Cognition, Emotion, and Mindfulness – Week 1

Prerequisites: UG/PG/PhD

Emotion is a fundamental human psychology component that plays a significant role in our lives. Understanding how humans process emotions is important to understanding others' feelings and sensibility. Also, it is essential to understand how the adaptive processing of emotions plays a significant role in being psychologically healthy and maintaining a harmonious society. For example, maladaptive processing of positive and negative emotional information might cause psychological problems like clinical depression that might affect individuals and society. This course applies findings from the interdisciplinary field of neuroscience and the psychological studies of cognition, motivation, and emotion. Basic, complex and social emotions are explored from the perspective of, for example, the subjective experience of emotion, non-conscious processes, and how emotions are interpreted, expressed, or regulated. Affective systems, neural networks, and their relationship to cognitive processes such as attention, learning, memory, and decision-making are addressed. Knowledge of the interaction between cognition and emotion helps create a balanced and harmonious society and is also helpful in technology development and its usage. Given this, it seems only sensible to commit to affect and emotion in human-computer interaction, investigate the underlying principles, study their role, develop methods to quantify them and build applications that use them. In this course, we will also discuss the role of mindfulness meditation in cognitive and emotional processes, which in turn may affect well-being from the scientific lens.

Contemporary Indian Philosophy – Week 1

Prerequisites: UG/PG/PhD

This course will introduce students to the philosophical ideas, ethical and political arguments, and conceptions of life's challenges as presented by a selection of thinkers from twentieth-century India. Topics will include the concept of action, self-realization, the doctrine of māyā, the destiny of the soul, creation, non-violence, the technique of ahimsā, satyāgraha, and the relationship between religion and morality.

Theory and Technology of Silicon Solar Cells – Week 1

Prerequisites: Senior UG (3rd or 4th year of a 4 year program), Master's program (1st year) or Integrated Master's program (4th and 5th year) of Electrical Engineering, Electronics, Physics, or Energy programs.

Photovoltaics is the leading renewable energy technology being considered for replacing fossil fuels. The installations are expected to grow by close to 60 times during the next 3 decades. Silicon solar cell technology currently dominates the market due to proven long term reliability, low cost and high conversion efficiency. This course aims to introduce the physics and technology of silicon solar cells to the participants. The course will benefit

practicing engineers, engineers and students who aspire to work in the domain of solar PV technology, and educators who are planning to train such students.

Course Contents:

- Introduction to the physics of semiconductor devices (band diagram, optical absorption, generation-recombination, transport, pn-junction diode characteristics)
- Theory of silicon solar cells (characteristics of silicon solar cell, design of silicon solar cells - optical design, junctions, passivation, impact of these parameters on solar cell characteristics, IV measurements, quantum efficiency measurements)
- Production of silicon wafers starting with sand
- Fabrication of industrial PERC, TOPCon and HJT solar cells
- Simulation of solar cell using PC1D: a practical session
- Loss analysis of solar cells: a practical session
- Luminescence imaging, Light Beam Induced Current (LBIC), dark lock-in thermography characterization of Si wafer & solar cells for process, device development and diagnostics
- An introduction to thin film and tandem solar cells

Introduction to Biostatistics – Week 1

Prerequisites: UG/PG/PhD

- Broad Introduction
- Experimental Design
- Numerical Data Presentation
- Numerical Measures
- Probability & Probability Distributions
- Central Limit Theorem/Sampling Distributions
- Large Sample Estimation
- Test of Hypothesis
- Inference from Small Samples
- Analysis of Variance
- Correlation & Regression

Power Electronics – Week 1

Prerequisites: UG/PG/PhD

Power Electronics, that enables energy-efficient and reliable power conversion, finds various applications including electric vehicles (propulsion and charging), grid integration of renewable energy sources, switched mode power supplies. This course begins with a brief outline on various power semiconductors used in power converters, including power diode, IGBT and MOSFET. The operating principle and steady state analysis of the following converters will be discussed in detail.

AC-DC Converters: Single-phase and three-phase diode rectifier circuits with resistive, inductive and capacitive loads, PWM rectifier.

DC-DC Converters: Buck, boost, buck-boost, Cuk and SEPIC converters, Forward, fly-back and push-pull converters.

DC-AC Converters: Introduction to PWM, Selective harmonic elimination PWM, Single phase half-bridge and full-bridge inverters, Sine triangle PWM, Unipolar and bipolar PWM, 3-phase inverters, Space vector PWM.

