



UNIVERSITY OF CALCUTTA

Notification No. CSR/34/19

It is notified for information of all concerned that the Syndicate in its meeting held on 08.08.2019 (vide Item No.55), subsequently confirmed by the Syndicate dated 27.08.2019 (Item No.01) approved new revised Syllabi of B.Sc. (Honours/General) in Computer Science under CBCS, under this University, as laid down in the accompanying pamphlet.

The above shall be effective from the Odd Semester Examinations, 2019.

SENATE HOUSE

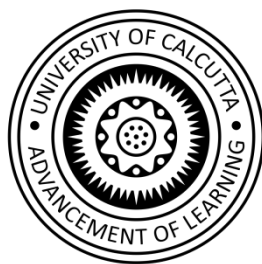
KOLKATA-700 073

The 20th September, 2019.

Prof.(Dr.) Debasis Das

Registrar (Acting)

S. Gayal
20.9.19



**UNIVERSITY
OF
CALCUTTA**

**SYLLABUS
of
Bachelor of Science (B. Sc.)
(Honours)
in
Computer Science (CMSA)
Choice Based Credit System (CBCS)
2018
SEMESTER – I - VI**

Semester - I

Course	Type	Course Code	Course Name	Credit
Core Course -1	Theory	CMS-A-CC-1-1-TH	Digital Logic	4
	Practical	CMS-A-CC-1-1-P	Digital Circuits	2
Core Course -2	Theory	CMS-A-CC-1-2-TH	Programming Fundamentals using C	4
	Practical	CMS-A-CC-1-2-P	Programming in C	2

Semester - II

Course	Type	Course Code	Course Name	Credit
Core Course -3	Theory	CMS-A-CC-2-3-TH	Data structure	4
	Practical	CMS-A-CC-2-3-P	Data structure using C	2
Core Course -4	Theory	CMS-A-CC-2-4-TH	Basic Electronic Devices and Circuits	4
	Practical	CMS-A-CC-2-4-P	Basic Electronic Devices and Circuits	2

Semester - III

Course	Type	Course Code	Course Name	Credit
Core Course -5	Theory	CMS-A-CC-3-5-TH	Computer Organization & Architecture	4
	Practical	CMS-A-CC-3-5-P	Computer Organization Lab	2
Core Course -6	Theory	CMS-A-CC-3-6-TH	Computational Mathematics	4
	Practical	CMS-A-CC-3-6-P	Computational Mathematics Lab	2
Core Course -7	Theory	CMS-A-CC-3-7-TH	Operating Systems	4
	Practical	CMS-A-CC-3-7-P	Operating Systems Lab	2
Skill Enhancement Course (SEC-A) (Candidate has to opt any one from the under mentioned courses)				
Course	Type	Course Code	Course Name	Credit
SEC-A-1	Theory	CMS-A-SEC-A-3-1-TH	Computer Graphics	2
SEC-A-2	Theory	CMS-A-SEC-A-3-2-TH	IoT (Internet of Things)	2

Semester - IV

Course	Type	Course Code	Course Name	Credit
Core Course -8	Theory	CMS-A-CC-4-8-TH	Data communication, Networking and Internet technology.	4
	Practical	CMS-A-CC-4-8-P	Computer Networking and Web Design Lab.	2
Core Course -9	Theory	CMS-A-CC-4-9-TH	Introduction to Algorithms & its Application.	4
	Practical	CMS-A-CC-4-9-P	Algorithms Lab.	2
Core Course - 10	Theory	CMS-A-CC-4-10-P	Microprocessor and its Applications.	4
	Practical	CMS-A-CC-4-10-P	Programming with Microprocessor 8085.	2
Skill Enhancement Course (SEC-B) Candidate has to opt any one from the under mentioned courses)				
Course	Type	Course Code	Course Name	Credit
SEC-B-1	Theory	CMS-A-SEC-B-4-1-TH	Information Security	2
SEC-B-2	Theory	CMS-A-SEC-B-4-2-TH	E-Commerce	2

Semester - V

Course	Type	Course Code	Course Name	Credit
Core Course -11	Theory	CMS-A-CC-5-11-TH	Database Management system (DBMS)	4
	Practical	CMS-A-CC-5-11-P	RDBMS lab using My SQL & PHP	2
Core Course -12	Theory	CMS-A-CC-5-12-TH	Object Oriented Programming (OOPs)	4
	Practical	CMS-A-CC-5-12-P	OOPs Lab using JAVA	2
Semester -V (DSE) Discipline Specific Elective Course - DSE-A(1&2)& DSE-B(1&2), (Candidates have to opt one course from DSE-A & one course from DSE-B)				
Course	Type	Course Code	Course Name	Credit
DSE-A-1	Theory	CMS-A-DSE-A-1-TH	Digital Image Processing	4
	Practical	CMS-A-DSE-A-1-P	Image processing Lab	2
DSE-A-2	Theory	CMS-A-DSE-A-2-TH	Data Mining & its Application	4
	Practical	CMS-A-DSE-A-2-P	Data Mining Lab	2
DSE-B-1	Theory	CMS-A-DSE-B-1-TH	Operation Research (O.R)	4
	Practical	CMS-A-DSE-B-1-P	Operation Research (O.R) Lab	2
DSE-B-1	Theory	CMS-A-DSE-B-2-TH	Programming using Python	4
	Practical	CMS-A-DSE-B-2-P	Programming in Python Lab	2

Semester - VI

Course	Type	Course Code	Course Name	Credit
Core Course -13	Theory	CMS-A-CC-6-13-TH	Software Engineering	4
Core Course -14	Theory	CMS-A-CC-6-14-TH	Theory of Computation	4
	Practical	CMS-A-CC-6-14-P	Project	4
Semester - VI (DSE) Discipline Specific Elective Course - DSE-A(3&4)& DSE-B (3&4) (Candidates have to opt one course from DSE-A & one course from DSE-B)				
Course	Type	Course Code	Course Name	Credit
DSE-A-3	Theory	CMS-A-DSE-A-3-TH	Embedded Systems	4
	Practical	CMS-A-DSE-A-3-P	Embedded Systems Lab	2
DSE-A-4	Theory	CMS-A-DSE-A-4-TH	Multimedia and its Application	4
	Practical	CMS-A-DSE-A-4-P	Multimedia and its Application Lab	2
DSE-B-3	Theory	CMS-A-DSE-B-3-TH	Introduction to Computational Intelligence	4
	Practical	CMS-A-DSE-B-3-P	Computational Intelligence Lab	2
DSE-B-4	Theory	CMS-A-DSE-B-4-TH	Advance Java	4
	Practical	CMS-A-DSE-B-4-P	Advance Java Lab	2

Semester - I

Course	Type	Course Code	Course Name	Credit
Core Course -1	Theory	CMS-A-CC-1-1-TH	Digital Logic	4
	Practical	CMS-A-CC-1-1-P	Digital Circuits	2
Core Course -2	Theory	CMS-A-CC-1-2-TH	Programming Fundamentals using C	4
	Practical	CMS-A-CC-1-2-P	Programming in C	2

CMS-A-CC-1-1-TH: Digital Logic

Core Course-1: Theory, Credits-04, Contact hours - 60.

Introduction to Computer fundamentals Central Processing Unit (CPU), Primary and Secondary Storage devices, I/O Devices, Classification of Computers: Super, Mainframe, Mini and Personal Computer, System and Application Software.	02 hours
Number Systems Weighted and Non - Weighted Codes, Positional, Binary, Octal, Hexadecimal, Binary Coded Decimal (BCD), Gray Codes, Alphanumeric codes, ASCII, EBCDIC, Conversion of bases, 1's, 2's complement representation, Parity bits. Single bit error detection and correcting codes: Hamming Code. Fixed and Floating Point Arithmetic: Addition, Subtraction, Multiplication and Division.	05 hours
Boolean Algebra Fundamentals of Boolean Expression: Definition of Switching Algebra, Basic properties of Switching Algebra, Huntington's Postulates, Basic logic gates (AND, OR, NOT), De-Morgan's Theorem, Universal Logic gates (NAND & NOR), Minterm, Maxterm, Minimization of Boolean Functions using K-Map up to four (4) variables, Two level and multilevel implementation using logic gates, simplification of logic expressions.	08 hours
Combinational Circuits Adder & Subtractor:- Design and Construction of Half adders (2-bit) & Subtractor (2-bit), Full Adder (3-bit) & Subtractor (3-bit) using basic logic gates (OR, AND, NOT) and universal logic gates (NAND & NOR). Multibit Adder:- Ripple Carry Adder, Carry Look Ahead (CLA) Adder, BCD Adder, design & construct 1'S & 2'S Complement Adder/Subtractor unit using 4-bit full adder units, 1-bit, 2-bit, 3-bit and 4-bit magnitude comparator using basic logic gates. Data Selector-Multiplexer: Expansion (Cascading), function realization, Universal function realization, Multifunction realization. Encoders:- Realization of simple Encoders and priority Encoders using Basic and Universal Logic gates. Data Distributor:- De-multiplexer, Cascading, realization of various functions.	20 hours

