B.Tech (Computer Science and Engineering) -2019 Model Scheme

SEMESTER I

S.N.	Course Code	Courses	L	T	P	Credit
1	EN3BS01	Engineering Mathematics-I	3	1	0	4
2	EN3BS05	Engineering Physics	3	1	2	5
3	EN3ES01	Basic Civil Engineering	3	0	2	4
4	EN3ES03	Basic Mechanical Engineering	3	1	2	5
5	EN3ES05	Basic Computer Engineering	3	0	0	3
6	EN3ES07	Documentation and Presentation	0	0	2	1
7	EN3HS01	History of Science & Tech.	2	0	0	2
8	EN3HS03	Environmental Sciences	2	0	0	2
		Total	19	3	8	26
		Total Contact Hours	30			

SEMESTER II

S.N.	Course Code	Courses	L	T	P	Credit
1	EN3BS02	Engineering Mathematics-II	3	1	0	4
2	EN3BS04	Engineering Chemistry	3	0	2	4
3	EN3ES02	Engineering Graphics	3	0	2	4
4	EN3ES04	Basic Electrical & Electronics Engineering	3	1	2	5
5	EN3ES06	Computer Programming	2	0	2	3
6	EN3ES08	Engineering Workshop	0	0	2	1
7	EN3HS02	Communication Skills	2	0	2	3
		Total	16	2	12	24
		Total Contact Hours	30			

SEMESTER – III

S.N.	Course Code	Courses	L	T	P	Credit
1	CS3BS03	Discrete Mathematics	3	1	0	4
2	CS3CO23	Object Oriented Programming	3	1	2	5
3	CS3CO21	Data Structures	3	1	2	5
4	CS3CO22	Computer System Architecture	3	1	2	5
5	CS3CO29	Digital Electronics	3	1	2	5
6	EN3MC09	Soft Skills-II	2	0	0	0
		Total	17	5	8	24
		Total Contact Hours	30			

SEMESTER – IV

S.N.	Course Code	Courses	L	T	P	Credit
1	CS3EXXX	Elective-1	3	0	0	3
2	CS3CO10	Theory of Computation	3	1	0	4
3	CS3CO28	Data Communication	3	0	0	3
4	CS3CO25	Database Management Systems	3	1	2	5
5	CS3CO08	Computer Programming - II	2	0	2	3
6	CS3CO09	Operating Systems	3	1	2	5
7	CS3ES12	Software Workshop-I	0	0	2	1
8	EN3MC01	Open Learning Courses	1	0	0	0
		Total	18	3	8	24
		Total Contact Hours	29			

SEMESTER – V

S.N.	Course Code	Courses	L	T	P	Credit
1	CS3CO24	Computer Graphics & Multimedia	3	1	2	5
2	CS3CO26	Software Engineering	3	1	2	5
3	CS3CO12	Computer Networks	3	1	2	5
4	OE000XX	Open Elective-1	3	0	0	3
5	CS3EXXX	Elective-2	3	0	0	3
6	EN3MC15	Universal Human Values & Professional Ethics	2	0	0	0
7	EN3MC10	Soft Skills-III	2	0	0	0
8	CS3ES13	Software Worshop-II	0	0	2	1
		Total	19	3	8	22
		Total Contact Hours	30			

SEMESTER – VI

S.N.	Course Code	Courses	L	T	P	Credit
1	CS3CO13	Design and Analysis of Algorithms	3	1	2	5
2	CS3CO15	Object Oriented Analysis and Design	3	1	2	5
3	CS3CO27	Compiler Design	3	0	2	4
4	CS3EXXX	Elective-3	3	0	0	3
5	CS3EXXX	Elective-4	3	0	0	3
6	CS3ES14	Software Workshop-III	0	0	2	1
7	OE000XX	Open Elective-2	3	0	0	3
		Total	18	2	8	24
		Total Contact Hours	28			

SEMESTER – VII

S.N.	Course Code	Courses	L	T	P	Credit
1	CS3EXXX	Elective-5	3	0	0	3
2	CS3EXXX	Elective-6	3	0	0	3
3	OE000XX	Open Elective-3	3	0	0	3
4	EN3HS04	Fundamentals of Mgmt, Economics & Accountancy	3	0	0	3
5	CS3PC01	Project Work I	0	0	8	4
6	CS3PC03	Industrial Training	0	2	0	2
		Total	12	2	8	18
		Total Contact Hours	22			

SEMESTER VIII

S.N.	Course Code	Courses	L	T	P	Credit
1	CS3PC02	Project Work II	0	0	28	14
		Total	0	0	28	14
		Total Contact Hours	28			

List of Program Electives

Web Technology Track

S. N.	Course Code	Courses	L	T	P	Credit
1	CS3EL03	Information Storage & Mgmt	3	0	0	3
2	CS3EL04	Distributed Systems	3	0	0	3
3	CS3EL05	Ad-Hoc Networks	3	0	0	3
4	CS3EL06	Internet of Things	3	0	0	3
5	CS3EL07	High Speed Networks	3	0	0	3
6	CS3EL08	Programming with XML	3	0	0	3
7	CS3EL09	Information Retrieval and Extraction	3	0	0	3
8	CS3EL10	Cloud Computing	3	0	0	3
10	CS3EW01	Internet and Web Technology	3	0	0	3
11	CS3EW02	Semantic Web Ontology	3	0	0	3
12	CS3EW03	Web Mining	3	0	0	3

Cloud Technology and Information Security (Inurture)

S. N.	Course Code	Courses	L	T	P	Credit
1	CS3EY01	Introdcution to Cloud Computing	3	0	0	3
2	CS3EY02	Cryptography	3	0	0	3
3	CS3EY04	Principles of Virtualization	3	0	0	3
4	CS3EY05	Ethical Hacking	3	0	0	3
5	CS3EY07	Cyber Forensics & Investigation	3	0	0	3
6	CS3EY09	Infrastructure Solutions on Cloud(Azure)	3	0	0	3
7	CS3EY10	Incident Response Management	3	0	0	3
8	CS3EY11	Fundamental of Storage and Data Centre	3	0	0	3
9	CS3EY12	Cloud Scripting using PaaS	3	0	0	3
10	CS3EY13	Application Security	3	0	0	3
11	CS3EY14	Server Security	3	0	0	3
12	CS3EY15	COBIT VALIT RISKIT	3	0	0	3
13	CS3EY16	IT Governance , Risks and Information Security Mgmt.	3	0	0	3

List of Open Electives

S. N.	Course Code	Courses	L	T	P	Credit
1	OE00015	Agile Development	3	0	0	3
2	OE00016	Blockchain Architecture	3	0	0	3
3	OE00017	Virtualization	3	0	0	3
4	OE00018	Python Essentials	3	0	0	3
5	OE00019	Biometrics	3	0	0	3
6	OE00020	ICT in Practice	3	0	0	3
7	OE00056	Cloud Security	3	0	0	3
8	OE00051	R Programming	3	0	0	3
9	OE00071	Server Administration	3	0	0	3
10	OE00072	Introduction to Data Science	3	0	0	3
11	OE00073	Cyber Security Fundamentals	3	0	0	3
12	OE00074	Cloud Web Services	3	0	0	3
13	OE00075	Exploratory Data Analytics	3	0	0	3
14	CS3EY06	Database Security	3	0	0	3
15	CS3ET08	Artificial Neural Networks	3	0	0	3

Artificial Intelligence Track

S. N.	Course Code	Courses	L	T	P	Credit
1	CS3EA01	Artificial Intelligence	3	0	0	3
2	CS3EA02	Digital Image Processing	3	0	0	3
3	CS3EA03	Soft Computing	3	0	0	3
4	CS3EA04	Pattern Recognition	3	0	0	3
5	CS3EA05	Evolutionary Algorithm	3	0	0	3
6	CS3EA06	Natural Language Processing	3	0	0	3
7	CS3EA07	Machine Learning	3	0	0	3
8	CS3EA08	Introduction to Cognitive Science	3	0	0	3
9	CS3EA09	Graph Theory	3	0	0	3

Data Science(Inurture)

S. N.	Course Code	Courses	L	T	P	Credit
1	CS3ET01	Statistics and Probability	3	0	0	3
2	CS3ET02	Statisticals Inference	3	0	0	3
3	CS3ET05	Big Data Analytics	3	0	0	3
4	CS3ET06	No SQL Databases	3	0	0	3
5	CS3ET07	Machine Learning	3	0	0	3
6	CS3ET09	Real Time Data Processing	3	0	0	3
7	CS3ET10	Visualization Techniques	3	0	0	3
8	CS3ET11	Deep Learning	3	0	0	3
9	CS3ET12	Reinforcement Learning	3	0	0	3
10	CS3ET13	Pattern Recognition	3	0	0	3
11	CS3ET14	Securiry and Privacy for Data Science	3	0	0	3
12	CS3ET15	Natural Language Processing	3	0	0	3
13	CS3ET16	Probabilistic Graphical Models	3	0	0	3
14	CS3ET17	Multivariate Statistical Analysis	3	0	0	3

Data Engineering Track

S. N.	Course Code	Courses	L	T	P	Credit
1	CS3ED01	Database Application &Tools	3	0	0	3
2	CS3ED02	Data Mining and Warehousing	3	0	0	3
3	CS3ED03	Data Visualization	3	0	0	3
4	CS3ED04	Big Data Engineering	3	0	0	3
5	CS3ED05	Simulation and Modeling	3	0	0	3
6	CS3ED06	Data Science	3	0	0	3
7	CS3EL09	Information Storage and Management	3	0	0	3
8	CS3EL10	Cloud Computing	3	0	0	3

Nature of Course	Code
Basic Science	BS
Engineering Science	ES
Humanities & Science	HS
Core	CO
Mandatory Core	MC
Project Work	PC
Program Elective	Ex
Open Elective	OE

Semsterwise Credit for B.Tech: Computer Science & Engineering

Nature of Course	Credits to be earned (As per Choice Based Credit System)								Total
	Semesters								
	I	II	III	IV	V	VI	VII	VIII	
Basic Science	9	8	4	0	0	0	0	0	21
Engineering Science	13	13	0	1	1	1	0	0	29
Humanities & Science	4	3	0	0	0	0	0	3	10
Core	0	0	20	20	15	14	0	0	69
Mandatory Core	0	0	2 Units	1 Unit	4 units	0	0	0	7 Units
Project Work	0	0	0	0	0	0	6	14	20
Program Elective	0	0	0	3	3	6	6	0	18
Open Elective	0	0	0	0	3	3	3	0	9
Total									176

B.Tech Computer Science and Engineering program is designed to offer industry oriented courses. Various tracks of elctives provides specialization in relative field. Following are the tracks of electives:

I. Artificial Intelligence

II. Data Engineering

III. Web Technology

IV. Cloud Computing and Information Security in collabaration with inurture

V. Data Science in collobaration with inurtute

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
CS3BS03	Discrete Mathematics	3	1	0	4

UNIT-I
Sets, sub-sets & operations on sets, Finite and infinite sets, principle of inclusion and exclusion Relations & Properties of relations – equivalence relation, Functions: Definition, Classification of functions, Composition of functions, Growth of Functions, Pigeon hole principle.

UNIT-II
Partial order relation, Poset, least upper bound, greatest lower bound, maximal and minimal elements of a poset – Definition & example of Boolean algebra – Lattices, Distributive laws in lattices – Complemented lattices – Propositional Calculus – Boolean functions, minimum & maximum terms, simplification of Boolean function with Karnaugh map & Quiane Mc Clusky method. Applications in computer Science.

UNIT-III
Binary composition, algebraic structure, Semi group, Monoid, Groups, Abelian Group, properties of groups, Coset Decomposition, Subgroup, Cyclic Group, Normal subgroup, Rings and Fields (definition and standard results). Applications in Computer Science.

UNIT-IV
Trees : Definition , Binary tree , Binary tree traversal , Binary search tree. .Graphs: Definition and terminology , Representation of graphs , Multigraphs , Bipartite graphs , Planar graphs , Isomorphism and Homeomorphism of graphs , Euler and Hamiltonian paths , Graph coloring. Application in Computer Science.

UNIT – V
Recurrence Relation & Generating function: Recursive definition of functions, Recursive algorithms, Method of solving recurrence relation. Combinatorics: Introduction, Counting Techniques -Basic theorems on permutations & combinations. Applications in Computer Science.

TEXT BOOKS

1. Liu and Mohapatra, Elements of Distcrete Mathematics   , McGraw Hill
2. Jean Paul Trembley, R Manohar, Discrete Mathematical Structures with Application to Computer Science, McGraw-Hill
3. R.P. Grimaldi, Discrete and Combinatorial Mathematics, Addison Wesley, Kenneth H. Rosen, Discrete Mathematics and Its Applications, McGraw-Hill,
4. B. Kolman, R.C. Busby, and S.C. Ross, Discrete Mathematical Structures, PHI

REFERENCES

1. Rings, Fields and Groups: An Introduction to Abstract Algebra (2nd Ed): Reg Allenby
2. First look at graph theory (1st Ed): John Clark & Derek Allan Holton, Allied Publishers
3. Elements of Discrete Mathematics (1st Ed): L CL Liu, McGraw-Hill
4. Discrete Computational Structures (2nd Ed): Robert R. Korfhage , Academic Press

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
CS3CO23	Object Oriented Programming	3	1	2	5

Unit-I

Introduction to object oriented programming, Characteristics, Applications, difference between object oriented and procedure based programming, object oriented programming languages, Object oriented concepts: Abstraction, Encapsulation, Polymorphism, Inheritance and Information Hiding.

Unit-II

Abstract data types, Objects and classes, Attributes and Methods, Objects as software units, Encapsulation and Information hiding, Objects instantiations and interactions, Object lifetime, Static and dynamic objects, global and local objects, Metaclass

Unit-III

Relationships between classes, Association of objects, Types of Association, Recursive Association, Multiplicities, Navigability, Named association, Aggregation of objects. Types of Aggregation, Delegation, Modeling Association and Aggregation.

Unit-IV

Inheritance and Polymorphism, Types of polymorphism, Static and dynamic polymorphism, Operator and Method overloading, Inherited methods, Redefined methods, the protected interface, Abstract methods and classes, Public and protected properties, Private operations, Disinheritance, Multiple inheritance.

Unit-V

Template Classes and Functions, Container Classes, Container types, typical functions and iterator methods, Heterogeneous containers, Persistent objects, stream, and files, Object oriented programming languages.

Text Books:
1. David Parsons; Object oriented programming with C++; BPB publication
2. Robert Lafore, Object-oriented programming in Turbo C++, Galgotia Publication.
3. E. Balaguruswami, "Object Oriented Programming in C++", TMH.
4. Scott W Amber, The Object Primer , 3/e, Cambridge 2004.
5. Timothy Budd, Object Oriented Programming, 3/e, Pearson Education 2002.

Reference Books:
1. Schildt H., Teach Yourself C++, Tata McGraw Hill.
2. Hubbard J. R., Schaum's Outline of Programming with C++, McGraw Hill.

List of Experiments:

1. Write a program to find out the largest number using function.
2. Write a program to find the area of circle, rectangle and triangle using function overloading.
3. Write a program to implement complex numbers using operator overloading and type conversion.
4. Write a program using class and object to print bio-data of the students.
5. Write a program which defines a class with constructor and destructor which will count number of object created and destroyed.
6. Write a program to implement single and multiple inheritances taking student as the sample base class.
7. Write a program to add two private data members using friend function.
8. Write a program using dynamic memory allocation to perform 2x2 matrix addition and subtraction.
9. Write a program to create a stack using virtual function.
10. Write a program that store five student records in a file.
11. Write a program to get IP address of the system.
12. Write a program to shut down the computer system.

| Course Code | Course Name | Hours per Week | | | |
		L	T	P	Credits
CS3CO21	Data Structures	3	1	2	5

Unit I
Definitions and Types of Data Structures, Concept of Linear and Non Linear, Static and Dynamic, Primitive and Non Primitive, Persistent and Non Persistent Data structure, Overview of array, one dimensional array and multidimensional array, Pointers, Recursive functions

Unit II
Concept of Linked List organization, Singly List, Doubly List, Circular list and doubly circular Linked List Operations: Linked list implementation of stack and queue, Applications of Linked List data structure

Unit III
Stack, Primitive Stack operations, Array Implementation of Stack, Multiple Stack, Application of stack: Prefix and Postfix Expressions, Evaluation of postfix expression, Recursion, Tower of Hanoi Problem, Queue, Overview of Queue, Operations on Queue, Circular Queues, Array implementation of Queues, Dequeue and Priority Queue

Unit IV
Searching and Sorting, Sequential search, Binary Search, Internal and external Sort **,** Bubble Sort, Selection Sort, Insertion Sort, Shell Sort, Radix Sort, Quick Sort and Merge Sort. Hashing: Hash Function, Collision Resolution Strategies, Storage Management: Garbage Collection and Compaction

Unit V
Trees, Basic terminology, Binary Trees, Binary Tree Representation, Complete Binary Tree, Algebraic Expressions, Extended Binary Trees, Array and Linked Representation of Binary trees, Tree Traversal, Threaded Binary trees, AVL tree, Heaps

Graphs, Basic terminology and types of Graph, Representations of Graphs, Graph Traversal

Text Books:
1. Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft. Data Structures and Algorithms
2. Tenebaum, Langsam & Augenstein, Data Structures Using C, Pearson
3. Debasis Samanta, Classic Data Structures, PHI learning

References:
1. Horowitz and Sahani, "Fundamentals of data Structures", University Press
2. Trembley and Sorenson , "Data Structures", TMH Publications
3. Venkatesan , Rose, "Data Structures" Wiley India Pvt.Ltd
4. Seymour Lipschutz, Data Structures, Schaum's Outlines Series, TMH

NPTEL *Reference:*

1. http://nptel.ac.in/courses/106102064/
2. http://nptel.ac.in/courses/106106133/
3. http://nptel.ac.in/courses/106106127/

Tentative List of Programs:

1. Write the algorithm and program for matrix multiplication of n x n.
2. Write the algorithm and program to Copy Elements of Array in another Array.
3. Write the algorithm and program to insert, delete and search an element in an Array.
4. Write the algorithm and program using pointers to read in an array of integers and print its elements in reverse order.
5. Write the algorithm and program to implement Stack and perform PUSH and POP Operation.
6. Write the algorithm and program to reverse the string using stack.
7. Write the algorithm and program to implement circular queue through array.
8. Write the algorithm and program to insert and delete an element into the Queue.
9. Write the algorithm and program to implement Singly Linked List and Doubly Link List.
10. Write the algorithm and program to sort N numbers in ascending order using
    a. Bubble sort
    b. Insertion sort
    c. Selection sort
    d. Quick sort
    e. Merge sort
    f. Radix Sort

11. Write the algorithm for implementing trees and its operations.
12. Write the algorithm and program to represent graphs and its traversal.
13. Write the program to implement travelling salesperson problem.
14. Think of solving a 2x2x2 Rubik's Cube.
15. Make a list of cities close to Indore for a pilgrimage trip and assign the distances between the cities. Make a travel plan to cover these cities in minimum distance.
16. Make a study of keeping the library cards of issued books in the library. How do we define the data structure for it and its efficiency to find the card in minimum time.

