Course outcomes:
The course is intended to equip the students with some fundamental tools for designing and analyzing approximation algorithms.
Course outcomes:
Recognize and identify the nature of the mathematical problems that are commonly encountered in aerospace engineering; choose and apply appropriate mathematical methods and tools to solve such problems.
Course outcomes:
After completing this course, the student should be able to understand and identify the nature of the aeroelastic problems encountered in flight vehicles, and choose the appropriate methods and tools to estimate and solve specific aeroelastic problems.
Course outcomes:

After taking the course the student would…

1. Design and fabricate the UAVs from scratch

2. Experience in building different types of UAVs and payload associated with it.

3. Have insight in selecting the avionics (Motors, SC, servos) for the UAVs.

4. Thorough knowledge in manufacturing field (CNC machining and laser cutting)

5. Hands on experience in composite manufacturing techniques.

6. Design, fabrication and flying of seed dropping UAVs, which has good societal impact.
Course outcomes:

The students would learn the basic discretization methods for the partial differential equations of Gas Dynamics, together with the modern and latest CFD algorithms for simulating compressible fluid flows.
Course outcomes:
Know foundational concepts for analysing fluid dynamics. Learn to perform integral analyses and overall balances from conservation laws and differential equations analyses for fields. Understand modeling approximations such as inviscid, incompressible, turbulent for different types of flows.
Course outcomes:

1) Understand that flow energetics and kinematics are closely coupled in gasdynamic phenomena.

2) Appreciate the critical role played by sound waves and the importance of acoustic speed.

3) Understand the role of Mach number in describing compressible flow phenomena.

4) Understand the differences in flow phenomena at subsonic and supersonic velocities.

5) Learn analytical tools using control volume methods to address gasdynamic problems of engineering interest.

6) Two important concepts - flow choking and directional nature of supersonic flows will be addressed.

7) Generation of supersonic flows using convergent-divergent nozzles and their operation will be understood.

8) Students will understand how to factor effects of friction and heat addition to gasdynamic flow, typical in aerospace engines.

9) Students will learn about modeling shock waves and their interactions, shock-expansion theory - a useful theory to determine aerodynamic loads on aerospace vehicles in supersonic flow.

10) The partial differential equations of gasdynamics will be elaborated.

11) Students will learn simplified technique useful in practical engineering design - small perturbation theory.

12) Method of characteristics is a useful technique to design supersonic nozzles and students will design a supersonic nozzle using this numerical tool.

13) Students will be exposed to the theories of measurement and testing techniques such as shock tunnels and wind tunnels, pitot measurements to name a few.

14) Students will learn the essentials of hypersonic flows.
Course outcomes:
Understand differences between compressible and incompressible flows. Understand driving forces and consequences and obtain quantitative estimates in duct flows. Know effects of shocks and expansions. Be able to calculate changes to flows across shocks/expansions.
Course outcomes:
From this course, the students would learn various theories and principles of analyzing vehicle structural components, method of calculating structural loads due to aerodynamics and various principles by which the structures are designed. The students would develop theoretical problem solving skills and skills to apply such understanding into structural design practices in aerospace industries.
Course outcomes:
Students will learn about different types of defects and damage in Engineering materials and structures, effect of those on the mechanical behaviour of the materials, how to evaluate the integrity of structural components. Choice of right techniques for different applications. Evaluation of safety & Reliability of metallic as well as composite structural components.
Course outcomes:
Strong grasp in fundamentals of Air Breathing Aero Engines: overall cycle analysis as well as component based analysis
Course outcomes:

After the completion of course, the student could able to:

1) Describe the thermodynamic flow process inside different aircraft engines;

2) Carry out performance analysis of different types of aircraft engine

3) Can provide estimation of specific thrust, specific impulse, isentropic efficiencies of major engine components, etc.

4) Can able to distinguish and describe engine flow across various engine components

5) Can actively participate in aircraft engine design

6) Can understand the complications associated with the aircraft engine technology
Course outcomes:
The course involves take home assignments constructed around the open source CANTERA tool which will train students to perform the sort of analysis routinely used in industry to support design and developments of combustion systems. This course would be useful to anyone looking for a career in research or in industry around combustion and related topics.
Course outcomes:
The students are expected to learn the art and science of carrying out experimental research. At the end of the course a student should be able to design and carry out an experiment on his/her own. This is an important skill which anybody wanting to do experimental research is expected to possess.
Course outcomes:
During the course, students would learn the fundamental theory behind hydrodynamic stability along with a selection of the latest concepts. At the end of this course, they would obtain hands-on experience in developing the necessary theory to analyse a new flow problem. Further, they would know how to solve such problems using applied mathematics concepts or, instead, numerically via developing a series of codes for hydrodynamic stability problems during the coursework.
Course outcomes:
Students would learn the fundamentals of acoustics and aeroacoustics theory during this course. A serious student should be able to extend such concepts to practical applications. Further, students are given significant exposure to computational aeroacoustics with an emphasis to the unique challenges that this particular application of CFD entails which should prepare them well for developing advanced codes in this area.
Course outcomes:
Concepts of homogenization, representative volume element, effective properties of a heterogeneous medium
Course outcomes:
Understanding of the atmospheric processes relating tropical convection and cloud formation.
Course outcomes:
Students will learn the relative importance of greenhouse effect, ice, aerosols, and clouds on earth's climate.
Course outcomes:

students will learn inversion techniques to convert radiance data from satellites to physical quantities like temperature, humidity, and rainfall
Course outcomes:
Get an appreciation of how weather and climate data are collected and disseminated
Course outcomes:
Solid understanding of the Angular momentum, water, energy, entropy and carbon budget in the climate system.
Course outcomes:

The students upon successful completion of course will have good understanding of Biomolecules (DNA/RNA/PROTEIN/LIPIDS). They would also have been exposed to latest advancements with regard to synthesis and turnover of these biomolecules.
Course outcomes:
Students will be introduced to Clinical medicine. They will get an exposure to basic embryology, physiology and associated human pathologies. They will also learn the principal treatment modalities.
Course outcomes:

Students will attain

1. Understanding of how ageing occurs and what is the evolutionary significance of ageing.

2. Understand the mechanistic basis of regeneration and the evolutionary significance of it.
Course outcomes:
Students gain knowledge in the broad subject areas of Biochemistry that will help them with their research.
Course outcomes:
Students develop both theoretical and experimental knowledge about large scale protein analysis which is a part of big data science. Each student is given hands-on training for 2D gel electrophoresis, sample preparation and mass spectrometry-derived proteomic data analysis. They also learn data analysis using databases and search engines such as Mascot and Protein Pilot through e-workshops as a part of this course.
Course outcomes:
Students develop important basic understanding about cellular processes including cell cycle, signalling, trafficking and organellar dynamics. A significant emphasis is laid on experimental approaches used and thereby an appreciation for experimental background behind discoveries is also developed by the students.
Course outcomes:

At the end of the course, students will be

1) well-versed with mathematical and statistical concepts of importance to bioengineers

2) have acquired facility with numerical tools for solving mathematical problems in bioengineering
Course outcomes:

Upon completion of the course, students will be able to:

1. Understand various chemical interactions between molecules in biological systems and the idea of pH
2. Describe the structure and function of various biological molecules
3. Explain basic concepts in enzyme kinetics, function and modes of inhibition
4. Compute association and dissociation constants during protein interactions
5. Discuss different aspects of molecular biology including DNA replication, transcription and RNA translation
6. Demonstrate an understanding of Mendelian laws of inheritance
7. Describe cellular architecture and utilize these concepts to design a synthetic organelle or cell mimic
8. Understand fundamental concepts in tissue architecture and physiology
9. Analyze basic biological laboratory experiments performed by others and critique literature
Course outcomes:
Upon completion of the course, students will be able to:

1. Describe concepts in polymer science and engineering
2. Understand the mechanics of materials and analyze stress strain relationships
3. Discuss fundamental principles in biomaterials and explain the Vroman effect
4. Write diffusion equations and describe basic transport phenomena in solids and liquids
5. Explain concepts in bioprocess engineering including reactor design, product separation and purification techniques
6. Design polymeric scaffolds for growing cells
7. Describe concepts in stem cell biology and their use in tissue engineering
8. Understand fundamental ideas in computational and systems biology
9. Assess and critique bioengineering literature
Course outcomes:
After taking this course, the student would become familiar with the concepts and methods of epidemiology in the context of the digital era of today. Statistical analysis methods, Cyber Physical Systems (CPS) approach to outbreak analysis and network models for communicable diseases will become familiar. Some exposure to precision medicine will also be provided.
Course outcomes:

Students will get a firm foundation towards neural networks and advance their research by building upon known things at a foundational level. It is useful for translational work for practicing engineers/scientists.
Course outcomes:
The students learn various physical chemistry principles, various types of chemical titrations, measurements techniques related various spectroscopic techniques, X-ray diffraction, thermal methods, electrochemical methods
Course outcomes:
Better understanding of the chemistry behind many compounds, that have been of use as materials in devices.

The fundamental understanding of the many structures would help the students to better tune their skills in modifying the properties, if they desire to work in this area.
Course outcomes:
The students will learn the chemistry of different elements belonging to the periodic table.
Course outcomes:
The students will learn a great deal of physical chemistry principles as applied to organic chemistry. This would enable them to devise experiments to understand new reactions mechanistically.
Course outcomes:
The students learn the basic mathematical tools required for analyzing their research data.
Course outcomes:
The student shall gain a sound understanding of the basics of organic synthesis, methodology development and multi-step synthesis.
Course outcomes:
Prepares the students to be self reliant in dealing many structure and conformational problems encountered in chemistry and biology.
Course outcomes:
A thorough understanding of the fundamentals of geomechanics, with a strong theoretical underpinning of mechanics.
Course outcomes:
Understanding geo-environmental challenges and corresponding design such as landfill designs, contaminant transport, barrier design, climate change effects
Course outcomes:
Student will learn about various ground improvement techniques available, how to design them and
implement them in field along with various case studies where ground failures were resolved using these
techniques and also many case studies that involved ground improvement in large scale with details of
engineering design aspects.
Course outcomes:
Students learn about soil mineralogy, type and formation of soils, mechanical response of soils to changes in physico-chemical environment.
Course outcomes:
Masonry behaviour; Design Principles; Design of real time masonry structures
Course outcomes:

Students would learn about various regionalization approaches which facilitate estimation of

hydrometeorological variables, hydrological processes and environmental extreme events (floods, rain storms, droughts) in real world scenario where data are often sparse or unavailable.
Course outcomes:

The essence of weak formulations and its advantages over direct solutions of strong forms in numerical implementation; how does the notion of piecewise implementation useful in solving solid mechanics problems with complex geometry; how to interpret convergence of numerical solutions
Course outcomes:
Students would learn about procedures for analysis of various hydrometeorological and hydrological processes in river basins, and environmental extremes (floods).
Course outcomes:

Rigorous introduction to the principles of solid mechanics, and the ability to apply these principles to solve problems in a wide variety of applications.
Course outcomes:
The students is trained for (i) determining earth pressures on retaining structures, (ii) computing stability of slopes and earthen dams in the presence of ground water seepage and earthquake forces, and (iii) design of braced excavation for deep cuts and excavation in ground.
Course outcomes:
Students would be equipped with methodologies of addressing uncertainties in hydrologic systems and one step ahead forecasting.
Course outcomes:
The student usually learns as to how to (i) design foundations and isolation systems subjected to different kinds of vibrations, (ii) determine dynamic properties of soils by using laboratory and non-destructive field tests, and (iii) assess the liquefaction potential of a given site.
Course outcomes:
Evaluation of bearing capacity from field and laboratory testing, designing of shallow and deep foundations for various loading conditions.
Course outcomes:
After the completion of course, students will learn about all the engineering aspects of earthquakes and ground response and they would be able to analyse and quantify earthquake hazard in terms of ground amplifications, deformations and liquefaction and would be able to design earthquake resistant structures.
Course outcomes:
Understanding all facts of earthquake hazards, will be able to quantify different earthquake hazards and its effects (e.g. site effects, liquefaction, landslides etc) using different methods, which facilitate in planning new structures/project and retrofit old buildings and infrastructures.
Course outcomes:
Student will understand how to formulate an engineering optimization problem and thereafter select appropriate tools needed to solve the problem.
Course outcomes:

1) Ability to model various uncertain parameters in a natural or engineering system, specially in a probabilistic way.

