# K S R INSTITUTE FOR ENGINEERING AND TECHNOLOGY

AN AUTONOMOUS INSTITUTION

(Approved by AICTE, New Delhi & Affiliated to Anna University)

K.S.R. Kalvi Nagar, Tiruchengode – 637 215, Namakkal Dist., Tamil Nadu, India.

## M.E - BIG DATA ANALYTICS

## CURRICULUM FOR SEMESTERS I to IV

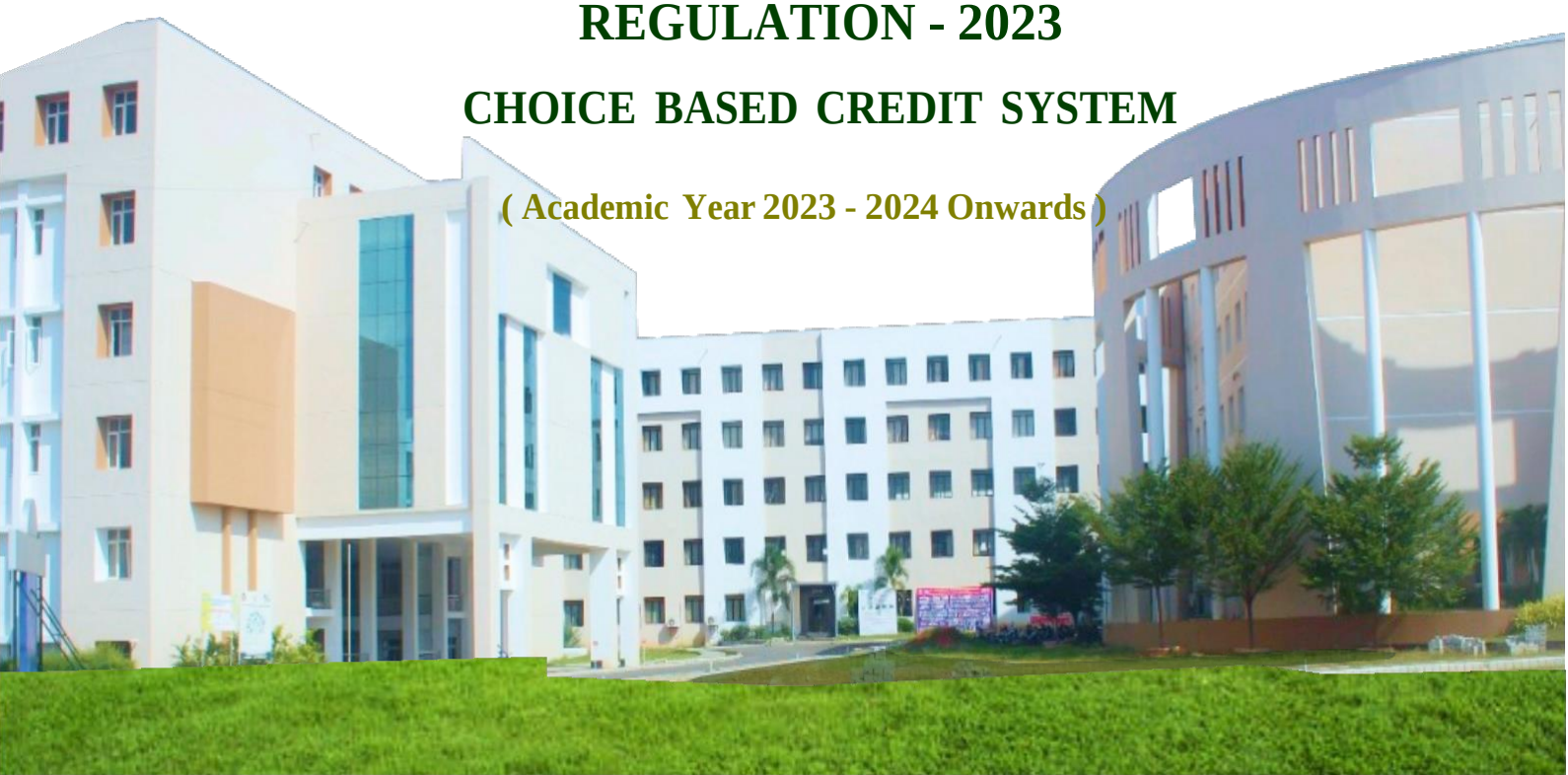
## &

## SYLLABUS FOR SEMESTERS I to II

**REGULATION - 2023**

**CHOICE BASED CREDIT SYSTEM**

**( Academic Year 2023 - 2024 Onwards )**



| | | |
|---|---|---|
| KSRIET | **K S R INSTITTUE FOR ENGINEERING AND TECHNOLOGY**<br>**An Autonomous Institution**<br>**Approved by AICTE and Affiliated to Anna University, Chennai**<br>**Accredited by NAAC ('A+' Grade) & NBA** | **Curriculum PG R - 2023** |
| **Department** | **Computer Science and Engineering** | |
| **Programme** | **M.E. BIG DATA ANALYTICS** | |

**SEMESTER I**

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| **Induction Programme** | | | - | - | - | - | - | - | - | - | - |
| **THEORY COURSES** | | | | | | | | | | | |
| 1. | 23MA1131 | Applied Probability and Statistics | FC | 4 | 0 | 0 | 4 | **4** | 40 | 60 | 100 |
| 2. | 23RM1131 | Research Methodology and IPR | RMC | 2 | 0 | 0 | 2 | **2** | 40 | 60 | 100 |
| 3. | 23BD1101 | Advanced Data Structures and Algorithms | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 4. | 23BD1102 | Foundations of Data Science | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 5. | 23BD1103 | Machine Learning | PCC | 3 | 0 | 2 | 5 | **4** | 40 | 60 | 100 |
| 6. | 23BD1104 | Database Practices | PCC | 3 | 0 | 2 | 5 | **4** | 40 | 60 | 100 |
| **LABORATORY COMPONENT** | | | | | | | | | | | |
| 7. | 23BD1111 | Advanced Data Structures and Algorithms Laboratory | PCC | 0 | 0 | 4 | 4 | **2** | 50 | 50 | 100 |
| 8. | 23BD1112 | Big Data Computing Laboratory | PCC | 0 | 0 | 2 | 2 | **1** | 50 | 50 | 100 |
| **AUDIT COURSES** | | | | | | | | | | | |
| 9. | 23AC113# | Audit Course – I* | AC | 2 | 0 | 0 | 2 | **0** | - | - | - |
| | | | **TOTAL** | **20** | **0** | **10** | **30** | **23** | **800** | | |

***Audit course is optional**

Chairman 23/9/23

| | | |
|---|---|---|
| KSRIET | **K S R INSTITTUE FOR ENGINEERING AND TECHNOLOGY**<br>**An Autonomous Institution**<br>**Approved by AICTE and Affiliated to Anna University, Chennai**<br>**Accredited by NAAC ('A+' Grade) & NBA** | **Curriculum**<br>**PG**<br>**R - 2023** |
| **Department** | **Computer Science and Engineering** | |
| **Programme** | **M.E. BIG DATA ANALYTICS** | |

**SEMESTER II**

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| **THEORY COURSES** | | | | | | | | | | | |
| 1. | 23BD1201 | Big Data Security | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 2. | 23BD1202 | Big Data Mining and Analytics | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 3. | 23BD1203 | Cloud Computing Technologies | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 4. | 23BD1204 | Information Storage Management | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 5. | 23BD1205 | Embedded Systems and IIOT | PCC | 3 | 0 | 2 | 5 | **4** | 40 | 60 | 100 |
| 6. | 23BD1P## | Professional Elective I | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| **LABORATORY COMPONENT** | | | | | | | | | | | |
| 7. | 23BD1211 | Big Data Mining And Analytics Laboratory | PCC | 0 | 0 | 4 | 4 | **2** | 50 | 50 | 100 |
| **AUDIT COURSES** | | | | | | | | | | | |
| 8. | 23BD1221 | Term Paper Writing and Seminar | EEC | 0 | 0 | 2 | 2 | **1** | 60 | 40 | 100 |
| 9. | 23AC123# | Audit Course – II* | AC | 2 | 0 | 0 | 2 | **0** | - | - | - |
| | | | **TOTAL** | **20** | **0** | **8** | **28** | **22** | **800** | | |

***Audit course is optional**

23/9/23
Chairman (BoS)

| | | |
|---|---|---|
| KSRIET | **K S R INSTITTUE FOR ENGINEERING AND TECHNOLOGY**<br>**An Autonomous Institution**<br>**Approved by AICTE and Affiliated to Anna University, Chennai**<br>**Accredited by NAAC ('A+' Grade) & NBA** | **Curriculum**<br>**PG**<br>**R - 2023** |
| **Department** | **Computer Science and Engineering** | |
| **Programme** | **M.E. BIG DATA ANALYTICS** | |

**SEMESTER III**

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| **THEORY COURSES** | | | | | | | | | | | |
| 1 | 23BD1P## | Professional Elective II | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 2 | 23BD1P## | Professional Elective III | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 3 | 23BD1P## | Professional Elective IV | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 4 | | Open Elective | OEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| **EMPLOYABILITY ENHANCEMENT COURSES** | | | | | | | | | | | |
| 5 | 23BD1321 | Project Work - Phase I | EEC | 0 | 0 | 12 | 12 | **6** | 60 | 40 | 100 |
| | | | **TOTAL** | **12** | **0** | **12** | **24** | **18** | **500** | | |

28/9/23
Chairman (BoS)

| | | |
|---|---|---|
| KSRIET | **K S R INSTITTUE FOR ENGINEERING AND TECHNOLOGY**<br>**An Autonomous Institution**<br>**Approved by AICTE and Affiliated to Anna University, Chennai**<br>**Accredited by NAAC ('A+' Grade) & NBA** | **Curriculum**<br>**PG**<br>**R - 2023** |
| **Department** | **Computer Science and Engineering** | |
| **Programme** | **M.E. BIG DATA ANALYTICS** | |

**SEMESTER IV**

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| **EMPLOYABILITY ENHANCEMENT COURSES** | | | | | | | | | | | |
| 1 | 23BD1421 | Project Work - Phase II | EEC | 0 | 0 | 28 | 28 | **14** | 50 | 50 | 100 |
| | | | **TOTAL** | 0 | 0 | 24 | 24 | **12** | **100** | | |
| | | | | | | | **TOTAL CREDITS** | **75** | | | |

**TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 75**

Note: PCC-Professional Core Courses, PEC-Professional Elective Courses, OEC- Open Elective Courses, EEC-Employability Enhancement Courses & AC- Mandatory Courses, FC-Foundation Courses, RMC - Research Methodology and IPR Courses

23/9/23
Chairman (BoS)

| RESEARCH METHODOLOGY AND IPR COURSES (RMC) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23RM1131 | Research Methodology and IPR | RMC | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |
| | | | TOTAL | 2 | 0 | 0 | 2 | 2 | | | |

| FOUNDATION COURSES (FC) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23MA1131 | Applied Probability and Statistics | FC | 4 | 0 | 0 | 4 | 4 | 40 | 60 | 100 |
| | | | TOTAL | 4 | 0 | 0 | 4 | 4 | | | |

| PROFESSIONAL CORE COURSES (PCC) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23BD1101 | Advanced Data Structures and Algorithms | PCC | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 2. | 23BD1102 | Foundations of Data Science | PCC | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 3. | 23BD1103 | Machine Learning | PCC | 3 | 0 | 2 | 5 | 4 | 50 | 50 | 100 |
| 4. | 23BD1104 | Database Practices | PCC | 3 | 0 | 2 | 5 | 4 | 50 | 50 | 100 |
| 5. | 23BD1111 | Advanced Data Structures and Algorithms Laboratory | PCC | 0 | 0 | 4 | 4 | 2 | 50 | 50 | 100 |
| 6. | 23BD1112 | Big Data Computing Laboratory | PCC | 0 | 0 | 2 | 2 | 1 | 50 | 50 | 100 |
| 7. | 23BD1201 | Big Data Security | PCC | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 8. | 23BD1202 | Big Data Mining and Analytics | PCC | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 9. | 23BD1203 | Cloud Computing Technologies | PCC | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 10. | 23BD1204 | Information Storage Management | PCC | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 11. | 23BD1205 | Embedded Systems and IIOT | PCC | 3 | 0 | 2 | 5 | 4 | 50 | 50 | 100 |
| 12. | 23BD1211 | Big Data Mining And Analytics Laboratory | PCC | 0 | 0 | 4 | 4 | 2 | 50 | 50 | 100 |
| | | | TOTAL | 18 | 0 | 12 | 30 | 24 | | | |



23/9/23
Chairman (BoS)