Course Code	Course Name	Hours per Week			Credits
		L	**T**	**P**	
CS3CO22	Computer System Architecture	3	1	2	5

Unit- I:
Difference Between Computer Organization and Computer Architecture, Computer Types, Functional Units, Basic Operational Concepts: Bus Structures, Generation of computer, Introduction to computer operation with a simple 8bit -instruction computer illustrating assembly and machine language. Register Transfer language. Register Transfer Bus and memory transfers, Arithmetic Microoperations, logic micro operations, shift micro operations, Arithmetic logic shift unit.

Unit-II:
Instruction codes, Registers, Buses, Design of computer Instructions, Timing and control, Instruction Cycle, Memory-Reference Instructions, Input-Output Interrupt, Design of Basic Computer, Accumulator logic. Programming the basic Computer-Machine Language, Assembly Language, Assembler. Address Sequencing, Microprogram Instructions Format, Addressing Modes.

Unit- III:
Computer Arithmetic- Addition and Subtraction with signed magnitude, Multiplication and Division Algorithms, Divide Overflow Booth Multiplication Algorithm, Hardware implementation for signed - Magnitude and hardware algorithms.

UNIT-IV:
Input -Output Organization. Input-Output Interface, Synchronous vs Asynchronous Data Transfer, Modes of Transfer- Interrupt and its Priority, DMA. Memory Hierarchy- Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management Hardware.

Unit-V
Flynn's Classification, RISC and CISC Processor, Pipelining and Vector Processing, Parallel Processing, Array processor, Multiprocessor Architectures Organization, Multi-core Architectures, Inter-processor Communication, System-on-Chips.

Text Books:
1. Computer System Architecture-M.Morris Mano- Pearson Education III Edition.
2. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization, McGraw-Hill.
3. William Stallings, Computer Organization and Architecture – Designing for Performance, Pearson Education.

Problem and Assignments Book:
1. Nicholas Carter and Raj Kamal, Computer Architecture and Organization, 2nd Edition, Schaum Outlines, Tata McGraw-Hill Ed., Second Edition.

Reference Books:
1. John P.Hayes, Computer Architecture and Organization, McGraw Hill, 3rd Edition.
2. David A.Patterson and John L.Hennessy, Computer Organization and Design: The hardware software interface, Morgan Kaufmann, 3rd Edition.

Web Resources
- http://www.cs.mcgill.ca/~mhawke1/cs208/02a-ComputerStructureNotes.pdf
- http://www.stat.auckland.ac.nz/~dscott/782/Computers.pdf
- *www-csag.ucsd.edu/teaching/cse141-w00/lectures/Introduction.pdf* –
- www.cise.ufl.edu/~prabhat/Teaching/cda5155-su09/lecture.html
- *www.ecl.incheon.ac.kr/courses/ca6/ca00.syllabus.pdf*

List of Practical

1. Hardware configuration of Desktop-case, Power Supply, Motherboard- Processor, Memory, Drive Controllers, Monitor, Keyboard, Mouse, Dismantling and assembly of Desktops.
2. Detailed study of motherboard-Memory Slot, RAM, Expansion Slot, CPU Socket, Processor, Heat Sink, Processor FAN, SATA Connectors, North Bridge and South Bridge chip, ROM BIOS, CMOS Battery, I/O Controller, Chipsets, FDD Header, IDE Header, AGP Slot, PCI Slot,
3. Types of RAM-SDR, DDR-1, DDR-2, DDR-3, DDR-4. Expansion Slot,
4. Instructions of 8085 microprocessor, Address, opcode, operand, Hex code.
5. Simulation of ALU using C/C++.
6. a)Write a program using 8085 microprocessor assembly language for decimal, hexadecimal addition and subtraction of two number. Store the result at memory location XXXX.
   b) Write a program using 8085 microprocessor assembly language to find the largest no in a given array. Store the result at memory location XXXX.
   c) Write a program using 8085 microprocessor assembly language to find the smallest no. in a given array. Store the result at memory location XXXX.
7. a)Write a program using 8085 microprocessor assembly language to arrange the given array in ascending and descending order.
   b) Write a program using 8085 microprocessor assembly language to find no. of 1's in given data byte. Store the result at memory location XXXX.
   8. a)Write a program using 8085 microprocessor assembly language to calculate the sum of series of even number. Store the result at memory location XXXX.
   b) Write a program using 8085 microprocessor assembly language to convert binary to ASCII Hex code. Store the result at memory location XXXX and XXXX+1 location.
   c) Write a program using 8085 microprocessor assembly language to multiply two 8 bit numbers and Store the result at memory location XXXX and XXXX+1 location.
   9. a) Write a program using 8085 microprocessor assembly language to add and subtract numbers in BCD. Store the result at memory location XXXX and XXXX+1 location.
   b) Write a program using 8085 microprocessor assembly language to divide and multiply 16 bit no. Store the result at memory location XXXX and XXXX+1 location.
   10. Write a program to Implement Booth's Multiplication Algorithm for Multiplication of 2 signed Numbers in C/C++.

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
CS3CO29	Digital Electronics	3	1	2	5

Unit-I: Number System Introduction to binary numbers, data representation, binary, octal, hexadecimal number system and their conversion, various coding schemes such as BCD codes, Excess-3 code, Gray code. Binary arithmetic, Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Boolean Functions, Canonical and Standard forms, minimization techniques, Sum of products and Product of Sums Simplification, Karnaugh's map method, Quine Mecluskey method.

Unit-II: Logic Gates and Combinational Logic
Digital Logic Gates such as AND,OR, NAND,NOR, EX-OR,EX-NOR. Realization of Boolean functions using logic gates. Adders, substractors, BCD adder, magnitude comparator, decoders and encoders, multiplexers and demultiplers, code converters. Analysis and design of combinational circuits. Implementation of combinational logic using multiplexers, decoders etc.

Unit-III: Sequential Circuits
Introduction, comparison of sequential and combinational circuits. Various types of flip-flops and their conversions, triggering of flip flops, timing issues, setup and hold times, registers, counters, ring, johnson, asynchronous and synchronous. Finite state machines, Moore and Mealy, design of synchronous sequential circuits.

Unit-IV: Memories
ROM, PLA and PAL. Memories: organisation and construction of RAM, SRAM, DRAM, ROM, PROM, EPROM, EEPROM.

Unit-V Logic Families
DTL, RTL, TTL, IIL, PMOS, NMOS and CMOS logic families, interfacing between TTL and MOS vice-versa.

Text Books:
1. D Roy Chudhury, Digital Circuits,Vol-I & II, Eureka Publication.
2. M. Mano, Digital and Computer Design, Pearson Education.

Reference Books:
1. Leach and Malvino, Digital Principles and Applications, TMH.
2. Millman and Taub, Pulse, Digital and Switching Waveforms, MGM.
3. A. Anand Kumar: Digital Circuits, PHI.
4. Salivahanam and Ari Vahagan: Digital Circuits and Design, Vikas Publishing House.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3MC09	Soft Skills-II	2	0	0	0

UNIT 1

Body Language and professionalism: To make participants aware of the importance of Body language trains them to project a better outlook of themselves. This helps in presenting themselves in Personal interview and Group discussions. Grooming and presenting oneself are the main focus. Interview dress code, facial expressions, body language, hand shake etiquettes etc., are dealt in the session. Worksheets, anecdotes, videos and role-plays are some of the important components of the session.

Interpersonal skills: Effective interpersonal skills are crucial to increase employment opportunities and to compete in the business environment. This session makes the participants understand different barriers to proper interpersonal communication and to tackle them head-on. Activities are an integral component of the session.

Reporter: The aim of the session is to make every student ask rational questions and make diplomatic replies. The session is a press- meet like group activity session.

UNIT 2

Team Building: • To make every student intermingle within a team and contribute to the team's success. To make them understand the importance of working as a team. Importance of complimentary skill sets, and synergy effects of a team are proved using real-life examples and classroom activities.

Picture connector: To make the students participate in group interactions, create dialogue and present on the stage. Students link various pictures from newspaper to come up with a pictorial representation of a story or idea and narrate/present the same. Creativity and presentation skills are concentrated. Students also learn to connect various variables and come up with concrete ideas.

UNIT 3

Time and work: Work with different efficiencies, Pipes and cisterns, Work equivalence, Division of wages

Goal Setting: • To make students goal oriented and to help them realise and sketch their personal and professional goals. SMART goal technique for goal setting is taught and explained using examples. Students will be encouraged to set a personal and career goal based on the SMART technique. Tactics to deal with hurdles for attaining the goals are dealt. Famous goal setting success stories are shared to boost confidence.

UNIT 4

Time Management: To make students understand the value of time and effective management of their time. Paper tower activity helps students practically experience the importance of managing time and to improve at it. Time management grid helps students understand the importance of prioritizing.

Tourism pitch: The session makes students present and promotes their choice of tourist spot or their favourite city in order to convince the client (trainer) to visit the city. Presentation skills are enhanced. Teamwork is practised during the preparation phase of the activity.

UNIT 5

Shopping role play: To enable students to frame dialogues for their day-to-day life scenarios. A shopping scenario has to be mimicked by the students with impromptu conversation. This helps them in practising speaking in English in their daily conversations. Sample everyday conversations are presented for practical learning.

Shipwreck: The main objective of this is to enhance the skill capacity of the students to think out of the box and try to enhance the cognitive thinking capability.

Play teacher: The session makes students understand the different values and virtues like empathy-by which they will try to enact the scenario given to them try solving the problem like an adviser.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3CO10	Theory of Computation	3	1	0	4

Prerequisite:
Students should have a background in discrete mathematics, data structures, and programming languages.

COURSE CONTENTS

Unit-I: Finite Automata and Regular Languages
Motivation for studying theory of computation, Notion of formal languages and grammars, Kleene's Closure, Regular Expressions and Regular languages, closure properties of regular languages, Finite Automata. Finite Automata with output: Mealy and Moore machines, applications.

Unit-II: Nondeterminism and Minimization
Nondeterministic Finite Automata, Acceptance condition. Kleene's Theorem, Myhill-Nerode relations, Minimization Algorithm, Non-Regular languages, Pumping Lemma for regular languages.

Unit-III: Grammars and Context-Free Languages
Grammars and Chomsky Hierarchy, Context-Free Grammars, Context-Free Languages (CFLs), Inherent Ambiguity of CFLs, closure properties of CFLs, Eliminating useless symbols; null-productions; and unit productions, Chomsky Normal Form, Greibach Normal Form, Cock-Younger-Kasami(CYK) Algorithm, Applications to Parsing.

Unit-IV: Pushdown Automata
Pushdown Automata (PDAs), PDAs vs CFLs. Deterministic PDAs and CFLs, applications, notion of acceptance for PDAs: acceptance by final states, and by empty stack; the equivalence of the two notions, Proof that CFGs generate the same class of languages that PDAs accept, Pumping Lemma for CFLs.

Unit-V: Turing Machines and Computability
Introduction to Turing Machines, Configurations, Halting vs Looping, Turing computability, Nondeterministic, multitape and other versions of Turing machines. Church`s thesis, Universal Turing Machines, Linear Bounded Automata (LBAs) and context-sensitive languages, Recursive and Recursively enumerable languages, Undecidability of Halting Problem and unsolvable problems about Turing Machines, the diagonalization language and proof that it is not Recursively enumerable.

Text Books:
1. Peter Linz, An Introduction to Formal Languages and Automata, Jones & Bartlett Learning, Canada.
2. John C. Martin, Introduction to Languages and the Theory of Computation, Tata McGrawHill.

Reference Books:
1. J.E. Hopcroft, Rajeev Motwani and J.D.Ullman, Introduction to Automata, Languages and '
   Computation, Pearson Education, Asia.
2. Daniel I.A. Cohen, Introduction to Computer Theory, John Wiley.
3. H.R. Lewis and C.H.Papadimitrou, Elements of the Theory of Computation, Prentice Hall Inc.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3CO28	Data Communication	3	0	0	3

UNIT-I:
Introduction to digital communications, Components, Data Representation, Data Flow. Analog and Digital Signals and their representation, Transmission Impairment, Data Rate Limits- Nyquist's theorem, Shannon's theorem, Signal propagation, Signal types, Transmission mode and techniques, Transmission Media-Guided and Non-Guided, Noise.

UNIT-II:-
Encoding of Signals -Analog to Digital Conversion, Digital to Digital conversion, - Unipolar, Polar, Bipolar line & block codes, Digital to Analog, Analog to Analog conversion, Spread Spectrum-FHSS, DHSS, CDMA. Modulation and Demodulation of Signals. Multiplexing: FDM, TDM, and WDM, QAM.
 Data compression-Frequency dependant codes, Run length encoding, Relative encoding, LZ Compression.

UNIT-III
Switched Communication Networks: Circuit, Message, Packet & Hybrid Switching, Data Gram Network, Connection oriented services Vs Connectionless services. Public Switching Telephone Network, Digital Subscriber Line, ADSL, HDSL, SDSL, VDSL. Study of various types of topology and their comparative study.

UNIT-IV
Reference model- OSI and TCP/IP model and its comparison, Layers in the model and its requirement, critiques of OSI and TCP/IP model, Use of Computer Networks. Architecture of Internet. Addressing-Physical, Logical, Port. Various Networking devices, Peer to Peer Protocols and service model.

UNIIT-V
Data Link Layer:-Transmission Errors : Content Error ,Error detection & Error correction ,Bit error rate , Error detection methods: Parity checking , Checksum Error Detection ,CRC ,Hamming code . Framing, Flow error Control - ARQ, Sliding Window Protocol, HDLC and PPP. L-2 Switches, Bridges.

Text Book:
1. Andrew S.Tannenbaum, Computer Networks, Pearson Education.
2. William Stallings, Data and Computer Communication, Pearson Education.
3. Behrouz A.Fourouzan, Data Communication and Networking, Mc Graw Hill Publication.
4. Alberto Leon-Garcia, Indra Widjaja, Communication Networks-Fundamental concepts and key Architecture, TMH.

Reference Books:
1. Aftab Ahmad, Data Communication Principles for fixed and wireless networks, Kluwer Academic Publishers.
2. Gilbert Held, Data Communications Networking Devices:-Operation, Utilization, Lan and Wan Interworking, John Wiley and Sons.

Course Code	Course Name	Hours per Week			Credit
		L	T	P	
CS3CO25	Database Management System	3	1	2	5

Unit I
Basic Concepts: Data Vs Information, Definition of Database, Advantages of Database Systems, Components of DBMS, DBMS Architecture and Data Independence, Data modeling, Entity Relationship Model, Relational, Network, Hierarchical and Object Oriented Models. Data Modeling Using The Entity Relationship Model.

Unit II
Relational Database: Relational Databases, Relational Algebra, Relational Algebra Operation, Tuple Relational Calculus, Domain Relational Calculus. Data Definition with SQL, Inserts, Delete and Update Statements in SQL, Views, Data Manipulation with SQL, PL/ SQL constructs: Triggers, Cursors etc.

Unit III
Database Design: Design Guidelines, Key concepts, Relational Database Design, Integrity Constraints, Domain Constraints, Referential Integrity, Functional Dependency, decomposition, Normalization Using Functional Dependencies: Normal Forms, First, Second and Third Normal Forms. Boyce Codd Normal Form, Multivalued Dependencies and Forth Normal Form, Join Dependencies and Fifth Normal Form, Decomosition in 2NF, 3NF and BCNF.

Unit IV
Database Transactions Processing: Introduction to Transaction Processing, Transaction Concepts, Desirable Properties of Transactions, Schedules, Concepts of Recoverability and Serializability, Concurrency control: introduction, locking protocols.

Unit V
Query Processing and Optimization, File organization and indexes, hashing techniques, B tree, B+ tree etc. Introduction to advanced databases: Distributed databases, Object oriented databases, mobile and web databases, Introduction to data warehousing and mining.

Text Books:
1. F.R. Mcfadden, J. Hoffer, M.Prescott, Modern Database Management, Addison Wesley.
2. Elmasri, Navathe, Fundamentals of Database System, Pearson Education Asia.

Reference Books:
1. C.J. Date, An Introduction to Database Systems, Pearson Education Asia.
2. Henry F Korth, Abraham Silbershatz, Database System Concepts, Mc Graw Hill .

Course Code	Course Name	Hours Per Week			
		L	T	P	Credits
CS3CO08	Computer Programming-II Java	2	0	2	3

Unit I: Basics of JAVA**:** Overview of Java, History and Evolution of Java, Feature of Java, Difference between Java, C++ and C, Structure of java program, Basics of JDK, JRE and JVM, Installation of JDK, Simple Java Program, Compilation and Execution of Java program. Elements of Java: keywords, data types, variable, declaration and initialization of a variable, the scope and life time of variable, constants, literals, identifiers, operators, types of java statements, Unicode System, Naming Convention, Comments, Arrays, type conversion and casting.

