# Mathematics and computing

| | | Semester II | | | | |
|---|---|---|---|---|---|---|
| S. No | Course Code | Course Name | L | T | P | C |
| 1 | MA109T | Linear Algebra and Differential Equations | 3 | 1.5 | 0 | 9 |
| 2 | CS101T | Data Structures and Algorithms | 3 | 0 | 0 | 6 |
| 3 | CS101L | Data Structures and Algorithms Laboratory | 0 | 0 | 3 | 3 |
| 4 | EE103T | Digital Systems | | | | 6 |
| 5 | EE102L | Digital Systems Lab | | | | 3 |
| 6 | CS202T | Discrete Structures | 3 | 0 | 0 | 6 |
| 7 | CE301T | Environmental studies | 3 | 0 | 0 | 6 |
| 8 | NO | NSO/NSS/NCA/NCC | 0 | 0 | 0 | 2 |
| | | **Total Credits** | | | | **42** |

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| 1 | Title of the course (L-T-P-C) | **Linear Algebra and Differential Equations** **(3-1.5-0-9)** |
|---|---|---|
| 2 | Pre-requisite courses(s) | -- |
| 3 | Course content | **Linear Algebra:** Vectors in $R^n$, notion of linear independence and dependence, linear span of a set of vectors, vector subspaces of $R^n$, basis of a vector subspace. Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix. Determinants and rank of a matrix in terms of determinants. Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product spaces, Gram-Schmidt process, orthonormal bases, projections and least squares approximation. Eigenvalues and eigenvectors, characteristic polynomials, eigenvalues of special matrices (orthogonal, unitary, Hermitian, symmetric, skew-symmetric, normal). Algebraic and geometric multiplicity, diagonalization by similarity transformations, spectral theorem for real symmetric matrices, application to quadratic-forms.<br><br>**Differential Equations:** Exact equations, integrating factors and Bernoulli equations. Orthogonal trajectories. Lipschitz condition, Picard's theorem, examples on non-uniqueness. Linear differential equations generalities. Linear dependence and Wronskians.<br><br>Dimensionality of space of solutions, Abel-Liouville formula. Linear ODE's with constant coefficients, the characteristic equations. Cauchy-Euler equations. Method of undetermined coefficients. Method of variation of parameters. Laplace transform generalities. Shifting theorems. Convolution theorem. |
| 4 | Texts/References | 1. H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley (1995).<br>2. G. Strang, Linear algebra and its applications (4th Edition), Thomson (2006)<br>3. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000)<br>4. E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999)<br>5. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005) |

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| 1 | Title of the course (L-T-P-C) | **Data Structures and Algorithms** **(3-0-0-6)** |
|---|---|---|
| 2 | **Pre-requisite courses(s)** | Exposure to Computer Programming |
| 3 | **Course content** | Introduction: data structures, abstract data types,analysis of algorithms. Creation and manipulation of data structures: arrays,lists, stacks, queues, trees, heaps, hash tables, balanced trees, tries, graphs. Algorithms for sorting and searching, order statistics, depth-first and breadth-first search, shortest paths and minimum spanning tree. |
| 4 | **Texts/References** | 1. Introduction to Algorithms, 3rd edition, by T. Cormen, C. Leiserson, R. Rivest, C. Stein, MIT Pressand McGraw-Hill, 2009. 2. Data structures and algorithms in C++, by Michael T. Goodrich, Roberto Tamassia, and David M. Mount,Wiley, 2004. |

| 1 | Title of the course (L-T-P-C) | **Data Structures and Algorithms Laboratory** **(0-0-3-3)** |
|---|---|---|
| 2 | Pre-requisite courses(s) | Exposure to Computer Programming (CS 102) |
| 3 | Course content | Laboratory course for CS 211 is based on creatingand manipulating various data structures and implementation of algorithms. |
| 4 | Texts/References | 1. Introduction to Algorithms, 3rd edition, by T. Cormen, C. Leiserson, R.Rivest, C. Stein, MIT Pressand McGraw-Hill, 2009. 2. Data structures and algorithms in C++, by Michael T.Goodrich, Roberto Tamassia, and David M. Mount, Wiley, 2004. |

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| 1 | **Title of the course** (L-T-P-C) | **Digital Systems** (2-1-0-6) |
|---|---|---|
| 2 | **Pre-requisite courses(s)** | None |
| 3 | **Course content** | • Introduction to Digital Systems<br>• Number systems and Logic: Number Systems, Different Codes, Boolean logic, basic gates, truth tables<br>• Introduction to Logic families: TTL, CMOS etc.<br>• Boolean Algebra: Laws of Boolean Algebra, logic minimization using K maps<br>• Combinational Logic Circuits: Adders, Subtractors, Multipliers, MSI components like Comparators, Decoders, Encoders, MUXs, DEMUXs<br>• Sequential circuits: Latches, Flipflops, Analysis of clocked sequential circuits, Registers and Counters (Synchronous and Asynchronous), State Machines<br>• Introduction to Hardware Description Languages<br>• Array based logic elements: Memory, PLA, PLD, FPGA<br>• Special Topics: Asynchronous State machines, Testing and Verification of Digital Systems |
| 4 | **Texts/References** | 1. J. F. Wakerly: Digital Design, Principles and Practices,4th Edition,Pearson Education, 2005<br>2. M. Moris Mano; Digital Design, 4th Edition, Pearson,2009<br>3. Ronald J. Tocci; Digital System, Principles and Applications, 10th Edition, Pearson, 2009<br>4. H.Taub and D. Schilling; Digital Integrated Electronics, McGraw Hill, 1977<br>5. Charles H Roth; Digital Systems Design using VHDL, Thomson Learning, 1998. |

