PES UNIVERSITY

(Established under Karnataka Act no. 16 of 2013)

100ft Ring Road, BSK 3rd Stage, Hosakerehalli, Bengaluru - 560085

Department of Computer Science & Engineering

Session:August-December 2020			Elective Time Table Semester : V	
Elective -I				
#	**Course Code**	**Course Title**	**Name of the Faculty**	**Timing & Day**
1	UE18CS311	Advanced Algorithms	Prof. N S Kumar	12:15 PM - 1:00 PM (Monday, Tuesday,Wednesday) && 9.15 AM – 10.00 AM (Thursday,Friday)
2	UE18CS312	Data Analytics	Dr. Gowri Srinivasa	
3	UE18CS313	Internet of Things	Prof. Revathi, Prof. Charanraj	
4	UE18CS314	Applied Cryptography	Prof. Rajashree S	
5	UE18CS315	Database Technologies	Prof. Suresj J	

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Department of Computer Science & Engineering

Session:August-December 2020			Elective Time Table Semester : V	
Elective -II				
#	**Course Code**	**Course Title**	**Name of the Faculty**	**Timing & Day**
1	UE18CS321	Principles of Programming Languages	Prof. Prafullata K A	9.15 AM – 10.00 AM (Monday,Tuesday, Wednesday) && 12:15 PM - 1:00 PM (Thursday,Friday)
2	UE18CS322	Big Data	Dr. K V Subramaniam	9.15 AM – 10.00 AM (Monday,Wednesday) && 12:15 PM - 2:00 PM Thursday && 12:15 PM - 1:00 PM
3	UE18CS323	Graph Theory & its applications	Dr. Surabhi Narayan	9.15 AM – 10.00 AM (Monday,Tuesday, Wednesday) && 12:15 PM - 1:00 PM (Thursday,Friday)
4	UE18CS324	Block Chain	Prof. Sunitha R	
5	UE18CS325	Web Technologies -II	Prof. Aruna S	
Signature:				
Name:	(Prof. Preet Kanwal,Prof.Sangeeta,Prof. Supriya)		(Prof. V R Badriprasad)	(Dr. Shylaja S S)
	TTO		CTTO	Chairperson, Dept. of CSE

Starts from August 17, 2020

UE18CS301: COMPUTER NETWORKS (4-0-0-0-4)

Course Information

# of Credits: 4 **# of Hours: 56**

Class #	Chapter Title /Reference Literature	Topics to be Covered	% of Portion covered	
			% of Syllabus	Cumulative %
Unit – 1 Computer Networks and the Internet				
1	1.1.1	Introduction to computer networks, What is internet? A Nuts-and-Bolts description	**17.86**	**17.86**
2	1.1.2, 1.1.3	A services description, What is a Protocol?		
3	1.2.1	Network edge: Access networks		
4	1.2.2	Physical media		
5	1.3.1	Network core: Packet witching		
6	1.3.2, 1.3.3	Circuit switching, Network of networks		
7	1.4.1, 1.4.2	Overview of delay in Packet-switched networks, Queuing delay and Packet loss		
8	1.4.3, 1.4.4	End-to-End delay, Throughput in computer networks		
9	1.5 (T1) 2.1, 2.2 (R1)	Protocol layers - The OSI model		
10	1 (R2)	TCP/IP protocol suite, Introduction to Cloud computing		
Unit – 2 Application Layer				
11	2.1.1, 2.1.2,	Network application principles: Network application architectures, Processes communication	**21.43**	**39.29**
12	2.1.3, 2.1.4	Transport services available to applications, Transport services by Internet		
13	2.2.1, 2.2.2	The web and HTTP, Non-persistent and Persistent connection		
14	2.2.3	HTTP message format, HTTP vs HTTPS		
15	2.2.4	Cookies		
16	2.2.5	Web caching		
17	2.4.1, 2.4.2	DNS – Services provided, Overview of how DNS works		
18	2.4.3	DNS records and messages		
19	2.5.1	Peer-to-Peer applications		

20	2.7.1	Socket Programming with UDP		
21	2.7.2	Socket Programming with TCP		
22		Other Application Layer Protocols: FTP, SMTP, SNMP, Telnet, SSH		
Unit – 3 Transport Layer				
23	3.1	Introduction to transport layer, Relationship between transport and network layer, Overview of the transport layer in the Internet	**21.43**	**60.72**
24	3.2	Multiplexing and Demultiplexing		
25	3.3	Connectionless transport: UDP, Segment structure, Checksum		
26	3.4.1	Principles of reliable data transfer, Building a reliable data transfer protocol		
27	3.4.2	Pipelined reliable data transfer protocol		
28	3.4.3	Go-Back-N protocol		
29	3.4.4	Selective repeat		
30	3.5.1, 3.5.2, 3.5.3, 3.5.4	Connection Oriented Transport: TCP, The TCP connection, TCP segment structure		
31	3.5.5	Flow control		
32	3.5.6	TCP connection management		
33	3.6	TCP congestion control		
34	3.6	TCP congestion control		
Unit – 4 Network Layer and Internet Protocol				
35	T1: 4.1	Overview of network layer, Forwarding and routing, Network service models	**21.43**	**82.15**
36	4.2.1, 4.2.2	Inside router: Input port processing and Destination-based forwarding, Switching		
37	4.2.3, 4.2.4, 4.2.5	Output port processing, where does Queueing occur? Packet scheduling		
38	4.3.1, 4.3.2	The Internet Protocol – IPv4, Datagram format, Fragmentation		
39	4.3.3	IPv4 Addressing		
40	4.3.3	IPv4 Addressing		
41	4.3.4	IPv4 Addressing, NAT		
42	26.1, 26.2, 26.3 (R1)	IPv6 Addressing: Introduction, Address space allocation, Global unicast addresses		
43	26.4, 26.5 (R1)	IPv6 Addressing: Autoconfiguration, Renumbering		
44	27.1, 27.2,	IPv6 Addressing: Packet format, Transition		

