# B.Tech. Computer Science & Engineering

# (Data Science)

COURSE STRUCTURE


## Department of Computer Engineering

### Jamia Millia Islamia

# B. TECH. COMPUTER SCIENCE & ENGINEERING (Data Science)
# COURSE STRUCTURE

**Codes for nature of courses**

**L :** Lecture courses

**P :** Laboratory Based courses

**S:** Seminar

**Category of Courses**

**PCC :** Program Core courses

**Weightage for Course Evaluation**

**L :** Lecture T : Tutorial P : Practical CCA : Continuous Class Assessment MTE :Mid TermExam

**B. TECH. COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE) - I YEAR**

| I Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S.No. | Course No. | Course Name | Type of Course | Credit | Periods/ week | | | Examination Scheme (Distribution of Marks) | | | |
| | | | | | | | | Mid Semester Evaluation | | | End Semester Evaluation | Total Marks |
| | | | | | L | T | P | CCA | MTE-1 | MTE-2 | | |
| **THEORY First SEMESTER** | | | | | | | | | | | | |
| 01 | AST-101 | Communication Skills | Theory (HSMC) | 2 | 2 | - | 0 | 20 | | | 30 | 50 |
| 02 | ASB-101 | Engineering Physics I | Theory (BSC) | 3 | 3 | - | 0 | 30 | | | 45 | 75 |
| 03 | ASB-102 | Engineering Chemistry | Theory (BSC) | 3 | 3 | - | 0 | 30 | | | 45 | 75 |
| 04 | ASB-103 | Engineering Mathematics I | Theory (BSC) | 3 | 3 | - | 0 | 30 | | | 45 | 75 |
| 05 | EES-101 | Basics of Electrical Engineering | Theory (ESC) | 3 | 3 | - | 0 | 30 | | | 45 | 75 |
| 06 | CSS-101 | Fundamentals of Computing | Theory (ESC) | 3 | 3 | - | 0 | 30 | | | 45 | 75 |
| **PRACTICAL (LAB.)** | | | | | | | | | | | | |
| I | ASL-101 | Language Laboratory | Lab (HSMC) | 1 | 0 | - | 2 | 15 | | | 10 | 25 |
| II | ASL-102 | Engineering Physics Laboratory I | Lab (BSC) | 1 | 0 | - | 2 | 15 | | | 10 | 25 |
| III | ASL-103 | Engineering Chemistry Laboratory | Lab (BSC) | 1 | 0 | - | 2 | 15 | | | 10 | 25 |
| IV | MEL-104 | Engineering Graphics & Design | Lab (BSC) | 2 | 0 | - | 4 | 30 | | | 20 | 50 |
| V | CSL-101 | Design Thinking & Idea Lab | Lab (ESC) | 1 | 0 | - | 2 | 15 | | | 10 | 25 |
| | | **Total** | | **23** | **17** | **-** | **12** | **260** | | | **315** | **575** |

| THEORY Second Semester | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | ASB-201 | Engineering Physics II | Theory (BSC) | 3 | 3 | - | 0 | 30 | 45 | 75 |
| 02 | ASB-202 | Engineering Mathematics II | Theory (BSC) | 3 | 3 | - | 0 | 30 | 45 | 75 |
| 03 | ASB-203 | Biology for Engineers | Theory (BSC) | 3 | 3 | - | 0 | 30 | 45 | 75 |
| 04 | ECS-201 | Basics of Electronics & Communication Engg. | Theory (ESC) | 3 | 3 | - | 0 | 30 | 45 | 75 |
| 05 | MES-201 | Engineering Mechanics | Theory (ESC) | 3 | 3 | - | 0 | 30 | 45 | 75 |
| 06 | CES-201 | Basics of Civil Engineering | Theory (ESC) | 3 | 3 | - | 0 | 30 | 45 | 75 |
| 07 | ASM-201 | Constitution of India | Theory (MC-1) | 0 | 2 | - | 2 | - | - | - |
| **PRACTICAL (LAB.)** | | | | | | | | | | |
| I | ASL-201 | Engineering Physics Laboratory II | Lab (BSC) | 1 | 0 | - | 2 | 15 | 10 | 25 |
| II | MEL-201 | Workshop Practice | Lab (ESC) | 2 | 0 | - | 4 | 30 | 20 | 50 |
| III | MEL-202 | Engineering Mechanics Laboratory | Lab (ESC) | 1 | 0 | - | 2 | 15 | 10 | 25 |
| | | **Total** | | **22** | **20** | - | **10** | **240** | **310** | **550** |

# B. TECH. COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE)
# COURSE STRUCTURE

## B. TECH. COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE) - II YEAR

| II Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S.No. | Course No. | Course Name | Type of Course | Credit | Periods /week | | | Examination Scheme (Distribution of Marks) | | | |
| | | | | | | | | Mid Semester Evaluation | | | End Semester Evaluation | Total Marks |
| | | | | | L | T | P | CCA | MTE-1 | MTE-2 | | |
| **THEORY Third Semester** | | | | | | | | | | | | |
| 01 | ASM-301 | Universal Human Values | **MC-II** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 02 | ASB-301 | Engineering Mathematics III | **BSC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 03 | DSC-301 | Discrete Mathematics – PCC1 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 04 | DSC-302 | Data Structure- PCC2 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 05 | DSC-303 | Digital Logic Design – PCC3 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 06 | DSC-304 | Database Management System- PCC4 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| **PRACTICAL (LAB.)** | | | | | | | | | | | | |
| I | DSL-301 | Data Structure Lab- PCL1 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| II | DSL-302 | Digital Logic Design Lab– PCL2 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| III | DSL-303 | C Programming Lab – PCL3 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| IV | DSL-304 | Database Management System Lab – PCL4 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| | | **Total** | | **22** | **18** | **-** | **6** | **240** | | | **310** | **550** |
| | | | | | | | | | | | | |
| **THEORY Fourth Semester** | | | | | | | | | | | | |
| 01 | ASM-401 | Environmental Science | **MC-III** | 2 | 2 | - | - | 20 | | | 30 | 50 |
| 02 | DSC-401 | Data Mining – PCC5 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 03 | DSC-402 | Computer Organization & Architecture- PCC6 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 04 | DSC-403 | Operating System - PCC7 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 05 | ASM-402 | Essence of Indian Traditional Knowledge | **MC-IV** | 0 | 2 | - | - | | | | | |
| 06 | AST-401 | Operations Research OEC-1 | **HSMC (OEC I)** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 07 | AST-402 | Economics OEC-2 | **HSMC (OEC II)** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| **PRACTICAL (LAB.)** | | | | | | | | | | | | |
| I | DSL-401 | Data Mining Lab - PCL5 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| II | DSL-402 | Python Programming Lab – PCL6 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| III | DSL-403 | Operating System & Linux Lab – PCL7 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| IV | ASL-401 | Numeric and Scientific Computing Lab. | **ESC** | 2 | - | - | 4 | 30 | | | 20 | 50 |
| | | **Total** | | **22** | **19** | **-** | **10** | **245** | | | **305** | **550** |

# B. TECH. COMPUTER SCIENCE & ENGINEERING (Data Science)

## COURSE STRUCTURE

### B. TECH. COMPUTER SCIENCE & ENGINEERING (Data Science) – III YEAR

| S.No. | Course No. | Course Name | Type of Course | Credit | Periods/ week | | | Examination Scheme (Distribution of Marks) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Mid Semester Evaluation | | | End Semester Evaluation | Total Marks |
| | | | | | L | T | P | CCA | MT E-1 | MT E-2 | | |
| **THEORY Fifth Semester** | | | | | | | | | | | | |
| 01 | DSE-501 | Introduction to Machine Learning – PEC1 | **PEC (CBCS)** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 02 | DSC-501 | Automata Theory – PCC8 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 03 | DSC-502 | Data Analytics - PCC9 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 04 | DSC-503 | Computer Networks - PCC10 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 05 | DSC-504 | Software Engg - PCC11 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 06 | DSC-505 | Object Oriented Programming – PCC12 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| **PRACTICAL (LAB.)** | | | | | | | | | | | | |
| I | DSL-501 | Object Oriented Programming Lab - PCL8 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| II | DSL-502 | Machine Learning Lab - PCL9 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| III | DSL-503 | Computer Network Lab - PCL10 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| IV | DSL-504 | Data Analytics Lab - PCL11 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| | | **Total** | | **22** | **18** | **-** | **8** | **240** | | | **310** | **550** |
| | | | | | | | | | | | | |
| **THEORY Sixth Semester** | | | | | | | | | | | | |
| 01 | DSC-601 | Analysis and Design of Algorithms - PCC13 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 02 | DSC-602 | Compiler Design PCC14 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 03 | DSC-603 | Data Visualization – PCC15 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 04 | DSC-604 | Artificial Intelligence – PCC16 | **PCC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 05 | DSE-605 | Deep Learning- PEC II | **PEC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| **PRACTICAL (LAB/SEMINAR)** | | | | | | | | | | | | |
| I | DSL-601 | Compiler Design Lab PCL12 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| II | DSL-602 | Artificial Intelligence Lab - PCL13 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| III | DSL-603 | Deep Learning Lab - PCL14 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| IV | DSL-604 | Data Visualization Lab - PCL15 | **PCC** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| V | DSL-605 | Seminar | **PROJ** | 1 | - | - | 2 | 15 | | | 10 | 25 |
| | | **Total** | | **20** | **15** | **-** | **10** | **225** | | | **275** | **500** |

# B. TECH. COMPUTER SCIENCE & ENGINEERING (Data Science)

# COURSE STRUCTURE

## B. TECH. COMPUTER SCIENCE & ENGINEERING (Data Science) – IV YEAR

| S.No. | Course No. | Course Name | Type of Course | Credit | Periods/ week | | | Examination Scheme (Distribution of Marks) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Mid Semester Evaluation | | | End Sem. Evaluation | Total Marks |
| | | | | | L | T | P | CCA | MTE-1 | MTE-2 | | |
| **THEORY Seventh Semester** | | | | | | | | | | | | |
| 01 | DSE-70x | PEC III | **PEC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 02 | DSE-70x | PEC IV | **PEC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 03 | DSE-70x | PEC V | **PEC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 04 | DSE-70x | PEC VI | **PEC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 05 | DSO-70x | OEC III | **OEC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| **PRACTICAL (LAB./MINOR PROJECT)** | | | | | | | | | | | | |
| I | DSP-792 | Summer Internship | **PROJ** | 2 | - | - | 4 | 30 | | | 20 | 50 |
| II | DSP-793 | Minor Project | **PROJ** | 3 | - | - | 6 | 45 | | | 30 | 75 |
| | | **Total** | | **20** | **15** | **-** | **10** | **225** | | | **275** | **500** |
| | | | | | | | | | | | | |
| **THEORY Eighth Semester** | | | | | | | | | | | | |
| 01 | DSO-80x | OEC IV | **OEC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| 02 | DSO-80x | OEC V | **OEC** | 3 | 3 | - | - | 30 | | | 45 | 75 |
| **PRACTICAL (LAB./MAJOR PROJECT)** | | | | | | | | | | | | |
| 06 | DSP-891 | Major Project | **PROJ** | 6 | - | - | 12 | 90 | | | 60 | 150 |
| | | **Total** | | **12** | **6** | **-** | **12** | **150** | | | **150** | **300** |

