer. **7 Hrs**

Unit 3. Determination of creep and stress relaxation. **7 Hrs**

Unit 4. Effect of temperature frequency and aptitude of vibration on dynamic properties, forced and free vibration machines, determination of loss modulus. **8 Hrs**

Unit 5. ISO 9001;2008 Quality management systems **7 Hrs**

Books:

TEXT BOOKS:

1. Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons. Inc.New York, 1998.
2. R.P. Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London,1981

REFERENCES:

1. ASTM test standards for plastics Vol.8.01 to 8.04, 9.01 & 9.02, 2002.
2. ISO test standards, 1998.
3.Testing & Eavaluation of Plastics by Mathur & Bhardwaj, Allied Publisher Pvt. Ltd

Semester: IV Subject Name: CAD Practice Lab	
Course Code: 404	Semester: III
Weekly Teaching Hours: PR: **02**	Scheme of Marking PR: **50**
Credit:1.5	

COMPUTER AIDED PRODUCTION DRAFTING

Detailed part drawing and assembly drawings (with suitable tolerances, machine symbols,specification of fit.

1. Injection moulding toggle type clamping
2. Polymerization Plant Layout
3. Polymerization Plant Layout - II

Semester: IV **Subject Name: Rubber Testing-II Lab**	
Course Code: 405	Semester: III
Weekly Teaching Hours: PR: **02**	Scheme of Marking PR: **50**
Credit:1.5	

LIST OF EXPERIMENTS:

RUBBER VULCANIZATE TESTING

1. Hardness, Resilience,
2. Tensile properties, Tear strength,
3. Fatigue (crack initiation and propagation)
4. Abrasion resistance, Compression Set Resistance Hot air aging Resistance, Swelling Resistance

Semester V
Syllabus

C	**Semester: V** **Subject Name: Rubber Compounding**
Course Code: 501	Semester: V
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

UNIT I SCIENCE OF COMPOUNDING 7 Hrs

Technical approach to compound development, standard practices, compounding for general and specific application, design of rubber compounds, processability, properties, performance and cost

UNIT II COMPONENTS 7 Hrs

Compounding additives, cross linkers, age resistors, reinforcers, process enablers, extenders, flexibilisers, thermal aging resistors, special functional additives, homongenisers. Safe handling of various rubber chemicals - environmental regulations.

UNIT III COMPOUNDING FOR GENERAL PURPOSE RUBBERS 7 Hrs

Hardness specified NR, SBR, compounds for age resistance, compression set resistance, flexural fatigue, abrasion resistance, vibration mounts and isolation pads, bridge bearing, conveyor belting.

UNIT IV COMPOUNDING FOR SPECIFIC END USES 7 Hrs

Principles and materials for EPDM, CR, halo butyls, nitriles, silicones, fluorocarbons, chlorosulphonated polyethylene's, acrylates, polyurethanes, hydrogenated nitriles.

UNIT V QC ASPECTS 8 Hrs

Application of QC, statistics on compounding, DOE, traceability, role of specific gravity on end use, sustainability, control and disposal of off spec compounds, matching of hardness.

TEXTBOOKS

1. The Mixing of Rubber (ed) by Richard F Grossman, Chapman & Hall, London, UK,1997,
2. "Rubber Technology - Compounding and Testing for Performance", John S Dick,Hanser Publishers, Munich, 2001.
3. Practical Rubber Compounding and Processing, Colin W Evans, Springer 1981.

REFERENCES

1. Bayer Handbook on Rubber Technology,
2. Vanderbilt Handook,
3. NOCIL manual,
4. Rubber Technology, Maurice Morton.

Semester: V Subject Name: Rubber Materials III	
Course Code: 502	Semester: V
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

UNIT - I Introduction **8 Hrs**

Rubber Elasticity – Requirements for rubber elasticity- flexible chain and Tg- Effect of chemical structure on the properties of rubbers - Natural Rubber Latex, tapping, processing, properties and applications – Conversion of Latex into dry rubber – Properties of dry rubber – Classification based on technical specifications – mastication of NR

UNIT - II Diene Rubbers **7 Hrs**

Modifications of Natural Rubber–Applications –epoxidase natural rubber - Synthetic polyisoprene– BR-Polyalkenamers and polynorbornene-Nitrile Rubber NBR-PVC blends, Butyl Rubber, halo butyl rubber, Polychloprene Rubbers

UNIT - III Special Purpose Elastomers **7 Hrs**

Ethylene Propylene Rubber and Ethylene – Vinyl acetate copolymers – Elastomers based on modified polyethylene – Acrylate rubbers Polysulphide rubbers- polyether rubbers – selection criteria for the special purpose rubbers for various applications

UNIT - IV High Performance Elastomers **7 Hrs**

HNBR- Fluoroelastomers-VDF based fluoro rubbers-perfluoro rubbers- base resistant rubbers- silicone elastomers- Preparation, structure, properties and applications – liquid silicone rubbers – silicones in medical applications

UNIT -V Polyurethanes and thermoplastic Elastomers **7 Hrs**

Poly urethanes- diisocyanates, polyols and chain extenders – castable PUs-millable PUs-Requirements for thermoplastic elastomeric behaviour – SBS and SIS Block copolymers – Thermoplastic Polyurethane elastomers – Thermoplastic-co-polyesters – Thermoplastic elastomers based on Plastic – Rubber Blends – Dynamic Vulcanization.

