



School of Engineering & Technology

B.Sc. (Hons) in Computer Science (Data Science and Analytics)

SISTER NIVEDITA UNIVERSITY

SYLLABUS

FOR

**THREE YEARS BACHELOR OF SCIENCE
HONOURS DEGREE COURSE**

IN

COMPUTER SCIENCE

(DATA SCIENCE AND ANALYTICS)

UNDER

UGC-CBCS SYSTEM



2020



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Course Structure

Category	Course name	Code	Credit	Teaching Scheme		
				L	T	P
Semester – I						
	Digital Electronics	1203211	6	3	1	4
	Introduction to C-Programming	1203212	6	4	0	4
	Mathematics- I	1191111	4	3	1	0
	Generic Elective	*	4	3	1	0
	Communicative English	1216115	2	2	0	0
	Mentored Seminar – I	1207311	1	1	0	0
	Foreign Language – I (German /Spanish /Japanese)	1278111/ 1278112/ 1278113	2	2	0	0
Total Credit = 25				Teaching Hour = 29		
Semester – II						
	Computer Architecture	1201221	6	3	1	4
	Data Structures with Python	1201222	6	4	0	4
	Mathematics II	1192121	4	3	1	0
	Generic Elective	*	4	3	1	0
	Environmental Science	1154121	2	2	0	0
	Mentored Seminar – II	1205121	1	1	0	0
	Foreign Language – II (German /Spanish /Japanese)	1276121/ 1276122/ 1276123	2	2	0	0
Total Credit = 25				Teaching Hour = 29		
Semester – III						
	Information theory and coding	1203131	4	3	1	0
	Database Management System	1203232	6	4	0	4
	Operating System & System Programming	1203232	6	3	1	4
	Computational Statistics with R lab	1192231	6	3	1	4
	Generic Elective	*	4	3	1	0
Total Credit = 26				Teaching Hour = 32		
Semester – IV						
	Advanced Database Management System	1203241	6	3	1	4
	Natural language processing with Python	1203242	6	3	1	4
	Machine Learning Algorithm (Tool Based)	1203243	6	3	1	4
	Numerical Analysis	1192241	6	4	0	4
Total Credit = 24				Teaching Hour = 32		
Semester – V						
	Data Science Project Management & Industry use cases	1203151	4	3	1	0
	Computer Networks	1203252	6	3	1	4
	Intelligent agents and Smart Systems	1203153	4	3	1	0
	Minor Project	1207451	6	0	0	12



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Total Credit = 20					Teaching Hour = 28	
Semester – VI						
Elective I	1204161	4	3	1	0	
Elective II	1204162	4	3	1	0	
Project Work II/ Dissertation	1207461	6	0	0	12	
Total Credit = 14					Teaching Hour = 28	

Elective I

- Cloud Computing
- Big data
- System Architecture and Internet of Things
- Business Intelligence

Elective II

- Soft Computing
- Image Processing & Pattern Recognition
- Cyber security
- Deep Learning

Credit Distribution

Name of Department: Data Science and Analytics

Name of the UG program: B.Sc

Duration of program: 6 Semester (3 years)

Head/ In-Charge of the department: Hemanta Dey

Semester	Credit						Total/ Sem
	CC	DSE	GE	AECC	SEC	USC	
1 st							25
2 nd							25
3 rd							26
4 th							24
5 th							20
6 th							14
Total Credit / Course							
Total Credit							134

***To be chosen from the List of Electives**

CC: Core Courses; **GE:** General Elective; **AECC:** Ability Enhancement Compulsory Course; **SEC:** Skill Enhancement Courses; **DSE:** Discipline Specific Elective; **USC:** University specified course



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CORE COURSES (CC)



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PAPER NAME: Digital Electronics

