

Course Title: Mechanics of Smart Materials

Department/Centre/School: Aerospace Engineering

Course Overview: Introduction of smart materials, Mathematical model preliminaries, Index notation, second order tensors and matrices, Deformation of a body, Strain (small) and stress tensor, Conservation of mass, momentum, and energy, Maxwell equations for electromagnetics in deformable solids, Fusion of mechanical and electromagnetic energies, Clausius-Duhem inequality, Coleman–Noll procedure to derive material constitutive equations, Introduction to dissipative system. Material symmetry restrictions on constitutive equations, Piezoelectric, Piezomagnetic, Magnetostriction, Shape memory alloys (SMA), Magnetic shape memory alloys (MSMA), Selected multi-physics coupled boundary value problems.

Prerequisite to attend the Course: UG & PG Students (Aerospace, Mechanical, Civil, Material Science, Electrical, Energy Science & conversed with Basic Linear & Vector Algebra and Vector Calculus).

Course Title: Biochemistry and Bioenergetics

Department/Centre/School: Biosciences and Bioengineering

Course Overview: Biochemistry and Bioenergetics are foundational topics for cell and molecular level biology. This course will primarily focus on biomolecules and bioenergetics but also will touch upon recent advances in origin of life. Discussion will cover topics typically included in standard Biochemistry books (e.g., Lehninger, Stryer, Voet and Voet) but will include recent advances.

Prerequisite to attend the Course: UG & PG Students (Life Sciences & Related Areas)

Course Title: Bridging the Energy Gap: The Energy Transition in Rural Communities

Department/Centre/School: Centre for Technology Alternatives for Rural Areas

Course Overview: While urban and semi-urban populations enjoy the comforts of fossil fuel-based energy systems, the same option often remains out of reach for those living in rural areas. This disparity challenges rural communities to ensure equitable access to modern energy services while transitioning away from unsustainable fossil fuels. This proposed course will help in shaping the future of rural communities in the wake of increasing population growth and demand for improved living standards. Through interactive lectures, case studies, and stakeholder mapping activities, students will gain an understanding of: Principles of energy transition, challenges and opportunities faced by rural communities, The complex network of stakeholders and understanding their roles and interests, interventions through solutions like improved cooking options and decentralized energy systems, Socio-economic-environmental impacts & Role of government policies and regulations.

Prerequisite to attend the Course: UG & PG Students (Energy Science & Engineering, Energy Policy, Public Policy & Governance, Community Development)

Course Title: Becoming an Entrepreneur: Leveraging Your University and Local Ecosystems
Department/Centre/School: Desai Sethi School of Entrepreneurship

Course Overview: Entrepreneurship goes beyond the idea of establishing a VC backed scalable start-up, to roles like a social innovator or an intrapreneur in a large organization. It is now understood that the seeds of entrepreneurship have to be sown early on, for individuals to harvest its benefits as they progress in their respective careers. Students can leverage entrepreneurship support systems existing in their institutes, even as they continue their mainstream studies, to activate their entrepreneurial cognition and identity. This course would provide inputs in form of practices and frameworks which students can adopt towards building an entrepreneurial identity independent of whether they wish to create a new venture during the period of their education. Having an entrepreneurial identity and related skill sets is known to create opportunities for the individual across domains and across time, apart from the possibility of creating a new venture should the circumstances afford such a possibility.

Prerequisite to attend the Course: UG & PG Students (All Departments)

Course Title: Computational Quantum Chemistry
Department/Centre/School: Chemistry

Course Overview: Computational chemistry lies at the nexus of theoretical concepts and practical applications, offering a powerful toolkit for unraveling the mysteries of molecular systems. This course provides a comprehensive introduction to the principles, methods, and applications of computational chemistry. Through a blend of theoretical discussions, hands-on exercises, and real-world case studies, students will gain a deep understanding of how computational methods enable the exploration of molecular structures, dynamics, and interactions.