Unit II: Dynamic Method Dispatch**:** Garbage Collection, static and dynamic binding, Inheritance and its types, Interfaces. Java Packages: Definition of package, types of package, differentiate package from header file, importing package, creating package.

Unit III: String in Java: Overview of string, Immutable String, String Comparison, String Concatenation, Substring, Methods of String class, String Buffer class, Creating Immutable class to_String method.

Unit IV: Exception Handling**:** Defining exception, types of exception, exception class, try and catch block, multiple catch blocks, Nested try, finally block, throw keyword, Exception Propagation, throws Keyword. Multithreading**:** Overview of thread, thread types, Life Cycle of a thread, Creating thread, Sleeping a thread, joining a thread, thread Priority, Daemon thread.

Unit V: I/O Handling**:** File Output Stream & File Input Stream, Buffered Output Stream & Buffered Input Stream, Input from keyboard by Input Stream Reader, Input from keyboard by Console, Input from keyboard by Scanner, Print Stream class. Java Applets**:** Applet Basics, the Applet Class, Applet Architecture, Applet Initialization and Termination, the HTML APPLET Tag, Passing Parameters to Applets. Introducing the AWT**:** Introduction to Windows, Graphics, and Text, AWT Classes, Window Fundamentals, Component, Container, Panel, Frame.

Text Books:
1. E. Balagurusamy, Programming with java A Primer, McGraw-Hill.
2. Herbert Schildt, The Complete Reference Java 2, Tata McGraw-Hill.
3.

References:
1. Horstmann & Cornell, Core Java 2 (Vol I & II), Pearson.
2. Sharanam Shah, Core Java 8 for Beginners, Shroff Publisher.
3. Joshua Bloch, Effective Java, Sun Microsystems.

List of Experiments:

1. Write a program that accepts two numbers from the user and print their sum.
2. Write a program to calculate addition of two number using prototyping of methods.
3. Program to demonstrate function overloading for calculation of average.
4. Program to demonstrating overloaded constructor for calculating box volume.
5. Program to show the detail of students using concept of inheritance.
6. Program to demonstrate package concept.
7. Program to demonstrate implementation of an interface which contains two methods declaration square and cube.
8. Program to demonstrate exception handling in case of division by zero error.
9. Program to demonstrate multithreading.
10. Program to display "Hello World" in web browser using applet.
11. Program to add user controls to applets.
12. Write a program to create an application using concept of swing.

Course Code	Course Name	Hours per Week			
		L	T	P	Credit
CS3CO09	Operating Systems	3	1	2	5

Unit I: Introduction Language Processors, Language Processing Activities and Language Processors Development Tools, Assemblers, Compiler, Macros and Macro Processors, Linkers, Introduction to OS. Operating system functions, evaluation of O.S., Different types of O.S.: Batch, Multi-Programmed, Time-Sharing, Real-Time, Distributed, Parallel.

Unit II: Process: Concept of Processes, Process Scheduling, Operations on Processes, Cooperating Processes, Inter-Process Communication. Precedence Graphs, Critical Section Problem, Semaphores, Threads. CPU Scheduling: Scheduling Criteria, Preemptive & Non-Preemptive Scheduling, Scheduling Algorithms, Algorithm Evaluation, Multi-Processor Scheduling, Deadlock: Deadlock Problem, Deadlock Characterization, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery From Deadlock, Methods for Deadlock Handling.

Unit III: Memory Management: Concepts of Memory Management, Logical and Physical Address Space, Swapping, Fixed and Dynamic Partitions, Best Fit, First Fit and Worst Fit Allocation, Paging, Segmentation, and Paging Combined With Segmentation.

Unit IV: Concepts of Virtual Memory, Cache Memory Organization, Demand Paging, Page Replacement Algorithms, Allocation of Frames, Thrashing, Demand Segmentation, Role of Operating System in Security, Security Breaches, System Protection, and Password Management.

Unit V: Disk Scheduling, File Concepts, File Manager, File Organization, Access Methods, Allocation Methods, Free Space Managements, Directory Systems, File Protection, File Organization & Access Mechanism, File Sharing Implement Issue, File Management in Linux, Introduction to Distributed Systems.

Text Books:
1. Silberschatz, Galvin, Operating Systems Concepts, Wiley Publications.
2. Andrew S. Tenenbaum, Modern Operating Systems, Pearson Education Asia / PHI.

Reference Books:

1. Terrence Chan, UNIX System Programming Using C++, Prentice Hall India.
2. W. Richard Stevens, Advanced Programming in UNIX Environment, Pearson Education.
3. William Stallings, Operating Systems, Pearson Education Asia.

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3EW01	Internet and Web technology	3	0	0	3	3

Unit – I
Introduction: Concept of WWW, HTTP Protocol: Request and Response, Web browser architecture and Web servers and Application server, Features of Web 2.0, Internetworking with TCP/IP, basics of DNS, SMTP, POP3.

Unit - II
Web Design: Concepts of effective web design, Planning and publishing website, Introduction to web architecture, HTML: list, tables, images, frames, forms, Document type Definition (DTD), Document Object Model (DOM), Cascading Style Sheets and their types, Java Script: Introduction, documents, forms, statements, functions, objects.

Unit - III
Introduction to XML, XML vs HTML uses of XML, simple XML, XML key components, DTD and Schemas, embedding XML into HTML documents, Transforming XML using CSS, XSL and XSLT.

Unit - IV
PHP: working with variables and constants, controlling program flow, working with functions, arrays, files and directories, working with forms and databases, Introduction to Servlet, Lifecycle, API, and Servlet Packages.

Unit - V
Introduction to Java Server Page (JSP), JSP Application Design, JSP objects, Conditional Processing, Declaring variables and methods, sharing data between JSP pages, Sharing Session and Application Data, Database Programming using JDBC, web application framework, MVC framework, Introduction to bootstrap, angular JS.

Text Books:
1. J. C. Jackson, Web Technologies: A computer science perspective, Pearson Education.
2. Black Book, Web Technologies, Kogent learning solutions Inc. dreamtech Press.
3. A. S. Godbole & A. Kahate, Web Technologies: TCP/IP Architecture, and Java Programming, TMH.

Reference Books:
1. Ralph Moseley and M. T. Savaliya, Developing Web Applications, Wiley-India.
2. Paul S. Wang Sanda, S Katila, An Introduction to Web Design, Programming, CENGAGE Learning.
3. P.J. Deitel& H.M. Deitel, Internet and World Wide Web How to program, Pearson.

Course Code	Course Name	Hours Per Week			
		L	T	P	Credits
CS3EA01	Artificial Intelligence	3	0	0	3

Unit I: Introduction to artificial intelligence, various types of production systems, Characteristics of production systems, Study and comparison of breadth first search and depth first search techniques.

Unit II: Optimization Problems: Hill-climbing search Simulated annealing like hill Climbing, Best first Search. A* algorithm, AO* algorithms etc, and various types of control strategies, Heuristic Functions, Constraint Satisfaction Problem.

Unit III: Knowledge Representation, structures, Predicate Logic, Resolution, Refutation, Deduction, Theorem proving, Inferencing,Semantic networks, Scripts, Schemas, Frames, Conceptual dependency.

Unit IV: Uncertain Knowledge and Reasoning, forward and backward reasoning,monotonic and nonmonotonic reasoning, Probabilistic reasoning, Baye's theorem, Decision Tree, Understanding, Common sense, Planning.

Unit V: Game playing techniques like minimax procedure, alpha-beta cut-offs etc, Study of the block world problem in robotics.

Text Book:
1. Elaine Rich, Kevin Knight and Nair, Artificial Intelligence, TMH
2. S. Russel, Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson.

Reference Books:
1. Saroj Kausik, Artificial Intelligence, Cengage Learning 4
2. Padhy, Artificial Intelligence and Intelligent Systems, Oxforfd University Press,
3. Nils Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann.
4. David Poole, Alan Mackworth, Artificial Intelligence: Foundations for Computational Agents, Cambridge Univ. Press..

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3ED06	Data Science	3	0	0	3	3

Unit I

Introduction to Data Science, Definition and description of Data Science, history and development of Data Science, terminologies related with Data Science, basic framework and architecture, importance of Data Science in today's business world, primary components of Data Science, users of Data Science and its hierarchy, overview of different Data Science techniques.

Unit II

Sample spaces, events, Conditional probability and independence. Random variables. Discrete and continuous random variables, densities and distributions, Normal distribution and its properties, Introduction to Markov chains, random walks, Descriptive, Predictive and prescriptive statistics, Statistical Inference, Populations and samples, Statistical modeling,

Unit III

Exploratory Data Analysis and the Data Science Process - Basic tools (plots, graphs and summary statistics) of EDA - Philosophy of EDA - The Data Science Process - Case Study:

Unit IV

Data Visualization: Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects, Exercise: create your own visualization of a complex dataset.

Unit V

 NoSQL, use of Python as a data science tool, Python libraries: SciPy and sci-kitLearn, PyBrain, Pylearn, Matplotlib, challenges and scope of Data Science project management.

Text books
1. Data Science from Scratch: First Principles with Python 1st Edition by Joel Grus
2. Principles of Data Science by Sinan Ozdemir, (2016) PACKT.

Reference Books
1. Data Science For Dummies by Lillian Pierson (2015)
2. Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking by Foster Provost, Tom Fawcett

Course Code	Course Name	Hours per Week			Total
		L	**T**	**P**	**Credits**
CS3EY01	Introduction to Cloud Computing	3	0	0	3

Unit I: Fundamentals of Cloud Computing:
Cloud Computing Basics – History of Cloud Computing, Characteristics of Cloud Computing, Need for Cloud computing, Advantages and Possible Disadvantages of cloud computing, Cloud Deployment Models – Public, Private, Hybrid, Community, Other deployment Models. Evolving Data Center into Private Cloud, Datacenter Components, Extracting Business value in Cloud Computing – Cloud Security, Cloud Scalability, Time to Market, Distribution over the Internet, Cloud Computing Case Studies.

Unit II: Cloud Delivery Models
Introduction to Cloud Services, Infrastructure as a Service (IaaS) – Overview, Virtualization, Container, Pricing Models, Service Level Agreements, Migrating to the Cloud, IaaS Networking options, Virtual Private Cloud(VPC), IaaS Storage – File and Object storage, Data Protection, IaaS security, Benefits, Risks and Examples of IaaS. Platform as a Service (PaaS) – Overview, IaaS vs PaaS, PaaS Examples, benefits and risks. Software as a Service (SaaS) – Introducing SaaS, SaaS Examples – Office 365, Google G Suite, Salesforce.com , Evaluating SaaS – user and vendor perspective, Impact of SaaS, Benefits and risks of SaaS. Other Services on Cloud, Cloud Delivery Models Considerations

Unit III: Cloud Platforms
Introducing Cloud Platforms, Evaluating cloud platforms, Cloud Platform technologies – Amazon Web Services, Microsoft Azure, Google Cloud Platform, Salesforce.com, Impact of Cloud platforms. Private Cloud Platforms – Introducing Private clouds – Microsoft Azure stack, Open stack, AWS Greengrass, Impact of Private clouds
Cloud Migration: Delivering Business Processes from the Cloud: Business process examples, Broad Approaches to Migrating into the Cloud, The Seven-Step Model of Migration into a Cloud, Efficient Steps for migrating to cloud., Risks: Measuring and assessment of risks, Company concerns Risk Mitigation methodology for Cloud computing, Case Studies

Unit IV: Cloud Computing - Challenges, Risk and Mitigation
Cloud Storage, Application performance, Data Integration, Security. Ensuring Successful Cloud Adoption: Designing a Cloud Proof of Concept, Vendor roles and capabilities, moving to the Cloud. Impact of Cloud on IT Service Management. Risks and Consequences of Cloud Computing – Legal Issues, Compliance Issues, Privacy and Security.

Unit V: Managing the Cloud
Managing and Securing Cloud Services, Virtualization and the Cloud, Managing Desktops and devices on the cloud, SOA and Cloud computing, Managing the Cloud environment, Planning for the Cloud – Economic Cost Model and Leveraging the Cloud, Cloud computing resources, Cloud Dos and Don'ts.
.
Text Books:

1. Kirk Hausman, Susan L. Cook, Telmo Sampaio, "CLOUD ESSENTIALS CompTIA® Authorized Courseware for Exam CLO-001", John Wiley & Sons Inc.
2. Judith Hurwitz, Robin Bloor , Marcia Kaufman , Fern Halper, "Cloud Computing for Dummies", Wiley Publishing Inc.

Reference Books:
1. Erl," Cloud Computing: Concepts, Technology & Architecture", Pearson Education.
2. Srinivasan, "Cloud Computing: A Practical Approach for Learning and Implementation "Pearson Education.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
CS3ET01	Statistics and Probability	3	0	0	3

Unit I: Introduction to Statistics

History of statistics, importance of statistics in different field of research, Types of statistics, types of data, variables, types of variables – based on measurement, based on observation, difference between cross sectional and time series data, importance of cross sectional and time series data in statistical analysis, important terminologies – sample, population, universe, statistics, statistic, parameter, estimation, estimator, probability distribution function, probability density function, probability mass function, sampling distribution and standard error, basic arithmetic operators in statistics, application of statistics in different research areas.

Unit II: Summarizing data using Statistical Measures

Descriptive Statistics – Measure of central tendency - Mean: Arithmetic mean, geometric mean and harmonic mean with its mathematical properties, mathematical relationship among these different means, median for raw data – odd number and even number, grouped data, mode for raw data and grouped data, properties of mean, median and mode and relationship among mean, median and mode, measure of dispersion – standard deviation, variance, covariance and its properties, coefficient of variation, quartiles, quartile deviation and mean deviation, graphical representation of data: Unidimensional, bidimensional and multidimensional.

Unit III: Testing of Hypothesis

Introduction to testing of hypothesis, Statistical assumptions, Level of significance, confidence level, Type I Error, Type II error, Critical value, power of the test, sampling distribution, small sample test – t test for one and two sample mean, F test, Large Sample test – Z test for equality of single mean, equality of two sample mean, equality of single proportion, equality of two sample proportions, multiple comparison of sample means, one way analysis of variance with unequal sample sizes, Introduction to general linear model, assumptions of ANOVA, factors and levels in ANOVA, layout of one way ANOVA, skeleton of one way and two way ANOVA, calculation and examples for one-way and two-way ANOVA.

Unit IV: Theory of Random variables and Expectations

Random variables- discrete and continuous random variables, statistical properties of random variables, Expectation of a random variables, expectation of random variable in terms of variance and covariance, jointly distributed random variables, moment generating function, characteristic function, limit theorems related to random variables.

Unit V: Introduction to Probability theory

History of probability theory, definition of various terms related to probability – trial, events, exhaustive events, mutually exclusive events, equally likely events, independent events, introduction to Apriori probability, limitations of classical probability, statistical or empirical probability, theory of sets, elements of sets, operations on sets, algebra of sets, axiomatic approach to probability, probability function, theorems on probabilities of events, law of probability theory, Introduction to conditional probability and expectations, examples for conditional probability and expectation, properties of conditional random variables, identity for compound random variables.

Text Books

1. SC Gupta and VK Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons Publication

Reference Books:

1. Sheldon M. Ross, "Introduction to Probability Models", Elsevier Publication, Academic Press, UK
2. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier Publication, Academic Press, UK

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3ES12	Software Workshop-I	0	0	2	1

This course has been associated with program electives of corresponding semesters. The lab experiments of respective program electives will be performed during the lab hours for respective students.

| Course Code | Course Name | Hours per Week | | | Total |
		L	T	P	Credit
CS3CO24	Computer Graphics & Multimedia	3	1	2	5

Unit-I
Introduction to Raster Scan Displays, Pixels, Frame Buffer, Vector & Character Generation, Random Scan Systems, Display Devices, Scan Conversion Techniques, Line Drawing: Simple DDA, Bresenham's Algorithm, Circle Drawing Algorithms: Midpoint Circle Drawing and Bresenham's Algorithm, Polygon Fill Algorithm: Boundary-Fill and Flood-Fill Algorithms.

Unit-II
2-D Transformation: Translation, Rotation, Scaling, Shearing, Reflection. Inverse Transformation, Homogenous Coordinate System, Matrices Transformation, Composite Transformation. Windowing & Clipping: World Coordinate System, Screen Coordinate System, Viewing Transformation, Line Clipping & Polygon Clipping Algorithms.

Unit-III
3-D Transformations: Translation, Rotation and Scaling. Parallel & Perspective Projection: Types of Parallel & Perspective Projection, Hidden Surface Elimination: Depth Comparison, Back Face Detection Algorithm, Painter's Algorithm, and Z-Buffer Algorithm.

Unit-IV
Curve Generation, Bezier and B-spline Methods. Basic Illumination Model: Diffuse Reflection, Specular Reflection, Phong Shading, Gouraud Shading, Ray Tracing, Color Models like RGB, YIQ, CMY, HSV.

Unit V
Multimedia: Characteristics of a Multimedia Presentation, Multimedia Architecture, Text –Types, Unicode Standard, Text File Formats, Audio- Components of an Audio System, Digital Audio, Digital Audio Processing, Audio File Formats, Video- Digital Video, Digital Video Processing, Video File Formats.
Animation: Uses of Animation, Principles of Animation, 3D Animation, Animation File Formats, Animation Software, MPEG Standards.

Text Book

1. Donald Hearn and M.P. Becker Computer Graphics Pearson Pub.
2. Vaughan, Tay. *Multimedia: Making it work*. Tata McGraw-Hill Education.

