B.Tech Programme for JEE qualified Aspirants in the area of Engineering Mechanics

Degree to be Awarded

B. Tech in Engineering and Computational Mechanics

Programme Code: AM 1

Department of Applied Mechanics
Indian Institute of Technology Delhi
New Delhi - 110016

Introduction

As one of the premier teaching, research and consulting organizations, Indian Institute of Technology Delhi needs little introduction. It has established itself as a world-class teaching and research institute. The institute also carries out expansion work on a large scale in the form of consulting, training programmes, and sponsored research for the industry. The alumni of the institute hold top technical and management positions in reputed Indian and multinational companies. This has come about because IIT Delhi provides an ideal setting conductive to learning engineering and technology.

About The Department

The Department of Applied Mechanics at IIT Delhi is an engineering department involved in teaching, research and industrial consultancy in the basic/fundamental areas of Engineering Mechanics and Product Design. The main focus is to disseminate the fundamental principles of Solid and Fluid Mechanics and implement these fundamental concepts to tackle real-life problems by using analytical, computational and experimental methods. The department follows these principles and methods in teaching and in research areas such as constitutive modelling, impact mechanics, nonlinear mechanics, nano-mechanics, bio-mechanics, off-shore structures, internal and external flows including laminar and turbulent flows, industrial aerodynamics, compressible aerodynamics. Over the last five decades, specialized laboratories have been developed to a high degree of sophistication especially in the broad areas of Solid Mechanics, Fluid Mechanics and Computation. Solid Mechanics Laboratories include state of the art facilities such as DIC system with high speed/high resolution Cameras, Gas Gun, Split Hopkinson Pressure Bar, Structural Health Monitoring System, CT Scanner, Atomic Force Microscope, Biaxial Testing Machine, Universal Testing Machines up to 100 Tons capacity, Material Testing System (2.5 and 25 Tons). Fluid Mechanics Laboratories are equipped with the latest flow diagnostic tools (PIV, LDV, PTV) besides various wind tunnels of different test sections. The largest wind tunnel has a test section of 1.5 m x 1.5 m x 9.75 m and is closed circuit tunnel. An environmental wind tunnel of 1.83 m x 1.83 m x 9.14 m with provision to simulate the atmospheric boundary layer is also available. Besides these facilities, a pilot plant exists for solid liquid flow and large water facility for doing research in instrumentation. Three computational laboratories having a reasonable number of networked workstations and an extensive array of software for engineering analysis and design have been set up for the students and faculty to facilitate the sharing of resources. A well-equipped workshop is used to fabricate specimens, products and experimental set-ups for research projects and graduate/undergraduate experiments. The department runs two post-graduate programmes namely M.

Tech. (Engineering Analysis and Design) and D.I.I.T. (Naval Construction). The M. Tech. course covers the wide spectrum of courses in Solid Mechanics, Fluid Mechanics and Product Design where as in the DIIT course which is offered to freshly recruited Naval Officers, covers broad areas of Engineering Mechanics and Warship Design. This course is jointly run by Applied Mechanics faculty and Naval officers as adjunct faculty. The PhD programme of the department offers research opportunities in the above areas.

The department offers several B. Tech. level courses in the areas of Engineering Mechanics, Computational Mechanics and Experimental Methods to undergraduate students of different engineering disciplines. In some of these courses, students are exposed to a vast variety of basic and advanced experiments. It has been consistently observed that a good fraction of these students get motivated to further pursue PG level Engineering Mechanics courses. These students ultimately end up doing B. Tech. Project with the faculty members of Applied Mechanics Department or Minor degree in Computational Mechanics.

The Proposed Programme

The Department of Applied Mechanics was set up in IIT Delhi in the early sixties to teach the fundamental courses in Engineering Mechanics across the Departments and to carry out research in the same area. Over the last few decades, vast knowledge hasaccumulated in the field of Engineering Mechanics and its application in engineering system design has created new areas of research. Further, in the last two decades, there has been a major shift towards interdisciplinary research which has given rise to several new avenues related to Engineering Mechanics (Biomechanics, Nano Mechanics, Multi-scale modellingetc). Hence, there is a strong need for an undergraduate program which can cater to these emerging areas.

Over the years most of the undergraduate engineering programmes have become broad-based and have not been able to address the emerging interdisplinary areas. This is a lacuna we wish to address in this programme. The emphasis will be on providing a strong grounding in the fundamentals of engineering mechanics along with the tools to address the needs of emerging areas such as biomechanics, nanomechanics, constitutive modeling at multiple length and time scales, parallel processing, machine learning, artificial intelligence in mechanics etc. The primary goal will be to cultivate in the young minds the art and science of Engineering Mechanics to analyze complex interdisciplinary phenomena relevant to problems in industry and cutting edge research through experimentation, analysis and computation. A strong grounding in engineering fundamentals will enable students to appreciate emerging trends and equip them with the tools to spearhead new areas of research.

A major focus of the program would be on exposing students to recent trends in computational techniques such as the use of parallel processing, machine learning, artificial intelligence, multi-scale modelling computational approach etc. A preliminary interaction with industry has given high employability prospect of such students after graduation. It is also hoped that such students would be more motivated to take up higher education and ultimately serve to improve the PG teaching and research in the country. Given the expertise of the current faculty the department of Applied Mechanics is well equipped to offer the undergraduate programme effectively. The department faculty teach several B.Tech level courses to undergraduate students of Mechanical, Civil and Textile engineering at IIT Delhi. It has been consistently observed that a good fraction of these students get highly motivated to pursue PG level mechanics courses. It appears that the students are able to relate the mechanics teaching at IIT with their mechanics education in school. They ultimately end up doing B.Tech project or Minor degree in Computational Mechanics or switch over to our Masters program. It is with this response that the department also feels starting of a B.Tech programme would be a successful endeavor and could potentially help in improved quality of intake students at both Masters and PhD level and further lead to better recognition of our teaching and research programme internationally.

Unique Features of the Programme

i) Focus on basic as well as the emerging areas of mechanics such as bio-mechanics, nano-mechanics, multi-scale and multi-physics modelling.
ii) Exposing students to recent trends in computational techniques (FEM, CFD, parallel processing), high performance computing, machine learning, Artificial Intelligence (AI) etc.
iii) Exposing students to fundamental and latest techniques in experiments and its importance for model validation.

Objective of the Programme

Cultivate young minds to analyse complex interdisciplinary phenomena and venture into cutting edge research through experimentation, analysis and computation.

Annual Intake

40 students through JEE Advanced

Degree on Offer

B. Tech in Engineering and computational Mechanics at Department of Applied Mechanics.

Programme Requirements

The student will be required to register for 154 credits (graded) and 11 non graded credits during the 4 years of the programme. (One semester course has 1 credit associated with it for each hour of lecture, each hour of tutorial or every two hours of practical work per week).

Under the non-graded units, 3 units are set out for design/ practical experience, these units by students of this programme will be earned by doing internship after 2nd year and 3rd year during summer vacation. Internship after 3rd year will be mandatory. Students doing internship after 2nd and 3rd year will earn 3 units if he spends 50 days each summer

Following is the classified list of core (or compulsory) and elective courses of the programme. The lecture, tutorial and practical (L-T-P) hours per week and the credits corresponding to each course are also given.