## List of Electives:

| Electives in VII$^{th}$ Semester | Electives in VIII$^{th}$ Semester |
|---|---|
| DSE -701: CV and Image Processing<br>DSE -702: Soft Computing<br>DSE -703: Cloud Computing<br>DSE -704: Social Network Analysis<br>DSE -705: NLP and Information Extraction<br>DSE -706: Artificial Neural Networks<br>DSE -707: Advanced Deep Learning<br>DSE -708: Embedded System<br>DSE -709: Parallel & Distributed Computing<br><br>**To be added as and when required** | DSO -801: Network Security<br>DSO -802: Blockchain Technology & its Application<br>DSO -803: Software Testing<br>DSO -804: Mobile Computing & IoT<br>DSO -805: Advanced Graph Theory<br><br>**To be added as and when required** |

- **Total Credits from III$^{rd}$ to VIII$^{th}$ Semester : 118**
- **Total Credits from I$^{st}$ to VIII$^{th}$ Semester : 163**
- **Total Marks from III$^{rd}$ to VIII$^{th}$ Semester : 2950**

## Honours/Specialization 1: Data Science

| S. No. | Code | COURSE NAME | Semester | COURSE TYPE | | Credit | L | T | P | HRS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DSH-411 | Mathematical Foundation for Data science | IV | Theory + Lab | PC | 4 | 2 | 1 | 2 | 5 |
| 2 | DSH-511 | Image and Video Analytics | V | Theory + Lab | PC | 4 | 2 | 1 | 2 | 5 |
| 3 | DSH-611 | Big Data Analytics | VI | Theory + Lab | PC | 4 | 2 | 1 | 2 | 5 |
| 4 | DSH-711 | Optimization Techniques | VII | Theory | PC | 3 | 2 | 1 | 0 | 3 |
| 5 | DSH-811 | Generative AI | VIII | Theory | PC | 3 | 2 | 1 | 0 | 3 |
| | | | | | Total | 18 | 10 | 5 | 6 | 21 |

## Minor Degree: Computer and Artificial Intelligence

| S. No. | Code | COURSE NAME | Semester | COURSE TYPE | | Credit | L | T | P | HRS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DSC-402 | Database Management System | IV | Theory + Lab | PC | 4 | 2 | 1 | 2 | 5 |
| 2 | DSC-503 | Computer Networks | V | Theory + Lab | PC | 4 | 2 | 1 | 2 | 5 |
| 3 | DSC-603 | Artificial Intelligence | VI | Theory + Lab | PC | 4 | 2 | 1 | 2 | 5 |
| 4 | DSC-703 | Soft Computing | VII | Theory | PC | 3 | 2 | 1 | 0 | 3 |
| 5 | DSC-803 | Data Analytics | VIII | Theory | PC | 3 | 2 | 1 | 0 | 3 |
| | | | | | Total | 18 | 10 | 5 | 6 | 21 |

## (CSS-101/201) FUNDAMENTALS OF COMPUTING

| | | | |
|---|---|---|---|
| **L** | **T** | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |

**Duration of Exam : 3 Hours**

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**UNIT 1: BASICS OF COMPUTERS**

Computer fundamentals, Bits and Bytes, CPU, Memory, Types of memory, Input and output devices, Operating system, application software, system software, generation of computer, classification of computer.

Number system: decimal number system, binary number system, octal number system, hexadecimal number system.

**UNIT 2: INTRODUCTION TO C PROGRAMMING**

Introduction to Programming Language, Compiler, Interpreter, Algorithms, flow chart, C character set, C-tokens: constants, variable, keywords, Data types, operator and expressions.
Decision controls: if-else, if-else ladder, nested if-else, conditional operator, switch case.

**UNIT 3: LOOP AND ARRAY**

For loop, while loop and do-while loop, continue and break statement, Function: inbuilt and user defined functions, call by value and call by reference, Array: Single dimensional array. 2D array, multidimensional array, Operations on array.

**UNIT 4: SEARCHING AND SORTING**

Pointers, searching and sorting, Searching techniques: linear search, binary search, Sorting techniques: bubble sort, selection sort, Strings, library string functions.

**UNIT 5: OPERATING SYSTEM & NETWORKING**

OS definition, role of OS in computer system, multi programming, time sharing OS, multitasking OS, multiprocessing OS, real time system OS, client server computing, distributed OS, functions of OS.

Computer Network, transmission media, network topologies, LAN, WAN, MAN, Internet, ISP, WWW, Email, URL, Web browsers, websites, intranet. Latest technologies in IT.

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References / Text Books:


- Herbert Schildt C-The Complete Reference., Tata McGraw Hill Edition
- Ritchie, D. M., Kernighan, B. W., & Lesk, M. E. (1988). The C programming language. Englewood Cliffs: Prentice Hall.

- Kamthane, A. N. (2011). Programming in C, 2/e. Pearson Education India.
- Doja, M. N. (2005). Fundamentals of Computers and Information Technology
- Yashwant, K. Let us C. 8th edition, BPB publication.
- Balagurusamy, E. (2012). *Programming in ANSI C*. Tata McGraw-Hill Education.


## DSC-301: DISCRETE MATHEMATICS

| | | | |
|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT 1: ALGEBRAIC STRUCTURES**

Review of Relations, Equivalence Relations, Partial Orders, Lattices, Characteristics Function. Algebraic Structure: Semi-Groups, Monoids, Groups, Permutation Groups, Cyclic Groups, Normal subgroups, Group Isomorphism, Rings, Fields, Integral Domain.

**UNIT 2: GRAPH THEORY**

Definition and properties of graphs, directed and undirected graphs, degree sequence, cycles, path, connectivity, adjacency matrix, incidence matrix. Complete graphs, Regular graphs, Bipartite graphs, Planar graphs. Graph Isomorphism. Euler circuit, Hamiltonian circuit. Coloring of graphs- Welch-Powell algorithm.

**UNIT 3: RECURRENCE RELATIONS**

Introduction, Generalized linear homogenous/non-homogenous recurrence relations, common recurrence relations. Solving recurrence relations: Iteration method, characteristic equation method. Introduction to generating functions. Solving recurrences using generating functions.

**UNIT 4: MATHEMATICAL TECHNIQUES**

Propositional Calculus, Principle of Inclusion and Exclusion, Principle of Mathematical Induction, Pigeon Hole Principle, Permutation and Combination, Derangements, Recursive Functions.

**UNIT 5: LINEAR PROGRAMMING PROBLEMS**

Introduction to Linear Programming Problems, Modeling and Formulation of LPP, Solution of LPP: Graphical methods, Simplex algorithm. Duality principle, Finding Duals of LPPs.

**BOOKS:**


1. K. H. Rosen, Discrete Maths and its Applications, McGraw Hill International Editions.

2. C. L. Liu, Elements of Discrete Mathematics, McGraw Hill International Editions.
3. Thomas Koshy, Discrete Maths with Applications, Elsevier Academic Press.
4. E. G. Goodaire, Discrete Maths with Graph Theory, Pearson.
5. J L Mott, AKandel, T P Baker, Discrete Maths for Computer Scientists & Mathematicians, Pearson.
6. Kolman, Ross & Busby, Discrete Mathematical Structures, Pearson
7. K. D. Joshi, Foundations of Discrete Maths, Wiley Eastern Ltd.

## DSC- 302: DATA STRUCTURES

| | | | |
|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT 1:**
Definition of Data Structure, Types & characteristics of Data structures, Abstract Data Type (ADT), Algorithms, Space and Time complexity, Characteristics of an array, Implementation of 1-D arrays, Row and Column Major Implementations of 2-D, 3-D and n-D arrays, Advanced concept of Pointers in C, Dynamic allocation of Memory.

**UNIT 2:**
Stack as an ADT, operations on stack, Stack implementation using array and linked list, Applications of Stack: Polish and reverse Polish notations, Recursion, Garbage collection. Queue as ADT, Operations on queue, and Types of queues: Linear Queue, Circular Queue, Priority Queue, and Double Ended Queue, Applications of Queue.

**UNIT 3:**
Concept of a Linked List, Linear Single and Double link lists, Circular Single and Double link List, Header Linked list, Applications of Link List.

**UNIT 4:**
Tree, Tree as ADT, binary trees, Operations on tree, Binary Search Tree, Tree traversal Algorithms, Types of Binary tree, AVL Trees, Heap Tree, Expression tree, B – Tree and B+ Tree.

**UNIT 5:**
Graph: Different terminology associated with Graphs, Types of graphs – directed/undirected, connected/disconnected, cyclic/acyclic, Representation of graphs: Adjacency matrix, Incidence Matrix, linked list. Graph Traversal algorithm, Graph algorithms, Minimum Spanning Tree – Prim's and Kruskal's Algorithm, Sorting Algorithms

**Recommended Books:**

- Data Structure, Seymour Lipschutz, Schaumn Series, Tata McGraw publications.
- An Introduction to Data Structure with Applications by Trembley and Sorenson, McGraw Hill education.
- Fundamentals of Data Structure in C by Horowitz, Sahni and Anderson-Freed, University Press.
- Data Structure and Algorithm – John Beidler, Springer.

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## DSC- 303: DIGITAL LOGIC DESIGN

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |

**Duration of Exam : 3 Hours**

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**UNIT 1: BOOLEAN ALGEBRA AND LOGIC GATES**

Introduction, Binary numbers, Base-conversions, Octal and hexadecimal numbers, complements, binary codes, concept of fixed and floating point numbers, Axiomatic definition of Boolean Algebra, Basic Theorems and properties Boolean frictions and representation in canonical and standard forms, SOP and POS forms, other logic operations,

**UNIT 2 FUNCTION MINIMIZATION**

Digital logic gates. Karnaugh map methods, limitations of K-maps for larger variables, POS-simplification, NAND/NOR implementation, other 2-level implementations, Don't-care conditions, Tabular method.