References

1. Parekh, Principles of Multimedia, Tata McGraw Hill.
2. Rogers, "Procedural Elements of Computer Graphics", Tata McGraw Hill.
3. Maurya, Computer Graphics with Virtual Reality System, Wiley India.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3CO26	Software Engineering	3	1	2	5

Unit I

Software Engineering – Definition, Process, Evolution and Myths, Generic Process Model, Framework, Process Models – Waterfall, Incremental, Evolutionary, Spiral, Component Based Model, Rational Unified Process

Unit II

Requirement Analysis, Stakeholders, Elicitation Techniques, Requirement Modelling - Use Cases, Activity Diagrams, Swimlane Diagrams, Data Modelling, Data Flow Diagram, Overview of Class Based Modelling, requirement Tracking

Unit III

Principles of Software Design, Design Concepts – Abstraction, Architecture, Modularity, Relationships, Design Model, Component Design, User Interface Design, Configuration Management

Unit IV

Software Quality, Approaches for Quality Assurance, Software Testing, Verification and Validation, Types of Testing, Risk Assessment, Risk Mitigation, Monitoring and Management

Unit V

Software Metrics, Process Metrics, Product Metrics, Function Oriented Metrics, Software Project Estimations, Function Point Based Metrics, COCOMO Models, Project Scheduling, Effort Distribution

Text Book:

1. Roger S. Pressman, Software Engineering: A Practitioner's Approach, McGraw-Hill.

2. Ian Sommerville, Software Engineering, Pearson Education Inc., New Delhi

Reference Book:

1. Fundamentals of Software Engineering by Rajib Mall, – PHI

Course Code	Course Name	Hours Per Week			
CS3C012	Computer Networks	**L**	**T**	**P**	**Credits**
		3	1	2	5

UNIT-I
MAC Sublayer: Static and Dynamic Chanel Allocation in LAN, MAC protocols-ALOHA and SlottedALOHA,CSMA, CSMA/CD, CSMA/CA, Collision Free protocols, Limited Contention Protocols. Ethernet-Ethernet Cabling, Frame Format, Binary Exponential Back-off Algorithm, Ethernet Performance, Fast and Gigabit Ethernet,MAC address.

UNIT-II
Network Layer: Design issues, Routing algorithms:Dijkstra's algorithm, Bellman-ford algorithm, Link State Routing, Hierarchical Routing,Congestion Control Algorithms: General Principles of Congestion control, Prevention Policies, Congestion Control in Virtual-Circuit Subnets, Congestion Control in Datagram subnets. QOS-techniques for achieving good QOS, Traffic Management, Integrated and Differentiated Services. RSVP

UNIT-III
Internetworking, Tunnelling, Fragmentation and Reassembly. IP protocol, IPv4 Addresses, Subnet Addressing, Subnet Mask, SupernettingCIDR, NAT, ICMP-header, message type, trace route, ARP & RARP, BOOTP and DHCP: Address allocation, configuration & packet format, OSPF and BGP,Comparative study of IPv4 & IPv6.

UNIIT-IV
Transport Layer: Design Issues, Transport Service Primitives, Socket Programming, TCP: Connection Management, Reliability of Data Transfers, TCP Flow Control, TCP Congestion Control, TCP Header Format, TCP Timer Management. UDP: Header Format, RPC, RTP, Session layer: Authentication, Authorization, Session layer protocol (PAP, SCP, H.245).

UNIT-V
Presentation layer: Data conversion, Character code translation, Presentation layer protocol.Application Layer: WWW Architectural Overview, URL-Static and Dynamic Web, FTP, SSH, Email- Architecture and Services, SMTP, DNS-Name System, Resource Records, Name Servers, Network Management (SNMP).

Recommended Text Book: -

5. Computer Networks-V Edition, Andrew S. Tanenbaum-Pearson Education (Chapter No.4-7).
6. Data and Computer Communication-VIII Edition, William Stallings-Pearson Education(Part-3-6)

7. Data Communication and Networking- V Edition, Behrouz A.Fourouzan- Mc Graw Hill Publication (Part-3-6).
8. Communication Networks-Fundamental concepts and key Architecture, Alberto Leon-Garcia &IndraWidjaja-TMH (Unit1,2,7,8,10,12)

Practical Understanding

3. Data Communication Principles for fixed and wireless networks-Aftab Ahmad, Kluwer Academic Publishers.
4. Data Communications Networking Devices:-Operation, Utilization, Lan and Wan Interworking-IV Edition, Gilbert Held-John Wiley and Sons.

| Course Code | Course Name | Hours per Week | | | Total |
		L	T	P	Credits
EN3MC15	Universal Human Values and Professional Ethics	2	0	0	0

UNIT-I
Introduction-Need, Basic Guidelines, Content and Process for Value Education
Understanding the need, basic guidelines, content and process for Value Education, Self-Exploration – what is it?-its content and process; 'Natural Acceptance' and Experiential Validation-as the mechanism for self - exploration, Continuous Happiness and Prosperity-A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities-the basic requirements for fulfilment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

UNIT-II
Understanding Harmony in the Human Being-Harmony in Myself
Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body'- Sukhand Suvidha, Understanding the Body as an instrument of 'I'(I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyamand Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

UNIT-III
Understanding Harmony in the Family and Society-Harmony in Human- Human Relationship
Understanding harmony in the Family- the basic unit of human interaction, Understanding values in human -human relationship ;meaning of Nyayaand program for its fulfilment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship, Understanding them eaning of Vishwas; Difference between intention and competence, Understanding the meaning of Samman ,Difference between respect and differentiation ;the other salient value in relationship, Understanding the harmony in the society(society being an extension of family):Samadhan, Samridhi, Abhay, Sah-astitvaas comprehensive Human Goals, Visualizing a universal harmonious order in society-Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)-from family to world family!.

UNIT- IV
Understanding Harmony in the Nature and Existence-Whole existence as Co-existence
Understanding the harmony in the Nature, Inter connectedness and mutual fulfilment among the four orders of nature –recyclability and self-regulation in nature, Understanding Existence as Co-existence(Sah-astitva) of mutually interacting units in all-pervasive space, Holistic perception of harmony at all levels of existence.

UNIT-V
Implications of the above Holistic Understanding of Harmony on Professional Ethics

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in Professional Ethics:

a) Ability to utilize the professional competence for augmenting universal human order,
b) Ability to identify the scope and characteristics of people- friendly and eco-friendly production systems, technologies and management models, Case studies of typical holistictechnologies,managementmodelsandproductionsystems,Strategyfor transition from the present state to Universal Human Order:
a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers,
b) At the level of society :as mutually enriching institutions and organizations.

TextBooks:
1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

References:
1. IvanIllich,1974,Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
2. E.F.Schumacher,1973, Smallis Beautiful: a sudy of economics as if people mattered, Blond & Briggs, Britain.
3. SussanGeorge,1976,HowtheOtherHalfDies,PenguinPress.Reprinted 1986, 1991
4. Donella H .Meadows, DennisL. Meadows,JorgenRanders, WilliamW. BehrensIII, 1972, Limits to Growth–Club of Rome's report, UniverseBooks.
5. ANagraj, 1998, JeevanVidyaEkParichay, DivyaPathSansthan, Amarkantak.
6. PLDhar, RRGaur,1990,Science and Humanism,Commonwealth Publishers.
7. A NTripathy, 2003, Human Values, New Age International Publishers. SubhasPalekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) KrishiTantraShodh, Amravati.
8. EGSeebauer&RobertL.Berry,2000,FundamentalsofEthicsforScientists&Engineers , Oxford University Press
9. MGovindrajran,SNatrajan&V.S.SenthilKumar,EngineeringEthics(includingHumanValues),EasternEconomyEdition,PrenticeHallofIndia Ltd.
10. BP Banerjee,2005, Foundations of Ethics andManagement, Excel Books. BLBajpai,2004,IndianEthosandModernManagement,NewRoyal Book Co., Lucknow. Reprinted 2008.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3MC10	Soft Skills-III	2	0	0	0

UNIT 1: **Introducing your friend:** This session involves icebreaker activities to orient the students for the entire program. The activity is to try using as many adjectives as possible to describe one's friend. Students are encouraged to speak about their friends on the stage. Also, students will learn and practice introducing them (Self introduction) as self-introduction is usually the first question in any personal interview. Also, the appropriate way to introduce oneself is taught.

Who gets the heart? To improve reasoning, convincing and speaking skills of students. Student groups are provided with specific case of an individual in requirement of a heart along with the profile of the person. Student will advocate why the person they represent deserves to get the heart over others. This imparts the needed convincing skills for group discussions and personal interview where students need to convincingly put forth their opinion and views.

Debate: The objective of the session is to strengthen students' skills in the areas of leadership, interpersonal characteristics, influence over others, problem analysis, solution and presentation. Students are given topics and are made to debate on it. Cross-questioning is encouraged.

UNIT 2

Sentence correction: Subject-Verb Agreement, Modifiers, Parallelism

Vocabulary: Vocabulary Demystified, Synonyms and Antonyms, Word Analogy, Miscellaneous Vocabulary

UNIT 3

Sentence completion and Para- jumbles: Pro-active thinking, Reactive thinking (signpost words, root words, prefix suffix, sentence structure clues), Fixed jumbles, Anchored jumbles

Time and work: Work with different efficiencies, Pipes and cisterns, Work equivalency, Division of wages

UNIT 4

Data arrangements and blood relations: Linear Arrangement, Circular Arrangement, Multi-dimensional Arrangement, Blood Relations.

Reading comprehension: Speed Reading Strategies, RC - Types and Tackling Strategies.

UNIT 5

Story Mason: To make the students participate in group interactions, create dialogue and present on stage as a group. This activity allows introverts or students with stage fear to present a narration along with the group mates on the stage. This slowly helps those students to come out of their inhibition to speak in-front-of an audience.

Ratio and Proportion: Ratio, Proportion, Variation, Simple equations, Problems on Ages.

Articles, Prepositions and Interrogatives: Definite and Indefinite Articles, Omission of Articles, Prepositions, Compound

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
CS3ES13	Software Workshop-II	0	0	2	1

This course has been associated with program electives of corresponding semester. The lab experiments of respective program electives will be performed during the lab hours for respective students.

Course Code	Course Name	Hours Per Week			
		L	T	P	Credits
CS3EL10	Cloud Computing	3	0	0	3

Unit I:
Introduction to cloud computing, characteristics of cloud computing as per NIST, cloud reference model, application of cloud computing ECG analysis, protein structure prediction, cloud deployment models.

Unit II:
Virtualization, virtualization advantages, Full virtualization, para-virtualization, hypervisors. Cloud interoperability, cloud service management, cloud analytics, Cloud broker, Capex, Opex, cloud architecture.

Unit III:
Platform as a service, Infrastructure as a service, software as a service, Desktop as a service, Backup as a service, DRaaS, Introduction to SLA, SLA lifecycle, SLA management, Business continuity plan.

Unit IV:
Cloud security fundamentals, vulnerability assessment, security architecture, identity management and access control, data at rest, data in flight, data in motion, security in virtualization.

Unit V:
Cloud application development platforms, Xen hypervisor, AWS, Google app engine, open stack.

Text Books:
1. S. Chand,R.Buyya, C. Vecchiola, S.T. Selvi, "Mastering Cloud Computing," McGraw Hill Education
2. T. Velte, A. Velte and R. Estenpeter, "Cloud Computing –A practical approach, McGraw Hill Education

Reference Books:
1. K. Chandrasekaran, "Essentials of Cloud Computing," CRC Press
2. Thomas Erl, Zaigham Mahmood, RichardoPuttini, Cloud Computing: Concepts, Technology & Architecture, ServiceTech press
3. K Jayaswal, J Kallakurchi, Donald Houde, Deven Shah, Cloud Computing Black Book, Dreamtech Press.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3EA07	Machine Learning	3	0	0	3

Unit I: Introduction to machine learning, Applications, Classification; Supervised Learning: Linear Regression: Cost function, Gradient descent; Logistic Regression, Nearest-Neighbors, Gaussian function.

Unit-II: Overfitting and Underfitting, Regularization, Bias and Variance, Decision Trees, Naïve Bayes, Support Vector Machines, Kernel Methods.

Unit III: Unsupervised Learning: Clustering: K-means, Dimensionality Reduction: PCA, Matrix Factorization and Matrix Completion, Ranking, Recommender System.

Unit IV: Introduction to Neural Network, Perceptron, Feed forward, Back Propogation, Recurrent Neural Network. Introduction to Python machine learning libraries: Keras, Tensorflow and Theano.

Unit V: Evaluating Machine Learning algorithms and Model Selection, Ensemble Methods: Boosting, Bagging, Random Forests, Deep learning Semi-supervised Learning, Reinforcement Learning.

Text Book:

5. Machine Learning, Tom Mitchell, McGraw Hill.
6. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.
7. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer (freely available online)

Reference Books:

1. Christopher Bishop, Pattern Recognition and Machine Learning, Springer.
2. Hal Daumé III, A Course in Machine Learning (freely available online)
3. Sebastian Raschka,Vahid Mirjalili, Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow, Packt Publishing.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
CS3EY02	Cryptography	3	0	0	3

Unit I: Introduction to Cryptography

The Confidentiality, Integrity & Availability (CIA) Triad, Cryptographic concepts, methodologies &practices, Symmetric &Asymmetric cryptography, public& private keys, Cryptographic algorithms and uses, Construction & use of Digital signatures

Unit II: Types of Algorithms

The basic functionality of hash/crypto algorithms (DES, RSA, SHA, MD5, HMAC, DSA) and effects on key length concepts in Elliptical Curve Cryptography & Quantum Cryptography.

Unit III: Key Management

The basic functions involved in key management including creation, distribution, verification, revocation and destruction, storage, recovery and life span and how these functions affect cryptographic integrity.

Unit IV: Application of Cryptography

Major key distribution methods and algorithms including Kerberos, ISAKMP etc., Vulnerabilities to cryptographic functions, the Use and functions of Certifying Authorities (CAs), Public Key Infrastructure (PKI) and System architecture requirements for implementing cryptographic functions, Web Services security, Cloud Security, VPNs.

Unit V: Cryptography in User Authentication

Basics of authentication, tokens, certificate-based and biometric authentication, extensible authentication protocols, and message digest, security handshake pitfalls, SSO, attacks on authentication schemes, email security

Text Books:

1. Information Systems Security: Security Management, Metrics, Frameworks and Best Practices by Nina Godbole, Wiley, 1sted; 2008
2. Cryptography and Security by C K Shyamala, N Harini and Dr T R Padmanabhan, Wiley India, 1sted; 2011
3. Cryptography and Network Security by AtulKahate, McGraw Hill India, 3rded; July 2017

4. Cryptography and Network Security by S. Bose, Pearson India, 1ˢᵗed; Mar 2016.

5. Cryptography and Information Security by V. K. Pachghare, Prentice Hall India, 2ⁿᵈ rev ed; 2015

Reference Book:

1. Understanding Cryptography: A Textbook for Students and Practitioners Hardcover, Springer, 1st ed; 2010

2. 2. Introduction to Modern Cryptography by Jonathan Katz, Chapman & Hall/CRC Cryptography, 2nd ed; 2014

   3. Everyday Cryptography: Fundamental Principles and Applications by Keith Martin, OUP Oxford, 2nd ed; 2017.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
CS3ET02	Statistical Inferences	3	0	0	3

Unit I: Introduction to Statistical Inference

History and development of statistical inference, introduction to statistical hypothesis, types of hypothesis – simple and composite, fundamental concepts of null hypothesis, alternative hypothesis, critical region, two types of statistical errors: type I and II error, importance of type I & II error, level of significance, confidence level and critical region, most powerful test, uniformly most powerful test and their construction, Neyman Pearson Lemma, application and importance of Neyman Pearson Lemma, unbiased test and unbiased critical region, concepts of likelihood ratio test.

Unit II: Testing of Hypothesis – Parametric Test

Introduction to Testing of hypothesis, steps involved in Hypothesis testing, small sample test : t test for one sample mean and two sample mean, F test for equality of two variances, Large sample test : Z test, single mean, two mean, single proportion and two proportions, test for the variance of normal distribution, test for the equality of two or more than two normal distributions, confidence interval for population arithmetic mean, confidence interval for population variance.

Unit III: Testing of Hypothesis: Non Parametric test

Introduction to non-parametric test, run test, Wilcoxon signed Rank Test, Wilcoxon Matched signed pair rank test, Mann-Whiteney U test, Kruskal Wallis test, Fried Man Rank Test for small sample and large sample, Goodness of fit test and independence of attributes using χ^2 test, testing of equality of more than two variances using χ^2 test.

Unit IV: Parameter Estimation

Introduction to estimation, central limit theorem and its application, types of estimation, properties of good estimator – unbiasedness, consistency, efficiency and sufficiency, Method of estimation – maximum likelihood estimation, properties of method of maximum likelihood estimator, estimation of mean and variance of normal distribution using maximum likelihood estimator, introduction and assumptions of ordinary least square method, estimation of parameters in multiple linear regression coefficients, properties of the OLS method.

Unit V: Bayesian Statistical Inference

Introduction to Bayes inference, Bayesian Procedures – Prior and posterior distributions, point estimation of Bayesian statistic, Bayesian Interval estimation, Bayesian testing procedures, Bayesian sequential procedures, important terms related to Bayesian statistical inference, introduction to modern Bayesian statistical inference, simple problems related to Bayesian inference and estimations.

Text Books

1. Fundamentals of Mathematical Statistics – SC Gupta and VK Kapoor, Sultan Chand & Sons Publication, New Delhi

Reference Books

1. Introduction to probability Models, Ninth Edition – Sheldon M. Ross, Elsevier Puplication, Academic Press, UK
2. An introduction to Probability and Statistical Inference – George Roussas, Academic Press

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00071	Server Administration	3	0	0	3

Unit I: Installing and Configuring Windows Server 2012

Introduction, Selecting a Windows Server 2012 Edition, Supporting Server Roles and Features, Server Licensing, Installing Windows Server 2012: System Requirement, Performing a Clean Installation, Working with Installation Partitions, Server Core Defaults, Server Core Capabilities, Completing Post-Installation Tasks, Converting Between GUI and Server Core, Upgrade paths, Installing Windows Server Migration Tools, Configuring NIC Teaming, Configuring local storage, Configuring WDS to install OS through networking.