UNIT I: TOPICS	Number Systems & Codes (6L) Decimal Number, Binary Number, Octal Number, Hexadecimal Number, Conversion – Decimal to Binary, Binary to Decimal, Octal to Binary, Binary to Octal, Hexadecimal to Binary, Binary to Hexadecimal, Octal to Binary to Hexadecimal, Hexadecimal to Binary to Octal; Floating Point Number Representation, Conversion of Floating Point Numbers, Binary Arithmetic, 1's and 2's Complement, 9's and 10's Complement, Complement Arithmetic, BCD, BCD addition, BCD subtraction, Weighted Binary codes, Non-weighted codes, Parity checker and generator, Alphanumeric codes
UNIT II: TOPICS	Logic Gates (2L) OR, AND, NOT, NAND, NOR, Exclusive – OR, Exclusive – NOR, Mixed logic
UNIT III: TOPICS	Boolean Algebra (4L) Boolean Logic Operations, Basic Law of Boolean Algebra, Demorgan's Theorem, Principle of Duality
UNIT IV: TOPICS	Minimization Techniques (5L) Sum of Products, Product of Sums, Karnaugh Map (up to 4 variables)
UNIT V: TOPICS	Multilevel Gate Network (3L) Implementation of Multilevel Gate Network, Conversion to NAND-NAND and NOR-NOR Gate Networks
UNIT VI: TOPICS	Arithmetic Circuits (5L) Half Adder, Full Adder, Half Subtractor, Full Subtractor, Carry Look Ahead Adder, 4-Bit Parallel Adder
UNIT VII: TOPICS	Combinational Circuits (5L) Basic 2-input and 4-input multiplexer, Demultiplexur, Basic binary decoder, BCD to binary converters, Binary to Gray code converters, Gray code to binary converters, Encoder
UNIT VIII: TOPICS	Sequential Circuits (5L) Introduction to sequential circuit, Latch, SR Flip Flop, D Flip Flop, T Flip Flop, JK Flip Flop, Master Slave Flip Flop
UNIT IX: TOPICS	Basics of Counters (2L) Asynchronous (Ripple or serial) counter, Synchronous (parallel) counter
UNIT X: TOPICS	Basics of Registers (3L) SISO, SIPO, PISO, PIPO, Universal Registers

Suggested Books:



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1. Digital Circuit & Design, Salivahan, VIKAS
2. Digital Design, M. Morris. Mano & Michael D. Ciletti, PEARSON
3. Fundamentals of Digital Circuits; Anand Kumar; PHI
4. Digital Electronics; Tokheim; TMH
5. Digital Electronics; S. Rangnekar; ISTE/EXCEL

PAPER NAME: Introduction to C-Programming

UNIT I: TOPICS	Overview of C: History of C, Importance of C, Structure of a C Program. Elements of C: C character set, identifiers and keywords, Data types, Constants and Variables, Assignment statement, Symbolic constant. Input/output: Unformatted & formatted I/O function in C, Input functions viz. scanf(), getch(), getche(), getchar(), gets(), output functions viz. printf(), putchar(), puts().
UNIT II: TOPICS	Operators & Expression: Arithmetic, relational, logical, bitwise, unary, assignment, conditional operators and special operators. Arithmetic expressions, evaluation of arithmetic expression, type casting and conversion, operator hierarchy & associativity. Decision making & branching: Decision making with IF statement, IF-ELSE statement, Nested IF statement, ELSE-IF ladder, switch statement, goto statement
UNIT III: TOPICS	Decision making & looping: For, while, and do-while loop, jumps in loops, break, continue statement. Functions: Definition, prototype, passing parameters, recursion. The C Preprocessor.
UNIT IV: TOPICS	Storage classes in C: auto, extern, register and static storage class, their scope, storage, & lifetime. Arrays: Definition, types, initialization, processing an array, passing arrays to functions, Strings & arrays. Pointers: Pointers and address, Pointers and function arguments, Pointers and arrays, Address arithmetic, Character pointer arrays, Pointers and functions, Pointer arrays, Pointers to pointers, Multidimensional arrays, initialization of pointer arrays, Pointer vs. Multi-dimensional arrays, Command-line arguments, Pointer to functions.
UNIT V: TOPICS	Structures and I/O: Basic of structures, Structures and functions, Arrays of structures, Pointers to structures, Self-referential structures, Table lookup, Type of, unions and bit-fields. Input and Output: Standard input and output, formatted output-Print, Variable length argument lists, File access, File descriptor, Low level I/O- Read and Write, Open, Create, Close.

