

**Course Title:** Heat Transfer: Aerospace Applications

**Department/Centre/School:** Aerospace Engineering

**Course Overview:** Introduction, Modes of Heat transfer and basic equations. Conduction, Convection, and Radiation Aerospace applications: Turbine blade cooling, Combustion Chamber Cooling, Nozzle cooling in solid and liquid rockets, Liquid rocket combustor cooling.

**Prerequisite to attend the Course:** UG & PG Students (Aerospace Engineering, Mechanical Engineering and Chemical Engineering).

**Course Title:** Data-driven Modelling of Flows

**Department/Centre/School:** Aerospace Engineering

**Course Overview:** Although fluid flows are all around us, modelling them remains a challenge due to the inherent nonlinearity of the underlying physics. The relatively recent branch of data-driven modelling and control of flows aims to partially circumvent this issue by leveraging the burgeoning fields of reduced-order modelling and data analysis. This course will give an overview of the common data-driven approaches, and delve deeper into two particularly popular ones - viz. proper orthogonal decomposition and dynamic mode decomposition. To appreciate the content, you have to be well-versed in the fundamentals of fluid dynamics, as well as engineering mathematics, particularly linear algebra. Further, familiarity with Python programming language is essential to pursue the examples and exercises of the course.

**Prerequisite to attend the Course:** UG & PG Students (Aerospace Engineering, Mechanical Engineering, Civil Engineering and Chemical Engineering). Participant must have taken courses in fluid mechanics and engineering mathematics, and be familiar with Python programming language

**Course Title:** Microwave Remote Sensing of Soil Moisture and Vegetation

**Department/Centre/School:** Centre for Studies in Resource Engineering

**Course Overview:** Satellite microwave remote sensing offers advantages in terms of monitoring the Earth system under all weather conditions compared to conventional optical/thermal remote sensing. Specifically, microwave sensors at low frequencies are sensitive to the soil and vegetation dynamics. Two kinds of microwave remote sensing exist: active microwave sensing (radar) and passive microwave sensing (radiometer). Numerous satellite sensors, such as Sentinel-1, Radar sat, Soil Moisture Active Passive (SMAP), and Soil Moisture Ocean Salinity (SMOS) exist, which are operational and are equipped to measure the water content in soil and vegetation. This course provides a theoretical and practical understanding of radar and radiometer-based sensing of soil moisture and vegetation. The radar component of the course encompasses fundamental concepts such as wave and scattering polarimetry, speckle statistics, target decomposition theorems, and the latest developments in radar polarimetry. The radiometer component includes principles of emission, radiative transfer theory, and inversion algorithms to estimate soil moisture and vegetation water content. There will be practical sessions that augment the theory.

**Prerequisite to attend the Course:** PG Students (Electrical, Electronics and Telecommunication, Agriculture Science and Engineering, Civil & Water Resources Engineering). A good background in Mathematics, Physics, Remote Sensing, and Programming is desirable.

**Course Title:** Waste to Wealth: Circular Economy & Sustainability

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

**Course Overview:** This course is designed to empower students with a comprehension of waste generation and innovative pathways for upcycling. Participants will delve into the intricacies of the circular economy model, exploring how waste materials can be reintegrated into the production cycle to minimize environmental impact. From sustainable waste management practices to the implementation of green energy solutions, students will gain invaluable insights into building a more resilient and eco-friendly future. The course will also include the concept of value chain analysis, examining how different crops contribute to waste generation and identifying opportunities for value addition at every stage. One of the highlights of the program is the exploration of how concentrated waste streams, particularly within the food processing industry, can serve as a catalyst for innovation in the burgeoning nutraceutical sector. By harnessing the latent potential of waste materials, circular thinking, turning challenges into opportunities for creating a parallel billion-dollar industry while simultaneously promoting environmental sustainability.

**Prerequisite to attend the Course:** UG & PG Students (Bio Processing, Chemistry, Chemical Engineering, Energy Science & Engineering, Environmental Engineering, Food Processing, Food Engineering, and Agricultural Sciences & Engineering).

