Program Name : **Diploma in Plastic Engineering**

Program Code : **PS**

Semester : **Fifth**

Course Title : **Fibre Technology (Elective-I)**

Course Code : **22553**

1. RATIONALE

Industrial applications of polymers in the form of fibre like rope, fabrics, etc. are increasing day by day. This course is introduced to acquaint plastic engineering technocrats about types, manufacturing techniques and applications of synthetic fibres. The application of this course is widely found in textile manufacturing, plastic packaging, advertising and media industries.

2. COMPETENCY

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

- **Use relevant technologies for manufacturing of different types of fibres.**

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 suitable fibre for plastic processing.
b. Use melt spinning technique and post spinning operation to make fibre.
c. Use solution spinning technique and post spinning operation to make fibre.
d. Use suitable synthetic fibre making material.
e. Select suitable high performance fibre for industrial application.

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.

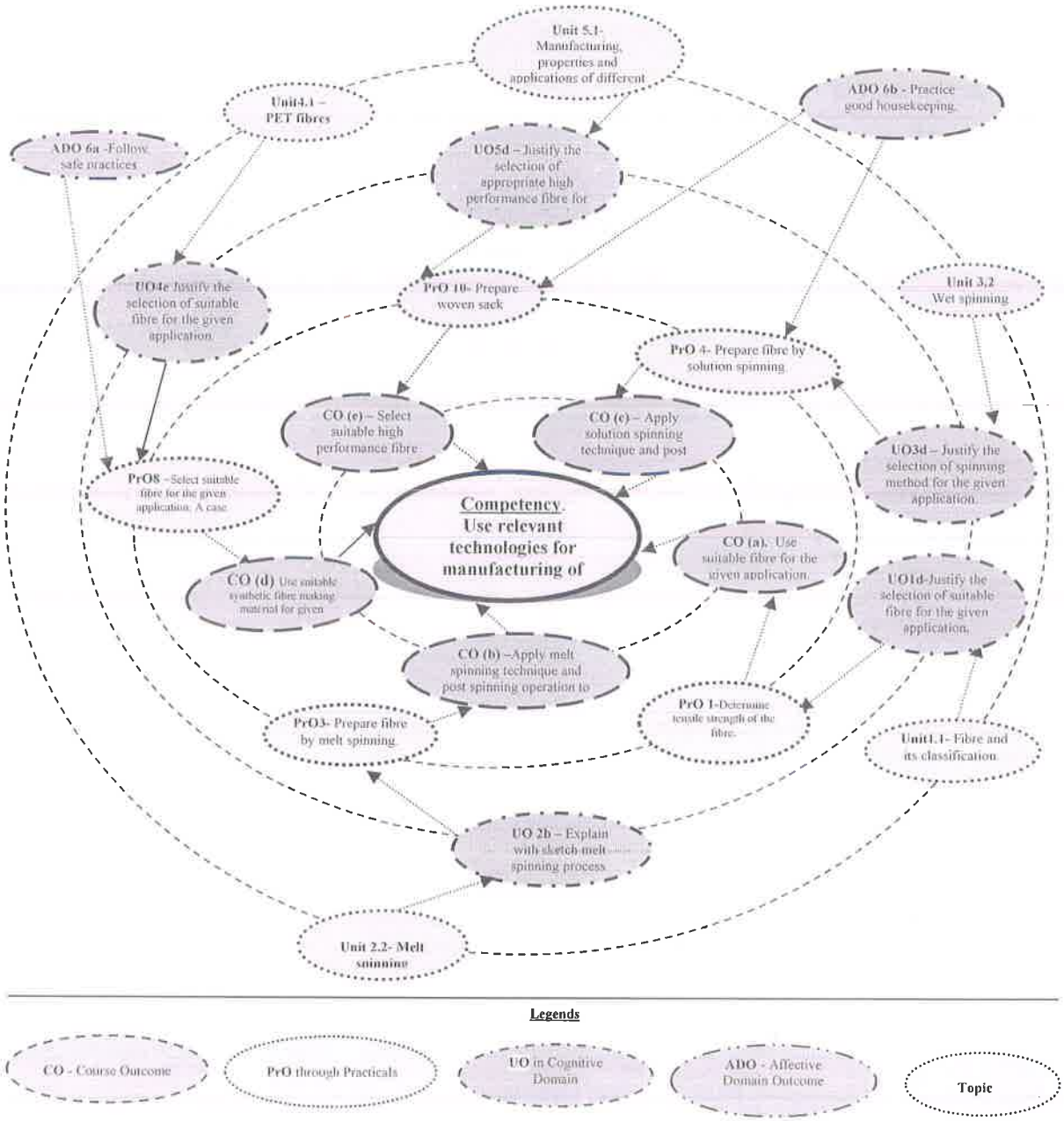

Figure 1 - Course Map

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 tensile strength of the fibre.	I	02*
2.	Determine size of the fibre.	I	02*
3.	Prepare fibre by melt spinning.	II	04*
4.	Prepare fibre by solution spinning.	III	04*
5.	Perform post spinning operation of fibre.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6.	Synthesize Nylon fibre.	IV	04*
7.	Synthesize PET fibre.	IV	04
8.	Select suitable fibre for the given application	IV	04*
