B.TECH. III Semester-6	L	T	P	C
CS 601: Introduction to Machine Learning	3	0	2	4

Prerequisite
Linear Algebra, Matrix Calculus, Probability and Statistics

Unit - 1	14 Hours
Introduction Supervised Learning: Linear Regression (Gradient Descent, Normal Equations), Weighted Linear Regression (LWR), Logistic Regression, Perceptron, (cross-)Entropy, Natural Gradient, Exponential Family and Generalized Linear Models, Generative Models (Gaussian Discriminant Analysis, Naive Bayes), k-Nearest Neighbours, Kernel Method (SVM, Gaussian Processes), Tree Ensembles (Decision trees, Random Forests, Boosting and Gradient Boosting)	
Unit - 2	**8 Hours**
Learning Theory: Regularization, Bias-Variance Decomposition and Tradeoff, Concentration Inequalities, Generalization and Uniform Convergence, VC-dimension Deep Learning: Neural Networks, Backpropagation, Deep Architectures	
Unit - 3	**10 Hours**
Unsupervised Learning: K-means, Gaussian Mixture Model (GMM), Expectation Maximization (EM), Variational Auto-encoder (VAE), Factor Analysis, Principal Components Analysis (PCA), Independent Components Analysis (ICA)	
Unit - 4	**10 Hours**
Reinforcement Learning: Markov Decision Processes (MDP), Bellmans Equations, Value Iteration and Policy Iteration, Value Function Approximation, Q-Learning Applications: Advice on structuring an ML project, Evaluation Metrics, Recent Applications	
Total Contact Time: 42 Hours	

Recommended Books

1. Alpaydin, Introduction to Machine Learning , Third Edition, PHI
2. Haykin, Neural Networks and Learning Machines, PHI
3. Chris Bishop, Pattern Recognition and Machine Learning, Springer
4. Tom Mitchell, Machine Learning, McGraw-Hill.
5. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, 2004
6. Cathy O'Neil & Rachel Schutt, “Doing Data Science, Straight Talk From The Frontline”, O'Reilly, 2014.
7. Joel Grus, “Data Science from Scratch: First Principles with Python”, O’Reilly Media, 2015.
8. Wes McKinney, “Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython”, O'Reilly Media, 2012.

B.TECH. III Semester-6	L	T	P	C
CS 602: High Performance Computing	3	0	2	4

Unit - 1	6 Hours
Introduction Single-Processor Computing: The Von Neumann architecture, Modern processors, Memory Hierarchies, Multicore architectures, Locality and data reuse, Programming strategies for high performance, Power consumption. 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. Numerical treatment of differential equations: Initial value problems, Boundary value problems, Initial boundary value problem. Numerical linear algebra: Elimination of unknowns, Linear algebra in computer arithmetic, LU factorization, Sparse matrices, Iterative methods. 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. 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) Molecular Dynamics: Force Computation, Parallel Decompositions, Parallel Fast Fourier Transform, Integration for Molecular Dynamics. Sorting: Brief introduction to sorting, Odd-even transposition sort, Quicksort, Bitonic sort. Graph analytics: Traditional graph algorithms, Real world graphs Hypertext algorithms, Large-scale computational graph theory, GraphQL N-body problems: The Barnes-Hut algorithm, The Fast Multipole Method, Full computation. Monte Carlo Methods: Parallel Random Number Generation. Computational biology: Dynamic programming approaches, Suffix tree, DNA-RNA sequencing 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-6	L	T	P	C
CS 603: Web Engineering	3	0	2	4