Core Courses

Course Category	**Credits**	**Status**
Institute Core Courses		
Basic Science (BS)	22	-
Engineering arts and Science (EAS)	18	-
Humanities and Social Science (EAS)	15	-
Programme linked Courses	12.5	-
Departmental Courses		
Departmental Core	64.5	-
Departmental Elective	12	-
Open Category Courses	10	-
Total Graded Credit Requirements	154	-
Non Graded Units	11	-

Institute Core (B.S)		**(22 Credits)**		
CML 100	Introduction to Chemistry	3-0-0	3	Existing
CMP100	Chemistry Laboratory	0-0-4	2	Existing
MTL 100	Calculus	3-1-0	4	Existing
MTL 101	Linear Algebra and Differential Equations	3-1-0	4	Existing
PYL 100	Electromagnetic Waves and Quantum Mechanics	3-0-0	3	Existing
PYP 100	Physics Laboratory	0-0-4	2	Existing
SBL 100	Introductory Biology for Engineers	3-0-2	4	Existing

Institute Core (EAS) **(18 Credits)**

APL 100	Engineering Mechanics	3-1-0	4	Existing
COL 100	Introduction to Computer Science	3-0-2	4	Existing
CVL 100	Environmental Science	2-0-0	2	Existing
ELL 100	Introduction to Electrical Engineering	3-0-2	4	Existing
MCP100	Introduction to Engineering Visualization	0-0-4	2	Existing
MCP101	Product Realization through Manufacturing	0-0-4	2	Existing

Program Linked Basic/Engineering Arts/Science Core **(12.5 Credits)**

MTL 107	Numerical Methods and Computations	3-0-0	3	Existing
COL206	Data Structures and Algorithms	3-0-4	5	Existing
ELL 201	Digital Electronics	3-0-3	4.5	Existing

Humanities and social Science (HUSS) **(15 Credits)**

Courses from Humanities, Social Science and Management offered under this Category

Departmental Core (Common to all Streams) **(64.5 Credits)**

APL101	Applied Mathematics for Engineers	3-0-0	3	New
APL 102	Introduction to Material Science and Engineering	3-0-2	4	Existing
APL 103	Experimental Methods	2-0-2	3	Existing
APL 104	Solid Mechanics	3-1-0	4	Existing
APL 106	Fluid Mechanics	3-1-0	4	Existing
APL 203	Dynamics of Mechanical Systems	3-1-0	4	New
APL 205	Basics of Computer Aided Design	2-0-0	2	New
APL 206	Engineering Thermodynamics	2-0-0	2	New
APL207	Heat Transfer	2-0-0	2	New
AMP 262	Solid & Fluids Lab	0-0-4	2	Existing
APL 302	Basics of Product Design	3-0-2	4	New
APL 311	Introduction to Finite Element Method	3-0-2	4	New
APL 321	Introduction to Computational Fluid Dynamics	3-0-2	4	New
APL 331	Advanced Mechanics of Solids	3-0-0	3	New
APL 361	Advanced Fluid Dynamics	3-0-0	3	New
APL 380	Bio-mechanics	3-0-0	3	Existing
APL 390	Experimental Techniques in Fluids and Solids	2-0-3	3.5	New
APL 405	Machine Learning in Mechanics	2-0-2	3	New
APL 410	Multi-Scale Modeling and Computation	3-0-0	3	New
APD411	B.Tech Project I	0-0-8	4	Existing

Department Elective **(12 Credits)**

APL 306	Vibration	3-0-0	3	New
APL 340	Chaos	3-1-0	4	Existing
APL 402	Fluid Solid Interaction	3-0-0	3	New
APL 411	Application of Finite Element Methods	2-0-2	3	New
APD 412	B.Tech Project II	0-0-12	6	-
APL 412	Computational Multi Body Dynamics	3-0-0	3	New
APL 415	Composite Mechanics and Structures	3-0-0	3	New
APL 421	Application of CFD	2-0-2	3	New
APL 422	Advanced CFD	2-0-2	3	New
APL 424	Introduction to Hydrodynamics Stability	3-0-0	3	New
APL 431	Aircraft Structures	3-0-0	3	New
APL 432	Aero-Elasticity	3-0-0	3	New
APL 433	Introduction to Plates and Shells	3-0-0	3	New
APL 434	Smart Material and Structures	3-0-0	3	New
APL 435	Impact Mechanics and Crash Worthiness	3-0-0	3	New
APL 440	Parallel Processing in Computational Mechanics	3-0-2	4	Existing
APL 450	Introduction to Soft Robotics	3-0-0	3	New
APL 452	Introduction to Digital Twins	2-0-2	3	New
APL 491	Reliability Engineering	3-0-0	3	New
APL 701	Continuum Mechanics	3-0-0	3	Existing
APL 713	Turbulence and its Modeling	3-0-0	3	Existing
APL 715	Physics of Turbulent Flow	3-0-0	3	Existing
APL 736	Multiscale Modeling of Crystalline Materials	3-0-2	4	Existing
APL 740	Mechanics of Biological Cells	3-0-2	3	Existing
APL 742	Advanced Bio-Mechanics	3-0-0	3	Existing
APL 764	Biomaterials	3-0-0	3	Existing
APL 765	Fracture Mechanics	3-0-0	3	Existing
APL 771	Design Optimization and Design Theory	3-0-0	3	Existing
ELL 715	Digital Image processing	3-0-0	3	Existing
ELL794	Human Computer Interface	3-0-0	3	Existing
APL 805	Advanced Finite Element methods	3-0-0	3	Existing

Suggested Courses under Open Elective Courses

COL 216	Computer Architecture	3-0-2
COL 334	Computer Networks	3-0-2
COL 341	Fundamentals of Machine Learning	3-0-2
COL 333	Principles of Artificial Intelligence	3-0-2
COL 362	Introduction to Database Management System	3-0-2
MTL 180	Discrete Mathematical Structures	3-1-0
MTL 290	Computing Laboratory	0-0-4
MTL 342	Analysis and Design of Algorithms	3-1-0
MTL 458	Operating Systems	3-0-2
MTL 415	Parallel Algorithms	3-0-0

Suggested Courses under HUSS

HUL211	Introduction to Economics	3-1-0
HUL212	Micro Economics	3-1-0
HUL213	Macro Economics	3-1-0
HUL261	Introduction to Psychology	3-1-0
MSL301	Organization and People Management	3-0-0
MSL302	Managerial Accounts and Financial Management	3-0-0
MSL708	Financial Management	3-0-0
MSL704	Science & Technology Policy Systems	3-0-0

Course content of Courses in the B. Tech. Programme:

CML 100 Introduction to Chemistry
3 Credits (3-0-0)
Entropy and free energy changes in chemical processes, chemical equilibria, phase transformations, structure and dynamics of microscopic systems, physics basis of atomic and molecular structure, three-dimensional arrangement of atoms in molecules, structure and reactivity of organic, inorganic and organometallic compounds, basic strategies for synthesis of carbon and silicon containing compounds, coordination chemistry, role of inorganic in living systems.