**PROFESSIONAL ELECTIVE COURSES (PEC)**
**SEMESTER II, ELECTIVE I**

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23BD1P01 | High Performance Computing for Big Data | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 2. | 23BD1P02 | Web Services and API Design | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 3. | 23BD1P03 | Information Retrieval Techniques | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 4. | 23BD1P04 | Data Visualization Techniques | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 5. | 23BD1P05 | Principles of Supply Chain Management | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 6. | 23BD1P06 | Computational Geometry | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| | | | **TOTAL** | **18** | **0** | **0** | **18** | **18** | | | |

**PROFESSIONAL ELECTIVE COURSES (PEC)**
**SEMESTER III, ELECTIVE II**

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23BD1P07 | Soft Computing Techniques | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 2. | 23BD1P08 | Multimedia Communication Networks | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 3. | 23BD1P09 | Parallel and Distributed Computing | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 4. | 23BD1P10 | Predictive Modeling | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 5. | 23BD1P11 | Image Processing and Analysis | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| | | | **TOTAL** | **15** | **0** | **0** | **15** | **15** | | | |

23/9/23
Chairman (BoS)

**PROFESSIONAL ELECTIVE COURSES (PEC)**
**SEMESTER III, ELECTIVE III**

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23BD1P12 | Cognitive computing | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 2. | 23BD1P13 | Social Network analysis | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 3. | 23BD1P14 | Virtualization techniques and applications | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 4. | 23BD1P15 | Natural Language Processing | PEC | 2 | 0 | 2 | 4 | 3 | 60 | 40 | 100 |
| | | **TOTAL** | | **11** | **0** | **2** | **13** | **12** | | | |

**PROFESSIONAL ELECTIVE COURSES (PEC)**
**SEMESTER III, ELECTIVE IV**

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23BD1P16 | Data Intensive Computing | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 2. | 23BD1P17 | R Language for Mining | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 3. | 23BD1P18 | Web analytics | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 4. | 23BD1P19 | Healthcare Analytics | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| 5. | 23BD1P20 | Statistics for Business Analytics | PEC | 3 | 0 | 0 | 3 | 3 | 60 | 40 | 100 |
| | | **TOTAL** | | **15** | **0** | **0** | **15** | **15** | | | |

**OPEN ELECTIVE COURSES TO OTHER DEPARTMENT (OEC)**

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23BD1X01 | Big Data Security | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 2. | 23BD1X02 | Foundations of Data Science | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 3. | 23BD1X03 | Web analytics | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 4. | 23BD1X04 | Analytics of Things | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| | | **TOTAL** | | **12** | **0** | **0** | **12** | **12** | | | |



23/9/23
Chairman (BoS)

## OPEN ELECTIVE COURSES BY OTHER DEPARTMENT (OEC)

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23CC1P01 | Additive Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 2. | 23CC1P02 | New Product Development | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 3. | 23CC1P03 | Reverse Engineering | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 4. | 23CC1P04 | Industrial Safety Management | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 5. | 23ET1P01 | IOT For Smart Systems | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 6. | 23ET1P02 | Embedded Processor Development | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 7. | 23ET1P03 | Embedded Networking and Automation of Electrical Systems | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 8. | 23ET1P04 | Electric Vehicle and Power Management | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| | | | **TOTAL** | **24** | **0** | **0** | **24** | **24** | | | |

## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23BD1221 | Term Paper Writing and Seminar | EEC | 0 | 0 | 2 | 2 | 1 | 60 | 40 | 100 |
| 2. | 23BD1321 | Project Work I | EEC | 0 | 0 | 12 | 12 | 6 | 60 | 40 | 100 |
| 3. | 23BD1421 | Project Work - Phase II | EEC | 0 | 0 | 24 | 24 | 12 | 50 | 50 | 100 |
| | | | **TOTAL** | **0** | **0** | **36** | **36** | **19** | | | |

## AUDIT COURSES (AC)

| S. No. | Course Code | Course Title | Category | Periods / Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1. | 23AC1131 | English for Research Paper Writing | AC | 2 | 0 | 0 | 0 | 0 | - | - | - |
| 2. | 23AC1132 | Disaster Management | AC | 2 | 0 | 0 | 0 | 0 | - | - | - |
| 3. | 23AC1133 | Constitution of India | AC | 2 | 0 | 0 | 0 | 0 | - | - | - |
| 4. | 23AC1134 | நற்றமிழ் இலக்கியம் | AC | 2 | 0 | 0 | 0 | 0 | - | - | - |
| | | | **TOTAL** | **8** | **0** | **0** | **0** | **0** | | | |



23/9/23
Chairman (BoS)

| Summary | | | | | | |
|---|---|---|---|---|---|---|
| Name of the Programme: M.E BDA | | | | | | |
| CATEGORY | Credits per Semester | | | | | |
| | I | II | III | IV | TOTAL CREDITS | % |
| FC | 4 | | | | 4 | 5.33 |
| PCC | 17 | 18 | | | 35 | 46.67 |
| PEC | | 3 | 9 | | 12 | 16.00 |
| RMC | 2 | | | | 2 | 2.67 |
| OEC | | | 3 | | 3 | 4.00 |
| EEC | | 1 | 6 | 12 | 19 | 25.33 |
| AC | ✓ | ✓ | - | - | - | - |
| Total | 23 | 22 | 18 | 12 | 75 | 100% |

23/9/23
Chairman (BoS)

| 23MA1131 | APPLIED PROBABILITY AND STATISTICS | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | FC | 4 | 0 | 0 | 4 |

(Common to All Branches)

**OBJECTIVES:**

**The Course will enable learners to:**

- To compute probabilities and moments of standard distributions.
- To gain knowledge about regression and correlation.
- To provide the most appropriate estimator of the parameter in statistical inference.
- To decide whether to accept or reject specific values of a parameter.
- To understand many real-world problems fall naturally within the framework of multivariate normal theory.

| UNIT - I | PROBABILITY AND RANDOM VARIABLES | 12 |
|---|---|---|

Probability – Axioms of probability – Conditional probability – Bayes theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

| UNIT - II | TWO DIMENSIONAL RANDOM VARIABLES | 12 |
|---|---|---|

Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

| UNIT - III | ESTIMATION THEORY | 12 |
|---|---|---|

Unbiased estimators – Method of moments – Maximum likelihood estimation - Curve fitting by principle of least squares – Regression lines.

| UNIT - IV | TESTING OF HYPOTHESIS | 12 |
|---|---|---|

Sampling distributions – Type I and Type II errors – Small and large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

| UNIT - V | MULTIVARIATE ANALYSIS | 12 |
|---|---|---|

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components - Population principal components – Principal components from standardized variables.

**TOTAL: 60 PERIODS**

Chairman (BoS) 23/9/23

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Basic probability axioms and rules and the moments of discrete and continuous random variables. | Understand |
| CO2 | To deal with problems involving two dimensional random variables. | Analyze |
| CO3 | Consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem. | Understand |
| CO4 | Use statistical tests in testing hypotheses on data. | Apply |
| CO5 | Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality. | Analyze |

**TEXT BOOKS:**

| | |
|---|---|
| 1 | Devore, J. L., "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, 2014. |
| 2 | Dallas E. Johnson, "Applied Multivariate Methods for Data Analysis", Thomson and Duxbury press, 1998. |

**REFERENCES:**

| | |
|---|---|
| 1 | Gupta S.C. and Kapoor V.K.," Fundamentals of Mathematical Statistics", 12th Edition, Sultan and Sons, New Delhi, 2020. |
| 2 | Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers ", 9th Edition, Pearson Education, Asia, 2016. |
| 3 | Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 6th Edition, Pearson Education, Asia, 2012. |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO2 | - | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 1 | 3 | 2 | 3 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 1 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 1 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| **Avg.** | **1** | **2.8** | **2** | **2.2** | **-** | **1** | **-** | **-** | **-** | **-** | **-** | **2.8** | **-** | **1** |

23/9/23
Chairman (BoS)

<table>
<tr><td colspan="6">ASSESSMENT SYSTEM:</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Examination (CIE)</td><td>End Semester Examination (ESE)</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>4</td><td>Theory only (40%)</td><td>Theory only (60%)</td></tr>
<tr><td colspan="6">CONTINUOUS INTERNAL EXAMINATION:</td></tr>
<tr><td colspan="6">THEORY</td></tr>
<tr><td>Assessment</td><td colspan="2">Portions</td><td>Duration</td><td>Max. Mark</td><td>Max CIE Marks</td></tr>
<tr><td>CIE - 1</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td><td rowspan="3">Best 2 out of 3 and Converted to 60</td></tr>
<tr><td>CIE - 2</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td>Improvement / Missed Test</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td rowspan="2">Other Assessment Methods</td><td colspan="3">Quizzes (10 MCQ per unit)</td><td>20</td><td rowspan="2">40</td></tr>
<tr><td colspan="3">Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test</td><td>20</td></tr>
<tr><td colspan="5"></td><td>100</td></tr>
<tr><td colspan="6">*The weighted average shall be converted into 40 marks for internal assessment.</td></tr>
</table>

23/9/23
Chairman (BoS)

| 23RM1131 | RESEARCH METHODOLOGY AND IPR | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | RMC | 2 | 0 | 0 | 2 |

(Common to All Branches)

**OBJECTIVES:**

**The Course will enable learners to:**

- To develop an appropriate framework for research studies.
- To develop an understanding of various research designs and techniques.
- To identify various sources of information for literature review and data collection.
- To develop an understanding of the ethical dimensions of conducting applied research.
- To Demonstrate enhanced Scientific writing skills, academic writing, patenting and avoid the common mistakes in the field of research methodology.

| UNIT - I | RESEARCH DESIGN | 9 |
|---|---|---|

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

| UNIT - II | DATA COLLECTION AND SOURCES | 9 |
|---|---|---|

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.
Data - Preparing, Exploring, examining and displaying.

| UNIT - III | DATA ANALYSIS AND REPORTING | 9 |
|---|---|---|

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation

| UNIT - IV | INTELLECTUAL PROPERTY RIGHTS | 9 |
|---|---|---|

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

| UNIT - V | PATENTS | 9 |
|---|---|---|

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

**TOTAL: 45 PERIODS**

Chairman (BoS) 23/9/23

| COURSE OUTCOMES<br>**Upon completion of the course, the students will be able to:** | | |
|---|---|---|
| **COs** | **Description** | **Blooms Taxonomy Level** |
| CO1 | Formulate research problem. | Understand |
| CO2 | Analyze literature review and find research gaps to finalize research objectives. | Analyze |
| CO3 | Identify the need of ethics in research. | Understand |
| CO4 | Identify the need of IPR of research projects for economic growth and social benefits | Understand |
| CO5 | Apply basic data analytics techniques: probability distribution, linear regression, ANOVA | Apply |

| **TEXT BOOKS:** | |
|---|---|
| 1 | Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012). |
| 2 | Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007. |
| **REFERENCES:** | |
| 1 | David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007. |
| 2 | The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013. |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| **CO2** | 2 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| **CO3** | 3 | 3 | 2 | 3 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| **CO4** | 3 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | - | 1 |
| **CO5** | 2 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| **Avg.** | **2.2** | **2.8** | **2** | **2.2** | **-** | **1** | **-** | **-** | **-** | **-** | **-** | **2.8** | **-** | **1** |

Chairman (BoS) 23/9/23

<table>
<tr><td colspan="6">ASSESSMENT SYSTEM:</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Examination (CIE)</td><td>End Semester Examination (ESE)</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td><td>Theory only (40%)</td><td>Theory only (60%)</td></tr>
<tr><td colspan="6">CONTINUOUS INTERNAL EXAMINATION:</td></tr>
<tr><td colspan="6">THEORY</td></tr>
<tr><td colspan="2">Assessment</td><td>Portions</td><td>Duration</td><td>Max. Mark</td><td>Max CIE Marks</td></tr>
<tr><td colspan="2">CIE - 1</td><td>2.5 units</td><td>3 Hours</td><td>100</td><td rowspan="3">Best 2 out of 3 and Converted to 60</td></tr>
<tr><td colspan="2">CIE - 2</td><td>2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td colspan="2">Improvement / Missed Test</td><td>2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td colspan="2" rowspan="2">Other Assessment Methods</td><td colspan="2">Quizzes (10 MCQ per unit)</td><td>20</td><td rowspan="2">40</td></tr>
<tr><td colspan="2">Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test</td><td>20</td></tr>
<tr><td colspan="5"></td><td>100</td></tr>
<tr><td colspan="6">*The weighted average shall be converted into 40 marks for internal assessment.</td></tr>
</table>

23/09/23
Chairman (BoS)

| 23BD1101 | ADVANCED DATA STRUCTURES AND ALGORITHMS | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To understand the usage of algorithms in computing
- To learn and use hierarchical data structures and its operations
- To learn the usage of graphs and its applications
- To select and design data structures and algorithms that is appropriate for problems
- To study about NP Completeness of problems.

| UNIT - I | ROLE OF ALGORITHMS IN COMPUTING & COMPLEXITY ANALYSIS | 9 |
|---|---|---|

Algorithms – Algorithms as a Technology -Time and Space complexity of algorithms- Asymptotic analysis-Average and worst-case analysis-Asymptotic notation-Importance of efficient algorithms-Program performance measurement - Recurrences: The Substitution Method – The Recursion- Tree Method- Data structures and algorithms.

| UNIT - II | HIERARCHICAL DATA STRUCTURES | 9 |
|---|---|---|

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of B - trees – Basic operations on B-Trees – Deleting a key from a B-Tree- Heap – Heap Implementation – Disjoint Sets - Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree.

| UNIT - III | GRAPHS | 9 |
|---|---|---|

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm; Dynamic Programming - All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd-Warshall Algorithm

| UNIT - IV | ALGORITHM DESIGN TECHNIQUES | 9 |
|---|---|---|

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: – Elements of the Greedy Strategy- An Activity-Selection Problem - Huffman Coding.

| UNIT - V | NP COMPLETE AND NP HARD | 9 |
|---|---|---|

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.