**UNIT 3: COMBINATIONAL SYSTEMS-1**

Hardware aspect of arithmetic logic functions, Half-Adder, Full-Adder, Binary Adder/Subtractor, Decimal Adder

**UNIT 4: COMBINATIONAL SYSTEMS-II**

Magnitude Comparator, De-multiplexer, Multiplexer, encoder, Priority Encoder, Parity Checker/Generator,

**UNIT 5: SEQUENTIAL SYSTEMS**

Definition and state representation, Filip-Flops, RS, D, JK-M/S, their working characteristics, State Tables, Excitation Taties and triggering Asynchronous and Synchronous Counters-Design and Analysis, Counter Applications, Description and Operations of Shift Registers, Shift Register/Counters

**Books :**

- W.I. Fletcher, "An Engineering Approach to Digital Design", PHI, 1990.
- R.J. Tocci, "Digital Systems: Principles, and Applications", PHI 1990.
- T.C. Bartee, "Digital Computer Fundamentals", McGraw Hill, 1994.

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**DSC- 304: DATABASE MANAGEMENT SYSTEMS**

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT 1: INTRODUCTORY CONCEPT OF DBMS**

Introduction and application of DBMS, Data Independence, Database System Architecture – levels, Mapping, Database users and DBA, Entity – Relationship model, constraints, keys, Design issues, E-R Diagram, Extended E-R features- Generalization, Specialization, Aggregation, Translating E-R model into Relational model, Introduction to TRC,DRC,RA

**UNIT 2: DATA BASE DESIGN**

Dependency and Normal forms-dependencies theory-functional dependencies-Armstrong Axiom of FD's-closure set of FD's- minimal covers Definition of 1NF-2NF-3NF and BCNF-decomposition and desirable properties of them-algorithm of 3NF and BCNF normalization 4 NF and 5 NF

**UNIT 3: STRUCTURED QUERY LANGUAGE (SQL and PL/SQL)**

**SQL**: Introduction to SQL constructors (SELECT FROM, WHERE GROUP BY HAVING ORDRDBY), Insert, Delete, Update, DROP, VIEW, Nested Quires, Integrity Constraint: Not null, unique, check, primary key foreign key,

**PL/SQL**: Variables literals, datatype, advantages of PL/SQL: control statements: if; iterative control loop, while, for, goto, function, cursor, trigger, View.

**UNIT 4: TRANSACTION MANAGEMENT**

Concept of transaction processing, ACID properties, Concurrency control, locking based protocol, Time stamp based protocol,

**UNIT 5: ADVANCE DATABASES AND ITS EMERGING AREAS**

Introduction to No SQL, Cloud Based DBMS, , Open source Data Base, Distributed Database, Object oriented Database, Mobile Database, Multimedia Database, Open Issues and Uncertainties.

**Reference Books:**


- "Fundamentals of Database Systems", Elmasri, Navathe, Pearson Education, IVth Edition. Pearson Education.
- "Database system concepts", Henry F Korth, Abraham Silberschatz, S. Sudurshan, McGraw-Hill.
- "An Introduction to Database Systems", C.J.Date, Pearson Education.
- "Data Base System", Michael kifer and et all, Pearson Education..
- "Database Management Systems" ,Ramakrishnan, Gehrke;Mcgraw-Hill.
- "The Database Book –Principle and Practice" By NarainGehani, University Press.
- "A first course in Database Systems", Jeffrey D. Ullman, Jennifer Windon, Pearson Education.


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**DSE-401: DATA MINING**

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |

**Duration of Exam : 3 Hours**

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**UNIT 1:**

**Introduction to Data Mining:** KDD, Process and Data Mining; KDD Steps; Types of Data for Data Mining, Data Mining Functionalities, Overview of data mining techniques.

**Data Preprocessing:** Introduction to Data Preprocessing; Descriptive Data Summarization: Measuring and Central Tendency and Dispersion of Data; Visualization of Descriptive Data Summaries; Data Cleaning: Handling Missing Values, Filtering Noisy Data – Binning Method; Data Integration; Data Transformation: Smoothing, Aggregation, Generalization, Normalization and Feature Selection; Data Reduction. Corerelation analysis

**UNIT 2:**

**Association Rule Mining:** Market basket Analysis; Frequent Item sets, Closed Item sets, and Association Rules; Support and Confidence; Apriori Algorithm for Mining Frequent Itemsets Using Candidate Generation; Generating Association Rules from Frequent Item sets; Improving the Efficiency of Apriori Algorithm; FP-Growth Algorithm for Mining Frequent Item sets without Candidate Generation; Mining Closed & Max Frequent Itemsets;

**UNIT 3:**

**Basic Classification:** Introduction to Classification and Prediction; Classification by Decision Induction; Attribute Selection Measures: Information Gain, Gain Ratio, and Gini Index; Tree Pruning; Bayesian Classification: Bayes'Theorem, Naïve Bayesian Classification

**UNIT 4:**

**Advanced Classification:** Bayesian Belief Networks; Classifier Accuracy Measures:

Sensitivity, Specificity, Precision, and Accuracy; Predictor Error Measures; Accuracy Evaluation Methods: Holdout, Random Sub sampling, Cross-validation, and Bootstrap Bagging and Boosting; Lazy Learners: K-Nearest- Neighbour Classifier; Prediction: Introduction to Linear and Non-Linear Regression.

**UNIT 5:**

**Cluster Analysis:** Introduction to Cluster and Clustering; Features Required for Clustering Algorithms; Data Types and Dissimilarity Measures in Cluster Analysis; Categorization of Clustering Methods; Partitioning-Based Clustering: k-means Algorithms, k-Medoids algorithms, Hierarchical Clustering: Agglomerative and Divisive Methods.
Introduction to Web Mining and Text mining, Problem discussion.

**Recommended Books:**

- Data Mining by Hanand Kamber, Elsevier Publication.
- Introduction to Data Mining by Tan, Steinba chand Kumar, Pearson Publication.
- Practical Machine Learning Tools and Techniques with Java Implementations by H. Witten and E. Frank Morgan Kaufmann.
- Advances in Knowledge Discovery and Data Mining by U. M. Fayyad, G. Piatetsky-Shapiro, P. Smyth, and R. Uthurusamy, MITPress.

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## DSC-402: COMPUTER ORGANIZATION AND ARCHITECTURE

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**Unit 1: INTRODUCTION TO COMPUTER ORGANIZATION**

Introduction, Basic Computer Organization – CPU, Memory, I/O, Performance Metrics, CPU organization - ALU, CU, Registers, Von Neumann Principle, Machine Instructions, Instruction Execution Cycle, Register Transfer and Micro-operations, Hardware Design of Micro-operations.

**Unit 2: PROCESSOR DESIGN**

Processing Unit – Instructions and Operations, Design of Microarchitectures, Single Cycle Data Path Design and Control, Design

**Unit 3: PROCESSING DESIGN– II**

Design of Microprogrammed Control, Microprogram Sequencer, Design of Microprogrammed Control, Horizontal and Vertical Microprogram.

**Unit 4: MEMORY SUBSYSTEM**

Memory Organization - Memory Hierarchy, Concept of Cache Memory, Mapping Techniques, Cache Organization and Design, Replacement Algorithms, Write Policies, Main Memory Unit - Internal organization of a Memory chip, Interleaved Memory, DRAM Chip Design.

**Unit 5: INPUT/OUTPUT SUBSYSTEM**

Access of I/O devices, I/O ports, I/O interfaces, Program controlled I/O, Interrupt controlled I/O, DMA controlled I/O.

**Text Books:**

- John D. Carpinelli **"Computer Systems Organization and Architecture"** Pearson Education.
- William Stallings, **"Computer Organization and Architecture: Designing for Performance"**9th Edition, Pearson Education, 2013.
- M. Morris Mano, **"Computer System Architecture"** Prentice Hall, 1993

**Reference Books:**

- D.A. Patterson and J.L. Hennessy, "**Computer Organization and Design, the Hardware/Software Interface**", Morgan Kaufmann, 1994.
- V.C.Hamacher, Z.G. Vranesic and S.G. Zaky, **"Computer Organization"**, 4th edition, McGraw Hill, 1996.

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**DSC- 403: OPERATING SYSTEM**

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT – I INTRODUCTION TO OS**

Introduction to OS, Multiprogramming, Time-sharing System, Operating System Operation, Dual Mode Operation: Kernel Mode, User Mode. Function of OS, Operating System Services, thread, multithreading model, System Call, Types of System calls, Operating system structure, The Process, Process State, Process Control Block, Process Scheduling, Operations on Processes, Schedulers and its types, Scheduling Criteria,

**UNIT- II PROCESS SCHEDULLING**

Scheduling Algorithms: First Come, First Served (FCFS), Shortest Job First(SJF), Shortest Remaining Time First(SRTF) , Longest Job First(LJF) , Longest Remaining Time First(LRTF), Highest Response Ratio Next (HRRN), Priority Scheduling, Round Robin

Scheduling, Multilevel Queue Scheduling(MLQ), Multilevel Feedback Queue(MLFQ) Scheduling, Multiprocessor Scheduling

**UNIT- III MEMORY-MANAGEMENT STRATEGIES**

Background: Basic Hardware, Address Binding, Logical vs. Physical Address Space. Swapping, Contiguous Memory Allocation, fixed partition, Best-Fit, First-Fit and Worst-Fit Memory Allocation Method, dynamic partitioning, compaction, Buddy System, fragmentation-internal and external , Non-Contiguous Allocation, Paging, hardware support for paging, Translation Look Aside Buffer, Structure of Page Table, Hierarchical Paging, Hashed Page Table, Inverted Page Table, Segmentation, Segmentation with paging, Virtual Memory: Background, swapping, Demand paging, Page Replacement Algorithms, First in First out(FIFO),Least-recently-used( LRU), optical page replacement, Least Frequently Used(LFU), Belady's Anomaly

**UNIT- IV SYNCHRONIZATION AND DEADLOCK**

The Critical- Section Problem, Race condition, Synchronization Hardware, Peterson's Solution, Semaphores, Mutex and Classical Problems of Synchronization: Bounded- Buffer Problem, The Reader- Writers Problem, Sleeper barber problem, Dining- Philosophers Problem, Deadlock characterization, Methods for handling deadlocks, Deadlock Prevention, Deadlock Avoidance, Banker's Algorithm, Deadlock Detection, Recovery from Deadlock

**UNIT – V FILE-SYSTEM INTERFACE AND MASS- STORAGE STRUCTURE**

File Concept, Access methods, Allocation Methods. Secondary Storage Disk- structure, Disk- scheduling: FCFS, SSTF, SCAN, C-SCAN,LOOK,C-LOOK Scheduling algorithms

**References / Text Books:**


- Operating system concepts: Silberchatz Galvin, Gagne: john Wiley & Sons, inc.2007
- Operating systems: A Concept-based approach: D M Dhamdhere 2nd edition TMH 2007
- Operating systems: Deitel Deitel Choffnes 3rd edition Pearson Education 2007
- Milenkovic, Milan: Operating system concepts and Design, McGraw Hill, 1994.e.g. Mac or Linux Operating System, Bash Shell, Gedit, GCC
- http://quiz.geeksforgeeks.org/


