

**SECOND SEMESTER 2021-2022**

# Course Handout Part II

Date: 1-1-2022

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

*Course No.* : MST G522

## Course Title : Advanced Composites

## Instructor-in-Charge : Dr. Pavan Kumar P

**Description :** Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fibre reinforced composites, metal-matrix composites, carboncarbon

composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibres, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture thoughness and fatigue; properties of fibre reinforcement and production technology of composites.

**Scope and Objective of the Course:**

Composite Materials have gained considerable importance due to their outstanding mechanical properties. They find extensive applications in automobile and aerospace industries. The topics that are to be covered : Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fiber reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibers, concept of microfibril; effect of orientation and adhesion; mechanical behavior of composites, stress-strain relationship, strength, fracture toughness and fatigue; properties of fiber reinforcement and production technology of composites.

**Textbooks :**

Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.

**Reference books :**

Analysis and Performance of Fiber Composites - BD Agarwal, L J Broutman and K Chandrashekhara, Wiley, 3rd Edition, 2006

**Prerequisites :**

Courses – Materials science and mechanics of solids

**Course Plan:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Lecture No.** | **Learning objectives** | **Topics to be covered** | **Chapter in the Text Book** |
| 1-4 | Definition and constituents of composites | Introduction to composites, Reinforcements, Matrices , Interfaces, | Ch1-T1,R1 |
| 5-6 | How to manufacture composite materials | Manufacturing methods of composites: | Ch2-T1,R1 |
| 7-10 | Mathematical analysis of tensorial stress and strain | Introduction to tensor algebra. Stress and strain tensor, Stress-strain relations for composite materials | Ch3-T1,  Ch2-R1 |
| 11-16 | Effect of interface on composite behavior | Micro and macro mechanics | Ch4-T1, |
| 17-20 | Stress and strain field in a laminate | Analysis of laminates | Ch6&Ch7-T1,  Ch2-R1 |
| 21-24 | Design of composites for various loads | Design and performance of fiber composites: Fatigue, Impact  Design of pressure vessels and storage tanks | Ch10-T1,  Ch3-R1 |
| 25-30 | Application of basic stress-strain relations to different class of materials | Advanced topics: Inter laminar stresses, Fracture mechanics of composites  Advanced composites | Ch11-T1,  Ch5-R1 |
| 31-35 | Analysis of advanced composites | Metal-matrix composites, carbon-carbon composites, molecular composites, concept of micro fibril; | Ch10-R1 |
| 36-38 | Characterization of composite strength | Experimental methods | Ch11-T1,  Ch5-R1 |
| 39-40 | Numerical analysis of composites | FE analysis of composites using ABAQUS |  |

This course also contains a lab component along with theory classes. The lab component will cover both numerical simulations and lab experiments.

**List of experiments:**

|  |  |
| --- | --- |
| **S. No** | **Name of the experiment** |
| 1 | Introduction to stress analysis in ABAQUS/COMSOL/ANSYS |
| 2 | Analysis of unidirectional lamina in ABAQUS/COMSOL/ANSYS |
| 3 | Analysis of composite laminate in ABAQUS/COMSOL/ANSYS |
| 4 | Analysis of hybrid laminate in ABAQUS/COMSOL/ANSYS |
| 5 | Making of short fiber carbon composites (Carbon + Polypropylene) |
| 6 | Making of carbon epoxy composite |
| 7 | Hand-layup technique |
| 8 | Wetting studies between fiber and matrix |
| 9 | Mechanical testing of fiber and matrix |
| 10 | Tensile testing of composite |
| 11 | Composites processing by Pultrusion technique |
| 12 | Processing of metal-matrix composites |

The numerical simulation studies will be carried out in CAD Laboratory. Processing studies of composites will be carried out in chemical engineering department laboratory and mechanical testing and machining will be carried out in mechanical engineering department laboratory.

**Evaluation Scheme:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Component** | **Duration** | **Weightage (%)** | **Date & Time** | **Nature of Component** |
| Mid semester test | 90 min | 25 | As per Timetable | 10% Open book  15 % Closed book |
| Literature Survey / Presentation |  | 10 |  | Open book |
| Research Seminar/Project |  | 15 |  | Open book |
| Lab exam |  | 10 |  | Open book |
| Comprehensive  Examination | 120 min | 40 | 20/5 FN | Closed book |

**Research seminar:**

Each student/batch of students is assigned a task of processing and testing of composites using various reinforcements and matrix materials. The students/batch have to prepare a plan through proper literature survey. After the composite perpetration and testing, numerical studies have to be carried out using ABAQUS or ANSYS or COMSOL. The progress of the project will be monitored through three time evaluation in the form of project plan proposal, mid-semester and end-semester presentations.

**Chamber Consultation Hour:**

To be announced in the class. Chamber: E217

**Notices:** All notices related to this course will be put on CMS only.

**Make-up Policy:**

Make-up will be granted **ONLY** in genuine cases with ***prior permission***. The request application for make-up test must be reached to the Instructor-in-charge before commencement of the scheduled test (documentary proof is essential).

**Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Dr. Pavan Kumar P**

**INSTRUCTOR-IN-CHARGE**