CMP100 Chemistry Laboratory
2 Credits (0-0-4)
Experiments involve the following: Titrations, Surface Tension and Viscosity, Potentiometry, Conductometry, Preparation of metal complexes and important organic compounds, Kinetics, Chromatography, Qualitative and quantitative estimation of organic compounds.

MTL100 Calculus
4 Credits (3-1-0)
Review of limit, continuity and differentiability, uniform continuity. Mean value theorems and applications, Taylor's theorem, maxima and minima. Sequences and series, limsup, liminf, convergence of sequences and series of real numbers, absolute and conditional convergence. Riemann integral, fundamental theorem of integral calculus, applications of definite integrals, improper integrals, beta and gamma functions. Functions of several variables, limit and continuity, partial derivatives and differentiability, gradient, directional derivatives, chain rule, Taylor's theorem, maxima and minima and the method of Lagrange multipliers. Double and triple integration, Jacobian and change of variable formula. Parameterization of curves and surfaces, vector fields, divergence and curl. Line integrals, Green's theorem, surface integral Gauss and Stokes' theorems with applications.

MTL101 Linear Algebra and Differential Equations
4 Credits (3-1-0)
Vector spaces over Q, R and C, subspaces, linear independence, linear span of a set of vectors, basis and dimension of a vector space, sum and direct sum. Systems of linear (homogeneous and non-homogeneous) equations, matrices and Gauss elimination, elementary row operations, row space, column space, null space and rank of a matrix. Linear transformation, rank-nullity theorem and its applications, matrix representation of a linear transformation, change of basis and similarity. Eigenvalues and eigenvectors, characteristic and minimal polynomials, Cayley-Hamilton theorem

(without proof) and applications. Review of first order differential equations, Picard's theorem, linear dependence and Wronskian. Dimensionally of space of solutions, linear ODE with constant coefficients of second and higher order, Cauchy-Euler equations, Method of undetermined coefficients and method of variation of parameters. Boundary Value Problems: Sturm-Liouville eigenvalue problems. System of linear differential equations with constant, coefficients, fundamental matrix, matrix methods, Power Series and its convergence, power series method, Fourier series, Laplace Transform Method.

PYL100 Electromagnetic Waves and Quantum Mechanics
3 Credits (3-0-0)
Electric and magnetic field in a medium, Susceptibility and conductivity, Maxwell's equations, Boundary conditions; EM wave equation, Plane wave solutions, Polarization of the EM waves, Poynting vector and intensity of the EM wave; Wave packet, Phase and Group velocities; Reflection and refraction of EM waves at a dielectric interface; Brewster angle; Total internal reflection at a dielectric interface; EM waves in a conducting medium and plasma. Wave – particle duality, de-Broglie waves; Quantum mechanical operators; Schrödinger equation, Wave function, Statistical interpretation, Superposition Principle, Continuity equation for probability density; Stationary states, Bound states, Free-particle solution, 1-D infinite potential well, Expectation values and uncertainty relations; 1-D finite potential well, Quantum mechanical tunnelling and alpha- decay, Kroning-Penney model and emergence of bands.

PYP100 Physics Laboratory
2 Credits (0-0-4)
Experiments based on Design and Study of Power sources, Changing and discharging of a capacitor, Electromagnetic Induction, Phase Measurement. Experiments on geometrical and wave optics including interference, diffraction, dispersion and polarization. Experiments based on mechanics, heat, sound, fluids, resonance, like linear air track, coupled pendulum and oscillators, thermal conductivity, elasticity. Experiments in the area of modern physics, like Planck's constant, laser, semiconductor band gap, wave motion, mechanical transmission lines.

SBL100 Introductory Biology for Engineers
4 Credits (3-0-2)
Darwinian evaluation & molecular perspective; Introduction to phylogeny – Classification systems in biology and relationships; Cellular assemblies – From single cell to multi-cellular organisms: Geometry, Structure ad Energetics; Comparing natural vs. Human made machines; Infection, disease and evolution – synergy and antagonism; Immunology – An example of permutations and combinations in biology; Cancer biology- Control and regulation; Stem Cell- Degeneracy in biological systems; Engineering designs inspired by biology – Micro to Macro – scales. Laboratory: Biosafety; Buffers in biology – Measuring microlitres, Preparation of standard biological buffers, response of cells and plant tissues in different buffering conditions; Observing cell surface and intracellular contents using light and fluorescence microscopy, measuring cellular motions using real-time video microscopy; Measuring and visualizing intracellular molecular components – Proteins and Genomic DNA.

Institute Core 8 APL100 Engineering Mechanics
4 Credits (3-1-0)
Kinematics, Statics, Equations of Motion, Rigid body dynamics, Introduction to variational mechanics.

COL100 Introduction to Computer Science
4 Credits (3-0-2)
Organization of Computing Systems. Concept of an algorithm; termination and correctness. Algorithms to programs: specification, top-down development and stepwise refinement. Problem solving suing a functional style; Correctness issues in programming; Efficiency issues in programming; Time and space measures. Procedures, functions. Data types, representational invariants. Encapsulation, abstractions, interaction and modularity. Identifying and exploiting inherent concurrency. Structures style of imperative programming. Introduction to numerical methods. At least one example of large program development.

CVL100 Environmental Science
2 Credits (2-0-0)
Pollutant sources and control in air and water, solid waste management, noise pollution and control, cleaner production and life cycle analysis, reuse, recovery, source reduction and raw material substitution, basics of environmental impact assessment, environmental risk assessment and environmental audit, emerging technologies for sustainable environmental management, identification and evaluation of emerging environmental issues with air, water, wastewater and solid wastes.

ELL100 Introduction to Electrical Engineering
4 Credits (3-0-2)
Elements in an Electrical circuit: R, L, C, Diode, Voltage and current sources (independent and dependent/controlled sources with examples). DC circuits, KCL, KVL, Network theorems, Mesh and nodal analysis. Step response in RL, RC, RL, C circuits. Phasor analysis of AC circuits. Single phase and 3-phase circuits. Two port network, BJT: CE and small signal model, Operational amplifiers: Model and applications Introduction to Digital circuits. Magnetic circuits, Transformers: Modelling and analysis; parameter determination. Energy in magnetic field. Electromechanical energy conversion principles with examples. Principles of measurement of voltage, current and power. Laboratory component and the List of experiments. CRO (mechanism and usage). KCL, KVL, Network theorem verification. Step/transient response of RL, RC, RLC, circuits. Steady state response of Circuits of sinusoidal excitation. Diode experiment (clipping, clamping and rectification,). Basic circuits using opamp. Transformers OC and SC tests. BH loop in an iron core, SC and AC motor – for observation only. A small mini-project.

MCP100 Introduction to Engineering Visualization
2 Credits (0-0-4)
Sketching of engineering objects and interpretation of drawings as a visualization and communication tool. Creating 3D components through the use of a CAD package. Simple assemblies, generation of assembly views from part drawings, animation of simple assemblies.