	27.3 (R1)	from IPv4 to IPv6		
45	4.3.3	Network layer protocols: DHCP, ICMP		
46	5.2	Introduction to routing algorithms: Link state and Distance vector		
Unit – 5 Link Layer and LAN				
47	T1: 6.1, 6.2: 6.2.1	Introduction to link layer, Error-detection and correction techniques: Parity checks, Internet checksum, Cyclic redundancy check	**17.85**	**100**
48	6.2.2	Multiple access protocols: CSMA/CD		
49	6.2.3	Switched LAN: Link layer addressing and ARP		
50	6.4.1	Ethernet		
51	6.4.2	Link-layer switches		
52	6.4.3	Retrospective: A day in the life of a web page request		
53	6.4.4	Physical layer: Purpose, Signals to Packets		
54	6.7	Analog vs Digital Signals, Transmission media		
55	7.3 (T1) 3.2 (R1)	Wireless LANs: IEEE 802.11 LAN architecture		
56	7.3.2, 7.3.3	802.11 MAC protocol, IEEE 802.11 Frame		

Book Type	**Code**	**Title & Author**	**Publication Information**		
			Edition	**Publisher**	**Year**
Text Books	T1	"Computer Networking - A Top - Down Approach", James F Kurose, Keith W.	6	Pearson	2012
Reference Books	R1	"TCP IP Protocol Suite", Behrouz Forouzan	4	McGraw-Hill	2010
	R2	"Mastering Cloud Computing, Foundations and Applications Programming", Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi.		Morgan Kaufmann, Elsevier	2013

UE18CS302 : OPERATING SYSTEM (4:0:0:0:4)

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# of Hours: 56

Class #	Unit description	Topic to be covered	Percentage of portions covered	
			% of Syllabus	Cumulative %
1	Unit 1 T1 (Chap 1-3,5)	Introduction: What Operating Systems Do, Computer-System Organization	21.40%	21.40%
2		Computer-System Architecture, Operating-System Structure & Operations		
3		Kernel Data Structures, Computing Environments		
4		Operating-System Services, Operating-System Design and Implementation		
5		Process concept: Process in memory, Process State, PCB, Context Switch, Process Creation and Termination		
6		CPU Scheduling & Scheduling Algorithms, Preemptive and Non-Preemptive, Scheduling criteria,		
7		Scheduling Algorithms: FIFO, SJF		
8		Round Robin, Priority Scheduling		
9		Multi-Level Queue, Multi-Level Feedback Queue		
10		Case Study: Linux/ Windows Scheduling Policies.		
11		Inter Process Communication – Shared Memory, Messages		
12		Named and unnamed pipes		
13	Unit 2 T1(Chap 4-7)	Introduction to Threads, types of threads, Multicore Programming, Multithreading Models ,	21.40%	42.80%
14		Thread creation, Thread Scheduling		
15		Pthreads and Windows Threads		
16		Mutual Exclusion and Synchronization, software approaches,		
17		principles of concurrency, hardware support		
18		Mutex Locks, Semaphores		
19		Classic problems of Synchronization:		
		Bounded-Buffer Problem, Readers-Writers problem		
20		Dining-Philosophers Problem		
21		Synchronization Examples: Synchronisation mechanisms provided by		
		Linux/Windows/Pthreads.		
22		Deadlocks: principles of deadlock, Deadlock Characterization		
23		Deadlock Prevention, Deadlock example		
24		Deadlock Detection, Algorithm	21.40%	
25		Main Memory: Hardware and control structures, OS support, Address translation		
26		Dynamic linking, Swapping		
27		Memory Allocation (Partitioning, relocation), Fragmentation		
28		Segmentation		

29	Unit 3 T1 (Chap 8-9)	Paging: OS Support, TLBs, Address Translation		64.20%
30		Structure of the Page Table		
31		Design Alternatives – Inverted Page Tables, Bigger Pages		
32		Virtual Memory: Demand Paging, Copy-OnWrite		
33		Page replacement policy – LRU		
34		FIFO & Optimal		
35		Thrashing		
36		Case Study: Linux/ Windows Memory Management		
37	Unit 4 T1 (Chap 10-14,16)	Mass-Storage Structure: Mass-Storage overview	17.80%	82.10%
38		Disk Scheduling – FCFS, SSTF, SCAN, C-SCAN, LOOK		
39		Swap-Space Management, RAID Structure		
40		File Concept, File Structure, Access Methods		
41		Directory and Disk Structure		
42		File-System Mounting, File Sharing, Protecting		
43		Implementing File-Systems: File control Block (inode), partitions & mounting		
44		Disk Space Allocation methods: Contiguous, Linked, Indexed		
45		Case Study: Unix/Linux File systems		
46		NFS		
47	Unit 5 T1 (Chap 14-15,21)	I/O Hardware, polling and interrupts	17.80%	100%
48		DMA		
49		Transforming I/O Requests to Hardware Operations, Device interaction, device driver, buffering.		
50		Goals, Principles and Domain of Protection		
51		Access Matrix		
52		Access control, Access rights		
53		The Security Problem		
54		Program Threats		
55		System Threats and Network Threats		
56		Case Study : Linux & Windows		

Pre-requisite Courses: Data Structures, Microprocessor and Computer Architecture.

Text Book:

Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne 9th Edition, John_Wiley_&_Sons, 2013.

References:

1. Operating Systems, Internals and Design Principles, William Stallings, 9th Edition, Pearson, 2018
2. Operating Systems: Three Easy Pieces, Remzi Arpaci-Dusseau and Andrea Arpaci Dusseau, http://pages.cs.wisc.edu/~remzi/OSTEP/
3. Advanced Programming in the Unix Environment", Richard Stevens and Stephen A Rago, Pearson, 3rd edition,2017

4. Operating Systems, Harvey Deitel, Paul Deitel, David Choffnes, 3rd Edition, Prentice Hall
5. Modern Operating Systems, Andrew S Tannenbaum, 3rd edition, Pearson

UE18CS303: Machine Intelligence(4:0:0:0:4)