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**DSE-501: INTRODUCTION TO MACHINE LEARNING**

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| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT I**

Introduction of Machine Learning, AI, ML and DL, Types of machine learning, fundamental of machine learning, challenges in Machine Learning, Application of ML, ML development life cycle (MLDLC), Concept Learning Task, Concept Learning as Search, Finding a Maximally Specific Hypothesis, Version Spaces ,List-Then-Eliminate algorithm, Find S Algorithm, and the Candidate Elimination Algorithm

**UNIT II**

Linear Regression, Regression Metrics, MAE, MSE, RMSE, R squared , Adjusted R squared, Multiple Regression, Gradient descent, Batch Gradient , Stochastic Gradient , Mini Gradient, Polynomial Regression, Bias, variance, bias-variance trade-off, regularization techniques, Regularization Methods, Lasso Regression, Ridge Regression, Elastic Net Regression, Logistic regression, classification evaluation metrics, Accuracy, confusion matrix, Precision, Recall, F1-Score, macro and weighted F1-Score, SoftMax regression or multinomial logistic regression, polynomial logistic regression

**UNIT III**

Dimensionality reduction, Subset selection, Forward selection, Backward selection, Principal component analysis , Linear Discriminant Analysis, Fisher's criterion, t-Distributed Stochastic Neighbor Embedding (t-SNE), Independent Component Analysis

**UNIT IV**

Neural Network based machine Learning, McCulloch-Pitts Neuron Model, Boolean Functions Using M-P Neuron, The Perceptron, Logistic regression using perceptron , Activation Functions, Multilayer Perceptron(MLP), Multilayer Forward propagation , Back Propagation: Input, output and hidden layer computation, Memorization

**UNIT V**

Introduction to Thompson Sampling, Reinforcement Learning, Markov Decision Process, Q-learning, Bellman Equation, Meta-Learning in Machine Learning, AUC ROC Curve in Machine Learning, cross-validation methods such as leave-one-out (LOO) cross-validation, k-folds Cross validation

**BOOKs:**


- Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)

- Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007
- Deep Learning, by Goodfellow, Bengio, and Courville.
- The Hundred-Page Machine Learning Book by Andriy Burkov by Andriy Burkov
- Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Third Edition

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**DSC- 501: AUTOMATA THEORY**

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| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT 1: INTRODUCTION TO FINITE AUTOMATA**

Introduction to Finite Automata, strings, alphabets and languages, graphs & trees, state tables & diagram, NDFA & DFA concepts, Conversion of NFA to DFA, Minimization of FA, Mealy & Moore machines.

**UNIT 2: REGULAR EXPRESSION**

Introduction to Regular Expressions, Identities for Regular expressions, Arden's Theorem, Conversion of Finite Automata to Regular Expression, properties of regular languages. Pumping Lemma for Regular sets.

**UNIT 3: CONTEXT FREE GRAMMARS& LANGUAGES**

Introduction to Grammars and Languages, Chomsky Classification of languages, Context free Grammar, Left Most & Right Derivations, Derivation tress, Ambiguity, Simplification of CFG, Conversion to Chomsky Normal Form.

**UNIT 4: PUSH DOWN AUTOMATON**

Introduction to Push Down Automaton (PDA) for Context Free languages, Basic Design of a PDA, Instantaneous configuration of PDA, Construction of PDA for Context free languages, conversion from CFG to PDA.

**UNIT 5: TURING MACHINES &COMPUTABILITY**

Introduction to Turing Machines (TM), Computing with Turing Machines, Non-deterministic TM, Primitive Recursive functions**,** Halting Problem of the TM, Computability and Types of Problems in Computer Science.

**Books:**

- J.E. Hopcroft & J.D. Ullmann, "Introduction to Automata Theory Language and Computation", Narosa Publications.
- K. L. P. Mishra & Chandrasekaran, “Theory of Computer Science: Automata, Languages and Computation”, 3rd Edition, PHI
- H.R. Lewis & C.H. Papadimitrou, "Elements of the Theory of Computation", PHI
- John C. Martin, "Introduction to Languages and the Theory of Computation", McGraw-Hill International
- D.A. Cohen, "Introduction to Computer Theory", John Wiley.


## DSC-502- DATA ANAYTICS

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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UNIT- 1

Data Analysis Fundamentals: Data Analysis foundations – Univariate, Bivariate and Multivariate Analysis; Graph Data, Kernel Methods; Working with High Dimensional data; Dimensionality reduction methods.

UNIT- 2

Frequent Pattern Mining: Constraint based mining, Subspace clustering, Sequence Mining, Graph Pattern Mining.

UNIT – 3

Advanced Classification Rule Mining: Support Vector Machines, Random forest and gradient boosting, Neural networks.

UNIT – 4

Cluster Analysis: Hierarchical clustering, Density based clustering, spectral clustering. EM Clustering; Introduction to Graph Clustering.

UNIT – 5

Advanced topics in Data Mining: Time series Analysis and Mining: Topic modelling, Time series data preprocessing, Forecasting models, Trend analysis, Opinion mining

**Books:**


1. Zaki and Meira : Data Mining & Analytics – Cambridge University Press, 3rd Edition.
2. Ethem Alpaydin : Introduction to Machine Learning – MIT Press, 3rd Edition
3. Jiawei Han, Micheline Kamber: *Data Mining Concepts and Techniques*, 2nd Edition, Morgan Kaufman Publishers.
4. Tan, Steinbach and Kumar: Introduction to Data Mining – Pearson Publication.

## DSC- 503: COMPUTER NETWORKS

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |

**Duration of Exam : 3 Hours**

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**UNIT 1: INTRODUCTION**

Introduction to Computer Networks, LAN, MAN, WAN, Uses of Computer Networks, LAN Technologies- Transmission Topologies, Access methods. Network Architecture, Protocol and standards, References Model: OSI-ISO and TCP/IP, Overview: Circuit switching, Message switching and Packet switching.

**UNIT- 2: THE DATA LINK LAYER**

Data Link Layer design issues, Framing, Error Detection and Correction, Flow control Protocols, Stop and Wait protocol, Sliding - window flow control, Error control, stop and wait ARQ, Go-back-N, Selective repeat ARQ, Examples of Data link Protocols- HDLC.

**UNIT- 3: THE MEDIUM ACCESS CONTROL SUB LAYER**

The channel allocation problem, ALOHA, Multiple access Protocols, Collision free Protocols, IEEE Standards for LANs and MANs, Wireless LAN: IEEE 802.11, High speed LANs.

**UNIT – 4: THE NETWORK LAYER**

Addressing in IPV4: Classful addresses, CIDR notation, Classless addresses, Special addresses, Network Design: Sub-netting and Super-netting, Network Address Translation, IPV6.

**UNIT – 5: ROUTING ALGORITHMS**

Routing Algorithms-Dijsktra's, Distance vector: RIP, Link state: OSPF, BGP,Multicast Routing, and Hierarchical Routing. Delivering and forwarding of IP Packets, Datagram.

**Books :**


- B.A. Forouzan, " Data Communication and Networking", TMH, 5TH Edition.
- A.S. Tanebaum, " Computer Networks", 4th Edition Pearson Education.
- W. Stallings, " Data and Computer Communication", 7th Edition , Pearson Education.
- Comer E. Doughlas, " Computer Networks and Internet", 2nd Edition Pearson Education.


## DSC- 504: SOFTWARE ENGINEERING

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| **L** | ] | **Internal:** | **30 Marks** |

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| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |

**Duration of Exam : 3 Hours**

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**Unit 1:**

Introduction Definition, Program Vs Software, Software processes, Software life cycle models: Build and Fix, Waterfall, Prototype, Iterative Enhancement Model, Evolutionary and Spiral model, V Model & RAD Model.

**Unit 2:**

Software Project Planning. Crucial process steps of Requirement Engineering, Types of requirements, Requirement Elicitation techniques and Requirement Documentation, SRS, COCOMO model, Risk management.

**Unit 3:**

Software Requirement Analysis and Specifications, Design & Software Reliability. Problem Analysis, Data Flow Diagrams, use case diagrams, Software Prototyping, Cohesion & Coupling, Classification of Cohesiveness & Coupling, Function Oriented Design, Object Oriented Design, User Interface Design. Software Reliability: Failure and Faults, Overview of Quality Standards like ISO 9001, SEI-CMM

**Unit 4:**

Software Testing Software Testing terminology, Functional testing: Boundary value analysis, Equivalence class testing, Cause- effect graphing, Structural testing: path testing, Data flow and mutation testing, unit testing, integration and system testing, Validation testing Debugging techniques & Approaches and Testing Tools.

**Unit 5:**

Software Maintenance Software Maintenance & its types: Management of maintenance, The Maintenance Process, Maintenance Models: Quick fix, Iterative Enhancement, Reuse Oriented. Reverse Engineering, Software RE-engineering, Configuration Management.

**BOOKS:**


- Prof: KK Aggarwal & Yogesh Singh: SOFTWARE ENGG:
- Pankaj Jalote, " An Integrated Approach to Software Engg" Narosa Publishing House, New Delhi.
- Pressman,"Priciples of Software Engg" TMC, 5th Ed. 2005


## DSC- 505: OBJECT ORIENTED PROGRAMMING

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| **L** | **T** | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |

**Duration of Exam : 3 Hours**

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**UNIT 1: OBJECT ORIENTED PROGRAMMING USING C++**

Object Oriented Paradigm, Structured vs Object Oriented Development, Concept of Object and classes, Encapsulation, Polymorphism, Inheritance, Merits and demerits of OOP. Class specification, Class objects, Defining member function, Inline functions, Data Hiding, Empty class, Passing objects as parameters, Returning objects from functions, Static data and member functions. Constructors and destructors, overloading of constructors, Dynamic initialization through constructors, Copy constructors, Static data members with constructors and destructors. Pointers to objects, Array of objects, this pointer.

**UNIT 2: IMPLEMENTING POLYMORPHISM IN C ++**

Function and Operator overloading, Overloading of unary and Binary operators, Limitations of overloading of increment and decrement operators, overloading of arithmetic, Relational, assignment, new and delete, subscript operators. Data conversion between objects. Complete conversion. Overloading through friend functions. Tracing of memory leaks.

**UNIT 3: INHERITANCE AND VIRTUAL FUNCTIONS**

Declaration of derived class, forms of inheritance, constructors and destructors in derived class, types of inheritance, abstract class, Virtual functions: Need of virtual functions, Pointers to derived class objects, pure virtual functions, Virtual destructors, Rules of writing virtual function.

**UNIT 4: OBJECT ORIENTED PROGRAMMING USING JAVA**

Classes, objects and constructor in Java, Implementing inheritance and polymorphism - dynamic binding, method overriding, abstract classes and methods. Interfaces - Interfaces vs. Abstract classes, defining an interface, implementing interfaces, accessing implementations through interface references, extending interfaces.