MCP 101 Product Realization through Manufacturing
2 Credits (0-0-4)
Exposing role of manufacturing processes in product realization; Understanding product realization by endeavoring hands on activities; Experience of product realization by undertaking manufacturing exercises and assembly activity in teams.

MTL107 Numerical Methods and Computations
3 Credits (3-0-0)
Overlap with: MTL509, CLL113, CVL763
Errors in computation: source and types of errors, error propagation. Computer representation of numbers: floating point representation, rounding error and floating point arithmetic. Roots of nonlinear equation in one variable: Direct and iterative methods, order of convergence. Iterative methods for roots of nonlinear system of equations. Linear systems of equations: Direct and iterative methods, rate of convergence of iterative methods, Condition number and ill-conditioned systems. Interpolation: Lagrange, Newton divided difference formula, Newton's interpolations, and errors in interpolation. Approximation: least square and uniform approximations. Differentiation: differentiation using interpolation formulas. Integration using interpolation: Newton-Cotes formulas, Gauss quadrature rules. Ordinary differential equations: Taylor, Euler and Runge-Kutta methods. Implementation of these methods.

COL106 Data Structures & Algorithms
5 Credits (3-0-4)
Pre-requisites:COL100
Introduction to object-oriented programming through stacks queues and linked lists. Dictionaries; skip-lists, hashing, analysis of collision resolution techniques. Trees, traversals, binary search tress, optimal and average BSTs. Balanced BST: AVL Trees, 2-4 trees, red-black trees, B-trees. Tries and Suffix trees. Priority queues and binary heaps. Sorting: merge, quick, radix, selection and heap sort, Graphs: Breadth first search and connected components. Depth first search in directed and undirected graphs. Disjkra's algorithm, directed acyclic graphs and topological sort. Some geometric data-structures.

ELL201 Digital Electronics
4.5 Credits (3-0-3)
Pre-requisites: EEL 100
Gates, binary number systems, arithmetic operations, Minimization using K-maps, reduced K-maps, tabular methods; design using multiplexers, decoders, and ROMs. Latches, flip-flops, registers and counters. Asynchronous, synchronous counters. Finite state machines, implementations thereof. Mealy, Moore machines. Clock period computation. Memories, Partitioning and pipelining. VHDL/Verilog, the register-transfer-level description style. Switch level interlocution to logic families, CMOS logic, static, pre-charge and clocked logic. Asynchronous circuits and design styles.

Departmental Core

APL101 Applied Mathematics in Engineering Applications
3 Credits (3-0-0)
Ordinary Differential Equation: Second order ODEs, Method of Undetermined Coefficients, Variation of Parameters, Strum-Liouville eigenvalue problem, Difference equation.Partial Differential Equation: Classification of PDEs, Heat, Wave and Laplace Equations, Separation of variables to solve PDEs.Fourier Transform: Fourier sine transform, Fourier cosine Transform, Technique for solving ODEs and PDEs. Probability Theory: Axioms of probability, Conditional probability, Random variable,

Uncertainty in engineering system, Discrete and Continuous distributions, Distribution function, Joint probability distribution, Moments, Covariance, Correlation coefficient. Stochastic Processes: Definition of Stochastic process, Stochastic FE model, Stationary process, Markov chain, Poisson process.

APL102 Introduction to Materials Science and Engineering
4 Credits (3-0-2)

Structure of Solids: atomic and inter-atomic bonding, crystal structure and imperfection in solids. Properties of Materials: Mechanical, chemical, electrical and magnetic properties of metals, ceramics and polymers. Processing of Materials: Thermodynamics basics, Phase diagrams and phase transformation of metallic systems, fabrication and processing of metals, polymers and ceramics. Performance of materials: Creep, fatigue, failure and corrosion of metals, ceramics (including cement and concrete), polymers, and composites (including fiber reinforced structure, sandwich panels, and wood). Selection of Material: selection of materials for various applications, materials selection charges, CSE software, Example case studies such as materials for large astronomical telescopes, springs, flywheels, safe pressure vessels and reactors. Laboratory: The behavior of different type of materials (e.g. metals, ceramics, composites, polymers) will be studied through carefully designed experiments. The fundamentals of structure and properties of various materials will be communicated through hands on experiments and model demonstration.

APL103Experimental Methods
3Credits (2-0-2)

Experimental Analysis: Types of measurements and errors, Relative frequency distribution, Histogram, True value, Precision of measurement, Method of least squares, the curve fitting, General linear regression, Theory of errors, Binomial and Gaussian distribution, Chi-square test.
Experimental Methods: Principles of Measurement, Basic Elements of a Measuring Device.
Displacement measurement,ForceandTorque Measurement, Temperature Measurement, Pressure Measurement, Fluid Velocity Measurement, Miscellaneous measurements, Dynamics of Measurements: Dynamic Response of a Measuring Instrument, Response to Transient and Periodic Signals, First and second order systems as well as their Dynamic Response Characteristics.
Laboratory:The experiments have been designed to understand Experimental Analysis physically, Laboratory will enable the students to apply various statistical methodologies (viz. Mean, Median, Mode, Std Dev. etc) to get the optimum output from the day to day Engineering life experiment.

APL104SolidMechanics
4Credits (3-1-0)
Pre-requisites: APL100
Overlapswith: APL105, APL108

Introduction, Stateofstressatapoint, equationsofmotion, principal stress, maximumshearstress. Concept ofstrain, straindisplacement relations, compatibility conditions, principal strains, transformationof stress/strain tensor, stateofplanestress/strain. Constitutive relations, uniaxial tensiontest, idealizedstress-strain diagrams, isotropic linear elastic, viscoelastic and elasto-plastic materials. Energy Methods. Uniaxial stress and strain analysis of bars, thermal stresses, Torsion, Bending and shear stresses inbeams, deflection of beams, stability ofequilibriumconfiguration,

APL106 Fluid Mechanics
4Credits (3-1-0)
Pre-requisites: APL100
Overlaps with: APL107, APL105
Introduction toFluidsandthe concept of viscosity, Flow visualization, Fluid Statics, Physical laws for control volume including continuity, momentum and energy equations, Bernoulli equation, Differential equations of fluid motion, Navier Stokes equations, vorticity and potential flows, dimensional analysis and similitude, Boundary layer theory, 1-Dcompressible flow.

APL203 Dynamics of Mechanical Systems
4 Credits (3-1-0)
Principles of Dynamics: Newton's laws and d'Alembert's principle; Energy methods; Generalized Dynamics: Kinematics and Kinetics, Kane's Equations and Lagrange's Equations. Introduction to Vibration with examples; Stability; Balancing; Cams and Gears; Introduction to Multibody Dynamics; Robot Dynamics; Application with Biosystems; Human Body Dynamics.