Suggested Books:

1. Programming With C, Gottfried, TMH
2. Practical C Programming, Oualline, SPD/O'REILLY
3. Let us C-Yashwant Kanetkar.
4. Programming in C- Ashok N Kamthane
5. The C programming Lang., Pearson Ecl – Dennis Ritchie.



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PAPER NAME: Computer Architecture

UNIT I: TOPICS:	1.Number Systems – decimal, binary, octal, hexadecimal, alphanumeric representation, 2.Complements – 1’s complement, 2’ complement, 9’s complement, 10’ complement, (r-1)’s complement, r’s complement, 3. Fixed point representation – Integer representation, arithmetic addition, arithmetic subtraction, overflow, decimal fixed point representation, 4. Floating point representation, 5. IEEE 754 floating point representation
UNIT II: TOPICS:	Computer arithmetic (5L) 1. Addition algorithm of sign magnitude numbers, 2. Subtraction algorithm of sign magnitude numbers, 3. Addition algorithms of signed 2’s complement data, 4. Subtraction algorithms of signed 2’s complement data, 5. Multiplication algorithm, Booth’s algorithm, 6. Division algorithm
UNIT III: TOPICS	Register transfer and micro-operations (5L) 1. Register transfer language, 2. Register transfer, 3. Bus system for registers, 4. Memory transfers– memory read, memory write, 5. Micro operations – register transfer micro operations, arithmetic micro operations, logic micro operations, shift micro operations, 6. Binary adder, binary adder, subtractor, binary incrementer, arithmetic circuit for arithmetic micro operations, 7. One stage logic circuit, 8. Selective set, Selective complement, Selective clear, Mask, Insert, Clear
UNIT IV: TOPICS	Basic Computer organization and design (4L) 1. Instruction codes, 2. Direct address, Indirect address & Effective address, 3. List of basic computer registers, 4. Computer instructions: memory reference, register reference & input – output instructions, 5. Block diagram & brief idea of control unit of basic computer, 6. Instruction cycle
UNIT V: TOPICS	Micro programmed control (2L) 1. Control memory, 2. Address sequencing, 3. Micro program examples
UNIT VI: TOPICS	Central processing unit (5L) 1. General register organization, 2. Stack organization, Register stack, Memory stack, Stack operations – push & pop, 3. Evaluation of arithmetic expression using stack, 4. Instruction format, 5.Types of CPU organization (single accumulator, general register & stack organization) & example of their instructions, 6. Three, two, one & zero address instruction, 7. Definition and example of data transfer, data manipulation & program control instructions, 8. Basic idea of different types of interrupts (external, internal & software interrupts), 9. Difference between RISC & CISC
UNIT VII: TOPICS	Pipeline and vector processing (3L) 1. Parallel processing, 2. Flynn’s classification, 3. Pipelining, Example of pipeline, space time diagram, speedup, 4. Basic idea of arithmetic pipeline, example of floating point addition/ subtraction using pipeline



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UNIT VIII: TOPICS	Input – output organization (6L) 1. Peripheral devices, 2. Input – output interface, 3. Isolated I/O, Memory mapped I/O, 4. Asynchronous data transfer: strobe & handshaking, 5. Programmed I/O, 6. Interrupt initiated I/O, 7. Basic idea of DMA & DMAC 8. Input – output processor
UNIT IX: TOPICS	Memory organization (6L) 1. Memory hierarchy, 2. Main memory definition, types of main memory, types of RAM, ROM, difference between SRAM & DRAM, 3. Cache memory, Cache memory mapping – Direct, Associative, Set Associative, 4. CAM, hardware organization of CAM, 5. Virtual memory, mapping using pages, page fault, mapping using segments, TLB, 6. Auxiliary memory, diagrammatic representation of magnetic disk & hard disk drive, 7. Definitions of seek time, rotational delay, access time, transfer time, latency

Suggested Books:

1. Computer System Architecture, M. Morris Mano, PEARSON
2. Computer Organization & Architecture – Designing For Performance, William Stallings, PEARSON
3. Computer Architecture & Organisation, J.P. Hayes, TATA MCGRAW HILL
4. Computer Organization and Architecture, T. K. Ghosh, TATA MCGRAW-HILL
5. Computer Architecture, Behrooz Parhami, OXFORD UNIVERSITY PRESS