Unit II: Securing Files and Disks.

How to Securing Files, Encryption files with EFS, Configuring EFS, Using the Cipher Command, Sharing Files Protected with EFS with others, Configuring EFS with Group Policies, Configuring EFS Recovery Agent, Managing EFS Certificates, Encrypting Files with BitLocker, Configuring BitLocker Encryption, configuring BitLocker to Go, Configuring BitLocker Policies, Managing BitLocker Certificates.

Unit III: Configuring File and Share Access Permissions

Designing a File-Sharing Strategy, Arranging Shares, Controlling Access, Mapping Drives, Creating Folder Shares, Assigning Permissions, Understanding the windows Permission Architecture and Basic, Advanced Permissions, Allowing and Denying Permissions, Inheriting Permissions, Understanding Effective Access, Setting Share Permissions, Understanding NTFS Authorization, Assigning Basic NTFS Permissions, Understanding Resource Ownership, Combining Share and NTFS Permissions, Installing File Server Resource Manager, Using, creating, changing Quotas, Managing Files with File Screening, Creating File Groups, Creating a File Screen, Creating a File Screen Exception, Creating a File screen Template. Storage Reports Management.

Unit IV: Configuring DNS Zones and Records

Understanding DNS, Understanding DNS Names and Zones, Understanding the Address Resolution Mechanism, configuring and Managing DNS Zones, Installing DNS, Configuring Primary and Secondary Zones, Configuring Active Directory-Integrated Zones, configuring Zone Delegation, configuring Stub Zones, configuring Caching-Only Servers, Configuring Forwarding and Conditional Forwarding, Configuring DNS Record types, creating and Configuring DNS Resource Records, Start of Authority(SOA) Records, Name Server(NS) Records, Host(A and AAAA) Records, Canonical Name(CNAME) Records, Pointer(PTR) Records..

Unit V: Implementing Patch Management and Monitoring Server Performance

Understanding windows Updates and Automatic Updates, Deploying Windows Server Update Services(WSUS), How to Install and Configure WSUS, Configuring WSUS Synchronization,

Configuring WSUS Computer Groups, Configuring Group Policies for Updates, Configuring Client-Side Targeting, Approving Updates, Viewing Reports, Administrating WSUS with Commands, Troubleshooting Problems with Installing Updates.

Introducing the Microsoft Management Console (MMC), Server Manager, Event Viewer, Understanding Logs and Events, Adding and Filtering Events, Managing Performance, Task Manager, Resource Monitor, Configuring Data Collector Sets (DCS), Monitoring the Network using Netstat and protocol analyzers.

Text Books:

1. Windows Server 2012: A Handbook for Professionals by Aditya Raj (Author)
2. Administering Windows Server 2012 (Certification Guide) by Orin Thomas
   Reference Book:

1. Administering Widows Server 2012 by Patrick Regan
2. Mastering Windows Server 2012 R2 by Mark Minasi, Kevin Greene, Christian Booth, and Robert Butler.

Course Code	Course Name	Hours per Week			Total
		L	**T**	**P**	**Credits**
OE00072	Introduction to Data Science	3	0	0	3

Unit I: Data Science   - An Overview

Introduction to Data Science, Definition and description of Data Science, history and development of Data Science, terminologies related with Data Science, basic framework and architecture, difference between Data Science and business analytics, importance of Data Science in today's business world, primary components of Data Science, users of Data Science and its hierarchy, overview of different Data Science techniques, challenges and opportunities in business analytics, different industrial application of Data Science techniques.

Unit II: Mathematics and Statistics in Data Science

Role of mathematics in Data Science, importance of probability and statistics in Data Science, important types of statistical measures in Data Science : Descriptive, Predictive and prescriptive statistics, introduction to statistical inference and its usage in Data Science, application of statistical techniques in Data Science, overview of linear algebra : matrix and vector theory, role of linear algebra in Data Science, exploratory data analysis and visualization techniques, difference between exploratory and descriptive statistics, EDA and visualization as key component of Data Science.

Unit III: Machine Learning in Data Science

Role of machine learning in Data Science, different types of machine learning techniques and its broad scope in Data Science : Supervised, unsupervised, reinforcement and deep learning, difference between different machine learning techniques, brief introduction to machine learning algorithms, importance of machine learning in today's business, difference between machine learning classification and prediction.

Unit IV:Computers in Data Science

Role of computer science in Data Science, various components of computer science being used for Data Science, role of relation data base systems in Data Science: SQL, NoSQL, role of data warehousing in Data Science, terms related with data warehousing techniques, importance of operating concepts and memory management, various freely available software tools used in Data Science : R, Python, important proprietary software tools, different business intelligence tools and its crucial role in Data Science project presentation.

Unit V:Data Science Project Management

Data Science project framework, execution flow of a Data Science project, various components of Data Science projects, stakeholders of Data Science project, industry use cases of Data Science implementation, challenges and scope of Data Science project management, process evaluation model, comparison of Data Science project methods, improvement in success of Data Science project models.

Text books:

1. Data Science from Scratch: First Principles with Python 1st Edition by Joel Grus
2. Principles of Data Science by Sinan Ozdemir, (2016) PACKT.

Reference Books:

1. Data Science For Dummies by Lillian Pierson (2015)
2. Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking by Foster Provost, Tom Fawcett
3. Data Smart: Using Data Science to Transform Information into Insight 1st Edition by John W. Foreman. (2015) Wiley Publication.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
OE00015	Agile Development	3	0	0	3

Unit-I
Understanding Agile: Introduction to Agile Project Management, Agile Manifesto, Agile Principles, Agile Benefits: Product Development and customers, Development teams etc.

Unit-II
Agile Frameworks: Agile approaches, reviewing the big three: Lean, Extreme programming and Scrum. Putting Agile in action: Environment, Behaviors- Agile roles, New values, Team philosophy.

Unit-III
Working in Agile: Planning in Agile, product vision, creating the product roadmap, refining requirement and estimates, release planning and Sprint planning.

Unit-IV
Managing in Agile: Managing Scope and procurement, managing time and cost, team dynamics and communication, managing quality and risk

Unit-V
Ensuring Agile Success: Building a foundation- Commitment, choosing the right project team members- Development team, scrum master etc. Being a change agent, Key benefits and key resources for agile project management.

Text Books:
1. Mark C. Layton, Agile Project Management For Dummies, Wiley publishers
2. Jim Robert Highsmith, Agile Project Management: Creating Innovative Products, Pearson education
3. Hitzler, Markus, Rudolph , Foundations of Semantic Web Technologies, Chapman & Hall/CRC
4. Allemang , Hendler , Semantic Web for the working Ontologist, Elsevier Pub

Reference Books:
1. Charles G. Cobb, Making Sense of Agile Project Management: Balancing Control and Agility, Wiley
2. Mike Cohn, Agile Estimating and Planning, Pearson
3. Liz Sedley and Rachel Davies, Agile Coaching, The Pragmetic Bookshelf

Course Code	Course Name	Hours Per Week			
OE00016	Blockchain Architecture	**L**	**T**	**P**	**Credits**
		3	0	0	3

Unit I: Cryptocurrency: History, electronic cash, double spending problem, Bitcoin protocols, Mining strategy and rewards, Types of crypto currency wallets, Legal aspects of crypto currency, Crypto currency exchanges.

Unit II: Introduction to Blockchain: History of blockchain, Hash functions, SHA-256, Symmetric cryptography, Asymmetric cryptography, Keys & Digital signatures, benefits and limitation of block chain, features of blockchain.

Unit III: Consensus: Nakamoto consensus, Proof of work, Proof of stake, Proof of burn, Difficulty Level, Sybil attack, Energy utilization, collision of energy utilization, Introduction to ethereum.

Unit IV: Blockchain Architectures: Blockchain network, Merkle patricia Tree, Soft & hard fork, Private and public blockchain, Tokenized blockchain.

Unit V: Blockchain Applications: Financial Sector, Medical record management system, domain name service and future of block chain, case study: Government on blockchain. Introduction to hashgraph and tangle.

Text Books:
1. Andreas Antonopoulos "Mastering Bitcoin Unlocking Digital Cryptocurrencies" O'Reilly publication.
2. Imran Bashir "Mastering Blockchain: Distributed ledger technology, decentralization, Packt publishing".

Reference Books:

1. Wattenhofer, The Science of the Blockchain
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University.

Course Code	Course Name	Hours Per Week				
		L	**T**	**P**	**Hrs.**	**Credits**
OE00018	Python Essentials	3	0	0	3	3

UNIT-I-Basic Introduction
Introduction to Python, History, Features, command interpreter and development environment-IDLE, Application of Python, Python 2/3 differences, Basic program structure-quotation and indentation, Operator, Basic data types and In-built objects.

UNIT-II-Function and Sequence
Functions: definition and use, Arguments, Block structure, scope, Recursion, Argument passing, Conditionals and Boolean expressions, Lambda Function, inbuild functions (str(),globals(),locals(),vars(),eval(),exec(),execfile(),repr(),ascii()) Sequences: Strings, Tuples, Lists Iteration, looping and control flow, String methods and formatting.

UNIT-III-File Operation & OOPS concepts
Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(),   Manipulating file pointer using seek.

UNIT-IV- OOPS Concepts
Object Oriented concepts- Encapsulation, Polymorphism, Classes, Class instances, Constructors & Destructors__init__, __del__, Multiple inheritance, Operator overloading Properties, Special methods, Emulating built-in types.

UNIT-V-Mutable data types, Exception and Standard modules
Dictionaries, Sets and Mutability, Exceptions, List and Dict Comprehensions, Standard Modules-math, random Packages.

Text Book:
 1. Dr.R.Nageswara Rao, Core Python Programming, dreamtech press.
 2. Paul Barry, Head First Python, O'REILLY.

Reference Book:

 1. Mark Luiz, Learning Python, O'REILLY.
 2. Jamie Chan, Learn Python in One Day, LCF Publishing.

Course Code	Course Name	Hours Per Week				
		L	**T**	**P**	**Hrs.**	**Credits**
CS3CO13	Design and Analysis of Algorithms	3	1	2	6	5

Unit-I: **Introduction to Algorithms**
Algorithms, Analysis, Performance issues: Time and Space complexity; Asymptotic Notations. Mathematical preliminaries: functions & their growth rates; Recurrence relations, Methods for solving recurrences. Elementary Sorting techniques and its analysis: Selection, Bubble, Insertion sort

Unit-II: Sorting and Divide & Conquer
Advance sorting techniques and its analysis: Heap sort, Radix sort and Bucket sort, Divide and Conquer techniques and its analysis - Binary search, Merge Sort, Quick sort, Strassen's Matrix multiplication.

Unit-III: Greedy Algorithms
Greedy problems and its complexity analysis: Optimal merge patterns, Huffman coding, Minimum spanning trees, Knapsack problem, Job sequencing with deadlines, Single source shortest path problem - Dijkstra's Algorithm

Unit-IV: Dynamic Programming
Dynamic programming problems and its complexity analysis: 0/1 Knapsack, Multistage graph, Bellman Ford Algorithm, Reliability design, Floyd-Warshall algorithm, Matrix Chain Multiplication, Longest Common subsequence.

Unit-V: Backtracking and Branch & Bound
Backtracking Approach: N-Queen's problem, Hamiltonian cycle, Graph coloring problem, Sum of Subset problem. Introduction to branch & bound method, examples of branch and bound method like15 puzzle traveling salesman problem, 0/1 knapsack. An introduction to P, NP, NP Complete and NP hard problems.

Text Books:
1. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction toAlgorithms, Second Edition, MIT Press/McGraw-Hill
2. E. Horowitz, S. Sahni, S Rajasekaran, Computer Algorithms, Galgotia Publications

Reference Books:
1. Saara Base, Computer Algorithms: Introduction to Design and Analysis, Addision Wesley.
2. A V Aho, J E Hopcroft & J D Ullman, The Design and Analysis of Computer Algorithms,Addison Wesley.

Course Code	Course Name	Hours Per Week			
		L	T	P	Credits
CS3CO15	Object Oriented Analysis and Design	3	1	2	5

Unit I

Structure of Complex Systems, Object Oriented Development Methods, Characteristics of Objects, Fundamental Concepts of Object orientation, UML- Overview, RUP and its Phases

Unit II

Models, Concepts in UML, Structural and Behavioral Models, Use Cases and functional Requirements, Use Case Descriptions,Classes, Relationships, Association, Generalization, Realization, Dependencies, Constraints

Unit III

State Machine View, Activity View, Interaction View, Sequence Diagram, Collaboration Diagram, Interaction Diagrams

Unit IV

Physical View, Component Diagram, Deployment Diagram, Package, Dependencies on Packages, Modelling System and Subsystems, Patterns and Types of Patterns, Applying Patterns

Unit V

Object Oriented Testing, Types of Testing, Quality Assurance Methods, Reusability, Reverse Engineering, Case Studies

Text Book:

1. Grady Booch, Object Oriented Analysis and Design with Applications, Addison Wesley
2. James Rambaugh, Ivar Jacobson, Grady Booch, The Unified Modelling Language Reference Manual, Addison Wesley

Reference Book:

1. Design Patterns - Elements of Reusable Object-Oriented Software, Gamma, et. al., Addison-Wesley.
2. Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and IterativeDevelopment, by Craig Larman, Pearson Education.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3CO27	Compiler Design	3	0	2	4

Unit I

Compiler structure: Pass Structure of compiler, Translators, Interpreter, Assembler, Phases of Compilers, Symbol Table, Error Handling, Lexical Analyzer: Role of Lexical Analyzer, Specification of tokens, Recognition of tokens and input Buffering, The Syntactic Specification of Programming Languages, Cross Compiler, bootstrap Compiler.

Unit II

Ambiguous Grammar, LL(0) and LL(1) grammar, Parsing, Basic Parsing Techniques: Top Down parsers, Recursive Descent Parsers, First() and Follow(), Recursive and Non- Recursive Predictive Parsers.

Unit III

LR Grammar, Operator Grammar, Bottom Up Parsing: Operator precedence parsing, LR(0) parsers, Construction of SLR, Canonical LR and LALR parsing tables.

Unit IV

Syntax Directed Definition, Translation Scheme, Synthesized and inherited attributes, dependency graph, Construction of syntax trees, S-attributed and L-attributed definitions, Three address codes, quadruples, triples and indirect triples, Translation of assignment statements.

Unit V

Storage organization, activation trees, activation records, allocation strategies, Parameter passing symbol table, dynamic storage allocation, Basic blocks and flow graphs, Optimization of basic blocks, Loop optimization, Global data flow analysis, Loop invariant computations.

Text Book:
1. Alfred V. Aho, and J.D. Ullman, Principle of Compiler Design, Narosa Publication.
2. A.Barret William and R.M. Bates, Compiler construction (Theory and Practice), Galgotia Publication.

Reference Book:
1. A.C. Holub, Compiler design in C, PHI.
2. O.G. Kakde, Compiler Design, Laxmi Publications

Course Code	Course Name	Hours Per Week				
CS3EL08	Programming with XML	**L**	**T**	**P**	**Hrs.**	**Credits**
		3	0	0	3	3

Unit-I: Introduction to XML
XML overview, Markup languages, Comparison with HTML, Usage, Rules for writing XML, XML syntax, Creating notebook XML, Tree structure of XML, Elements, Attributes and values, Root element, Child element, Nesting of elements, Empty elements, Adding attributes, Elements and Attributes uses, Writing comments, Predefined entities, XML tools, XML validation.

Unit-II: XML-DTDs (Document Type Definitions)
Document Type Definition, DTD syntax, Creating a DTD for notebook XML, Defining elements with children, Empty element, Number of occurrences, Defining choices, Attribute definitions, Internal and external DTD's, Validating XML with DTD, Pros and cons of using DTD.

Unit-III: XML-Schema
Introduction to Schema, Namespace, Schema definition, Data types, Simple and complex data types, Attributes definition, Restrictions on values, Creating schema definition for notebook XML, Link and Validate XML with schema.

Unit-IV: XSLT
Introduction to XSL, Layout of an XSL Document and Templates, Linking XSL to your XML Source, Transforming XML with XSLT, xsl:output, xsl:template, xsl:apply-templates, Looping over nodes using xsl:for-each, Apply conditions using xsl:if, Processing and output using xsl:value-of, Sorting nodes, Create a XSLT for notebook and XML file and generate output in different conditions.

Unit-V: XPath and Project
Introduction to XPath, Using XPath to navigate an XML document, Predicates.
Sample Project: Store the information of students in XML file, validate it using XML schema and display the information of students in HTML using XSLT with proper formatting and conditions like having enrollment number, name start with, having CGPA between, in sorted order, etc.

Text Books:
1. Introduction to XML V.1, O'Reilly Publication.
2. Deitel H.M., XML How to Program, Pearson Publication.
3. Uttam K. Roy, Web Technologies, Oxford University Press.

References
1. Michael J. Young, XML Step by Step, Microsoft Press; 2nd edition
2. Elliotte Rusty Harold, XML Bible Second Edition, Hungry Minds Publication.

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3EA03	Soft Computing	3	0	0	3	3

Unit- I: Concept of Computing Systems, Introduction to Soft Computing, Soft Computing vs. Hard Computing, Components of Soft Computing, Neural Networks: Structure and function of Biological Neuron and Artificial Neuron, Definition and characteristics of ANN, Training techniques in different ANNs, Activation functions, Different ANNs architectures, Introduction to basic ANN architectures: McCulloch & Pitts model, Perceptron Model, Linear separability, ADALINE and MADALINE.

