

Course Code	Course Name	Credit
CSC501	Computer Networks	03

<b>Pre-requisite: None</b>	
<b>Course Objectives:</b> The course aims:	
1	To introduce concepts of computer networks and working of various layers of OSI.
2	To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
3	To assess the strengths and weaknesses of various routing algorithms.
4	To understand various transport layer and application layer protocols
5	To design enterprise network for given user requirements in an application.
<b>Course Outcomes:</b>	
1	Demonstrate the concepts of data communication at physical layer and compare ISO - OSI model with TCP/IP model.
2	Explore different design issues at data link layer.
3	Design the network using IP addressing and sub netting / supernetting schemes.
4	Analyze transport layer protocols and congestion control algorithms.
5	Explore protocols at application layer
6	Understand the customer requirements and Apply a Methodology to Network Design and software defined networks

Module		Detailed Content	Hours
1		<b>Introduction to Networking</b>	
	1.1	Introduction to computer network, Network Devices, Network topology, Switching: Circuit-Switched Networks, Packet Switching, Network Types: LAN, MAN, WAN	6
	1.2	Reference models: Layer details of OSI, TCP/IP models. Difference between OSI and TCP/IP	
2		<b>Physical and Data Link Layer</b>	10
	2.1	Physical Layer: Communication mechanisms and Electromagnetic Spectrum, Guided Transmission Media: Twisted pair, Coaxial, Fiber optics	
	2.2	Data Link Layer: DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction (Hamming Code, CRC, Checksum), Elementary Data Link protocols, Stop and Wait, Sliding Window (Go Back N, Selective Repeat), Medium Access Control sublayer Channel Allocation problem, Multiple access Protocol (ALOHA, Carrier Sense Multiple Access,	

		(CSMA/CD)).	
<b>3</b>		<b>Network Layer</b>	<b>7</b>
	3.1	Network Layer: Communication Primitives, IPv4 Addressing (classful and classless), Subnetting, IPv4 Protocol, Network Address Translation (NAT), IPv6 addressing, IPv4 vs IPv6 addressing, Routed vs Routing protocols, Classification of Routing algorithms, Shortest Path algorithms (Dijkstra's), Link state routing, Distance Vector Routing	
<b>4</b>		<b>Transport Layer and Application Layer</b>	<b>7</b>
	4.1	Transport Layer: Service primitives, Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers, TCP Flow control (sliding Window)	
	4.2	Application Layer: HTTP, SMTP, Telnet, FTP, DHCP, DNS and Types of Name Server	
<b>5</b>		<b>Enterprise Network Design</b>	<b>5</b>
		The Cisco Service Oriented Network Architecture, Network Design Methodology, Top-Down vs Bottom up Approach to Network Design, Classic Three-Layer Hierarchical Model: Core, Access and Distribution Layers, Campus Design Considerations, Designing a Campus Network Design Topology.	
<b>6</b>		<b>Software Defined Networks</b>	<b>4</b>
		Introduction to Software Defined Network, Fundamental Characteristics of SDN, SDN Building Blocks, Control and Data planes, SDN Operation, OpenFlow messages – Controller to Switch, Symmetric and Asynchronous messages, SDN OpenFlow Controllers: PoX, NoX Architecture.	

<b>Textbooks:</b>	
1	A.S.Tanenbaum, Computer Networks, 4th edition Pearson Education
2	B.A. Forouzan, Data Communications and Networking, 5th edition, TMH
3	James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet, 6th edition, Addison Wesley
4	Behrouz A. Forouzan, Forouzan Mosharrat, Computer Networks A Topdown Approach, McGraw Hill education
5	Diane Teare, Authorized Self-Study Guide, Designing for Cisco Internetwork Solutions (DESGN), Second Edition, Cisco Press.
6	Paul Göransson, Chuck Black, Software Defined Networks: A Comprehensive Approach, MK Publication
7	Thomas D. Nadeau and Ken Gray, Software Defined Networks, 1 <sup>st</sup> Edition, O'Reilly publication