Introduction to soft matter physics: Fundamentals, Experiments and Methods – Week 1

Prerequisites: UG/PG/PhD

This course introduces the basic concepts of soft matter physics, focusing on materials that are easily deformed and have unique properties, such as polymers, gels, and colloids. Students will explore key topics such as polymer physics, liquid crystals, colloids, and biomaterials, gaining insights into their thermodynamic behaviors and phase transitions. The course will also cover important experimental techniques, including microscopy, scattering methods, and rheology, to study soft matter systems in detail. By the end of the course, participants will have a foundational understanding of soft matter physics and its applications in everyday materials and technologies.

Waste to Energy – Week 1

Prerequisites: UG/PG/PhD

'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 sustainable way in managing the animal, agricultural, industrial and municipal waste towards cleaner environment. The course will discuss about waste categorisation and various waste to energy technologies, including biological, chemical and thermochemical conversion processes, and it's underlying principles. Course will have (2 + 2) hrs lecture for 5 days and will have interactive lab session and demonstration of few waste to energy conversion systems.

Take away message from the offered course – 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.

Micromachining of Engineering Materials – Week 1

Prerequisites: UG/PG/PhD in Mechanical Engineering or Materials Engineering

In the last decade, non-conductive brittle materials, such as fused silica, alumina, silicon etc, have been used in various applications including MEMS packaging, automotive electronics,

high-frequency wireless transmission etc. However, micromachining of these materials is relatively difficult due to their hardness and brittle nature. This course will discuss the fundamentals of Electrochemical discharge machining and Ultrasonic micromachining processes used to create microfeatures in non-conductive brittle materials. The process mechanism, parameters and process capability will be discussed along with their basic numerical simulation and laboratory demonstration.

Sustainable Marine Engineering and Blue Economy – Week 1

Prerequisites: Senior UG, PG, and PhD students; also useful for practicing engineers and researchers

The course will contain the following topics.
a. Basics of Water Wave Mechanics
b. Coastal Processes and Engineering
c. Sustainable Development of Marine Infrastructure
d. Nature Positive Coastal Management
e. Ocean Renewable Energy for Blue Economy
f. Hybrid Infrastructure for Coastal Protection and Blue Energy

'Becoming' an Entrepreneur: Leveraging Your University and Local Ecosystems – Week 1

Prerequisites: UG/PG/PhD

Entrepreneurship goes beyond the idea of establishing a VC backed scalable startup, 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.

Field Immersion

FiPopular research has identified that among various reasons for failure of new ventures, incorrect identification of customer need and problem statement is by far the most prevalent. This course will aid aspiring entrepreneurs in deep understanding of customer needs and pain points thus eliminating the drain of time / money that usually occurs in venture creation

Furthermore, for doctoral students, ethnographic enquiry is a well established methodology for theory building endeavours. With the field of entrepreneurship veering towards 'entrepreneurship as practice,' a sociological approach to understanding this domain, field immersion techniques become crucial from academic research perspective. This methodology forms the bedrock of theory building efforts and is an essential tool for researchers.

Structural Biology with cryoEM – Week 2

Prerequisites: UG/PG/PhD

- Introduction to electron microscopy and its biological applications
- Principles and optics of the electron microscope
- Digital image formation and Fourier analysis of image
- Electron–Specimen Interactions.
- Point spread function and contrast transfer
- Sample preparation: negative staining and cryo-EM
- Single particle reconstruction
- Cryo-Electron tomography
- Map validation, visualization, molecular modelling

Online Machine Learning and Optimization – Week 2

Prerequisites: UG/PG/PhD with background in probability and linear algebra

At the heart of several machine learning applications today, including advertisement placement, movie recommendation, and network traffic management – is a prediction and optimization engine trying to make the best decision at each time with the information gathered thus far, i.e. the problem of online learning. To solve these problems, one must make online, real-time decisions and continuously improve the performance with the arrival of data and feedback from previous decisions. This short course aims to introduce the attendees to some of the foundational methods / principles in this area (such as learning with expert advice, multi-armed bandits, follow the leader etc.) and the mathematical tools used for analyzing their performance. Prerequisites for the course are familiarity and comfort with mathematical arguments.

Introduction to Systems Biology – Week 2

Prerequisites: UG/PG/PhD

Description: Even the simplest of living cell comprises of thousands of "parts", which work together to facilitate growth and replication. To understand how a cell works, we need a systems perspective of how its parts come together and function, rather than study individual parts in isolation. In this short course, we will discuss fundamental approaches in systems biology which help accomplish this task. These fundamentals help design strains and systems for applications in metabolic engineering, synthetic biology.