Books:

Text Book:

1. Kothandaraman B, Rubber Materials, Ane Books, New Delhi, 2007

REFERENCES

1. Brydson, J.A., Rubber Chemistry, Allied science Publishers, London, 1978.
2. Morton.M., Rubber Technology, Chapman Hall, 1995.
3. Franta, Elastomers and Rubber Compounding materials, Elsevier, 1989.
4. Klingender R.C, Handbook of speciality elastomers, CRC Press, 2008

Subject Name: Mould Design	
Course Code: 503	Semester: V
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

CONTENT:

Unit :1. Introduction to detail study of mould construction for different moulding process. Including feeding of raw materials to mould component ejection system. **8 Hrs**

Unit: 2. Detail designing of mould components core, cavity, moving parts, etc. Design of guide pin bushes. **7 Hrs**

Unit :3. Compression moulds: Design of positive mould, semi-positive mould Single cavity and multicavity mould Flash allowance, shrinkage allowance and draft allowance. **7 Hrs**

Unit :4. Transfer moulds: design of transfer pot and punch **7 Hrs**

Unit :5. Extrusion die design: aspects of pipe die, Mandrel, Land length, Angle of entry. Profile dies elementary study.

7 Hrs

References:

1. Injection Mould Design Handbook, 2022, Broue catoen and Herbert Rees
2. Injecion Mould Design Engineering,2016, David O. Kazmer

Semester: V Subject Name: Project Stage-I	
Course Code: 504	Semester: V
Weekly Teaching Hours: PR: **04**	Scheme of Marking TW: 200
Credit:02	

Students are allowed to select the topic of their project work subject to approval of the scope by the faculty. Maximum 4 students can work in group for a common topic. Students are expected to visit the site, shops, etc. They can discuss the topic with manufactures, owners, consultants. The project report comprising drawing, sketches, photographs and description must be elaborate to cover the topic in its entirety.

Semester VI
Syllabus

Semester: VI Subject Name: Rubber Processing and Product Manufacturing	
Course Code: 602	Semester: VI
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

UNIT-I COMPOUNDING AND MIXING OPERATIONS 8 Hrs

Rubber mixing mechanism, mixing machinery – construction and operations - Open mill mixing – Internal mixing – Energy mixing, Continuous mixing – Factors affecting mixing – Flow behavior of gum and rubber compound, processability test, Common problems in mixing.

UNIT-II FORMING OPERATIONS 7 Hrs

Extrusion- construction and operations - Screw type – L/D ratio and its influence – Hot and cold feed extruders – Pin barrel extruder – Twin screw extruder –Factors affecting the extrusion process, Common problems in extrusions. Calendaring – construction and operations - Sheeting – Coating – Fractioning – Topping – Roll configurations – Control of thickness - Factors affecting the calendaring process, common problems in calendaring process.

UNIT-III MOULDING AND OTHER VULCANISING TECHNIQUES 7 Hrs

Compression, transfer and injection molding process — Blanks & pre-heating techniques, preparation of surfaces for bonding, common problems in molding. Vulcanization –Batch vulcanization- Autoclaves, Hot air chambers - curing of hand built up products - tank, pipe lining, roller covering. Continuous vulcanization - L.C.M. (Liquid Curing Media), Microwave curing, Roto cure, Hot air oven, common problems in curing.

UNIT-IV MANUFACTURE OF RUBBER PRODUCTS 7 Hrs

Belting, Hoses, Cables, Rubber Footwear, Sports goods, molded products -Rubber to Metal bonded products- Bridge Bearings, Engine mountings, Finishing of rubber components.

UNIT-V PLANT DESIGN FOR RUBBER COMPONENTS MANUFACTURING

Plant layout design, Plant services, Power transmission, Hydraulics, Heating and cooling systems - automation, Safety systems, man power requirements, Storage and Flow patternof materials, Energy conservation- Case study**. 7 Hrs**

REFERENCES

1. Blow.C.M. andHepburn.C. Rubber Technology and manufacture, Butterworths, 1982.
2 Evans.C.W., Practical Rubber Compounding and processing, Applied SciencePublishers, London, 1981.
3 Whelan.A., Injection Moulding Machines, Elsevier, 1989.

Semester: VI Subject Name: Rubber Testing-III	
Course Code: 604	Semester: VI
Weekly Teaching Hours: TH: **03**	Scheme of Marking TH: **100** ISE: **50**, ESE: **50**
Credit:3	

Unit 1. Destruction tests- Theories of tearing. Relative merits of various tests **7 Hrs**

Unit 2. Determination of abrasion resistance to crack invitation and crack growth by the De Mattia method, review of other flex cracking test **8 Hrs**

Unit 3. flexural fatigue failure in rubber fabric comparatives. **7 Hrs**

Unit 4. Adhesion/ Band testing- Peel test, shear test. **7 Hrs**

Unit 3. ISO 14001:2004 Environmental Management Systems - Introduction and awareness **7 Hrs**

TEXT BOOKS:

1 Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons. Inc.NewYork, 1998.
2 R.P. Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London,1981

REFERENCES:

1 ASTM test standards for plastics Vol.8.01 to 8.04, 9.01 & 9.02, 2002.
ISO test standards, 1998.

Semester: VI **Subject Name: Project Stage II**	
Course Code: 606	Semester: VI
Weekly Teaching Hours: PR: **04**	Scheme of Marking TW:200
Credit:02	

Students are allowed to select the topic of their project work subject to approval of the scope by the faculty. Maximum 4 students can work in group for a common topic. Students are expected to visit the site, shops, etc. They can discuss the topic with manufactures, owners, consultants. The project report comprising drawing, sketches, photographs and description must be elaborate to cover the topic in its entirety. The Drawing should specify sizing followed by report writing.

The oral examination based on the project work submitted, shall be conducted in the presence of an external examiner.