<p>Chip Selector/Minterm Generator - Decoder- Function Realization, BCD Decoders, Seven Segment Display and Decoders.</p> <p>Parity bit and Code Converters: Parity bit Generator/Checker, Gray to Binary code converter, Binary to Gray Code Converter.</p>	
<p>Sequential Circuits</p> <p>Latch: Set/Reset (SR) using NAND and NOR gates, Gated S-R latches, D Latch, J-K Latch, T Flip Flop, race around condition, Master-Slave J-K flip flop, Clock - Duty Cycle, rising time, falling time, negative and positive edge detector circuits, edge triggered SR, D and JK flip flop, flip-flop Conversions, flip-flops with preset/set and clear/reset asynchronous inputs.</p> <p>Registers: Serial Input Serial Output (SISO), Serial Input Parallel Output (SIPO), Parallel input Serial Output (PISO), Parallel Input Parallel Output (PIPO), Universal Shift Registers.</p> <p>Counters: Asynchronous Counter: UP/DOWN Counters, Mod - N Counters, BCD Counter (Counter Construction using J-K and T Flip Flops).</p> <p>Synchronous Counter: UP/DOWN Counters, Mod-N Counters, Ring & Johnson Counters.</p>	21 hours
<p>Integrated Circuits (Qualitative study only)</p> <p>Bipolar Logic Families: DTL, TTL NOT Gate, TTL NAND Gate, TTL NOR Gate, Open Collector, Fan-in, Fan-out.</p> <p>MOS Logic Families: NMOS, PMOS, CMOS, SSI, MSI, LSI and VLSI classification (concepts only).</p>	04 hours

CMS-A-CC-1-1-P: Digital Circuits

Core Course-1: Practical, Credits - 02, Contact hours - 40.

Combinational Circuits

1. Implementation of different functions (SOP, POS) using basic (AND, OR and NOT) logic gates.
2. Study and prove De-Morgan's Theorem.
3. Realization of Universal functions using NAND and NOR gates.
4. Implementation of half (2-bit) and full adder (3-bit) using basic (AND, OR and NOT) and Universal logic gates (NAND & NOR).
5. Implementation of half (2-bit) and Full Subtractor (3-bit) using basic (AND, OR and NOT) and Universal logic gates (NAND & NOR).
6. Design and implement 1-Digit BCD adder using 7483/74283 and other necessary logic gates.
7. Design 4 to 1 multiplexer using basic or Universal logic gates and implement half and full adder/subtractor.
8. Design and implement half and full adder /subtractor and other functions using multiplexers 74151/74153 and other necessary logic gates.
9. Cascading of Multiplexers.
10. Design 2 to 4 decoder using basic or universal logic gates.
11. Study 74138 or 74139 and implement half and full Adder/Subtractor and other functions.

12. Implementation of 1-bit magnitude comparator using decoders (74138/74139) and other necessary logic gates.
13. Cascading of Decoders.
14. Study magnitude comparators 7485.
15. Design and construct magnitude comparator (2-bit) using basic (AND, OR & NOT) and universal (NAND/NOR) logic gates.
16. Design a display unit using Common anode or cathode seven segment display and decoders (7446/7447/7448)
17. Design and implement 4-input 3-output (one output as valid input indicator) priority encoder using basic (AND, OR & NOT) logic gates.
18. Study Priority Encoder IC 74147/74148.
19. Design a parity generator and checker using basic logic gates

Sequential Circuits

1. Realization of SR, D, JK Clocked/Gated, Level Triggered flip-flop using basic or Universal logic gates.
2. Conversion of flip-flops: D to JK, JK to D, JK to T, SR to JK, SR to D Flip-flop.
3. Design synchronous and asynchronous counters MOD-n (MOD-8, MOD-10) UP/ DOWN and connecting Seven Segment Display along with decoder for display of counting sequence.
4. Construction of ODD/EVEN n-bit Synchronous Counter, where n is maximum 4.
5. n-bit binary arbitrary sequence synchronous counter where n is maximum 4.

Text/Reference Books

1. Digital Circuits, Vol - I & II, D. Ray Chaudhuri, Platinum Publishers.
2. Digital Systems - Principle & Applications, Tocci&Widmer, EEE.
3. Digital Logic & State Machine Design, Comer, Oxford.
4. Digital Principle & Applications, Malvino& Leach, McGraw Hill.
5. Digital Design, Morris Mano, PHI.
6. Digital Integrated Electronics, H.Taub & D.Shilling, McGraw Hill.
7. Digital Circuits and Design, Salivahan, Vikas.

CMS-A-CC-1-2-TH: Programming Fundamentals using C

Core Course-2: Theory: 04 Credits: 60 hours

Introduction: History, Basic Structure, Algorithms, Structured programming constructs.	04 hours
C Programming elements: Character sets, Keywords, Constants, Variables, Data Types, Operators-Arithmetic, Relational, Logical and Assignment; Increment and Decrement and Conditional, Operator Precedence and Associations; Expressions, type casting. Comments, Functions, Storage Classes, Bit manipulation, Input and output.	08 hours
C Preprocessor: File inclusion, Macro substitution.	06 hours
Statements: Assignment, Control statements- if, if else, switch, break, continue, goto, Loops-while, do while, for.	06 hours

Functions: Argument passing, return statement, return values and their types, recursion	06 hours
Arrays: String handling with arrays, String handling functions.	07 hours
Pointers: Definition and initialization, Pointer arithmetic, Pointers and arrays, String functions and manipulation, Dynamic storage allocation.	10 hours
User defined Data types: Enumerated data types, Structures. Structure arrays, Pointers to Functions and Structures, Unions	07 hours
File Access: Opening, Closing, I/O operations.	06 hours

CMS-A-CC-1-2-P: Programming with C

Core Course-2: Practical: 02 Credits: 40 hours

1. WAP to print the sum and product of digits of an integer.
2. WAP to reverse a number.
3. WAP to compute the sum of the first n terms of the following series,
 $S=1+1/2+1/3+1/4+.....$
4. WAP to compute the sum of the first n terms of the following series, $S = 1-2+3-4+5+.....$
5. Write a function that checks whether a given string is Palindrome or not. Use this function to find whether the string entered by user is Palindrome or not.
6. Write a function to find whether a given no. is prime or not. Use the same to generate the prime numbers less than 100.
7. WAP to compute the factors of a given number.
8. Write a macro that swaps two numbers. WAP to use it.
9. WAP to print a triangle of stars as follows (take number of lines from user):


```

          *
        ***
      *****
    *********
  ***********

```
10. WAP to perform following actions on an array entered by the user :
 - i) Print the even-valued elements
 - ii) Print the odd-valued elements
 - iii) Calculate and print the sum and average of the elements of array
 - iv) Print the maximum and minimum element of array
 - v) Remove the duplicates from the array
 - vi) Print the array in reverse order

The program should present a menu to the user and ask for one of the options. The menu should also include options to re-enter array and to quit the program.
11. WAP that prints a table indicating the number of occurrences of each alphabet in the text entered as command line arguments.
12. Write a program that swaps two numbers using pointers.

13. Write a program in which a function is passed address of two variables and then alter its contents.
 14. Write a program which takes the radius of a circle as input from the user, passes it to another function that computes the area and the circumference of the circle and displays the value of area and circumference from the main() function.
 15. Write a program to find sum of n elements entered by the user. To write this program, allocate memory dynamically using malloc() / calloc() functions or new operator.
 16. Write a menu driven program to perform following operations on strings:
 - a) Show address of each character in string
 - b) Concatenate two strings without using strcat function.
 - c) Concatenate two strings using strcat function.
 - d) Compare two strings
 - e) Calculate length of the string (use pointers)
 - f) Convert all lowercase characters to uppercase
 - g) Convert all uppercase characters to lowercase
 - h) Calculate number of vowels
 - i) Reverse the string
 17. Given two ordered arrays of integers, write a program to merge the two-arrays to get an ordered array.
 18. WAP to display Fibonacci series (i) using recursion, (ii) using iteration.
 19. WAP to calculate Factorial of a number (i) using recursion, (ii) using iteration.
 20. WAP to calculate GCD of two numbers (i) with recursion (ii) without recursion.
 21. Write a menu-driven program to perform following Matrix operations (2-D array implementation): a) Sum b) Difference c) Product d) Transpose
 22. Copy the contents of one text file to another file, after removing all whitespaces.
 23. Write a function that reverses the elements of an array in place. The function must accept only one pointer value and return void.
 24. Write a program that will read 10 integers from user and store them in an array. Implement array using pointers. The program will print the array elements in ascending and descending order.
 25. Add two distances in meter kilometer system using structure.
 26. Add two complex numbers using structures.
 27. Calculate the difference between two time periods using structures.
- These are only examples; more can be included related to the theory.
Use open source C compiler.