PAPER NAME: Data Structure with Python

UNIT I: TOPICS	Introduction to Python (12L) Python variables, expressions, statements: Variables, Keywords, Operators & operands, Expressions, Statements, Order of operations, String operations, Comments, Keyboard input, Example programs Functions: Type conversion function, Math functions, Composition of functions, Defining own function, parameters, arguments, Importing functions, Example programs
UNIT II: TOPICS	Conditions & Iterations (8L) Conditions: Modulus operator, Boolean expression, Logical operators, if, if-else, if-elif-else, Nested conditions, Example programs. Iteration: while, for, break, continue, Nested loop, Example programs
UNIT III: TOPICS	Recursion: Python recursion, Examples of recursive functions, Recursion error, Advantages & disadvantages of recursion Strings: Accessing values in string, Updating strings, Slicing strings, String methods – upper(), find(), lower(), capitalize(), count(), join(), len(), isalnum(), isalpha(), isdigit(), islower(), isnumeric(), isspace(), isupper() max(), min(), replace(), split(), 2.5 Example programs List: Introduction, Traversal, Operations, Slice, Methods, Delete element, Difference



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	<p>between lists and strings.</p> <p>Dictionaries: Introduction, Brief idea of dictionaries & lists</p> <p>Tuples: Introduction, Brief idea of lists & tuples, Brief idea of dictionaries & tuples.</p>
UNIT IV: TOPICS	<p>Data Structure using Array (4L)</p> <p>Stack, queue, circular queue, priority queue, dequeue and their operations and applications.</p>
UNIT V: TOPICS	<p>Searching and Sorting (6L)</p> <p>Searching: linear search, Binary search, their comparison, Sorting: insertion sort, Selection sort. Quick sort, Bubble sort Heap sort, Comparison of sorting methods , Analysis of algorithm, complexity using big 'O' notation</p>
UNIT VI: TOPICS	<p>Linked List (4L)</p> <p>Linear link lists, doubly linked lists, stack using linked list, queue using linked list, circular linked list and their operations and applications.</p>
UNIT VII: TOPICS	<p>Trees (5L)</p> <p>Binary trees, binary search trees, representations and operations, thread representations, sequential representations, B tree , B+ tree,</p>
UNIT VIII: TOPICS	<p>Graphs (5L)</p> <p>Introduction to graphs, Definition, Terminology, Directed, Undirected & Weighted graph, Representation of graphs, Graph Traversal: Depth first search and Breadth first search. Spanning Trees, minimum spanning Tree, Shortest path algorithm</p>
UNIT IX: TOPICS	<p>Hashing (4L)</p> <p>Definition, Hashing functions, Load factor and collision, open addressing (linear probing) and chaining method to avoid collision</p>

Suggested Books:

1. Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser
2. Data Structures and Algorithmic Thinking with Python, Narasimha Karumanchi
3. Python Data Structures and Algorithms: Benjamin Baka

PAPER NAME: Database management System

UNIT I: TOPICS	<p>Database System Concepts & Architecture: Data Independence, Schemas, Instances, Database Languages, Database System Environments Data Models, Basic Structure of Oracle System, Storage Organization in Oracle.</p>
UNIT II: TOPICS	<p>Data Modelling: Use of High –level Conceptual Data Models, ER Diagrams, Subclasses, Super classes and Inheritance, Specialization & Generalization, Conceptual Object Modeling using UML Class Diagrams, Knowledge Representation Concepts,</p>



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	Exercises.
UNIT III: TOPICS	Relational Data Model: Relational constraints, domain constraints, key constraints referential integrity Constraints, relational algebra, fundamental operations of relational algebra & their Implementation, interdependence of operations, example queries.
UNIT IV: TOPICS	ER and EER to Relational Mapping: Mapping EER model concepts to relation, tuple relational calculus, domain relational Calculus queries.
UNIT V: TOPICS	Database Design: Functional dependencies, irreducible sets of dependencies, loss less decomposition, 1st, 2 nd & 3 rd NF, dependency preservation, Boyce Codd NF, Multivalued Dependency & 4th NF, join Dependency & 5 NF, domain key normal form, restriction –union normal form, Denormalization.
UNIT VI: TOPICS	Query Processing And Optimization: SQL Basic Queries in SQL, Sub queries, Retrieving a Query Plan – Table Space Span & I/O, Index Scan, Equal Unique Index Lookup, Clustered vs. Non Clustered Indexing, Index Only Scan, Methods for Joining Tables –Nested Loop Join Merge Join, Hybrid Join, Multiple table Join, Transforming Nested Queries to Joins, Object Relational SQL, Procedural SQL, Introduction to Embedded SQL.
UNIT VII: TOPICS	Transaction: Schedules, Serializability, Precedence Graph, Concurrency Control Techniques, Implementation of Transaction in Programs, Cursors and Transaction, Dynamic SQL, Locking Levels of Isolation, Recovery, Checkpoints.