**Course Title:** Heritage Structures

**Department/Centre/School:** Civil Engineering

**Course Overview:** The course covers the history and significance of heritage constructions, factors impacting their durability, condition assessment using NDT (Non-Destructive Testing) and conservation strategies.

**Prerequisite to attend the Course:** UG & PG Students (Civil Engineering and Architecture)

**Course Title:** Introduction to Numerical Optimization

**Department/Centre/School:** Civil Engineering

**Course Overview:** This course introduces optimization and its application in solving engineering problems and provides understanding on various classifications of optimization problems (single variable, multi-variable, constrained, unconstrained, linear, non-linear), theoretical properties and concepts and their applications. The primary focus will be on non-linear programming, which includes

- Formulation of mathematical models to tackle non-linear problems
- Some efficient algorithms for solving non-linear programs (Unrestricted search with fixed and accelerated step size, Bounding phase and Exhaustive search methods, Interval halving and Fibonacci search methods, Golden section search and Dichotomous search methods, Quadratic and cubic interpolation methods, Gradient-based interpolation methods, Random search methods, Grid search method and Univariate method, Evolutionary optimization method and Simplex search method, Pattern search method, Gradient-based methods)
- Basic computer implementation through algorithm applications in solving example problems

**Prerequisite to attend the Course:** UG & PG Students (All branches of Engineering) conversed with Basic knowledge of Calculus, Numerical Methods, Algorithm Development, Computer Programming.

**Course Title:** Natural Language Processing, Large Language Models and Generative AI

**Department/Centre/School:** Computer Science and Engineering

**Course Overview:** Current times are witnessing unprecedented growth in AI and especially Natural Language Processing (NLP) with emphasis on LLMs and Gen AI. In this course we will cover the foundations and frontiers of NLP, delving deep into Model Training, Language Models, Transformers, Generative Techniques and Cutting-edge applications like summarization, chatbots, translation, sentiment and emotion analysis and so on.

**Prerequisite to attend the Course:** UG & PG Students (All Science, Engineering, Management and Humanities and Social Sciences Depts (Linguistics, Cognitive Science, Psychology) & Programming skills will be an advantage

**Course Title:** Introduction to Paninian Grammar

**Department/Centre/School:** Humanities & Social Science

**Course Overview:** This course aims to introduce the students to the Grammar of Sanskrit composed by Panini. The course will also contain an introduction to the living Paninian grammatical tradition, the structure of the grammar of Panini, meta-language and its features and its effective use in Paninian grammar, rules of interpreting the rules of Paninian grammar. The most important point of this course would be the approach to learn Panini: from data to rules. This course will introduce students to the methodology of making the rules from the data as visible in Paninian grammar.

**Prerequisite to attend the Course:** UG & PG Students (Indology, Sanskrit, Linguistics, Computational Linguistics)

**Course Title:** Green Building Technologies

**Department/Centre/School:** Energy Science & Engineering

**Course Overview:** The course will introduce and explain the technologies of green building such as 1. Active and passive heating and cooling systems, 2. Active and passive lighting systems 3. Energy-efficient and alternative building materials, and 4. Renewable integration including power generation. The course will also cover the indoor thermal comfort and star rating of building equipment. The course will also briefly introduce the international building certification programs. The course will have a tutorial in each session. In addition, brief software-based modelling will be taught to understand the effect of various technologies for the given climatic conditions. The course will include a field trip to “Team Shunya Building” for the demonstration of the technologies.

**Prerequisite to attend the Course:** PG Students from Mechanical, Civil, Architecture and Energy Science & Engineering.

**Course Title:** Statistical Machine Learning

**Department/Centre/School:** Department of Mathematics

**Course Overview:** ‘Statistical machine learning refers to learn the pattern/features masked by random noise in the data and subsequently automating the process of prediction, classification and clustering based on these learnings. In this course, we will introduce the concept of probability, randomness, linear regression and prediction and a few classification techniques. The related statistical models and their implementation in R will be illustrated in detail. A real data application will be described to carefully investigate these concepts.

**Prerequisite to attend the Course:** UG & PG Students from any stream

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