2) Propagating this uncertainty via various computational methods to predict the output quantity of interest.

3) Ability to write efficient computer programs related to probabilistic methods.
Course outcomes:

Concepts of Bridge design and ability of students to understand force flow and design bridges.
Course outcomes:
The students would be prepared to analyse urban stormwater systems, urban precipitation and stormwater runoff. They would also learn quantification of impacts of climate change on short duration high intensity rainfall in urban areas. Case studies of several cities in India are dealt with, in the seminars presented by the students, and thus they get an exposure to a variety of urban flooding problems. An exposure to the entire urban water cycle is also provided.
Course outcomes:
The students will learn to use various quantitative methods (in modeling, simulation, and optimization) to solve problems of urban transportation systems both with respect to planning and operations. The students will be equipped with adequate know how to plan various transport improvements in a given urban area.
Course outcomes:
The students will learn to use various data science approaches for understanding and analyzing transportation data, measuring reliability of transportation system, doing impact studies, before-and-after improvement studies, assessing the performance of transportation system etc.
Course outcomes:
Students will learn to formulate multi-agent systems using a game theoretic approach and will devise algorithms and implement them to find the equilibrium solutions to these problems.
Course outcomes:

At the end of the course, students will have

1. developed an appreciation of the power of theoretical techniques in investigating biological phenomena

2. gained an understanding of selected classic and current topics in theoretical biology

3. acquired hands-on experience in the application of theoretical techniques to biological problems
Course outcomes:
Students will learn about the availability and distribution of water, different methods of treating water to make it potable, and mathematical models for some of the processes.
Course outcomes:
Students completing this course will be equipped to analyze and solve problems arising in a variety of fields in engineering and science that are of the form of algebraic, differential, or integral equations. They will be able to classify ordinary and partial differential equations, and choose the appropriate method of solution. They will be equipped to obtain series solutions of ordinary differential equations, and solve homogeneous and inhomogeneous partial differential equations. They will learn tools of orthogonal decomposition, and use it for numerical quadrature, and the solution of inhomogeneous initial and boundary value problems.
Course outcomes:
- Using Matlab to execute numerical algorithms
- Numerical solutions of multivariable nonlinear algebraic equations
- Data fitting algorithms
- Finite difference techniques for solving differential equations
Course outcomes:
Students should have a comprehensive understanding of how a balance between convection and diffusion in heat/mass and momentum transfer at the microscopic level gives rise to the transport rates at the macroscopic scale, and how these can be calculated using solution procedures such as similarity transforms, separation of variables and boundary layer theory.
Course outcomes:
A student who has successfully completed the course should be able to perform thermodynamic analysis of real-world systems, irrespective of the number of phases or components in the system. The student will gain expertise in computing phase equilibria, as well as modelling thermodynamics of solutions. He/She will also gain an understanding of statistical thermodynamics at the introductory level such as the concept of partition functions and its relationship to thermodynamics.
Course outcomes:

Identify appropriate reactor networks for a given reacting system

Ability to generate appropriate reaction schemes for a given set of reactants

Perform non-ideal reactor analysis

Understand elements of catalytic processes

Handle complex design problems using computational tools
Course outcomes:
The students will be able to deliver well-organised technical presentations at conferences and other symposia.
Course outcomes:
A student should be able to analyze a complex system at hand, in general area of interest to chemical engineers, identify/hypothesize equilibrium steps, rate processes, driving forces at work, and coupling/inter-dependence among them, and express this understanding in terms of mathematical relationships by making use of established physical laws. The set of mathematical relationships, complete with initial and boundary conditions, and constitutive and equilibrium relationships, should be solvable to make quantitative predictions to test validity of model, explain existing observations, and make new predictions to either aid in engineering design and control or establish model through experimental corroboration.
Course outcomes:
The student will gain an understanding of the principles of statistical thermodynamics and lays the foundation for studying advances topics in statistical mechanics. A successful completion of the course will enable the student to pursue scientific research in the areas of statistical mechanics, physical chemistry and chemical physics.
Course outcomes:
After taking this course, a student should be able to quantitatively understand:

1. the constraints on the nature of intermolecular attraction to lead to system size independent intrinsic properties of materials
2. the origin of van der Waals attraction between molecules, and the factors that make it strong/weak
3. how intermolecular forces lead to long range attractive forces between particles, and continuum properties of three phases involved modulate it
4. Double layer formation—distribution of counter-ions and other ions in vicinity of a charged surface in a medium
5. Balance of repulsion between charged surfaces due to osmotic pressure buildup and van der Waals attraction between bodies decides kinetic stability of dispersed phase systems using DLVO theory.
6. Hydrophobic effect which imparts surfactant molecules their special character
7. Cause of formation of self-assembled structures such as micelles of various sizes and shapes, bilayers and vesicles, and link it to 2 and 3 component surfactant phase diagrams
8. The molecular origin of interfacial tension through anisotropic pressure tensor, and excess surface energy
9. Laplace pressure jump across curved interfaces leading to jet breakup and capillarity
10. Consequences through Kelvin equation for particle size dependent properties of small fluid and solid structures
11. The angle of contact when three phases meet on a contact line: wetting, non-wetting, and partial wetting behavior
12. Contact angle hysteresis through receding and advancing contact angle.

13. And most important, relate all the concepts to day to day observations, manifestations in nature, and in emerging technologies.

14. A student should be able to identify how interparticle and surface forces could be playing a role in a new system, isolate them by reasoning and additional experiments, and make progress towards engineering desired control on it.
Course outcomes:
The student will learn both basic and advanced molecular simulation techniques. Also upon successful completion, the student will be able to write his/her own code for performing molecular simulations.
Course outcomes:
Students are expected to be comfortable with basic mathematical concepts in Calculus, Linear Algebra and Statistics by the end of the course.
Course outcomes:
"Students are exposed to the state-of-the-art in concepts, methodologies, and controversies in the subject matter of the course. They will learn how to think critically about the subject and to critique published material as well as online material available on the internet."
Course outcomes:
The course aims to make students understand the fundamental principles that govern the dissemination of hereditary information. As this understanding is crucial in all subjects in biology, the course provides the necessary foundation. As the discussions are interactive, the students are challenged to come up with answers to critical questions rather than being spoon-fed with information. As the course also discusses classical experiments, the students gain the understanding of the scientific process of discovery. This also helps to sharpen their critical abilities.
Course outcomes:

It will teach and make students aware of research methods and also develop important soft skills for the students.
Course outcomes:
This course teaches students to develop scalable machine learning techniques, both in standalone and in distributed settings. Students learn about design considerations in this area, available tools and algorithms, and also about open problems. Students also get to learn about developments in the industry through various guest lectures from the industry.
Course outcomes:
Medical Imaging is an interdisciplinary subject that requires understanding of physics, technology, and practice of each medical imaging modality. This course will cover physics and technology part. Homework, presentations, and exams will test your understanding of physics and technology aspects. Project will involve development of a compact solution to current problem/s in medical imaging, such that it will enhance your understanding of challenges related to medical imaging.
Course outcomes:

Numerical methods and their analysis for solving different types of linear systems.
Course outcomes:
An algorithmic view of stochastic simulation and analysis of convergences, confidence intervals, modeling of input, statistical interpretation of outputs etc.
Course outcomes:
The students will learn the mathematical theory of finite element methods and fully practical finite element algorithms for solving partial differential equations elliptic and parabolic scalar PDES, linear elasticity, Mindlin-Reissner plate problem, Navier-Stokes equations.
Course outcomes:
At the end of the course, the students should be able to parse a real-world data analysis problem into one or more computational components learned in this course, apply suitable machine learning and/or visualization techniques and analyze the results obtained to enable optimal decision making. This would also act as a first course in data science which would provide necessary pre-requisites and knowledge to explore more specialized and involved topics in machine learning, analytics, statistics etc.
Course outcomes:
Familiarity with basics of modern data assimilation techniques
Course outcomes:

Many Core Architectures for SoCs

Programming massively parallel and runtime reconfigurable systems

Programming Models

Execution Models
Course outcomes:
Contemporary Cloud data centers are complex distributed system setups involving many technologies to deliver the common goals of cloud computing paradigm. As a result of this course the student gets to understand the conceptual constructs of system virtualization that is extensively used as a building block in many of the cloud datacenters. This course prepares them to understand, architect, use and innovate the distributed systems architectures in such setups.
Course outcomes:
Fundamentals of Parallel programming and architectures. Good knowledge of concurrent data structures, cloud computing fundamentals. And mainly ability to devise and program parallel algorithms.
Course outcomes:
At the end of the course, students will have learned about the following concepts.

1) Types of Big Data, Design goals of Big Data platforms, and where in the systems landscape these platforms fall.

2) Distributed programming models for Big Data, including Map Reduce, Stream processing and Graph processing.

3) Runtime Systems for Big Data platforms and their optimizations on commodity clusters and Clouds.

4) Scaling data Science algorithms and analytics using Big Data platforms.
Course outcomes:
The students would primarily learn to apply advanced optimizations to parallel programs and write efficient parallel codes for scientific applications.
Course outcomes:
Ability to understand the biological problem at hand and device appropriate computational/bioinformatic strategies to solve it and interpret the results.
Automated Software Engineering with Machine Learning

Department: CSA

**Course outcomes:**

After completing this course successfully, students can:

* Design and implement simple Android applications

* Identify concurrency and security issues in Android applications

* Apply machine/deep learning for analyzing software

* Understand and use state-of-the-art program analysis tools
Course outcomes:
The student gets a thorough familiarity with basics of graph theory and its methods.
Course outcomes:

Basic notions and techniques of combinatorics. Can be very useful in theoretical computer science. Also for researchers in other aspects of computer science.
Course outcomes:

Students will learn basics of computational algebra and Grobner bases techniques.
Course outcomes:
The students get a good handle on probability theory analytics and some aspects of modelling and simulation.
Course outcomes:

1. Fundamentals of Artificial Intelligence
2. Learn general problem solving, logic, reasoning
3. Learn different learning techniques
4. Communication using natural language
5. Programming in AI languages
6. Multiple agent systems
Course outcomes:
At the end of the course, a student of the course is expected to know the following:

1. Knowledge of the mathematical basis for various one way functions, viz., RSA cryptography, prime number based discrete log, ECC based discrete log, block encryption functions, hash functions, MAC functions, pseudorandom number generators, and how they are designed.

2. How these one way functions are used to design a security protocol to meet the security requirements of a distributed system.

3. How to identify the security requirements of a distributed systems, and design a security protocol to meet these requirements.

4. The student is able to deal with 512 or 1024 bit integers in C++ or Java and is able to implement a security protocol in C++ or Java using 512 or 1024 bit integers.
Course outcomes:
Students will learn modeling techniques, key statistical principles, data handling techniques, will get hands-on experience with large data sets, and will learn to program in a language like Python.
Course outcomes:
The students would be fully conversant with the design principles of the engines and middleware of contemporary database systems, and their interactions with the related computing components, including the hardware, the operating system, and the data network.
E0 264 January-April 3:01
Distributed Computing Systems

Department: Department of Computer Science and Automation

Course outcomes:
At the end of the course, a student is expected to know the following:

1. Fundamental problems of distributed systems like clock synchronization, remote procedure call, group communication, etc, and techniques for solving these problems.