Text/Reference Books:

1. Programming with C, Byron S. Gottfried, McGraw Hill.
2. The C Programming Language, Kernighan and Dennis, PHI.
3. The Complete reference C, Herbert Schildt, McGraw Hill.
4. Let Us C, Kanetkar, BPB Publication.
5. Programming in ANSI C, Balaguruswamy, McGraw Hill.
6. Programming Languages, Allen B. Tucker, Tata McGraw Hill.

Semester - II

Course	Type	Course Code	Course Name	Credit
Core Course -3	Theory	CMS-A-CC-2-3-TH	Data structure	4
	Practical	CMS-A-CC-2-3-P	Data structure using C	2
Core Course -4	Theory	CMS-A-CC-2-4-TH	Basic Electronic Devices and Circuits	4
	Practical	CMS-A-CC-2-4-P	Basic Electronic Devices and Circuits	2

CMS-A-CC-2-3-TH: Data Structure

Core Course-3: Theory, Credits - 04, Contact hours - 60.

Introduction to Data Structure Abstract Data Type.	01 hour
Arrays 1D, 2D and Multi-dimensional Arrays, Sparse Matrices. Polynomial representation	05 hours
Linked Lists Singly, Circular and Doubly Lists, Polynomial representation.	09 hours
Stacks Array and linked representation of stack, Prefix, Infix and Postfix expressions, utility and conversion of these expressions from one to another, evaluation of postfix and prefix expression using stack, applications of stack, limitations of Array representation of stack.	05 hours
Queues Array and Linked representation of Queue, Circular Queue, De-queue, Priority Queues.	05 hours
Recursion Developing Recursive Definition of Simple Problems and their implementation; Advantages and Limitations of Recursion; Understanding what goes behind Recursion (Internal Stack Implementation), Tail recursion.	05 hours
Trees Introduction to Tree as a data structure: Binary Trees (Recursive and Iterative Traversals), Binary Search Tree (Traversal, Insertion, Deletion and Searching), Threaded Binary Trees (Traversal and advantages).	15 hours
Searching and Sorting Linear Search, Binary Search, Comparison of Linear and Binary Search with respect to time complexity, Selection Sort, Bubble sort, Insertion Sort, Merge Sort, Quick sort, Heap sort, Shell Sort, Radix sort, Comparison of Sorting Techniques with respect to time complexity.	10 hours
Hashing Introduction to Hashing, Different hashing Techniques, Collision and resolving collision by Open Addressing, Closed Hashing, Separate Chaining, Choosing a Hash Function.	05 hours

CMS-A-CC-2-3-P: Data Structure Lab using C.
Core Course- 3: Practical, Credits - 02, Contact hours - 40.

Lab based on Data Structure theory except Threaded Binary Tree, Shell Sort, Radix Sort and hashing

1. Write a program to search an element from a list. Give user the option to perform Linear or Binary search.
2. Write a program to sort a list of elements. Give user the option to perform sorting using Insertion sort, Bubble sort or Selection sort.
3. Implement Linked List. Include functions for insertion, deletion and search of a number, reverse the list and concatenate two linked lists.
4. Implement Doubly Linked List. Include functions for insertion, deletion and search of a number, reverse the list.
5. Implement Circular Linked List. Include functions for insertion, deletion and search of a number, reverse the list.
6. Perform Stack operations using Linked List implementation.
7. Perform Stack operations using Array implementation.
8. Perform Queue operations using Array and linked list implementation.
9. Create and perform different operations on Double-ended Queues using Linked List implementation.
10. Write a program to scan a polynomial using linked list and add two polynomials.
11. Write a program to create a Binary Search Tree and include following operations in tree:
 - (a) Insertion (Recursive and Iterative Implementation).
 - (b) Deletion.
 - (c) Search a node in BST.
 - (d) Display its preorder, postorder and inorder traversals recursively.
 - (e) Display its preorder, postorder and inorder traversals Iteratively.
 - (f) Display its level-by-level traversals.
 - (g) Count the non-leaf nodes and leaf nodes.
 - (h) Display height of tree.
 - (i) Create a mirror image of tree.
12. Write a program to reverse the order of the elements in the stack using additional stack.
13. Write a program to reverse the order of the elements in the stack using additional Queue.

Note: These are only sample programs; more can be included related to the theory.

Text/ Reference Books

1. Fundamentals of Data Structures in C, Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, University Press.
2. Data Structures: A Pseudocode Approach with C, Richard F. Gilberg and Behrouz A. Forouzan, Cengage Learning.
3. Data Structure using C, E Balagurusamy, McGraw Hill.
4. Data Structures Using C and C++, Aaron M. Tanenbaum, Moshe J. Augenstein, Yedidiah Langsam, PHI.
5. Classic Data Structures, Debasis Samanta, Second Edition, EEE, PHI.
6. Data Structures, Seymour Lipschutz, Schaum's Outlines, Tata McGraw Hill.
7. Data Structures Through C (A practical approach), G.S Baluja, Dhanpat Rai & Co.

CMS-A-CC-2-4-TH: Basic Electronic Devices and Circuits
Core Course-4: Theory, Credits - 04, Contact hours - 60.

Basics of Circuit Theory KVL, KCL, Thevenin's, Norton's, superposition, maximum power transfer theorem, application to simple problems.	04 hours
Theory of Semiconductor devices Semiconductor materials and their properties, classification based on energy band diagram, Intrinsic and extrinsic semiconductors, P & N type.	03 hours
Diode and its applications PN junction diode: Construction, characteristics and working principle, unbiased and biased band diagram, Single Phase Half and Full wave rectifier circuits, working principle, derivation and calculation of average dc current, average dc voltage, RMS, ripple factor, efficiency, Peak Inverse Voltage (PIV), Circuit and working of bridge rectifiers. Zener diode: Characteristics and its application as a voltage regulator, simple problems.	09 hours
Bipolar Junction Transistor Working Principle of Junction bipolar Transistor (including current components, current gains), Modes: Common Emitter (CE), Common Base (CB), Common Collector (CC), DC biasing in CE mode: Fixed bias, Emitter Stabilized bias, Voltage divider bias and Collector feedback bias, simple related numerical problems, Q-Point, dc load line analysis, single stage CE mode based transistor amplifying action (qualitative study). Inverter using transistors: Transistor as a switch, transfer characteristics and threshold voltages.	08 hours
Unipolar Junction Transistor Principle of JFET and MOSFET, Depletion and Enhancement mode operations, Concept of NMOS, PMOS and CMOS. CMOS circuits for basic logic gates (AND, OR, NOT, NAND and NOR).	08 hours
PNPN Devices Construction, characteristics, working and simple applications: SCR, DIAC, TRIAC. Power supply (qualitative study only): SCR regulated power supply, Switch Mode Power Supply (SMPS).	06 hours
Optoelectronic materials (Qualitative study) Construction and working: LED, LCD, Photo Sensors and basics of Optical fiber and Opto-couplers).	02 hours
Operational Amplifiers (OPAMP) Ideal Characteristics, Open loop operation, Single and double ended operation, Common mode operation, Common mode rejection ratio (CMRR), Offset parameters, Concept of Virtual ground. Application: Inverting, Non-inverting Amplifier, Inverting and Non-inverting Adder, Differentiator, Integrator, Scale changer and Schmitt Trigger. Signal Generation using OPAMP: Monostable, Astable (Square wave generator).	12 hours
Timer Construction and Functional description of 555, Mono-stable, Bi-stable and Astable Operation, VCO.	04 hours

Data Acquisition Digital to Analog Converter (DAC): R-2R ladder, Weighted resistor type. Analog to Digital Converters (ADC): Flash, Counter, Successive Approximation Register (SAR), Dual Slope type.	04 hours
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CMS-A-CC-2-4-P: Basic Electronic Devices and Circuits Lab.
Core Course-4: Practical, Credits - 02, Contact hours - 40.