Unit- II: Neural Network Architectures: Supervised Learning: Backpropagation Network architecture, Backpropagation algorithm, Limitation, Characteristics and Application of EBPA, Bidirectional associative memories (BAM), Unsupervised Learning: Hebbian Learning, Generalized Hebbian learning algorithm, Competitive learning, Self- Organizing Computational Maps: Kohonen Network, Applications of ANN to solve real world's problems.

Unit- III: Fuzzy Logic: Introduction to Fuzzy logic, Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications and inferences, Defuzzification techniques, Fuzzy logic controller design, Some applications of Fuzzy logic.

Unit- IV: Genetic Algorithms: Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques, Basic GA framework and different GA architectures, GA operators: Encoding, Crossover, Selection, Mutation, etc, solving single-objective optimization problems using GAs.

Unit- V: Hybrid Systems: Genetic Algorithm based Backpropagation Network, Fuzzy – Backpropagation, Fuzzy Logic Controlled Genetic Algorithms. Case studies. Case studies in Engineering

Text Book:
1. Sinha, N.K. and Gupta, M. M.: "Soft Computing and Intelligent Systems - Theory and Applications", Academic Press.
2. S. Rajasekaran and G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis, and Applications" , Prentice Hall of India, 2007.

Reference Books:
1. D. K. Pratihar, "Soft Computing", Narosa, 2008.
2. Jang, J-S. R., Sun,C-T, Mizutani, E.: "Neuro–Fuzzy and Soft Computing", Prentice Hall of India.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3EA06	Natural Language Processing	3	0	0	3

Unit-1

Introduction: Human languages, Main approach of NLP, Knowledge in speech and language processing, Ambiguity, Models and algorithms, Formal language and Natural Language, Regular Expression and automata.

Unit-2

Text Pre-processing, Tokenization, Feature Extraction from text, Morphology: Inflectional and Derivational, Finite state morphological parsing, Finite state transducer

Part of Speech Tagging: Rule based, Stochastic POS, Transformation based tagging.

Unit-3

Speech Processing: Speech and phonetics, Vocal organ, Phonological rules and Transducer, Probabilistic models: Spelling error, Bayesian method to spelling, Minimum edit distance, Bayesian method of pronunciation variation.

Unit-4

N-Grams: Simple N-Gram, perplexity, Smoothing, Backoff, Entropy, Parsing: Statistical Parsing, Probabilistic parsing, TreeBank.

Unit-5

Application: Sentiment analysis, Spelling correction, Word sense disambiguation, Machine translation, Text Classification, Question answering system.

Text Book:

1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing", Pearson Education.

2. James Allen, "Natural Language Understanding", Pearson Education.

Reference book:

1. Christopher D. Manning and Hinrich Schutze, "Foundation of statistical Natural Language Processing", MIT Press.

2. Mary Dee Harris "Introduction to Natural language Processing" ,Reston .

Course Code	Course Name	Hours Per Week				
	Big Data Engineering	**L**	**T**	**P**	**Hrs.**	**Credits**
CS3ED04		3	0	0	3	3

Unit 1: Foundations of Big Data Systems
Introduction to Big Data and its Applications Data Abstraction Linear data structures like Hashtables, Hashmaps, Bloom Filters Non-linear data structures like Binary Search Trees, KD Trees Distributed Algorithm Design Algorithm Design using MapReduce

Unit 2: Platforms for Big Data
Distributed Computing Environment for Big Data NoSQL databases for Big Data Storage Applications (HBase) Distributed Processing of data using MapReduce & Pig In-memory distributed processing using Apache Spark Data Storage on Cloud (Amazon S3 & Dynamo DB)

UNIT 3: Processing Big Data – ETL & Batch Processing
Performing ETL Operations Concepts in Data Warehousing and its relevance for Big Data Ingesting data into Big Data Platforms using Sqoop & Flume Workflow management for Hadoop using OOZIE Batch Processing on Cloud

UNIT 4: Processing of Real Time Data & Streaming Data
Applications of Streaming Data in Industry Sourcing Streaming data using Apache Flume Building real-time data pipelines using Apache Storm Streaming on Apache Spark

UNIT 5: Big Data Analytics
Regression, Clustering & Classification using Spark MLLib Building visualizations using Big Data Case Studies on applications of Big Data Analytics

Text Books
1. Mayank Bhushan, Big Data and Hadoop- Learn by Example, BPB Publications
2. Erl/Khattak/Buhler, Big Data Fundamentals: Concepts Drivers and Techniques, Prentince Hall

References
1. Jeffrey Aven , Hadoop in 24 Hours, Sams Teach Yourself, SAMS Publications.
2. DT Editorial Services, Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization, Dream Tech Publications

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3ED01	Database Application and Tools	3	0	0	3	3

UNIT I

Database Environment: Data versus information, traditional file processing, disadvantages, database approach, range of database application, advantages of database approach. Cost and risk factors, components of database environment, evolution of database system.
Database Development Process: Information engineering, information architecture, enterprise data model, planning, SDLC, CASE etc. Steps of planning, strategic planning factors, corporate planning objects. Developing preliminary data model, and use of planning matrices, SDLC steps, CASE role, people in database development, three-schema architecture for database development. Examples to demonstrate the development process.

UNIT II
Modeling Data in the Organization: Modeling of the rules of organization, data names and definitions, ER model constructs entities and its types, attributes, relationships, degree, unary, binary, ternary, n-ary, cardinalities constraints, ER modeling examples.
Enhanced ER modeling: supertype, subtypes, specialization, generalization, specifying constraints in EER models, completeness, Disjointness, discriminators, defining super/sub type hierarchies, EER modeling examples, live demos modelling for few scenarios.

UNIT III
Logical database design: and relational model development, Relational model properties, keys, primary, secondary, composite, properties of relations. Codd's rules, integrity constraints, creating relational tables, Transform EER diagrams into relations, seven different steps for mapping EER model into relations.

UNIT IV
Introduction to normalization: steps, functional dependencies, basic normal forms, definition of first, second, third normal form and removing anomalies from the relations. De-normalization and merging relations.

UNIT V
Special Topics (Overview) : Data Warehousing, Data Mining, Distributed Databases, Object oriented modeling, definitions, activities in phases of model development, advantages of OOM, UML class diagrams, Example of a model development.

Text Book:
1. Hoffer, Prescott, "Modern Database Management", Seventh Edition, McFadden Pearson Education.

Reference Book(s):
1. Thomas M. Connolly, Carolyn E. Begg, "Database Systems", Pearson Education.
2. Raghu R and Johannes G., "Database management Systems", Mc Hill 3rd Edition, 2002.
3. Elmasri R, Navathe S, "Fundamentals of Database Systems", Addison Wesley

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3EL06	Internet of Things	3	0	0	3

Unit-I

Introduction : Definition, Characteristics of IoT, IoT Architectural view, Physical design of IoT, IoT Protocols, Communication Models of IoT, IoT Communication APIs, IoT Enabling Technologies.

Unit-II

IoT and M2M: Machine-to-Machine (M2M), Difference between M2M and IoT, SDN (Software Defined Networking) and NFV (Network Function Virtualization) for IoT, Data Storage in IoT, IoT Cloud Based Services.

Unit –III

IoT Platform Design Methodology: Specifications of Purpose and Requirement, Process, Domain Model, Information Model, Service, IoT Level, Functional View, Operational View, Device and Component Integration, Application Development.

Unit –IV

Security issues in IoT: Introduction, Vulnerabilities, Security requirements and threat analysis, IoT security Tomography, layered attacker model, identity management and establishment, access control.

Unit-V

Application areas of IoT: Home Automation, smart lighting, home intrusion detection, smart cities, smart parking, environment, weather monitoring system, agriculture.

Text Books:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach",

   Universities Press.

2. Rajkamal,"Internet of Things", Tata McGraw Hill publication

Reference Books:

1. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley

2. Donald Norris "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black", McGraw Hill publication.

Open Learning Source:

1. https://nptel.ac.in/courses/106105166/

2. https://github.com/connectIOT/iottoolkit

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
CS3EY04	Principle of Virtualization	3	0	0	3

Unit I: Introduction

Introduction to Virtualization - Types of virtualization - Difference between cloud and virtualization - Physical infrastructure and virtual infrastructure - Virtualization approaches - Partitioning - Hosting - Isolation - Hardware independence - Virtual machine - Hypervisor - Types of hypervisor - Virtual machine manager - Types of hypervisor - Introduction to datacenter virtualization Esxi - Difference between Esxi and Esx - Versions of Esxi - Installation and configuration of Esxi 6.0 - vSphere 6.0

Unit II: Components of vSphere 6.0

Components of VMware vSphere - vSphere 6.0: Overview and Architecture - Topology of vSphere 6.0 Data Center - vSphere 6.0 Configuration MaximumsvCenter Server - vCenter Server Features - Certificate Management - Alarms and Alerts - Monitoring Features - Template Management - Linked Mode Deployment - Storage Features in vSphere - Shared Storage - Storage Protocols - Datastores - Virtual SAN - Virtual Volumes - Networking Features in vSphere - Virtual Networking - Virtual Switches and its types

Unit III: Features of vSphere and NSX

vSphere Resource Management Features - vMotion - Distributed Resource Scheduler (DRS) - - Distributed Power Management (DPM) - Storage vMotion - Storage DRS - Storage I/O Control - Network I/O Control - vSphere Availability Features - vSphere Data Protection - High Availability - Fault Tolerance - vSphere Replication - Introduction to NSX.

Unit VI: VSphere Solutions to Data Center Challenges and vSphere Security.

Challenges - Availability Challenges - Scalability Challenges - Management Challenges - Optimization Challenges - Application Upgrade Challenges - Cloud Challenges - Security - Describe the features and benefits of VMware Platform Services Controller - Configure ESXi host access and authorization - Secure ESXi - vCenter Server - and virtual machines - Upgrade ESXi and vCenter Server instances

Unit V: Resource optimization and resource management

Network Optimization - Configure and manage vSphere distributed switches - Migrate virtual machines from standard switches to distributed switches - Explain distributed switch features such as port mirroring - LACP - QoS tagging - and NetFlow - CPU Optimization - Explain the CPU scheduler operation - NUMA support - and other features that affect CPU performance - Monitor key CPU performance metrics - Memory Optimization - Explain ballooning - memory compression - and host swapping techniques for memory reclamation when memory is overcommitted - Monitor key memory performance metrics - Storage Optimization - Diagnose storage access problems - Configure VMware vSphere Flash Read Cache - Monitor key storage performance metrics

Text Books:

1. Virtualization Essentials Paperback – 26 Apr 2012 by Matthew Portnoy - wiley publications

2. VMware Cookbook Paperback – 17 Jul 2012 by Troy - Shroff/O'Reilly; Second edition (17 July 2012)

Reference Book:

1. Mastering VMware vSphere 5.5 (SYBEX) Paperback – 2014 by Scott Lowe, Nick Marshall, Forbes Guthrie , Matt Liebowitz , Josh Atwell - Wiley (2014) edition.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
CS3EY05	Ethical Hacking	3	0	0	3

Unit I: Introduction to Ethical Hacking

Ethical Hacking, why is it necessary, scope and limitations, skills required, phases of ethical hacking, tools and techniques, Black Box, Gray Box and White Box techniques, differences between vulnerability assessment, ethical hacking and penetration testing, Reverse engineering, Ethical hacking terminology, Exploit, Vulnerability – Zero-day, manual PT, Case Studies on data breaches and cybercrimes involving hacking

Unit II: Ethical Hacking through Attacks and Exploits

EH methodology, attacks, exploits, Denial of Service, Sniffers, malware, Session Hijacking and ethical hacking of Web Servers and applications, Password Cracking, Key Logger, Hash Injection attack, replay and man-in-the-middle attacks, rainbow table attack, distributed network attack, spoofing, phasing, spyware, rootkits, hiding files, counter measures

.Unit III: Web and Network Hacking
Enumeration and scanning, host discovery, type of scanning – TCP SYN, ACK, XMAS & UDP Port scanning, SQL Injection, Social Engineering, Buffer Overflows, Input data validation, physical penetration attacks, Hacking Wireless Networking, Hacking mobile platforms, Windows and Linux Hacking, Evading IDS, Firewalls and Honeypots, DDoS attacks, using metasploit, counter measures.

Unit VI: Report Writing & Mitigation

Introduction to Report Writing & Mitigation, requirements for low level reporting & high-level reporting of Penetration testing results, Demonstration of vulnerabilities and mitigation of issues identified including tracking, CVSS scoring for vulnerabilities, rating and prioritization, impact of these in reporting**.**

Unit V: Ethical Hacking and Legal System

Overview of India's Information Technology Amendment Act 2008 (IT Act 2008), hacker vs cracker, liabilities – civil and penal, cyber theft and IPC sec 378, IT Act 2008 – sections 43, 65 and 66, how to file a complaint of suspected hacking, Case Studies, understanding how hacking is legally dealt with among BRICS countries

Text Books:

1. Gray Hat Hacking The Ethical Hackers Handbook, 3rd Edition Paperback – 1 Jul 2017 by Allen Harper, Shon Harris, Jonathan Ness, Chris Eagle, McGraw Hill Education; 3 ed (1 July 2017)
2. CEH v9: Certified Ethical Hacker Version 9 Study Guide by Sean-Philip Oriyano, Sybex; Stg edition (17 June 2016)
3. Hacking for Beginners: Ultimate 7 Hour Hacking Course for Beginners. Learn Wireless Hacking, Basic Security, Penetration Testing by Anthony Reynolds, CreateSpace Independent Publishing Platform (10 April 2017)
4. An Ethical Guide To WI-FI Hacking and Security by SwaroopYermalkar, BecomeShakespeare.com; First edition (15 August 2014)

5. Hands-On Ethical Hacking and Network Defense by Michael T. Simpson | Kent Backman | James Corley, Cengage India 1st edition (2016)

Reference Book:
1. The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy by Patrick Engebretson, Syngress; 2 edition (12 September 2013)
2. Hacking With Python: The Complete Guide to Ethical Hacking, Basic Security, Botnet Attack, Python hacking and Penetration Testing Kindle Edition by John C. Smalls.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
CS3ET07	Machine Learning	3	0	0	3

Unit I: Introduction to Machine Learning Algorithms

Introduction to Machine learning – Statistical Learning – types of Machine Learning –learning models: geometric, probabilistic and logistic models, introduction to supervised, unsupervised and reinforcement learning – model evaluation – model implementation – model accuracy indicators.

Unit II: Supervised Learning – Simple Linear Regression Analysis

Introduction to parametric machine learning method, assumptions of parametric machine learning methods, linear model and its assumptions, simple linear regression, scatter diagram, Simple linear Regression parameter estimation, properties of regression parameters, testing the significance of regression parameters using ANOVA and t test, estimation of σ^2, Interval Estimation of the Mean Response, R Square, Adjusted R Square, Normality of response variable, prediction of new observations, Confidence interval for β_0, β_1 and σ^2.

Unit III: Supervised Learning – Multiple Linear Regression Analysis I

Multiple linear regression model, assumptions of Multiple linear regression variables – multicollinearity, homoscedasticity, autocorrelation, effects of multicollinearity, effect of homoscedasticity and auto autocorrelation in parameter estimation, Least - Squares Estimation of the Regression Coefficients, Geometrical Interpretation of Least Squares, Properties of the Least - Squares Estimators, Estimation of σ^2, Inadequacy of Scatter Diagrams in Multiple Regression.

Unit IV:Supervised Learning – Multiple Linear Regression Analysis II

testing the general linear hypothesis, Test for Significance of Regression, Tests on Individual Regression Coefficients and Subsets of Coefficients, Special Case of Orthogonal Columns in X, Confidence Intervals on the Regression Coefficients, CI Estimation of the Mean Response, Simultaneous Confidence Intervals on Regression Coefficients, predicting new observations, residual analysis, model adequacy and validation.

Unit V: Supervised Learning – Non Linear Regression Analysis

Introduction to non-linear regression models, non-linear least square method to estimating the regression parameters, transformation of non-linear model to linear model, linearization, other parameter estimation methods, starting values, statistical inference in non-linear regression models

Text Books

1. Introduction to Linear Regression Analysis, Fifth Edition - DOUGLAS C. MONTGOMERY, ELIZABETH A. PECK, G. GEOFFREY VINING, A JOHN WILEY & SONS, INC., PUBLICATION
2. Introduction to Machine Learning - EthemAlpaydm, The MIT Press

Reference Books

1. Python Machine Learning - Sebastian Raschka, PACKT Publishing
2. Using Multivariate Statistics - Barbara G. Tabachnick, Linda S. Fidell, Pearson Education Inc

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
CS3ET05	Big Data Analytics	3	0	0	3

Unit I: Understanding BigData

Defining Data, Types of Data, Structured Data, Semi Structured Data, Unstructured Data, How data being Generated, Different source of Data Generation, Rate at which Data is being generated, Different V's, Volume, Variety, Velocity, Veracity, Value, How single person is contributing towards BigData, Significance for BigData, Reason for BigData, Understanding RDBMS and why it is failing to store BigData. Future of BigData, BigData use cases for major IT Industries.

Unit II : Introduction to Hadoop

What is Hadoop, Apache Community, Cluster, Node, Commodity Hardware, Rack Awareness, History of Hadoop, Need for Hadoop, How is Hadoop Important, Apache Hadoop Ecosystem, Different Hadoop offering , Hadoop 1.x Architecture, Apache Hadoop Framework, Master- Slave Architecture, Advantages of Hadoop.

Unit III:Storage Unit

Hadoop Distributed File System, Design of HDFS, HDFS Concept, How files are stored in HDFS, Hadoop File system, Replication factor, Name Node, Secondary Name Node, Job Tracker, Task tracker, Data Node, FS Image, Edit-logs, Check-pointing Concept, HDFS federation, HDFS High availability, Architectural description for Hadoop Cluster, When to use or not to use HDFS, Block Allocation in Hadoop Cluster, Read operation in HDFS, Write operation in HDFS, Hadoop Archives, Data Integrity in HDFS, Compression & Input Splits.