2. Implementation of distributed algorithms solving a specific problem in Distributed Computing Systems
Course outcomes:
At the end of the course, the students should be comfortable in framing and solving standard convex optimization problems arising in various scientific and engineering applications.
Course outcomes:

1. Various soft computing techniques
2. Application in various areas
3. Course will help M.Tech students in their project and research students in their research
Course outcomes:
Students learn both theory and practical aspects of machine learning models. Towards the end of the course, they also get a flavor of machine learning research by doing course projects.
Course outcomes:
Students who complete the course will be proficient in the basic techniques and tools for carrying out formal verification of software systems.
Course outcomes:

After taking this course

1. Students will be able to design any digital system.

2. Students will learn the basics from simple transistor design to complex digital system.

3. This is a very industry oriented course, students learn various CAD tools used in the chip design industry.

The course makes the students highly employable in various IC design companies.
Course outcomes:
Tools from combinatorics is used in several areas of computer science. This course aims to teach some advanced techniques and topics in combinatorics. In particular, we would like to cover probabilistic method which is not covered in the introductory course `graph theory and combinatorics'. Moreover the course would aim to cover to some extent the linear algebraic methods used in combinatorics. We will also discuss some topics from extremal combinatorics.
Course outcomes:
This is a research course in Cryptographic Security and Privacy. By crediting the course a student is expected to acquaint her/him-self with recent advances in the research areas covered in this course.
Course outcomes:
The students would gain a close understanding of the current research trajectories in the international database community, receive training in reading and critiquing research papers, and gain experience in constructing and delivering effective research presentations.
Course outcomes:
In this course, students will learn to implement, train and invent neural network models and make these models work on practical problems in Natural Language Processing.
Course outcomes:
The course project is geared towards building the programming skills required for implementing large software systems.
Course outcomes:

Students completing the course should be able to implement Optimisation algorithms to real life problems.

They should be also able to formulate engineering problems as an Optimisation.
Course outcomes:
Understanding of processor microarchitecture (single and multi-core), memory system design, parallel architecture, accelerator architecture, latest developments and research problems in the area of computer architecture.
Course outcomes:

students should be able to schedule the jobs in RTOS

how to handle allocation of resources.
E0247 Aug 3:01

Sensor Networks

Department: Department of Electrical Engineering

Course outcomes:
Design the applications using sensors and apply the topics used in the course material
Course outcomes:
The students will understand how advanced optimizations work in a compiler. They will also learn to program optimizations and code generation using the LLVM framework.
Course outcomes:

Most of the state of the art to start conducting basic research in computer systems security
Course outcomes:
Students will learn mathematical and computational techniques for modeling, representing, and displaying 3D geometric objects. Students will also learn about current research topics in computer graphics and its applications, particularly to geometry processing and visualization. They will get hands on experience working on one such topic by reading relevant research project and working on a mini project.
Course outcomes:
There is an emerging need for computational frameworks that permit extracting meaningful information from noisy, high-dimensional brain data. The students will review the state-of-the-art in machine learning and dimensionality reduction as well as theoretical and computational models in brain research. The course project will train them to develop and apply computational algorithms to large-scale neuroscience datasets, for example, for decoding cognitive states from brain imaging data.
Course outcomes:
Understanding advanced topics in Computer Architecture with specific focus on processor architecture (multi-core architecture), memory system design, accelerators, and high performance architectures
Course outcomes:
Theoretical and practical understanding of topics in compiler parallelization and optimization for parallel architectures, high-performance domain-specific languages and compilers, and an understanding of the state-of-the-art research in this area.
Course outcomes:
The course equips the students with strong basics in Machine Learning (ML). The students would study different algorithms for learning pattern classifiers and would also explore different datasets to get a feel for ML algorithms. The statistical and/or optimization principles underlying different algorithms would be emphasized and thus the students would pick up the background needed to study more advanced topics in ML. The course would be useful both for students wanting to build a career in industry using ML as well as for students wanting to pursue research in ML.
Course outcomes:
- Students would learn about state space description of systems.

- Students would learn fundamental concepts in linear systems and controls such as stability, controllability and observability.

- Students would learn formal mathematical (theorem-
Course outcomes:

- Students would learn about state space description of systems.

- Students would learn fundamental concepts in linear systems and controls such as stability, controllability and observability.

- Students would learn formal mathematical (theorem-proof...
Course outcomes:

- The students would learn to use various basic and commonly used tools to analyze nonlinear systems and to design controllers for the same.

- The students would learn formal mathematical (theorem-proof style) analysis in the context of controls.

- The
Course outcomes:
To enable an engineer to model, design and implement digital controllers
Course outcomes:
This course provides a modern and statistical perspective on natural language processing. The course will enable the student to: acquire fundamentals of language technology; understand, implement, and apply state-of-the-art techniques to novel problems involving natural language data; and be able to read and understand current research literature.
Course outcomes:
The objective of this course is to provide a foundation of game theory to help students apply game theory to problem solving in a rigorous way.

At the end of this course, the students can expect to be able to model real-world situations using game theory, analyze the situations using game theoretic concepts, and design correct and robust solutions (mechanisms, algorithms, protocols) that would work for rational and intelligent agents.

The students will have an opportunity to obtain an exposure to and a serious appreciation of the seminal contributions of celebrities such as von Neumann, John Nash, Lloyd Shapley, Robert Aumann, William Vickrey, Leonid Hurwicz, Eric Maskin, and Roger Myerson.

After completing the course, the students will be able to make forays into topical areas such as algorithmic game theory, algorithmic mechanism design, computational social choice, auctions and market design, electronic commerce, Internet monetization, social network research, and mechanism design for multiagent systems.

Students would be able to pursue inter-disciplinary topics such as cyberphysical systems, intelligent transportation, service science, green supply chains, and human computation systems (such as crowdsourcing networks) by formulating and solving topical problems using the conceptual foundations covered in the
course.
Course outcomes:
The students will get to know modelling and analysis tools and techniques for problems of dynamic decision making under uncertainty. They will know the algorithms they can apply when faced with such problems and the convergence and accuracy guarantees that such algorithms would provide.
Course outcomes:
Students would acquire a rigorous understanding of basic concepts in probability theory. They would learn some important concepts concerning multiple random variables such as Bayes rule for random variables, conditional expectation and its uses etc. They would also learn stochastic processes, including Markov Chains and Poisson Processes. The course would provide the background needed to study topics such as Machine Learning, Adaptive Signal Processing, Estimation Theory etc.
Course outcomes:

1. Study the qualitative problems of detection and estimation in the framework of statistical inference.

2. Gain an understanding of, and develop the ability to design, automated systems for detection and estimation (these are often key subsystems of larger systems in real life).

3. Write down hypothesis tests and estimation schemes (e.g., Likelihood ratio tests, Maximum likelihood estimators) for typical problems of interest.
Course outcomes:
Students will have understood the conditions of optimality and their meaning.
The students will be able to implement important types of unconstrained
optimization algorithms, and essential variants of linear programming methods.
Selected Topics in Markov Chains and Optimization

Department: Electronic Systems Engg.

Course outcomes:
Students will get a flavor of fairly advanced topics in Markov chains, graph theory, combinatorics and optimization useful to their research, build upon existing theory towards applications. In some cases, research papers are directly discussed.
Course outcomes:
Students would have basic understanding of probability theory, random variables, random vectors, and discrete valued random processes.
Course outcomes:
Students would be able to model complex systems with uncertainty using random processes, and analyze the system performance.
Course outcomes:
At the end of the course, a student is expected to have a good understanding of the principles underlying the design and implementation of error-correcting codes. The course places an emphasis on code design and implementation, and on decoding algorithms in particular. Specifically, the students are exposed to a variety of code constructions, both classical (algebraic) and modern (graphical). They are also introduced to a wide range of decoding algorithms, from basic linear-algebraic decoders to sophisticated algebraic decoders to modern iterative message-passing decoders.
Course outcomes:
A student taking this course is expected to learn the basic tools and techniques needed to carry out research in information-theoretic security. The student will also understand the practical barriers that prevent this paradigm from becoming a viable alternative to mainstream cryptography.
Course outcomes:
The course aims to bring students up to speed on the major directions of ongoing research in this field. Along the way, the student may also pick up the important mathematical paradigm of dynamic programming.
Course outcomes:
The course aims to bring students up to speed on the major directions of ongoing research in this field. Along the way, the student may also pick up the basic ideas involved in dynamic programming.
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Course outcomes:
The course aims to bring students up to speed on the major directions of ongoing research on finite-state
channels, and to provide the mathematical tools and techniques needed to carry out research in this field. In
particular, students are exposed to the fundamental mathematical technique of dynamic programming.
Course outcomes:
The course aims to bring students up to speed on the major directions of ongoing research on finite-state channels, and to provide the mathematical tools and techniques needed to carry out research in this field. In particular, students are exposed to the fundamental mathematical technique of dynamic programming.
Course outcomes:
Students acquire detailed understanding of how TCP/IP networks operate.

Discussions of concepts and notions in class and a variety of lab exercises enable students to grasp the essentials, and prepare them to solve practical networking problems.
Course outcomes:

Students learn basic concepts, techniques, and elementary proof methods in Probability and Random Processes.
Course outcomes:
Understanding of the Internet architecture, applications, protocols, and design from an end-to-end and layering perspective and a performance analysis perspective.
Course outcomes:
Students learn basic principles, concepts, techniques, and methods, for the design and analysis of Wireless Networks.
Course outcomes:
The students would learn modeling of various multiuser communication systems as linear vector channels, learn optimum detection, linear and non-linear detection algorithms, and multiuser/MIMO signal detection algorithms based on local search, meta-heuristics, message passing, and Markov Chain Monte Carlo techniques.
Course outcomes:
This course will give exposure and in-depth treatment to modeling or RF impairments in communication systems and use these models for design and performance evaluation of communication systems.
Course outcomes:
The student is expected to understand the definitions of various measures of information and have a working knowledge of their properties. Furthermore, the student should be able to formalize compression, transmission, and estimation problem in an information theoretic setting. The course will also teach the student how to show the optimality of codes for compression and transmission. Finally, advanced students will develop heuristics for identifying packing and covering problems in many standard information processing scenarios.
Course outcomes:
How to model wireless channels? How to design and analyze diversity techniques? Understand cellular system design. Understand MIMO and OFDM techniques.
Course outcomes:
This course is meant for second or third year graduate students who already have encountered communication complexity and information theory in their research. On completion of this course, a student is expected to understand various measures of communication complexity and relation between them. He or she should be able to identify the communication complexity bottlenecks in various theory problems and should develop the art of showing optimality using communication complexity lower bounds. The student should have a good exposure to recent developments in this fundamental field and also to various use-cases.
Course outcomes:

Students taking this course will be introduced to a new class of problems and algorithms that involve the study of geometry and topology. The course will also introduce various algorithmic paradigms and hence help students improve their algorithmic skills. After successful completion of the course, a student will be able to effectively apply the techniques to specific application domains of interest or pursue independent research in this area.
Course outcomes:
The students would learn the following from this course:

1. Mathematical foundation of quantum mechanics, including bra and ket algebra.
2. Fundamental postulates of quantum mechanics,
5. Description of electrons in solids, and understanding Fermi energy and its difference with chemical potential.
7. Basic concepts of carrier transport in semiconductors.
8. MOSFET device concepts and details of its operations, different quantum mechanical effects including quantization, quantum capacitance, Intra- and Inter-band tunneling.
Course outcomes:

At the end of the course, a student ...