Suggested Books:

1. Fundamental of Database Systems- Elmasri Navathe- Pearson Education Asia
2. Database- Principles, Programming and Performance- Parick O' Neil Elizabeth O'Neil, Harcourt Asia PTE Limited
3. An Introduction to Database Systems- C.J.Date, Addison Wesley, Pearson EducationPress
4. Database System Concepts- Abraham Silberschat, Henry F. Korth, S.Sudarshan, Tata McGraw Hill.

PAPER NAME: Operating System & System Programming

UNIT I: TOPICS	Introduction : Importance of OS, Basic concepts and terminology, Types of OS, Different views, Journey of a command execution, Design and implementation of OS
UNIT II: TOPICS	Process : Concept and views, OS view of processes, OS services for process management, Scheduling algorithms, Performance evaluation; Inter-process communication and synchronization, Mutual exclusion, Semaphores, Hardware support for mutual exclusion, Queuing implementation of semaphores, Classical problem of concurrent programming, Critical region and conditional critical region, Monitors, Messages, Deadlocks
UNIT III: TOPICS	Storage Management: Memory Management- Backward, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Segmentation with Paging.



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UNIT IV: TOPICS	File-System Interface and Implementation: File Concept, Access Methods, Directory Structure, Protection, File-System Structure, File-System Implementation, Directory Implementation; Allocation Methods, Free-Space Management.
UNIT V: TOPICS	Mass-Storage Structure: Disk Structure; Disk Scheduling; Disk Management; Swap-Space Management
UNIT VI: TOPICS	Assemblers: Elements of Assembly Language Programming, Design of the Assembler, Assembler Design Criteria, Types of Assemblers, Two-Pass Assemblers, One-Pass Assemblers, Single pass Assembler for Intel x86 , Algorithm of Single Pass Assembler, Multi-Pass Assemblers
UNIT VII: TOPICS	Compilers: Causes of Large Semantic Gap, Binding and Binding Times, Data Structure used in Compiling, Scope Rules, Memory Allocation, Compilation of Expression, Compilation of Control Structure, Code Optimization

Suggested Books:

1. Operating Systems, Galvin, John Wiley
2. Operating Systems , Milankovic, TMH
3. An Introduction to Operating System, Bhatt, PHI
4. Modern Operating System, Tannenbaum, PHI
5. Guide to Operating Systems, Palmer, VIKAS
6. Operating Systems, Prasad, Scitech

PAPER NAME: Natural language processing with Python

UNIT I: TOPICS	Introduction and Overview What is Natural Language Processing, Ambiguity and uncertainty in language. The Turing test. Course outline and logistics. Regular Expressions Chomsky hierarchy, regular languages, and their limitations. Finite-state automata. Practical regular expressions for finding and counting language phenomena. A little morphology.
UNIT II: TOPICS	String Edit Distance and Alignment Key algorithmic tool: dynamic programming, first a simple example, then its use in optimal alignment of sequences. String edit operations, edit distance, and examples of use in spelling correction, and machine translation.
UNIT III: TOPICS	Context Free Grammars Constituency, CFG definition, use and limitations. Chomsky Normal Form. Top-down parsing, bottom-up parsing, and the problems with each. The desirability of combining evidence from both directions.
UNIT IV: TOPICS	Non-probabilistic Parsing Efficient CFG parsing with CYK, another dynamic programming algorithm. Also,