**References:**

1	S.Keshav,AnEngineeringApproachToComputerNetworking, Pearson.
2	NataliaOlifer&VictorOlifer,ComputerNetworks:Principles,Technologies&Protocolsfor NetworkDesign,WileyIndia,2011
3	Larry L.Peterson, Bruce S.Davie, Computer Networks:ASystemsApproach, Second Edition TheMorganKaufmannSeriesin Networking
4	SiamakAzodolmolky,SoftwareDefinedNetworking withOpen Flow :PACKTPublishing.
5	PriscillaOppenheimer,Top-DownNetworkDesign(NetworkingTechnology)3rdEdition, Cisco Press Book

**Assessment:****InternalAssessment:**

Assessmentconsistsoftwoclasstestsof20markseach.Thefirst-classtestistobeconductedwhen approx.40%syllabusiscompletedandsecondclasstestwhenadditional40%syllabusiscompleted.Durati onof each test shall be one hour.

**End SemesterTheory Examination:**

1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

**Useful Links**

1	<a href="https://nptel.ac.in/courses/106105183">https://nptel.ac.in/courses/106105183</a>
2	<a href="https://www.coursera.org/specializations/computer-communications">https://www.coursera.org/specializations/computer-communications</a>
3	<a href="https://www.coursera.org/learn/tcpip?action=enroll">https://www.coursera.org/learn/tcpip?action=enroll</a>

Course Code	Course Name	Credit
CSC502	WebComputing	03

**Pre-requisite:**

**Course Objectives:** The course aims:

- 1 To orient students to Web Programming fundamental.
- 2 To expose students to JavaScript to develop interactive web page development
- 3 To orient students to Basics of REACT along with installation
- 4 To expose students to node.js applications using express framework
- 5 To orient students to Fundamentals of node.js
- 6 To expose students to Advanced concepts in REACT

**Course Outcomes:**

- 1 Select protocols or technologies required for various web applications
- 2 Apply JavaScript to add functionality to web pages. .
- 3 Design front end application using basic React. .
- 4 Construct web based Node.js applications using Express
- 5 Design front end applications using functional components of React.
- 6 Design back-end applications using Node.js

Module		Detailed Content	Hours
1		<b>Web programming fundamentals</b>	
	1.1	Working of web browser, HTTP protocol, HTTPS, DNS, TLS, XML introduction, Json introduction, DOM, URL, URI, REST API	8
2		<b>Javascript</b>	8
	2.1	Introduction to JavaScript: JavaScript language constructs, Objects in JavaScript- Built in, Browser objects and DOM objects, event handling, form validation and cookies. Introduction to ES5, ES6, Difference between ES5 and ES6. Variables, Condition, Loops, Functions, Events, Arrow functions, Setting CSS Styles using JavaScript, DOM manipulation, Classes and Inheritance. Iterators and Generators, Promise, Client-server communication, Fetch	
3		<b>React Fundamentals</b>	10
	3.1	Installation, Installing libraries, Folder and file structure, Components, Component lifecycle, State and Props, React Router and Single page applications, UI design, Forms, Events, Animations, Best practices.	
4		<b>Node.js</b>	5

	4.1	Environment setup, First app, Asynchronous programming, Callback concept, Event loops, REPL, EventEmitter, Networking module, Buffers, Streams, File system, Web module.	
5		<b>Express</b>	4
	5.1	Introduction, Express router, REST API, Generator, Authentication, sessions, Integrating with React	
6		<b>Advance React</b>	4
	6.1	Functional components- Refs, Use effects, Hooks, Flow architecture, Model-View-Controller framework, Flux, Bundling the application. Webpack.	

#### Textbooks:

1	Rediscovering JavaScript, Master ES6, ES7, and ES8, By Venkat Subramaniam · 2018
2	Learning React Functional Web Development with React and Redux, Alex Banks and Eve Porcello, O'Reilly
3	Learning Redux, Daniel Bugl, Packt Publication
4	Learning Node.js Development, Andrew Mead, Packt Publishing
5	RESTful Web API Design with Node.js 10, Valentin Bojinov, Packt Publication

#### References:

1	"Web Development with Node and Express, Ethan Brown, O'Reilly
2	HTML5 Cookbook, By Christopher Schmitt, Kyle Simpson, O'Reilly Media
3	Core Python Applications Programming by Wesley J Chun Third edition Pearson Publication