1. Study the forward characteristic of a p-n junction diode and calculate the static and dynamic resistance.
2. Construct a Half wave rectifier using power diodes and study its load regulation characteristics with and without capacitor filter.
3. Construct a full wave rectifier using power diodes and study its load regulation characteristics with and without capacitor filter.
4. Construct a Bridge rectifier using power diodes and study its load regulation characteristics with and without capacitor filter.
5. Study the reverse characteristic of a Zener diode and calculate the Zener voltage from the characteristic curve and also calculate the value of current limiting resistance.
6. Construct a voltage regulator using Zener diode and study its load regulation characteristics.
7. Construct a positive and negative voltage regulator using three terminal linear voltage regulators 78XX and 79XX. Study its load regulation characteristics.
8. Construct a variable positive voltage regulator using three terminal linear voltage regulator LM317 and study its load regulation characteristics for different sets of output voltage.
9. Study the output characteristics of a transistor in CE mode and calculate the dc current gain (β) from the graph.
10. Realize a NOT operation using a Transistor. Draw its transfer characteristics and measure the threshold voltage.
11. Construct and study an Inverting amplifier using OPAMP with different sets of voltage gain and calculate the gain from the graph.
12. Construct and study a non-inverting amplifier using OPAMP with different sets of voltage gain and calculate the gain from the graph.
13. Construct and study an inverting adder using OPAMP capable of adding two inputs.
14. Construct and study a non-inverting adder using OPAMP capable of adding two inputs.
15. Construct and study a subtractor using OPAMP.
16. Construct and study the OPAMP as a subtractor.
17. Construct and study the OPAMP as a differentiator. Apply sine and square wave and study and record the output waveforms.
18. Construct and study the OPAMP as an integrator. Apply sine and square wave and study and record the output waveforms.
19. Construct an astable multivibrator using Timer 555.
20. Construct and study a R-2R ladder digital to analog converter.
21. Convert an analog signal into digital using ADC 0804/0808/0809.

Text/Reference Books

1. Electronic Devices & Circuits Theory, Boylestad & Nashelsky, Prentice Hall.
2. Electronics fundamental & Application, Chattopadhyay, Rakshit, New Age International Publishers.
3. Op-Amps and Linear Integrated Circuits, R. A. Gayakwad, Prentice Hall.

4. Linear Integrated Circuits, D. Roy Choudhury, Shail B. Jain, fourth edition, New Age International Publishers.
5. Solid State Electronic Devices, Streetman, PHI.
6. Elements of Electronics, Bagde Singh, S Chand Publication.
7. Microelectronic circuits, Sedra Smith, Oxford.
8. Operational Amplifier and Linear Integrated Circuits, Coughlin Driscoll.
9. Electronic Devices and Circuits, Salivahanan, Suresh Kumar, McGraw Hill education.

Semester - III

Course	Type	Course Code	Course Name	Credit
Core Course -5	Theory	CMS-A-CC-3-5-TH	Computer Organization & Architecture	4
	Practical	CMS-A-CC-3-5-P	Computer Organization Lab	2
Core Course -6	Theory	CMS-A-CC-3-6-TH	Computational Mathematics	4
	Practical	CMS-A-CC-3-6-P	Computational Mathematics Lab	2
Core Course -7	Theory	CMS-A-CC-3-7-TH	Operating Systems	4
	Practical	CMS-A-CC-3-7-P	Operating Systems Lab	2
Skill Enhancement Course (SEC-A) (Candidate has to opt any one from the under mentioned courses)				
Course	Type	Course Code	Course Name	Credit
SEC-A-1	Theory	CMS-A-SEC-A-3-1-TH	Computer Graphics	2
SEC-A-2	Theory	CMS-A-SEC-A-3-2-TH	IoT (Internet of Things)	2

CMS-A-CC-3-5-TH: Computer Organization and Architecture

Core Course- 5: Theory, Credits:04, Contact hours: 60.

Basic Structure of Computers (Qualitative Discussion) Computer Types, Basic Functional Units, Basic Operational Concept, Bus Structure, Software, Performance, Multiprocessor and Multicomputer, IAS Computer, Historical perspectives.	05 hours
Register Transfer and Micro-operation Register Transfer Language, Register Transfer, Bus and Memory Transfers, Three State Bus Buffers, memory Transfer, Arithmetic and Logical micro-operations, Shift and Arithmetic shifts.	05 hours
Basic Computer Organization and Design Instruction Codes, Stored Program Organization, Indirect Address, Computer Registers, Common Bus System, Computer Instruction, Timing and Control, Instruction Cycle, fetch Decode, Register Reference Instructions, Memory Reference Instruction, Input-Output and Interrupt, Design of Basic Computer, Design of Accumulator Logic.	05 hours
CPU Organization Arithmetic and Logic Unit (ALU)- Combinational ALU, 2'S Complement Addition, Subtraction Unit, Booths Algorithm for Multiplication, Division Hardware using Restoration Division Algorithm. General register organization, Control Word, Accumulator Based, Register Based, Stack Type CPU organization.	06 hours
Control Unit Hardwired Control Unit, Micro-programmed Control Unit: Control memory, Address Sequencing, conditional branching, mapping of instructions, subroutine, Design of Control Unit.	07 hours
CPU Registers Program Counter, Stack Pointer Register, Memory Address Register, Instruction Register, Memory Buffer Register, Flag registers, Temporary Registers.	06 hours
Instructions. Operational Code, Operands, Zero, One, Two and Three Address Instruction, Instruction Types, Addressing modes, Data Transfer and Manipulation instructions, Program control instructions.	03 hours

CISC and RISC processors Introduction, relative merits and De-merits.	03 hours
Computer Peripherals VDU, Keyboard, Mouse, Printer, Scanner (Qualitative approach).	08 hours
Input / Output Organization Polling, Interrupts, subroutines, Memory mapped IO, IO mapped IO, DMA, I/O Bus and Protocol, SCSI, PCI, USB, Bus Arbitration.	02 hours
Memory Primary memory: ROM, PROM, EPROM, EEPROM, Flash memory, RAM: SRAM, DRAM, Asynchronous DRAMs, Synchronous DRAMs, Structure of Larger Memories, RAMBUS Memory, Cache Memory: Mapping Functions, Replacement Algorithms, interleaving, Hit and Rate penalty, Virtual memories, Address Translation, Memory Management requirements, Secondary Storage: Magnetic Hard Disks, Optical Disks, Magnetic Tape Systems.	10 hours

CMS-A-CC-3-5-P: Computer Organization Lab.

Core Course-5, Practical, Credits: 02, Contact hours:40.

- (1). Construct an Arithmetic Unit capable of performing 4-bit subtraction and Addition using 2's complement method. Use Parallel Adders and other necessary logic gates.
- (2). Construct a logical unit using logic gates capable of performing 4-bit, Bitwise ORing, ANDing, XORing and inversion.
- (3). Construct a 4-bit ALU unit which can perform the following operation;

Selection		Function
S ₁	S ₀	
0	0	Addition
0	1	Subtraction
1	0	XOR-ing
1	1	Complement

- (4). Construct a 2-bit Carry Look Ahead Adder using logic gates.
- (5). Study and Construct a 1-digit BCD/Decimal adder using parallel adders and other necessary logic gates.
- (6). Construct a Binary Multiplier using basic logic gates.
- (7). Construct a Binary Divider using basic logic gates.
- (8). Subtraction with 1's complement method using parallel adders and other necessary logic gates.
- (9). Construction of BCD Subtractor with 9'S complement method using parallel adders and logic gates.
- (10). Construction of BCD Subtractor with 10'S complement method using parallel adders and logic gates.
- (11). Binary magnitude comparators (up to 4 bits) using parallel adder and logic gates.
- (12). Construct a Binary 4-bit and 8-bit adder using logic gates.
- (13). Construct a Serial in Serial out 4-bit register.
- (14). Construct a 4-bit Universal Shift register.
- (15). Construct a 4 bit ring counter.

- (16). Construct a 4 - bit Johnson Counter.
 (17) Construct RAM (4-bit) and extend it
 (18). Horizontal and Vertical Cascading of Memory modules.
 (19). Code converters using memory modules.

Text/Reference Books

1. Computer System Architecture, Morris Mano, Pearson.
2. Computer Organization & Architecture, Williams Stallings, Pearson.
3. Computer Organization, Hamacher, Vranesic and Zaky, McGraw Hill.
4. Computer Architecture and Organization, Govindrajalu, Tata McGraw Hill.
5. Computer Architecture and Organization, J P Hayes, Tata McGraw Hill.
6. Structured Computer Organization, Andrew S. Tanenbaum, Austin, Pearson.

CMS-A-CC-3-6-TH: Computational Mathematics

Core Course- 6: Theory, Credits: 04, Contact hours: 60.