#of Credits:4 **#of Hrs: 56**

Class #	Chapter Title / Reference Literature	Topics to be Covered	% of Portion Covered	
			% of Syllabus	Cumulative %
Unit 1 :Introduction & Basics				
1		Introduction to AI and ML	21.4	21.4
2		Intelligent Agents and its Types		
3		Machine Learning and its Models		
4		Problem solving by Searching- Uninformed Search		
5	**T1 1.1**	Problem solving by Searching- Informed Search		
6	**T1 1.2** **T1 3.3-3.4**	Perspectives and Issues, designing learning systems		
7	**T1 3.5-3.6**	Concepts of hypotheses, Version space, inductive bias		
8	**T2 1.2-1.3** **T2 2.1-2.4,2.7**	Performance metrics-accuracy, precision, recall, sensitivity, specificity, AUC, RoC		
9	**T2 3.1-3.7**	Decision Trees- Basic algorithm (ID3)		
10		Hypothesis search and Inductive bias, Entropy and Gain calculations		
11		Issues in Decision Tree Learning – Overfitting		
12		Solutions to overfitting, Dealing with continuous values		

Unit 2 : Classification and Regression				
13	**T2 :Ch8:Pages 230-238, Ch4:Pages 81-105, 108-111 R1 Ch7.3**	Instance-based learning: k-nearest neighbor learning	21.4	42.8
14		Simple problems – weighted KNN		
15		Issues with KNN – discussion		
16		Artificial Neural networks: Introduction		
17		Perceptrons – implementing LOGIC gates		
18		Multi-layer networks and back-propagation		
19		Back-propagation derivation		
20		Activation Units – discussion		
21		Support Vector Machines – margin and maximization		
22		SVM - The primal problem, the Lagrangian dual		
23		SVM – Solution to the Lagrangian dual		
24		Simple problems on SVM		
Unit 3 : Stochastic Learning				
25	**R4: Pages 129-133, T2: Ch6 – Pages 154-166, 170-171, 174-182, R3 - Ch13**	Improving performance: Bagging and Boosting	21.4	64.2
26		Adaboost - combining weak learners		
27		Bayesian Learning – Bayes theorem, Concept learning		
28		Maximum likelihood, Bayes optimal classifier		
29		Naïve Bayes classifier and text classification.		
30		Expectation Maximization Algorithm		
31		Expectation Maximization Algorithm		
32		Gaussian Mixture Models		
33		Hidden Markov models – discrete Markov processes		
34		Hidden Markov models – 3 basic problems		
35		Learning the state sequence		
36		Learning the parameters, Baum-Welch Algorithm		

Unit 4 : Unsupervised Learning and Dimensionality Reduction				
37	**R4: Ch10: Pages 207-217,Ch11: Pages 224-234, Ch12:Pages 248-260, Course Notes**	Unsupervised Learning: Hierarchical vs non-hierarchical clustering, Agglomerative and divisive clustering	18	82.2
38		K-means clustering, Simple problems		
39		Bisecting k-means, issues with k-means.		
40		K Means as special case of Expectation Maximization		
41		Apriori algorithm - Association analysis, the Apriori principle.		
42		Finding frequent itemsets, mining association rules		
43		FP-growth – FP trees, building an FP-tree		
44		Mining frequent items from an FP-Tree		
45		Dimensionality reduction techniques PCA		
46		SVD – Applications.		
Unit 5 : Genetic Algorithms and Computational Learning Theory				
47	T2: Ch7.1-7.4,Ch9,Course Notes	Genetic Algorithms – Representing hypothesis, Genetic operators	17.8	100
48		Fitness function and selection methods, crossover, mutation		
49		Simple applications of the Genetic Algorithm, application of GA in Decision tree		
50		Genetic Algorithm based clustering		
51		Single Objective and Bi-objective optimization problems using GA		
52		Using GA to emulate Gradient descent/ascent		
53		Introduction to PSO		

54		Application in Single Objective optimization problems	
55		Computational Learning Theory, PAC-Learnability	
56		The Vapnik-Chervonenkis Dimension	

Literature:

Book Type	Code	Author & Title	*Publication info*		
			Edition	Publisher	Year
Text books	T1	Artificial Intelligence: A Modern Approach by Stuart Russel and Peter Norvig	3rd	Pearson	2009
	T2	Machine Learning by Tom Mitchell,	Indian Edition	McGraw Hill Education (India)	1997

Book Type	Code	Author & Title	*Publication info*		
			Edition	Publisher	Year
Reference books	R1	Machine Learning The Art and Science of Algorithms that Make Sense of Data by Peter Flach	1st editon	Cambridge University Press	2012
	R2	Pattern Recognition and Machine Learning by Christopher Bishop	2nd printing	springer	2011
	R3	Introduction to Machine Learning by Ethem Alpaydin	2nd Editio	PHI Learning	2019

			n		
	R4	Machine Learning in Action by PETER HARRINGTON	1st	Manning	2012

UE18CS311: ADVANCED ALGORITHMS (4-0-0-0-4)

# of Credits: 4 **# of Hours: 56**

Class #	Chapter Title / Reference Literature	Topics to be Covered	% of Syllabus	
	Unit I.:	**Basics of Complexity:**	**21.43**	**21.43**
1	**T1: Chapter 3 3.1**	Asymptotic Notations- Basic operation, time analysis		
2	**3.1**	Asymptotic Notations-Big O, Big Omega, Big Theta, Little o, Little omega		
3	**3.2**	Standard functions and common functions		
4	**T1:4.3**	Recurrence Relations		
5	**4.3**	Substitution Method		
6	**4.4**	Recurrence Tree method		
7	**4.5**	The Master method		
8	**T1: 17.1**	Amortized Complexity Analysis		
9	**17.1,17.2, 17.3**	Aggregate, Accounting and Potential Methods: Stack, Binary Counter		
10	**17.4**	Aggregate, Accounting and Potential Methods: Dynamic Array		
11	**T1: 34.1, 34.3**	NP-Completeness		
12	**34.3**	NP Reduction		
	Unit II:	**String Algorithms**		
13	**T1- 32.1**	Naïve String Match	**17.85**	**39.28**
14	**R1:18.3**	Boyer–Moore		
15	**R1:18.3**	Boyer–Moore		
16	**T1:32.2**	Rabin–Karp		
17	**32.3**	String matching with Finite State Automata		
18	**32.4**	Knuth–Morris–Pratt Algorithm		
19	**32.4**	Knuth–Morris–Pratt Algorithm		
20	**R1:12.3**	Suffix Trees		