#### Assessment:

##### Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

##### End Semester Theory Examination:

1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

#### Useful Links

1	<a href="https://www.coursera.org/learn/html-css-javascript-for-web-developers?action=enroll">https://www.coursera.org/learn/html-css-javascript-for-web-developers?action=enroll</a>
2	<a href="https://onlinecourses.swayam2.ac.in/ugc19_lb05/preview">https://onlinecourses.swayam2.ac.in/ugc19_lb05/preview</a>
3	<a href="https://reactjs.org/tutorial/tutorial.html">https://reactjs.org/tutorial/tutorial.html</a>
4	<a href="https://react-redux.js.org/introduction/quick-start">https://react-redux.js.org/introduction/quick-start</a> <a href="https://webpack.js.org/">4. https://webpack.js.org/</a>

Course Code	Course Name	Credit
CSC503	Artificial Intelligence	03

**Pre-requisite: C Programming**

**Course Objectives:** The course aims:

- |   |  |
|---|--|
| 1 | To gain perspective of AI and its foundations.   |
| 2 | To study different agent architectures and properties of the environment   |
| 3 | To understand the basic principles of AI towards problem solving, inference, perception, knowledge representation, and learning. |
| 4 | To investigate probabilistic reasoning under uncertain and incomplete information.   |
| 5 | To explore the current scope, potential, limitations, and implications of intelligent systems                                    |

**Course Outcomes:**

**After successful completion of the course students will be able to:**

- |   |   |
|---|---|
| 1 | Identify the characteristics of the environment and differentiate between various agent architectures.                          |
| 2 | Apply the most suitable search strategy to design problem solving agents.   |
| 3 | Represent a natural language description of statements in logic and apply the inference rules to design Knowledge Based agents. |
| 4 | Apply a probabilistic model for reasoning under uncertainty.  |
| 5 | Comprehend various learning techniques.   |
| 6 | Describe the various building blocks of an expert system for a given real word problem.   |

Module		Detailed Content	Hours
1		<b>Introduction to Artificial Intelligence</b>	3
	1.1	Artificial Intelligence (AI), AI Perspectives: Acting and Thinking humanly, Acting and Thinking rationally	
	1.2	History of AI, Applications of AI, The present state of AI, Ethics in AI	
2		<b>Intelligent Agents</b>	4
	2.1	Introduction of agents, Structure of Intelligent Agent, Characteristics of Intelligent Agents	
	2.2	Types of Agents: Simple Reflex, Model Based, Goal Based, Utility Based Agents.	
	2.2	Environment Types: Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent	
3		<b>Solving Problems by Searching</b>	12
	3.1	Definition, State space representation, Problem as a state space search, Problem formulation, Well-defined problems	
	3.2	Solving Problems by Searching, Performance evaluation of search strategies, Time Complexity, Space Complexity, Completeness, Optimality	

	3.3	Uninformed Search: Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Search, Uniform Cost Search, Bidirectional Search	
	3.4	Informed Search: Heuristic Function, Admissible Heuristic, Informed Search Technique, Greedy Best First Search, A* Search, Local Search: Hill Climbing Search, Simulated Annealing Search, Optimization: Genetic Algorithm	
	3.5	Game Playing, Adversarial Search Techniques, Mini-max Search, Alpha-Beta Pruning	
<b>4</b>		<b>Knowledge and Reasoning</b>	<b>10</b>
	4.1	Definition and importance of Knowledge, Issues in Knowledge Representation, Knowledge Representation Systems, Properties of Knowledge Representation Systems	
	4.2	Propositional Logic (PL): Syntax, Semantics, Formal logic-connectives, truth tables, tautology, validity, well-formed formula, Introduction to logic programming (PROLOG)	
	4.3	Predicate Logic: FOPL, Syntax, Semantics, Quantification, Inference rules in FOPL,	
	4.4	Forward Chaining, Backward Chaining and Resolution in FOPL	
<b>5</b>		<b>Reasoning Under Uncertainty</b>	<b>5</b>
		Handling Uncertain Knowledge, Random Variables, Prior and Posterior Probability, Inference using Full Joint Distribution	
		Bayes' Rule and its use, Bayesian Belief Networks, Reasoning in Belief Networks	
<b>6</b>		<b>Planning and Learning</b>	<b>5</b>
	6.1	The planning problem, Partial order planning, total order planning.	
	6.2	Learning in AI, Learning Agent, Concepts of Supervised, Unsupervised, Semi-Supervised Learning, Reinforcement Learning, Ensemble Learning.	
	6.3	Expert Systems, Components of Expert System: Knowledge base, Inference engine, user interface, working memory, Development of Expert Systems	
		<b>Total</b>	<b>39</b>

#### Textbooks:

1	Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach — Second Edition" Pearson Education.
2	Elaine Rich and Kevin Knight — Artificial Intelligence Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
3	George F. Luger "Artificial Intelligence" Low Price Edition, Pearson Education., Fourth edition.