**UNIT 5: GENERIC PROGRAMMING IN JAVA**

Introduction to Exception Handling, Generic programming in Java. Why Use Generics? Types of Java Generics. Generic classes. Generic functions. Generics, Inheritance, and Subtypes. Type inference. Wildcards. Type erasure.

**BOOKS**

1. The C++ Programming Language by B.Stroustrup, Pearson Education.
2. Thinking in C++ by Bruce Eckel, Pearson Education
3. Object Oriented Programming in C++ by N.Barkakati, PHI
4. Mastering C++ by Venugopal and et all, Tata McGraw Hill

5. C++ How to Program by Deitel and Deitel, Pearson Education
6. The Complete Reference Java by Herbert Shildt, Tata McGraw Hill
7. Object-Oriented Programming in C++ by Robert Lafore, 4th Edition, Pearson Education.
8. Java Generics and Collections: Speed Up the Java Development Process, 1st Edition. O'Reilly.

## DSC- 601: ANALYSIS AND DESIGN OF ALGORITHMS

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| **L** | **3** | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT I**

Introduction to algorithm, analyzing algorithm, RAM Model of Computation. Best-case, worst-case and average-case complexity analyses. Asymptotic Notations: Big-Oh, Big-Omega, Theta notations, Small-oh, Small-omega notations, Rules of notations. Solving recurrence equations: Iterative method, Recursion-tree method, Guess method, Master method, Master's theorem, Rate of growth of functions and their ranking. Review and analysis of searching and sorting algorithms

**UNIT II**

Divide and Conquer Strategy: Introduction, Counterfeit coin detection, binary search, merge sort, quick sort, Heap sort, integer multiplication, matrix multiplication (Strassen's algorithm), exponentiation problem, polynomial multiplication, when to avoid divide-&-conquer strategy.

**UNIT III**

Graph Algorithm: Introduction, topological sorting, Dijkstra's algorithm shortest path for weighted graph, DFS algorithm, BFS algorithm, Greedy Algorithm: Introduction, activity selection problem, change-making problem, Huffman coding, Minimum spanning tree problem, disjoint set data structure, prims and kruskal algorithm, 0/1 knapsack problem using greedy, backtracking and branch and bound, fractional knapsack problem,.

**UNIT IV**

Dynamic Programming: Introduction, Fibonacci series calculation, 0/1 knapsack problem, matrix chain multiplication, Longest common subsequence problem, memoization, Floyd-Warshal's algorithm. Backtracking

**UNIT V**

String Search Problem: Naïve algorithm, Rabin-karp algorithm, FSA based algorithm, Complexity theory: P class of problem, NP-class of problem, Decidability of problems, NP

hardness and NP completeness.

**BOOKs:**

- T H Cormen, C E Leisersor, and R L Rivest, Introduction to Algorithm, Third Edition, PHI.
- Richard Neapolitan and Kumarss Naimipour, Foundation of Algorithms, Fourtht Edition, Jones & Bartlet.
- A V Aho, J E Hopcroft and J D Ullman, The Design and analysis of computer algorithms, Pearson Education
- E Horwitz, and S Sahni, Fundamentals of Computer Algorithm, PHI
- Goodrich & Tamassia, Algorithm Design, Wiley
- A Levitin, Introduction to the Design & Analysis of Algorithms, 2nd Edition, Pearson Education.

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**DSC- 602: COMPILER DESIGN**

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT 1: INTRUCTION TO COMPILER AND LEXICAL ANALYSIS PHASE**

Introduction to compilation, Language processing system, Analysis of the Source Program, Phases and Passes in compilers, Introduction to Lexical analysis, Input buffering, tokens, lexemes & pattern, FA and regular Expressions with related concepts, Specification, and recognition of tokens, and Design of lexical analyzer generator.

**UNIT 2: SYNTAX ANALYSIS PHASE (PARSING)**

Role and position of a Parser, Predictive Parsing, Context Free Grammar, Parsing approaches. Top-down Parsing: LL Parsing; Bottom-Up Parsing technique: LR Parsing, SLR, CLR & LALR Parsing

**UNIT 3: SEMANTIC ANALYSIS AND TYPE CHECKING**

Syntax Directed Definitions and translations, Attributes and Attribute grammar, construction of syntax trees, Type Checking, Type checking for expression and statements.

**UNIT 4: INTERMEDIATE CODE GENERATION& OPTIMISATION**

Intermediate representations, TAC statements, TAC implementations, Short circuit code, TAC generation for Assignment statements, Boolean expression and flow of control statements,

Various TAC Optimizations, Control Flow Analysis & Data Flow Analysis, Leaders &

Blocks, Flow Graphs, Dominators, Natural Loops, Gen-Kill and IN-OUT information for blocks.

**UNIT 5: TARGET CODE GENERATION**

Issues in the design of a code generator, the target machine, code generation from DAG, Heuristic Node Listing Algorithm, Code generation from a tree, Labeling Algorithm, and Function Gencode.

**Books:**

- Aho, Sethi, Ullmann& Lam "Compilers: Principles, techniques and tools", Pearson Education Asia
- Keith Cooper& Linda Torczon, "Engineering a Compiler", Morgan Kaufmann publication.
- Levine, Mason, and Brown, "Lex&Yacc", O'Reilly publication.
- Vinu V. Das, "Compiler Design using FLEX and YACC" PHI.

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**DSC- 603: DATA VISUALIZATION**

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| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**Unit -1**

Introduction to Data Visualization, Importance of data visualization, Overview of visualization tools and techniques, Principles of visual perception and cognition
Data Types and Visual Encodings
Types of data (numerical, categorical, temporal), Visual encodings (position, size, color, shape, etc.), Choosing appropriate visual encodings for different data types

**Unit-2**

Data Visualization Design Principles, Designing for clarity, accuracy, and efficiency, Exploratory Data Analysis, Univariate and multivariate data exploration, Distribution visualization (histograms, box plots, etc.), Correlation and relationship visualization

**Unit-3**

Static Visualization Techniques, Bar charts, line charts, and scatter plots, Pie charts, area charts, and heatmaps, Tree maps, bubble charts, and parallel coordinates, Interactive Data Visualization, Principles of interactive visualization, Tools for creating interactive, visualizations, Adding interactivity to static visualizations

**Unit-4**

Geographic Visualization, Choropleth maps, dot maps, and cartograms, Spatial data visualization techniques, Tools for geographic visualization, **Mapbox, Google Maps API** Story telling with Data, Narrative visualization techniques, Designing data-driven stories, Communicating insights effectively through visual storytelling

**Unit-5**

Data Visualization Tools and Technologies, Introduction to popular data visualization tools, **Tableau, Power BI, ggplot2,** Overview of programming libraries for data visualization, **matplotlib, seaborn, plotly,** Hands-on exercises using selected tools and technologies, Ethical and Responsible Data Visualization, Ethical considerations in data visualization, Avoiding bias and misrepresentation in visualizations, Communicating uncertainty and limitations

**Textbook:** "Data Visualization: A Practical Introduction" by Kieran Healy

**Reference Materials:**

- "The Visual Display of Quantitative Information" by Edward Tufte
- "Storytelling with Data: A Data Visualization Guide for Business Professionals" by Cole Nussbaumer Knaflic
- Online tutorials and resources

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**DSC- 604: ARTIFICIAL INTELLIGENCE**

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| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT-1: INTRODUCTION TO AI**

What is Artificial Intelligence, AI problems, Task domain of AI, AI Technique, Scope and areas of application of AI, representing simple facts in logic- predicate logic, Conversion to clause form, Resolution and Natural Deduction.

**UNIT-2: PROBLEMS, PROBLEM SPACES AND SEARCH, HEURISTIC SEARCH TECHNIQUES**

Defining the problem as a state space search, Production system, problem characteristics, informed and uninformed search technique: Generate and Test, Hill Climbing, Best first search, A*, AO*, Means-ends, analysis, Approaches to Knowledge Representation.

**UNIT-3: AI, MACHINE LEARNING, DEEP LEARNING & GAME PLAYING**

Fundamental of AI, Machine Learning, Deep Learning, Application of Machine Learning, IoT, and Game playing: Minimax Search Procedure and Alpha- Beta algorithm.

**UNIT-4: LEARNING, NLP, NEURAL NETWORK**

What is learning? Rote learning, learning by taking advice, learning in problem solving, learning from examples: Induction, Phases of Natural Language Processing, Neural Network, Learning in Neural Networks, Application of Neural Networks.

**UNIT-5: WEAK AND STRONG SLOT-AND–FILLER STRUCTURES, CONNECTIONIST MODELS, EXPERT SYSTEM.**

Semantic Nets, Frames, Conceptual Dependency, Scripts & Reasoning: Forward versus Backward Reasoning, Monotonic Reasoning, Logics for Non monotonic Reasoning, Introduction to Hopfield Networks, Expert Systems: Characteristics, Architecture of Expert System, Some Major Applications of Expert System.

**Books:**


- Artificial Intelligence, 3RD Edition, E. Richand Knight(TMH).
- Introduction to Artificial Intelligence–Rajendra Akerkar, PHI.
- Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter Norvig, PHI/Pearson Education.
- Artificial Intelligence, 3rd Edition, Patrick Henry Winston., Pearson Edition,
- Artificial Intelligence and Expert Systems–Patterson PHI
- Expert Systems: Principles and Programming-Fourth Edn, Giarrantana/Riley, Thomson
- PROLOG Programming for Artificial Intelligence. Ivan Bratka-Third Edition–Pearson Education.


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## DSE-605: DEEP LEARNING

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| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

**UNIT – I: INTRODUCTION TO NEURAL NETWORKS**

Learning and its types, Simple Neuron, Linear separability, XOR Problem, ANN Architectures, Review of Error Backpropagation algorithms, Need of Deep Neural Networks

**UNIT- II: MODEL BASICS**

Vector, scalar, Matrix & Tensor, Performance Metrics, Bias Variance, Underfitting, Overfitting, Model Regularizations, Early Stopping, Dropouts.

**UNIT- III: CONVOLUTIONAL NEURAL NETWORKS**

Introduction to Convolutional neural networks, CNN Operations, Convolutions & Strides, Pooling, Zero Padding, Convolution Arithmetic.

**UNIT- IV: CNN ARCHITECTURES**

CNN architectures LeNet-5, AlexNet, GoogLeNet, ResNet Optimizers for CNN, Network weight initialization techniques Optimizers for CNN.

**UNIT- V: SEQUENCE MODELING**

Introduction to Recurrent Neural Networks (RNNs), Encoder-Decoder Sequence to Sequence Architecture, Deep RNNs, Long Short Term Memory (LSTM) networks.

References / Text Books:


- Ian Goodfellow, YoushuaBengio and Aaron Courville, "Deep Learning", MIT Press.
- Simon Haykin, "A comprehensive foundation to Neural Networks" PHI.


