Program Name : **Diploma in Plastic Engineering**

Program Code : **PS**

Semester : **Fourth**

Course Title : **Elastomer Technology**

Course Code : **22455**

1. RATIONALE

An 'Elastomer' is an important class of polymer material in the polymer engineering field. These materials has excellent thermal and mechanical stability and hence widely used in many industrial applications. This course imparts skills of manufacturing, properties and applications of rubber materials commonly used in industries. The plastics diploma engineer (also called technologist) will be able to manufacture and test rubber product using suitable methods.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Manufacture elastomeric components**.

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Use latex technology for collection of natural rubber.
b. Manufacture various synthetic rubbers.
c. Compound rubber ingredients for product formulation.
d. Manufacture products using relevant vulcanization process of rubber manufacturing.
e. Test the propereties of various rubbers.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *- Practical;* ***C*** *– Credit,* ***ESE*** *- End Semester Examination;* ***PA*** *- Progressive Assessment.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

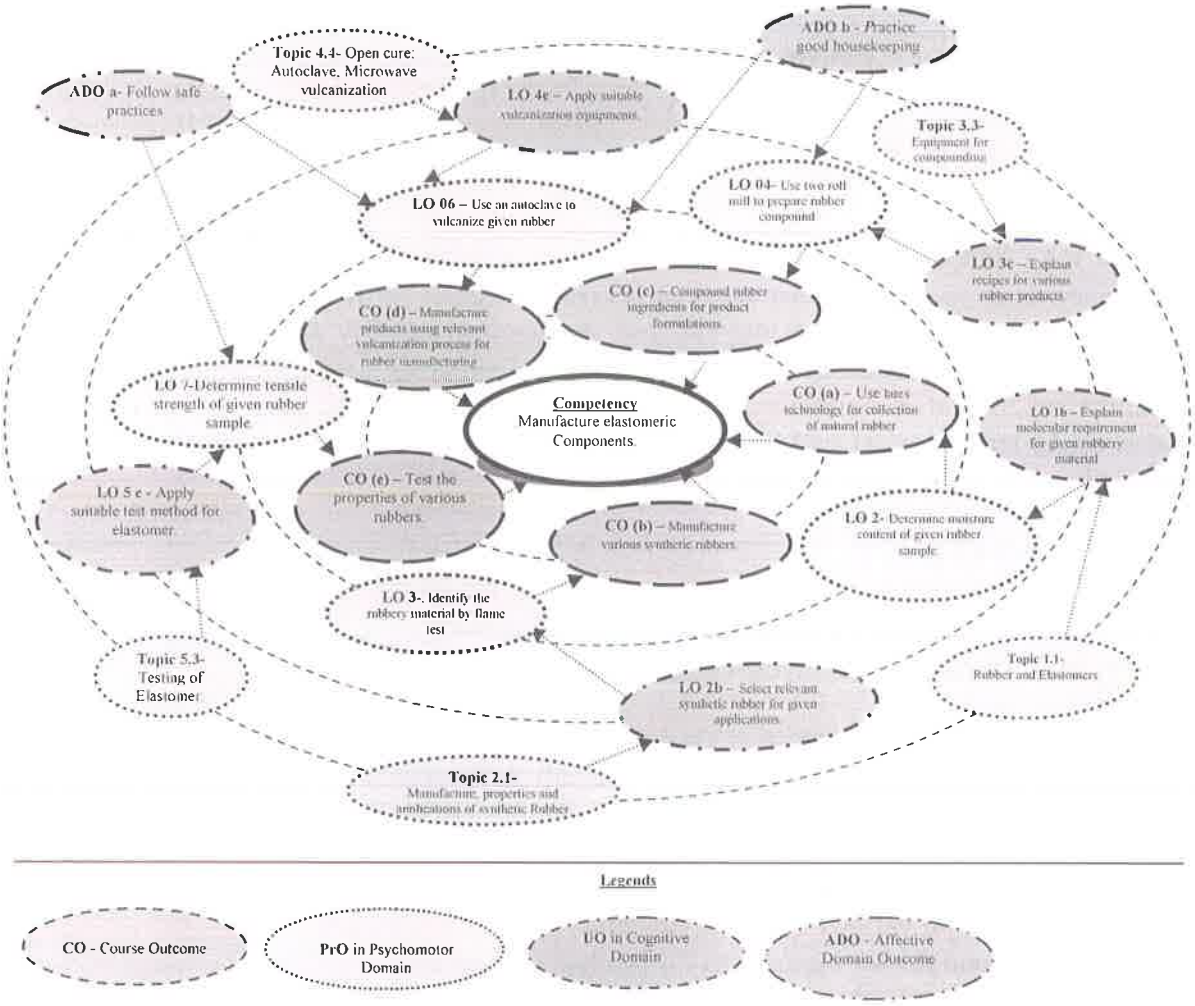

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Determine ash content of given rubber sample.	I	02
2	Determine moisture content of given rubber sample.	I	02
3	Identify the rubbery material by flame test.	II	02
4	Use two roll mill to prepare rubber compound.	III	02
5	Use internal mixer to prepare rubber compound.	III	02
6	Use an autoclave to vulcanize given rubber.	IV	02
7	Determine tensile strength of given rubber sample.	V	02
8	Determine elongation of given rubber sample.	V	02
9	Measure hardness of given rubber sample.	V	02
10	Determine compression set by constant deflection methods.	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
11	Determine compression set by constant stress method.	V	02
12	Set the process parameter for rubber extrusion.	V	02
13	Use extrusion plant to manufacture rubber product.	V	02
14	Determine rebound elasticity of given rubber sample.	V	02
15	Determine abrasion resistance of given rubber sample.	V	02
16	Determine flex strength of rubber.	V	02