#### References:

1	Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
2	D.W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.
3	Saroj Kaushik "Artificial Intelligence", Cengage Learning.
4	Davis E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
5	Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley, Third Edition.
6	N.P. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press.



<b>Assessment:</b>	
<b>Internal Assessment:</b>	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
<b>End Semester Theory Examination:</b>	
1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

<b>Useful Links</b>	
1	<a href="https://nptel.ac.in/courses/1-688-1001/">An Introduction to Artificial Intelligence - Course (nptel.ac.in)</a>
2	<a href="https://www.nptel.ac.in/">NPTEL</a>
3	<a href="https://www.classcentral.com/course/independent-elements-of-ai-12469">https://www.classcentral.com/course/independent-elements-of-ai-12469</a>
4	<a href="https://tinyurl.com/ai-for-everyone">https://tinyurl.com/ai-for-everyone</a>



Course Code	Course Name	Credit
CSC504	Data Warehousing and Mining	03

Pre-requisite: Database Management concepts	
<b>Course Objectives:</b> The course aims:	
1	To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse
2	To introduce the concept of data Mining as an important tool for enterprise data management and as a cutting edge technology for building competitive advantage.
3	To enable students to effectively identify sources of data and process it for data mining
4	To make students well versed in all data mining algorithms, methods of evaluation
5	To impart knowledge of tools used for data mining, and study web mining
<b>Course Outcomes:</b>	
1	Organize strategic data in an enterprise and build a data Warehouse.
2	Analyze data using OLAP operations so as to take strategic decisions and Demonstrate an understanding of the importance of data mining.
3	Organize and Prepare the data needed for data mining using preprocessing techniques
4	Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on large data sets.
5	Define and apply metrics to measure the performance of various data mining algorithms
6	Understand Concepts related to Web mining

Module		Detailed Content	Hours
1		<b>Data Warehouse and OLAP</b>	
		Data Warehousing, Dimensional Modeling and OLAP The Need for Data Warehousing; Data Warehouse Defined; Benefits of Data Warehousing ;Features of a Data Warehouse; Data Warehouse Architecture; Data Warehouse and Data Marts; Data Warehousing Design Strategies. Dimensional Model Vs ER Model; The Star Schema, The Snowflake Schema; Fact Tables and Dimension Tables; Factless Fact Table; Updates To Dimension Tables, Primary Keys, Surrogate Keys & Foreign Keys; Aggregate Tables; Fact Constellation Schema or Families of Star Need for Online Analytical Processing; OLTP vs OLAP; OLAP Operations in a cube: Roll-up, Drill down, Slice, Dice, Pivot; OLAP Models: MOLAP, ROLAP, HOLAP. Major steps in ETL Process	9
2		<b>Introduction to Data Mining, Data Exploration and Data Preprocessing</b>	8

		Data Mining Task primitives, Architecture, KDD process, Issues in data Mining, Types of Attributes; Statistical Description of Data; Data Visualization; Measuring similarity and dissimilarity. Why Preprocessing? Data Cleaning; Data Integration; Data Reduction: Attribute subset selection, Histograms, Clustering and Sampling; Data Transformation & Data Discretization: Normalization, Binning, Histogram Analysis and Concept hierarchy generation.	
3		<b>Classification</b>	6
		Basic Concepts; Classification methods: 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naïve Bayes Classifier. Prediction: Structure of regression models; Simple linear regression, Multiple linear regression. Accuracy and Error measures, Precision, Recall	
4		<b>Clustering</b>	4
		Cluster Analysis: Basic Concepts; Partitioning Methods: K-Means, K-Medoids; Hierarchical Methods: Agglomerative, Divisive, BIRCH; Density-Based Methods: DBSCAN What are outliers? Types, Challenges; Outlier Detection Methods: Supervised, Semi Supervised, Unsupervised, Proximity based, Clustering Based	
5		<b>Frequent Pattern</b>	8
		Market Basket Analysis, Frequent Itemsets, Closed Itemsets, and Association Rules; Frequent Pattern Mining, Efficient and Scalable Frequent Itemset Mining Methods, The Apriori Algorithm for finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemsets; Mining Frequent itemsets using vertical data formats; Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules; From Association Mining to Correlation Analysis, lift, ; Introduction to Constraint-Based Association Mining	
6		<b>Web Mining</b>	4
		Introduction to Web content Mining, Crawlers, Personalization, Web structure mining, Pagerank,., Clever, Web Usage Mining	