Computer Usage / Software Requires: Python with Tensorflow API

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**DSE-701: COMPUTER VISION AND IMAGE PROCESSING**

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |

**Duration of Exam : 3 Hours**

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**UNIT 1: INTRODUCTION TO COMPUTER VISION AND BASIC CONCEPT OF IMAGE FORMATION**

Introduction and Goal of computer vision and Human vision, Image formation Concept, Radiometry, Geometry transformations, Geometric camera model viewing through camera, Multiview Geometry

**UNIT 2: IMAGE PROCESSING CONCEPTS AND IMAGE FORMATION**

Camera calibration, Image formation in a sterio vision Setup, Image Reconstruction from a series of Projection, Image Transformation, Image filtering, Colour image processing.

**UNIT 3: MACHINE LEARNING ALGORITHM FOR COMPUTER VISION**

Statistical Machine Learning Algorithm for computer vision, supervised and unsupervised learning, Gaussian classifier, parameter estimation, Clustering for Knowledge representation, Dimension Reduction, Artificial and Deep network for computer vision application.

**UNIT 4: IMAGE DESCRIPTOR AND FEATURES**

Texture descriptor, color feature, Edge/Boundraies, Object boundary and shape representations, Histogram of Orident Gradient., Scale Invariant Feature Transform, Speedup Robust feature.

**UNIT 5: APPLICATION OF COMPUTER VISION**

Artificial Neural Network for Pattern classification, Convolutional Neural Network, Autoencoders, Gesture Recognition, Motion Estimation and Object tracking, Object dection using CNN and RCNN,Image Fusion, YOLO, Deep learning Architecture in computer vision, Basics of GAN.

**Reference Books:**


- Handbook of Pattern Recognition and Image Processing, K.S. Fu and T.Y. Young, Academic
  Press.
- Digital Image Processing - Gonzalez & Woods, Person Education.
- Fundamental of Digital Image processing by Anil Jain , PHI,
- Digital Image processing and Analysis Chanda and Majumder, PHI Learning
- Digital Image processing –Jayaraman ,Esakkirajan and Veerakumar,TMH
- Digital Image processing –William k.Pratt,Wiely India
- The Image Processing Handbook, John C. Russ, CRC Press SIUE Library
- Computer vision: Algorithms and Applications by Richard Szeliski.
- Computer vision-A modern approach, by Forsyth and J.Ponce,Prentice Hall .
- Dictionary of Computer vision and Image processing, by Fisher et al.
- List of Open Source Software/learning website: Open CV, Python


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**DSE- 705: SOFT COMPUTING**

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT I: INTRODUCTION**

Introduction to Soft Computing, various types of soft computing techniques: Neural Networks, Fuzzy Logic, Genetic algorithm, Intelligent systems.

**UNIT II: ARTIFICIAL NEURAL NETWORKS (ANN)**

Function of Neuron, Biological Neuron, Artificial Neuron, Brain vs ANN, Basic Model of ANN: connections, weights, bias, activation functions. McCulloch-Pitts Neuron, Neuron as Memory element, Hebb Training algorithm, Linear separability, XOR problem.

**UNIT III: ANN LEARNING**

Neural Network architectures and characteristics, ANN Learning, Supervised learning: Perceptron, Delta Rule, ADALINE, MADALINE, Multi-layer perceptron, Back-Propagation algorithm. Unsupervised learning: Hopfield network- characteristics and algorithm.

**UNIT IV: BASICS OF FUZZY LOGIC**

Introduction to Fuzzy logic, Fuzzy set theory, Fuzzy set vs Crisp set, Fuzzy relation & Crisp relation, Fuzzy logic operations, Tolerance & Equivalence relations, Membership functions, Features of membership functions, Basics of Fuzzy arithmetic.

**UNIT V: FUZZY INFERENCE AND GENETIC ALGORITHM**

Fuzzy If-Then rule, Features of If-then rules, Fuzzy Inference, Fuzzy rule base system, Fuzzification, Defuzzification and its methods, Basics of Genetic algorithm: working principle, Encoding, Fitness function, Selection, Cross-over, Mutation.

**BOOKs:**

1. F O Karray and C De Silva, "Soft Computing & Intelligent Systems Design", Pearson, 2009.
2. Timothy J Ross, "Fuzzy Logic with Engineering Applications", Wiley, 2011.
3. Rajasekaran&Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications", PHI, 2011.
4. J J S Roger, S Chuen-Tsai, E Mizutani, "Neuro-Fuzzy and Soft Computing", PHI.
5. David E Goldberg, "Genetic Algorithm in Search, Optimization & Machine Learning", Pearson, 2011.
6. S Haykin, "Neural Networks: A Comprehensive Foundations" Pearson,

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**DSE-703: CLOUD COMPUTING**

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT 1: INTRODUCTION TO CLOUD COMPUTING**

Ubiquitous Cloud Computing, Properties of Cloud Computing, Definition of Cloud Computing, The Emergence and Development of Cloud Computing, The Advantage of Cloud Computing, Classification of Cloud Computing, Cloud Enabling Technology, Cloud Computing Applications

**UNIT 2: CLOUD COMPUTING SYSTEM**

Cloud Infrastructure Mechanism, Cloud Management Mechanism, Cloud Security Mechanism, Basic Cloud Architecture, Virtualization Technology, Basic Knowledge of Server Virtualization, Supporting Technology of Server Virtualization, Main Functions of Virtual Machine

**UNIT 3: NETWORK BASICS IN CLOUD COMPUTING**

Computer Network Overview, Network Layering and Encapsulation, Network Interconnection Equipment, Network Virtualization, Software-Defined Network, Storage

Basics in Cloud Computing, Basic Storage Unit, Storage Virtualization

**UNIT 4: OPENSTACK CLOUD FRAMEWORK**

Overview of OpenStack, OpenStack Operating Interface Management, OpenStack Certification Management, OpenStack Image Management, OpenStack Computing Management, OpenStack Network Management

**UNIT 5: CONTAINER TECHNOLOGY**

Overview of Container Technology, Overview of Kubernetes, Kubernetes Management Objects,

Kubernetes Service, Kubernetes Network, Kubernetes Storage, Kubernetes Service Quality, Kubernetes Resource Management

**Textbooks/References**

Introduction to Cloud Computing Computing, Huawei Technologies, Springer Link, Open Access https://link.springer.com/chapter/10.1007/978-981-19-3026-3_1#Sec1

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## DSE-706: SOCIAL NETWORK ANALYSIS

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT-I: INTRODUCTION**

Introduction to Semantic Web: Limitations of current Web, Development of Semantic Web, Emergence of the Social Web. Social Network analysis: Development of Social Network Analysis, Key concepts and measures in network analysis. Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities, Web-based networks, Applications of Social Network Analysis.

**UNIT-II: MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION**

Ontology and their role in the Semantic Web: Ontology-based knowledge Representation. Ontology languages for the Semantic Web: Resource Description Framework, Web Ontology Language. Modelling and aggregating social network data: State-of-the-art in network data representation, Ontological representation of social individuals, Ontological representation of social relationships, Aggregating and reasoning with social network data, Advanced representations.

**UNIT-III: EXTRACTION AND MINING COMMUNITIES IN WEB SOCIAL NETWORKS**

Extracting evolution of Web Community from a Series of Web Archive, Detecting communities in social networks, Definition of community, Evaluating communities, Methods

for community detection and mining, Applications of community mining algorithms, Tools for detecting communities social network infrastructures and communities, Decentralized online social networks, Multi-Relational characterization of dynamic social network communities.

**UNIT-IV: PREDICTING HUMAN BEHAVIOR AND PRIVACY ISSUES**

Understanding and predicting human behaviour for social communities, User data management, Inference and Distribution, Enabling new human experiences, Reality mining, Context, Awareness, Privacy in online social networks, Trust in online environment, Trust models based on subjective logic, Trust network analysis, Trust transitivity analysis, Combining trust and reputation, Trust derivation based on trust comparisons, Attack spectrum and counter measures.

**UNIT-V: VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS**

Graph theory, Centrality, Clustering, Node-Edge Diagrams, Matrix representation, Visualizing online social networks, visualizing social networks with matrix-based representations, Matrix and Node-Link Diagrams, Hybrid representations, Applications, Cover networks, Community welfare, Collaboration networks, Co-Citation networks.

TEXT BOOKS:


1. Peter Mika, ―Social Networks and the Semantic Web, First Edition, Springer 2007.
2. Borko Furht, ―Handbook of Social Network Technologies and Applications, 1st Edition, Springer, 2010.

REFERENCES:

3. Guandong Xu ,Yanchun Zhang and Lin Li,-Web Mining and Social Networking – Techniques and applications, First Edition, Springer, 2011.
4. Dion Goh and Schubert Foo,-Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively, IGI Global Snippet, 2008.
5. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet, 2009.
6. John G. Breslin, Alexander Passant and Stefan Decker, -The Social Semantic Web, Springer, 2009.


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**DSE- 705: NATURAL LANGUAGE PROCESSING AND INFORMATION EXTRACTION**

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT 1: BASIC TEXT PROCESSING AND PROBABILISTIC TEXT CLASSIFICATION**

Introduction to Text, Speech and Language Technologies, Basic Text Processing Tasks, N Grams, La Place Smoothing. Text Classification, Evaluation of Text Classification Model

**UNIT 2: SEQUENCE MODELLING**

Sequence Modelling: Markov Models, Hidden Markov Models, Conditional Random Fields, Beam, Greedy and Viterbi inference, POS tagging, Named Entity Recognition, Sentiment Analysis, Recurrent Neural Networks, Sequence Evaluation

**UNIT 3: VECTOR SEMANTICS**

Vector Semantics: Distributed Representations, Word Context Matrix Generation, Word Embeddings Skip Gram with Negative Sampling, Neural Embeddings Word2Vec, Glove

**UNIT 4: NEURAL LANGUAGE MODELS**

Neural Language Models: Long Term Dependencies, Vanishing Gradients, Long Short Term Memory (LSTM), LSTM based language models, Convolutional Neural Networks (CNN), CNN based language models, LSTM and CNN based text Classification, Attention and Transformer, Types of Attention Mechanism, Neural Machine Translation

**UNIT 5: LARGE LANGUAGE MODELS**

Transfer Learning, Pre-Training, Fine Tuning, Masked Language Models, BERT, Variants of BERT, Question Answering, Chatbots, Natural Language Generation, GPT.

**Books:**


- Daniel Jurafsky and James H. Martin, "Speech and Language Processing", 2nd Edition, Pearson Education, 2013.
- Yoav Goldberg, "Neural Network Methods in Natural Language Processing", Morgan & Claypool Publishers, 2017.
- Steven Bird, Ewan Klein, Edward Loper "Natural Language Processing with Python", O′Reilly, 2009.
- Manning and Schuetze, "Foundations of Statistical Natural Language Processing", MIT Press,1999.