1. Given a set of specifications for a digital system, will be able to design the system meeting the specifications.

2. In particular, given an algorithm, will be able to design the datapath and the controller(s) to implement the functionality.

3. Will be able to design datapath using higher level combinational and sequential blocks.

4. Will be able to solve the functional and timing problems in the datapath.

5. Will be able to resolve various issues related to the controller design.

6. Will be able to resolve synchronization issues.

7. Will be able to write a VHDL code to implement a particular design/block.

8. Will be able to analyze a VHDL code and infer what circuit a synthesis tool might generate out of a code.
9. Will know how the VHDL simulation tool simulates the code.

10. Will be able to write test benches to automate the verification process.

11. Will be able to choose a particular FPGA for a particular application.

12. Will be able to use FPGAs in your design, meeting the area and delay constraints and estimate the power consumption.

13. Will be able to design and code to exploit the architectural features of FPGA.
Course outcomes:
At the end of the course, a student ...

1. Given a set of specifications for a Processor, will be able to design the processor meeting the specifications.

2. In particular, given the specification, required Multi-cycle, Single-cycle or pipelined CPU would be designed.

3. Will be able to do the detailed timing analysis and would be able to meet the timing requirements.

4. Will be able to resolve data dependences by stalling.

5. Will be able to solve data dependences by data forwarding and bypassing.

6. Will be able to design the bus interface for the processor

7. Will be able to design peripheral devices compatible to BUS

8. Will be able to design the BUS bridges
Course outcomes:
1. Student masters the fundamental knowledge of electronics packaging including package styles or forms, hierarchy and methods of packaging necessary for various environments.
2. Provide pathway for further studies in packaging if the student is inclined to do so.
3. Provide industry perspective
4. Ability to distinguish between engineering performance and economic considerations to develop cost-efficient and high performance packaging approaches. Students should be able to predict the reliability of electronic components and structures.
Course outcomes:
Very less power semiconductor device expertise is available in industry and numerous research options are available. This course will provide insight into physics of power semiconductor devices under extreme operation conditions like high voltage, high current and high temperature which are encountered under typical power electronic environment. The knowledge developed from this, will help in designing power devices with desired specifications.
Course outcomes:
The students would learn the following from this course:

(1) Brief overview of basic quantum mechanics, crystal structure and Brillouin zone, electrons in crystalline solids, momentum space, Energy band structure in semiconductors, quantum confinement, semi-classical electrodynamics in perfect crystal.

(2) Concepts of scattering of carriers, Fermi golden rule.

(3) Different types of scattering mechanisms including Ionized impurity scattering, various phonon scattering methods, e-e scattering, surface roughness scattering, and scattering for quantum confined carriers.

(4) Concept of distribution function, Boltzmann transport equation(BTE), relaxation time approximation.

(5) Solution of BTE, numerical solutions, validity of BTE, coupled electrical and thermal transport.

(6) Quantum transport - conduction quantization, current flow in a one-level model, different regimes of transport including self-consistent field and Coulomb blockade, current carrying modes in quantum wire and 2D electron gas, ballistic versus non-ballistic transport.
(7) Open system versus closed system, concept of level broadening, Formal treatment of open system, coherent transport using Green's function, ballistic current in a two-terminal device.
Course outcomes:
The course will enable students to understand and appreciate the synergy between quantum mechanics and semiconductor materials, which will eventually lead to a general framework of concepts applicable across a variety of semiconductor devices. The students will be able to comprehend the drift and diffusion mode of electrical transport through semiconductor devices. The course will empower students to use quantum mechanics and transport theory to investigate complex and novel electrical devices.
Course outcomes:
Students should be able to design and implement fairly complex embedded systems that may use interrupts and have certain real time requirements to meet. Further, they should be able to troubleshoot and debug already deployed systems.
Course outcomes:
Compact modeling techniques, Verilog-A, Implementation of compact model in circuit simulator
Course outcomes:
Able to choose a processor, design a power supply, choose the powering modality, choose the communication protocol, choose communication technology, choose between sensors, ICs and components.

In summary ability to build complete (hardware and software) embedded devices.
Course outcomes:
This course discusses the advanced topics related to power system analysis. Knowledge about these advanced topics will help students in research and professional career.
Course outcomes:
Students will learn modelling & control of various advanced control technologies of power grids, like FACTS, HVDC, Renewables, etc.... They get ability to design & implement them in basic programming languages like C, C++ & fortran. Through an individual project they will learn 100% implementation of a IEEE transactions paper by properly identifying the tasks, various implementation stages, gathering concepts, etc...
Course outcomes:
This course mostly use IEEE and CIGRE standards to teach advanced topics of power system protection. As a result, students will be familiar with the industrial practices.
Course outcomes:
Recent trends in the area of power system protection and to learn through lab exercises to implement high speed and accurate power protection algorithms on DSP hardware. Understanding the use of Artificial Intelligence techniques such as Neural Networks and Fuzzy logic techniques in digital power system protection schemes.
E4231 Aug 3:00

Power system dynamics and control

Department: Electrical Engineering

Course outcomes:
Students will learn development of various types of models used for synchronous machines, Hydro & steam turbine, governors & excitation systems. Students will get the ability to simulate these models using numerical methods in basic programming languages like C, C++ or fortran. Get knowledge of Transient & small signal stability assessment methods for large power systems. Will get the knowledge of developing various stability controls for Power Systems. Through the project each student will learn various advances in Power Systems Dynamic modelling & Control by implementing 50% results of a reputed journal paper (IEEE Transactions on Power Systems). This gives the ability of doing literature review, understanding technical paper & ability to get the required concepts & tools for paper implementation. This gives a good research training.
Course outcomes:
This course is targeted for giving thorough understanding of how an operator does planning, analysis & operation of day to day scenarios in large scale power systems. Students will learn various mathematical techniques, steady state models & control center functions. They get ability to design & implement various control center functionalities in basic programming languages like C, C++ & fortran. Through a group project they will learn 100% implementation of a IEEE transactions paper by properly identifying the tasks, various implementation stages, gathering concepts, exchange of concepts, etc.,
Course outcomes:
The outcome of the course are:

1. Clear understanding on the governing electric fields under various operating contingencies

2. Comprehensive knowledge on the three commonly employed numerical methods for electrical insulation

3. Basic aspects of the computer program development for these methods

4. Practical aspects of field computation and its interpretation/usage
Course outcomes:
This course will train the students to design pulsed power systems for use in various military, atomic energy and industrial applications
E5-232  May-June 2:01
Advances in Electric Power Transmission

Department: Electrical Engg

Course outcomes:
Advanced knowledge in high voltage insulation and transmission engg,
Understanding of the SCADA and substation automation etc..
Course outcomes:

Course outcomes can be itemised as:

1. Advanced knowledge in high voltage insulation aspects
2. Expertise in generation and measurement of high voltages
3. Enhanced understanding in air breakdown aspects
4. Enhanced understanding in pollution aspects related to insulators
5. Enhanced understanding in high voltage application for pollution control
Course outcomes:

* Advanced knowledge in high voltage power apparatus

* enhanced understanding in monitoring and diagnostic aspects of transformer

* expertise in testing aspects of circuit breakers

* advanced knowledge in power transformer design, testing, short circuit force calculations
Course outcomes:

* time-domain treatment of overvoltage on transmission lines

* methods to compute it

* analyse overvoltage data or phenomenon in systems, networks

* protection against overvoltage
Course outcomes:
To enable the student to understand the PV source and how to interface it to real world applications. To enable the student to design such power interfaces.
Course outcomes:
Prepare students for research
Course outcomes:

To be able to design any power converter circuit for a given set of specifications and to develop a prototype.
Course outcomes:
MODELING, DESIGN AND CLOSED LOOP CONTROL OF VARIABLE SPEED DRIVES
Course outcomes:
The student is expected with both the design and control of dc-dc converters at the end of the course. The laboratory exercises are designed to make the student comfortable with the auxiliary circuits associated with the power electronics converters and also with basic dc-dc converters.
Course outcomes:
The student is expected to understand the various challenges behind introducing distributed generation. The student is also expected to become comfortable with the design methods for electronic power converters for optimized industrial requirements.
Course outcomes:

After the completion of the course, the student will,

Be able to design and analyze an integrated optic waveguide

Understand the working of various photonic components

Be able to choose the technology suitable for the intended device.

Also he/she will be ready to understand current developments.
Course outcomes:
(i) understand the basic working mechanism of the devices, (ii) understand the governing equations to be able to perform calculations to characterize the performance of the devices and, (iii) have the practical knowledge and an understanding of the trade-offs when using these devices in their respective applications.
Course outcomes:
Students learn about the various optical sources, detectors and fiber types and their suitability/choice for any application.
Course outcomes:

The outcome of the course (as stated by the students) are:

1. It generates real interest in this not so well-perceived subject

2. Clear understanding of the basic principles associated with electromagnetic field theory

3. Comprehend the framework of the governing laws and their applicability to the electrical engineering problems

4. Able to solve standard problems through acquires basic mathematical skills
Course outcomes:
Understand why/how RF circuit design differs from others, Learn to design and analyse RF circuits, Exposure to industry standard tools for RF circuit design, and Learn Vector Network analyzer based measurement of circuit components and antennas.
Course outcomes:

Students learn about different electromagnetic and circuit simulation methods
Course outcomes:
Students are expected to be able to interpret video processing algorithms from the point of view of their perceptual relevance, know what kind of signal processing models explain processing along the human visual pathway and even try to incorporate such ideas in video processing algorithms such as compression, quality assessment, denoising, saliency, and so on.
Course outcomes:
The students would learn how to use iterative techniques to solve parameter estimation problems. Further, the theoretical guarantees of iterative and recursive methods will be learnt to enable them to choose the appropriate method for signal processing systems. A good understanding of techniques like Kalman Filtering and Recursive Least-Squares techniques will be useful to extend them to machine learning paradigms.
Course outcomes:
The students would be equipped with the tools and techniques to handle nonstationary signals arising in various real-world contexts.
Course outcomes:
The students would get a firm foundation in 2-D signal processing and be able to handle real-world image processing problems and develop image processing software.
Course outcomes:

After taking this course ...

1. The student will learn principles of tomographic imaging with different modalities such as x-ray, PET and SPECT, NMR/MRI, ultrasound and optical with non-diffracting and diffracting energy sources.

2. Learn principles of non-invasive medical imaging techniques and non-destructive techniques for industrial imaging.

3. Understand projections and projection slice theorem

4. Various types of data acquisition in tomography - parallel beam, fan-beam and cone-beam as well as circular and helical trajectories of the source and detectors. First to 4th generation of CT.

5. Learn transform domain non-iterative 2D and 3D reconstruction techniques for non-diffracting radiation sources

6. Understand Fourier inversion technique and Fourier methods of reconstruction techniques

7. Learn the statistical nature of the radiation energy generation, propagation, and detection. The errors and artifacts due to the practical limitations of these processes.

