| B.TECH. III Semester-5 | L | T | P | C |
|---|---|---|---|---|
| CS 501: Data Science | 3 | 0 | 2 | 4 |

| Unit - 1 | 14 Hours |
|---|---|

Introduction to Data Science; Random variable, distribution, Maximum Likelihood Estimation usingmaxLik, basic multivariate stats matrix summarisation, Simpson's paradox, variance- covariance, correlation, canonical correlation; Data preprocessing, exploratory data analysis and high quality visualisation. Advanced scientific plots stacked histograms for multivariate data, bi-variate scatter plots, parallel coordinate plot, tableplot, mosaic plot etc. Goodness of fit - likelihood ratio test, Lagrange multiplier test, Q-Q plot, performing variety of hypothesis testing.

| Unit - 2 | 14 Hours |
|---|---|

Data Collection and Management: Introduction, Sources of Data, Data collection and APIs, Exploring and fixing data, Data storage and management, using multiple data sources.

Generalised linear models (GLM) with various link functions (eg logit). Specific focus on gamma regression.
Time series modeling using autoregressive errors (AR), moving average (MA), ARIMA - stationary and non-stationary time series data, mean stationarity, trend stationarity, statistical test for stationarity.
Survival Analysis using survfit - Kaplan Meier survival density estimation, Cox proportional hazards model, Naive Bayes, assessment of model performance

| Unit - 3 | 14 Hours |
|---|---|

Bootstrapping and Monte Carlo methods, randomisation test.
Introduction to handling large data - locality sensitive hashing, sizing sketches, coreset
Applications - gene expression, EHR data, demand forecasting, price optimisation in retail, probability of default in banking

**Total Contact Time: 42 Hours**

| Recommended Books |
|---|

1. Han, Jiawei, Jian Pei, and Micheline Kamber. Data mining: concepts and techniques. Elsevier, 2011.
2. Tan, Pang-Ning. Introduction to data mining. Pearson Education India, 2007.
3. Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. The elements of statistical learning. Vol. 1. No. 10. New York, NY, USA:: Springer series in statistics, 2001.
4. Shalev-Shwartz, Shai, and Shai Ben-David. Understanding machine learning: From theory to algorithms. Cambridge university press, 2014.
5. R for Data Science, by Garrett Grolemund and Hadley Wickham (2016)
6. Exploratory Data Analysis with R, by Roger D. Peng (2016)
7. An Introduction to Statistical Learning with Application in R, First Edition, by Gareth James et al. (2013)
8. Introduction to linear algebra, by Gilbert Strang

| B.TECH. III Semester-5 | L | T | P | C |
|---|---|---|---|---|
| **CS 502: Computer Graphics** | **3** | **0** | **2** | **4** |

| **Prerequisite** |
|---|
|  |

| **Graphic Primitives** | **10 Hours** |
|---|---|
| Coordinate representation, Pixel, Raster Scan & Random Scan methods; Color CRT Raster Scan Basics, Video Basics, Interactive, Graphics Input and Output Devices. Image Formation, Image Representation and Modeling, Overview of Image and Graphics Applications, Vector graphics, Coordinates, points, lines and polygons: Coordinate systems, Geometric shapes using Graphics Libraries. Points, lines, circles and ellipses as primitives, scan conversion algorithms for primitives, Fill area primitives including scan- line polygon filling, inside-outside test, boundary and flood-fill, character generation, line attributes, area-fill attributes, character attributers. | |
| **2D - 3D Transformations** | **10 Hours** |
| Transformations (Scaling, Rotation, Translation), Combined Transformations; Homogeneous coordinates, 3-D representation, Solid Body transformations, Projections: Perspective, Orthographic, Axonometric, Oblique projections, 2-D, 3-D dimensional transformations, perspective transformations using Graphics Libraries. | |
| **Clipping** | **10 Hours** |
| 2-D Clipping, Sutherland-Cohen subdivision Line Clipping algorithm, Mid-point subdivision algorithm, 3- D Clipping, 3-D Mid-point subdivision algorithm; Polygon Clipping, Sutherland-Hodgman algorithm; Character Clipping, clipping functions using Graphics Libraries. | |
| **Modeling, Rendering and Advance Topics** | **12 Hours** |
| Modeling: Polygonal meshes, Spline & subdivision surfaces, Volumetric Representations Rendering: Lighting models, Global Illumination, Visibility, Image-based rendering, Animation: Kinematics, Passive dynamics, Active dynamics. Hidden lines & hidden surface removal algorithms, Color, Additive and Subtractive picture representation, Shading, Shadows, Texture and Ray Tracing, Fractals, Half-toning, Anti-aliasing methods. | |
| **Total Contact Time: 42 Hours** | |