Note

i. *A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safe practices
b. Practice good housekeeping
c. Practice energy conservation
d. Demonstrate working as a leader/a team member
e. Maintain tools and equipment
f. Follow ethical practices

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	Weight balance (0 to 100 g digital)	1,2
2	Two roll mill (Laboratory Model)	4
3	Internal Mixer	5
4	Autoclave (Laboratory Model)	6
5	Universal Testing Machine (up to 1000 kg with all gripers)	7,8
6	Shore'A' and Shore 'D' hardness tester	9
7	Compresion set tester	10,11
8	Rubber Extrusion Plant (Laboratory Model)	12,13
9	Resilience Tester (The microcomputer controlled ball rebound tester)	14
10	Abrasion Tester (Platform speeds 60 and 72 rpm)	15
11	De Mattia Flex Tester (3 samples can be tested, Adjustable from 1" (25.4mm) to 3" (75mm))	16

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics are to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Rubber and Elastomer	1a. Describe the properties of the given rubber and elastomer. 1b. Explain molecular requirement for given rubbery material. 1c. Explain the properties of given thermoplastic elastomers. 1d. Apply relevant preservation method for given rubbery material.	1.1 Rubber and Elastomers: Definition, Molecular requirements for rubber 1.2 Classification: Natural and Synthetic rubber, thermoplastic rubber, Sources of natural rubber. 1.3 Latex technology: tapping, collection, preservation, processing of latex.
Unit– II Synthetic Rubber	2a. Describe the manufacturing of given synthetic rubber. 2b. Select relevant synthetic rubber for given application. 2c. Desribe the advantages of given TPE. 2d. Describe the block copolymerization process for given copolymers.	Manufacturing, properties and applications of synthetic rubbers: 2.1 Nitrile Rubber 2.2 Styrene Butadiene Rubber 2.3 EPM and EPDM Rubber 2.4 Neoprene Rubber 2.5 Silicone Rubber 2.6 Butyl Rubber 2.7 Introduction, need and Advantages of TPE: PU based block copolymer, Polyolefins based block copolymer, Styrene Based block copolymer.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– III Compounding of Rubber	3a. Describe the need of compounding. 3b. Select suitable method of compounding. 3c. Explain recipes for various rubber products.	3.1 Principle and need of mastication. 3.2 Compounding additives: Antioxidant, Antiozonant, Processing Aid, Fillers, Plasticizer, its need, function and sequence of addition. 3.3 Equipments for compounding: Two roll mill, Banbury Mixer, Kneader. 3.4 Compound recipes for seals, O rings, tubes, gasket, conveyor belt, hoses.
Unit– IV Vulcanization of rubber	4a. Justify need of Vulcanization 4b. Describe effect of Vulcanization. 4c. Select suitable vulcanization system. 4d. Differentiate between shulpur and non sulphur vulcanization. 4e. Apply suitable vulcanization equipments.	4.1 Vulcanization: Need and Effect. 4.2 Vulcanization types: Sulphur, accelerated sulphur, peroxide and metal oxide vulcanization. 4.3 Vulcanization Techniques, Compression moulding, Transfer moulding. 4.4 Open cure: Autoclave, Microwave vulcanization.
Unit– V Processing and Testing	5a. Explain Extrusion of rubber. 5b. Describe Calendering of rubber 5c. Apply suitable test method for elastomer.	5.1 Extrusion: Hot feed, cold feed & ram extrusion. 5.2 Calendaring: 3 and 4 roll calendar, skimming, fractioning & topping, single and double side coating. 5.3 Testing of elastomer: Solubility test, Tack test, Rotating disk rheometer test, Hardness test, Resilience test, Rebound elasticity test, Aging test, Compression set test, Flex test, Abrasion Resistance test.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Rubber and Elastomer	08	02	06	04	12
II	Synthetic Rubber	10	04	06	06	16
III	Compounding of Rubber	10	02	06	06	14
IV	Vulcanization of rubber	10	04	04	06	14
V	Processing and Testing	10	02	06	06	14
Total		**48**	**14**	**28**	**28**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of ULOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

a. Prepare list of rubber products.
b. Collect information of different rubber grades.
c. Collect information on rubber product manufacturing industries.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Use Flash/Animations to explain various rubber processing techniques.
f. Guide student(s) in undertaking micro-projects

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs.The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty. Students should conduct following activities in group and prepare reports of about 4 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews.

a. **Preparation of chart:** Prepare a chart of elastomer, properties and applications.

b. **Exhibition:** Collect product of different rubber materials.
c. **Analysis:** Perform tensile and elongation test for rubber and plastics specimen and interpret the results.
d. **Presentation:** Prepare power point presentation on recycling of rubber.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Rubber Technology Handbook	Hoffmann, W.	Hanser, Oxford University Press,1989 ISBN-13: 978-344614895
2	Rubber Technology	Blow, C.M.	Butterworth-Heinemann Ltd, 1982, London ISBN: 9780408005876
3	Rubbery Materials	Brydson, J.A.	Springer, Netherlands, 1988 ISBN : 978-0-07-340458-5
4	Rubber Technology	Mortan, M.	Elsevier 1987, US ISBN: 978-1-4615-7823-9
5	Rubber Technology Handbook	White, J.R.; De, S.K.	iSmithers Rapra Publishing, 2001, UK ISBN: 9781859572627

14. SOFTWARE/LEARNING WEBSITES

a. www.omnexus.com
b. www.rubberasia.com
c. www.iisrp.com/synthetic_rubber
d. www.westernrubber.com
e. www.dreamtechpress.com /ebooks
f. www.nptelvideos.in
g. www.ndl.iitkgp.ac.in