8. Exposed to a class of Algebraic Reconstruction Techniques (ART) and its variants.

9. Some applications of Tomographic principles in signal processing and image processing.
Course outcomes:
Students are expected to have an understanding of and implement various advanced image processing algorithms and analyze their performance on datasets to make improvements. This is achieved through a series of hands on assignments and projects.
Course outcomes:
This course expands the horizon of signal processing and communication students to non-linear techniques and their optimality, deviating from the predominantly Gaussian-linear analysis of signals and systems. Non-filters are also power efficient and are based on sorting and boolean logic implementations.
Course outcomes:
Students will gain in depth knowledge of digital representation of signals and information. Performance measures of SQNR, Noise shaping, perceptual masking will be understood. The trade offs between signal models and adaptive schemes will be realized. Offline optimum design Vs online adaptation of signal models and quantization schemes will be appreciated.
Course outcomes:

Students would learn the theory and practice of machine learning methods.
Course outcomes:
Students will get a firm foundation towards advanced research by building upon known things at a foundational level in physical data storage. This is very useful for advanced research in the field, as well as, translational work for practicing engineers/scientists.
E9252 Mainly Aug until now, sometimes Jan 3:00
Mathematical methods and techniques in signal processing

Department: Electronic Systems Engg.

Course outcomes:
Students will get the foundations into signal theory necessary to pursue advanced research. Masters' level students can use these skills in the industry having a solid analytical background.
Course outcomes:
Students are expected to be comfortable in using a variety of signal processing techniques on a wide variety of brain signals by the end of this course.
Course outcomes:
Students will have the in depth knowledge of hardware they have used, how to write their programs using fixed and floating point implementations. How to pipeline/parallelize the algorithms on the hardware to have either reduce the power consumption or increase the speed of operation of algorithms.
Course outcomes:
At the end of this course, we expect the student to have a better understanding of the different evolutionary processes that shape biodiversity. The course also addresses microevolutionary processes using quantitative genetics at the molecular level. In the practical section of the course, the students will learn how to use analytical tools to construct and interpret phylogenetic trees from molecular data and understand the evolutionary diversification of gene/protein families.
Course outcomes:
At the end of this course, students should develop an ecological intuition that is quantitatively grounded, be able to read and critique mathematical/computational modelling papers, reproduce their results, and possibly even build basic models themselves. PhD students working in biological research are expected learn to think quantitatively and with a theoretical bent on their own research. This course is also expected to inspire many quantitatively trained UG students towards mathematical biology research.
Course outcomes:

Broad introduction to ecology and its relevance to society
Course outcomes:
Students gain an understanding of the history of animal behaviour research, physiological basis of behaviour, ecology and evolution of behaviour, as well as are exposed to different approaches to studying the subject. The practical component gives them hands-on training in designing and analysing behavioural experiments, as well as presenting these results.
Course outcomes:
"Students are exposed to the state-of-the-art in concepts, methodologies, and controversies in the subject matter of the course. They will learn how to think critically about the subject and to critique published material as well as online material available on the internet."
Course outcomes:
This will train students to apply ideas from nonequilibrium statistical physics and stochastic processes to
Biological systems. The course will also train towards presentation skills as well as research skills via an
independent project that students would develop.
Course outcomes:
Design
Course outcomes:
There is an emerging need for computational frameworks that permit extracting meaningful information from noisy, high-dimensional brain data. The students will review the state-of-the art in machine learning and dimensionality reduction as well as theoretical and computational models in brain research. The course project will train them to develop and apply computational algorithms to large-scale neuroscience datasets, for example, for decoding cognitive states from brain imaging data.
Course outcomes:
complete PV from basic device physics to plant working principals
Course outcomes:
Get insights about the working of the planet, and an appreciation of its origin, uniqueness. It explains the way the earth's unique environment has evolved as the only known planet in the Universe that sustains life. It provides reasoning as to why the natural calamities occur, as part of the earth's natural evolution and leads to an appreciation of the fact that the long term survival of the human race is contingent on its ability to understand the earth processes and its long-term consequences such as climate change.
Course outcomes:
For the student with no prior Earth science knowledge: fundamental concepts related to the origin and evolution of our planet

For the student with prior Earth science knowledge: improved understanding of Earth processes, introduction to cosmochemistry
Course outcomes:
Vector notation and calculus, construction of partial differential equations (PDEs) in vector form that describe geophysical phenomena, elementary fluid mechanics, basic electromagnetism, basic solutions to PDEs, construction of dimensionless parameters and equations, hands-on experience in problem solving through 3 assignments.
Course outcomes:
Advanced fluid mechanics in stationary and rotating reference frames, principles of rotating convection, magnetohydrodynamics (MHD) of planets, applications of turbulence theories to planetary interiors and atmospheres.
Course outcomes:
Students will develop a better understanding of the different isotopic-proxies used for addressing wide-ranging Earth science problems. They will also get a better understanding of how these isotope ratio measurements are performed.
Course outcomes:
Knowledge of group theory as is necessary for the study of relativistic particle physics
Course outcomes:

Students would learn the framework of quantum computation, and how that may be useful for future quantum technologies.
Course outcomes:

Students are equipped to start research in particle physics. More material would be taught in QFT-II.
Course outcomes:
Expertise in quantum field theory, which is the key ingredient and tool of high energy physics, both experimental and theoretical. Most of the material is also of key use to condensed matter physicists.
Course outcomes:

Should have a working knowledge of Einstein’s general relativity and some modern research areas.
Course outcomes:

Students learn the phenomenon involved at small scale lengths that provided the information about the working of the systems and all the information related to fabrication. Case by case study is taken to teach them about various systems.
Course outcomes:
The course connects circuit performance to material and device behavior. At the end of the course, the students would learn to:

1.) Analyse semiconductor devices (electrostatics and current-voltage characteristics) from fundamental principles.
2.) Understand the implications of material properties and device physics when the device is used in circuits.
3.) Engineer and innovate on device design and even construct new devices intended for special applications in circuits. There is special emphasize placed on this aspect.
4.) Learn the fundamentals of analog circuit design (with the example of voltage amplifiers) and observe how device properties and device design impact circuit behaviour (eg. dc and ac response, noise)
Course outcomes:
The course connects circuit performance to material and device behavior. At the end of the course, the students would learn to:

1.) Analyse semiconductor devices (electrostatics and current-voltage characteristics) from fundamental principles.

2.) Understand the implications of material properties and device physics when the device is used in circuits.

3.) Engineer and innovate on device design and even construct new devices intended for special applications in circuits. There is special emphasize placed on this aspect.

4.) Learn the fundamentals of analog circuit design (with the example of voltage amplifiers) and observe how device properties and device design impact circuit behaviour (eg. dc and ac response, noise)
IN214 Jan (was offered in Aug till 2016) 3:00
Semiconductor Devices and Circuits

Department: Instrumentation and Applied Physics

Course outcomes:
The concepts and analysis of semiconductor device physics.
Methods to develop novel semiconductor devices.
Impact of device physics on circuit design.
IN224 Jan 3:00
Nanoscience and Device fabrication

Department: Instrumentation and Applied Physics

Course outcomes:
After taking this course a student will be able to understand

1. Role of quantum mechanics in Nanomaterials
2. Band structure of nanomaterials
3. Structural, optical, electronic properties of nanomaterials
4. How to analyse data from characterization techniques like XRD, TEM, Absorption and emission spectroscopy.
### Course outcomes:

This course will expose students to the basic concepts in solid state physics, along with relevant experimental details. By the end of this course students will be able to appreciate the physics of metals, semiconductors and insulators. Students will also learn to evaluate advanced research articles and effectively communicate scientific ideas via writing and speaking.
Course outcomes:
Basics of Optical Instrumentation, Computational Imaging, and Image Analysis/ Demodulation Techniques.
Gains hands on experience in setting up the optical systems and making measurements with them. Experience with processing the digital images acquired in optical metrology tools to decode the information about the measurand on MATLAB platform.
Course outcomes:

Fluorescence based techniques
Course outcomes:
Exposure to the design and fabrication techniques of Microfluidic Devices, hands-on experience. Familiarity with various applications of Microfluidics and Lab-on-Chip Technologies and doing a term-project in realizing a specific application.
Course outcomes:

The classical and quantum nature of light.
Course outcomes:
TO THE STUDENTS OF CHEMISTRY BACK GROUND AFTER THE COURSE, THEY WILL BE CONFIDENT TO DO THE SINGLE CRYSTAL X-RAY DIFFRACTION STUDIES THEMSELVES.
Course outcomes:

Students will come out with:

a strong appreciation of all aspects of polymer chemistry

an understanding of how polymers are prepared and where they are used

an knowledge of how polymers are characterized

knowledge of all contemporary methods of polymer synthesis

an appreciation of several specialty polymers and their applications
Course outcomes:
The students would learn about the importance of metal ions in biological systems and how the metal ions mediate various biological functions such as metal-protein interactions, metal-nucleic acid interactions. They would also learn medicinally important metalloproteins, and development of drugs based on metalloproteins inhibition.
Course outcomes:

Students learn analysis of multivariable functions, continuity, differentiability integration of these functions. This course material will serve as foundation for many subsequent courses both in pure and applied areas.
Course outcomes:
Students develop knowledge in the real analysis of multivariable functions. Differentiation, Integration and some results in integral calculus.
MA 220 Aug. 3:00
Representation Theory of finite groups

Department: Mathematics

Course outcomes:
At the end of the course, a student would

a) Understand the basics of representation theory of finite groups

b) have enough knowledge about basic tools of representation theory

c) be able to use these tools to determine representations of "Good Enough" groups

d) Know pros and cons of these tools and apply suitably

e) be able to describing complex representations of symmetric groups and of $\text{GL}_2(F_q)$
Course outcomes:

Lebesgue integral. Lebesgue differentiation.
Course outcomes:

The students will learn everything written in the Syllabus.
Course outcomes:
After this course, a student learns the basics of functional analysis. They learn to treat the vector spaces which have the additional property of being topological spaces. Blending of these two structures brings them an exposure to higher mathematics. Important theorems like the Hahn-Banach theorem are taught here. These theorems stand a student in good stead throughout his mathematical life.
Course outcomes:
Students would learn the structure theory and representations theory of Lie algebras from this course.
Course outcomes:

Some beautiful theorems in analysis. More importantly basic techniques needed to work in analysis.
Course outcomes:
Students taking this course ought to

a) Know why we care about defining manifolds and what we expect to do with them.

b) Give examples of manifolds.

c) Understand how to construct diffeomorphisms using vector fields.

d) Understand why to care about differential forms and the Stokes theorem and how to prove the latter.

e) Know how differential calculus can help with distinguishing different objects (through De Rham cohomology).
Course outcomes:

After taking this course, a student ought to

1) Understand what a PDE on a manifold means.

2) Why we care about setting up and studying PDE on manifolds.

3) How one proves existence and uniqueness for linear and some nonlinear PDE.

4) As a part of 3), know about Sobolev spaces and Holder spaces of functions.
Course outcomes:

After taking this course, a student ought to

1) Understand what a PDE on a manifold means.

2) Why we care about setting up and studying PDE on manifolds.

3) How one proves existence and uniqueness for linear and some nonlinear PDE.

4) As a part of 3), know about Sobolev spaces and Holder spaces of functions.
Course outcomes:
Fundamental concepts of Gaussian processes. Also about stationary Gaussian processes on the line which are useful in signal processing and filtering theory.
Course outcomes:
Solving linear equations, working with matrices, in particular eigenvalues and eigenvectors, and applying the techniques to real life problems like graph theory, computer science, electronics and applied mathematics. Spectral theorems, prevalent in many branches of mathematics.
Course outcomes:
Proficiency in (a) dealing with functions of one and several variables, including integration and differentiation of the same, (b) A working knowledge of metric spaces and continuous functions defined on the same, (c) on a broader level, a rigorous mindset towards problem solving, including linear reasoning.
Course outcomes:
The students learnt:

1. techniques to compute the fundamental group of topological spaces, and the proof that it is a topological invariant.

2. acquired an understanding of covering spaces and the correspondence with subgroups of the fundamental group.