HTML, Javascript, JQuery	10 Hours
Introduction to Web Engineering, Web Programming vs. Web Engineering, Introduction to Web: HTTP, URL, Web Browser, Web Server, SMTP Server, ISP, Hyperlink, DNS, XML, Parsers and Internet based services, Web Architecture, An Overview about HTML (Basic Tags), HTML5 forms, GET and POST data, Introduction to Cascading style sheets, CSS3 Properties (BOX model, Advance Selectors), Responsive Designs, Need of responsive designs (bootstrap), Introduction to Javascript and jquery, Angular JS (A Client Side MVC framework).	
PHP, Database Connectivity	**10 Hours**
Introduction to PHP, Associative arrays, Include, require, header, Developing Dynamic Content/Web page using PHP, Sessions and Cookies, Database Connectivity Using PHP and Insert Record into Database, Update, Delete and View Records from Database, Building a CRUD application, AJAX, How AJAX works, Case Study on Code Management Tool (Github), Secure Web Applications, Usability of web applications, Accessibility of web applications, Introduction to MVC, Model View Controller, Performance Optimization of Web Application.	
PHP Framework	**12 Hours**
Introduction to PHP Framework (LARAVEL), MVC Routing, Static and Dynamic Routing, Route Parameters, Named Routes, Route Groups, HTTP Middleware Introduction, Defining Middleware, Registering Middleware, Middleware Parameters, Blade Templates Introduction, Template Inheritance, Defining A Layout, Extending A Layout, Database: Migrations, How to Work on View Section in LARAVEL, Basic Usage, Passing Data To Views, Sharing Data With All Views, Introduction Generating Migrations, Migration Structure, Running Migrations, Rolling Back Migrations, Writing Migrations, Creating Tables, Renaming / Dropping Tables, Database Seeding in LARAVEL, Writing Seeder, Running Seeder.	
MVC in LARAVEL, Web Services	**10 Hours**
MVC Controller in LARAVEL, Introduction Basic Controllers, Controller Middleware, MVC Model and Eloquent ORM in LARAVEL, Getting Started, Relationships, Collections, Introduction to Web Services, Restful Services, Introduction to SOAP Services, SOAP Service Architecture, WSDL with SOAP Service, UDDI with SOAP, Web Application Testing, Test Driven Development(TDD), TDD and Traditional Testing, Introduction to CMS Systems (Wordpress/Magneto).	
Total Contact Time: 42 Hours	

Recommended Books

1. Web Engineering: A Practitioner's Approach by Roger Pressman and David Lowe, McGraw-Hill, 2009.
2. Web 2.0 Architectures: What Entrepreneurs and Information Architects Need to Know by James Governor, Dion Hinchcliffe, and Duane Nickull, O'Reilly, 2009.
3. Web Engineering: Modelling and Implementing Web Applications: Modelling and Implementing Web Applications.
4. Web Engineering - The Discipline of Systematic Development of Web Applications, GertiKappel, Birgit Proll, Siegfried Reich, Werner Retschitzegger.

B.TECH. III Semester-6	L	T	P	C
CS 604: Advance Database Management	3	0	2	4

Introduction	12 Hours
Features of Distributed versus Centralized Databases, Principles Of Distributed Databases, Levels Of Distribution Transparency, Reference Architecture for Distributed Databases, Types of Data Fragmentation, Integrity Constraints in Distributed Databases. Translation of Global Queries to Fragment Queries, Equivalence Transformations for Queries, Transforming Global Queries into Fragment Queries, Distributed Grouping and Aggregate Functions, Evaluation of Parametric Queries. Optimization of Access Strategies, A Framework for Query Optimization, Join Queries, General Queries. The Management of Distributed Transactions, A Framework for Transaction Management, Supporting Atomicity of Distributed Transactions, Concurrency Control for Distributed Transactions, Architectural Aspects of Distributed Transactions.	
Locking and Concurrency Control	**12 Hours**
Correctness of interleaved execution, Locking and management of locks, Two Phase Locking, deadlocks, multiple level granularity, Concurrency Control on B+ trees, Concurrency Control, Foundation of Distributed Concurrency Control, Distributed Deadlocks, Concurrency Control based on Timestamps, Optimistic Methods for Distributed Concurrency Control. Reliability, Basic Concepts, Non-blocking Commitment Protocols, Reliability and concurrency Control, Determining a Consistent View of the Network, Detection and Resolution of Inconsistency, Checkpoints and Cold Restart, Distributed Database Administration, Catalogue Management in Distributed Databases, Authorization and Protection.	
Architectures and Query execution	**9 Hours**
Architectural Issues, Alternative Client/Server Architectures, Cache Consistency Object Management, Object Identifier Management, Pointer Swizzling, Object Migration, Distributed Object Storage, Object Query Processing, Object Query Processor Architectures, Query Processing Issues, Query Execution, Transaction Management, Transaction Management in Object DBMSs, Transactions as Objects.	
Query optimization and Databases	**9 Hours**
Database Integration, Scheme Translation, Scheme Integration, Query Processing Query Processing Layers in Distributed Multi-DBMSs, Query Optimization Issues. Transaction Management Transaction and Computation Model Multi-database Concurrency Control, Multi- database Recovery, Object Orientation And Interoperability Object Management Architecture CORBA and Database Interoperability Distributed Component Model COM/OLE and Database Interoperability, PUSH-Based Technologies. Current trends in No SQL and New SQL data management issues on the cloud, Stream data management.	
Total Contact Time: 42 Hours	