Introduction Set Theory: Finite and Infinite Sets, Uncountable Infinite Sets, Relations: Properties of Binary Relations, Closure, Partial Ordering Relations, Equivalence, Functions: definition, one-to-one, onto and invertible, Mathematical Functions: Exponential and Logarithmic, Counting: Mathematical Induction, Pigeonhole Principle, Permutation and Combination, Binomial Theorem, Principle of Inclusion and Exclusion.	10 hours
Introduction to Probability Elementary events, Sample space, Classical and Axiomatic definition of Probability, Theorems on Total Probability, Conditional Probability, Bernoulli Trials and Binomial Distribution, Bayes' Theorem, Random Variables, Expectation, Variance, Standard Deviation.	10 hours
Growth of Functions Asymptotic Notations, Standard notations and common functions with simple examples.	04 hours
Recurrences Relations, Generating Functions, Linear Recurrence Relations with Constant Coefficients and their solution, Substitution Method, Recurrence Trees.	06 hours
Numerical Methods (Algorithmic Approach) Errors: Approximate and Rounding of Numbers, Significant digits, Errors and their types, Propagation of errors. Interpolation: Newton Forward and Backward interpolation, Lagrange interpolation. Solving a Set of Linear Equations: Gaussian Elimination, Gauss-Jordan, Iteration methods and their convergence conditions, Gauss-Seidel, Gauss-Jacobi Iterative Methods. Solving Non-linear equations: Bisection, Regula-falsi, Secant and Newton-Raphson, their order of convergence. Solving Differential Equations: Euler, Runge-Kutta second and fourth order methods. Numerical Integration: Trapezoidal and Simpson's $1/3^{\text{rd}}$ rules. Curve fitting : Least square approximation, Linear regression, Polynomial regression, Fitting Exponential and Trigonometric functions.	20 hours

Graph Theory

Basic Terminology, Models and Types, Multi graphs and Weighted graphs, Graph Representation, Graph Isomorphism, Connectivity, Euler and Hamiltonian Paths and Circuits, Planar Graphs, Trees and their basic terminologies and properties.

10 hours**CMS-A-CC-3-6-P: Computational Mathematics Lab.****Core Course- 6: Practical, Credits:02, Contact hours: 40.****Lab. based on Numerical Methods using C.****Text/ Reference Books:**

1. Elements of Discrete mathematics, C.L. Liu & Mahapatra, Tata McGraw Hill.
2. Discrete Mathematics and Its Applications, Rosen, McGraw Hill.
3. Introduction to algorithms, T.H. Cormen, C.E. Leiserson, R. L. Rivest, Prentice Hall .
4. Discrete Mathematics with Algorithms, M. O. Albertson and J. P. Hutchinson, John Wiley Publication.
5. Discrete Structures, Logic, and Computability, J. L. Hein, Jones and Bartlett Publishers.
6. Essentials of Discrete Mathematics, D.J. Hunter, Jones and Bartlett Publishers.
7. Numerical Analysis and Computational Procedures by Mollah, New Central Book.
8. Computer Oriented Numerical Methods, 3rd Edition, V Rajaraman, PHI
9. Graph Theory With Applications To Engineering And Computer Science by Narsingh Deo, PHI.
10. Graph Theory by J.A. Bondy and U.S.R. Murty, Springer.
11. Introduction to Graph Theory by D B West, 2nd edition, Pearson Education

CMS-A-CC-3-7-TH: Operating Systems**Core Course- 7: Theory, Credit: 04, Contact hours: 60.**

Introduction Basic OS functions, types of operating systems- batch processing, multiprogramming, time sharing, multiprocessing, distributed and real time systems.	6 hours
Operating System Organization Processor and user modes, kernels, system calls and system programs.	6 hours
Process System view of the process and resources, process control block, I/O and CPU bound process, process hierarchy, concept of threads Process Scheduling: Preemptive and non-preemptive scheduling, Long term scheduling, short term/CPU scheduling (FCFS, SJF, SRJF, RR and priority) and medium term scheduling Process Synchronization: Concurrent processes, critical section, semaphores and application, methods for inter-process communication;	18 hours
Deadlock: Definition, Prevention, Avoidance, Detection, Recovery.	9 hours

Memory Management Physical and logical address space; memory allocation strategies – fixed and variable partitions, paging, segmentation, virtual memory	14 hours
File and I/O Management Directory structure, file operations, file allocation methods, disk management.	5 hours
Protection and Security Policy mechanism, Authentication	2 hours

CMS-A-CC-3-7-P: Operating Systems Lab.

Core Course- 7: Practical, Credit: 02, Contact hours: 40.

Shell programming in LINUX

1. Write a shell script to convert the content of a file from lower case to upper case.
2. Write a shell script to count the words, lines and characters of a given file. File name should be provided at run time.
3. Write a shell script that take a word from user and find out the frequency of the word in a given file.
4. Write a shell script that gets executed at the moment of user login and it displays Good Morning, Good afternoon, Good Evening, Good Night, depending upon the time at which the user logs on.
5. Write a shell script to print Pascal diamond.
6. Write a shell script to find a number using sequential search method.
7. Write a shell script to find a number using binary search technique.
8. Write a shell script to sort a set of integer numbers using bubble sort.
9. Write a shell script to find out the factorial of a given number.
10. Write a shell script to reverse a string and check whether it is a palindrome.
11. Write a shell script to find the roots of a quadratic equation $ax^2 + bx + c = 0$, considering all possible cases.
12. Write a shell script for menu based system to insert records for employees with employee ID, name, designation, salary in a data file, also display records when necessary. Display salary for the employee asked.

These are only examples, more can be included.

Text/ Reference Books

1. Operating Systems Concepts, A Silberschatz, P.B. Galvin, G. Gagne, John Wiley Publications.
2. Modern Operating Systems, A.S. Tanenbaum, 3rd Edition, Pearson Education.
3. Operating Systems: A Modern Perspective, G. Nutt, Pearson Education.
4. Operating Systems, Internals & Design Principles W.Stallings, PHI.
5. Operating Systems- Concepts and design, M. Milenkovic, Tata McGraw Hill.
6. Sumitabha Das , UNIX Concepts and Applications, Tata McGraw-Hill.
7. Understanding the Linux Kernel,D. P. Bovet and M. Cesati, O'Reilly.

CMS-A-SEC-A-3-1-TH: Computer Graphics**Skill Enhancement Course: SEC-A: Choice -1: Theory, Credit:02, Contact hours: 40.**

Introduction Basic concepts of Graphics Devices– CRT monitor, Monochrome and Color Monitor displaying technique only, Physical and logical units of graphics devices – Pixel and its different properties, Basic idea for image or picture formation using pixels – Raster Scan and Vector Scan.	05 hours
Basic geometrical shapes formation algorithms Concepts Co-ordinate System, Line Segment, Digital Differential Analyzer, Circle and arc segment, elliptic segment, Bresenham's and Midpoint scan conversion algorithms.	05 hours
Two and Three Dimensional Transformations Transformations operations - Translation, Rotation, Scaling, Reflection, Shearing and Inverse of these operations, Homogeneous coordinate system representation, matrix representation. Composite Transformations Operations – Basic ideas and matrix representations by matrix concatenation for a particular operation.	14 hours
Two Dimensional Clipping View port, window port, display device, Point Clipping, Line Clipping, Cohen-Sutherland line clipping algorithm, Sutherland Hudgeman polygon clipping algorithm	08 hours
Projection Basic Concept of Projection operation and its application, Classification – Perspective, Parallel and its subclasses, Principles of these projections (Geometric representation only, no Mathematical Foundation and algorithms)	06 hours
Applications Basic Concepts Computer Art, Animation – Animating and modeling of real world, Morphing – Classification of morphing and Application to the Advertisements and publicities.	02 hours

Text/ Reference Books:

1. Computer Graphics by Zhigang Xiang, Roy Plastock, Schaum's Outlines Series.
2. Computer Graphics by Hearn & Baker, Pearson.
3. Procedural Elements for Computer Graphics by David F. Roger, 2nd Edition, TMH.
4. Computer Graphics by Foley, Van Dam, Feimer & John, Pearson.
5. Introduction to Computer Graphics and Multimedia, Mukhopadhyay and Chattopadhyay, Vikas publication.

CMS-A-SEC-A-3-2-TH: Internet of Things (IoT)**Skill Enhancement Course: SEC-A: Choice -2, Theory, Credit:02, Contact hours: 40.**

Introduction to Internet of Things (IoT) Defining IoT, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Communication models & APIs.	04 hours
IoT and M2M Difference between IoT and M2M, Software defined Network, network function virtualization (NFV), difference between SDN and NFV.	04 hours

Network & Communication aspects Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Edge connectivity and protocols, Fog/Gateway Devices for Data aggregation and dissemination, Security challenges.	08 hours
IoT Physical Servers and Cloud Offerings Introduction to Cloud Storage models and communication APIs Web Server – Web Server for IoT, Cloud for IoT, Python web application framework.	05 hours
Developing IoTs Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python.	08 hours
IoT Physical Devices and Endpoints Introduction to Raspberry PI-Interfaces (serial, SPI, I2C) Programming – Python program with Raspberry PI with focus of interfacing external gadgets.	04 hours
IoT Analytics Signal processing, real-time and local analytics, Databases, cloud analytics and applications.	04 hours
Domain specific applications of IoT Home automation, Industry applications, Surveillance applications.	03 hours

Text/ Reference Books:

1. Foundational Elements of an IoT Solution, J. Biron and J. Follett, O'Reilly Media.
2. IoT fundamentals, David, Pearson Education.
3. Internet of Things by Tripathy and Anuradha, CRC Press.
4. Internet of Things – A hands-on approach, Arshdeep Bahga and Vijay Madisetti, Universities Press.
5. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly.
6. Internet of Things by Bahga, Madisetti, Orient Blackswan Pvt Ltd.