Chairman (BoS) 23/9/23

**TOTAL: 45 PERIODS**

**SUGGESTED ACTIVITIES:**

1. Write an algorithm for Towers of Hanoi problem using recursion and analyze the complexity (No of disc-4)
2. Write any one real time application of hierarchical data structure
3. Write a program to implement Make_Set, Find_Set and Union functions for Disjoint Set Data Structure for a given undirected graph G(V,E) using the linked list representation with simple implementation of Union operation
4. Find the minimum cost to reach last cell of the matrix from its first cell
5. Discuss about any NP completeness problem

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Design data structures and algorithms to solve computing problems. | Understand |
| CO2 | Choose and implement efficient data structures and apply them to solve problems | Analyze |
| CO3 | Design algorithms using graph structure and various string-matching algorithms to solve real-life problems. | Understand |
| CO4 | Design one's own algorithm for an unknown problem. | Understand |
| CO5 | Apply suitable design strategy for problem solving. | Apply |

**TEXT BOOKS:**


| | |
|---|---|
| 1 | S.Sridhar," Design and Analysis of Algorithms", Oxford University Press, 1st Edition, 2014. |
| 2 | Adam Drozdex, "Data Structures and algorithms in C++", Cengage Learning, 4th Edition, 2013. |


**REFERENCES:**


| | |
|---|---|
| 1 | Mark Allen Weiss, "Data Structures and Algorithms in C++", Pearson Education, 3rd Edition, 2009. |
| 2 | T.H. Cormen, C.E.Leiserson, R.L. Rivest and C.Stein, "Introduction to Algorithms", Prentice Hall of India, 3rd Edition, 2012. |
| 3 | E. Horowitz, S. Sahni and S. Rajasekaran, "Fundamentals of Computer Algorithms", University Press, 2nd Edition, 2008. |
| 4 | Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006. |


23/9/23
Chairman (BoS)

| Mapping of COs with POs and PSOs | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO2 | 2 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 3 | 3 | 2 | 3 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 3 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 2 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| **Avg.** | **2.2** | **2.8** | **2** | **2.2** | **-** | **1** | **-** | **-** | **-** | **-** | **-** | **2.8** | **-** | **1** |

| **ASSESSMENT SYSTEM:** | | | | | |
|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Continuous Internal Examination (CIE)** | **End Semester Examination (ESE)** |
| 3 | 0 | 0 | 3 | Theory only (40%) | Theory only (60%) |

**CONTINUOUS INTERNAL EXAMINATION:**

**THEORY**

| **Assessment** | **Portions** | **Duration** | **Max. Mark** | **Max CIE Marks** |
|---|---|---|---|---|
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |

*The weighted average shall be converted into 40 marks for internal assessment.

23/9/23

Chairman (BoS)

| 23BD1102 | FOUNDATIONS OF DATA SCIENCE | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To apply fundamental algorithms to process data.
- Learn to apply hypotheses and data into actionable predictions.
- Document and transfer the results and effectively communicate the findings using visualization techniques.
- To learn statistical methods and machine learning algorithms required for Data Science.
- To develop the fundamental knowledge and understand concepts to become a data science professional..

| UNIT - I | INTRODUCTION TO DATA SCIENCE | 9 |
|---|---|---|

Data science process – roles, stages in data science project – working with data from files – working with relational databases – exploring data – managing data – cleaning and sampling for modeling and validation – introduction to NoSQL.

| UNIT - II | MODELING METHODS | 9 |
|---|---|---|

Choosing and evaluating models – mapping problems to machine learning, evaluating clustering models, validating models – cluster analysis – K-means algorithm, Naïve Bayes – Memorization Methods – Linear and logistic regression – unsupervised methods.

| UNIT - III | INTRODUCTION TO R | 9 |
|---|---|---|

Reading and getting data into R – ordered and unordered factors – arrays and matrices – lists and data frames – reading data from files – probability distributions – statistical models in R - manipulating objects – data distribution.

| UNIT - IV | DATA VISUALIZATION | 9 |
|---|---|---|

Documentation and deployment – producing effective presentations – Introduction to graphical analysis – plot() function – displaying multivariate data – matrix plots – multiple plots in one window - exporting graph using graphics parameters - Case studies.

| UNIT - V | NP COMPLETE AND NP HARD | 9 |
|---|---|---|

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.

**TOTAL: 45 PERIODS**

Chairman (BoS) 23/9/23

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Obtain, clean/process and transform data. | Understand |
| CO2 | Analyze and interpret data using an ethically responsible approach. | Analyze |
| CO3 | Use appropriate models of analysis, assess the quality of input, derive insight from results, and investigate potential issues. | Understand |
| CO4 | Apply computing theory, languages and algorithms, as well as mathematical and statistical models, and the principles of optimization to appropriately formulate and use data analyses. | Apply |
| CO5 | Formulate and use appropriate models of data analysis to solve business-related challenges. | Apply |

**TEXT BOOKS:**


| | |
|---|---|
| 1 | Nina Zumel, John Mount, "Practical Data Science with R", Manning Publications, 2014. |
| 2 | Mark Gardener, "Beginning R - The Statistical Programming Language", John Wiley & Sons, Inc., 2012 |


**REFERENCES:**


| | |
|---|---|
| 1 | W. N. Venables, D. M. Smith and the R Core Team, "An Introduction to R", 2013. |
| 2 | Tony Ojeda, Sean Patrick Murphy, Benjamin Bengfort, Abhijit Dasgupta, "Practical Data Science Cookbook", Packt Publishing Ltd., 2014. |
| 3 | Nathan Yau, "Visualize This: The FlowingData Guide to Design, Visualization, and Statistics", Wiley, 2011. |
| 4 | Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich, "Professional Hadoop Solutions",John Wiley & Sons Inc., 2013. |


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO2 | 2 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 1 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 3 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 2 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| **Avg.** | **2.2** | **2.8** | **2** | **2.2** | **3** | **1** | **-** | **-** | **-** | **-** | **-** | **2.8** | **-** | **1** |

23/9/23

Chairman (BoS)

<table>
<tr><td colspan="6">ASSESSMENT SYSTEM:</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Examination (CIE)</td><td>End Semester Examination (ESE)</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>Theory only (40%)</td><td>Theory only (60%)</td></tr>
<tr><td colspan="6">CONTINUOUS INTERNAL EXAMINATION:</td></tr>
<tr><td colspan="6">THEORY</td></tr>
<tr><td colspan="2">Assessment</td><td>Portions</td><td>Duration</td><td>Max. Mark</td><td>Max CIE Marks</td></tr>
<tr><td colspan="2">CIE - 1</td><td>2.5 units</td><td>3 Hours</td><td>100</td><td rowspan="3">Best 2 out of 3 and Converted to 60</td></tr>
<tr><td colspan="2">CIE - 2</td><td>2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td colspan="2">Improvement / Missed Test</td><td>2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td colspan="2" rowspan="2">Other Assessment Methods</td><td colspan="2">Quizzes (10 MCQ per unit)</td><td>20</td><td rowspan="2">40</td></tr>
<tr><td colspan="2">Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test</td><td>20</td></tr>
<tr><td colspan="5"></td><td>100</td></tr>
<tr><td colspan="6">*The weighted average shall be converted into 40 marks for internal assessment.</td></tr>
</table>

23/9/23
Chairman (BoS)

| 23BD1103 | MACHINE LEARNING | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To learn different aspects of unsupervised learning and reinforcement learning
- To learn the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

| UNIT - I | INTRODUCTION AND MATHEMATICAL FOUNDATIONS | 9 |
|---|---|---|

What is Machine Learning? Need –History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Bayesian Conditional Probability -Vector Calculus & Optimization - Decision Theory - Information theory

| UNIT - II | SUPERVISED LEARNING | 9 |
|---|---|---|

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbors - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

| UNIT - III | UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING | 9 |
|---|---|---|

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning

| UNIT - IV | PROBABILISTIC METHODS FOR LEARNING | 9 |
|---|---|---|

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models.

| UNIT - V | NEURAL NETWORKS AND DEEP LEARNING | 9 |
|---|---|---|

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning – Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases

**TOTAL: 45 PERIODS**

**SUGGESTED ACTIVITIES:**

1. Give an example from our daily life for each type of machine learning problem
2. Study at least 3 Tools available for Machine Learning and discuss pros & cons of each
3. Take an example of a classification problem. Draw different decision trees for the example and explain the pros and cons of each decision variable at each level of the tree
4. Outline 10 machine learning applications in healthcare
5. Give 5 examples where sequential models are suitable.
6. Give at least 5 recent applications of CNN

23/9/23
Chairman (BoS)

| COURSE OUTCOMES<br>Upon completion of the course, the students will be able to: | | |
|---|---|---|
| **COs** | **Description** | **Blooms Taxonomy Level** |
| CO1 | Understand and outline problems for each type of machine learning | Understand |
| CO2 | Design a Decision tree and Random forest for an application. | Design |
| CO3 | Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results. | Apply |
| CO4 | Use a tool to implement typical Clustering algorithms for different types of applications. | Apply |
| CO5 | Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification. | Design |

| **TEXT BOOKS:** | |
|---|---|
| 1 | Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, 2nd Edition, 2014. |
| 2 | Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012. |
| **REFERENCES:** | |
| 1 | Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014. |
| 2 | Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013. |
| 3 | Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012. |
| 4 | Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015. |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | - | 2 | 2 | - | - | - | - | - | - | 3 | - | 1 |
| **CO2** | 2 | 2 | - | 2 | 2 | 2 | - | - | - | - | - | 3 | - | 1 |
| **CO3** | 3 | 2 | - | 3 | 2 | 3 | - | - | - | - | - | 3 | - | 1 |
| **CO4** | 3 | 3 | - | 2 | 2 | 2 | - | - | - | - | - | 2 | - | 1 |
| **CO5** | 2 | 3 | 2 | 2 | 2 | 3 | - | - | - | - | - | 3 | - | 1 |
| **Avg.** | **2.2** | 2.6 | 2 | **2.2** | **2** | 2.5 | **-** | **-** | **-** | **-** | **-** | **2.8** | **-** | **1** |

23/9/23
Chairman (BoS)

**ASSESSMENT SYSTEM:**

| L | T | P | C | Continuous Internal Examination (CIE) | End Semester Examination (ESE) |
|---|---|---|---|---|---|
| 3 | 0 | 2 | 4 | Theory only (40%) | Theory only (60%) |

**CONTINUOUS INTERNAL EXAMINATION:**

**THEORY**

| Assessment | Portions | Duration | Max. Mark | Max CIE Marks |
|---|---|---|---|---|
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |

*The weighted average shall be converted into 40 marks for internal assessment.

23/9/23
Chairman (BoS)

| 23BD1104 | DATABASE PRACTICES | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

**The Course will enable learners to:**

- Describe the fundamental elements of relational database management systems
- Explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
- Understand query processing in a distributed database system
- Understand the basics of XML and create well-formed and valid XML documents.
- Distinguish the different types of NoSQL databases
- To understand the different models involved in database security and their applications in real time world to protect the database and information associated with them.

| UNIT - I | RELATIONAL DATA MODEL | 9 |
|---|---|---|

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language – Database Normalization.

**Suggested Activities:**

Data Definition Language

- Create, Alter and Drop
- Enforce Primary Key, Foreign Key, Check, Unique and Not Null Constraints
- Creating Views

Data Manipulation Language

- Insert, Delete, Update
- Cartesian Product, Equi Join, Left Outer Join, Right Outer Join and Full Outer Join
- Aggregate Functions
- Set Operations
- Nested Queries

Transaction Control Language

- Commit, Rollback and Save Points

| UNIT - II | DISTRIBUTED DATABASES, ACTIVE DATABASES AND OPEN DATABASE CONNECTIVITY | 9 |
|---|---|---|

Distributed Database Architecture – Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management – Event Condition Action Model – Design and Implementation Issues for Active Databases – Open Database Connectivity.