| **Recommended Books** |
|---|
| 1. Donald Hearn & M. Pauline Baker, "Computer Graphics", Pearson Education, 3/E, 2004 |
| 2. David F Rogers, "Procedural Elements for Computer Graphics", TMH International Ed,2001. |
| 3. David F Rogers, "Mathematical Elements for Computer Graphics", TMH International Ed, 2002. |
| 4. F. S. Hill, Jr., "Computer Graphics using OpenGL", 2/E, Pearson Education, Reprint 2005. |
| 5. James D. Foley, "Computer Graphics: Principles and Practice", by Addison-Wesley. |

| B.TECH. III Semester-5 | L | T | P | C |
|---|---|---|---|---|
| CS 503: High Performance Computing | 3 | 0 | 2 | 4 |

| Unit - 1 | 6 Hours |
|---|---|
| Introduction<br><br>Single-Processor Computing: The Von Neumann architecture, Modern processors, Memory Hierarchies, Multicore architectures, Locality and data reuse, Programming strategies for high performance, Power consumption.<br><br>Parallel Computing: Quantifying parallelism, Parallel Computers Architectures, Different types of memory access, Granularity of parallelism, Parallel programming, Topologies, Multi-threaded architectures, Coprocessors. | |

| Unit - 2 | 14 Hours |
|---|---|
| Computer Arithmetic: Integers, Real numbers, Round-off error analysis, Compilers and round-off.<br><br>Numerical treatment of differential equations: Initial value problems, Boundary value problems, Initial boundary value problem.<br><br>Numerical linear algebra: Elimination of unknowns, Linear algebra in computer arithmetic, LU factorization, Sparse matrices, Iterative methods.<br><br>High performance linear algebra: Collective operations, Parallel dense matrix-vector product, LU factorization in parallel, Matrix-matrix product, Sparse matrix-vector product, Parallelism in solving linear systems from Partial Differential Equations (PDEs), Computational aspects of iterative methods, Parallel preconditioners, Ordering strategies and parallelism, Operator splitting, Parallelism and implicit operations, Grid updates, Block algorithms on multicore architectures. | |

| Unit - 3 | 14 Hours |
|---|---|
| Parallel Programming – I: Introduction to OpenMP, Parallel constructs, Runtime Library routines, Work-sharing constructs, Scheduling clauses, Data environment clauses, atomic, master Nowait Clause, Barrier Construct, overview of MPI, MPI Constructs, OpenMP vs MPI.<br><br>Parallel Programming – II: Introduction to GPU Computing, CUDA Programming Model, CUDA API, Simple Matrix, Multiplication in CUDA , CUDA Memory Model, Shared Memory Matrix Multiplication, Additional CUDA API Features | |

| Unit - 4 | 8 Hours |
|---|---|
| Applications (Selected few from the followings)<br>Molecular Dynamics: Force Computation, Parallel Decompositions, Parallel Fast Fourier Transform, Integration for Molecular Dynamics.<br>Sorting: Brief introduction to sorting, Odd-even transposition sort, Quicksort, Bitonic sort.<br>Graph analytics: Traditional graph algorithms, Real world graphs Hypertext algorithms, Large-scale computational graph theory, GraphQL<br>N-body problems: The Barnes-Hut algorithm, The Fast Multipole Method, Full computation.<br>Monte Carlo Methods: Parallel Random Number Generation.<br>Computational biology: Dynamic programming approaches, Suffix tree, DNA-RNA sequencing<br>Big data: Recommender systems. Computer graphics, Other physics applications, Lattice Boltzmann methods, Hartree-Fock / Density Functional Theory. | |

| Total Contact Time: 42 Hours | |

| Recommended Books |
|---|
| 1. Introduction to High Performance Scientific Computing, by V. Eijkhout et al. (Creative Commons, 2015) |
| 2. Introduction to High Performance Computing for Scientists and Engineers, by G. Hager and G. Wellein, (CRC Press, 2011) |
| 3. Applied Parallel Computing, by Y. Deng (World Scientific, 2011) |

4. Petascale Computing: Algorithms and Applications, by D. Bader, ed. (Chapman and Hall, 2008)
5. Scientific Parallel Computing, by L. R. Scott et al. (Princeton, 2005)
6. An Introduction to Parallel Computing: Design and Analysis of Algorithms, 2nd, by A. Grama et al. (Pearson Addison Wesley, 2003)
7. Sourcebook of Parallel Computing by J. Dongarra et al., eds. (Morgan-Kaufmann, 2002)
8. Rob Farber, CUDA  Application Design  and Development, Morgan Kaufmann Publishers, 2013
9.  Zbigniew J. Czech, Introduction to parallel computing, 2nd edition, Cambridge University Press,2016

| B.TECH. III Semester-5 | L | T | P | C |
|---|---|---|---|---|
| CS 504: Cloud Computing & Big Data Infrastructure | 3 | 0 | 2 | 4 |