Recommended Books
1. M. Stonebraker, Readings in Database Systems, 4th Edition, MIT Press, 2005.
2. M T Ozsu, Patrick Valduriez, Principles of Distributed Database Systems, Springer, 2011
3. S. Ceri and G. Pelaggati, Distributed Database System Principles and Systems, MGH, 1985.

B.TECH. III Semester-6	L	T	P	C
CS 631: Mathematical Optimization	3	0	0	3

Linear Programming	10 Hours
Basic Problem, Graphical Solution, Simplex Method, Slack Variables, Simplex Method for Resource Requirements, General Constraints, Duality, Duality for Non-standard Linear Programs, Duality Theorems, Sensitivity Analysis, Changes in Objective Function Coefficients, Theory for Simplex Method.	
Unconstrained Extrema	**10 Hours**
Mathematical Background, Types of Subsets of R^n, Continuous Functions, Existence of Extrema, Differentiation in Multi-Dimensions, Second Derivative and Taylor's Theorem, Quadratic Forms, Derivative Conditions, First Derivative Conditions, Second Derivative Conditions.	
Constrained Extrema	**10 Hours**
Implicit Function Theorem, Extrema with Equality Constraints, Interpretation of Lagrange Multipliers, Extrema with Inequality Constraints: Necessary Conditions, Extrema with Inequality Constraints: Sufficient Conditions, Convex Structures, Karush-Kuhn-Tucker Theorem under Convexity, Rescaled Convex Functions, Global Extrema for Concave Functions, Proof of Karush-Kuhn-Tucker Theorem, Second-Order Conditions for Extrema of Constrained Functions.	
Dynamic Programming	**12 Hours**
Parametric Maximization and Correspondences, Budget Correspondence for Commodity Bundles, Existence of a Nash Equilibrium, Finite-Horizon Dynamic Programming, Supremum and Infimum, General Theorems, Infinite-Horizon Dynamic Program, Examples, Theorems for Bounded Reward Function, Theorems for One-Sector Economy, Continuity of Value Function.	
Total Contact Time: 42 Hours	

Recommended Books

1. Russell C. Walker, Introduction to Mathematical Programming, 4th edition, Pearson Learning.
2. R. Clark Robinson, Introduction to Mathematical Optimization, 2013.
3. Wayne L. Winston, Operations Research - Applications and algorithms, Fourth edition.
4. Edwin K. P. Chong, Stanislaw H. Zak, An Introduction to optimization, Fourth Edition.