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	perhaps, the Earley parser. Designing a little grammar, and parsing with it on some test data.
UNIT V: TOPICS	String Edit Distance and Alignment Key algorithmic tool: dynamic programming, first a simple example, then its use in optimal alignment of sequences. String edit operations, edit distance, and examples of use in spelling correction, and machine translation.
UNIT VI: TOPICS	Information Theory What is information? Measuring it in bits. The "noisy channel model." The "Shannon game"--motivated by language! Entropy, cross-entropy, information gain. Its application to some language phenomena.
UNIT VII: TOPICS	Language modelling and Naive Bayes Probabilistic language modelling and its applications. Markov models. N-grams. Estimating the probability of a word, and smoothing. Generative models of language. Their application to building an automatically-trained email spam filter, and automatically determining the language

Suggested Books:

PAPER NAME: Computer Networks

Module I: (6L)

Definition of computer system, Block Diagram, Components of a computer system, generations of computers, storage devices, Memory Hierarchy, Software, Classification of software, Operating System and its functionalities

Module II: (6L)

Introduction to networking; Data communications: components, data representation (ASCII, ISO etc.), direction of data flow (simplex, half duplex, full duplex); network criteria, physical structure (type of connection, topology), categories of network (LAN, MAN, WAN); Internet: brief history, Protocols and standards; Reference models: OSI reference model, TCP/IP reference model, their comparative study.

Overview of data (analog & digital), signal (analog & digital), transmission (analog & digital) & transmission media (guided & unguided);

Module III: (8L)

Local Area Networks and data link protocols, point-to-point links and sliding window flow control, CSMA/CD, Ethernet, wireless LAN, cellular networks, and advanced multi-user communication (CDMA, SDMA/MIMO), mobility

Internetworking using TCP/IP: network programming using socket API, network client/server design



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Packet/circuit switching and wide-area networks: store-and-forward networks, source routing, virtual/permanent, circuits and call set-up, LAN/WAN addressing, hop-by-hop vs. end-to-end control

Module IV: (10L)

Routing techniques - intra-domain routing (OSPF, RIP), inter-domain policy routing (BGP) and network connectivity

Transport protocols - TCP and UDP, Congestion control, TCP window control, multimedia streaming

High-level network services - DNS, HTTP, SMTP, network management (SNMP), network security

Module V: (10L)

Introduction and history of Internet, WWW, Markup Language: HTML, XML and tags, Scripting Languages, Client-Server Architecture, websites, Internet security and threats, Firewall, Introduction to e-commerce

Text Books:

1. Fundamental of Computers, V. Rajaraman, Prentice Hall India
2. Computer Networks by AS Tanenbaum, Fourth Edition, 2002, Pearson Education
3. Data Communication and Networking by B. Forouzan
4. Data and Communication by W. Stallings
5. Web Technologies: Achyut Godbole, Atul Kahate - McGraw Hill

PAPER NAME: Cloud Computing

Introduction: Cloud computing definition, reference model, Characteristics, Benefits, Challenges, Distributed Systems, Virtualization, Service-oriented computing, Utility-oriented computing, Overview on computing platforms & technologies – AWS, Google App Engine, MS Azure, Hadoop, Salesforce.com, Manjrasoft Aneka

Parallel & Distributed Computing: Parallel vs. Distributed computing, Elements of parallel computing, Parallel processing - hardware architecture & approaches, Concept & Component of Distributed Computing, RPC, Service-oriented computing Virtualization: Cloud reference model – IaaS, PaaS, SaaS, Types of clouds – Public, Private, Hybrid, Community, Cloud interoperability & standards, scalability & fault tolerance, Security, trust & privacy

Concurrent Computing, High-throughput Computing and Data-Intensive Computing: Programming applications with Threads, Thread API, Parallel computation with Threads, Task computing, Frameworks for Task computing, Task-based application model,

Data-intensive computing, characteristics, technology Cloud Platforms and Applications: Overview on Amazon Web Services, Google AppEngine and Microsoft Azure, Cloud applications in scientific, business and consumer Domain

Text Books:

1. Buyya, Vecciola and Selvi, Mastering Cloud Computing: Foundations and Applications Programming, Tata McGraw Hill
2. Rittinghouse and Ransome, Cloud Computing: Implementation, Management, and Security, CRC Press



