

GUJARAT TECHNOLOGICAL UNIVERSITY

RUBBER TECHNOLOGY (26) RUBBER COMPOUNDING MATERIALS SUBJECT CODE: 2142601 B.E. 4th SEMESTER

Type of course: B.E. (Rubber Technology)

Prerequisite: Nil

Rationale: Nil

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
		PA	ALA		ESE	OEP				
3	0	3	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightag
1	Organic Materials: Hydrocarbons, Unsaturated Hydrocarbons, Aromatic Hydrocarbons, Phenols, Phenolic Antioxidants, Aldehydes & Ketones, Alcohols, Fatty Acids, Amines, Rubber Chemicals, Paraphenylene diamines derivatives, Solvents, Fattices, Organic Peroxides, Resins, Quantitative Analysis of Organic Compounds.	5	10
2	Inorganic Materials: Calcium & Magnesium, Copper & Zinc, Compounds of Aluminum, Silicone and Ozone, Other Inorganic Compounds used in Rubber Industries, Sulfur, Water etc.	5	10
3	Rubber Additives: Basic Principles, Introduction, Classification of Additives, Recurring Theories, Synergism, Toxicity.	5	10
4	Antidegradants: Introduction, Autoxidation of Hydrocarbon Polymers, Chain-Braking Antioxidants, Amine & Phenolic Antioxidants, Antiozonants, Prevention of Ozone Attack, Use of Waxes & Saturated Polymer for Ozone Protection.	5	10
5	Compounding Materials: Plasticizers, Process aids & Fattices, Accelerators, Blowing Agents, Bonding Agents, Other Compounding Aids, Peptisers, Colors & Pigments, Special Purpose Additives, Non Black Fillers etc.	9	10
6	Environmental requirements in Compounding:	5	10
7	Principles of Compounding: Introduction, The ingredients & formulation of a mix, Compounding to	5	10

	meet processing requirements, Compounding of Vulcanizate properties, Compounding for bonding to non-rubber substrates.		
8	Art of compounding: Calculation of compound cost of a recipe, Calculation of compound volume of a recipe, Calculation of compound specific gravity of a recipe, formulation of mix, Processing requirements.	5	10
9	Carbon Black: Introduction, Properties, Rubber compounding aspects, Furnace process, Thermal process channel or impingement process, Lamp black process, Particles size, Structure, Particle porosity, Classification. Effect of properties of carbon black on properties of rubber Vulcanizates.	5	10
10	Reinforcement by fillers: Introduction, reinforcement, Factors influencing elastomers reinforcement, fillers characteristics, main effects of fillers, characteristics of Vulcanizate properties, Influence of fillers characteristics on the cross linking process, Filler incorporation, the roll of bound rubber, reinforcement and crosslink density, The mechanism of reinforcement & its applications.	5	10
	Total Hours	45	100%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
12	12	16	15	15

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Reference Books:

1. Rubber Engg. by IRI
2. Rubber Technology Handbook, by Hofmann
3. Science & Technology of Rubber, by J. Mark, B. Erman, F. Eirich
4. Rubbery Materials & their Compounds, by J. A. Brydson
5. Rubber Technology & manufacture, by C. M. Blow
6. Rubber Product Mfg. Technology, by Anil K. Bhowmick

Course Outcome:

After learning the course the students should be able to:

1. Able to do analysis of Organic Compounds.
2. Identify the inorganic materials.
3. Compare the ageing and anti- ageing properties.
4. Understand the function of different compounding ingredients in rubber products.
5. Develop the Compound to meet processing requirements.
6. Able to do Calculation for compound cost of a recipe.
7. Understand the effect of properties of carbon black on properties of rubber Vulcanizates.
8. Learn the mechanism of reinforcement & its applications

List of Experiments:

Tutorials/Presentation/Practicals based on above topics

Design based Problems (DP)/Open Ended Problem:

- Toxicity of Rubber Additives.
- Thermal Carbon Black in NBR Compound.
- The Use of Fly Ash fillers in Rubber.

Major Equipment:

Ph meter, Specific gravity balance, Weighing balance, Hot Plate, Melting Point Apparatus etc

List of Open Source Software/learning website:

- www.britannica.com/EBchecked/topic/511800/rubber/289657/Additives
- www.ndsseals.com/rubber-ingredients.html
- rubbertrainer.blog.com/2012/09/24/compounding-ingredients
- <https://rubbertech.wordpress.com/2013/07/.../basic-rubber-compounding>

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.