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**DSE- 706: ARTIFICIAL NEURAL NETWORKS**

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| | | | |
|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT I: INTRODUCTION**

Introduction to Artificial Neural Networks, Historical evolution of ANN. Biological Neuron-Working principle, Biological Neural Networks, Artificial Neuron and its modeling, Comparison between BNN and ANN, Basic building blocks of Artificial Neural Networks, ANN terminologies.

**UNIT II: ANN MODELS**

Fundamental models of Artificial Neural Networks- McCulloch-Pitts Neuron Model, Neuron as Memory element, Hebb Training algorithm, Linear Separability, XOR problem, Hebbian Learning Rule Perceptron Learning Rule, Delta Learning (Widrow-Hoff Rule or Least Mean Square) Rule, ADALINE, Gradient Descent Rules, Competitive Learning Rule, Out Star Learning, Boltzmann Based Learning.

**UNIT III: MULTI-LAYER ANN**

Neural Network architectures, ANN Learning, Supervised learning, MADALINE, Multi-layer perceptron, Back-Propagation algorithm, Overfitting. Feedback Networks, Unsupervised learning, Discrete and Continuous Hopfield network- characteristics and algorithm. Bidirectional Associative Memory, Boltzmann Machine.

**UNIT IV: SELF-ORGANIZATION FEATURE MAP**

Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector
Quantization, Self -organization Feature Maps, Application of SOM, Growing Neural Gas.

**UNIT V: SVM & RADIAL BASIS FUNCTION**

Learning from Examples, Statistical Learning Theory, Support Vector Machines, SVM application to Image Classification, Radial Basis Function Network (RBFN), Regularization theory, Generalized RBF Networks, Learning in RBFNs, RBF application to face recognition.

BOOKs:

1. Simon Haykin, “Neural networks A comprehensive foundations”, 2nd ed., Pearson Education, 2004.
2. B Yegnanarayana, “Artificial neural networks”, 1st ed., Prentice Hall of India P Ltd, 2005.
3. Sivanandam, S Sumathi, S N Deepa; “Introduction to Neural Networks”, 2nd ed.,Tata McGraw Hill, 2005.
4. Li Min Fu, “Neural networks in Computer intelligence”, 1st ed., Tata McGraw Hill, 2003
5. Rajasekaran & Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2011.
6. J.M. Zurada, “Introduction to Artificial Neural Systems”, Jaico Publications 1994.

Online Resources:

1. 1. https://ocw.mit.edu/courses/9-641j-introduction-to-neural-networks-spring-2005/
2. https://nptel.ac.in/courses/117105084

## DSE-707: ADVANCED DEEP LEARNING

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| **L** | ] | **Internal:** | **30 Marks** |
| **2** | 1 | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

## DSE- 708: EMBEDDED SYSTEMS

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | 1 | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT 1:**

Embedded system:- Definition, components, I/O, Processor, Memory, Characteristics, attributes, design metrics , design challenges, application areas, Issues of designing efficient Embedded system, Difference between ES and PC, Design Technology, Integration and Testing of Embedded Hardware and Firmware, Embedded System Development Environment:-IDE, compiler, assembler, simulator, Emulator, debugging, Target hardware debugging and Boundary Scan , EDLC, Trends in the Embedded Industry:-Processor trends, OS trends, Development languages trends, Open Standard and framework, S/W H/W Co-design , RTOS:- introduction, type, overview of commercially available RTOS, Introduction to ES design using RTOS ., Soc, NOC

**UNIT 2:**

Microcontroller:-Introduction, criteria for choosing a microcontroller**,** Overview of 8051 Microcontroller family: Architecture, basic assembly language programming concepts, Memory Organization of 8051,SFR, Watch Dog Timer, Real Time clock. Interfacing to an external memory and Accessing External data Memory and External Code Memory, Interfacing to LCD/Keyboard, DAC/ADC, Sensors, a Stepper Motor, Interfacing with 8255

**UNIT 3:**

Addressing Modes, Instruction set including bit manipulating instruction and programming using it, Subroutine, Stack, , I/O port programming, programs based on the instruction set,

**UNIT 4:**

Programming of 8051 Timers, Counter Programming. Time delay generations and calculations, Basic Concepts of Interfacing, Introduction to Arm, Pic, and AVR Processors and other recent processors

**UNIT 5:**

basics of Communication with 8051**,** Basics of Communication, Overview of RS-232, $I^2C$ Bus, UART, USB, 8051 connections to RS-232, 8051 serial communication programming, 8051 interrupts, Programming of timer interrupts, Programming of External hardware interrupts, Programming of the serial communication interrupts, Interrupt priority in the 8051

**Books:**


- Shibu K V , "Introduction to Embedded Systems" , TMH 2009
- M.A. Mazidi and J. G. Mazidi, "The 8051 Microcontroller and Embedded Systems", PHI, 2004
- Frank Vahid & Tony Givargis, "Embedded System Design ", John Wiley & sons , 2002
- David E. Simon, "An Embedded Software Primer", Pearson Education, 1999.
- Raj Kamal, "Embedded Systems", TMH, 2004.
- K.J. Ayala, "The 8051 Microcontroller", Penram International, 1991.
- Dr. Rajiv Kapadia, "8051 Microcontroller & Embedded Systems", Jaico Press
- Dr. Prasad, "Embedded Real Time System", Wiley Dreamtech, 2004.
- Wayne Wolf, "Computers As Components, Principle of Embedded Computing System Design" , Morgan Kauf man Publishers, 2008.
- Asang Dani & Yashavant Kanetkar, "Go Embedded", BPB Publications, 2008


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## DSC- 709: PARALLEL AND DISTRIBUTED COMPUTING

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT 1:**

Parallel system , Parallel computing, architectural classification schemes, Evolution of computer Architecture ,Parallel architecture, superscalar processor, Vector processors, Principle of multithreading, latency-hiding techniques, multi core processors, GPU, massive parallel processors, Cache coherence and synchronization mechanism, Arithmetic mean performance, geometric performance, harmonic performance, Performance laws, Amdahl's law, Gustafson's law, Sun and Ni' law, Bernstein's criteria, dependency analysis, flow

dependency, anti-dependency, output dependency, dependency flow graph, Evaluating parallel programs, Debugging and evaluating parallel program empirically.

**UNIT 2:**

Pipeline, Design and analysis of pipeline and system based on it, optimal no. of stages, Instruction scheduling, pipeline hazards and their solutions, Tomasulo algorithm, Branch predictions, pipeline and branch predictor of recent processors, Collision free scheduling, Reservation table and stations.

**UNIT 3:**

Design and analysis of parallel algorithms, Preliminaries, decomposition techniques, characteristics of tasks and interactions, mapping techniques for load balancing, methods for containing interaction overheads, parallel algorithm models, the task/channel model, Foster 's design methodology, matrix multiplication, Parallelizing sequential algorithms, SIMD algorithm for matrix multiplication, PRAM model

**UNIT 4:**

Parallel Programming, Cluster programming using MPI, Multi core programming using OPEN MP, Programming massive parallel processors using CUDA, GPU, OPENCL, OPENACC

**UNIT 5:**

Distributed system, distributed computing, distributed applications, paradigms of Distributed Computing, Cloud Computing, Distributed algorithms, Logical clocks, clock synchronization algorithms

**Books:**


- Michael J. Quinn, "Parallel Computing theory and practice", TATA McGraw Hill
- AnanthGramma, Anshulgupta, George Karypis&Vipin Kumar, "Introduction to parallel computing", Pearson Education.
- Michael J. Quinn, "Parallel Programming in with MPI and OpenMP" , Pearson Education
- Barry Wilkinson & Michael Allen, "Parallel Programming techniques and Applications using networked work stations and parallel computers", Pearson Education
- Kai Hwang, "Advanced Computer architectures, Parallelism, Scalability & Programmability", McGraw Hill.
- John L. Hennessey and David A. Patterson, "Computer Architecture – A quantitative approach", Morgan Kaufmann / Elsevier Publishers, 5th. Edition, 2012.
- David B. Kirk and Wen-mei W. Hwu, Programming Massively Parallel Processors, A hands on approach, Morgan Kaufman publishers,Elsevier.
- Peter S. Pacheco, "An Introduction to Parallel Programming", Morgan Kaufmann, 2011.
- Michael J Quinn, "Parallel programming in C with MPI and OpenMP", Tata McGraw Hill,2003.
- 4. David B. Kirk and Wen-mei W. Hwu, "Programming Massively Parallel Processors",Morgan Kaufmann, 2010.

- AnanthGrama, George Karypis, Vipin Kumar and Anshul Gupta, "Introduction to Parallel Computing", Second Edition, Pearson Education Limited, 2003.
- Shameem Akhter and Jason Roberts, "Multi-core Programming", Intel Press, 2006.
- Ian Foster, "Designing and Building Parallel Programs: Concepts and Tools for Parallel Software Engineering", Addison Wesley Longman Publishing Co., USA, 1995.
- David E. Culler, Jaswinder Pal Singh, "Parallel Computing Architecture: A hardware/ Software approach" , Morgan Kaufmann / Elsevier Publishers, 1999.
- OpenMP Programmer's Manual.
- MPI Programmer's Manual
- Kai Hwang, Distributed and Cloud Computing, Elsevier
- Raj kumarBuya , Mastering Cloud Computing, TMH publications.


## DSO-801: NETWORK SECURITY

| | | | |
|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |

**Duration of Exam : 3 Hours**

**UNIT – I**

Introduction of Network Security, Security goals, The need of security, Security approaches, Principles of Security, Services and mechanism, Types of attacks, Traditional Symmetric key ciphers: Substitution ciphers, Transposition ciphers, Stream and Block ciphers, Steganography.

**UNIT- II**

Modular Arithmetic, Linear congruence, Algebraic structure, Totient function, Primality testing, Factorization, Chinese Remainder Theorem, Quadratic congruence, Fermat's Theorem, Euler's Theorem, Galois Field, Euclidean and Extended Algorithm, Diophantine equation. Exponentiation and logarithm.

**UNIT- III**

Modern Block ciphers, Stream ciphers, Symmetrical key cryptography: Data Encryption Standard: rounds, S-Boxes, analysis of DES, Uses of Secret key Cryptography, Advance Encryption Standard AES cipher: Transformations, Key expansion, analysis of AES.

**UNIT- IV**

Public key cryptography: Knapsack, RSA: keys generating, encryption and decryption, Taxonomy of potential attacks on RSA, Optimal Asymmetric Encryption Padding, Rabin cryptosystem, El-Gamal cryptosystem, Elliptical curve cryptography, and uses of public key cryptography.