21	**R1:12.3**	Applications of Suffix Trees		
22	**R1:12.3**	Regular Expression Searches Using Suffix Trees.		
	Unit III:	**Maximum Flow, Polynomials and FFT**:		
23	**T1: 26.1**	Flow Networks: Max Flow	**21.43**	**60.71**
24	**26.1**	Max Flow – Min Cut Theorem		
25	**26.2**	The Ford-Fulkerson method		
26	**26.2**	The Edmonds-Karp algorithm		
27	**26.3**	Maximum Bi-Partite Matching		
28	**26.3**	Maximum Bi-Partite Matching		
29	**T1:30.1**	Polynomials and FFT: Representation of Polynomials		
30	**30.1**	Polynomials and FFT: Representation of Polynomials		
31	**30.1**	Efficient Polynomial Multiplication		
32	**30.2**	DFT		
33	**30.2**	FFT		
34	**30.3**	Efficient Implementation of FFT		
	Unit IV:	**Number-Theoretic Algorithms**:		
35	**T1: 31.1**	Elementary notions	**17.85**	**78.57**
36	**31.2**	GCD, Modular Arithmetic		
37	**31.3**	Solving modular linear equations		
38	**31.3**	Solving modular linear equations		
39	**31.4**	Modular Inverse		
40	**31.5**	The Chinese remainder theorem		
41	**31.6**	Powers of an element		
42	**31.7**	RSA cryptosystem		
43	**31.8**	Primality testing		
44	**31.9**	Integer factorization		

	Unit V.	**Dynamic Programming, Randomized Algorithms and Approximation Algorithms**		
45	**T1: 15.1**	Elements of Dynamic Programming	**21.43**	**100**
46	**15.1**	Dynamic Programming, Problems - Coin-Row		
47	**15.1**	Dynamic Programming, Problems - Rod-Cutting		
48	**15.2**	Dynamic Programming, Problems Matrix-Chain Multiplication		
49	**15.4**	Dynamic Programming, Problems: Longest Common Subsequence		
50	**T1: 5.1**	Randomized Algorithms: Introduction		
51	**5.1**	Randomized Algorithms: Hiring Problem		
52	**5.2**	Indicator random variables		
53	**T1: 35.1**	Approximation Algorithm: Vertex Cover Problem		
54	**35.2**	Approximation Algorithm: TSP		
55	**35.3**	Approximation Algorithm: Subset Sum Problem		
56	**35.4**	Randomization and Linear Programming		

Book Type	**Code**	**Title & Author**	**Publication Information**		
			Edition	**Publisher**	**Year**
Text Books	T1	"Introduction to Algorithms", T H Cormen, C E Leiserson, R L Rivest and C Stein	3	PHI	2010
Reference Book	R1	"The Algorithm Manual", Steven Skiena	2	Springer	
	R2	"Randomized Algorithms", R Motwani and P Raghavan		Cambridge University Press	2011

UE18CS312: DATA ANALYTICS (4–0–0–4)

of Credits: 4 No. of Hours: 56

Class #	Chapter Title/Reference Literature	Topics to be Covered	% of Portions Covered	
			% of Syllabus	Cumulative
1	**Unit: 1** **Exploratory Data Analysis and Visualization** T1: 2 R1: 2, 3	Introduction to data analytics, data sources and representations	18	18
2		Exploring data - basic statistics		
3		Data preprocessing - sampling, normalization, transformations		
4		Dimensionality reduction		
5		Other data preprocessing techniques		
6		The R programming environment		
7		Data visualization – motivation, general concepts		
8		Data visualization and R Graphics		
9		Case study		
10				
11	**Unit : 2** **Regression Analysis** T1: 8, 9,10, 11	Distance and similarity measures	21	39
12		Correlation and simple regression		
13		Concept of training, validation and testing		
14		Linear regression approaches (MLE, Gradient descent)		
15		Multiple regression		
16		Multivariate regression		
17		Non-linear regression		
18		Confusion matrices, RoC and AUC		
19		Logistic regression (concept of odds, odds ratio)		
20		Ridge and Lasso Regression		
21		Case study		
22				
23	**Unit :3** **Time Series**	Introduction to Time series data, concept of stationarity and singularities	21	60
24		Signal types (additive, multiplicative,…)		

	T1: 13	'Decomposing' a time series signal – into seasonal, trend and irregular components		
26		Trend analysis – simple and exponential smoothing		
27		ACF and PACF and forecasting using AR, MA and ARMA		
28		Concept of stationarity and tests for stationarity (DF, ADF, differencing, Ljung-Box) and Forecasting using ARIMA		
29		Box Jenkins and ARIMAX		
30		Evaluating time series models		
31		Signal representations (Fourier transform, wavelet transform)		
32		Concept of filtering and types of filters		
33		Case study		
34				
35	**Unit : 4** **Recommendation Systems** T1: 12, 14 R1: 6, 8, 9	Introduction to recommendation systems	20	80
36		Collaborative filtering		
37		Knowledge based filtering using knn		
38		Decision trees – CART, Ensemble methods and Random Forest		
39		Brief review of other classifiers: SVM, ANN and data driven approaches		
40		Brief review of unsupervised learning – clustering algorithms – DBSCAN		
41		Content based analysis – dealing with textual data		
42		Text classification and clustering		
43		Market basket analysis (Apriori algorithm)		
44		Generation and evaluation of association rules from frequent item sets		
45		Case study		
46				
47	**Unit : 5** **Advanced techniques**	Sparse data processing, LSA and sparse PCA	20	100
48		Concept of hidden and confounding variables		

	T1: 16 + Additional Reference material	Introduction to stochastic models and Markov processes (first order)	
50		Introduction to discrete Markov Chains	
51		Interpreting business values	
52		Case study 1	
53		Case study 1	
54		Case study 2	
55		Case study 2	
56		Review	