#### Textbooks:

1	Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition
2	P.N. Tan, M. Steinbach, Vipin Kumar, "Introduction to Data Mining", Pearson Education.
3	Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals", Wiley India.
4	Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems" 3rd Edition - McGraw Hill
5	Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education

#### References:

1	Theraja Reema, "Data Warehousing", Oxford University Press, 2009
2	Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide To Dimensional Modeling", 3rd Edition. Wiley India.

3	MichaelBerryandGordonLinoff“MasteringDataMining-Art&scienceofCRM”,Wiley Student Edition
4	MichaelBerryandGordonLinoff“DataMiningTechniques”,2ndEditionWileyPublications

<b>Assessment:</b>	
<b>InternalAssessment:</b>	
Assessmentconsistsoftwoclasstestsof20markseach.Thefirst- classtestistobeconductedwhenapprox.40%syllabusiscompletedand second class test when additional40% syllabus is completed. Durationofeachtestshallbeonehour.	
<b>End SemesterTheory Examination:</b>	
1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

<b>Useful Links</b>	
1	<a href="https://www.coursera.org/learn/data-warehousing-business-intelligence">https://www.coursera.org/learn/data-warehousing-business-intelligence</a>
2	<a href="https://www.coursera.org/specializations/data-mining-foundations-practice">https://www.coursera.org/specializations/data-mining-foundations-practice</a>
3	<a href="https://onlinecourses.nptel.ac.in/noc20_cs12/preview">https://onlinecourses.nptel.ac.in/noc20_cs12/preview</a>
4	<a href="https://nptel.ac.in/courses/106105174">https://nptel.ac.in/courses/106105174</a>

Course Code	Course Name	Credit
CSDLO5011	Statistics for Artificial Intelligence Data Science	03

### Prerequisite: C Programming

**Course Objectives:** The course aims:

- |   |  |
|---|--|
| 1 | To Perform exploratory analysis on the datasets      |
| 2 | To Understand the various distribution and sampling  |
| 3 | To Perform Hypothesis Testing on datasets            |
| 4 | To Explore different techniques for Summarizing Data |
| 5 | To Perform The Analysis of Variance                  |
| 6 | To Explore Linear Least Squares                      |

**Course Outcomes:** Learner will be able to

- |   |  |
|---|--|
| 1 | Illustrate Exploratory Data Analysis                   |
| 2 | Describe Data and Sampling Distributions               |
| 3 | Solve Statistical Experiments and Significance Testing |
| 4 | Demonstrate Summarizing Data                           |
| 5 | Interpret the Analysis of Variance                     |
| 6 | Use Linear Least Squares                               |