Suggested Activities:

- Distributed Database Design and Implementation
- Row Level and Statement Level Triggers
- Accessing a Relational Database using PHP, Python and R

23/9/23
Chairman (BoS)

| UNIT - III | XML DATABASES | 9 |
|---|---|---|

Structured, Semi structured, and Unstructured Data – XML Hierarchical Data Model – XML Documents – Document Type Definition – XML Schema – XML Documents and Databases – XML Querying – XPath – XQuery

Suggested Activities:

- Creating XML Documents, Document Type Definition and XML Schema
- Using a Relational Database to store the XML documents as text
- Using a Relational Database to store the XML documents as data elements
- Creating or publishing customized XML documents from pre-existing relational databases
- Extracting XML Documents from Relational Databases
- XML Querying

| UNIT - IV | NOSQL DATABASES AND BIG DATA STORAGE SYSTEMS | 9 |
|---|---|---|

NoSQL – Categories of NoSQL Systems – CAP Theorem – Document-Based NoSQL Systems and MongoDB – MongoDB Data Model – MongoDB Distributed Systems Characteristics – NoSQL Key-Value Stores – DynamoDB Overview – Voldemort Key-Value Distributed Data Store – Wide Column NoSQL Systems – Hbase Data Model – Hbase Crud Operations – Hbase Storage and Distributed System Concepts – NoSQL Graph Databases and Neo4j – Cypher Query Language of Neo4j – Big Data – MapReduce – Hadoop – YARN.

**Suggested Activities:**

- Creating Databases using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j.
- Writing simple queries to access databases created using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j.

| UNIT - V | DATABASE SECURITY | 9 |
|---|---|---|

Database Security Issues – Discretionary Access Control Based on Granting and Revoking Privileges – Mandatory Access Control and Role-Based Access Control for Multilevel Security – SQL Injection – Statistical Database Security – Flow Control – Encryption and Public Key Infrastructures – Preserving Data Privacy – Challenges to Maintaining Database Security – Database Survivability – Oracle Label-Based Security.

**Suggested Activities:**

Implementing Access Control in Relational Databases.

**TOTAL: 45 PERIODS**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data | Understand |
| CO2 | Understand and write well-formed XML documents | Design |
| CO3 | Be able to apply methods and techniques for distributed query processing. | Apply |
| CO4 | Design and Implement secure database systems | Apply |
| CO5 | Use the data control, definition, and manipulation languages of the NoSQL databases. | Design |

Chairman (BoS)

| TEXT BOOKS: | |
|---|---|
| 1 | R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education 2016 |
| 2 | Henry F. Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2019.. |
| **REFERENCES:** | |
| 1 | C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006 |
| 2 | Raghu Ramakrishnan , Johannes Gehrke "Database Management Systems", Fourth Edition, McGraw Hill Education, 2015. |
| 3 | Harrison, Guy, "Next Generation Databases, NoSQL and Big Data" , First Edition, A press publishers, 2015 |
| 4 | Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Sixth Edition, Pearson Education, 2015 |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 2 | - | 3 | - | - | - | - | - | 3 | - | 1 |
| CO2 | 2 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 3 | 3 | 2 | 3 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 3 | 3 | 2 | 2 | - | 2 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 2 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| **Avg.** | **2.2** | **2.8** | **2** | **2.2** | **-** | 2 | **-** | **-** | **-** | **-** | **-** | **2.8** | **-** | **1** |

**ASSESSMENT SYSTEM:**

| L | T | P | C | Continuous Internal Examination (CIE) | End Semester Examination (ESE) |
|---|---|---|---|---|---|
| 3 | 0 | 2 | 4 | Theory only (40%) | Theory only (60%) |

**CONTINUOUS INTERNAL EXAMINATION:**

**THEORY**

| Assessment | Portions | Duration | Max. Mark | Max CIE Marks |
|---|---|---|---|---|
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |

*The weighted average shall be converted into 40 marks for internal assessment.

23/9/23
Chairman (BoS)

| 23BD1111 | ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

The Course will enable learners to:

- To acquire the knowledge of using advanced tree structures
- To learn the usage of heap structures
- To understand the usage of graph structures and spanning trees
- To understand the problems such as matrix chain multiplication, activity selection and
- Huffman coding
- To understand the necessary mathematical abstraction to solve problems.

**LIST OF EXPERIMENTS**

1. Implementation of recursive function for tree traversal and Fibonacci
2. Implementation of iteration function for tree traversal and Fibonacci
3. Implementation of Merge Sort and Quick Sort
4. Implementation of a Binary Search Tree
5. Red-Black Tree Implementation
6. Heap Implementation
7. Fibonacci Heap Implementation
8. Graph Traversals
9. Spanning Tree Implementation
10. Shortest Path Algorithms (Dijkstra's algorithm, Bellman Ford Algorithm)
11. Implementation of Matrix Chain Multiplication
12. Activity Selection and Huffman Coding Implementation.

**HARDWARE/SOFTWARE REQUIREMENTS**

1. 64-bit Open source Linux or its derivative
2. Open Source C++ Programming tool like G++/GCC

**TOTAL: 60 PERIODS**

23/9/23
Chairman (BoS)

| COURSE OUTCOMES<br>Upon completion of the course, the students will be able to: | | |
|---|---|---|
| **COs** | **Description** | **Blooms Taxonomy Level** |
| CO1 | Design and implement basic and advanced data structures extensively | Design |
| CO2 | Design algorithms using graph structures | Design |
| CO3 | Design and develop efficient algorithms with minimum complexity using design techniques | Design |
| CO4 | Develop programs using various algorithms. | Develop |
| CO5 | Choose appropriate data structures and algorithms, understand the ADT/libraries, and use it to design algorithms for a specific problem. | Understand |

| **REFERENCES:** | |
|---|---|
| 1 | Lipschutz Seymour, "Data Structures Schaum's Outlines Series", Tata McGraw Hill, 3rd Edition, 2014. |
| 2 | Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006. |
| 3 | http://www.coursera.org/specializations/data-structures-algorithms |
| 4 | http://www.tutorialspoint.com/data_structures_algorithms |
| 5 | http://www.geeksforgeeks.org/data-structures/ |

| Mapping of COs with POs and PSOs | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/ POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | 3 | 2 | 1 | - | - | - | - | - | - | - | 3 | - | 1 |
| **CO2** | 2 | 3 | 2 | 1 | - | - | - | - | - | - | - | 3 | - | 1 |
| **CO3** | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | 3 | - | 1 |
| **CO4** | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | 2 | - | 1 |
| **CO5** | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | 3 | - | 1 |
| **Avg.** | **2.2** | **2.8** | **2** | 1 | - | - | - | - | - | - | - | **2.8** | - | **1** |

| **ASSESSMENT SYSTEM:** | | | | | |
|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Continuous Internal Examination (CIE)** | **End Semester Examination (ESE)** |
| 0 | 0 | 4 | 2 | Laboratory only (60 %) | Laboratory only (40 %) |

| **LABORATORY** | | |
|---|---|---|
| **Evaluation of Laboratory Record (100 Marks)** | **Model Practical Examination (100 Marks)** | **Total** |
| 75 | 25 | 100* |
| * Total marks shall be converted into 60 marks | | |

23/9/23
Chairman (BoS)

| 23BD1112 | BIG DATA COMPUTING LABORATORY | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 0 | 0 | 2 | 1 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To set up single and multi-node Hadoop Clusters.
- To solve Big Data problems using Map Reduce Technique.
- To learn NoSQL queries. To design algorithms that uses Map Reduce Technique to apply on Unstructured and structured data.
- To learn Scalable machine learning using Mahout.

**LIST OF EXPERIMENTS**

1. Set up a pseudo-distributed, single-node Hadoop cluster backed by the Hadoop Distributed File System, running on Ubuntu Linux. After successful installation on one node, configuration of a multi-node Hadoop cluster (one master and multiple slaves).
2. MapReduce application for word counting on Hadoop cluster.
3. Unstructured data into NoSQL data and do all operations such as NoSQL query with API.
4. K-means clustering using map reduce.
5. Page Rank Computation.
6. Mahout machine learning library to facilitate the knowledge build up in big data analysis.
7. Application of Recommendation Systems using Hadoop/mahout libraries.

**HARDWARE/SOFTWARE REQUIREMENTS**

1. Java
2. Hadoop
3. Mahout
4. HBase/MongoDB

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Set up single and multi-node Hadoop Clusters. | Understand |
| CO2 | Apply Map Reduce technique for various algorithms. | Apply |
| CO3 | Design new algorithms that use Map Reduce to apply on Unstructured and structured data. | Design |
| CO4 | Develop Scalable machine learning algorithms for various Big data applications using Mahout. | Develop |
| CO5 | Represent NoSQL data. | Design |

23/9/23
Chairman (BoS)

| REFERENCES: | |
|---|---|
| 1 | Kristina Chodorow, "MongoDB: The Definitive Guide – Powerful and Scalable Data Storage", O'Reilly, 3rd Edition, 2019. |
| 2 | Lars George, "HBase: The Definitive Guide", O'Reilly, 2015. |
| 3 | Tom White, "Hadoop: The Definitive Guide – Storage and Analysis at Internet Scale", O'Reilly, 4th Edition, 2015. |
| 4 | Robin Anil, Sean Owen, Ellen G. Friedman, Ted Dunning, "Mahout in Action", Manning Publications, 2011. |

| Mapping of COs with POs and PSOs | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/ POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 1 | - | - | 1 | - | - | - | - | - | - | - | 3 | - | 1 |
| **CO2** | 2 | - | 1 | 1 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| **CO3** | 2 | 3 | 3 | 2 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| **CO4** | 2 | 3 | 2 | 2 | - | 2 | - | - | - | - | - | 2 | - | 1 |
| **CO5** | 2 | 1 | - | 2 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| **Avg.** | 1.8 | 2.3 | 2 | 1.6 | - | 1.5 | - | - | - | - | - | **2.8** | - | **1** |

| ASSESSMENT SYSTEM: | | | | | |
|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Continuous Internal Examination (CIE)** | **End Semester Examination (ESE)** |
| 0 | 0 | 2 | 1 | Laboratory only (60 %) | Laboratory only (40 %) |

| **LABORATORY** | | **Total** |
|---|---|---|
| **Evaluation of Laboratory Record (100 Marks)** | **Model Practical Examination (100 Marks)** | |
| 75 | 25 | 100* |
| * Total marks shall be converted into 60 marks | | |

23/9/23
Chairman (BoS)

| 23BD1201 | BIG DATA SECURITY | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To understand the mathematical foundations of security principles
- To appreciate the different aspects of encryption techniques
- To understand the role played by authentication in security
- To understand the security concerns of big-data.

| UNIT - I | SYMMETRIC TECHNIQUES | 9 |
|---|---|---|

Probability and Information Theory - Algebraic foundations – Number theory - Substitution Ciphers – Transposition Ciphers – Classical Ciphers – DES – AES – Confidentiality Modes of Operation.

| UNIT - II | ASYMMETRIC TECHNIQUES | 9 |
|---|---|---|

Diffie-Hellman Key Exchange protocol – Discrete logarithm problem – RSA cryptosystems & cryptanalysis – ElGamal cryptosystem – Elliptic curve architecture and cryptography - Data Integrity techniques.

| UNIT - III | AUTHENTICATION | 9 |
|---|---|---|

Authentication requirements – Authentication functions – Message authentication codes – Hash functions – Security of hash functions and MACS – MD5 Message Digest algorithm – Secure hash algorithm.

| UNIT - IV | SECURITY ANALYTICS I | 9 |
|---|---|---|

Introduction to Security Analytics – Techniques in Analytics – Analysis in everyday life –Challenges in Intrusion and Incident Identification – Analysis of Log file – Simulation and Security Process.

| UNIT - V | NEURAL NETWORKS AND DEEP LEARNING | 9 |
|---|---|---|

Access Analytics – Security Analysis with Text Mining – Security Intelligence – Security Breaches.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Design algorithms in a secure manner for Big data applications | Design |
| CO2 | Use available security practices in big-data analytics. | Design |
| CO3 | Understand Mathematical foundations of security principles and different aspects of encryption techniques. | Understand |
| CO4 | Explain the role played by authentication in security | Understand |
| CO5 | Analyze and find solutions for Security concerns of big-data | Analyze |

Chairman (BoS) 23/9/23

| | |
|---|---|
| **TEXT BOOKS:** | |
| 1 | William Stallings, "Cryptography and Network security: Principles and Practices",Pearson/PHI, 7th Edition, 2017 |
| 2 | . Behrouz A. Forouzan, Debdeeep Mukhopadhyay "Cryptography and Network Security", Tata McGraw Hill Education, 3rd Edition, 2015. |
| **REFERENCES:** | |
| 1 | Douglas R. Stinson ,"Cryptography Theory and Practice ", Chapman & Hall/CRC, 3rd Edition, 2021. |
| 2 | Mark Talabis, Robert McPherson, I Miyamoto and Jason Martin, "Information Security Analytics: Finding Security Insights, Patterns, and Anomalies in Big Data",Syngress Media, U.S.,2014 |
| **WEB REFERENCES:** | |
| 1 | http://www.smartercomputingblog.com/category/big-data/ |
| 2 | https://www.rd-alliance.org/group/big-data-ig-data-security-and-trust-wg/wiki/big-data-security-issues-challenges-tech-concerns |
| **ONLINE RESOURCES:** | |
| 1 | https://www.tutorialspoint.com/big_data_tutorials.html |
| 2 | https://www.simplilearn.com/tutorials/big-data-tutorial |

| Mapping of COs with POs and PSOs | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/ POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | 2 | - | 2 | - | 3 | - | - | - | - | - | 3 | - | 1 |
| **CO2** | 2 | 2 | - | 2 | - | 3 | - | - | - | - | - | 3 | - | 1 |
| **CO3** | 2 | 2 | - | 2 | - | 3 | - | - | - | - | - | 3 | - | 1 |
| **CO4** | 2 | 2 | - | 2 | - | 3 | - | - | - | - | - | 2 | - | 1 |
| **CO5** | 2 | 2 | - | 2 | - | 3 | - | - | - | - | - | 3 | - | 1 |
| **Avg.** | 2 | 2 | - | 2 | - | 5 | - | - | - | - | - | **2.8** | - | **1** |

23/9/23
Chairman (BoS)

**ASSESSMENT SYSTEM:**

| L | T | P | C | Continuous Internal Examination (CIE) | End Semester Examination (ESE) |
|---|---|---|---|---|---|
| 3 | 0 | 0 | 3 | Theory only (40%) | Theory only (60%) |

**CONTINUOUS INTERNAL EXAMINATION:**

**THEORY**

| Assessment | Portions | Duration | Max. Mark | Max CIE Marks |
|---|---|---|---|---|
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |

*The weighted average shall be converted into 40 marks for internal assessment.