Prerequisite to attend the Course: UG & PG Students (Chemistry, Physics, Biology, Material Science) Basic knowledge of quantum chemistry is required

Course Title: Quantum Computing for Machine Learning and Optimization
Department/Centre/School: Electrical Engineering

Course Overview: Quantum computing, which envisages to exploit some strange laws of quantum mechanics for real-world computing applications, is one of the most actively pursued research areas currently. This summer school will focus on applications of quantum computing principles in the context of machine learning and optimization, two very popular sub-fields within the domain of artificial intelligence currently. The student will be taught not just the basic theoretical principles of quantum mechanics and computing but they will also be taught how to code on real-world quantum computers through Qiskit and related packages. Basic operational principles of quantum hardware based on superconducting qubits and semiconducting spin qubits will also be taught.

Prerequisite to attend the Course: UG & PG Students (Computer Science, Physics, Electronics and Electrical Engineering, Mathematics) with Basic Knowledge of Coding and High-school/ first-year-Undergraduate level Physics and Mathematics required.

Course Title: Waste to Energy

Department/Centre/School: Energy Science & Engineering

Course Overview: ‘Waste-to-Energy’ technologies are not only relevant in generating green energy and fuel for various power, transport and industrial/thermal application, but also features as a sustainable way in managing the animal, agricultural, industrial and municipal waste towards a cleaner and safe environment. The course will discuss about waste categorisation and various waste-to-energy technologies, including biological, chemical and thermochemical conversion processes, and its underlying principles. Course will have (2 + 2) hrs lecture for 5 days and will have interactive lab session and demonstration of few wastes to energy conversion systems. At the end of the course, students will be able to understand various categories of waste and apply knowledge towards suitable options for efficient conversion of given waste to energy.

Prerequisite to attend the Course: UG & PG Students (Students from Science/Engineering background).

Course Title: Using Artificial Intelligence for Academic Research

Department/Centre/School: IDP in Educational Technology

Course Overview: This course is designed for beginners who are interested in learning about how to do academic research using AI but have little to no programming experience. This is a five-day (3 hour per day) course. Each day will consist of a 1.5-hour lecture/discussion followed by a 1.5-hour hands-on group-based activity to reinforce the concepts learned in class. At the end of this course, the participants will be able to: a. Know how to perform Systematic Literature Review (SLR) using No Code AI tools for academic research. b. Get an overview of No-Code AI tools for SLR. c. Develop a framework for doing SLR using No-Code AI tools.

Prerequisite to attend the Course: PG Students (Open for all). Basic Computer Proficiency Preferred

Course Title: Additive Manufacturing: Design, Processes and Inspection

Department/Centre/School: Mechanical Engineering

Course Overview: Additive manufacturing is one of the most emerging manufacturing technologies in the last decade. The wide range of applications, from topological optimisation to food printing to patient-specific implants, has made this topic of implementation in almost every area. This course is required to systematically study the requirements, standards, processes, science, post-processing requirement and modern applications of AM. Demonstrating different techniques in this course will help to understand the theoretical aspects of the subject. The course will give vital knowledge of standards, quality and inspection methods and corresponding characterisation techniques for AM required at the Industry level.

Prerequisite to attend the Course: PG Students (Mechanical and Materials) with knowledge in CAD Modelling, Coding, Manufacturing and Materials Science at UG Level

Course Title: Principles and Applications of Ferroelectric and Piezoelectric Materials

Department/Centre/School: Mechanical Engineering

Course Overview: Ferro/piezoelectric materials form an increasingly important category of functional materials. The applications range from non-volatile data storage to various kinds of sensors to electronic components required in RF communications in general. Through this course, we will take a look at the governing principles of these phenomena and their various existing and emerging applications.

Prerequisite to attend the Course: UG Students from Materials Science and Engineering, Mechanical Engineering, Energy Science and Engineering, Electrical Engineering, Physics, etc. Knowledge of Basic Crystallography is Preferred.