Unit IV: Processing Unit

What is MapReduce, History of MapReduce, How does MapReduce works, Input files, Input Format types Output Format Types, Text Input Format, Key Value Input Format, Sequence File Input Format, Input split, Record Reader, MapReduce overview, Mapper Phase, Reducer Phase, Sort and Shuffle Phase, Importance of MapReduce

Data Flow, Counters, Combiner Function, Partition Function, Joins, Map Side Join, Reduce Side Join, MapReduce Web UI, Job Scheduling, Task Scheduling, Fault Tolerance, Writing MapReduce Application, Driver Class, Mapper Class, Reducer Class, Serialization, File Based Data Structure, Writing a simple MapReduce program to Count Number of words, MapReduce Work Flows

Unit V: YARN &Hadoop Cluster

YARN, YARN Architecture, YARN Components, Resource Manager, Node Manager, Application Master, Concept of Container, Difference between Hadoop 1.x and 2.x Architecture, Execution of Job in Yarn Cluster, Comparing and Contrasting Hadoop with Relational Databases

Cluster Specification, Cluster Setup and Installation, Creating Hadoop user, Installing Hadoop, SSH Configuration, Hadoop Configuration, Hadoop daemon properties, Different modes of Hadoop, Standalone Mode, Pseudo Distributed Mode, Fully Distributed Modes,

Text Book:

1.   Hadoop: The Definitive Guide, By: Tom White, O'REILLY

Reference Books:

1. Hadoop for Dummies, By: Dirk deRoos, Paul C. Zikopoulos, Bruce Brown, Rafael Coss, and Roman B. Melnyk, A Wiley brand
2. Hadoop in Action, Writer: Chuck Lam Published By: Manning Publications

Course Code	Course Name	Hours Per Week				
	R Programming	**L**	**T**	**P**	**Hrs.**	**Credits**
OE00051		3	0	0	3	3

Unit 1 - R basics
Introduction: Basic features of R, advantages of using R, Limitations, R resources, Arithmetic and objects, Math, Variables, and Strings, Vectors and Factors, Vector operations.

Unit 2 - Data structures in R
Data types, Arrays, Tables, Matrices: operations, Lists: operations, Data frames: creation, factors, reading.

Unit 3 - R programming fundamentals
Conditions and loops, Functions in R, Objects and Classes, Recursion, Debugging

Unit 4 - Working with data in R
Reading CSV and Excel Files, Reading text files, Writing and saving data objects to file in R, Reading in larger, Datasets, Exporting data. Interface to outside world.

Unit 5 – String & Dates in R, Graphics
String operations in R, Regular Expressions, Dates in R, Time in R, Graphics: one dimension plot, legends, function plot, box plot.

Text Books
1. Andrie de Vries , Joris Meys, R Programming For Dummies, Wiley Publications.
2. Roger D. Peng, R Programming for Data Science, Leanpub.

References
1. Emmanuel Paradis, R For Beginners, CRAN Publications.
2. Michael J. Crawley, The R Book, Wiley Publications.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
OE00015	Agile Development	3	0	0	3

Unit-I
Understanding Agile: Introduction to Agile Project Management, Agile Manifesto, Agile Principles, Agile Benefits: Product Development and customers, Development teams etc.

Unit-II
Agile Frameworks: Agile approaches, reviewing the big three: Lean, Extreme programming and Scrum. Putting Agile in action: Environment, Behaviors- Agile roles, New values, Team philosophy.

Unit-III
 Working in Agile: Planning in Agile, product vision, creating the product roadmap, refining requirement and estimates, release planning and Sprint planning.

Unit-IV
Managing in Agile: Managing Scope and procurement, managing time and cost, team dynamics and communication, managing quality and risk

Unit-V
Ensuring Agile Success: Building a foundation- Commitment, choosing the right project team members- Development team, scrum master etc. Being a change agent, Key benefits and key resources for agile project management.

Text Books:
5. Mark C. Layton, Agile Project Management For Dummies, Wiley publishers
6. Jim Robert Highsmith, Agile Project Management: Creating Innovative Products, Pearson education
7. Hitzler, Markus, Rudolph , Foundations of Semantic Web Technologies, Chapman & Hall/CRC
8. Allemang , Hendler , Semantic Web for the working Ontologist, Elsevier Pub

Reference Books:
4. Charles G. Cobb, Making Sense of Agile Project Management: Balancing Control and Agility, Wiley
5. Mike Cohn, Agile Estimating and Planning, Pearson
6. Liz Sedley and Rachel Davies, Agile Coaching, The Pragmetic Bookshelf

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00074	Cloud Web Services	3	0	0	3

UNIT I   CLOUD COMPUTING AS A SERVICE

Cloud Computing, Software-as-a-service: SaaS, Platform-as-a-service: PaaS, Hardware-as-a-service: HaaS, Infrastructure-as-a-service: IaaS, Google Cloud Infrastructure, Google File System, Search engine, Map Reduce, Grid Computing, Amazon Web Services, REST APIs, SOAP API, Query API, User Authentication, Connecting to the Cloud, Open SSH Keys, Tunneling / Port Forwarding, Simple Storage Service – S3,Overview,Buckets,Objects,ACL,Logging,Signed URI,S3 Applications, Elastic Cloud Compute - EC2.

UNIT II   NETWORKING BASICS

Overview, Keypairs, Network Types, LAN, Gateways and Router, IP Classes and Subnets, CIDR, Utilities, Instances Management, Image Management, Security groups, Amazon Elastic Block Storage - EBS, Ubuntu in the Cloud, Installation, Utilities, File system, Shell.

UNIT III PROGRAMMING AND CONTROL STRUCTURES

Programming, Control Structures, Event based Init Daemon, Apache Instances in EC2, Introduction, Installation and Running, Testing server and content, Configuring Apache, Directives, Virtual hosts, Amazon Simple Queue Service, Amazon Simple Notification Service, Amazon Simple DB, Amazon Relational Database Service, Mysql Server Replication in Cloud, Mysql Database,▪ Batch mode, Mysql Apache Integration, Storage Engines, Replication Basics, Availability and scalability, Caching, Proxy.

UNIT IV BACKUP AND RECOVERY

Backup and Recovery, Database Sharding, EC2 Applications, Web application design, Focus on Search Engine, Security, Firewall, Data, Network and Host, AWS EC2 Capacity Planning, Apache Servers, Mysql Servers.

UNIT V AMAZON CLOUD

Amazon Cloud Watch, Monitoring Tools, Amazon Cloud Front, Youtube, Amazon Elastic Load Balancing, Cluster Balancing, Amazon Auto Scaling, Apache Scaling, Mysql Scaling, Amazon Virtual Private Cloud, DHCP, DNS, NFS, NIS, Virtualization, Private Cloud for Enterprise, Hybrid Cloud for Enterprise.

TEXT BOOKS:

1. Cloud Computing: Principles and Paradigms, Editors: RajkumarBuyya, James Broberg, Andrzej M. Goscinski, Wiley, 2011

2. Visible Ops Private Cloud: From Virtualization to Private Cloud in 4 Practical Steps, Andi Mann, Kurt Milne, Jeanne Morain, IT Process Institute, Inc.; first edition (April 8, 2011)

REFERENCE BOOK:
1. Cloud Computing Explained: Implementation Handbook for Enterprises, John Roton, Recursive Press (November 2, 2009)

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00075	Exploratory Data Analytics	3	0	0	3

Unit I: Introduction to Data and its types

Definition and importance of data, classification of data : based on observation – Cross Sectional, times series and panel data, based on measurement – ratio, interval, ordinal and nominal, based on availability – primary, secondary, tertiary, based on structural form – structured, semi structured and unstructured, based on inherent nature – quantitative and qualitative, concepts on sample data and population, small sample and large sample, statistic and parameter, types of statistics and its application in different business scenarios, frequency distribution of data.

Unit II: Introduction to Exploratory Data Analysis (EDA)

Definition of EDA, difference between EDA with classical and Bayesian Analysis, comparison of EDA with Classical data summary measures, goals of EDA, Underlying assumptions in EDA, importance of EDA in data exploration techniques, introduction to different techniques to test the assumptions involved in EDA, role of graphics in data exploration, introduction to unidimensional, bidimensional and multidimensional graphical representation of data.

Unit III: Data Preparation

Introduction to data exploration process for data preparation, data discovery, issues related with data access, characterization of data, consistency and pollution of data, duplicate or redundant variables, outliers and leverage data, noisy data, missing values, imputation of missing and empty places, with different techniques, missing pattern and its importance, handling non numerical data in missing places.

Unit IV: Univariate Data Analysis

Description and summary of data set, measure of central tendency – mean: Arithmetic, geometric and harmonic mean – Raw and grouped data, confidence limit of mean, median, mode, quartile and percentile, interpretation of quartile and percentile values, measure of dispersion, concepts on error, range, variance, standard deviation, confidence limit of variance and standard deviation, coefficient of variation, mean absolute deviation, mean deviation, quartile deviation, interquartile range, concepts on symmetry of data, skewness and kurtosis, robustness of parameters, measures of concentration.

Unit V:Bivariate Data Analysis

Introduction to bivariate distributions, association between two nominal variables, contingency tables, Chi-Square calculations, Phi Coefficient, scatter plot and its causal interpretations, correlation coefficient, regression coefficient, relationship between two ordinal variables – Spearman Rank correlation, Kendall's Tau Coefficients, measuring association between mixed combination of numerical, ordinal and nominal variables.

Text Books

1. Exploratory Data Analysis – John W Tukey, Addison Wesley Publishing Company
2. Exploratory Data Analysis in Business and Economics - An Introduction Using SPSS, Stata and Excel – Thomas Cleff, Springer Publication

Reference Books

1. Graphical Exploratory Data Analysis - S.H.C. du Toit A.G.W. Steyn R.H. Stumpf, Springer Publication

2. Hand book of Data Visualization – Chun-houh Chen, Wolfgang Härdle, Antony Unwin, Springer Publication.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3EL03	Information Storage and Management	3	0	0	3

Unit-I Introduction to Storage Technology: Data proliferation, evolution of various storage technologies, Overview of storage infrastructure components, Information Lifecycle Management, Data categorization.

Unit-II Storage Systems Architecture: Intelligent disk subsystems overview, Contrast of integrated vs. modular arrays, Component architecture of intelligent disk subsystems, Disk physical structure components, properties, performance, and specifications, RAID levels & parity algorithms, hot sparing, Front end to host storage provisioning, mapping and operation.

Unit-III Introduction to Networked Storage: JBOD, DAS, NAS, SAN & CAS evolution and comparison. Applications, Elements, connectivity, standards, management, security and limitations of DAS, NAS, CAS & SAN.

Unit –I V Hybrid Storage solutions; Virtualization: Memory, network, server, storage & appliances. Data center concepts & requirements, Backup & Disaster Recovery: Principles Managing & Monitoring: Industry management standards (SNMP, SMI-S, CIM), standard framework applications, Key management metrics (Thresholds, availability, capacity, security, performance).

Unit-V Information storage on cloud :Concept of Cloud, Cloud Computing, storage on Cloud, Cloud Vocabulary, Architectural Framework, Cloud benefits, Cloud computing Evolution, Applications & services on cloud, Cloud service providers and Models, Essential characteristics of cloud computing, Cloud Security and integration.

Text Books:

1. G. Somasundaram & Alok Shrivastava (EMC Education Services) editors; Information Storage and Management: Storing, Managing, and Protecting Digital Information; Wiley India.
2. Ulf Troppens, Wolfgang Mueller-Friedt, Rainer Erkens, Rainer Wolafka, Nils Haustein; Storage Network explained : Basic and application of fiber channels, SAN, NAS, iSESI, INFINIBAND and FCOE, Wiley India.

References:

1. John W. Rittinghouse and James F. Ransome; Cloud Computing : Implementation , Management and Security, CRC Press, Taylor Frances Pub.
2. Nick Antonopoulos, Lee Gillam; Cloud Computing : Principles, System & Application, Springer.

Course Code	Course Name	Hours Per Week				
		L	**T**	**P**	**Hrs.**	**Credits**
CS3EA09	Graph Theory	3	0	0	3	3

Unit I
Introduction: Graphs- Introduction, Isomorphism, Sub Graphs, Walks, Paths, Circuits, Connectedness, Components, Euler Graphs, Hamiltonian Paths and Circuits, Trees- Properties of Trees, Distance and Centers in Tree, Rooted and Binary Trees. Special Classes of Graphs: Bipartite Graphs, Line Graphs, Chordal Graphs.

Unit II
Spanning Trees: Fundamental Circuits, Spanning Trees in a Weighted Graph, Cut Sets: Properties of Cut Set, All Cut Sets, Fundamental Circuits and Cut Sets, Connectivity and Separability, Network Flows, 1-Isomorphism, 2-Isomorphism, Combinational and Geometric
Graphs, Planer Graphs, Different Representation of a Planer Graph.

Unit III
Chromatic Number, Chromatic Partitioning, Chromatic Polynomial, Matching, Covering, Greedy Coloring Algorithm, Four Color Problem, Directed Graphs -Types of Directed Graphs, Digraphs and Binary Relations, Directed Paths and Connectedness, Euler Graphs.

Unit IV
Fundamental Principles of Counting, Permutations and Combinations, Binomial Theorem, Combinations with Repetition, Combinatorial Numbers, Principle of Inclusion and Exclusion, Derangement.

Unit V
Generating Functions, Partitions of Integers, Exponential Generating Function, Summation Operator, Recurrence Relations, First Order and Second Order, Non-homogeneous Recurrence Relations, Method of Generating Functions.

Text Books:

1. Narsingh Deo, "Graph Theory: With Application to Engineering and Computer Science", Prentice Hall of India, 2003.
2. Grimaldi R.P. "Discrete and Combinatorial Mathematics: An Applied Introduction", Addison Wesley, 1994.
3. Clark J. And Holton D.A, "A First Look at Graph Theory", Allied Publishers, 1995.

Reference Books:

1. Mott J.L., Kandel A. And Baker T.P. "Discrete Mathematics for Computer Scientists and Mathematicians", Prentice Hall of India, 1996.
2. Liu C.L., "Elements of Discrete Mathematics", Mc Graw Hill, 1985.
3. Rosen K.H., "Discrete Mathematics and Its Applications", Mc Graw Hill, 2007.

Course Code	Course Name	Hours Per Week				
		L	**T**	**P**	**Hrs.**	**Credits**
CS3ED03	Data Visualization	3	0	0	3	3

Unit I:
Introduction to data visualization, Look at Data, Data source, Visualizing data: Mapping data onto aesthetics, Data visualization: basic principles, Coordinate systems and axes, time series, and statistical data graphics.

Unit II:
Computer Visualization: Exploring Complex Information Spaces , Fisheye Views – Applications , Comprehensible Fisheye Views ,Fisheye Views for 3D data, Non Linear Magnification , Comparing Visualization of Information Spaces , Abstraction in Computer Graphics , Abstraction in User Interfaces.

Unit III:

Visualization in 1D, 2D, 3D, Trees, Web Works, Data Mapping, Encoding Data using Color, Encoding Data using Size, Data Visualization tools and its Applications, Stacked & Grouped Bar Chart, Stacked Area Chart & Streamgraph, Line Chart with Multiple Lines.

Unit IV:
Words and text visualization, Document visualization, Interactive 3D illustrations with Images and Text, Consistency of rendered – Images and their Textual labels, Zoom Techniques for Illustration Purpose, Interactive Handling of Images and Text, Continuous time-series visualization , Discrete event visualization.

Unit V:
Introduction to D3 Scales , Loading and Parsing Data with D3.js , Encoding Data with Marks and Channels , Rendering Marks and Channels with D3.js and SVG(Scalable Vector Graphics) , Reusable Dynamic Components using the General Update Pattern , Reusable Scatter Plot , Common Visualization Idioms with D3.js , Bar Chart, Vertical & Horizontal , Pie Chart and Coxcomb Plot, Line Chart , Area Chart.

Text Books:
1. Tamara Munzner , Visualization Analysis & Design (ISBN 9781466508910)
2. Thomas Strothotte, Computer Visualization,Graphics Abstraction and Interaction

Reference Books:
1. Scott Murray , Interactive Data Visualization for the Web
2. Colin Ware ―Information Visualization Perception for Design, Morga.
3. Stuart.K. Card, Jock.D. Mackinlay and Ben Shneiderman, ―Readings in Information Visualization Using Vision to Think, Morgan Kaufmann Pub.
4. Elijah Meeks , D3.js in Action
5. Jacques Bertin , Semiology of Graphics
6. Leland Wilkinson , The Grammar of Graphics
7. Hadley Wickham , ggplot2: Elegant Graphics for Data Analysis

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3EL04	Distributed Systems	3	0	0	3

Unit I
Introduction: Definition, Design Issues, Goals, Types of distributed systems, Centralized Computing, Advantages of Distributed systems over centralized system .Limitation of Distributed systems Architectural models of distributed system, Client-server communication, Introduction to DCE

Unit II
Distributed Objects and Remote Invocation: Communication between distributed objects Remote procedure call, Events and notifications, operating system layer Protection, Processes and threads, Operating system architecture. Introduction to Distributed shared memory, Design and implementation issue of DSM.Case Study: CORBA and JAVA RMI.

Unit III
Clock synchronization: Clocks, events and process states, Synchronizing physical clocks, Logical time and logical clocks, Lamport's Logical Clock, Global states, Distributed mutual exclusion algorithms: centralized, decentralized, distributed and token ring algorithms, election algorithms, Multicast communication.

Unit IV
Distributed File Systems: File service architecture, Distributed File Systems Implementation, Naming System, Network File System (NFS), Flat and nested distributed transactions, Atomic commit protocols, Concurrency control in distributed transactions, Distributed deadlocks.