3. learnt how to compute simplicial homology groups of a simplicial complex.
Course outcomes:
How to approach problems in combinatorics
Course outcomes:
Learn basis of algebraic combinatorics
Course outcomes:
Students will be able to understand advanced probability models and be able to analyse and develop such models.
Course outcomes:
Learn basis of the theory of Coxeter groups
Course outcomes:

Advance methods in molecular modeling
Course outcomes:
Students will study applications of equilibrium thermodynamics to biological systems and obtain a molecular level understanding of non-covalent interactions important for determining macromolecular conformation. They will also become familiar with various methodologies for determining binding constants and hydrodynamic methods for estimating macromolecular size and shape.
Course outcomes:
Learn to interpret spectroscopic data for structural analysis.
Conformational and structural aspects of biopolymers

Department: Molecular Biophysics Unit (MBU)

Course outcomes:
A student of this course is expected to have learnt about 3-D aspects of molecules in general and in particular, peptides, proteins and nucleic acids.
Course outcomes:

They will have exposure to structural basis of Gene expression
Course outcomes:
The students would get a broad introduction to cellular and molecular neurophysiology. Whereas the first part of the course deals with the quantitative details of neuronal passive properties, action potential generation, synaptic transmission using simple experimental systems, the second part of the course delves into details of mammalian neuronal physiology with a specific focus on neuronal and synaptic plasticity during learning.
Course outcomes:
The students would learn the structure and conformation of natural and unnatural amino acid containing peptides, the methods for their combinatorial and parallel synthesis, the reagents for efficient amide bond coupling. They learn how to design a bioactive sequence from a given protein or hormonal peptide sequence, they learn about strategies for macrocyclization and conformational restriction that are important for the lead development in drug discovery. They learn about strategies to enhance the cellular permeability of peptides, along with the strategies to enhance their metabolic stability. Finally they learn about the various peptide bond isosteres that are used in drug discovery, which have forwarded peptide leads into clinic.
MB212 January 2:00
Electron microscopy and 3D image processing for Life sciences

Department: Molecular Biophysics Unit

Course outcomes:
Cryo-electron microscopy and the image processing is an emerging technology.
This course will clear the idea about image formation, Fourier analysis, Contrast Transfer Function, Point Spread Function and Electromagnetic applications in biology and medicine. Also, this course will help to understand the common line methods, particle symmetry, Projection Theorem, K-means clustering algorithm. Researchers (Ph.D. student and postdoctoral researchers) will learn how to handle the electron microscope, what is the basic principle and how we can use this instrument for our research purposes. They will also learn the data processing, data collection, data analysis, model building and molecular docking.
Course outcomes:

Introduction to structural biology
Course outcomes:
The student will learn the basic theory of NMR spectroscopy. Furthermore, they will learn the theoretical and practical aspects of NMR data acquisition and the details of analysis of Pulsed NMR methodology. The course is intended to train students to become independent users of the NMR instruments.
Course outcomes:
As detailed in the syllabus, basic as well as advanced learning exposure in field of Microbiology
Course outcomes:
The student will have a better understanding of mechanism behind cancer development and progression, cancer diagnosis and treatment, genetic and epigenetic basis of cancer development.
Course outcomes:

Learn about mechanism of Ageing and Regeneration
Course outcomes:

After successful completion of this course, students will have better understanding in genetic principles,
Course outcomes:
The students learns to understand and appreciate the basic mechanism of biological processes.
Course outcomes:
Basic knowledge of RNA and update with advanced concepts in RNA Biology, which will help students in understanding the regulation of gene expression at different levels. Students working in the area of RNA Biology will be specifically benefited with this comprehensive course contents.
Course outcomes:

Theoretical and practical knowledge to use recombinant DNA techniques in research.
Course outcomes:

undergrad and postgraduate students
Course outcomes:
Students will learn current knowledge on cell biology including basic techniques
Course outcomes:
Nonlinear finite element procedures are extensively used by structural engineers to design components for applications where large deformations or material nonlinearities are encountered. Also, manufacturing engineers require knowledge of these procedures to design dies and fixtures for various forming processes like sheet metal forming, rolling and extrusion. This course will provide the necessary fundamentals to students to undertake these tasks. In addition to exposure to algorithmic aspects, the course will provide the student with hands-on experience in implementing them in finite element codes and debugging them through carefully designed example problems. Thus, the student will acquire the skill to implement the algorithms via user-defined subroutines in general purpose finite element codes like ANSYS and ABAQUS. Moreover, a quick but thorough exposure will be given to Continuum Mechanics concepts which are crucial to understanding nonlinear finite element procedures.
Course outcomes:
Fundamentals of the subject contents to advanced level topics.
Course outcomes:
Refrigeration field is the most important applied energy and a major energy consuming sector. The students will come to know both the older technologies and the newer developments in the face of ozone depletion and global warming problems.
Course outcomes:
Upon completion of this course, students will have a solid background in all (i.e. fundamental and applied) aspects of air conditioning. The knowledge gained will be useful in their further studies or to become an independent consultant on air conditioning.
Course outcomes:
The students will have solid foundation in the fundamentals. With the knowledge gained in this course, they will be able to go through any advanced literature and understand.
Course outcomes:
The students understand how to control the properties of materials and the genesis of the property of materials including metals, ceramics and polymers.
Course outcomes:

After taking this course, the students would...

1) become familiar with the field of microelectromechanical systems (MEMS)

2) be able to analyze MEMS components and devices using reduced-order (lumped) models

3) be able to model and simulate multi-physics phenomena found in MEMS and other systems

4) appreciate how to think about a MEMS device at the systems level

5) become comfortable with using MEMS simulation software

6) gain experience in designing MEMS devices
Course outcomes:
The students will learn concept of degree of freedom and generalised coordinates of a rigid body and multi-body system, how to specify orientation of a rigid body using Euler angles and other representations, obtain linear and angular velocities of rigid multi-body systems, analyse kinematics of rigid multi-body systems, learn about the Lagrangian and Newton-Euler formulation to derive equations of motion and solve them numerically, perform linearization of the equations of motion to analyse small motions. The students will be exposed to classical control techniques using root locus and bode plots and to modern state space methods. They will be introduced to the concepts of stability, controllability and observability in linear control systems.
Course outcomes:
Understanding concepts in Solid Mechanics like stress, strain, equilibrium and constitutive equations is essential for a design engineer. This course will expose the student to advanced concepts in Solid Mechanics and Elasticity theory building on elementary Strength of materials which is taught in undergraduate programs. Emphasis will be placed on tensor character of stress, strain and governing field equations after a thorough introduction to tensor algebra and calculus. Important concepts such as Uniqueness of solutions, St.Venant principle, Minimum potential energy theorem will discussed. The student will learn about solution of elasticity problems using not only stress function / potential function methods but also using energy methods. The limitations of plane elasticity assumptions (plane strain and plane stress) will be emphasized. At the end of the course, the student is expected to have a thorough knowledge of Solid Mechanics and should be able to apply it for strength / stiffness based design of engineering components. Also, he /she would acquire adequate background to take more advanced courses such as Fracture Mechanics, Impact Mechanics and Contact Mechanics.
Course outcomes:

Students learn a unified treatment of all materials that can be treated as continua including balance laws that are common to all continua, and constitutive laws and the constraints that they should satisfy.
Course outcomes:
The class is an elective, aimed at providing exposure to topics that are not usually covered in classes on fluid mechanics, and solid mechanics.

The material to be covered and assessment procedure will particularly benefit students engaged in research projects related to the content of the course. This includes problems related to microfluidics, biomechanics, and lab-on-chip devices.
Course outcomes:
The students will

a) learn how to model a robot and its components

b) learn how to derive and solve forward and inverse kinematics of serial and parallel manipulators

c) learn how to obtain equations of motion of a serial and parallel robot

d) different control techniques (linear and nonlinear) used to control the motion of a robot

e) be exposed to advanced topics such as flexible robots, mobile robots etc.
Course outcomes:

1) The student will learn how to pose an engineering problem that involves sound propagation. This will be in the form of an integral equation that can be solved either analytically or numerically.

2) The student will understand the physics of sound propagation outdoors and in enclosed spaces.

3) The student will learn how to solve a hyperbolic pde with initial conditions and boundary conditions.

4) The student will get an exposure to Green Functions that are fundamental to pdes.

5) He will get exposed to deep concepts like, integral equations, Sommerfeld radiation condition, sound structure interaction.
ME256 Jan. 3:00
Variational Methods and Structural Optimization

Department: Mechanical Engineering

Course outcomes:
After taking this course, a student would...

1) Understand the difference between ordinary calculus and calculus of variations as well as functions and functionals.

2) Get a quick grasp of the terminology of function spaces, energy spaces in particular.

3) Be able to take the first variation of a functional.

4) Write down necessary conditions of functionals involving multiple functions; multiple derivatives of a function; one, two, or three independent variables on which the functions depend.

5) Understand how to write the boundary conditions, including variable end conditions and transversality conditions.

6) Appreciate energy and variational methods in mechanics as well as the interconnection between force-balance (differential equation), weak form (principle of virtual work and D’Lambert principle), and energy principles (minimum potential energy and Hamilton’s principle) in mechanics.

7) Be able to think about the inverse problem of writing the minimization principle from the differential equation.

8) Gain a thorough understanding of Karush-Kuhn-Tucker (KKT) conditions for constrained minimization problems and the concept of Lagrange multipliers and their various interpretations.

9) Be able to analytically obtain the necessary conditions for optimizing a bar of variable cross-section profile for different objective functions and constraints.

10) Be able to the same for beams, plates, 2D and 3D continuous structures.
11) Understand the sensitivity analysis in structural optimization.

12) Be able to implement the numerical optimization algorithm to obtain optimized geometry of bars, beams, plates, 2D continua, 2D and 3D trusses, 2D and 3D frames and grillages.

13) Be able to consider transient and multiphysics problems in structural optimization.

14) Become familiar with Optimization Toolbox in Matlab.

15) Be able to formulate optimization problems in the framework of calculus of variations and then convert into the discretized form as a finite-variable continuous optimization.
Course outcomes:
The students will not only learn how to use the finite element method, but also how to formulate and code a finite element method for any given set of partial differential equations. Thus, the finite element method is developed as a tool for the numerical solution of partial differential equations, and not confined only to structural mechanics applications the way it is typically taught.
Course outcomes:

After taking this course, the student would...

