

International Summer School- Manipal University Jaipur [ISSMUJ]-2025

[Hybrid Mode]



Course Overview

Name of Course- Design and Characterizations of Composite Materials: Phase Change Materials, Soft Gels, and Coatings

Name of instructor: Dr. Ankur Srivastava (MUJ) and Dr Shikha Awasthi (IES College of Technology Bhopal)

Session: May-July 2025

Language of instruction: English

Number of contact hours: 36

Credit awarded: 03

Pre-requisite: write NA if no pre-requisite required

Objective of Course/Project:

1. Introduction to Composite Materials
2. Types of Composites, including phase change materials, soft gels, and coatings
3. Various characterization techniques
4. Thermal, mechanical and tribological analysis of composite materials.
5. Recent research on composite materials

Syllabus:

Module 1: Introduction to Composite Materials

Key Topics:

- Definition and importance of composites
- Basic constituents: Matrix vs Reinforcement
- Advantages and limitations of composites
- Applications in aerospace, automotive, and biomedical

Module 2: Types of Composites, Including Phase Change Materials, Soft Gels, and Coatings

Key Topics:

- Phase Change Materials: Thermal energy storage
- Soft Gels: Smart materials for biomedical and wearable technologies
- Advanced coatings for protective, thermal, and tribological applications

Module 3: Various Characterization Techniques

Key Topics:

- Microscopy Techniques: SEM, TEM, AFM
- Spectroscopy: FTIR, Raman, XRD
- Thermal Analysis: TGA, DSC, DMA
- Mechanical Testing: Tensile, compression, Nanoindentation
- Surface analysis and profiling

Module 4: Thermal, Mechanical, and Tribological Analysis of Composite Materials

Key Topics:

- Thermal conductivity and thermal expansion
- Experimental and theoretical hardness
- Wear resistance and lubrication mechanisms

Module 5: Recent Research on Composite Materials

Key Topics:

- Self-healing and smart composites
- Sustainable and bio-based composites
- Multifunctional composites: Structural + Energy Storage
- Future directions

Organization of Course:

Total contact Hours: 36		
1st week:	5 hrs (classes)	4 hrs (self-study/project)
2nd week:	5 hrs (classes)	4 hrs (Mid-term exam/assessment/discussion)
3rd week:	5 hrs (classes)	4 hrs (self-study/project)
4 th week:	5 hrs (Classes)	4 hrs (End term exam)

Mode of lectures: Online

Course/Project Plan:

Lecture no.	Topic	Lecture mode	Instructor
L: 1-3	Introduction, constituents (matrix and reinforcement), history, importance, and classification overview.	Online/Offline	Dr. Ankur Srivastava

L: 4-6	Mechanical, thermal, electrical properties, advantages/limitations, and industrial applications (aerospace, automotive, biomedical).	Online/Offline	Dr. Ankur Srivastava
L: 7-8	Structures, types, manufacturing methods, and applications of PMCs.	Online/Offline	Dr. Ankur Srivastava
L: 9-10	Introduction to PCMs, working principles, thermal energy storage, and integration into composites.	Online/Offline	Dr. Ankur Srivastava
L: 11-12	Soft gels and coatings (properties, uses in biomedical field) and advanced coatings (types, performance enhancement).	Online	Dr. Shikha Awasthi
L:13-16	Morphological and phase characterization of composites	Online	Dr. Shikha Awasthi
L: 17-19	TGA, DSC, DMA — thermal stability, transitions, and mechanical damping behaviour	Online/Offline	Dr. Ankur Srivastava
L:20-21	Tensile, compression, and hardness testing	Online	Dr. Shikha Awasthi
L: 22-25	Thermal conductivity, thermal expansion, thermal shocks, and insulation properties	Online/Offline	Dr. Ankur Srivastava
L: 26-30	Wear mechanisms, friction, lubrication strategies, and surface modifications for enhanced performance.	Online	Dr. Shikha Awasthi
L: 31-34	Recent advances in composites, carbonaceous composites.	Online	Dr. Shikha Awasthi
L: 35-36	Future directions, conclusions, and course summarizations	Online/Offline	Dr. Ankur Srivastava

Brief profile of the instructors:



Dr. Ankur Srivastava is currently working as an Assistant Professor in the Department of Mechanical Engineering, Manipal University Jaipur. He has a teaching experience of around 13 plus years. He did his PhD. in the field of Heat Transfer and Fluid Mechanics and M. Tech in Thermal Engg. and B.E in Mechanical Engineering. His area of expertise includes convective heat transfer and fluid flow parameters. He has several research articles published in reputed journals, proceedings and books.



Dr. Shikha Awasthi is currently working as an Associate Professor at IES College of Technology, Bhopal, India. She is an experimental materials chemist, and her research area covers electrochemical and electrophoretic deposition of different types of coatings utilized in biomedical, aerospace, and automotive applications. She also works on hydrogel by encapsulation of various metals and carbonaceous additives for cartilage repair applications. She has published extensively with three Indian patents and more than 50 publications in renowned journals. She worked at the Indian Institute of Technology, Kanpur, India (CSIR-Senior Research Fellow) for her doctoral work and obtained her Ph.D. degree in 2019. She received Dr. D. S. Kothari's Postdoctoral Fellowship and completed her postdoctoral work at the Indian Institute of Science, Bangalore. Being a Silver medallist

in graduation and postgraduation, Dr. Shikha also received the Best Researcher in Surface Engineering Award from the World Research Council, Young Scientist Award, Best Oral, Best Poster Award, and so on. She also served as a reviewer for more than 30 prominent journals from Elsevier, Royal Society of Chemistry (RSC), Springer Nature, IOP, and so on. Dr. Awasthi's research has been highlighted in several Hindi and English newspapers like Dainik Jagran, IISc Bangalore Media, ETV Bharat News, Times of India, etc. She has obtained a Certificate of Appreciation for a Highly Cited Article from the RSC. She was also recognized as an 'Excellent Woman Conducting Research in Nanoscience' by the RSC on International Women's Day 2025.