Literature

Book Type	Code	Title & Author	Publication Information		
			Edition	Publisher	Year
Text Book	T1	**1.** Business Analytics, The Science of Data-Driven Decision Making, U. Dinesh Kumar		Wiley	2017
Reference Book	R1	Data Mining: Concepts and Techniques by Jiawei Han, Micheline Kamber and Jian Pei	3rd	The Morgan Kaufmann Series in Data Management Systems	
	R2	The Elements of Statistical Learning, Trevor Friedman, Robert Tibshirani and Jerome Hastie		Data Mining, Inference and Prediction, Springer	2001
	R3	Practical Data Science with R, Nina Zumel and John Mount		Manning Publications	2014

Programming language:

1. R

UE18CS313: INTERNET OF THINGS (4:0:0:0:4)

# of Credits: 4 **# of Hours: 56**

Class #	Chapter Title / Reference Literature	Topics to be Covered	% of Portion covered	
			% of Syllabus	Cumulative %
1	**Unit#1** **Introduction** T1: Ch1 and Ch2	What is IOT? Trends in adoption of IOT	**21.4%**	**21.4%**
2		Convergence of IT and IoT, Challenges in IoT		
3		IOT network Architecture and design		
4		Physical design and logical design, Behind New Network Architectures		
5		Comparing IoT Architectures		
6		A Simplified IoT Architecture		
7		The Core IoT		
8		IOT Design Methodology		
9		Domain specific IOT, Functional Stack		
10		IoT Data Management and Compute Stack		
11		Hands-on Session on Microcontrollers		
12		Hands-on Session on Microcontrollers		
13	**Unit#2** **Smart objects** T1: Ch3 and Ch4	Smart Objects: The "Things" in IoT, Sensors	**17.8%**	**39.2%**
14		Actuators, Smart Objects		
15		Sensor Networks		
16		Connecting Smart Objects		
17		Communications Criteria		
18		Communications Criteria		
19		IoT Access Technologies		
20		IoT platforms, Programming with Arduino, Programming with Raspberry Pi and Node MCU		
21		Hands-on Session on Connecting Smart Objects		
22		Hands-on Session on Connecting Smart Objects		
23	**Unit #3** **IP as the IoT network Layer** T1: Ch5 and Ch6	IP as the IoT Network Layer -The Business Case for IP	**21.4%**	**60.6%**
24		The Need for Optimization		
25		Optimizing IP for IoT		
26		Optimizing IP for IoT		
27		Profiles and Compliances		
28		Application Protocols for IoT -The Transport Layer		
29		IoT applications transport methods		
30		IoT applications transport methods		
31		Networking technologies, Communication aspects Wireless medium access issues		
32		Common protocols, Software & Management Tools for IoT		
33		Hands-on Session on Protocols		
34		Hands-on Session on Protocols		
35	**Unit#4** **Data and Analytics for IoT**	Data and Analytics for IoT - An Introduction to DataAnalytics for IoT		
36		Machine Learning		
37		Big Data Analytics Tools and Technology		

38	T1: Ch7 and Ch8	Edge Streaming Analytics		
39		Network Analytics		
40		**Securing IoT** : A Brief History of OT Security, Common Challenges in OT Security	**21.4%**	**82.0%**
41		How IT and OT Security Practices and Systems Vary		
42		Formal risk analysis structures-OCTAVE and FAIR		
43		The Phased Application of Security in an Operational Environment		
44		Identify and analyze IoT security, Privacy risks		
45		Hands-on Session on IOT Analytics		
46		Hands-on Session on IOT Analytics		
47	**Unit#5** **Case Studies and Advanced Topics** T1: Ch12	**Case Studies and Advanced Topics**	**17.8%**	**100%**
		IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino, UNO		
48		FundamentalsofArduino Programming.		
49		IoT Physical Devices and Endpoints- RaspberryPi: Introduction to RaspberryPi		
50		About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi		
51		Programming RaspberryPi with Python		
54		Introduction to ESP32 Dev Board , Programming ESP32 with Arduino		
55		Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City		
56		Home automation, Industry applications, Surveillance applications, Rural IoT, Various Real time applications of IoT		

Book Type	Code	Title & Author	Publication Information		
			Edition	Publisher	Year
Text Book	T1	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things -David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry	1	Pearson	2017
Reference Book	R1	Internet of Thingshands-on approach-Arshdeep Bahga, Vijay Madisetti	1	OrientBlackswan Private Limited	2015
	R2	Designing the Internet of Things - Adrian McEwen, HakinCassimally	1	Wiley	2013
	R3	Enterprise IoT by Dirk Slama, Frank Puhlmann, Jim Morrish, Rishi M Bhatnagar	1	O'Reilly	2015

UE18CS314 : Applied Cryptography 4:0:0:0:4

# of Credits: 4 **# of Hours: 56**

Class #	Chapter Title / Reference Literature	Topics to be Covered	% of Portion covered	
			% of syllabus	Cumulative %
1	**Unit#1 Classical Ciphers (Chapter 1,2)**	Introduction to cryptography, cryptanalysis, and cryptology		
2		Overview of cryptography		
3		Basic Cryptographic primitives		
4		Classical ciphers: substitution cipher – Caesar, Playfair and Hill cipher	**21.43**	**21.43**
5		Transposition cipher – Rail fence, Columnar and Double columnar		
6		Cryptanalysis of classical ciphers		
7		Introduction to probability, Conditional probability, Law of Total probability		
8		Shannon's theorem		
9		One-time-pad encryption		
10		Limitations of One-Time-Pad		
11		**Lab1**		
12				
13	**Unit#2**	Introduction to symmetric key cryptography		
14	**Symmetric Key Cryptography (chapter- 3,6)**	Pseudo Random Numbers		
15		Feistel Cipher		
16		S-box and E-box		
17		Initial and Final permutations		
18		Data Encryption Standard (DES)	**21.41**	**42.84**
19		Cryptanalysis and avalanche effect		
20		Advanced Encryption Standard (AES)		
21		AES key scheduling		
22		Block and Stream ciphers		
23		**Lab2**		
24				
25	**Unit #3**	Introduction to Public key		