APL205/APL710 Computer Aided Design
2 Credits (2-0-0)
Pre-requisites: EC75
Principles ofcomputer aideddesign, Computergraphicsfundamentals, 2D and3DTransformationsand projections, Plane Curves, Space Curves, Syntheticcurves. Analytical andparametric surfaces, Synthetic surfaces, Solid Modeling basics, Solid modeling techniques and schemes, Half-spaces, Boundary Representation (B-rep), Constructive Solid Geometry (CSG), Sweep Modeling, Analytical Solid Modeling, Visual Realism, hidden linesand surface.

APL206: Engineering Thermodynamics
2 Credits (2-0-0)
Basic concepts and definitions, thermodynamic properties of a pure substance. Work and heat – definition and applications. 1st Law – internal energy and enthalpy, applications to non-flow/closed and flow/open systems (SSSF and USUF). 2nd Law – corollaries, Claudius inequality, entropy.Carnot cycle. Basics of gas-vapor mixtures. Vapor power cycles – Rankine cycle and its modifications. Steam generation and its use – power plants, co-generation, combined cycles.Thermodynamic analysis of fluids in standard fixtures and equipment (piping fixtures, power plants, engines, refrigerators). Equilibrium properties of pure materials and mixtures. Understanding the phase behavior and phase transitions of pure fluids.

APL207: Heat Transfer
2 Credits (2-0-0)
Modes of heat transfer - conduction, convection, radiation; Basic conservation equations; Conduction: Fourier's law, heat diffusion equation, 1-D steady state conduction in extended surfaces, heat generation, lumped capacitance and 1D transient models, semi-infinite wall. Heat transfer coefficients in natural and forced convection; Convection: Forced and free convection - mass, momentum and energy conservation

equations, scaling analysis and significance of non-dimensional numbers, thermal boundary layers, heat transfer in external and internal laminar and turbulent flows and use of correlations. Heat exchanger types and analysis: LMTD and effectiveness-NTU method. Introduction to radiative heat transfer; Radiation: properties, Laws, view factor, 3-surface network for diffuse - gray surfaces. Gas radiation

AMP262 Fluids and Solids Laboratory
2 Credits (0-0-4)
Pre-requisites: APL104 & APL106
Overlaps with: APL105/APL107/APL108
Experiments will build-up on knowledge of Mechanics of Solids and Mechanics of Fluids. Applications of uncertainty analyses. A professional report is to be prepared for each experiment. Students work in a group of two.

APL302 Basics of Product Design
4 Credits (3-0-2)
Design Methods- Introduction, identification of customer needs, product specifications, concept generation & selection concept testing, product generation and prototype/model testing. Product Design Human factors in engineering, Man-Machine systems, Human Sensorimotor, Active and Passive Interaction, Sense organs: Capabilities and Limitations, Visual and Auditory Display Systems. Anthropometry, Physical capabilities. Effect of Environment, Air pollution, Motion, Noise Vibrations, Allocation of functions between man and machine, work place design, human error, accidents and safety.
Feasibility – Introduction, prefeasibility study, market analysis, technical analysis, financial analysis and feasibility report. Practical – To fabricate a working prototype/model following all the steps of feasibility study preliminary and details design and the concepts of design methods.

APL311/APL705 Introduction to FiniteElementMethod
4Credits (3-0-2)
Pre-requisites: EC75
Strong and weak forms ofgoverning differential equations, and their equivalence, weighted residual and variational approaches. Ritz method. Discretization of weakformandboundaryconditions. Convergence. Bar andbeamelements. Truss andframeproblems, Isoparametric formulation. Planestrain, planestressandaxi-symmetric problems, 3D elasticityproblems, one andtwodimensional heat transfer. Formulation ofdynamicsproblems. Laboratory workonsolidmechanics andheattransferproblems.

APL321/APL720Introduction to Computational FluidDynamics
4Credits (3-0-2)
Pre-requisites: EC75
Review of governing equations for fluid flow, finite difference and finite volume method and its application to steady 1-D, 2-D and 3-D convection-diffusion problems, extension of FVM to unsteady 1-D, 2-D and 3-D convection diffusion problems, solution of discretized Navier Stokes equations and boundary conditions, physical description of turbulence, Reynolds-Averaged Navier-Stokes equations, closure problem; RANS based turbulence models; introduction to DNS and LES.

APL331 Advanced Mechanics of Solids
3Credits (3-0-0)
Pre-requisites: APL104/APL105/APL108 EC50
Mathematical Preliminaries (scalar, vector, tensor operation) Thermodynamics thermodynamically framework for constitutive modeling), Kinematics ofDeformation&Motion, Stress-strain principles, Elasticity, Anisotropy, viscoelasticity, multi-physical coupling effect, plasticity, viscoelasticity. Experimental: Experimental characterization, data analysis, Model fitting

APL361Advanced Fluid Dynamics
3Credits (3-0-0)
Pre-requisites: APL100andEC50
Derivation of Navier-Stokes (NS) equations; Boundary-conditions and Exact/Similarity solutions. General Boundary-Layer assumption; Free-shear flows; Separation and drag crisis. Low Reynolds Number flows: Stokes Flow; Oseen's Correction; Lubrication Theory. Hydrodynamic Stability Theory: Capillary Instability; Orr-Sommerfeld Equation; Squire's Theorem; Turbulence: Nature of turbulence; Averaging and scales; Reynolds decomposition and the closure problem; Kolmogorov hypotheses and microscales; Reynolds stress; eddy viscosity vs. molecular viscosity. Dynamics of turbulence; balance of kinetic energy, vorticity dynamics, scalar dispersion. Statistics; convergence of averages; correlations and probability density functions. Turbulent shear flows.

APL380 Biomechanics
3Credits (3-0-0)
Pre-requisites: APL100andEC50
Basics of rigid body mechanics, solid mechanics, and fluid mechanics applied in biological system; Basic introduction to anatomy and physiology; Mechanics of Human Motion; Mechanics of response of tissues including bones; Mechanics of Blood flow, Bio solid-fluid interaction. Computer Labcontents: Matlab Programming basics, Image processing basics, Design of Joint: Rigid Body Mechanics basedapproach, Matlab programming for bone or Aortic Tissue; Matlab programming for blood flow analysis.

APL390: Experimental Techniques in Fluids and Solids
3.5 Credits (2-0-3)
Review of errors in measurements and other statistical concepts related to errors and their combinations, and probabaility distributions. Advanced techniques in fluid flow: Hot wire Anemometry, Laser Doppler Velocimetry and particle sizing, particle Image Velocimetry, Volumetric methods: Tomo PIV and background oriented Schlieren, Derived Quantities from PIV: Vorticity, strain rate and pressure. Applications related to Strain gauges, Clip gauges, Piezoelectric sensors, and Ultrasonic sensors. Coherent gradient sensing (CGS). 2D Digital image correlation (DIC) for full field measurements. Moire fringe methods. Particle image velocimetry (PIV). Hardness testing of the common engineering

materials. Characterization of solids under compression, tension and shear. Fatigue and Creep testing. Drop tower. Modal analysis and structural vibrations. Sound absorption characterization of the material.