Semester - IV

Course	Type	Course Code	Course Name	Credit
Core Course -8	Theory	CMS-A-CC-4-8-TH	Data communication, Networking and Internet technology.	4
	Practical	CMS-A-CC-4-8-P	Computer Networking and Web Design Lab.	2
Core Course -9	Theory	CMS-A-CC-4-9-TH	Introduction to Algorithms & its Application.	4
	Practical	CMS-A-CC-4-9-P	Algorithms Lab.	2
Core Course - 10	Theory	CMS-A-CC-4-10-P	Microprocessor and its Applications.	4
	Practical	CMS-A-CC-4-10-P	Programming with Microprocessor 8085.	2
Skill Enhancement Course (SEC-B) Candidate has to opt any one from the under mentioned courses)				
Course	Type	Course Code	Course Name	Credit
SEC-B-1	Theory	CMS-A-SEC-B-4-1-TH	Information Security	2
SEC-B-2	Theory	CMS-A-SEC-B-4-2-TH	E-Commerce	2

CMS-A-CC-4-8-TH: Data Communication, Networking and Internet Technology.

Core Course- 8: Theory, Credit: 04, Contact hours: 60.

Overview of Data Communication and Networking Introduction: Data communications Components, data representation, direction of data flow (simplex, half duplex, full duplex). Network Hardware: Physical structure (type of connection, topology), categories of network (LAN, MAN, WAN). Internet: Brief history, Protocols and standards, Reference models: OSI reference model, properties of all the layers, TCP/IP reference model, their comparative study.	04hours
Physical Layer Data & Signals: Analog & Digital Data and Signals, periodic and non-periodic signals, composite signals, bandwidth, bit rate, transmission of digital signals. Transmission Impairments: Attenuation, Distortion and Noise. Data Rate Limits: Noiseless Channel: Nyquist Data rate, Noisy Channel: Shannon's Capacity, calculation of data rate using both limits. Digital Transmission Digital to Digital Conversion: Line coding, schemes (RZ, NRZ, Manchester, Differential Manchester), block coding. Analog to Digital Conversion: Sampling, Nyquist rate of sampling, Pulse code modulation (PCM), Delta Modulation (DM), Adaptive Delta Modulation (ADM), parallel and serial transmission. Analog Transmission Digital to Analog: Amplitude shift keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Quadrature Amplitude Modulation (QAM). Analog to Analog Conversion: Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation.	12hours

Bandwidth Utilization Techniques Multiplexing: FDM, Synchronous & Statistical TDM, WDM.	04hours
Transmission Medium Guided media: Twisted pair, Coaxial, Fiber optics. Unguided: Radio waves, microwaves, Infrared, Antenna, Communication satellites (qualitative study only).	06hours
Switching and Telephone network Circuit switched networks, Packet Switched networks, Virtual Circuit switch. Major components of telephone network, Dial up modem, DSL and ADSL modems, Cable TV for data transfer (qualitative study only)	04hours
Data link Layer: Types of errors, framing (character and bit stuffing), error detection & correction methods, Linear and cyclic codes, checksum. Protocols: Stop & wait ARQ, Go-Back- N ARQ, Selective repeat ARQ, HDLC (qualitative study only). Physical addressing: MAC address and its format.	04hours
Medium Access sub layer Point to Point Protocol, Token Ring: Reservation, Polling. Multiple access protocols: Pure & Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA. Channelization: FDMA, TDMA, CDMA (Qualitative study only). Wired and Wireless LAN: Standards, fast Ethernet, Protocol 802.11, Bluetooth.	08hours
Network layer Internetworking & devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway, Addressing: IP addressing, Subnetting, Routing techniques: static vs. dynamic routing , Protocols: RARP, ARP, IP, ICMP	11 hours
Transport layer Process to Process delivery: UDP, TCP	03 hours
Application Layer Introduction to DNS, Remote logging, FTP, Electronic mail, WWW & HTTP	04hours

CMS-A-CC-4-8-P: Computer Networking and Web Design Lab

Core Course- 8: Practical, Credit: 02, Contact hour: 40.

Computer Networks: Practical Familiarization with Networking cables (CAT5, CAT6, UTP), Connectors (RJ-45, T-connector), Hubs, Switches, LAN installation & configuration (peer-to-peer) process.	05 hours
Web Design: Practical Web page design by HTML	
Handling HTML form HTML Capturing Form Data, GET and POST form methods, Dealing with multi value fields Redirecting a form after submission.	20 hours
Array Anatomy of an Array ,Creating index based and Associative array, Accessing array Looping with Index based array, with associative array using each() and for each() Some useful Library function.	15 hours

Text/ Reference Books:

1. Data Communication and Networking, B.A. Forouzan, Tata McGraw Hill.
2. Computer Networks, A.S. Tanenbaum, Pearson Education .
3. Data and Computer Communication, W. Stallings, Pearson Education.
4. Data & Computer Communication, Black, PHI.
5. Internet & World Wide Web: How to program, Harvey M. Deitel & Paul J. Deitel.
6. CGI Programming on the world wide web, Shishir Gundavaram, O'Reilly and Associates.

CMS-A-CC-4-9-TH: Introduction to Algorithms & its Applications**Core Course- 9: Theory, Credit: 04, Contact hours: 60.**

Introduction to Algorithms: Definition, Characteristics, Recursive and Non-recursive algorithms.	05 hours
Asymptotic Complexity Analysis of Algorithms: Space and Time Complexity, Efficiency of an algorithm, Growth of Functions, Polynomial and Exponential Complexity, Asymptotic Notations: Big O Notation and Small o notation, Big Ω and Small ω , Big Θ and Small ϕ Notations, Properties: Best case/worst case/average case analysis of well-known algorithms.	10 hours
Algorithm Design Techniques: Concepts and simple case studies of Greedy algorithms. Divide and conquer: Basic concepts, Case study of selected searching and sorting problems using divide and conquer techniques: Dynamic programming: General issues in Dynamic Programming.	15 hours
Graph Representation and Algorithm: Graph traversal algorithms: BFS, DFS, Minimal spanning trees: Prim's Algorithm, Kruskal's Algorithm, Shortest path algorithms: Floyd's Algorithm, Floyd-Warshall Algorithm, Dijkstra's Algorithm, Graph Coloring Algorithms.	25 hours
Classification of Problems: Concept of P, NP.	05 hours

CMS-A-CC-4-9-P: Algorithms Lab.**Core Course- 9: Practical, Credit:02, Contact hour: 40.****Lab. based on Graph Theory using C****Graph Algorithms:**

Implementation of Graph algorithms: Single Spanning Tree Generation using - BFS, DFS, Minimal Spanning Tree Generation using - Prim's Algorithm, Kruskal's Algorithm, Shortest Path finding using - Floyd's Algorithm, Floyd-Warshall Algorithm, Dijkstra's Algorithm, Graph Partitioning Algorithm.

Text/References Books:

1. Introduction to Algorithms, Cormen, Leiserson, Rivest and Stein, TMH.
2. The Design and Analysis of Algorithms, Aho, Hopcroft and Ullman, Pearson Education.
3. The Art of Computer Programming, D.E. Knuth, Pearson Education.
4. Algorithm Design, Jon Kleinberg and Eva Tardos, Pearson Education.
5. Data Structures and Algorithms - K.Mehlhorn.

6. Computer Algorithms, S.Baase, Pearson Education.
7. Fundamentals of Computer Algorithms, E. Horowitz and Sahani, Galgotia
8. Combinational Algorithms- Theory and Practice, E.M. Reingold, J. Nievergelt and N. Deo, PHI.

CMS-A-CC-4-10-TH: Microprocessor and its Applications

Core Course- 7: Theory, Credits:04, Contact hours: 60.

Introduction to Microcomputer based system: Evolution of Microprocessor and Microcontrollers and their advantages and disadvantages.	03 hours
Microprocessor Architecture and Memory Interfacing Basic Architecture of Microprocessor 8085 and explanation of each block, Microprocessor 8085 pin out and signals, Addressing modes, Instruction Formats, Instruction Cycle, Clock Cycle, Multiplexed Address Data Bus, Control and Status signals, Microprocessor and Bus Timing, De-multiplexing of Address Data Bus, Generation of Control Signals for I/O and Memory, Basic concepts in Memory Interfacing, Address Decoding and memory Addresses.	14 hours
Interfacing I/O Devices Basic Interfacing concepts, Peripheral I/O instructions (I/O mapped I/O), Device Selection and data Transfer, Absolute and Partial Decoding, Input Interfacing, Interfacing I/O using decoders, Memory mapped I/O techniques, Data transfer schemes, Interfacing 8155 memory segment.	10 hours
Programming 8085 Instruction Set of 8085, Different Programming Techniques, Stack and Subroutines, Counter and Time Delays, Code Conversion, BCD Arithmetic and 16 bit Data Operation.	10 hours
Interfacing Peripheral Devices and Applications Interrupts: 8085 Interrupt, RST instructions, Software and Hardware interrupt, multiple Interrupts and Priorities, 8085 Vectored Interrupts, Restart as Software Instructions. Interfacing Digital to Analog Converters, Analog to Digital Interfacing, keyboard interfacing, interfacing 8255 (Mode - 0, BSR), Support IC chips- 8237/8257,8259	13 hours
Microprocessor 8086 The 8086 microprocessor- Architecture, Instruction set, Addressing modes, Interrupts, Memory interfacing with 8086.	10 hours

CMS-A-CC-4-10-P:Programming with Microprocessor 8085

Core Course- 10: Practical, Credits:02, Contact hours: 40.