Unit V
Scheduling -Issues in Load Distributing, Components for Load Distributing Algorithms, Different Types Distributed of Load Distributing Algorithms, Fault-tolerant services Highly available services, Introduction to Distributed Database and Multimedia system

Text Book:
1. G. Coulouris, J. Dollimore and T. Kindberg, Distributed Systems: Concepts and design, Pearson.
2. P K Sinha, Distributed Operating Systems: Concepts and design, PHI Learning.

Reference Book:
1. Tanenbaum and Steen, Distributed systems: Principles and Paradigms, Pearson.
2. Sunita Mahajan & Shah, Distributed Computing, Oxford Press.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3EA02	Digital Image Processing	3	0	0	3

Unit I

Imaging, Digital Image Processing, Fundamental Steps in Image Processing, Components of Image Processing System, Elements of Visual Perception, Structure of Human Eye, Image Sensing and Acquisition, Image Sampling and Quantization

Unit II

Imaging Geometry, Digital Geometry, Image Acquisition Systems, Different types of digital images Introduction to Fourier Transform and DFT, Properties of 2D Fourier Transform, FFT, Separable Image Transforms, Walsh – Hadamard, Discrete Cosine Transform, Haar, Slant – Karhunen – Loeve transforms.

Unit III

Basic Grey Level Transformations, Histogram Processing, Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Filter Methods, Segmentation of Grey Level Images, Water Shade Algorithm, Fuzzy Techniques for Intensity Transformation and Spatial Filtering

Unit IV

Color Image Processing, Color Models and Representation, Laws of Color Matching, Chromaticity Diagram, Color Enhancement, Color Image Segmentation, Color Edge Detection

Unit V

Image Compression: Lossy and Lossless Compression Schemes, Prediction Based Compression Schemes, Vector Quantization, Sub-Band Encoding Schemes, JPEG Compression Standard, Fractal Compression Scheme, Wavelet Compression Scheme, Fundamentals of Redundancies, Basic Compression Methods: Huffman Coding, Arithmetic Coding, LZW Coding, JPEG Compression Standard

Text Book:

1. Rafael C. Gonzalez, Richard E Woods, Digital Image Processing, Prentice Hall

2. Maria Petrou and Costas Petrou , Image Processing the Fundamentals, John-Wiley and Sons

Reference Book:

1. Tinku Acharya and Ajoy K. Ray, "Image Processing Principles and Applications", John Wiley & Sons

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3EA04	Pattern Recognition	3	0	0	3

Unit- I

Overview of pattern recognition, Supervised learning, Bayes Decision Theory: Minimum-error-rate classification, Classifiers, Decision surfaces, discriminant function; Decision trees: CART, Bayesian Belief Network.

Unit- II

Parameter Estimation Methods: Maximum-Likelihood estimation: Gaussian case; Bayesian parameter estimation: Gaussian case, Gibbs Algorithm, Hidden Markov Models (HMMs)

Unit- III

Dimensionality reduction: Problems of Dimensionality, Principal component analysis; Fisher discriminant analysis

NonParametric Technique : Parzen windows, k-nearest neighbour estimation.

Unit- IV

Unsupervised learning : Algorithms for clustering: K-Means, Unsupervised Bayesian learning, Criterion functions for clustering; Hierarchical, partitional and online clustering methods.

Unit- V

Support Vector Machines, Pattern recognition applications: Image analysis, Biometrics: Face and speech recognition, OCR.

Text Book:

1. Richard O. Duda, Peter E. Hart and D G. Stork, "Pattern Classification", Wiley.

2. Sergios Theodoridis and Konstantinos Koutroumbas, "Pattern Recognition", Academic Press.

Reference Books:

1. Tou and Gonzales, "Pattern Recognition Principles", Wesley Publication Company.

2. Earl Gose, Richard Johnsonbaugh, Steve Jost "Pattern Recognition and Image Analysis", PHI Learning.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
CS3EL05	Ad-hoc Networks	3	0	0	3

Unit 1:
Introduction to Ad hoc networks, Definition, characteristics features, applications, characteristics of wireless channel, architecture of Ad hoc network.

Unit 2:
Medium access protocol MAC, design issues, goals, classification, contention based protocols, IEEE standards 802.11, 802.15 and HIPERLAN.

Unit 3:
Routing protocols for Ad hoc Network, Design issues, classifications, Table driven routing protocol, Destination Sequenced Distance-Vector Routing Protocol, Cluster-Head Gateway switch routing protocol, On Demand routing protocol, Dynamic source routing protocol, Ad hoc On Demand Distance Vector Routing Protocol.

Unit 4:
Transport layer and security protocols for Ad hoc Network, design issues, goals, classifications, security in Ad hoc network, issues and challenges in security provisioning, Network security attacks.

Unit 5:
Secure routing in Ad hoc network, requirement, security aware Ad hoc routing protocols, Introduction to wireless sensor network, Applications of sensor network, comparison with Ad hoc wireless network.

Text Books

1. C. Siva Ram Murthy and B.S. Manoj, Ad Hoc Wireless Networks Architectures and Protocols, , Prentice Hall
2. Charles E. Perkins, "Ad hoc Networking," Addison-Wesley

Reference Books

1. Carlos de Morais Cordeiro and Dharma Agrawal, Ad Hoc and Sensor Networks: Theory and Applications, World Scientific
2. Mohammad Ilyas, The Handbook of Ad hoc Wireless Networks, CRC Press
3. C. K. Toh, Adhoc Mobile Wireless Protocol: Protocols and Systems, Pearson

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3ED02	Data Mining and Warehousing	3	0	0	3	3

UNIT-I: Introduction
Data warehousing Components –Building a Data warehouse, Need for data warehousing, Basic elements of data warehousing, Data Mart, Data Extraction, Cleanup, and Transformation Tools – Metadata. Star, Snow flake and Galaxy Schemas for Multidimensional databases, Fact and dimension data, Partitioning Strategy-Horizontal and Vertical Partitioning.

UNIT-II: Data Mining
Basics of Data Mining – Data mining techniques, KDP (Knowledge Discovery Process), Application and Challenges of Data Mining, Data Preprocessing: Overview, Data cleaning, Data integration, Data reduction, Data transformation and discretization.

UNIT-III: Association and Classification
Basic concepts, Pattern Mining: Apriori algorithm, FP-growth Algorithm; Generating association rules, Pattern evaluation methods, Multi-level and multi-dimensional pattern mining.Introduction, Decision tree induction, Bayes classification, Rule based classification, Advance classification methods: Bayesian belief networks, backpropogation etc.

UNIT-IV: Clustering
Clustering: Introduction, Types of clustering; Partition-based clustering: K-Means, K-Medoids; Density based clustering: DBSCAN, Clustering evaluation.
Mining Data Stream, Mining Time-Series Data, Mining Sequence Patterns in Transactional Database, Social Network analysis and Multirelational Data Mining.

UNIT-V: Business Analysis
Reporting and Query Tools and Application-Tool Categories-Need for Applications-SAS, KNIME, ORANGE, ETL, Data Quality, OLAP, Dimensional Modelling, Multidimesional Model, Multidimensional vs Multirelational OLAP, OLAP Tools

Text Books:
1. Han, Kamber and Pi, Data Mining Concepts & Techniques, Morgan Kaufmann, India, 2012.
2. Mohammed Zaki and Wagner Meira Jr., Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press.
3. Z. Markov, Daniel T. Larose Data Mining the Web, Jhon wiley & son, USA.

Reference Books:
1. Sam Anahory and Dennis Murray, Data Warehousing in the Real World, Pearson Education Asia.
2. W. H. Inmon, Building the Data Warehouse, 4th Ed Wiley India.

Course Code	Course Name	Hours Per Week				
		L	**T**	**P**	**Hrs.**	**Credits**
OE00051	R Programming	3	0	0	3	3

Unit 1 - R basics
Introduction: Basic features of R, advantages of using R, Limitations, R resources, Arithmetic and objects, Math, Variables, and Strings, Vectors and Factors, Vector operations.

Unit 2 - Data structures in R
Data types, Arrays, Tables, Matrices: operations, Lists: operations, Data frames: creation, factors, reading.

Unit 3 - R programming fundamentals
Conditions and loops, Functions in R, Objects and Classes, Recursion, Debugging

Unit 4 - Working with data in R
Reading CSV and Excel Files, Reading text files, Writing and saving data objects to file in R, Reading in larger, Datasets, Exporting data. Interface to outside world.

Unit 5 – String & Dates in R, Graphics
String operations in R, Regular Expressions, Dates in R, Time in R, Graphics: one dimension plot, legends, function plot, box plot.

Text Books
1. Andrie de Vries , Joris Meys, R Programming For Dummies, Wiley Publications.
2. Roger D. Peng, R Programming for Data Science, Leanpub.

References
1. Emmanuel Paradis, R For Beginners, CRAN Publications.
2. Michael J. Crawley, The R Book, Wiley Publications.

Course Code	Course Name	Hours Per Week			
		L	**T**	**P**	**Credits**
OE00015	Agile Development	3	0	0	3

Unit-I
Understanding Agile: Introduction to Agile Project Management, Agile Manifesto, Agile Principles, Agile Benefits: Product Development and customers, Development teams etc.

Unit-II
Agile Frameworks: Agile approaches, reviewing the big three: Lean, Extreme programming and Scrum. Putting Agile in action: Environment, Behaviors- Agile roles, New values, Team philosophy.

Unit-III
Working in Agile: Planning in Agile, product vision, creating the product roadmap, refining requirement and estimates, release planning and Sprint planning.

Unit-IV
Managing in Agile: Managing Scope and procurement, managing time and cost, team dynamics and communication, managing quality and risk

Unit-V
Ensuring Agile Success: Building a foundation- Commitment, choosing the right project team members- Development team, scrum master etc. Being a change agent, Key benefits and key resources for agile project management.

Text Books:
9. Mark C. Layton, Agile Project Management For Dummies, Wiley publishers
10. Jim Robert Highsmith, Agile Project Management: Creating Innovative Products, Pearson education
11. Hitzler, Markus, Rudolph , Foundations of Semantic Web Technologies, Chapman & Hall/CRC
12. Allemang , Hendler , Semantic Web for the working Ontologist, Elsevier Pub

Reference Books:
7. Charles G. Cobb, Making Sense of Agile Project Management: Balancing Control and Agility, Wiley
8. Mike Cohn, Agile Estimating and Planning, Pearson
9. Liz Sedley and Rachel Davies, Agile Coaching, The Pragmetic Bookshelf

Course Code	Course Name	Hours Per Week				
		L	**T**	**P**	**Hrs.**	**Credits**
OE00073	Cyber Security Fundamentals	3	0	0	3	3

Unit-I: Symmetric Ciphers

Symmetric Cipher model, Substitution techniques, Transposition techniques, Steganography, Block cipher principles, Data Encryption Standard, Confidentiality using symmetric encryption: Potential locations for confidentiality attacks, Link versus End-to-End Encryption.

Unit-II: Public key encryption and HASH functions

Public key Cryptosystems: Principles, applications and requirements, RSA algorithm Key Management: Distribution of Public keys and Secret keys, Diffie-Hellman key exchange. Message Authentication: Authentication requirements, Authentication Functions like Message Encryption, Message Authentication code and Hash Function. Requirement for a Hash function, simple hash function, Block chaining techniques, Brute-force attack.

Unit-III: Cybercrimes-I

Introduction and classification of Cybercrimes, Cyberattack and its types viz Passive attacks, Active attacks, Type of Malware and malware attack, Vulnerability and threads: Classification of Vulnerability(Technology weakness, Configuration weakness, Security policy weakness) , Types of threat (Unstructured, structured, external, internal etc), common cyber attack terms: Hacker, Cracker, Phreaker, Spammer, Phisher, white hat, black hat etc.

Unit-IV: Cybercrimes-II

Proliferation of mobile and wireless devices, attacks on mobile phone, Security challenges in mobile devices, Registry setting and RAS security for Mobile devices, Credit card fraud. Tools and Methods used in cybercrimes: Proxy anonymizers, Phishing, Password creaking, Keyloggers, Spywares, Virus, worms, Trojan Horses, Backdoors.

Unit-V: Cyberlaws and Forensics

Need of cyber laws, Basic Indian IT Act-2000 and its various sections, Amended IT Act-2000, Digital signature, Public key certificate . Digital forensics : Basics, investigation methods, reporting and management of evidence.

Text Books:
1. William Stallings, "Cryptography and Network Security – Principles and Practices",
    Prentice Hall
2. Mark Rhodes- Ousley, "Information Security: The Complete Reference", Tata McGraw Hill

Reference Books:
1. Rajkumar Buyya, James Broberg and Anderzej Goscinski, "Cloud Computing Principles and Paradigms", Willey

2. Behrouz A. Forouzan and Debdeep Mukhopadhyay, "Cryptography and Network Security", Tata McGraw Hill

| Subject Code | Subject Name | Hours per Week | | | Total |
		L	T	P	Credits
EN3HS04	Fundamentals of Management, Economics and Accountancy	3	0	0	3

Unit I: Concepts of Management
Definition, characteristics and importance of management; Management: Science or Art, Difference between Management and Administration, Levels of management, Functions of Management, Managerial Roles, Managerial skills and competencies; Decision Making: Definition, process and types; Decision making under certainty, uncertainty and risk; Cross cultural issues in management and challenges.

Unit II: Fundamentals of Marketing and Human Resource Management
Introduction to Marketing: Definition, importance, function and scope of marketing, Core concepts of marketing, Marketing concepts and orientations, Marketing environment, Marketing-mix, Holistic marketing concept, Customer Relationship Management (CRM).

Introduction to Human Resource Management (HRM): Nature, Scope, Objectives and Functions; Role of HR manager, Process and need for Human Resource Planning, Human resource policies, Changing role of Human Resource in India, Globalization and its impact on Human Resource.

Unit III: Fundamentals of Economics
Introduction to Economics: Definition, nature, scope and significance; Difference between micro and macro economics; Time value of money, Law of diminishing marginal utility; Theory of Demand and Supply, Price elasticity of demand; Meaning and types of costs, Law of variable proportions; Types of market structure; National income and related aggregates; Meaning and types of Inflation; Meaning and phases of business cycle.

Unit IV: Basic Accounting Principles
Accounting Principles and Procedure, Double entry system, Journal, Ledger, Trail Balance, Cash Book; Preparation of Trading, Profit and Loss Account; Balance sheet; Cost Accounting: Introduction, Classification of costs, Methods and Techniques of costing, Cost sheet and preparation of cost sheet; Breakeven Analysis: Meaning and its application.

Unit V: Fundamentals of Financial Management
Introduction of Business Finance: Meaning, Definition of Financial Management, Goals of Financial Management (Profit Maximization and Wealth Maximization), Modern approaches to Financial Management – (Investment Decision, Financing Decision and Dividend Policy Decisions).

Text Books
1. R. D. Agarwal, "Organization and Management", McGraw Hill Education.
2. P. C. Tripathy and P. N. Reddy, "Fundamentals of Management, Economics and Accountancy", Tata McGraw Hill
3. Kotler Philip and Keller Kevin Lane, "Marketing Management", Pearson

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3PC01	Project Work-I	0	0	8	0	4

A project encourages students to learn new techniques and technology which will be required in their professional place / industry and gain experience in the professional employment world. This program is an essential component in the curriculum of Engineering Bachelor Degrees at Medi-Caps University.

This course is also essential to keep in pace with the advancements and expectations of industry. The development life cycle of any project is essential component of learning in this course. Broadly, the objectives of the course may be defined as follows:

i. To implement his knowledge to realistic and practical problems
ii. To encourage students to work in synergetic collaboration within teams
iii. To develop professional attitude and critical thinking
iv. To learn organizational ethics and work culture
v. To apply his skills in the actual development scenario

Prerequisites: Nil

Procedure: Project Completion Stages

Project Analysis and design Plan

Stages	Concern	Timeline
Topic Selection	• Interest in a domain • Interest in technology • Research interest • Availability of resources • Time feasibility • Course / Skill sufficiency	
Finalizing the Choice	• Finalize Title • Finalize supervisor	1st week
Pre-Project Planning	• Synopsis • Estimations – Time and Features	2nd week
Analysis	• Software Requirement Specification • Presentation I	4th week
Design	• Software Design Specification • Presentation II	8th week
Implementation	Presentation – III	14th week
	Dissertation – I Report + Viva – Voce	End Sem exam (Evaluation by External examiner must)

Computer Science Engineering (Batch – 2016) Fourth Year Even Semester

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3PC02	Project Work-II	0	0	28	0	14

Project Implementation Plan

Finalizing the Choice for New Project/ Continuation of Old Project	• Finalize Title • Finalize supervisor • Presentation I	1st week
Implementation	• Interfaces • Databases • Full Implementation • Presentation II	6th week
Testing and Deployment	• Test Cases • Test Reporting • Presentation III	10th week
Report in Format (Spiral Binding)	• Evaluation by supervisor and 2 additional teachers	
Final Presentation	• Presentation IV • Assessment by Departmental Project Evaluation Committee	14th week At least one paper must be presented in an International Conference or Publication in referred Journal.
Final Report Binding	• Assessment by Departmental Project Evaluation Committee with one external member. At least three members including External Member will make the Quorum. • Viva – Voce	End semester Examination

1. For external projects there will be an external guide in addition to the allotted guide from the department.
2. The schedule of meeting with the supervisor shall be depending on the nature of project execution.

3. Interdisciplinary projects will have guided from concerned departments duly approved by the Dean (Engineering).

4. The project conducted in the location of the industries with more than 10 crores Turn Over will be accepted for valuation of project. Professor in charge Training / HoDs must verify the company details from www.mca.gov.in before accepting the report for valuation. It is not mandatory have publications for these students for the evaluation of project.

5. For Project– I Total marks is 200 (80+ 120).
    Project-II Total marks 500 (200+300).