**Prerequisite:** Discrete Structures and Graph Theory

Module		Detailed Content	Hours
1		<b>Exploratory Data Analysis</b>	5
	1.1	Elements of Structured Data, Further Reading, Rectangular Data, Data Frames and Indexes, Nonrectangular Data Structures, Estimates of Location, Mean, Median and Robust Estimates, Estimates of Variability, Standard Deviation and Related Estimates, Estimates Based on Percentiles, Exploring the Data Distribution, Percentiles and Boxplots, Frequency Tables and Histograms, Density Plots and Estimates.	
	1.2	Exploring Binary and Categorical Data, Mode, Expected Value, Probability, Correlation, Scatterplots, Exploring Two or More Variables, Hexagonal Binning and Contours (Plotting Numeric Versus Numerical Data), Two Categorical Variables, Categorical and Numeric Data, Visualizing Multiple Variables.	
2		<b>Data and Sampling Distributions</b>	6
	2.1	Random Sampling and Sample Bias, Bias, Random Selection, Size Versus Quality, Sample Mean Versus Population Mean, Selection Bias, Regression to the Mean, Sampling Distribution of a Statistic, Central Limit Theorem, Standard Error, The Bootstrap, Resampling Versus Bootstrapping.	
	2.2	Confidence Intervals, Normal Distribution, Standard Normal and QQ-Plots, Long-Tailed Distributions, Student's t-Distribution, Binomial Distribution, Chi-Square Distribution, F-Distribution, Poisson and Related Distributions, Poisson Distributions, Exponential Distribution, Estimating the Failure Rate, Weibull Distribution. <b>Self Study:</b> Problems in distributions.	
3		<b>Statistical Experiments and Significance Testing</b>	8
	3.1	A/B Testing, Hypothesis Tests, The Null Hypothesis, Alternative Hypothesis, One-Way Versus Two-Way Hypothesis Tests, Resampling, Permutation Test, Example: Web Stickiness, Exhaustive and Bootstrap Permutation Tests, Permutation Tests: The Bottom Line for Data Science, Statistical Significance and p-Values, p-	

		Value,Alpha,Type1and	
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		Type 2 Errors	
	3.2	Data Science and p-Values, t-Tests, Multiple Testing, Degrees of Freedom, ANOVA, F-Statistic, Two-Way ANOVA, Chi-Square Test, Chi-Square Test: A Resampling Approach, Chi-Square Test: Statistical Theory, Fisher's Exact Test, Relevance for Data Science, Multi-Arm Bandit Algorithm, Power and Sample Size, Sample Size.  <b>Self Study:</b> Testing of Hypothesis using any statistical tool	
4		<b>Summarizing Data</b>	6
	4.1	Methods Based on the Cumulative Distribution Function, The Empirical Cumulative Distribution Function, The Survival Function, Quantile-Quantile Plots, Histograms, Density Curves, and Stem-and-Leaf Plots, Measures of Location.	
	4.2	The Arithmetic Mean, The Median, The Trimmed Mean, M-estimates, Comparison of Location Estimates, Estimating Variability of Location Estimates by the Bootstrap, Measures of Dispersion, Boxplots, Exploring Relationships with Scatterplots.  <b>Self Study:</b> using any statistical tool perform data summarization	
5		<b>The Analysis of Variance</b>	6
	5.1	The One-Way Layout, Normal Theory; the F-Test, The Problem of Multiple Comparisons, A Nonparametric Method—The Kruskal-Wallis Test, The Two-Way Layout, Additive Parametrization, Normal Theory for the Two-Way Layout, Randomized Block Designs, A Nonparametric Method—Friedman's Test.	
6		<b>Linear Least Squares</b>	8
	6.1	Simple Linear Regression, Statistical Properties of the Estimated Slope and Intercept, Assessing the Fit, Correlation and Regression, The Matrix Approach to Linear Least Squares, Statistical Properties of Least Squares Estimates, Vector-Valued Random Variables, Mean and Covariance of Least Squares Estimates, Estimation of $\sigma^2$ , Residuals and Standardized Residuals, Inference about $\beta$ , Multiple Linear Regression—An Example, Conditional Inference, Unconditional Inference, and the Bootstrap, Local Linear Smoothing.  <b>Self Study :</b> Create a Linear Regression model for a dataset and display the error measures, Choose a dataset with categorical data and apply linear regression model	

Textbooks:	
1	Bruce, Peter, and Andrew Bruce. Practical statistics for data scientists: 50 essential concepts. Reilly Media, 2017.
2	Mathematical Statistics and Data Analysis John A. Rice University of California, Berkeley, Thomson Higher Education
References:	
1	Dodge, Yadolah, ed. Statistical data analysis and inference. Elsevier, 2014.
2	Ismay, Chester, and Albert Y. Kim. Statistical Inference via Data Science: A Modern Dive into R and the Tidyverse. CRC Press, 2019.
3	Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
4	Johnson. R.A. and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.
5	A. Chandrasekaran, G. Kavitha, "Probability, Statistics, Random Processes and Queuing Theory", Dhanam Publications, 2014.