	Public Key Cryptography (chapter-8,11)	cryptography	**21.43**	**64.27**
26		Modes of operation		
27		Prime number, Primitive root		
28		Modular arithmetic		
29		Polynomials		
30		Diffie Hellman Protocol		
31		Elgamal crypto systems		
32		Prime Factorization		
33		Rivest–Shamir–Adleman cryptosystem (RSA)		
34		Applications.		
35		**Lab3**		
36				
37	**Unit#4**	Key management and distribution (KDC)	**17.85**	**82.12**
38				
39	**Key management Hashing Techniques**	Birthday attack		
40		Zero knowledge protocols		
41		MD5, One-way function, Collision resistant hash function (CRHF)		
42	**(chapter 10,6,7)**			
43		Secure Hash Algorithm (SHA), Applications		
44				
45		**Lab4**		
46				
47	**Unit #5**	Identification protocols	**17.88**	**100**
48		Digital Signature (DS)		
49	**Authentication using Cryptography**	Elliptic Curve cryptography-based signature (ECDSA)		
50		RSA based signature		
51	**Chapter-4,12,8.3**	Message Authentication Code (MAC)		
52		Cipher Block Chain MAC (CBC MAC)		
53		Different areas where cryptography needs to be applied		
54				
55		**Lab5**		
56				

Lab:

Lab 1	**Pseudo Random Number Generation.**
Lab 2	**Secret-Key Encryption.**
Lab 3	**RSA Encryption and Signature.**
Lab 4	**Hash Length Extension Attack.**

Lab 5	**MD5 Collision Attack.**

Literature

Book Type	Code	Title & Author	Publication Information		
			Edition	Publisher	Year
Textbook	T1	"Introduction to Modern Cryptography", Jonathan Katz, Yehuda Lindell	2	CRC Press	2015

UE18CS315: DATABASE TECHNOLOGIES: 4:0:0:0:4

# of Credits: 4 **# of Hours: 56**

Class #	Chapter Title/Reference Literature	Topics to be covered	% of Portions Covered	
			Reference Chapter	Cumulative
1	T1: 1.1 – 1.3	Review of The Relational Model of Data	18	18
2	T1: 2.1 – 2.6	Design Theory for Relational Databases		
3	T1: 13.1	Secondary Storage Management - The Memory Hierarchy		
4	T1: 13.2	- Disks		
5	T1: 13.3 – 13.4	- Accelerating Access to Secondary Storage		
6	T1: 13.5 – 13.8	- Arranging Data on Disk		
7	T1: 14.1	Index structures - Basics		
8	T1: 14.2	- B Trees		
9	T1: 14.3, 14.6.1, 14.6.2	- Hash tables		
10	T1: 14.6.7 - 14.7	- R Trees, Bitmap indexes		
11	T1: 15.1	Query Execution - Introduction to Physical Query Plan Operators	21	39
12	T1: 15.2	- One pass algorithm		
13	T1: 15.3	- Tuple-Based Nested-Loop Join		
14	T1: 15.4 – 15.5	- Two pass algorithm		
15	T1: 15.6	- Index-Based Algorithms		
16	T1: 15.7	- Buffer management		
17	T1: 15.8	- Algorithms Using More Than Two Passes		
18	T1: 16.1	The Query Compiler - Parsing and Preprocessing		
19	T1: 16.2	- Algebraic Laws for Improving Query Plans		
20	T1: 16.3	- From Parse Trees to Logical Query Plans		
21	T1: 16.4	- Estimating the Cost of Operations		
22	T1: 16.5 – 16.7	- Introduction to Cost-Based Plan Selection		
23	T1: 20.1.1	Models of Parallelism	21	60

	T1: 20.1.2	Parallel Algorithms on Relations		
25	T1: 20.1.4	Performance of Parallel Algorithms		
26	T1: 20.2	The Map-Reduce Parallelism Framework		
27				
28	T1: 20.3.1	Distributed Databases		
29	T1: 20.3.2	Distributed transactions		
30	T1: 20.4	Distributed Query Processing		
31				
32	T1: 20.5	Distributed Commit		
33	T1: 20.6	Distributed Locking		
34	T1: 20.7	Peer-to-Peer Distributed Search		
35	R2: 24.1	Characteristics and Categories of NoSQL systems	21	81
36	T2: 4, 5	Document Databases		
37				
38	T2: 3	Column Oriented Databases		
39				
40	T2: 8	Key Value stores		
41				
42	T2: 6	Graph Databases		
43				
44				
45	Reference material	In memory databases		
46				
47	R2: 28.1	Overview of Data Mining Technology	19	100
48	R2: 28.5 – 28.6	Applications of Data Mining		
49				
50	R2: 29.1	Overview of Data Warehousing and OLAP		
51	R2: 29.3	Data Modeling for Data Warehouses		

53	R2: 29.4	Building a Data Warehouse	
54	Ref Material	Overview of Data lakes	
55	Ref Material	Multi-model databases	
56			

UE18CS321: PRINCIPLES OF PROGRAMMING LANGUAGES (4-0-0-0-4)

# of Hours: 56

Class #	Chapter Title/Reference Literature	Topics to be Covered	% of Portions Covered	
			% covered	Cumulative
1.	**Unit: I** **Preliminary Concepts; Names, Binding, Type Checking and Scopes;** **Chapter 1 and Chapter 5**	**Preliminaries:** Reasons for studying concepts of programming languages, Programming domains	21.4%	21.4%
2.		Language Evaluation Criteria		
3.		Influences on Language design, Language categories, Programming Paradigms		
4.		Programming Language Implementation – Compilation and Virtual Machines		
5.		**Names, Binding, Type Checking and Scopes:** Names, Variables, Type bindings, Type Inferencing, Type Checking, Strong Typing.		
6.		**Case Study**: Linux utilities and Program Debuggers for languages such as C, Python.		
7.	**Unit: II** **Type Checking and Scopes, Data types:** **Chapter 6, Chapter 7 - 7.6, 7.7, 7.8**	**Type Checking and Scopes (continued..):** Type Equivalence, Scope and Lifetime, Referencing Environments.	21.4%	42.8%
8.		**Data types:** Introduction, primitive, character, user defined, array, associative		
9.		record, union, pointer and reference types, design and implementation issues related to these types.		
10.		Names, Variables, concept of binding, type checking,		
11.		type compatibility, named constants, variable initialization.		
12.		**Expressions and Statements:** Short circuit evaluation mixed mode assignment, Assignment Statements.		