<ol style="list-style-type: none"> 1. Assembly Language Programming for Arithmetic Operations like Addition, Subtraction, Multiplication and Division on 8, 16 bit data. 2. Assembly Language Programming for different logical operations. 3. Assembly Language Programming for code conversions. 4. Assembly Language Programming for different sorting techniques. 5. Assembly Language Programming for memory block transfer. 6. Assembly Language Programming for AP series and Fibonacci series. 7. Assembly Language Programming for HCF, LCM etc.
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8. Assembly Language Programming for Searching.
9. Assembly Language Programming for frequency distribution.
10. Block Replacement and transfer

Many more programs can be included related to the programming techniques of Microprocessor 8085

Text/Reference books

1. Microprocessor architecture, programming and applications with 8085/8085A, Ramesh Gaonkar, Penram International Publication (PRI).
2. Fundamental of Microprocessors and Microcontrollers, B.Ram, Dhanpat Rai Publications.
3. Microprocessors and Microcontrollers, Senthil, Saravanan, Jeevananthan, Oxford.
4. Advanced Microprocessors and Peripherals by Ray and Bhurchandi – McGrawHill.
5. Intel Corp. Micro Controller Handbook – Intel Publications.
6. Microprocessors and Interfacing Programming and hardware by Douglas V. Hall, McGraw Hill.
7. Microprocessor 8085 and its Interfacing, Mathur, PHI..
8. The Intel Microprocessors: 8086/8088, 80186, 80286, 80386 & 80486, Bary B. Brey, Prentice Hall, India.

Skill Enhancement Course: SEC-B: Information Security/ E-Commerce

CMS-A-SEC-B-4-1-TH: Information Security

Skill Enhancement Course: SEC-B: Choice-1: Theory, Credit:02, Contact Hours: 40.

Overview Overview of Security Parameters: Confidentiality, Integrity and availability-security violation, Assumptions and Trust- Security assurance, OSI security architecture.	05 hours
Cryptography Mathematical Tools for Cryptography, Symmetric Encryption Algorithm, Theory of Block cipher design, Symmetric cipher model, Risk assessment, quantitative and qualitative approaches, Network security management, Firewalls, Web and wireless security management, Computer security log management, IT security infrastructure, Operating system security, user security, program security.	10 hours
Finite Field and Number Theory Groups, Rings, Fields-Modular, Prime numbers, Fermat's and Euler's Theorem, Chinese remainder Theorem, Discrete Logarithm.	03 hours
Hash Functions and Digital Signatures Authentication requirement – Authentication function -MAC, Hash functions, Security of hash function, Hashing Algorithms: MD5.	05 hours
Internet Firewalls for Trusted System Roles of Firewalls, Firewall related terminology, Types of Firewalls, Firewall designs.	02 hours
E-Mail, IP & Web Security (Qualitative study) E-mail Security: Security Services for E-mail-attacks possible through E-mail, Pretty Good S/MIME. IP Security: Overview of IPsec, IP Security Architecture, Authentication Header, Encapsulation Security Payload. Web Security: Secure Socket Layer/Transport Layer Security, Basic Protocol, SSL	05 hours

Attacks, Secure Electronic Transaction (SET).	
Cyber Cyber laws to be covered as per IT 2008 Definitions, Digital Signature And Electronic Signature. 1) [Section 43] Penalty and Compensation for damage to computer, computer system, etc. 2) [Section 65] Tampering with Computer Source Documents. 3) [Section 66 A] Punishment for sending offensive messages through communication service, etc. 4) [Section 66 B] Punishments for dishonestly receiving stolen computer resource or communication device. 5) [Section 66C] Punishment for identity theft. 6) [Section 66D] Punishment for cheating by personation by using computer resource. 7) [Section 66E] Punishment for violation of privacy. 8) [Section 66F] Punishment for cyber terrorism. 9) [Section 67] Punishment for publishing or transmitting obscene material in electronic form. 10) [Section 67A] Punishment for publishing or transmitting of material containing sexually explicit act, etc. in electronic form. 11) [Section 67B] Punishment for publishing or transmitting of material depicting children in sexually explicit act, etc. in electronic form. 12) [Section 72] Breach of confidentiality and privacy.	10 hours

Text/ Reference Books

1. Computer Security: Art and Science, M. Bishop, Pearson Education.
2. Information Security: Principles and Practice, M. Stamp, John Wiley & Sons.
3. Cryptography and Network Security, William Stallings, Eastern Economy Edition, PHI.
4. Understanding Cryptography, Paar and Pelzi, Springer.
5. Cryptography and Network Security, Behrouz A Forouzan, McGraw Hill Education.
6. Information Security Principles and Practices by M. Merkow, J. Breithaupt,, Pearson Education.
7. Computer Security: Concepts, Issues and Implementation by A. Basta, W.Halton, Cengage Learning India.

CMS-A-SEC-B-4-2-TH: E-Commerce

Skill Enhancement Course: SEC-B: Choice -2: Theory, Credit:02, Contact hours: 40.

An introduction to Electronic commerce What is E-Commerce (Introduction And Definition), Main activities E-Commerce, Goals of E-Commerce, Technical Components of E-Commerce, Functions of E-Commerce, Advantages and disadvantages of E-Commerce, Scope of E-Commerce, Electronic Commerce Applications, 9 Electronic Commerce and Electronic Business (C2C) (C2G,G2G, B2G, B2P, B2A, P2P, B2A, C2A, B2B, B2C).	05hours
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The Internet and WWW Evolution of Internet, Domain Names and Internet Organization (.edu, .com, .mil, .gov, .net etc.) , Types of Network, Internet Service Provider, World Wide Web, Internet & Extranet, Role of Internet in B2B Application, building own website, Cost, Time, Reach, Registering a Domain Name, Web promotion, Target email, Banner, Exchange, Shopping Bots.	10hours
Internet Security Secure Transaction, Computer Monitoring, Privacy on Internet, Corporate Email privacy, Computer Crime(Laws , Types of Crimes), Threats, Attack on Computer System, Software Packages for privacy, Hacking, Computer Virus(How it spreads, Virus problem, virus protection, Encryption and Decryption, Secret key Cryptography, DES, Public Key Encryption, RSA, Authorization and Authentication, Firewall, Digital Signature(How it Works).	10hours
Electronic Data Exchange Introduction, Concepts of EDI and Limitation, Applications of EDI, Disadvantages of EDI, EDI model, Electronic Payment System: Introduction, Types of Electronic Payment System, Payment Types, Value Exchange System, Credit Card System, Electronic Fund Transfer, Paperless bill, Modern Payment Cash, Electronic Cash.	05hours
Planning for Electronic Commerce Planning Electronic Commerce initiates, Linking objectives to business strategies, Measuring cost objectives, Comparing benefits to Costs, Strategies for developing electronic commerce web sites.	05hours
Internet Marketing: The PROS and CONS of online shopping, The cons of online shopping, Justify an Internet business, Internet marketing techniques, The E-cycle of Internet marketing, Personalization e-commerce.	05hours

Text/ Reference Books

1. E-Commerce Concepts, Models, Strategies by G.S.V. Murthy, Himalaya Publishing House.
2. The E-Commerce Book, Teffano Korper and Juanita Ellis, Morgan Kaufmann.
3. E-Commerce 2017, Kenneth C. Laudon and Carol Guercio Traver, Pearson.
4. E- Commerce, Kamlesh K Bajaj and Debjani Nag Tata McGraw-Hill Education.
5. Electronic commerce by Gray P. Schneider , International Student Edition.
6. E-Commerce, Fundamentals and Applications by Henry Chan, Raymond Lee, Tharam Dillon, Elizabeth Chang, Wiley Student Edition.