Be able to formulate and implement topology optimization of structures and compliant mechanisms

Be able to write sensitivity (gradients) for cost functionals with respect to design variables and shape-changing parameters

Be able to appreciate the connection between homogenization theory and topology optimization

Become familiar with numerical methods used in topology optimization

Be conversant with the contemporary literature in the field of topology optimization
ME271 Aug-Dec 3:00
Thermodynamics

Department: Mechanical

Course outcomes:
Basic Concepts, Advanced Topics in Thermodynamics, Strengthening of Fundamentals.
Course outcomes:
Methods of analysis of two phase flows with and without phase change.
Course outcomes:

Students would learn methods of analysis of two phase flows with and without phase change.
Course outcomes:
The course gives exposure to the basic principles of axial and radial turbomachines, and ways to analyze and understand the flow within them.
Course outcomes:
Fracture Mechanics is important both from the perspective of material development and design of engineering components. While conventional design for strength, stiffness or fatigue life make use of elementary concepts based on Strength of Materials and Theory of Elasticity, these may give erroneous estimates of load bearing capacity or life of a structural component due to presence of flaws. In this course, the student will learn about mechanics of crack tip fields and appropriate fracture characterizing parameters like stress intensity factor and J integral or nonlinear energy release rate and how to compute them using various methods. Special emphasis will be given to experimental methods for determining the fracture toughness (for example, ASTM standard procedure for JIC testing). Failure of structures by fatigue crack growth is another important topic which the student will learn in this course. Various empirical fatigue crack growth laws, role of stress ratio, overload cycle, etc., will be discussed. An engineering approach to elastic-plastic fracture mechanics which makes use of a handbook style approach to evaluate important fracture characterizing parameters like J and CMOD will be described. At the end of the course, the student should be able to apply the concepts that he/she has learnt to design of structural components taking into account presence of flaws, nature of loading and constitutive behavior of the material. Also, he / she should be able to conduct experiments in the laboratory following standard test procedures to determine the fracture toughness of materials.
Course outcomes:
Fracture Mechanics is important both from the perspective of material development and design of engineering components. While conventional design for strength, stiffness or fatigue life make use of elementary concepts based on Strength of Materials and Theory of Elasticity, these may give erroneous estimates of load bearing capacity or life of a structural component due to presence of flaws. In this course, the student will learn about mechanics of crack tip fields and appropriate fracture characterizing parameters like stress intensity factor and J integral or nonlinear energy release rate and how to compute them using various methods. Special emphasis will be given to experimental methods for determining the fracture toughness (for example, ASTM standard procedure for JIC testing). Failure of structures by fatigue crack growth is another important topic which the student will learn in this course. Various empirical fatigue crack growth laws, role of stress ratio, overload cycle, etc., will be discussed. An engineering approach to elastic-plastic fracture mechanics which makes use of a handbook style approach to evaluate important fracture characterizing parameters like J and CMOD will be described. At the end of the course, the student should be able to apply the concepts that he/she has learnt to design of structural components taking into account presence of flaws, nature of loading and constitutive behavior of the material. Also, he / she should be able to conduct experiments in the laboratory following standard test procedures to determine the fracture toughness of materials.
Course outcomes:
After taking this course a student should be able to

1. Build a discrete event simulation model in simply and perform statistical analysis to compare the outputs
2. Perform steady state and transient simulation output analysis
3. Understand the notion of pareto optimality
4. Develop method for estimating the efficient frontier
5. Build ANN and SVM models for classification problems
6. Develop DEA models for study the relative efficiencies of DMU's
Course outcomes:
After taking this course a student should be able to

1. Write non-trivial programs in Python
2. Work on a hadoop system and work with MapReduce framework
3. Perform market basket analysis using Apriori and FP tree
4. Perform clustering analysis
5. Understand the advantages and limitations of some of the popular clustering methods
6. Build a decision tree for classification
7. Work with BayesNet
8. Use PCA for data summarisation
Course outcomes:

A fair understanding of micro behaviour of consumers and firms in different market structures.
MG202 August-December 3:00  
Macroeconomics  

Department: Management Studies  

Course outcomes:  
A student would be able to appreciate the macroeconomic developments and its implications fairly well, at the end of the course.
Course outcomes:
The course is designed to help students appreciate the various aspects of financial markets, need for their existence, and risk management for financial derivatives. The course lays the foundation for more advanced topics in Quantitative finance.
Course outcomes:
The course was completed successfully. Importantly, I organised extra lectures by neurosurgeons and prosthodontist by clinicians to excite the students into the clinical relevance of the biomaterials.
Course outcomes:
The appeal of this course goes beyond the divisions as the students attending this course are from both sciences as well as engineering backgrounds. It is also very popular among the senior undergraduate students.
Course outcomes:

Fundamental understanding of principles of operation of SEM, TEM and interpretation of images and diffraction patterns. This course will be a prerequisite for undergoing hands-on training on TEM at AFMM.
Course outcomes:
Students who have taken the previous course have immensely benefited from this course, there have been many other students, who, without any prerequisite knowledge of quantum mechanics, statistical mechanics etc. have grasped the underlying concepts and have successfully applied the learning from this course to their research work.
Course outcomes:

Knowledge of various thermodynamic quantities and their inter-relationships

Thermodynamic origins of phase diagrams, reaction equilibrium constant, equilibrium defects, curvature effects, etc.

Solution to the diffusion equation in simple systems; their implications

Understanding of diffusion mechanisms, and the origin of temperature dependence of diffusion coefficient
MT 256 January 3:00

Fracture

Department: Materials Engineering

Course outcomes:
Understanding of the factors that govern failure in systems ranging from structural metals to functional materials, knowledge of external factors that affect reliability and how to anticipate and quantify them, methods of measuring toughness quantitatively with 3 demonstrations in the laboratory that cover contact loading, adhesion and plane strain fracture toughness
Course outcomes:
Basics of polymers to physical chemistry of polymers, structure property relationship and processing techniques.
Course outcomes:
Fundamental understanding of organic electronics and appreciate importance of structure property relationship of molecules in devices like OPV, OLED, sensors and transistors.
Course outcomes:
Encourage a combination of simple hands-on experiments and software, both individually and in groups, to develop a broad sense of various properties of materials. Recognise need to, and develop procedures to, compromise when there are conflicting objectives in design. Include awareness of ecological and sustainability issues.
Course outcomes:

1. Acquaintance with crystallography of polycrystals
2. Knowledge of texture representation and analysis
3. Understanding of texture measurement procedures and modelling
4. Knowledge of textures developed in different types of materials
5. Application of existing knowledge to tailor texture in new materials
6. Familiarization of application of texture to industrial problems
7. Idea of grain boundary structure and its implication in engineering properties
Course outcomes:

Diffusion-controlled phase transformation and microstructural evolution in inhomogeneous material systems
MT209 Aug 3:00
Defects in materials

Department: Materials Engineering

Course outcomes:
Thermodynamics and kinetics of crystal defects, and their central role on properties of materials
Course outcomes:
It is an introductory course to mostly students who did not have much exposure to semiconductor physics before. So it starts with Classical Drude model, and ends with complex devices. At the end of this course students have a flavor of electronic properties, they start to understand that many physical properties of material are based on their electronic structure. They understand band structures and electronic transport mechanisms of a wide range of material and with the exposure to many functional devices, such as LEDs, photovoltaics, transistors, supercapacitors, magnetoelectrics their academic / research interest broadens into a wider subject space.
Microstructural Design and Development of Engineering Materials

Department: Materials Engineering

Course outcomes:
- An appreciation for the importance of microstructure on properties of structural materials.
- An overview of the various schemes available to control microstructure
- A survey of engineering materials and the role of microstructure.
Course outcomes:
Encouraging a healthy skeptical approach to examining existing theories, models and experiments. Develop skills in evaluating critically experimental data and different potential mechanisms. Utilize fundamental understanding to assess results on new materials.
Course outcomes:
Students will learn about fundamentals of crystallography, describe structures from symmetry viewpoint, formal description of point defects and its importance in influencing properties, interpretation of x-ray powder diffraction pattern to obtain structural and microstructural information, essentials about SEM and TEM.
Course outcomes:
Student would be able to understand the basic transport processes which are occurring in the daily life in their respective disciplines and would be able to explain the complex phenomena up to some extent.
Course outcomes:
This course will provide a sound knowledge of relevant tools that are necessary to build physical and mathematical models to describe the complex physical phenomena pertaining to real world and simulate their behaviour at laboratory and pilot scale. After completing this course one should be able to apply the knowledge gained in this subject to many other complex engineering systems/processes.
Course outcomes:
Learn the basic concepts in the use of materials for biomedical applications and the principles of biological response to materials
Course outcomes:
Students are expected to be able to write good sentences, draft abstracts, manuscripts, and thesis chapters after going through the course.
Course outcomes:
Basics of the following: quantum mechanics and relevance to solid state science and esp. to nanoscience; crystal structures and defects; electrical, thermal, and magnetic properties of solids; semiconductors and dielectrics
Course outcomes:
At the end of the course, the student should have hands-on experience and familiarity in using micro and nano fabrication process tools. The student should be able to independently develop process flow to fabricate a device and identify suitable unit process.
Advanced Micro and Nano fabrication technology and process

Department: Centre for Nano Science and Engineering

Course outcomes:
A thorough understanding of the various unit-processes in micro/nano fabrication. Focus is on fundamental understanding but practical details are also covered.
Course outcomes:
Students would learn fundamentals as well as advanced concepts in semiconductors and semiconductor devices.
Course outcomes:
Understanding of MEMS technology
Multiphysics modelling of MEMS devices
Design of MEMS devices and simulation of response
Understanding of issues in MEMS implementation
Course outcomes:
Students will learn to design various microfluidic devices required for tackling real life applications.
Course outcomes:

A student,

should have gained knowledge of properties of light in dielectric and free space.

should be able to understand optical wave propagation in dielectric medium.

should be able to design photonic devices to manipulate properties of light using waveguides.

should be able to interpret wave propagation dynamics in complex medium.

should be able to design optical functions such as, light coupling, wavelength filtering, power splitting, polarisation rotation, light generation and detection.

should be able to identify suitable material and fabrication process to realise photonic functionalities on-chip.
Course outcomes:

Strong working knowledge in applied nonlinear photonics

Ability to design practical systems based on nonlinear optics such as harmonic generators, parametric amplifiers, difference frequency generation, Raman and Brillouin effects, Modelocked Lasers
Course outcomes:

Extensive Practical Knowledge in Laser Systems

Ability to analyze laser phenomena and apply it to variety of situations

Ability to design and build different laser systems such as Fiber Lasers, Solid State Lasers, Optical communication amplifiers, pulsed lasers
Course outcomes:

After taking the course, a student should have a basic knowledge of brain function, understand the neural basis of sensory, motor, attention and space.
Course outcomes:
Students will get a fundamental understanding of nervous system structure, development, neurotransmitter systems, synaptic plasticity, learning and memory.
Course outcomes:

After taking this course, students should be in a position to critically read and evaluate papers in cognitive and systems neuroscience. They should also be able to write grants on these topics.
Course outcomes:
At the end of the course the students will have deeper understanding on a wide area of research in neuroscience. They will be taught to critically read a scientific paper, assess the technical soundness and the conclusions drawn from the experiments. This will enable them to formulate hypotheses based on scientific data and design experiments to test them.
Course outcomes:
After the completion of the course, the students would learn the application of retrosynthetic analysis in organic synthesis. The special emphasis on bio-active natural products synthesis gives them an idea of planning, design, understanding the mechanistic implications and execution of synthetic organic chemistry which is pivotal in organic chemistry. After the completion of the course the students would able to theoretically devises strategies for the synthesis of simple to complex organic molecules synthesis.
Course outcomes:
Students are expected to learn the basics of asymmetric synthesis and catalysis such as various types of catalysis, modes of asymmetric induction, stereochemical models etc. Contemporary literature is covered so that students completing this course would be in a position to take up research projects in this area of organic synthesis.
Course outcomes:
Students understand the basic principles of spectroscopy and able to solve structural problems, particularly Organic Molecules.
Course outcomes:
By going through the course, the student will gain an understanding of immense chemistry constituting carbohydrates. Chemistry of carbohydrates is not taught in most of academic environments in the country at large, even when carbohydrates are ever pervasive in all walks chemistry, materials development and biologically driven technological advancements. The course aims to provide a sound understanding of the fundamentals of the chemistry of carbohydrates, that will enable the student to carry forward.
Course outcomes:
The students are introduced to the concept of sustainability, the process of design based on boundary conditions, selection of materials for the given properties, reliability, failure analysis. At the end of the course they should be in a position to choose the right material for a given application.
Course outcomes:

- Basic guidelines to design good interface
- Idea of user modelling and interface personalization
- A usability evaluation tool to develop inclusive interfaces
- Conducting usability evaluation and reporting results
- Knowledge about novel interaction technologies
- Knowledge about HCI issues in developing countries and in automotive and aviation environments
- Basic know-how about writing international standards
- A HCI research paper co-authored by students as course project
Course outcomes:

- Using AI to develop intelligent interface and interaction

- Idea of user modelling and interface personalization

- Exposure to state-of-the-art eye gaze, hand, head and finger movement and EEG trackers

- Developing new input modalities tracking eye gaze, hand, finger, head movement of users

- Hands on training on Expert System and Machine Learning toolbox

- Conducting usability evaluation and reporting results
Course outcomes:

These course will help the students to learn about the basics of solid state physics.
Course outcomes:
The student would learn Lagrangian and Hamiltonian formalisms which are essential to understand modern developments in physics, like quantum mechanics, field theory, condensed matter physics, particle physics, etc.
Course outcomes:
Students learn how to evaluate macroscopic thermal properties of matter (specific heat, magnetic susceptibility, etc) from microscopic dynamics. The course begins with first using classical dynamics and then using quantum dynamics as the microscopic principles.