23/9/23
Chairman (BoS)

| 23BD1202 | BIG DATA MINING AND ANALYTICS | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To understand the computational approaches to Modeling, Feature Extraction
- To understand the need and application of Map Reduce
- To understand the various search algorithms applicable to Big Data
- To analyze and interpret streaming data.
- To learn how to handle large data sets in main memory and learn the various clustering techniques applicable to Big Data

| UNIT - I | DATA MINING AND LARGE SCALE FILES | 9 |
|---|---|---|

Introduction to Statistical modeling – Machine Learning – Computational approaches to modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining - Distributed File Systems – Map-reduce – Algorithms using Map Reduce – Efficiency of Cluster Computing Techniques.

| UNIT - II | SIMILAR ITEMS | 9 |
|---|---|---|

Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Methods for High Degree of Similarities.

| UNIT - III | MINING DATA STREAMS | 9 |
|---|---|---|

Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows..

| UNIT - IV | LINK ANALYSIS AND FREQUENT ITEMSETS | 9 |
|---|---|---|

Page Rank –Efficient Computation - Topic Sensitive Page Rank – Link Spam – Market Basket Model – A-priori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets.

| UNIT - V | CLUSTERING | 9 |
|---|---|---|

Introduction to Clustering Techniques – Hierarchical Clustering –Algorithms – K-Means – CURE – Clustering in Non –– Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems.

**TOTAL: 45 PERIODS**

23/9/23
Chairman (BoS)

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Design algorithms by employing Map Reduce technique for solving Big Data problems | Design |
| CO2 | Design algorithms for Big Data by deciding on the apt Features set. | Design |
| CO3 | Design algorithms for handling petabytes of datasets. | Design |
| CO4 | Design algorithms and propose solutions for Big Data by optimizing main memory consumption. | Design |
| CO5 | Design solutions for problems in Big Data by suggesting appropriate clustering techniques. | Design |

**TEXT BOOKS:**

| | |
|---|---|
| 1 | Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 3rd Edition, 2020. |
| 2 | Jiawei Han, MichelineKamber, Jian Pei, "Data Mining Concepts and Techniques", Morgan Kaufman Publications, Third Edition, 2012 |

**REFERENCES:**

| | |
|---|---|
| 1 | Ian H.Witten, Eibe Frank "Data Mining – Practical Machine Learning Tools and Techniques", Morgan Kaufman Publications, Third Edition, 2011. |
| 2 | David Hand, HeikkiMannila and Padhraic Smyth, "Principles of Data Mining", MIT PRESS, 2001. |

**WEB REFERENCES:**

| | |
|---|---|
| 1 | https://swayam.gov.in/nd2_arp19_ap60/preview |
| 2 | https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106104189/lec1.pdf |

**ONLINE RESOURCES:**

| | |
|---|---|
| 1 | https://examupdates.in/big-data-analytics/ |
| 2 | https://www.tutorialspoint.com/big_data_analytics/index.htm |
| 3 | https://www.tutorialspoint.com/data_mining/index.htm |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 3 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| CO2 | 2 | 2 | 2 | 3 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 2 | 2 | 2 | 3 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 2 | 2 | 2 | 3 | - | 2 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 2 | 2 | 2 | 3 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| Avg. | 2 | 2 | 2 | 3 | - | 2 | - | - | - | - | - | 2.8 | - | 1 |

23/9/23
Chairman (BoS)

<table>
<tr><td colspan="6">ASSESSMENT SYSTEM:</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Examination (CIE)</td><td>End Semester Examination (ESE)</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>Theory only (40%)</td><td>Theory only (60%)</td></tr>
<tr><td colspan="6">CONTINUOUS INTERNAL EXAMINATION:</td></tr>
<tr><td colspan="6">THEORY</td></tr>
<tr><td>Assessment</td><td colspan="2">Portions</td><td>Duration</td><td>Max. Mark</td><td>Max CIE Marks</td></tr>
<tr><td>CIE - 1</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td><td rowspan="3">Best 2 out of 3 and Converted to 60</td></tr>
<tr><td>CIE - 2</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td>Improvement / Missed Test</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td rowspan="2">Other Assessment Methods</td><td colspan="3">Quizzes (10 MCQ per unit)</td><td>20</td><td rowspan="2">40</td></tr>
<tr><td colspan="3">Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test</td><td>20</td></tr>
<tr><td colspan="5"></td><td>100</td></tr>
<tr><td colspan="6">*The weighted average shall be converted into 40 marks for internal assessment.</td></tr>
</table>

23/9/23
Chairman (BoS)

| 23BD1203 | CLOUD COMPUTING TECHNOLOGIES | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by
- Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

| UNIT - I | VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTUR | 9 |
|---|---|---|

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization – Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

| UNIT - II | CLOUD PLATFORM ARCHITECTURE | 9 |
|---|---|---|

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

| UNIT - III | AWS CLOUD PLATFORM - IAAS | 9 |
|---|---|---|

**Amazon Web Services:** AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

| UNIT - IV | PAAS CLOUD PLATFORM | 9 |
|---|---|---|

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

| UNIT - V | PROGRAMMING MODEL | 9 |
|---|---|---|

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

**TOTAL: 45 PERIODS**

23/9/23
Chairman (BoS)

| COURSE OUTCOMES<br>Upon completion of the course, the students will be able to: | | |
|---|---|---|
| **COs** | **Description** | **Blooms Taxonomy Level** |
| CO1 | Employ the concepts of virtualization in the cloud computing | Understand |
| CO2 | Identify the architecture, infrastructure and delivery models of cloud computing. | Understand |
| CO3 | Develop the Cloud Application in AWS platform. | Develop |
| CO4 | Apply the concepts of Windows Azure to design Cloud Application. | Apply |
| CO5 | Develop services using various Cloud computing programming models. | Develop |

**TEXT BOOKS:**


| | |
|---|---|
| 1 | Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013. |
| 2 | Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019. |


**REFERENCES:**


| | |
|---|---|
| 1 | Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010. |
| 2 | Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing, MCGraw Hill Education (India) Pvt. Ltd., 2013. |
| 3 | Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guidell, McGraw-Hill Osborne Media, 2009. |


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 1 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO2 | 2 | 3 | 2 | 1 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 3 | 3 | 2 | 2 | 3 | 2 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 3 | 3 | 2 | 2 | 3 | 2 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 3 | 3 | 2 | 2 | 3 | 2 | - | - | - | - | - | 3 | - | 1 |
| Avg. | 2.6 | 3 | 2 | 1.6 | 3 | 1.6 | - | - | - | - | - | **2.8** | - | **1** |

23/9/23
Chairman (BoS)

**ASSESSMENT SYSTEM:**

| L | T | P | C | Continuous Internal Examination (CIE) | End Semester Examination (ESE) |
|---|---|---|---|---|---|
| 3 | 0 | 0 | 3 | Theory only (40%) | Theory only (60%) |

**CONTINUOUS INTERNAL EXAMINATION:**

**THEORY**

| Assessment | Portions | Duration | Max. Mark | Max CIE Marks |
|---|---|---|---|---|
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |

*The weighted average shall be converted into 40 marks for internal assessment.

23/9/23
Chairman (BoS)

| 23BD1204 | INFORMATION STORAGE MANAGEMENT | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To understand the storage architecture and technologies in Information management
- To learn to establish and manage a data center
- To learn various storage technologies for the required application
- To apply security measures to the data center

| UNIT - I | STORAGE TECHNOLOGY | 9 |
|---|---|---|

Review data creation - Amount of data being created - Understand the value of data to a business - Challenges in data storage and data management - Solutions available for data storage - Core elements of a data center infrastructure - Role of each element in supporting business activities.

| UNIT - II | STORAGE SYSTEM ARCHITECTURE | 9 |
|---|---|---|

Hardware and software components of the host environment - Key protocols and concepts used by each component - Physical and logical components of a connectivity environment - Major physical components of a disk drive and their function - Logical constructs of a physical disk - Access characteristics - Performance Implications - Concept of RAID and its components - Different RAID levels and their suitability for different application environments - Compare and contrast integrated and modular storage systems - High-level architecture and working of an intelligent storage system

| UNIT - III | INTRODUCTION TO NETWORKED STORAGE | 9 |
|---|---|---|

Evolution of networked storage - Architecture - Components - Topologies of FC-SAN - NAS - IP-SAN - Benefits of the different networked storage options - Understand the need for long-Term archiving solutions - Describe how CAS fulfill the need - Understand the appropriateness - Different networked storage options - Different application environments.

| UNIT - IV | INFORMATION AVAILABILITY, MONITORING & MANAGING DATA CENTERS | 9 |
|---|---|---|

List reasons for planned or unplanned outages - Impact of downtime - Business continuity (BC) - Disaster recovery (DR) - RTO - RPO - Identify single points of failure - List solutions to mitigate failures - Architecture of backup/recovery - Different backup or recovery topologies - Replication technologies - Role in ensuring information availability and business continuity - Remote replication technologies - Role in providing disaster recovery and business continuity capabilities - Identify key areas to monitor in a data center - Industry standards for data center monitoring and management - Key metrics - Key management tasks.

| UNIT - V | SECURING STORAGE AND STORAGE VIRTUALIZATION | 9 |
|---|---|---|

Information security - Critical security attributes - Storage security domains - List and analyze the common threats in each domain - Virtualization technologies - Block-level and file-level virtualization technologies and processes.