APL405MachineLearninginMechanics
3Credits(2-0-2)
Introduction: Linear Algebra, Probability review, Programming Basics, Challenges in Data Handling Regression: Simple Linear Regression, Multiple Linear Regression, Nonlinear Regression, Logistic regression Introduction to Machine learning: Supervised Learning, Unsupervised Learning, Classification and Clustering Algorithms Applications of Machine Learning in Mechanics: Case Studies include Identifying faulty/healthy wind turbines, Turbulent Flow Analysis, Leakage Detection in Hydraulic Circuits, Fault Detection in Motor-Bearings, Human Activity Recognition, Heart Sound Classification etc. Deep learning: Introduction to Neural Networks, Convolution and Artificial Neural Networks, Applications in Engineering Mechanics Practical's: MATLAB tools including Curve Fitting Toolbox, Classification Learner App, Deep Network Designer App, Tensor Flow, Training models on GPUs

APL410 Multiscale Modelling and Computation
3 Credits (3-0-0)
Introduction to multiscale modeling; Bridging nano, micro and macro scale in materials; Basic equations of continuum mechanics; Micromechanical homogenization theory: Ergodicity principle, representative volume element, periodic boundary conditions, eigenstrain, eigenstress, inclusions; Effective elastic modulus: self-consistent method, Mori-Tanaka method, Eshelby method, Multi-inclusions problems; Voigt and Reuss bound; Hashin-shtrikmanvariational principles; Micromechanical damage theory; Micromechanics of phase transformation in solids; Nanomechanics: Linear atomic chains, two and three dimensional lattices, Molecular mechanics, Cauchy-Born rule.

APD411 B. Tech Project I
4Credits (0-0-8)
Pre-requisites:EC50*,*

Department Elective

APL306 Dynamics and Vibrations
3 Credits (3-0-0)
Axioms, Euler angles, equations of motion, kinematics and dynamics of constrained rigid bodies. Free vibration response of single-degree-of-freedom (SDOF) systems, undamped and damped vibration. Forced response of SDOF system, response to periodic excitation, impulse response, response to arbitrary excitation, convolution integral, and shock spectrum. Two degrees-of-freedom systems, orthogonality of modes, harmonic response, vibration absorbers. Multi-degrees-of-freedom (MDOF) systems, modal analysis. Continuous systems, axial vibration of rods, bending vibration of beams torsional vibration of rods, Rayleigh-Ritz method, symmetric and antisymmetric modes. Time domain and frequency domain analyses. Numerical methods-extraction of eigenvalues and eigenvectors, time integration techniques.

APL340Chaos
4Credits (3-1-0)
Pre-requisites: APL100andEC50
Introductionto linear systems and itsclassification, Fixed point and stability, linear stability analysis, Linearization' of nonlinear systems, Typesof bifurcation andexamples, imperfect bifurcations and catastrophes, Coupled oscillators andquasi periodicity, Poincare Maps, Introduction toChaos,Lorenzequation, one-dimensional map,fractals.

APL402 Fluid Structure Interaction
3 Credits (3-0-0)
Introduction, Flow separation, Vortex shedding, Basics of vibration, Spring-mass system, Free and forced vibration, Dimensional analysis, Coupled equations of fluid and structure, Dimensionless coupled equation, Dimensionless numbers in FSI, Added mass. Vortex induced vibrations, Wake oscillator model, Galloping, Vibration induced in pipes by external and internal axial flow, sloshing, Dynamics of continuous solid and fluid systems, Waves and vibrations in FSI, basics of acoustics. Computational techniques for FSI solvers: Monolithic vs partitioned approach, One-way/explicit vs two-way/implicit coupling, accuracy, and stability criterion.

APL411: Application of Finite Elements (Project Oriented)
3 Credits (2-0-2)
Introduction to FEM, Types of elements, degrees of freedom, loads and boundary conditions.Introduction to finite element software, Mesh refinement, convergence criterion, Stress analysis in a three-dimensional body, Application to frames, beam and plate elements, Transient dynamic analysis, Stability of lightweight structures, Fracture analysis, Application to smart structures.

APL412/APL725: Computational to Multi-body Dynamics
3 Credits (3-0-0)
Course Objective:
Kinematics, Angular velocity, Frame, Composition of velocities, Euler Newton formulation of equations of motion. Energy based formulation of Equations of motion (Hamiltonian and Lagrangian).Constraints equations (2D & 3D) and ActuatorsSystem level multibody equation formulation for 2D examples. Numerical integration of the E.O.M of the system (2D). Orientation parameterization: Euler angles, Euler parameters, Quaternions etc. Examples of 3D rigid multibody systems. Intro to flexible-multibody systems (governing equations etc).

APL415/APL835 Composite Mechanics and Structures
3Credits (3-0-0)
Composites, Various reinforcement and matrix materials, Strength and stiffness properties, Effective moduli, Spherical inclusions, Bio-composites, cylindrical and lamellar systems, Laminates: Laminated plates , Analysis and Design with composites, Fiber reinforced pressure vessels, dynamic, inelastic and non-linear effects, Fabrication of composites, Machining of composites, Strength evaluation, Technological applications.

APL 421 Applications of CFD
3 Credits (2-0-2)
Pre- requisites: APL 720

Review of basics of the Finite Volume Method (FVM): discretization schemes, time stepping, stability, types of grid, iterative solution methods.Structured and unstructured grid generation. Projects on simulations of steady laminar flow (lid driven cavity and boundary layer flow), unsteady laminar flow (flow past a cylinder), turbulent flows (using Reynolds-averaged Navier-Stokes equations, channel flow and pipe flow), large eddy simulation, direct numerical simulations and extraction of various statistics from raw CFD data.

APL 422 Advanced Computational Fluid Mechanics
3 Credits (2-0-2)
Introduction to numerical methods, mesh generation and mesh adaptivity, spectral methods and applications to fluid simulations, discrete and fast Fourier transforms, Chebyshev polynomials, Gibbs phenomena, spectral discretization methods for diffusion and convection-diffusion problems, staggered and collocated grids, pressure velocity coupling, predictor corrector method multigrid method.

APL424 Introduction to Hydrodynamic Stability
3 Credits (3-0-0)
Introduction, Mechanisms of instability, Kelvin-Helmholtz Instability, Inviscid Instability of Parallel Flows, Viscous Instability of Parallel Flows, Free Surface Flows, Orr-Sommerfeld equation, Tollmien-Schlitchting waves.

APL431: Aircraft Structures
3 Credits (3-0-0)
Introduction to elasticity and aerospace structures Loads on aerospace structures, Beams, Truss and Frame
Torsion of noncircular prismatic bars. Curved beams. Stability of structures. Theory of Thin-walled beams, Open and closed cross-section, Torsion and bending of thin-walled beams. Normal stresses and shear flows, shear Centre, bending and torsional stability. Energy and variational based numerical methods.

APL432 Aeroelasticity
3 Credits (3-0-0)
Introduction to aeroelasticity and aeroelastic phenomena, Static and dynamic aeroelastic phenomena using simplified aerodynamic and structural models, 1-Daeroelastic model of airfoil, Divergence of 2-D airfoil and straight wing, Wing loading and deformations, Flutter model of 2-D airfoil, Unsteady aerodynamics, 2-D and 3-D supersonic flow, Subsonic flow, Theodorsen theory, Flutter calculation, Exact treatment of bending – torsion, Flutter of uniform wing, Flutter analysis by assumed mode method, Panel flutter, Numerical aeroelastic calculations using software.