The notion of an ensemble is introduced to the students for the first time.
PH204 January 3:00
Quantum Mechanics II

Department: Physics

Course outcomes:
Students are fully trained to take up research work in the fields of condensed matter physics and astrophysics
PH204 Jan 3:00
Quantum Mechanics II

Department: course offered by CHEP and Physics

Course outcomes:
various approximation methods used in QM, scattering theory as well as a brief introduction to relativistic quantum mechanics
Course outcomes:
Students receive an all round introduction to this fundamental course and can build on the deliverables from this course to attack problems in condensed matter physics, elementary particle physics and astrophysics theory, and also apply this if they become experimentalists
Course outcomes:

UG+Integrated Ph.D.
Course outcomes:
skills in experimental methods
Advanced experiments in condensed matter physics

Department: Physics

Course outcomes:

hands on training on diverse experimental tools and data analysis that an experimental condensed matter physicist requires.
Course outcomes:
Students are fully furnished with knowledge of Nuclear and Particle physics, at the level of CSIR and UGC

Net exam pre-requisites
Course outcomes:
The student will learn the basics techniques to deal with interacting quantum systems, e.g. mean field theory, second quantized operators. Also transport and linear response theories that connect between theory and experimental observations are taught. It introduces theoretical framework such as BCS theory of superconductivity.
Course outcomes:
Writing basic MD and MC code. Understand advanced sampling, Able to get started with the research in this area
PH325 August 3:00
Advanced Statistical Physics

Department: Physics

Course outcomes:
Students would get a good grasp of modern statistical mechanics of interacting, classical and quantum systems and learn the techniques mentioned in the syllabus. A good grasp of this subject is essential to understand recent developments in large parts of condensed-matter science.
Course outcomes:
Ideally: the ability to formulate, from general principles, the dynamical equations describing the large-scale, long-time behaviour of fluctuations in a wide range of ordered and disordered many-particle systems including fluids, liquid crystals, crystalline solids, and magnets, at thermal equilibrium and possibly with extensions to a variety of out-of-equilibrium situations.
PH350 Jan 3:00
Physics of Soft Condensed Matter

Department: Physics

**Course outcomes:**

The course gives the basic principles and application of soft matter physics towards understanding properties and phenomena occurring in materials like polymers, colloids, surfactants etc. General principles of understanding structure, dynamics as well as flow and mechanical properties of these materials would also be covered.
Course outcomes:
The student will learn about the crystal growth mechanisms and techniques. Various thin films deposition techniques and thin film characterisation techniques are also covered in the course.
Course outcomes:

After the course, a student must be able to:

1. Understand the difference between metals, semiconductors and insulators
2. Calculate the band structure using a simple tight-binding model
3. Estimate the number of carriers at a given temperature for a semiconductor
4. Understand the importance of doping to change carrier density
5. Understand the importance of different scattering mechanisms that limit mobility
6. Understand the difference between direct and indirect semiconductors
7. Relate the optical absorption to the band structure
8. Calculate non-equilibrium densities for different carrier lifetimes
9. Understand the band diagram and depletion layer in PN junctions
10. Understand the fundamental operation of a bipolar transistor
Course outcomes:
Learn basic programming and applying it to physics problems.
Course outcomes:
The students would be exposed to the basic physics of topological phases of mater and their implications in transport properties of condensed matter systems. They are also expected to gain an understanding of the current level of research, both experimental and theoretical, in topological systems.
Course outcomes:
End product is students who are ready to carry out research in particle physics and field theory
Course outcomes:
Basic mechanisms underlying ageing in animals and interventions to slow aging and improve health span.
Course outcomes:
At the end of the course, the students will acquire an understanding of the integration between different cells, tissues and organs that results in physiological homeostasis and how it is lost in disease. On a practical level, the course will help students get acquainted with studying results like stained tissue sections, X-rays etc.
Course outcomes:
How quantum mechanics determines molecular shape; how molecular properties are computed.
Course outcomes:

After taking this course the students would learn

1. Basics concepts of p-n junction, Light management in Solar Cells, Shockley–Queisser limit or detailed balance limit

2. Electron Transfer Theory, Emerging light harvesting materials,

Course outcomes:
This course in particular exposes the students towards addressing the energy conversion process for biomass for various outputs. The background acquired in this course will be a starting point for further research in the energy technologies or even bio-fuel programs.
ST 204 Aug 1:01

Sustainable Energy and Environment lab

Department: Centre for Sustainable Technologies

**Course outcomes:**
Through this course, students entering CST will get an exposure to various areas of research conducted at the centre which is interdisciplinary by nature.

The range of areas and the experimental methodology provides the student an opportunity to have hands on experience in conducting experiments and analyse the data. They would also experiencing how to represent the data.
Course outcomes:

Major take away from this course is in arriving at empirical relationships towards arriving at power and efficiency of a standard diesel/gasoline engine on alternate gaseous and liquid fuels.
ST-202: August 3:00
Energy Systems and Sustainability

Department: Centre for Sustainable Technologies

Course outcomes:
The course provides an insight into various energy conversion technologies with emphasis on addressing the overall mass and energy balance. Efficiency of the conversion processes and comparison with various technologies.

Using low carbon energy, creating scenarios using techno-economic studies which could intervene into the policy decisions.
Course outcomes:
- Origin of blade shape of different turbomachines operating with incompressible and compressible flows.
- Design under conditions of variability in input fluid and output load
- Specialized design of water pumps
- Renewable energy dynamics in both tur
Course outcomes:
At the end of the course, the student is expected to learn

1) Dimensional analysis leading to functionalities; uncertainty analysis and curve fitting

2) Simplified understanding of complex probability theories

3) Design of experiments, replication, randomization and blocking

4) Anova and screening experiments

5) First hand learning in applying the tools and skills learnt in the classroom onto experimental test rigs in planning, design collection and analysis of data.
Course outcomes:
Learn about mammalian Physiology
Course outcomes:

Students are expected to learn concept of homeostasis with some examples. Students will be exposed to the vast area of endocrinology and its importance in body homeostasis.

Plant biology- synthesis of various of plant compounds and their importance in the treatment of diseases
Course outcomes:
The course is expected to present a broader picture of living systems by integrating the reductionistic concepts of molecular biology with holistic concepts such as evolution. As the discussions are interactive, students are encouraged to develop a critical approach and enhance their analytical abilities.
Course outcomes:
Students will learn key techniques in Microbiology. In the Ecology module, students will learn how to frame questions and hypotheses, as well as how to design experiments. There will be one weekend field trip to a National Park, where students conduct an independent research project. Students also independently create one nature documentary.
Course outcomes:

Thermodynamics and its applications to prediction of reaction outcomes, spontaneity etc.
Course outcomes:
As the title reflects, this is a basic organic chemistry course and compulsory for the Chemistry major UG students. Students successfully completing this course are expected to learn through this course the basic concepts of organic chemistry such as electronic structure and reaction mechanism.

All major reactions of alkenes, alkynes and carbonyls are taught through this course. In addition, preliminary aspects of pericyclic reactions and organometallics are also covered.
Course outcomes:
The course is the first organic chemistry course in the undergraduate program of the institute in which the students learn about the usefulness of organic chemistry in diverse areas and everyday life ranging from natural products, drugs and pharmaceuticals, dyes and pigments, detergents, food and beverages, essential oils and fragrance, polymers to electronic materials and also in knowing the molecules of all living systems and understanding the basic biological processes at molecular level.

They are taught why chirality and stereochemistry are important in understanding the basic biological processes, drug-receptor interactions etc. This is intended to help the students to understand the three dimensionality of organic and biomolecules and their significance. Lectures on conformations of cyclic and acyclic systems apprise them about the conformations of peptides/proteins, biomolecules like DNA and RNA.
Course outcomes:
The students get an idea of the different analytical tools required for carrying out research in Chemistry and Materials.
Course outcomes:
Students get a basic understanding of analog electronics, digital electronics and microcontrollers. They carry out experiments using diodes, transistors, operational amplifiers, combinational and sequential circuits, and state machines.

In microcontrollers, they write programs to light up an LED, read a temperature sensor and develop programs for a PID controller.
Course outcomes:
Teaches the student about the geochemical and anthropogenic causes that cause water pollution, permissible limits of common pollutants in drinking water and provides hands on experimental practice to determine the pollutant concentrations in water samples
Course outcomes:

• Acquire general knowledge and understanding of the principles upon which environmental engineering is based, including general engineering, mathematical and scientific computations as well the physical, chemical, and biological science.

• Appreciate the need for multidisciplinary approaches to engineering solutions to environmental problems, and the cross-media (air, water, earth) nature of environmental problems.

• Gain basic knowledge and skills to identify solutions to environmental engineering and understand current issues and the context in which environmental engineering is practiced.

• Appreciate and value the environmental engineering and professional ethics.
Course outcomes:
Students learn standard methods to characterize hazardous chemical wastes, how inorganic pollutants react with soils, how pollutants are transported through soils and how to minimize release of pollutants from solid waste.
Course outcomes:
Students learn the basic thermodynamic processes of the atmosphere like formation mechanism of fog and clouds. The static stability of the atmosphere is taught to understand the state of the climate. Radiative transfers in the atmosphere gives fundamentals of energy balance at the top of the atmosphere, and at the surface of the earth, and thus provides a conceptual background for understanding the climate variations of the earth including global warming. The general circulation basics provide the mean circulation pattern and energy exchange between north and south through atmospheric winds and ocean currents. These are relevant to understanding climate change scenario with differential heating across latitudes. Finally, the carbon cycle concepts are introduced to enable students understand the carbon budget of the earth.
Course outcomes:
Students will appreciate polymer processing techniques used for various articles.
Course outcomes:

Introduction to analysis
Course outcomes:

Basic notion of probability and statistical methods.
Course outcomes:

Basic understanding of structure, microstructure and property correlation in materials
Course outcomes:
An understanding of loads and stresses experienced by structures, how they fail, and how to select materials based on their behavior for different structural applications.
Introduction to Materials Manufacturing

Department: UG-Materials

Course outcomes:
They will learn different types of manufacturing processes for metals and polymers, including practical experience of lab scale manufacturing of different materials.
Course outcomes:
The students receive an exposure to a large range of functional properties, starting from precise resistance measurement to Seebeck coefficient determination, determination of piezoelectric constant, hall-effect measurements, Curie temperature determination of a ferromagnet, figure of merit of a solar cell, exposure to UV-visible spectroscopy for band gap determination and exposure to electrochemistry in terms of capacity and Coulombic efficiency of supercapacitor and Li-ion batteries.
Course outcomes:
Basic concepts in mechanics and their applications in solving problems and explaining observable phenomena as seen in laboratory experiments.
Course outcomes:
The students are expected to understand propagation of light or electromagnetic waves under different limiting regimes.