**TOTAL: 45 PERIODS**

23/9/23
Chairman (BoS)

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Understand the basics of storage management for Information maintenance. | Understand |
| CO2 | Study the requirements and strategies for the data center. | Understand |
| CO3 | Learn various storage technologies for the required application | Understand |
| CO4 | Apply security measures to the data center. | Apply |
| CO5 | Analyze Quality of Service in Storage. | Analyze |

**TEXT BOOKS:**

| | |
|---|---|
| 1 | . EMC Corporation, "Information Storage and Management: Storing, Managing, and Protecting Digital Information", 2nd Edition, Wiley, India, 2012. |
| 2 | Marc Farley, "Building Storage Networks", Tata McGraw Hill" ,Osborne, 2001. |

**REFERENCES:**

| | |
|---|---|
| 1 | Ulf Troppens, Rainer Erkens, Wolfgang Muller-Friedt, Rainer Wolafka, Nils Haustein, "Storage Networks Explained: Basics and Application of Fibre Channel SAN, NAS, ISCSI, InfiniBand and FCoE", Wiley, 2015. |
| 2 | Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill , 2017. |

**WEB REFERENCES:**

| | |
|---|---|
| 1 | https://nptel.ac.in/courses/106108058/. |

**ONLINE RESOURCES:**

| | |
|---|---|
| 1 | https://dokumen.tips/engineering/cp7029-information-storage-management-notes-58f9ada4e0e17.html. |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | 2 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| CO2 | 2 | 1 | 2 | 2 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 3 | 3 | 3 | 2 | - | 3 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 3 | 3 | 3 | 2 | - | 3 | - | - | - | - | - | 3 | - | 1 |
| Avg. | 2.6 | 2.2 | 2.6 | 2 | 2 | 2.6 | - | - | - | - | - | **2.8** | - | **1** |

23/9/23
Chairman (BoS)

<table>
<tr><td colspan="6">ASSESSMENT SYSTEM:</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Examination (CIE)</td><td>End Semester Examination (ESE)</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>Theory only (40%)</td><td>Theory only (60%)</td></tr>
<tr><td colspan="6">CONTINUOUS INTERNAL EXAMINATION:</td></tr>
<tr><td colspan="6">THEORY</td></tr>
<tr><td>Assessment</td><td colspan="2">Portions</td><td>Duration</td><td>Max. Mark</td><td>Max CIE Marks</td></tr>
<tr><td>CIE - 1</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td><td rowspan="3">Best 2 out of 3 and Converted to 60</td></tr>
<tr><td>CIE - 2</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td>Improvement / Missed Test</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td rowspan="2">Other Assessment Methods</td><td colspan="3">Quizzes (10 MCQ per unit)</td><td>20</td><td rowspan="2">40</td></tr>
<tr><td colspan="3">Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test</td><td>20</td></tr>
<tr><td colspan="5"></td><td>100</td></tr>
<tr><td colspan="6">*The weighted average shall be converted into 40 marks for internal assessment.</td></tr>
</table>

23/9/23

Chairman (BoS)

| 23BD1205 | EMBEDDED SYSTEMS AND IIOT | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To learn the internal architecture of an embedded processor including timers and interrupts.
- To learn and use embedded C programming.
- To provide exposure on architecture and components of IIOT.
- To introduce the communication protocols of IIOT.
- To study about visualization and data processing of IIOT.

| UNIT - I | EMBEDDED PROCESSOR | 9 |
|---|---|---|

Embedded processors –8051 Microcontroller – Architecture, Instruction set and programming. Programming parallel ports, Timers and serial port – Memory and I/O devices interfacing – Interrupt handling

| UNIT - II | EMBEDDED C PROGRAMMING | 9 |
|---|---|---|

Programming Embedded Systems in C - Memory And I/O Devices Interfacing - Implementing Timers, Interrupts and Serial communication in embedded C- Need For RTOS - Multiple Tasks and Processes – Context Switching - Priority Based Scheduling Policies.

| UNIT - III | INTRODUCTION & ARCHITECTURE OF IIOT | 9 |
|---|---|---|

Introduction to IOT, IIOT, IOT Vs. IIOT, Architecture of IIoT, IOT node- Components of IIOT - Fundamentals of Control System, introductions, components, closed loop & open loop system, IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, Introduction to sensors, Types of sensors, working principle of basic Sensors - Ultrasonic Sensor, IR sensor, MQ2, Temperature and Humidity Sensors (DHT-11). Digital switch, Electro Mechanical switches, Roles of sensors and actuators in IIOT, Special requirements for IIOT sensors.

| UNIT - IV | COMMUNICATION TECHNOLOGIES OF IIOT | 9 |
|---|---|---|

Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACNet , Current, M2M etc. Need of protocols; Communication Protocols: Wi-Fi, Wi-Fi direct, IEEE 802.15.4, Zigbee, Z wave, BLE, SPI, RFID, Industry standards communication technology (COAP, LoRAWAN, OPC UA, MQTT AMQP IIOT), connecting into existing Modbus and Profibus technology, wireless network communication.

| UNIT - V | VISUALIZATION OF IIOT | 9 |
|---|---|---|

**Cloud platforms: Overview of cots cloud platforms, predix, thingworx, azure etc.** Front- end EDGE devices, Enterprise data for IIoT, Emerging descriptive data standards for IIoT, Cloud database, Cloud computing, Fog or Edge computing. Connecting an Arduino/Raspberry pi to the Web: Introduction, setting up the Arduino/Raspberry pi development environment, Options for Internet connectivity with Arduino, Configuring your Arduino/Raspberry pi board for the IoT.

23/9/23

Chairman (BoS)

**TOTAL: 45 PERIODS**

**SUGGESTED ACTIVITIES:**

1. A Study on the various embedded processors like virtual watches, PDAS, digital cameras, mp3 players
2. Develop an application using embedded C programming in arduino
3. Build a project using IIOT components.
4. Study of communication protocols and technology in IIOT
5. Presentation on most prominent IIOT visualization tools.

**PRACTICAL EXERCISES:**

1. Experiments on Arduino, ESp8266, raspberry Pi
2. Measurement of temperature & pressure values of the process using raspberry pi/node mcu.
3. Modules and Sensors Interfacing (IR sensor, Ultrasonic sensors, Soil moisture sensor) using Raspberry pi/node mcu.
4. Modules and Actuators Interfacing (Relay, Motor, Buzzer) using Raspberry pi/node mcu.
5. Demonstration of MQTT communication
6. Demonstration of LoRa communication.

**TOTAL:30 PERIODS**

**HARDWARE/SOFTWARE REQUIREMENTS**

1. Arduino
2. ESp8266
3. Raspberry Pi

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Describe the internal architecture of an embedded processor including timers and interrupts | Understand |
| CO2 | Write the embedded C programming. | Understand |
| CO3 | Use the components of IIOT for building applications. | Understand |
| CO4 | Demonstrate and perform the communication by using the protocols. | Demonstrate |
| CO5 | Explain about visualization and data processing of IIOT. | Understand |

**TEXT BOOKS:**

| | |
|---|---|
| 1 | Michael J. Pont, "Embedded C", Pearson Education, 2007. |
| 2 | Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", Pearson Education, Second Edition, 2014 |

**REFERENCES:**

| | |
|---|---|
| 1 | Mahmood, Zaigham(Ed), "The Internet of Things in the Industrial Sector", Springer Publication, 2019. |
| 2 | Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cyber manufacturing System (wireless Technology)", Springer Publication, 2017. |

23/9/23
Chairman (BoS)

| | |
|---|---|
| 3 | Hakima Chaouchi, "The Internet of Things Connecting Objects to the Web" ISBN: 978-1-84821-140-7, Willy Publications, 2010. |
| 4 | Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017. |
| 5 | Ismail Butun, "Industrial IoT Challenges, Design Principles, Applications, and Security",vSpringer Publications, 2020 |
| 6 | Wayne Wolf, "Computers as Components: Principles of Embedded Computer System Design", Elsevier, 2006. |
| 7 | David Etter, "IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT", 2016 |
| 8 | Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2 nd Edition, Willy Publications |
| 9 | Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications. |


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 1 |
| CO2 | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 1 |
| CO3 | 3 | 2 | 2 | 1 | 1 | 2 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 3 | 2 | 2 | 1 | - | 2 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 3 | 1 | 2 | 1 | 2 | 2 | - | - | - | - | - | 3 | - | 1 |
| Avg. | 3 | 1.6 | 2 | 1 | 1.5 | 2 | - | - | - | - | - | 2.8 | - | 1 |

**ASSESSMENT SYSTEM:**

| L | T | P | C | Continuous Internal Examination (CIE) | End Semester Examination (ESE) |
|---|---|---|---|---|---|
| 3 | 0 | 2 | 4 | Theory only (40%) | Theory only (60%) |

**CONTINUOUS INTERNAL EXAMINATION:**

**THEORY**

| Assessment | Portions | Duration | Max. Mark | Max CIE Marks |
|---|---|---|---|---|
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |

*The weighted average shall be converted into 40 marks for internal assessment.

23/9/23
Chairman (BoS)

| 23BD1211 | BIG DATA MINING AND ANALYTICS LABORATORY | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To learn to process big data using Hadoop framework and MapReduce.
- To analyze big data using classification and clustering techniques.
- To realize storage of big data using MongoDB and Hbase.
- To develop big data applications for streaming data using Apache Spark

**LIST OF EXPERIMENTS**

1. Install, configure and run Hadoop and HDFS.
2. Implement word count / frequency programs using MapReduce(MR).
3. Implement an MR program that processes a weather dataset.
4. Implement SVM and clustering techniques using R.
5. Visualize data using any plotting framework.
6. Implement an application that stores big data in Hbase / MongoDB using Hadoop / R.
7. Install, deploy and configure Apache Spark cluster. Run an application using Apache Spark.

**SOFTWARE**

Hadoop, R Package, Hbase, MongoDB, Apache Spark

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Process big data using Hadoop framework.. | Understand |
| CO2 | Implement MapReduce framework for processing big data. | Implement |
| CO3 | Perform data analysis using classification and clustering techniques | Implement |
| CO4 | Realize storage of big data using MongoDB , Hbase and Apache Spark | Apply |
| CO5 | Perform graphical data analysis | Apply |

Chairman (BoS)

| Mapping of COs with POs and PSOs | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 1 | 1 | 3 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| CO2 | 2 | 2 | 2 | 3 | - | 2 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | 3 | - | 1 |
| Avg. | 2.8 | 2.4 | 2.4 | 3 | 3 | 2.6 | - | - | - | - | - | **2.8** | - | **1** |

| **ASSESSMENT SYSTEM:** | | | | | |
|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Continuous Internal Examination (CIE)** | **End Semester Examination (ESE)** |
| 0 | 0 | 4 | 2 | Laboratory only (60 %) | Laboratory only (40 %) |

| **LABORATORY** | | **Total** |
|---|---|---|
| **Evaluation of Laboratory Record (100 Marks)** | **Model Practical Examination (100 Marks)** | |
| 75 | 25 | 100* |
| * Total marks shall be converted into 60 marks | | |

23/9/23
Chairman (BoS)

| 23BD1221 | TERM PAPER WRITING AND SEMINAR | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | EEC | 0 | 0 | 2 | 1 |

**OBJECTIVES:**

**The Course will enable learners to:**

- In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas.

**THE WORK INVOLVES THE FOLLOWING STEPS:**

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation.

**TOTAL: 30 PERIODS**

| Activity | Instructions | Submission week | Evaluation |
|---|---|---|---|
| Selection of area of interest and Topic<br>Stating an Objective | You are requested to select an area of Interest , topic and state an objective | 2nd week | **3 %** Based on clarity of thought, current relevance and clarity in writing |
| Collecting Information about your area & topic | 1. List 1 Special Interest Groups or professional society<br>2. List 2 journals<br>3. List 2 conferences, symposia or workshops<br>4. List 1 thesis title<br>5.List 3 web presences (mailing lists, forums, news sites)<br>6.List 3 authors who publish regularly in your area<br>7. Attach a call for papers (CFP) from your area. | 3rd week | **3%** ( the selected information must be area specific and of international and national standard) |

23/8/23

Chairman (BoS)

| | | | |
|---|---|---|---|
| Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter | You have to provide a complete list of references you will be using- Based on your objective - Search various digital libraries and Google Scholar<br>When picking papers to read - try to:<br>Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them,<br>Favour papers from well- known journals and conferences,<br>Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper),<br>Favour more recent papers,<br>Pick a recent survey of the field so you can quickly gain an overview,<br>Find relationships with respect to each other and to your topic area (classification scheme/categorization)<br>Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered | 4th week | **6%**<br>( the list of standard papers and reason for selection) |
| Reading and notes for first 5 papers | Reading Paper Process<br>For each paper form a Table answering the following questions:<br>What is the main topic of the article?<br>What was/were the main issue(s) the author said they want to discuss?<br>Why did the author claim it was important?<br>How does the work build on other's work, in the author's opinion?<br>What simplifying assumptions does the author claim to be making?<br>What did the author do?<br>How did the author claim they were going to evaluate their work and compare it to others?<br>What did the author say were the limitations of their research?<br>What did the author say were the important directions for future research?<br>Conclude with limitations/issues not addressed by the paper ( from the perspective of your survey) | 5th week | **8%**<br>( the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper) |
| Reading and notes for next5 papers | Repeat Reading Paper Process | 6th week | **8%**<br>( the table given should indicate your understanding |

23/9/23
Chairman (BoS)

| | | | |
|---|---|---|---|
| | | | of the paper and the evaluation is based on your conclusions about each paper) |
| Reading and notes for final 5 papers | Repeat Reading Paper Process | 7th week | **8%** ( the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper) |
| Draft outline 1 and Linking papers | Prepare a draft Outline, your survey goals, along with a classification / categorization diagram | 8th week | **8%** ( this component will be evaluated based on the linking and classification among the papers) |
| Abstract | Prepare a draft abstract and give a presentation | 9th week | **6%** (Clarity, purpose and conclusion) **6%** Presentation & Viva Voce |
| Introduction Background | Write an introduction and background sections | 10th week | **5%** ( clarity) |
| Sections of the paper | Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey | 11thweek | **10%** (this component will be evaluated based on the linking and classification among the papers) |
| Your conclusions | Write your conclusions and future work | 12th week | **5%** ( conclusions – clarity and your ideas) |
| Final Draft | Complete the final draft of your paper | 13th week | **10%** (formatting, English, Clarity and linking) **4%** Plagiarism Check Report |
| Seminar | A brief 15 slides on your paper | 14th & 15th week | **10%** (based on presentation and Viva-voce) |