**UNIT – V**

Cryptographic Hash function, Message Digest algorithms: Length of HASH, uses, Message Digest 5: algorithm (padding, stages, and digest computation.) SHA1 and SHA512: Overview, padding, stages. Message Authentication Codes (MACs), Digital signature techniques, Zero-knowledge signatures.

**References / Text Books:**


- Behrouz A Forouzan, Cryptography and Network Security, 3RD Edition 2016, McGraw Hill.
- Stallings, W., Cryptography and Network Security: Principles and Practice, Sixth edition., Pearson Print.,2016
- Kaufman, c., Perlman, R., and Speciner, M., Network Security, Private Communication in a public world, 2nd ed., Prentice Hall Print, 2002.


**Computer Usage / Software Requires:** C++/ PYTHON /JAVA

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## DSO- 802: BLOCKCHAIN TECHNOLOGY AND ITS APPLICATION

| | | | |
|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT – 1: INTRODUCTION TO BLOCKCHAIN AND APPLICATIONS**

Introduction to Blockchain and Distributed Ledger, Blockchain Properties, Blockchain, Features, Blockchain Platforms, Generalized Architecture of Blockchain Platform, Applications of Blockchain

**UNIT – 2: ESSENTIALS OF CRYPTOCURRENCIES**

Distributed identity: Public and private keys, Digital identification, and wallets; Decentralized network- Distributed ledger: Permissioning framework, Blockchain data structure- Double spending; Network consensus- Sybil attack, Block rewards and miners, Difficulty under competition, Forks and consensus chain, the 51% attack, Confirmations and finality- The limits of proof-of-work- Alternatives to Proof of work.

**UNIT – 3: BLOCKCHAIN FOUNDATIONAL CONCEPTS & BITCOIN PLATFORM**

Bitcoin Architectures: Distributed peer-to-peer network, nodes, consensus protocol, mining: Type, Process, Bitcoin Crypto: Hashing, Digital Signatures, Wallet and Transactions in Bitcoin; Smart Contract and Ethereum Platform: Introduction Ethereum, Architecture, Smart Contracts, Elements of Smart Contracts, Ethereum Operations, Incentive Model, Transactions in Ethereum, Introduction Solidity.

**UNIT – 4: CONSENSUS PROTOCOLS AND SECURITY ISSUES**

Trust Essentials: Decentralized Systems, Consensus Protocols: Proof-of-Work (PoW), Proof-

of-Stake (PoS), Delegated Proof-of-Stake (DPoS), Proof-of-Burn (PoB), Byzantine Fault Tolerance (BFT), Practical Byzantine Fault Tolerance (PBFT), Proof-of-Activity (PoA), Proof of Elapsed Time (PoET). Blockchain Security Threats, Challenges and Issues.

**UNIT – 5: ENTERPRISE BLOCKCHAIN PLATFORMS AND BLOCKCHAIN USE CASES**

Introduction to Enterprise Blockchain Platforms and tools: Hyperledger, Corda, Ripple, Staler, Blockchain Use Cases in Finance and Banking, International Trade, Supply- Chain, Healthcare and Pharmaceuticals, Energy and Power, Government public services and Defense.

**TEXT BOOKS:**


- Debjani Mohanty, Blockchain from Concept to Execution: BitCoin, Ethereum, Quorum, Ripple, R3 Corda, Hyperledger Fabric/Saw Tooth/Indy, Multi Chain, IOTA, CoCo, BPB Publications, 2018.
- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University
- Andreas M. Antonopoulos, Gavin Wood Ph.D., Mastering Ethereum: Building Smart Contracts and DApps, O'Reilly Media, 2018
- Ashwani Kumar, Hyperledger Fabric In-Depth Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric, BPB PUBN, 2020.
- Debajani Mohanty, R3 Corda for Architects and Developers with Case Studies in Finance, Insurance, Healthcare, Travel, Telecom, and Agriculture, Apress, 2019


**REFERENCE BOOKs:**


- Mastering Blockchain - Distributed ledgers, decentralization and smart contracts explained, Author- Imran Bashir, Packt Publishing Ltd, Second Edition, ISBN 978- 1-78712-544-5, 2017
- Kenny Vaneetvelde, Ethereum Projects for Beginners: Build Blockchain-based Cryptocurrencies, Smart Contracts, and DApps, 2018
- Mastering Bitcoin: Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media, First Edition, 2014
- Jamiel Sheikh, Mastering Corda Blockchain for Java Developers,O'Reilly Media, 2020


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**DSO- 803: SOFTWARE TESTING**

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT-1 INTRODUCTION**

Testing as an Engineering Activity – Testing as a Process – Testing axioms – Basic definitions – Software Testing Principles – The Testers Role in a Software Development Organization – Origins of Defects – Cost of defects – Defect Classes – The Defect Repository and Test Design – Defect Examples– Developer/Tester Support of Developing a Defect Repository

**UNIT-2 TEST CASE DESIGN**

Test case Design Strategies – Using Black Box Approach to Test Case Design – Boundary Value Analysis –Equivalence Class Partitioning – State based testing –Decision Table Based Testing- Cause-effect graphing – Compatibility testing – user documentation testing – domain testing – Random Testing – Requirements based testing – Using White Box Approach to Test design – Test Adequacy Criteria – static testing vs. structural testing – code functional testing – Coverage and Control Flow Graphs – Covering Code Logic – Paths – code complexity testing – code review, code inspection and code walkthrough & its advantages.

**UNIT-3 LEVEL OF TESTING**

The need for Levels of Testing – Unit Test – Unit Test Planning – Designing the Unit Tests – The Test Harness – Running the Unit tests and Recording results – Integration tests – Designing Integration Tests – Integration Test Planning – Scenario testing – Defect bash elimination System Testing – Acceptance testing – Performance testing – Regression Testing – Ad-hoc testing – Alpha, Beta Tests – Testing OO systems – Usability and Accessibility testing – Configuration testing.

**UNIT-4 TESTING TOOLS & TEST MANAGEMENT**

Introduction to Software Testing, Types of Software Testing, Benefits of using Testing tools, features of a good testing tools, how to select a proper testing tool, Types of testing tools, People and organizational issues in testing – Organization structures for testing teams – testing services – TestPlanning – Test Plan Components – Test Plan Attachments – Locating Test Items – test management – test process – Reporting Test Results – Introducing the test specialist – Skills needed by a test specialist.

**UNIT-5 TEST AUTOMATION**

Software test automation – skills needed for automation – scope of automation – design and architecture for automation – requirements for a test tool – challenges in automation – Test metrics and measurements – project, progress and productivity metrics.

**Books:**


1. Ian Sommerville: Software Engineering
2. Roger S. Pressman: Software Engineering: a PRACTITIONER'S Approach.
3. Yogesh Singh & Prof. K.K. Aggarwal: Software Engineering.
4. Aditya P. Mathur: Foundations of software Testing
5. Rajiv Chopra: Software Testing (A Practical Approach)

## DSO-804: MOBILE COMPUTING AND IOT

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|---|---|---|---|
| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT – I**

Introduction to Mobile Computing and its Architecture, Basic cellular system, Transmission problems and its solution in cellular system, cellular geometry, components of a cellular Mobile network, Concept of Frequency re-use channels, Cell splitting, Sectoring and Clustering of a cell, Co-channel interferences and system capacity, Trunking and Grade of services.

**UNIT- II**

GSM Architecture, Channels used in GSM, GSM Transmission process to Network, Traffic cases in GSM. Location tracking and call setup, Mobility management, Frame structure for GSM, Handoff and dropped calls, Security and Authentication in GSM, GSM network identities.

**UNIT- III**

CDMA Architecture, Chipset sequences in CDMA, Channels used in CDMA, CDMA system design, capacity of a CDMA system, Next generation cellular technology.

**UNIT – IV**

Introduction to Internet of Things- Definition and Characteristics of IoT, IoT Standards and Protocols, IoT communication models, IoT Communication APIs, IoT Applications: Home, City, Environment, Agriculture and Industry.

**UNIT- V**

Sensors and Actuators in IoT, Controlling Hardware, Connecting LED, Buzzer, Controlling AC Power devices with Relays, Controlling servo motor, speed control of DC Motor, Stepper motors, Light sensor, temperature sensor with thermistor, Motion Detection Sensors, Distance Measurement with ultrasound sensors, Basic Networking with ESP8266 Wi-Fi module ,Data Management in IoT.

**Text / References Books:**


- Theodore S. Rappaport, Wireless communications Principles and Practice, Pearson Education.
- Jochen Schiller, Mobile Communications, Pearson Education 2012.
- Vijay K. Garg, Wireless communication and Networking, Elsevier Morgan Kaufmann

Publishers.
- Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013
- Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-onApproach)”, 1st Edition, VPT, 2014
- Raj Kamal, “Internet of Things, Architecture and Design Principles”, McGraw Hill, 6th Reprint 2020.

**Computer Usage / Software Requires: C++/ PYTHON / Mobile Simulator/Emulator/ IoT simulator.**

## DSO- 805: ADVANCED GRAPH THEORY

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| **L** | ] | **Internal:** | **30 Marks** |
| **2** | **1** | **External:** | **45 Marks** |
| **Credits : 3** | | **Total:** | **75 Marks** |
| **Duration of Exam : 3 Hours** | | | |

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**UNIT – I**

Introduction to Graphs & its Applications, Basics of Paths, Cycles, and Trails, Connection,

Bipartite Graphs, Eulerian Circuits, Vertex Degrees and Counting, Degree-sum formula, The Chinese Postman Problem and Graphic Sequences.

**UNIT- II**

Trees and Distance, Properties of Trees, Spanning Trees and Enumeration, Matrix-tree computation, Cayley's Formula, Prufer code.

**UNIT- III**

Matchings and Covers, Hall's Condition, Min-Max Theorem, Independent Sets, Covers and Maximum Bipartite Matching, Augmenting Path Algorithm, Weighted Bipartite Matching,

Hungarian Algorithm.

**UNIT- IV**

Stable Matchings and Faster Bipartite Matching, Factors & Perfect Matching in General Graphs, Matching in General Graphs: Edmonds’ Blossom Algorithm.

**UNIT – V**

Connectivity and Paths: Cuts and Connectivity, k-Connected Graphs, Network Flow Ford-Fulkerson Labeling Algorithm, Max-Flow Min-cut Theorem, Menger's Proof using Max-Flow Min-Cut Theorem.

References / Text Books:


- D.B. West, Introduction to Graph Theory, Prentice Hall, 2001
- Jon Kleinberg and Eva Tardos, Algorithm Design, Addison-Wesley, 2005
- J.A.Bondy and U.S.R.Murty: Graph Theory, Springer, 2008.
- R.Diestel: Graph Theory, Springer( low price edition) 2000.
- F.Harary: Graph Theory, Narosa, (1988)
- C. Berge: Graphs and Hypergraphs, North Holland/Elsevier, (1973)