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3. Aravind Doss, Cloud Computing, Tata McGraw Hill
4. Kris Jamsa, Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security and More, Jones & Bartlett Learning

PAPER NAME: Project – I

PAPER NAME: Project Work II/ Dissertation

To carry out a computer application based project individually or in groups



DISCIPLINE SPECIFIC ELECTIVES (DSE)

DSE – 1: Mathematics –I

UNIT I (10 lectures)

Matrix Algebra- Introduction & definition, properties of matrix, special type of matrices, arithmetic of matrices, symmetric & skew-symmetric matrices, orthogonal matrices, singular and non-singular matrices with their properties, Trace of a matrix, Eigen value and Eigen vector computation, Inverse of a matrix and related properties, numerical problems solving.

UNIT II (10 lectures)

Differential Calculus: Review of limit, continuity and differentiability, L-Hospital rule, Leibnitz rule, successive differentiation, Rolle's theorem, Mean value theorem, Taylor series expansion, Function of several variables, Euler's theorem on homogeneous function, Partial differentiation, Jacobian, Maxima and Minimum of functions of one and two variables.

UNIT III (10 lectures)

Integral Calculus: Review of integration and definite integral. Differentiation under integral sign, double integral, change of order of integration, transformation of variables. Beta and Gamma functions: properties and relationship between them.

UNIT IV (10 lectures)

Differential Equations: Exact differential equations, integrating factors, change of variables, Total differential equations, Differential equations of first order and first degree, Differential equations of first order but not of first degree, Equations solvable for x, y, q, Equations of the first degree in x and y, Clairaut's equations. Higher Order Differential Equations: Linear differential equations of order n, Homogeneous and non-homogeneous linear differential equations of order n with constant coefficients.

SUGGESTED READING:

- Lay David C: Linear Algebra and its Applications, Addison Wesley, 2000.
- Schaum's Outlines: Linear Algebra, Tata McGraw-Hill Edition, 3rd Edition, 2006.
- Searle S.R: Matrix Algebra Useful for Statistics. John Wiley & Sons., 1982.



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- Gorakh Prasad: Differential Calculus, Pothishala Pvt. Ltd., Allahabad (14th Edition - 1997).
- Gorakh Prasad: Integral Calculus, Pothishala Pvt. Ltd., Allahabad (14th Edition - 2000).
- David C. Lay: Linear Algebra and Its Applications, 3rd Edn, Pearson Education, Asia.

DSE – 2: Mathematics II

UNIT I (10 lectures)

Theory of equations, statement of the fundamental theorem of algebra and its consequences. Relation between roots and coefficients or any polynomial equations. Solutions of cubic and biquadratic equations when some conditions on roots of equations are given. Evaluation of the symmetric polynomials and roots of cubic and biquadratic equations. Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem.

UNIT II (10 lectures)

Algebra of matrices - A review, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, unitary, involutory and nilpotent matrices. Adjoint and inverse of a matrix and related properties.

UNIT III (10 lectures)

Determinants of Matrices: Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants. Use of determinants in solution to the system of linear equations, row reduction and echelon forms, the matrix equations $AX=B$, solution sets of linear equations, linear independence, Applications of linear equations, inverse of a matrix.

UNIT IV (10 lectures)

Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Generalized inverse (concept with illustrations). Partitioning of matrices and simple properties. Characteristic roots and Characteristic vector, Properties of characteristic roots, Cayley Hamilton theorem.

SUGGESTED READINGS:

- Lay David C.: Linear Algebra and its Applications, Addison Wesley, 2000.
- Schaum's Outlines : Linear Algebra, Tata McGraw-Hill Edition, 3rd Edition, 2006.
- Krishnamurthy V., Mainra V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V).
- Jain P.K. and Khalil Ahmad: Metric Spaces, Narosa Publishing House, New Delhi, 1973



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- Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International, 1997.
- Gupta S.C.: An Introduction to Matrices (Reprint). Sultan Chand & Sons, 2008.
- Artin M.: Algebra. Prentice Hall of India, 1994.
- Datta K.B.: Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd., 2002.
- Hadley G.: Linear Algebra. Narosa Publishing House (Reprint), 2002.
- Searle S.R.: Matrix Algebra Useful for Statistics. John Wiley & Sons., 1982.