	Unit: III **Control Structures, Subprograms and Blocks** **Chapter 8, 9**	**Control Structures**: Statement Level, Compound Statements, Selection, Iteration	21.4%	64.2%
14.		Unconditional Statements, and guarded commands.		
15.		**Subprograms and Blocks:** Fundamentals of sub-programs, Scope and lifetime of variable		
16.		static and dynamic scope		
17.		Design issues of subprograms and operations, local referencing environments, parameter passing methods,		
18.		overloaded sub-programs, generic sub-programs, parameters that are sub-program names		
19.	**Unit: IV** **Functions, Abstract Data Types, Object Oriented Concepts** **Chapter 9.11, 9.12, 9.13, Chapter 11, 12.**	**Functions** (continued..)**:** Design issues for functions, user defined overloaded operators, co routines and Function closures.	17.8%	82.1%
20.		**Abstract Data types:** Abstractions and encapsulation, introduction to data abstraction, design issues.		
21.		Object oriented concepts.		
22.		Object oriented concepts. (Continued...)		
23.		Object oriented concepts. . (Continued...)		
24.	**Unit: V** **Exception Handling, Logic Programming and Functional Programming** **Chapter 13, 14, 15 and 16**	**Exception handling:** Exceptions, Specifications, Exception Propagation.	17.8%	100%
25.		**Logic Programming Language:** Introduction and overview of logic programming,		
26.		Basic elements of prolog, application of logic programming.		
27.		**Functional Programming Languages:** Introduction, fundamentals of FPL,		
28.		Application of Functional Programming Languages and exploration of the features.		
(Note: Each class is of 2 Hour duration.)				

Literature

Book Type	Code	Title & Author	Publication Information		
			Edition	Publisher	Year
Text Book	T1	Concepts of Programming Languages, Robert .W. Sebesta	10th	Pearson Education	2012
Reference Book	R1	Programming Language Pragmatics, Michael L. Scott	3rd	Elsevier	2009
	R2	Programming Languages Design and Implementation – Pratt and Zelkowitz	4th	PHI/Pearson Education	2001

UE18CS322: Big Data (4:0:0:0:4)

# of Hours: 56

Class #	Chapter Title/Reference Literature	Topics to be Covered	% of Portions Covered	
			Reference Chapter	Cumulative
1.	**Unit: I** **Introduction** **T1**	Big Data definition, Challenges and opportunities with Big Data	21.4%	**21.4%**
2.		Data intensive scientific discovery and the role of Big Data, History		
3.		Map Reduce – Storage (HDFS)		
4.		Map Reduce – Computation model, Map Reduce architecture,		
5.		Demo class: Map-Reduce – Hands on programming		
6.		Case Study: Google. YARN introduction.		
7.	**Unit: II** **Big Data Infrastructures for Compute/Storage** T2	Overview of Hadoop Ecosystem	21.4%	**42.8%**
8.		Introduction to sample Big Data Algorithms – matrix multiplication.		
9.		Introduction to sample Big Data Algorithms - Pagerank computations		
10.		Relational operators on Map-reduce,		
11.		HIVE with hands on		
12.		case study: Other storage - Hbase/Cassandra		
	Unit : III **In Memory Computation** T3	Issues with Hadoop, Spark and Scala	21.4%	**64.2%**
13.		PySpark programming model		
14.		Transformations and Actions, Spark SQL		
15.		Spark architecture – RDD, DataFrames, Wide and Narrow dependencies,		
16.		Complexity of Big Data algorithms – Communication Cost complexity model.		
17.		Spark HandsOn		
18.	**Unit : IV** **Streaming analysis** **T1,T2**	Streaming analytics use cases, Streaming Spark,	17.8%	**82.1%**
19.		Kafka – use cases, architecture		
20.		Streaming Algorithms - Sampling, set membership		
21.		Kafka with HandsOn		
22.		Streaming Algorithms - Bloom Filters, Counting Counting unique elements – Flajolet Martin Algorithm.		
23.	**Unit : V** **Advanced Analytics on Big Data**	Clustering Algorithms - kmeans and collaborative filtering	17.8%	**100%**
24.		Scaling Neural Networks for Big Data, case study MLLib.		
25.		Project Work		
26.		Project Work		
27.		Project Evaluations		
(Note: Each class is of 2 Hour duration.)				

Literature

Book Type	Code	Title & Author	Publication Information		
			Edition	Publisher	Year
Text Book	T1	Big Data Analytics, Rajkamal, Preeti Saxena,	1st	McGraw Hill Education	2019
	T2	Big Data Simplified, Sourabh Mukherjee, Amit Kumar Das, Sayan Goswami	1st	Pearson	2019
Reference Book/Papers	R1	Mining of Massive Datasets, Anand Rajaraman, Jure Leskovec, Jeffrey D. Ullman	2nd	Cambridge University Press	2014
	R2	Big Data Analytics Beyond Hadoop: Real-Time Applications with Storm, Spark, and More Hadoop Alternatives, Vijay Srinivasa Agneeswaran	1st	Pearson	2014
	R3	Hadoop: The Definitive Guide, Tom White	4th	O'Reilly	2009

UE18CS 324 – BLOCKCHAIN (4:0:0:0:4)