B.TECH. III Semester-6	L	T	P	C
CS 632: Cloud Computing & Big Data Infrastructure	3	0	0	3

Unit -1	8 Hours
Introduction to Cloud computing, Cloud computing: IaaS, PaaS, SaaS; Cloud computing: Current & future trends, Impact on scientific research 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, 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. 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. Hadoop – Architecture, Hadoop distributed file system (HDFS) MapReduce – Programming model, Task scheduling algorithms, Data serialization	
Unit - 5	**10 Hours**
Apache Spark Java AWS SDK, S3 API, Relational Database Service, SimpleDB Service, NoSQL Databses, HIVE, MongoDB, HBase 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-6	L	T	P	C
CS 633: Introduction to Game Design	3	0	0	3

Introduction	10 Hours
History of Video Games, Impact of Games on Society, Introduction to the Class, Role of the Game Designer, Game Design, Game types, Game genres, Game Writing, UI Layout, Asset Management, game state, gamer services and Interactive Storytelling Understanding Hardware, Input Devices, Output Devices, Network Requirements, Managing Game Performance, CPU vs GPU, and Graphics Networking Performance, Dramatic elements of games and Narrative Design, Narrative Game.	
Game design and Development	**12 Hours**
Concepts: Mathematical concepts, Collision Detection and resolution, Real-time game Physics, Graphics, System dynamics, Challenge, Skill and Chance, Character Animation, Animate basic characters, Transform objects, Artificial Intelligence Agents, Architecture, and Techniques, Overview of Path finding, Audio Programming, Conceptualization, Communication, Networking and Multiplayer.	
Audio visual design and production	**10 Hours**
Visual Design, 3D Modeling using 3D Studio Max, 3D Environments, 2D Textures and Texture mapping, Special Effects, Lighting, Animation, Cinematography, Audio design and production, Social play Games as culture, Introduction to Unity and 3D games.	
Working with unity and Scripting	**10 Hours**
Level design and properties of living things, Functionality, Completeness and Balance, Simple Playtesting and Quality Assurance, Design a board game, Game economies, Black Friday, the board game, Unity Demos, Courses Wiki, Lesson Files, Managing Project, Interface and Assets, Unity Interfaces, Prototyping and Scripting Basics, Collection, Inventory and HUD, Building Unity Game, Terrain, Unity Terrain Assets, Camera, Layer, GUI, Curves, Surfaces, Visible Surface.	
Total Contact Time: 42 Hours	

Recommended Books

1. Steve Rabin, Introduction to Game Development, Cengage Technology (2010).
2. Michael Dawson, Beginning C++ Through Game Programming, Cengage Learning (2010).
3. Kelly C., Programming 2D Games, A K Peters/CRC Press(2012).
4. A. Thorn, Learn Unity for 2D Game Development, Apress, (2013).

B.TECH. III Semester-6	L	T	P	C
CS 641: Augmented and Virtual Reality	3	0	0	3

Unit - 1	10 Hours
Introduction to Virtual Reality: Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. Multiple Models of Input and Output Interface in Virtual Reality: Input --Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices.	
Unit - 2	**14 Hours**
Visual Computation in Virtual Reality: Fundamentals of Computer Graphics. Software and Hardware Technology on Stereoscopic Display. Advanced Techniques in CG: Management of Large Scale Environments & Real Time Rendering. Interactive Techniques in Virtual Reality: Body Track, Hand Gesture, 3D Manus, Object Grasp. Augmented and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR	
Unit - 3	**18 Hours**
Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR, Introduction and Overview of OpenGL and Unity Application of VR in Digital Entertainment: VR Technology in Film & TV Production, Demonstration of Digital Entertainment by VR, Technological Online-Education enhancement by AR and VR A short course project in OpenGL or Unity	
Total Contact Time: 42 Hours	

Recommended Books

1. Burdea, G. C. & P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, Understanding Augmented Reality, Concepts & Applications, Morgan Kaufmann, 2013.
3. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
4. LaValle "Virtual Reality", Cambridge University Press, 2016.
5. John Vince, “Virtual Reality Systems “, Pearson Education Asia, 2007.
6. Anand R., “Augmented and Virtual Reality”, Khanna Publishing House, Delhi.
7. Stanford Course: Virtual Reality (https://stanford.edu/class/ee267/syllabus.html)