23/9/23
Chairman (BoS)

| 23BD1P01 | HIGH PERFORMANCE COMPUTING FOR BIG DATA | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To learn the fundamental concepts of High Performance Computing.
- To learn the network & software infrastructure for high performance computing.
- To understand real time analytics using high performance computing.
- To learn the different ways of security perspectives and technologies used in HPC.
- To understand the emerging big data applications.

| UNIT - I | INTRODUCTION | 9 |
|---|---|---|

The Emerging IT Trends- IOT/IOE-Apache Hadoop for big data analytics-Big data into big insights and actions – Emergence of BDA discipline – strategic implications of big data – BDA Challenges – HPC paradigms – Cluster computing – Grid Computing – Cloud computing – Heterogeneous computing – Mainframes for HPC - Supercomputing for BDA – Appliances for BDA.

| UNIT - II | NETWORK & SOFTWARE INFRASTRUCTURE FOR HIGH PERFORMANCE BDA | 9 |
|---|---|---|

Design of Network Infrastructure for high performance BDA – Network Virtualization – Software Defined Networking – Network Functions Virtualization – WAN optimization for transfer of big data – started with SANs- storage infrastructure requirements for storing big data – FC SAN – IP SAN – NAS – GFS – Panasas – Luster file system – Introduction to cloud storage

| UNIT - III | REAL TIME ANALYTICS USING HIGH PERFORMANCE COMPUTING | 9 |
|---|---|---|

Technologies that support Real time analytics – MOA: Massive online analysis – GPFS: General parallel file system – Client case studies – Key distinctions – Machine data analytics – operational analytics – HPC Architecture models – In Database analytics – In memory analytics.

| UNIT - IV | SECURITY AND TECHNOLOGIES | 9 |
|---|---|---|

Security, Privacy and Trust for user – generated content: The challenges and solutions – Role of real time big data processing in the IoT – End to End Security Framework for big sensing data streams – Clustering in big data.

| UNIT - V | EMERGING BIG DATA APPLICATIONS | 9 |
|---|---|---|

Deep learning Accelerators – Accelerators for clustering applications in machine learning - Accelerators for classification algorithms in machine learning – Accelerators for Big data Genome Sequencing.

**TOTAL: 45 PERIODS**

23/9/23
Chairman (BoS)

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Understand the basics concepts of High Performance computing systems. | Understand |
| CO2 | Apply the concepts of network and software infrastructure for high performance computing | Apply |
| CO3 | Use real time analytics using high performance computing | Analysis |
| CO4 | Apply the security models and big data applications in high performance computing | Apply |
| CO5 | Understand the emerging big data applications. | Understand |

**TEXT BOOKS:**

| | |
|---|---|
| 1 | "Big Data Management and Processing", Kuan-Ching Li , Hai Jiang, Albert Y. Zomaya, CRC Press,1st Edition,2017. |
| 2 | Pethuru Raj, Anupama Raman, Dhivya Nagaraj and Siddhartha Duggirala, "High- Performance Big-Data Analytics: Computing Systems and Approaches", Springer, 1st Edition, 2015 |

**REFERENCES:**

| | |
|---|---|
| 1 | "High Performance Computing for Big Data: Methodologies and Applications", Chao wang ,CRC Press,1st Edition,2018 |
| 2 | "High-Performance Data Mining And Big Data Analytics" , Khosrow Hassibi, Create Space Independent Publishing Platform,!st Edition,2014 |
| 3 | "High performance computing: Modern systems and practices", Thomas Sterling, Matthew Anderson, Morgan Kaufmann publishers,1st Edition,2017 |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 3 | 1 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO2 | 2 | 2 | 3 | 2 | 1 | 2 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 2 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 3 | 3 | 3 | 3 | - | 3 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 3 | 3 | 3 | 3 | - | 3 | - | - | - | - | - | 3 | - | 1 |
| Avg. | 2.6 | 2.2 | 3 | 2.4 | 2 | 2.2 | - | - | - | - | - | **2.8** | - | **1** |

23/9/23
Chairman (BOS)

**ASSESSMENT SYSTEM:**

| L | T | P | C | Continuous Internal Examination (CIE) | End Semester Examination (ESE) |
|---|---|---|---|---|---|
| 3 | 0 | 0 | 3 | Theory only (40%) | Theory only (60%) |

**CONTINUOUS INTERNAL EXAMINATION:**

**THEORY**

| Assessment | Portions | Duration | Max. Mark | Max CIE Marks |
|---|---|---|---|---|
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |

*The weighted average shall be converted into 40 marks for internal assessment.

23/9/23
Chairman (BoS)

| 23BD1P02 | WEB SERVICES AND API DESIGN | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To learn the basics of Web service.
- To become familiar with the Web Services building blocks
- To learn to work with RESTful web services.
- To implement the RESTful web services.
- To understand resource oriented Architecture

| UNIT - I | INTRODUCTION TO WEB SERVICE | 9 |
|---|---|---|

Overview – Web service-Architecture – Service-Oriented Architecture (SOA), Architecting Web Services: Web Services Technology Stack, Logical Architectural View, Deployment Architectural View, and Process Architectural View

| UNIT - II | WEB SERVICE BUILDING BLOCKS | 9 |
|---|---|---|

Introduction to SOAP: SOAP Syntax- Sending SOAP Messages - SOAP Implementations - Introduction to WSDL: WSDL Syntax - SOAP Binding - WSDL Implementations - Introduction to UDDI: The UDDI API - Implementations - The Future of UDDI.

| UNIT - III | RESTFUL WEB SERVICES | 9 |
|---|---|---|

Programmable Web - HTTP: Documents in Envelopes - Method Information - Scoping Information - The Competing Architectures - Technologies on the Programmable Web -Leftover Terminology - Writing Web Service Clients: The Sample Application - Making the Request: HTTP Libraries - Processing the Response: XML Parsers - JSON Parsers: Handling Serialized Data - Clients Made Easy with WADL

| UNIT - IV | IMPLEMENTATION OF RESTFUL WEB SERVICES | 9 |
|---|---|---|

Introducing the Simple Storage Service - Object-Oriented Design of S3 - Resources - HTTP Response Codes Resource- URIs - Addressability - Statelessness - Representations - Links and Connectedness - The Uniform Interface – Spring Web Services – Spring MVC Components - Spring Web Flow - A Service Implementation using Spring Data REST.

| UNIT - V | RESOURCE ORIENTED ARCHITECTURE | 9 |
|---|---|---|

Resource- URIs - Addressability - Statelessness - Representations - Links and Connectedness - The Uniform Interface- Designing Read-Only Resource-Oriented Services : Resource Design - Turning Requirements Into Read-Only Resources - Figure Out the Data Set- Split the Data Set into Resources- Name the Resources - Design Representation- Link the Resources to Each Other- The HTTP Response.

**TOTAL: 45 PERIODS**

23/9/23
Chairman (BoS)

| COURSE OUTCOMES<br>**Upon completion of the course, the students will be able to:** | | |
|---|---|---|
| **COs** | **Description** | **Blooms Taxonomy Level** |
| CO1 | Explain how to write XML documents. | Understand |
| CO2 | Apply the web service building blocks such as SOAP, WSDL and UDDI | Apply |
| CO3 | Describe the RESTful web services. | Understand |
| CO4 | Implement the RESTful web service with Spring Boot MVC | Implement |
| CO5 | Discuss Resource-oriented Architecture | Understand |

**TEXT BOOKS:**


| | |
|---|---|
| 1 | Leonard Richardson and Sam Ruby, RESTful Web Services, O'Reilly Media, 2007 |
| 2 | McGovern, et al., "Java Web Services Architecture", Morgan Kaufmann Publishers,2005 |


**REFERENCES:**


| | |
|---|---|
| 1 | Lindsay Bassett, Introduction to JavaScript Object Notation, O'Reilly Media, 2015 |
| 2 | Craig Walls, "Spring in Action, Fifth Edition", Manning Publications, 2018 |
| 3 | Raja CSP Raman, Ludovic Dewailly, "Building A RESTful Web Service with Spring 5", Packt Publishing, 2018 . |
| 4 | Bogunuva Mohanram Balachandar, "Restful Java Web Services, Third Edition: A pragmatic guide to designing and building RESTful APIs using Java", Ingram short title, 3rd Edition, 2017. |


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | | - | - | - | - | - | - | 3 | - | 1 |
| CO2 | 2 | 2 | - | 1 | | 2 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 2 | 1 | - | 1 | | 1 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 2 | 2 | 1 | 1 | | 1 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 2 | 2 | 1 | 1 | | 2 | - | - | - | - | - | 3 | - | 1 |
| Avg. | 2 | 1.75 | 1 | 1 | - | 1.5 | - | - | - | - | - | **2.8** | - | **1** |

23/9/23
Chairman (BoS)

**ASSESSMENT SYSTEM:**

| L | T | P | C | Continuous Internal Examination (CIE) | End Semester Examination (ESE) |
|---|---|---|---|---|---|
| 3 | 0 | 0 | 3 | Theory only (40%) | Theory only (60%) |

**CONTINUOUS INTERNAL EXAMINATION:**

**THEORY**

| Assessment | Portions | Duration | Max. Mark | Max CIE Marks |
|---|---|---|---|---|
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |

*The weighted average shall be converted into 40 marks for internal assessment.

Chairman (BoS) 23/9/23

| 23BD1P03 | INFORMATION RETRIEVAL TECHNIQUES | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To understand the basics of information retrieval with pertinence to modeling, query operations and indexing
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the various applications of information retrieval giving emphasis to multimedia IR, web search
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the concepts of digital libraries

| UNIT - I | INTRODUCTION: MOTIVATION | 9 |
|---|---|---|

Basic Concepts – Practical Issues - Retrieval Process – Architecture - Boolean Retrieval –Retrieval Evaluation – Open-Source IR Systems–History of Web Search – Web Characteristics–The impact of the web on IR —IR Versus Web Search–Components of a Search engine

| UNIT - II | MODELING | 9 |
|---|---|---|

Taxonomy and Characterization of IR Models – Boolean Model – Vector Model - Term Weighting – Scoring and Ranking –Language Models – Set Theoretic Models - Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing

| UNIT - III | INDEXING | 9 |
|---|---|---|

Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching - Sequential Searching and Pattern Matching. Query Operations -Query Languages – Query Processing - Relevance Feedback and Query Expansion - Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency

| UNIT - IV | EVALUATION AND PARALLEL INFORMATION RETRIEVAL | 9 |
|---|---|---|

Traditional Effectiveness Measures – Statistics in Evaluation – Minimizing Adjudication Effect – Nontraditional Effectiveness Measures – Measuring Efficiency – Efficiency Criteria –Queueing Theory – Query Scheduling – Parallel Information Retrieval – Parallel Query Processing – MapReduce

| UNIT - V | SEARCHING THE WEB | 9 |
|---|---|---|

Searching the Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis - XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries.

**TOTAL: 45 PERIODS**

Chairman (BoS) 23/9/23

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Build an Information Retrieval system using the available tools. | Design |
| CO2 | Identify and design the various components of an Information Retrieval system | Understand |
| CO3 | Categorize the different types of IR Models | Analyze |
| CO4 | Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval. | Apply |
| CO5 | Design an efficient search engine and analyze the Web content structure | Design |

**TEXT BOOKS:**

| | |
|---|---|
| 1 | Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval, Cambridge University Press, First South Asian Edition, 2008. |
| 2 | Stefan Buttcher, Implementing and Evaluating Search Engines, The MIT Press, Cambridge, Massachusetts London, England, 2016. |

**REFERENCES:**

| | |
|---|---|
| 1 | Ricardo Baeza – Yates, Berthier Ribeiro – Neto, "Modern Information Retrieval: The concepts and Technology behind Search (ACM Press Books), Second Edition, 2011. |
| 2 | Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | - | 1 | 2 | - | - | - | - | - | - | 3 | - | 1 |
| CO2 | - | - | - | 1 | - | - | - | - | - | - | - | 3 | - | 1 |
| CO3 | 2 | 1 | - | 2 | - | - | - | - | - | - | - | 3 | - | 1 |
| CO4 | 3 | 3 | - | 2 | - | 2 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 3 | 3 | 2 | 2 | - | 3 | - | - | - | - | - | 3 | - | 1 |
| Avg. | 2.25 | 2 | 2 | 1.6 | 2 | 2.5 | - | - | - | - | - | **2.8** | - | **1** |

23/9/23
Chairman (BoS)

**ASSESSMENT SYSTEM:**

| L | T | P | C | Continuous Internal Examination (CIE) | End Semester Examination (ESE) |
|---|---|---|---|---|---|
| 3 | 0 | 0 | 3 | Theory only (40%) | Theory only (60%) |

**CONTINUOUS INTERNAL EXAMINATION:**

**THEORY**

| Assessment | Portions | Duration | Max. Mark | Max CIE Marks |
|---|---|---|---|---|
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |

*The weighted average shall be converted into 40 marks for internal assessment.