9.	Prepare woven sack.	IV	04
10.	Prepare woven mat.	V	04*
11.	Prepare a product using glass fibre.	V	02
	Total		36

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. All the above listed practical need to be performed compulsorily, so that the student reaches the 'Applying Level' of Blooms's 'Cognitive Domain Taxonomy' as generally required by the industry.

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

S. No.	Performance Indicators	Weightage in %
a.	Procedure	60
b.	Safety precautions	10
c.	Accuracy of result	10
d.	Answer to sample questions	10
e.	Submit 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 safety practices.
b. Practice good housekeeping.
c. Work as a leader/a team member.
d. 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
- 'Organisation Level' in 2nd year and
- 'Characterisation 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	PrO S.No.
1.1	Laboratory scale tensile testing machine.	1

S. No.	Equipment Name with Broad Specifications	PrO S. No.
1.2	Laboratory scale thickness gauge	2
1.3	Laboratory scale melt Spinning machine Screw Diameter: 16 mm to 25 mm (range) L/D ratio: 24:1 to 36:1 (range), melt pressure rating 7000 psi or higher, Working Temperature: Minimum 300oC or better.	3
1.4	Solution spinning setup -Total power required for the machine is 15 kW, Machine Operating supply AC 3 phase, physical space required for the machine 15 m X 2m.	4
1.5	Woven PP sack weaving machine -production Capacity: 150-600 Kg/Hr, power consumption: 85 KW, voltage: 220 V.	9
1.6	Mat weaving machine- 2 extruders, starting from 36 inch (90 cm) width.	10