| Unit -1 | 8 Hours |
|---|---|
| Introduction to Cloud computing, Cloud computing: IaaS, PaaS, SaaS; Cloud computing: Current & future trends, Impact on scientific research <br> Types of Cloud services providers: Google, Amazon, Microsoft Azure, IBM, Sales force | |
| **Unit - 2** | **8 Hours** |
| Virtualization for Cloud: Need for Virtualization, Pros and cons of virtualization, Types of virtualization; system VM, process VM, virtual machine monitor; Virtual machine properties, Interpretation and Binary translation, <br> HLL VM – Hypervisors – Xen, VMWare, Hyper - V | |
| **Unit - 3** | **8 Hours** |
| Introduction to Big data. Big data and its importance, Drivers, Big data analytics, Big data applications. <br> Algorithms, Matrix-Vector, Multiplication by Map Reduce. YARN, SQOOP, PIG | |
| **Unit - 4** | **8 Hours** |
| OpenStack – Cloud operating system, object storage (SWIFT). Introduction, distributed file system. <br> Hadoop – Architecture, Hadoop distributed file system (HDFS) <br> MapReduce – Programming model, Task scheduling algorithms, Data serialization | |
| **Unit - 5** | **10 Hours** |
| Apache Spark <br> Java AWS SDK, S3 API, Relational Database Service, SimpleDB Service, NoSQL Databses, HIVE, MongoDB, HBase <br> Elastic search, Qlik Sense, Superset. Building Interactive Visualization using Superset. | |
| **Total Contact Time: 42 Hours** | |

| Recommended Books |
|---|
| 1.  John Rittinghouse & James Ransome, Cloud Computing, Implementation, Management and Strategy, CRC Press, 2010. |
| 2. Mastering Cloud Computing by Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, McGraw Hill Education (India) Private Limited, 2013. |
| 2. Dr. Kumar Saurabh, "Cloud Computing 2nd Kindle Edition", Wile India, 2012. |
| 3. "Big Data, Black Book: Covers Hadoop, MapReduce, Hive, YARN, Pig, R and Data Visualization", Dreamtech Press, 1st Edition, 2016. |
| 4. Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", MC Press, 2012. |
| 5. Tom White, "Hadoop: The Definitive Guide", O'Reilly Media, Third Edition, 2012. |

| B.TECH. III Semester-5 | L | T | P | C |
|---|---|---|---|---|
| HM 505: Innovation and Entrepreneurship | 2 | 0 | 0 | 2 |

| Unit - 1 | 14 Hours |
|---|---|

*Concepts of Entrepreneurship*: Scope of Entrepreneurship, Definitions of Entrepreneurship and Entrepreneur, Characteristics of an Entrepreneur, Entrepreneurial Development models and Theories, Entrepreneurs Vs Managers Classification of Entrepreneurs; Major types of Entrepreneurship – Techno Entrepreneurship, Women Entrepreneurship, Social Entrepreneurship, Intrapreneurship (Corporate entrepreneurship), Rural Entrepreneurship, Family Business etc.; Problems for Small Scale Enterprises and Industrial Sickness; Entrepreneurial Trait Tests; Entrepreneurial Environment – Political, Legal, Technological, Natural, Economic, Socio – Cultural etc. ; Motivation; Business Opportunity Identification

*Project Planning*: Product Development – Stages in Product Development; Feasibility analysis – Technical, Market, Economic, Financial etc.; Project report; Project appraisal; Setting up an Industrial unit – procedure and formalities in setting up an Industrial unit; Business Plan Development

| Unit - 2 | 14 Hours |
|---|---|

*Innovation and Incubation*: Innovation and Entrepreneurship, Creativity, Green Technology Innovations, Grassroots Innovations, Issues and Challenges in Commercialization of Technology Innovations, Introduction to Technology Business Incubations, Process of Technology Business Incubation

*Sources of Information and Support for Entrepreneurship*: State level Institutions, Central Level institutions and other agencies

*Protection of Innovation Through IPR*: Introduction to Intellectual Property Rights – IPR, Patents, Trademarks, Copy Rights

**Total Contact Time: 28 Hours**

**Recommended Books**

1. Desai Vasant, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, India, 6th Revised Edition, 2011
2. Charantimath P. M., Entrepreneurial Development and Small Business Enterprises, Pearson Education, 3rd Edition, 2018
3. Holt David H., Entrepreneurship: New Venture Creation, Pearson Education, 2016
4. Chandra P., Projects: Planning, Analysis, Selection, Financing, Implementation and Review, Tata McGraw Hill, 9th Edition, 2019
5. Banga T. R. &Shrama S.C., Industrial Organisation & Engineering Economics, Khanna Publishers, 25th Edition, 2015
6. Prasad L.M., Principles & Practice Of Management, Sultan Chand & Sons, 8th Edition,2015