Data Driven Modelling of Flows – Week 2

Prerequisites: UG/PG/PhD with experience in fluid mechanics, linear algebra, and Python programming

Powered by ever-improving computational resources, Computational Fluid Dynamics (CFD) has become the default tool for understanding and designing fluid flows. However, the huge amounts of data coming out these calculations bedevil the easy grasping of the fundamentals of the flows. It turns out that many flows – even highly turbulent ones – have an innate simple (reduced-order) structure that often affords an intimate, albeit approximate, insight that is difficult to attain directly from CFD data. This course will introduce the student to the tools required to arrive at such reduced-order models using data derived from CFD. This will allow students to bridge the gap between the simple canonical flows studied in theoretical fluid mechanics and the practical engineering flows computed with CFD.

AI EdTech Product Sprint: From Vision to Validated MVP in 5 Days (20 hours) – Week 2

Prerequisites: UG/PG/PhD with understanding of AI and product management

Day 1: Product Vision and Problem Discovery (4 hours)

Teaching (1.5 hours):
- Introduction to AI in EdTech
- The importance of product vision and strategy
- Identifying valuable problems in education

Development (2 hours):
- Define product vision and strategy for an AI EdTech solution
- Conduct problem framing exercise to identify key educational challenges
- Create a value proposition canvas

Review (30 minutes):
- Team presentations on product visions and identified problems

Day 2: Customer-Centric Solution Design (4 hours)

Teaching (1.5 hours):
- AI technologies applicable to education
- User-centered design principles
- Rapid prototyping techniques

Development (2 hours):
- Create user personas and journey maps
- Sketch AI solution concepts

- Develop paper prototypes or wireframes

Review (30 minutes):
- Critique session on prototypes and alignment with user needs

Day 3: AI Model Selection and Product Risks (4 hours)

Teaching (1.5 hours):
- Types of AI models for EdTech and their implications
- Identifying and addressing product risks
- Data strategy and ethical considerations in AI

Development (2 hours):
- Select appropriate AI models for the prototype
- Conduct a risk assessment and mitigation planning
- Develop a data acquisition and management plan

Review (30 minutes):
- Peer review of AI model choices, risk assessments, and data strategies

Day 4: MVP Development and Experimentation (4 hours)

Teaching (1.5 hours):
- Minimum Viable Product (MVP) in AI EdTech
- Rapid development techniques for AI products
- Designing product experiments

Development (2 hours):
- Build a basic MVP of the AI EdTech product
- Design experiments to test key assumptions
- Prepare user testing scenarios

Review (30 minutes):
- Progress check and experiment design review

Day 5: User Testing, Iteration, and Next Steps (4 hours)

Teaching (1.5 hours):
- Conducting effective user tests for AI products
- Analyzing feedback and iterating on AI models
- Continuous discovery and delivery in AI product development

Development (2 hours):
- Conduct user tests with the MVP
- Rapid iteration based on feedback
- Develop a roadmap for continued product development

Review (30 minutes):

- Final presentations of MVPs, lessons learned, and future plans
- Course wrap-up and action planning

Sustainable Buildings – Week 2

Prerequisites: UG/PG/PhD

- Climate and Buildings
- Building envelope performance
- Estimation of cooling, heating and lighting loads
- Energy efficiency strategies to reduce the cooling, heating, lighting and appliances' loads
- International building energy rating systems
- Thermal comfort
- Indoor air quality
- Design builder software training (to understand the implications of studied concepts in real-time scenarios under various climatic and building operating conditions)

AI and Policy – Week 2

Prerequisites: PG and PhD with background in computation or social sciences with interest in intersection of AI, governance, public policy, and political economics

This course is an interdisciplinary introductory course for policymaking for governance of AI and Data. It will bring the student up to scratch with the international landscape of extant policymaking on AI, the frameworks being used, their strengths and weaknesses, as well as make certain they learn the basic concepts, digital and philosophical, of AI, machine learning, and data. The course will also make the student conversant with the basic theory around data policy and governance structures as they exist in India and worldwide, and the ongoing debates on the same. By the end of the 20 hours course, the student would have learnt a basic amount of what AI technologies are and aren't, how data interacts with them, how they influence and are influenced by human society, and why/how national and international actors design policy around them. Students with a background in technology but wishing to learn the social impact of AI, or conversely with a background in the social sciences wishing to understand the technology of AI, along with students of public policy and related areas will be benefited from this course.