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Types of Fibre	1a. Explain with sketches the types of fibres and its classification. 1b. Explain with sketches and justification advantages and limitations of given fibres for the given process. 1c. Compare natural fibres with synthetic fibres on the basis of their properties. 1d. Justify the selection of suitable fibre for the given application.	1.1 Fibre and its classification. 1.2 Molecular requirement of fibre forming polymers. 1.3 Difference between natural and synthetic fibres. 1.4 Advantages and limitations of synthetic fibres.
Unit-II Melt Spinning	2a. Describe with sketches the stages in fibre forming. 2b. Explain with sketch melt spinning process. 2c. Explain with sketch the post spinning operation. 2d. Justify the selection of spinning technique and post spinning operation to make fibre.	2.1 Stages in preparation of synthetic fibres. 2.2 Melt spinning: Different techniques of melt spinning, Melt spinning line, cooling system, Melt spinning variables, Structure formation during melt spinning, Spin finish application, Post Spinning operations.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit- III Solution Spinning	3a. Explain with sketches dry spinning process for the given application. 3b. Describe with sketches wet spinning process for the given application. 3c. Compare dry spinning versus wet spinning on the basis of their operation. 3d. Justify the selection of spinning method for the given application.	3.1 Dry spinning: Process variables for solution spinning, Preparation of the dope, Steps in Dry Spinning Process, Post Spinning Operations. 3.2 Wet spinning: Solution preparation and transport, Coagulation, Development of structure and morphology, Finish application and winding, Post Spinning Operations. 3.3 Difference between dry and wet spinning. 3.4 Dry jet wet spinning, Steps in Dry jet wet spinning, Post Spinning Operations.
Unit- IV Synthetic Fibres	4a. Describe with sketches the synthesis of PET and Nylon fibres. 4b. Explain properties and applications of PET and Nylon Fibres. 4c. Describe with sketches the synthesis of PP, Acrylic and Cellulose fibres. 4d. Explain properties and applications of PP, Acrylic and Cellulose fibres. 4e. Justify the selection of suitable fibre for the given application.	4.1 PET fibres: Polymer production, Fibre production, Different melt spinning processes based on spinning speed, Production of staple fibre, LOY, POY, HOY, FOY spinning processes, PET staple fibre problems and their causes, Stress –strain behaviour of PET fibres, Properties and Applications of PET Fibres. 4.2 Nylon fibres: Nylon 66 Polymer production, Fibre Production, LOY, POY, HOY, FOY spinning processes, Post spinning operations, Properties and Applications of Nylon Fibres. 4.3 PP fibres: Polymer manufacture, Fibre Production, Different processes of fibre production, Properties and Limitations of fibres, Applications of fibres. 4.4 Acrylic fibres: Polymer manufacture, Spinning processes, Tow processing, Gel spinning, Properties and Applications of Acrylic fibres. 4.5 Modified cellulose fibres: Manufacturing of modified cellulose fibres, Properties and Applications of Modified cellulose fibres.
Unit– V High Performance	5a. Describe with sketches the manufacturing of the given high performance fibre.	5.1 Manufacturing, Properties and applications of: Aramid fibres, Aromatic polyesters fibres,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Fibres	5b. Compare glass fibre and carbon fibre on the basis of their manufacturing method, properties and applications. 5c. Differentiate between aramid fibres and aromatic polyester fibres on the basis of their properties. 5d. Justify the selection of appropriate high performance fibre for the given application.	5.2 Manufacturing, Properties and applications of: Glass Fibres, Boron fibres. 5.3 Manufacturing, Properties and applications of: Carbon fibres, Graphite fibres

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' 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	Types of Fibre	06	02	02	04	08
II	Melt Spinning	06	02	04	04	10
III	Solution Spinning	10	02	04	06	12
IV	Synthetic Fibres	16	06	08	12	26
V	High Performance Fibres	10	02	06	06	14
Total		**48**	**14**	**24**	**32**	**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 UOs. 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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare chart of types and names of fibre materials.
b. Prepare data sheet for properties of fibre materials.
c. Collect information on spinning machine specifications, manufacturers, cost etc.
d. Visit fibre manufacturing industry and prepare a report.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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. Guide student(s) in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.
i. Demonstrate students thoroughly before they start doing the practice.
j. Encourage students to refer different websites to have deeper understanding of the subject.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably 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. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. 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. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Applications of fibre materials in industry, household and technology: Power point presentation.
b. Layout of spinning plant: Chart preparation and report submission.
c. Properties of synthetic fibres: Data Collection and class presentation.
d. Any other micro-projects suggested by subject faculty on similar line.

13. SUGGESTED LEARNING RESOURCES :

S. No.	Title of Book	Author	Publication
1	Production of Synthetic Fibres	Vaidya, A. A.	Prentice-Hall of India Pvt. Ltd., New Delhi, 1988. ISBN: 9780876925782.
2	Manufactured Fibre Technology	Gupta, V.B. and Kothari, V. K.	Springer Science + BusinessMedia, 1997. ISBN: 9789401064736.
3	Synthetic Fibres: nylon,	McIntyre, J. E.	Woodhead Publishing, New Delhi,

S. No.	Title of Book	Author	Publication
	polyester, acrylic, polyolefin.		2004.ISBN: 9781855735880.
4	SPI Handbook of Plastic Engineering	Berins, M. L.	Springer - Verlag, New Delhi, 1991, ISBN:9780412991813
5	Chemical processing of synthetic fibers and blends	Datye, K. V. and Vaidya, A. A.	Wiley-Interscience, Noida, 1984.

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=cvzPkzfQu_4 for natural and synthetic fibres.
b. https://www.youtube.com/watch?v=Q8j7uu94180 for synthetic fibres and plastics.
c. https://www.youtube.com/watch?v=QFh9I99oVdo for synthetic fibres.
d. https://www.youtube.com/watch?v=f_AvqnMTJjg for making rayon fibre.