B.TECH. III Semester-6	L	T	P	C
CS 642: Cognitive Psychology	3	0	0	3

Unit – 1	10 Hours
Introduction to Cognitive Psychology: A brief history of cognitive psychology, studying cognition *Basic Cognitive Process*: Perception (Basic Principles), Models of Perception *Organizational of Knowledge*: Basic Attention Process, Models of Attention, Automization and Attention	
Unit-2	**10 Hours**
The use of Knowledge: Memory Introduction, Short term Memory, Working Memory *Long Term Memory*: Long-Term Memory Encoding, Retrieval from Long-Term Memory *Memory of general Knowledge*: Semantic Memory Basics, Models of Semantic Memory	
Unit – 3	**10 Hours**
Concept Formation: Introducing concepts and categories *Visual and Spatial Memory*: Basics of Visual Memory, Object transformation in Visual memory Verbal Representation of Knowledge *Human Language Skills*: Basic issues in language, Comprehension and understanding of language	
Unit – 4	**12 Hours**
Thought process and problem solving: Introducing to problem solving, Factors influencing problem solving, Insight and Creativity *Reasoning* *Decision Making*: Classical theory of decision making, Prospect theory of decision making	
Total Contact Time: 42 Hours	

Recommended Books

1. NPTEL course: Introduction to Cognitive Psychology (https://nptel.ac.in/courses/109/103/109103134/)
2. Stanford course: Introduction to Cognitive Science (https://web.stanford.edu/class/ling144/home.html#syllabus)
3. Goldstein, B. (2018). Cognitive Psychology: Connecting Mind, Research and Everyday Experience, 5th Edition. Wadsworth Cengage Learning.
4. Hofstadter, Douglas R. (1999). Godel, Escher, Bach: An Eternal Golden Braid. New York: Basic Books.

B.TECH. III Semester-6	L	T	P	C
EC 641: Information Theory and Coding	3	0	0	3

Information and Sources	10 Hours
Introduction, The Definition of Information, The Zero-memory Information Source, properties of Entropy, Extension of a Zero-memory Source, The Markov Information Source, The Adjoint Source.	
Source Coding, Channels and Mutual Information	**12 Hours**
Properties of Codes, Uniquely Decodable Codes, Instantaneous Codes, Construction of an Instantaneous Code, Kraft's Inequality. The Average Length of A Code, A method of Encoding for Special Sources, Shannon's First Theorem, Coding without Extensions, Huffman Codes, Code Efficiency And Redundancy. Introduction, Information Channels, Probability Relations in a Channel, A priori and A Posteriori Entropy, Mutual information, Properties of Mutual Information, Noiseless Channels and Deterministic Channels, Cascaded Channels, Additivity of Mutual Information.	
Linear Block Codes	**10 Hours**
Introduction and basic definitions, Encoding and Decoding of a linear block codes, Syndrome decoding, Perfect Codes, Hamming Codes, Minimum Distance, Error Correction And Error Detection Capabilities.	
Cyclic, BCH & Convolution Codes	**10 Hours**
Introduction to Cyclic Codes, Polynomials, Cyclic Code Generation, Quasi-cyclic and Shortened Cyclic Codes, Burst Error Correction, Fire Codes, Golay Codes, BCH Codes, Convolution Codes and Turbo Codes.	
Total Contact Time: 42 Hours	

Recommended Books

1. RanjanBose,"Information theory, coding and cryptography", Tata McGraw-Hill,2nd Edition,2008.
2. Giridhar K, "Information Theory & Coding", Pooja Publications, 2010.
3. Skalar, Digital Communications,
4. Carlson A., Communication Systems, 3rd Ed., McGraw Hill, 1986.
5. Proakis J.J., Digital Communications, 2nd Ed., McGraw Hill, 1989.
6. Blahut R.F., Digital transmission of Information, Addison Wesley 1990.