# of Hours: 56

Class #	Chapter Title / Reference Literature	Topics to be Covered	% of Portion covered	
			% of Syllabus	Cumulative %
1.	**Unit#1/ 1.1**	Blockchain Introduction	17.8	17.8
2.		Key Blockchain Concepts: Peer to Peer Network		
3.		Nodes		
4.		Cryptocurrency		
5.		Tokens		
6.		Public Ledger		
7.		Types of blockchain		
8.		Permissioned blockchain model		
9.		Permission-less blockchain model		
10.		Laboratory-1		
11.	**Unit#2/.1,2.2, 2.3,2.4,5.1**	Cryptography 1: Machines that encrypted data in the past	21.4	39.2
12.		Cryptography 2: Modern Cryptography		
13.		Digital Signature		
14.		Hash functions 1		
15.		Hash functions 2		
16.		Hash Pointer, Markle tree		
17.		Ledgers, Transactions and trade, public witness, Computers that witness		
18.		Distributed Consensus		
19.		Smart contract design		
20.		Bitcoin Blockchain Network		
21.				
22.		Laboratory-2		
23.	**Unit #3/3.1,3.2,3.3, 3.4,3.5,3.6,3.7**	Proof of Work	21.4	60.6
24.		Proof of Stake		
25.		Delegated Proof of Stake		
26.		Proof of Authority		
27.		Proof of Elapsed Time		
28.		Proof of Capacity, Proof of Burn		
29.		Proof of Space		
30.		RAFT		
31.		PAXOS		
32.		Byzantine Fault Tolerance System		
33.		PBFT		

		Laboratory-3		
35.	**Unit#4 / 5.1,5.2,5.3,5.4 (T1) 4.1,4.2,4.3,4.4 ,4.5,4.6(R1)**	Smart contracts: origins and how they function	21.4	82
36.		Creating and deploying smart contracts		
37.		Second generation tokens Decentralized applications		
38.		How are DApps constructed?		
39.		Decentralized Autonomous Organizations (DAOs)		
40.		Blockchain-as-a-service (BaaS),		
41.		Hyperledger fabric model 1		
42.		Architecture		
43.		Core components		
44.		Hyperledger Model		
45.		Bitcoin Versus Ethereum versus Hyperledger		
46.		Laboratory-4		
47.	**Unit #5/5.1,5.2,5.3, 5.4,9.1(R1)**	Blockchain vulnerabilities	17.8	100
48.		Smart contract vulnerabilities		
49.		Blockchain on CIA security triad: Confidentiality		
50.		Blockchain on CIA security triad: Integrity		
51.		Blockchain on CIA security triad: Availability		
52.		Blockchain based DNS security platform		
53.		Blockchain based DNS security platform		
54.		Deploying blockchain based DDOS protection		
55.		Deploying blockchain based DDOS protection		
56.		Deploying blockchain based DDOS protection		

Literature

Book Type	Code	Title & Author	Publication Information		
			Edition	Publisher	Year
Textbook	T	Introduction to Blockchain Technology by Tiana Laurence	1	Van Haren Publishing	2019
Reference Book	R1	Hands-On Cybersecurity with Blockchain: Implement DDoS protection, PKI-based identity, 2FA, and DNS security using Blockchain by Rajneesh Gupta	1	Packt Publishing	2018

	R2	Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" by Narayanan, Bonneau, Felten, Miller and Goldfeder,	-	Princeton Universi	2016

UE18CS325: WEB TECHNOLOGIES- II (4:0:0:0:4)

# of Hours: 56

Class #	Chapter Title/Reference Literature	Topics to be Covered	% of Portions Covered	
			% of Syllabus	Cumulative %
1.	**Unit #1** T1: Chapter 2 R1 : Chapter 5	Javascript Objects, Object Oriented Concepts	**17.85%**	**17.85%**
2.		Prototypal Inheritance		
3.		Hidden Frames Technique - GET		
4.		Hidden Frames Technique - POST		
5.		Image-based AJAX,JSON vs XML		
6.		XMLHttpRequest Object		
7.		XMLHttpRequest Object		
8.		Fetching binary data with XHR		
9.		Maintaining history in AJAX calls		
10.		Cross-domain access (CORS)		
11.	**Unit #2** T1: Chapters 3,6,7,8	Introduction to Ajax patterns, Predictive Fetch	**21.42%**	**39.27%**
12.		Multi-Stage Download		
13.		Periodic Refresh and Fallback Patterns		
14.		Periodic Refresh and Fallback Patterns		
15.		Submission Throttling		
16.		Submission Throttling		
17.		Comet Techniques, Long Polling		
18.		HTTP Streaming		
19.		Server Sent Events		
20.		Server Sent Events		
21.		Principles of REST		
22.		SOAP Based Services		
23.	**Unit #3** T2: Chapters 2,3,4	Introduction , HTTP methods and Verbs, NodeJS process and child process	**21.42%**	**60.69%**
24.		buffers, streams, File system		
25.		timers, events, call backs		
26.		query string, TLS/SSL and web module		
27.		Leveraging with Express REST API's		
28.		Express Installation and Server setup, Building the application stack		
29.		Routing, List API, Create API		
30.		Error Handling		
31.		Express Scaffolding		
32.		Templates		
33.		Cookies & File Upload		
34.		Cookies & File Upload		
35.	**Unit #4** T2: Chapters 5,6	Introduction to MVC	**21.42%**	**82.11%**
36.		Typescript basics		
37.		Introduction to Angular		
38.		Modules, Components		
39.		Component Lifecycle		
40.		Angular forms		
41.		Controls and Validations		
42.		Template and Views		
43.		Component metadata		
44.		Data binding		
45.		Directives, Pipes		
46.		Services and Dependency Injection		

47.	**Unit #5** R1 – Chapter 6	Performance Considerations - Timeouts, Retries, Handling Server Errors,	**17.85%**	**100%**
48.		Multiple Requests, The HTTP 1.1 Two Connection Limit		
49.		Caching on Client Side		
50.		Compression of Data		
51.		HTTP 2.0 – New Features, HTTP 2.0 vs 1.1.		
52.		Various Vulnerabilities and Precautions,		
53.		SQL Injection		
54.		XSS		
55.		CSRF		
56.		Guest Lecture		

Literature

Book Type	**Code**	**Title & Author**	**Publication Information**		
			Edition	**Publisher**	**Year**
Text Book	T1	"Professional AJAX", Nicholas C. Zakas et. al	2nd	Wiley Publishing	2007
Text Book	T2	[illegible]	2nd	Addison-Wesley Professional	11 October 2017
Reference Book	R1	Web Application Security, A Beginner's Guide by by Bryan Sullivan and Vincent Liu	1st	McGraw Hill Education	10th January 2012