APL433: Introduction to Plates and Shells
3 Credits (3-0-0)
Basic assumptions of two-dimensional (surface) theories Theory of thin plates, bending of rectangular and circular plates, shear deformation theories. General theory of curved shells, Axi-symmetric problems of cylindrical, conical and spherical shells and pressure vessels, membrane problems of cylindrical, spherical and conical shells. Energy methods, Design considerations.

APL434: Smart Materials and Structures
3 Credits (3-0-0)

Introduction to Smart Material Systems; Overview of smart materials, Modeling mechanical, thermal and electrical systems (thermo mechanics and electrostatics);Piezoelectric materials: constitutive modelling, piezoelectric beam static and vibration analysis Shape memory alloys (SMA): constitutive modelling, actuation models for SMA, electrical actuation Brief overview of Electroactive Polymers, Magnetostrictive materials, Electro and Magneto Rheological Fluids Mechanics of smart composite structures Transducer applications: Vibration control and damping using piezoelectric materials. Case study: Sensing and control of Smart beams and plates.

APL 435: Impact Mechanics and Crash Worthiness
3 Credits (3-0-0)
Rigid body impact, Stress waves in solids, Applications of one dimensional stress wave theory. Reflection at boundaries and interface, Waves in infinite and semi-infinite medium, Plasticity and Plastic Waves, Shock waves and Equation of State, Material Characterization and Impact Tests, Computational Methods for Impact, Applications to Ballistic Impact and Vehicle Collision.

APL440Parallel Processing in Computational Mechanics
4Credits (3-0-2)
Pre-requisites: APL310
Introduction tomulti-processor; multi-core, multi-threaded processing and their clusters, GPUs and CUDA programing, Introduction to parallel processing hardware and software, Open MP,MPI, MPICH, HPC/Clustering tools andsoftwaresuits.Exploring parallelism insolid/fluid mechanics problems andformulationofnumerical methods, Partitioning anddivide-and-conquer strategies, Parallel algorithms for solving dynamical and non-linear systems, Finite difference and Finite element analysis of plate and shells, Finite elements in fluids, Reduced integration patch test, Dynamic FEanalysis, Geometrically nonlinear problems, Material nonlinearity, Automated mesh generation, Pre and post processing, Solid fluid interaction problems, Efficient solution technique-PCG, Domain decomposition, Pointsource method, Boundary element method, Aero elastic flutter, Other special topics,

APL 450 Introduction to Soft Robotics
3 Credits (3-0-0)
Soft robots Vs Rigid robots, manufacturing techniques of multifunctional soft robot devices: Modeling soft mechanics (numerical, computational, analytical), Introduction to morphological simulation: Soft actuators (Dielectric, pneumatic, fluidics):Soft sensors (Fluidic, solid, composites, textiles):Soft logic (controllers, semiconducting polymer, thin film silicon):Soft energy (thermodynamics, soft batteries, soft combustion) Applications (wearable robotics, space robotics, deep-sea robotics)

APL452 Introduction to Digital Twins
3 Credits (2-0-2)
Introduction to Digital Twins and establishing the need for Computational Tools in modern engineering. First Principles Modelling using numerical solutions of ODEs and PDEs, Simulation of Dynamic systems in the Time-domain using Block-domain methods & Physical Modelling using Lagrangian Methods. Data-driven Modelling: Data Handling, Filtering and pre-processing, Visualization and Classification, Fitting classification models to data. Case Study or Project.

APL491 Reliability Engineering
3 Credits (3-0-0)
Uncertainties in Engineering Systems, Bathtub analogy, RAM Concept, Limit State/Performance function, Random variables, Probability concepts and statistical models, Joint probability distribution, Application of Boolean Algebra, Bayesian Theory, Logic gates, Baye's theorem, System reliability, Series and parallel system, System with standby units, Reliability assessment methods, Deterministic and probabilistic approaches, Codal provisions, Probabilistic design methodology, Stochastic finite element method, Applications, Case studies in project mode.

APL 701 Continuum Mechanics
3 Credits (3-0-0)
Concept of Continuum, Kinematics of deformation, concept of stress and strain tensor-their transformation and decomposition, finite strain tensor and its linearization with examples, rate of deformation tensor-velocity gradient and spin tensor, derivation of conservation laws mass continuity, linear and angular momentum conservation, derivation of linear equations of elasticity and Navier stokes equations in both Cartesian and polar co-ordinates, principle of minimum potential energy, virtual work theorem, uniqueness and reciprocal theorem, constitutive laws for linearly elastic solids and Newtonian viscous fluids, incompressible case, applications in solid and fluid mechanics problems.

APL713TurbulenceanditsModeling
3Credits (3-0-0)
Nature of turbulence, Governing equations, Fourier, Lagrnagian and Eulerian description of turbulence, Statistical description of turbulence, Kolmogorov's hypotheses, turbulence processes, turbulence closure modelling.

APL715PhysicsofTurbulent Flows
3Credits (3-0-0)
Introduction, nature of turbulence, methods of analysis, scales of turbulent flows. Reynolds decompositionand theclosureproblem, estimates oftheReynoldsstress, comparisonwiththekinetictheoryofgases. Dynamics ofturbulence, balance ofkineticenergy, vorticity dynamics, scalarfluctuations. Freeshearflows: jets, wakesandmixing layers. Wall boundedflows: channel andpipeflows, boundarylayers. Kolmogorov hypotheses; probability density function, characteristic function and moments; structure and correlation functions; energy spectra, intermittency. Turbulent transport and dissipation.

APL736MultiscaleModelingofCrystallineMaterials
4Credits (3-0-2)
Pre-requisites: EC75
Reviewofcontinuum mechanics, material symmetry, thermodynamics and constitutive relations, symmetry incrystals, empirical and semi- empirical models of inter-atomic potential, molecular statics and dynamics, finite temperature effects inmolecular systems, probabilistic behaviorofmaterial characteristics atmacroscale,multiscale methods -Cauchy-Born ruleandQuasi-continuum method, Mechanicsofhelical nanostructures (e.g., carbon nanotubes, DNA,polymers), Bendingand twisting of nanotubes and nano-rods. Computer Lab contents: Programming molecular statics andmolecular

dynamics, molecular statics viaconjugate gradient minimization and Newton-Raphson method, MonteCarlosimulation, Implementation of Cauchy-Born ruleandQuasi-continuum method, Exposure toLAMMPS and AMBER.