| 1 | Title of the course (L-T-P-C) | Discrete Structures (3-0-0-6) |
|---|---|---|
| 2 | Pre-requisite courses(s) | -- |
| 3 | Course content | There are four modules in the course: <br> 1. **Proofs and structures** <br> Introduction, propositions, predicates, examples oftheorems and proofs, types of proof techniques, Axioms, Mathematical Induction, Well-ordering principle, Strong Induction, Sets, Russell's paradox, infinite sets, functions, Countable and uncountable sets, Cantor's diagonalization technique, Relations, Equivalence relations, partitions of a set. <br> 2. **Counting and Combinatorics** <br> Permutations, combinations, binomial theorem, pigeon hole principle, principles of inclusion and exclusion, double counting. Recurrence relations, solvingrecurrence relations. <br> 3. **Elements of graph theory** <br> Graph models, representations, connectivity, Euler andHamiltonian paths, planar graphs, Trees and tree traversals. <br> 4. **Introduction to abstract algebra and numbertheory** <br> Semigroups, monoids, groups, homomorphisms,normal subgroups, congruence relations. Ceiling, floor functions, divisibility. Modular arithmetic, prime numbers, primality theorems. |
| 4 | Texts/References | 5. Discrete Mathematics and its applications with Combinatorics and graph theory, 7th edition, by Kenneth H Rosen. Special Indian Edition published by McGraw-Hill Education, 2017. <br> 6. Introduction to Graph Theory, 2nd Edition, by Douglas B West. Eastern Economy Edition published by PHI Learning Pvt. Ltd, 2002. <br> 7. Discrete Mathematics, 2nd Edition, by Norman L Biggs. Indian Edition published by Oxford UniversityPress, 2003. |

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| 1 | Title of the course (L-T-P-C) | Environmental studies (3-0-0-6) |
|---|---|---|
| 2 | Pre-requisite courses(s) | Nill |
| 3 | Course content | **Module A:** Natural Resources, Ecosystems, Biodiversity and its conservation: Natural resources and ecosystems, Forest, grassland, desert and aquatic ecosystems, biodiversity at global, national and local levels, conservation of biodiversity<br>**Module B:** Air Pollution Introduction to understanding air quality management, fundamental processes of meteorology, Air Pollutants – Gaseous and particulate, Criteria for pollutants, ambient and source standards, Aerosols: Characterisation of aerosols, size distributions, measurement methods; Transport behaviour: diffusion, sedimentation, inertia; Visibility; principles of particulate control systems.<br>**Module C:** Water Treatment Discussion of water quality constituents and introduction to the design and operation of water and wastewater treatment processes.<br>**Module D:** Solid Waste Management and Climate Change Different aspects of solid and hazardous waste management. Climate change and greenhouse gas emissions, technologies would reduce the greenhouse gas emissions. Climate change and its possible causes.<br>**Module E:** Sociology/Environmentalism Description: Environmentalism in sociological tradition, Sustainability, North-South divide, Political economy approaches in environmental studies, Debates over environmental issues.<br>**Module F:** Economics Energy economics and financial markets, Market dynamics, Energy derivatives, Energy Efficiency; Sustainable Development: Concept, Measurement & Strategies, Interaction between Economic Development and the Environment<br>**Module G:** Philosophy Environmental ethics, Deep ecology, Practical ecology, Religion and attitude towards environmental ethics, Ecofeminism and its evolution.<br>**Module H**: Field work and project: visit to a local area to document environmental assets, case studies of a simple ecosystem and group discussions on current environmental issues. |
| 4 | Texts/References | 1. Cunningham W.P. and Cunningham M.A. (2002), Principles of Environmental Science, Tata McGraw-Hill Publishing Company, New Delhi.<br>2. Dasgupta, P. and Maler, G. (eds.), (1997), The Environment and Emerging Development Issues, Vol. I, Oxford University Press, New Delhi.<br>3. Jackson, A.R.W. and Jackson, J.M. (1996), Environmental Sciences: The Environment and Human Impact, Longman Publishers.<br>4. Nathanson, J.A., (2002), Basic Environmental Technology, Prentice Hall of India, New Delhi<br>5. Redclift, M. and Woodgate, G. (eds.), (1997), International Handbook of Environmental Sociology.<br>6. Srivastava, K.P. (2002), An Introduction to Environmental Study, Kalyani Publishers, Ludhiana.<br>7. Review articles from literature. |