Chairman (BoS) 23/9/23

| 23BD1P04 | DATA VISUALIZATION TECHNIQUES | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To develop skills to both design and critique visualizations.
- To introduce visual perception and core skills for visual analysis.
- To understand technological advancements of data visualization
- To understand various data visualization techniques
- To understand the methodologies used to visualize large data sets

| UNIT - I | INTRODUCTION AND DATA FOUNDATION | 9 |
|---|---|---|

Basics - Relationship between Visualization and Other Fields -The Visualization Process - Pseudo code Conventions - The Scatter plot. Data Foundation - Types of Data - Structure within and between Records - Data Preprocessing - Data Sets

| UNIT - II | FOUNDATIONS FOR VISUALIZATION | 9 |
|---|---|---|

Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables – Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson's Affordance theory – A Model of Perceptual Processing.

| UNIT - III | VISUALIZATION TECHNIQUES | 9 |
|---|---|---|

Spatial Data: One-Dimensional Data - Two-Dimensional Data – Three Dimensional Data - Dynamic Data - Combining Techniques. Geospatial Data : Visualizing Spatial Data - Visualization of Point Data -Visualization of Line Data - Visualization of Area Data – Other Issues in Geospatial Data Visualization Multivariate Data : Point-Based Techniques - LineBased Techniques - Region-Based Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks.

| UNIT - IV | INTERACTION CONCEPTS AND TECHNIQUES | 9 |
|---|---|---|

Text and Document Visualization: Introduction - Levels of Text Representations - The Vector Space Model - Single Document Visualizations -Document Collection Visualizations – Extended Text Visualizations Interaction Concepts: Interaction Operators - Interaction Operands and Spaces - A Unified Framework. Interaction Techniques: Screen Space - Object-Space –Data Space - Attribute Space- Data Structure Space - Visualization Structure – Animating Transformations - Interaction Control.

| UNIT - V | RESEARCH DIRECTIONS IN VISUALIZATIONS | 9 |
|---|---|---|

Steps in designing Visualizations – Problems in designing effective Visualizations- Issues of Data. Issues of Cognition, Perception, and Reasoning. Issues of System Design Evaluation , Hardware and Applications.

**TOTAL: 45 PERIODS**

23/9/23
Chairman (BoS)

| COURSE OUTCOMES<br>Upon completion of the course, the students will be able to: | | |
|---|---|---|
| **COs** | **Description** | **Blooms Taxonomy Level** |
| CO1 | Visualize the objects in different dimensions. | Design |
| CO2 | Design and process the data for Visualization. | Design |
| CO3 | Apply the visualization techniques in physical sciences, computer science, applied mathematics and medical sciences. | Apply |
| CO4 | Apply the virtualization techniques for research projects. | Apply |
| CO5 | Identify appropriate data visualization techniques given particular requirements imposed by the data | Understand |

**TEXT BOOKS:**

| | |
|---|---|
| 1 | Matthew Ward, Georges Grinstein and Daniel Keim, "Interactive Data Visualization Foundations, Techniques, Applications", 2010 |
| 2 | Colin Ware, "Information Visualization Perception for Design", 4th edition, Morgan Kaufmann Publishers, 2021. |

**REFERENCES:**

| | |
|---|---|
| 1 | Robert Spence "Information visualization – Design for interaction", Pearson Education, 2nd Edition, 2007. |
| 2 | Alexandru C. Telea, "Data Visualization: Principles and Practice," A. K. Peters Ltd, 2008. |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | - | 2 | 2 | 1 | - | - | - | - | - | 3 | - | 1 |
| CO2 | 1 | 2 | - | 2 | 2 | 1 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 2 | 3 | 2 | 2 | 2 | 2 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 2 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | - | - | - | - | - | 3 | - | 1 |
| **Avg.** | 2 | 2.6 | 3 | 2.2 | 2 | 1.8 | - | - | - | - | - | **2.8** | - | **1** |

Chairman (BoS) 23/9/23

| ASSESSMENT SYSTEM: | | | | | |
|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Continuous Internal Examination (CIE)** | **End Semester Examination (ESE)** |
| 3 | 0 | 0 | 3 | Theory only (40%) | Theory only (60%) |

| CONTINUOUS INTERNAL EXAMINATION: | | | | |
|---|---|---|---|---|
| **THEORY** | | | | |
| **Assessment** | **Portions** | **Duration** | **Max. Mark** | **Max CIE Marks** |
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |
| *The weighted average shall be converted into 40 marks for internal assessment. | | | | |

| 23BD1P05 | PRINCIPLES OF SUPPLY CHAIN MANAGEMENT | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To analyze the supply chain scenario in India and its enabling factors.
- To make students to get insights on supply chain process from sourcing to distribution.
- To enhance the skills on supply chain integration and sustainable supply chain strategies among the students.
- To build knowledge in students to take care of any kinds of supply chain assignments in business organizations.

| UNIT - I | INTRODUCTION | 9 |
|---|---|---|

Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

| UNIT - II | SUPPLY CHAIN NETWORK DESIGN | 9 |
|---|---|---|

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions.

| UNIT - III | LOGISTICS IN SUPPLY CHAIN | 9 |
|---|---|---|

Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation.

| UNIT - IV | SOURCING AND COORDINATION IN SUPPLY CHAIN | 9 |
|---|---|---|

Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain coordination - Bullwhip effect – Effect of lack of coordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

| UNIT - V | SUPPLY CHAIN AND INFORMATION TECHNOLOGY | 9 |
|---|---|---|

The role IT in supply chain- The supply chain IT framework Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain.

**TOTAL: 45 PERIODS**

Chairman (BoS) 23/9/23

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Understand the framework and scope of supply chain management. | Understand |
| CO2 | Build and manage a competitive supply chain using strategies, models, techniques and information technology. | Design |
| CO3 | Analyze the logistics in supply chain. | Analyze |
| CO4 | Plan the demand, inventory and supply and optimize supply chain Network | Apply |
| CO5 | Evaluate the impact of IT on the Supply chain. | Evaluate |

**TEXT BOOKS:**

| | |
|---|---|
| 1 | Sunil Chopra, Peter Meindl and Kalra, "Supply Chain Management, Strategy, Planning, and Operation", Pearson Education,6th edition, 2015. |
| 2 | Jeremy F.Shapiro, "Modeling the Supply Chain", Thomson Duxbury,2nd edition, 2006 |

**REFERENCES:**

| | |
|---|---|
| 1 | David J.Bloomberg , Stephen Lemay and Joe B.Hanna, "Logistics", PHI, 2002. |
| 2 | James B.Ayers, "Handbook of Supply Chain Management ", St.Lucie press,2nd edition, 2006 |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | 1 | - | - | - | - | - | - | - | 3 | - | 1 |
| CO2 | 1 | 1 | 1 | 1 | 2 | 2 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 2 | 2 | 1 | 1 | 2 | 2 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 2 | 2 | 1 | 2 | 1 | 2 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 2 | 3 | 2 | 2 | 2 | 2 | - | - | - | - | - | 3 | - | 1 |
| Avg. | 1.75 | 2 | 1.25 | 1.6 | 1.4 | 2 | - | - | - | - | - | **2.8** | - | **1** |

23/9/23
Chairman (BoS)

<table>
<tr><td colspan="6">ASSESSMENT SYSTEM:</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Examination (CIE)</td><td>End Semester Examination (ESE)</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>Theory only (40%)</td><td>Theory only (60%)</td></tr>
<tr><td colspan="6">CONTINUOUS INTERNAL EXAMINATION:</td></tr>
<tr><td colspan="6">THEORY</td></tr>
<tr><td colspan="2">Assessment</td><td colspan="2">Portions</td><td>Duration</td><td>Max. Mark</td><td>Max CIE Marks</td></tr>
<tr><td colspan="2">CIE - 1</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td><td rowspan="3">Best 2 out of 3 and Converted to 60</td></tr>
<tr><td colspan="2">CIE - 2</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td colspan="2">Improvement / Missed Test</td><td colspan="2">2.5 units</td><td>3 Hours</td><td>100</td></tr>
<tr><td colspan="2" rowspan="2">Other Assessment Methods</td><td colspan="3">Quizzes (10 MCQ per unit)</td><td>20</td><td rowspan="2">40</td></tr>
<tr><td colspan="3">Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test</td><td>20</td></tr>
<tr><td colspan="6"></td><td>100</td></tr>
<tr><td colspan="7">*The weighted average shall be converted into 40 marks for internal assessment.</td></tr>
</table>

23/9/23
Chairman (BoS)

| 23BD1P06 | PRINCIPLES OF SUPPLY CHAIN MANAGEMENT | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

**The Course will enable learners to:**

- To understand geometric problems.
- To learn the algorithmic solutions for geometric problems.
- To learn the solutions for proximity problems
- To map problems in various application domains to a geometric problem.

| UNIT - I | INTRODUCTION | 9 |
|---|---|---|

Introduction – Application Domains – Line Segment Intersection – Intersection of Convex Polygons – Polygon Triangulation.

| UNIT - II | GEOMETRIC SEARCHING | 9 |
|---|---|---|

Geometric Searching – Range Searching – K- d-Trees – Range trees – Point-Location Problems.

| UNIT - III | CONVEX HULL PROBLEM | 9 |
|---|---|---|

Convex hull Problem – Preliminaries – Convex Hull Algorithms in the Plane – Graham"s scan - Jarvis's March – Quick Hull – Divide-and-conquer – Dynamic Convex Hull Maintenance – Delaunay Triangulation.

| UNIT - IV | PROXIMITY PROBLEMS | 9 |
|---|---|---|

Proximity Problems – Fundamental Algorithms (Closest Pair – All Nearest Neighbours – Euclidean Minimum Spanning Tree – Nearest Neighbour Search) – Lower bounds – Closest Pair Problem : A Divide-and-Conquer Approach.

| UNIT - V | VORONOI DIAGRAM | 9 |
|---|---|---|

Voronoi Diagram – Proximity Problems Solved by the Voronoi Diagram – Planar Applications.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

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

| COs | Description | Blooms Taxonomy Level |
|---|---|---|
| CO1 | Transform problems in different applications to geometric problems | Understand |
| CO2 | Use algorithms and techniques to solve search and point location problems | Apply |
| CO3 | Understand and solve the complex hull problem | Understand |
| CO4 | Solve proximity problems using various techniques | Apply |
| CO5 | Use the appropriate and relevant, fundamental and applied computational knowledge, methodologies and modern tools in solving real -world problems. | Apply |

23/9/23
Chairman (BoS)

| TEXT BOOKS: | |
|---|---|
| 1 | Dr. Kalyanrao Takale , Dr. Shrikisan Gaikwad , Dr. Mrs. Nivedita Mahajan , Dr. Amjad Shaikh , Prof. Mrs. Shamal Deshmukh , Prof. S.R. Patil,1st Edition,,"Computational Geometry",2021. |
| 2 | David Mount,CMSC 754: Computational Geometry, 2021.Lecture notes from his Fall 2021 computational geometry course at Maryland. |
| **REFERENCES:** | |
| 1 | Herbert Edelsbrunner, "Algorithms in Combinatorial Geometry, EATCS Monographs in Computer Science", Springer Verlag, 2011. |

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | - | 1 | - | - | - | - | - | 3 | - | 1 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 2 | - | - | - | - | - | 3 | - | 1 |
| CO3 | 2 | 2 | 1 | 2 | 1 | 2 | - | - | - | - | - | 3 | - | 1 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 3 | - | - | - | - | - | 2 | - | 1 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | 3 | - | 1 |
| Avg. | 2.2 | 2 | 1.6 | 1.8 | 1.5 | 2.2 | - | - | - | - | - | **2.8** | - | **1** |

**ASSESSMENT SYSTEM:**

| L | T | P | C | Continuous Internal Examination (CIE) | End Semester Examination (ESE) |
|---|---|---|---|---|---|
| 3 | 0 | 0 | 3 | Theory only (40%) | Theory only (60%) |

**CONTINUOUS INTERNAL EXAMINATION:**

**THEORY**

| Assessment | Portions | Duration | Max. Mark | Max CIE Marks |
|---|---|---|---|---|
| CIE - 1 | 2.5 units | 3 Hours | 100 | Best 2 out of 3 and Converted to 60 |
| CIE - 2 | 2.5 units | 3 Hours | 100 | |
| Improvement / Missed Test | 2.5 units | 3 Hours | 100 | |
| Other Assessment Methods | Quizzes (10 MCQ per unit) | | 20 | 40 |
| | Assignment / Case Study / Seminar / Tutorial / Mini Project / Open Book Test | | 20 | |
| | | | | 100 |

*The weighted average shall be converted into 40 marks for internal assessment.

23/9/23
Chairman (BoS)