APL740MechanicsofBiologicalCells
3Credits (3-0-2)
Pre-requisites: EC75
Theoretical Part: BasicIntroduction to mechano-biology, Concept of LengthScale, MechanicalForces,Mass,StiffnessandDampingofProteins, Thermal Forcesand Diffusion, Chemical Forces, Polymer Mechanics. Intracellular Mechanics: Structures ofCytoskeleton Filaments, Dynamics ofCellFilaments, Molecular motors, Introduction toEntropic Elasticity and Persistence Length, ForceGeneration byCytoskeleton Filaments. Extracellular Mechanics: TheExtracellularmatrix (ECM), cell-ECM Interactions, CellMigration, ForcesandAdhesion. Tissue Mechanics: Cell-cell Assemblies, Tissue Material Behavior, Introduction toLinearViscoelasticity, ConceptofConstitutive Modeling. Experimental Part: Different Experimental Methods for ProbingCell Mechanical Properties. Intro to indentation, aspiration, tweezer, Nano-patterned platform basedtechniquesetc.

APL742 Advanced Biomechanics
3Credits (3-0-0)
Basic Introduction to biomechanics of tissue/cells, Concept of Length Scale, Mechanical Forces, Mass, Stiffness and Damping of Proteins, Thermal Forces and Diffusion, Chemical Forces, Polymer Mechanics.
Tissue Mechanics: Cell –cell Assemblies, Tissue Material Behaviour, Introduction to Linear Viscoelasticity, Concept of Constitutive Modeling, Nonlinear continuum frame work of Biomechanical simulation, special topic on tissue-device interaction, orthopaedic/spinal implants etc.Intercellular Mechanics: Structures of Cytoskeleton Filaments, Dynamics of Cell Filaments, Molecular motors, Introduction to Entropic Elasticity and Persistence Length, Force Generation by Cytoskeleton Filaments.

APL764Biomaterials
3Credits (3-0-0)
Pre-requisites: EC75
Introduction andhistoryofbiomaterials; Basicclassesofengineering materials and structure property correlation; Structure and property of cells and tissues; Property requirement of biomaterials including biocompatibility, and biodegradability; Basic types of biomaterials; Mechanical testing of biomaterials; application of biomaterials (orthopaedic, cardiovascular, dental) including detailed case study, Materialsforbiomedicaldevicesandpackaging(electronic interfacing etc.)

APL765FractureMechanics
3Credits (3-0-0)
Pre-requisites: EC75
Fracture: anoverview, theoretical cohesive strength, defect population insolids, stress concentration factor, notch strengthening, elements offracture mechanics, Griffiths crack theory, stress analysis

ofcrack, energy and stress field approaches, plane strain and plane stress fracture toughness testing, crackopening displacement, elastic-plastic analysis, J-integral, ductile-brittle transition, impact energy fracture toughness correlation, microstructural aspects offracturetoughness, environmental assistedcracking, cyclicstressandstrainfatigue, fatigue crack propagation, analysis ofengineering failures.

APL771DesignOptimization andDecisionTheory
3Credits (3-0-0)
Introduction, classification of optimization problems, single variable and multivariableunconstrained optimizationproblems, constrained optimization, integer programming, genetic algorithms andsimulated annealing, review ofprobability theory, decisiontheory.

APL805 Advanced Finite Element Methods
3 Credits (3-0-0)
Variationalcalculus;Weak formulation of governing equations and its linearization; discretization of nonlinear weak form and its solution; convergence requirement of shape functions; systematic generation of higher order elements; mixed FEM/ penalty method; non-uniform and adaptive discretization –p and H convergence; solid-fluid interaction problems; Generalized and extended finite element methods.

APD412B.Tech Project II
3Credits (0-0-6)

SEMESTER	COURSE-I	COURSE-II	COURSE-III	COURSE-IV	COURSE-V	COURSE-VI	COURSE_VII	COURSE-VIII	COURSE_IX	L	T	P	Credits	Non Graded Units	Contact Hours
I	ELL100	MCP100	PYL100	MTL100	PYP100	MCP101	NIN100	NEN100	NLN100						
	Introduction to Electrical Engineering	Introduction to Engineering Visualization	Electromagnetic Waves and Quantum Mechanics	Calculus	Physics Laboratory	Product Realization through Manufacturing	Introduction to Engineering (Non-graded)	Professional Ethics and Social Responsibility-1 (Non-graded)	Language and writing Skills-1 (Non-Graded)						
	3 0 2 4	0.5 0 3 2	3 0 0 3	3 1 0 4	0 0 4 2	0 0 4 2	0 0 2 1	001 0.5	0 0 2 1	9.5	1.0	13	17	2.5	28.5
II	APL100	COL100	CML100	MTL101	CMP100			NEN100	NLN100						
	Engineering Mechanics	Introduction to Computer Science	Introduction to Chemistry	Calculus	Chemistry Laboratory			Professional Ethics and Social Responsibility-2 (Non-graded)	Language and writing Skills-2(Non-Graded)						
	3 1 0 4	3 0 2 4	3 0 0 3	3 1 0 4	0 0 4 **2**			0 0 1 0.5	0 0 2 1	12	2	6	17	1.5	23.O
III	APL102	COL106	APL104	APL101	SBL100	HUL	EMN101								
	Introduction to Material Science and Engineering	Data Structures and Algorithms	Solid Mechanics	Applied mathematics for Engineers	Introduction to Biology for Engineers		Introduction to Dept. of Applied Mechanics								
	3 0 2 4	3 0 4 5	3 1 0 4	3 0 0 3	3 0 2 4		0 0 2 1			15	1.0	8	20	1.0	26
IV	APL103	APL106	MTL107	ELL201	CVL100	HUL	APL206								
	Experimental Methods	Fluid Mechanics	Numerical Methods and Computations	Digital Electronics	Environmental Science		Engineering Thermodynamics								
	2 0 2 3	3 1 0 4	3 0 0 3	3 0 3 4.5	2 0 0 2	3 0 0 3	2 0 0 2			18	1.0	5	21.5		24

V	APL203	APL 205	AMP262	APL302	APL380	HUL	APL207			16	1.0	6	20		23
	Dynamics of Mechanical System	Basics of Computer Aided Design		Basics of Product Design	Bio-mechanics		Heat Transfer								
	3 1 0 4	2 0 0 2	0 0 4 2	3 0 2 4	3 0 0 3	3 0 0 3	2 0 0 2								
VI	APL331	APL361	APL311	OC1	APL 390	HUL				17	0.0	5.0	19.5		22
	Advanced Mechanics of Solids	Advanced Fluid Dynamics	Introduction to Finite Element Methods		Advanced Experiments in Solids & Fluids										
	3 0 0 3	3 0 0 3	3 0 2 4	3 0 0 3	2 0 3 3.5	3 0 0 3									
VII	DE 1	APL410	APL321	APL405	DE2	OC2	APD411			16	0.0	12	22		28
		Multi-scale Modeling and Computation	Introduction to Computational Fluid Dynamics	Machine Learning in Mechanics			B.Tech. Project I								
	3 0 0 3	3 0 0 3	3 0 2 4	2 0 2 3	3 0 0 3	2 0 0 2	0 0 8 4								
VIII	APD412	DE3	DE4	OC3	OC4					11	0.0	12	17		23
	B.Tech. Project II														
	0 0 12 6	3 0 0 3	3 0 0 3	2 0 0 2	3 0 0 3										