Semester - V				
Course	Type	Course Code	Course Name	Credit
Core Course -11	Theory	CMS-A-CC-5-11-TH	Database Management system (DBMS)	4
	Practical	CMS-A-CC-5-11-P	RDBMS lab using My SQL & PHP	2
Core Course -12	Theory	CMS-A-CC-5-12-TH	Object Oriented Programming (OOPs)	4
	Practical	CMS-A-CC-5-12-P	OOPs Lab using JAVA	2
Semester -V (DSE)				
Discipline Specific Elective Course - DSE-A(1&2)& DSE-B(1&2), (Candidates have to opt one course from DSE-A & one course from DSE-B)				
Course	Type	Course Code	Course Name	Credit
DSE-A-1	Theory	CMS-A-DSE-A-1-TH	Digital Image Processing	4
	Practical	CMS-A-DSE-A-1-P	Image processing Lab	2
DSE-A-2	Theory	CMS-A-DSE-A-2-TH	Data Mining & its Application	4
	Practical	CMS-A-DSE-A-2-P	Data Mining Lab	2
DSE-B-1	Theory	CMS-A-DSE-B-1-TH	Operation Research (O.R)	4
	Practical	CMS-A-DSE-B-1-P	Operation Research (O.R) Lab	2
DSE-B-1	Theory	CMS-A-DSE-B-2-TH	Programming using Python	4
	Practical	CMS-A-DSE-B-2-P	Programming in Python Lab	2

CMS-A-CC-5-11-TH: Database Management System (DBMS).

Core Course- 11: Theory, Credit: 04, Contact hour: 60 hours.

Introduction Drawbacks of Legacy System; Advantages of DBMS; Layered Architecture of Database, Data Independence; Data Models; Schemas and Instances; Database Languages; Database Users, DBA; Data Dictionary.	04hours
Entity Relationship(ER) Modeling Entity, Attributes and Relationship, Structural Constraints, Keys, ER Diagram of Some Example Database, Weak and strong Entity Set, Specialization and Generalization, Constraints of Specialization and Generalization, Aggregation.	04hours
Relational Model Basic Concepts of Relational Model; Relational Algebra; Tuple Relational Calculus; Domain Relational Calculus.	08hours
Integrity Constraints Domain Constraints, Referential Integrity, View.	04hours
Relational Database Design Problems of Un-Normalized Database; Functional Dependencies (FD), Derivation Rules, Closure of FD Set, Canonical Cover; Normalization: Decomposition to 1NF, 2NF, 3NF or BCNF Using FD; Lossless Join Decomposition Algorithm; Dependency preservation.	16hours
SQL Basic Structure, Data Definition, Constraints and Schema Changes; Basic SQL Queries (Selection, Insertion, Deletion, Update); Order by Clause; Complex Queries, Aggregate Function and Group by Clause; Nested Sub Queries; Views, Joined Relations; Set Comparisons (All, Some); Derived Relations.	16hours

Record Storage and File Organization (Concepts only) Fixed Length and Variable Length Records; Spanned and Un-Spanned Organization of Records; Primary File Organizations and Access Structures Concepts; Unordered, Sequential, Hashed; Concepts of Primary and Secondary Index; Dense and Sparse Index; Index Sequential Files; Multilevel Indices.	08hours
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CMS-A-CC-5-11-P: Relational Database Management System

Core Course- 11, Practical, Credit:02, Contact hours: 40 hours.

RDBMS Lab using My SQL & PHP

Text/ Reference Books

1. Fundamentals of Database Systems 6th Edition, R. Elmasri, S.B. Navathe, Pearson Education.
2. Database Management Systems, R. Ramakrishanan, J. Gehrke, 3rd Edition, McGraw-Hill.
3. Database System Concepts 6th Edition, A. Silberschatz, H.F. Korth, S. Sudarshan, McGraw Hill.
4. Database Systems Models, Languages, Design and application Programming, R. Elmasri, S.B. Navathe, Pearson Education.
5. SQL and Relational Theory: How to Write Accurate SQL Code, Christopher J. Date, O'Reilly Media.
6. Database Systems: A Practical Approach to Design, Implementation and Management, Thomas M. Connolly and Carolyn E. Begg, Pearson.

CMS-A-CC-5-12-TH: Object Oriented Programming System (OOPs)

Core Course- 12: Theory, Credit:04, Contact hours: 60.

Concept of OOPs Difference with procedure oriented programming, Data abstraction and information hiding: Objects, Classes, methods.	02hours
Introduction to Java Java Architecture and Features, Understanding the semantic and syntax differences between C++ and Java, Compiling and Executing a Java Program, Variables, Constants, Keywords Data Types, Operators (Arithmetic, Logical and Bitwise) and Expressions, Comments, Doing Basic Program Output, Decision Making Constructs (conditional statements and loops) and Nesting, Java Methods (Defining, Scope, Passing and Returning Arguments, Type Conversion and Type and Checking, Built-in Java Class Methods).	04hours
Arrays, Strings and I/O Creating & Using Arrays (One Dimension and Multi-dimensional), Referencing Arrays Dynamically, Java Strings: The Java String class, Creating & Using String Objects, Manipulating Strings, String Immutability & Equality, Passing Strings To & From Methods, String Buffer Classes. Simple I/O using System.out and the Scanner class, Byte and Character streams, Reading/Writing from console and files.	08hours
Object-Oriented Programming Overview Principles of Object-Oriented Programming, Defining & Using Classes, Controlling Access to Class Members, Class Constructors, Method Overloading, Class Variables & Methods, Objects as parameters, final classes, Object class, Garbage Collection.	04hours

Inheritance, Interfaces, Packages, Enumerations, Autoboxing and Metadata. Single Level and Multilevel, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Packages, Extending interfaces and packages, Package and Class Visibility, Using Standard Java Packages (util, lang, io, net), Wrapper Classes, Autoboxing/Unboxing, Enumerations and Metadata.	14hours
Exception Handling, Threading, Networking and Database Connectivity Exception types, uncaught exceptions, throw, built-in exceptions, Creating your own exceptions; Multi-threading: The Thread class and Runnable interface, creating single and multiple threads, Thread prioritization, synchronization and communication, suspending/resuming threads. Using java.net package, Overview of TCP/IP and Datagram programming. Accessing and manipulating databases using JDBC.	15hours
Applets Java Applets: Introduction to Applets, Writing Java Applets, Working with Graphics, Incorporating Images & Sounds. Event Handling Mechanisms, Listener Interfaces, Adapter and Inner Classes. The design and Implementation of GUIs using the AWT controls, Swing components of Java Foundation Classes such as labels, buttons, textfields, layout managers, menus, events and listeners; Graphic objects for drawing figures such as lines, rectangles, ovals, using different fonts. Overview of servlets.	13hours

CMS-A-CC-5-12-P: Object Oriented Programming Lab.

Core Course- 12: Practical, Credit: 02, Contact hours: 40 hours.

OOPs Lab Using JAVA

Text/Reference Books

1. Java: The Complete Reference, Herbert Schildt, McGraw-Hill Education.
2. The Java Language Specification, Java SE by James Gosling, Bill Joy, Guy L Steele Jr, Gilad Bracha, Alex Buckley, Published by Addison Wesley.
3. Effective Java by Joshua Bloch, Publisher: Addison-Wesley.
4. Core Java 2 by Cay S. Horstmann, Gary Cornell, Volume 1, Prentice Hall.
5. Programming with Java by E. Balaguruswamy, McGraw Hill.
6. Java: How to Program by Paul Deitel, Harvey Deitel, Prentice Hall.
7. Programming with JAVA by John R. Hubbard, Schaum's Series.

Discipline Specific Elective Course A: DSE-A:
Digital Image Processing/ Data Mining & its Applications.

CMS-A-DSE-A--1-TH: Digital Image Processing.
DSE-A: Choice-1: Theory, Credit:04, Contact hours: 60.

Introduction Image definition and its representation, Pixels, Co-ordinate conventions, Image formats (Study of the image matrix), neighbourhood metrics, Sampling and quantization, Types of distance measure (concept only).	15hours
Spatial Domain Image enhancement techniques in spatial domain, Contrast stretching, Histogram Processing, Noise smoothing, Sharpening, Pixel Classification, RGB & Grey image. Transformation: Arithmetic Transformation, Logical Geometric Transformation, Hough Transformation, FFT. Filtering: Spatial domain filters: Convolution, Edge Detection Filters	15hours
Thresholding Grey level thresholding, global/ local thresholding, Iterative thresholding, Edge detection operators, Region growing, Split/ merge techniques, Image feature/ primitive extraction, Background correction, Color enhancement.	15hours
Image Segmentation Boundary detection based techniques, Point, line detection, Edge detection, Local processing.	15hours

CMS-A-DSE-A--1-P: Image Processing Lab.
DSE-A: Choice-1: Practical, Credit:02, Contact hours: 40.

Assignments on Different Image Processing Functions based on Open CV & Python/Scilab

Text/ Reference Books:

- 1) Digital Image Processing by Gonzalez, Pearson.
- 2) Digital Image Processing by Jayaraman and Veerakumar, TMH.
- 3) Digital Image Processing using MATLAB by Gonzalez, Eddins and Woods, McGraw Hill.
- 4) Digital Image Processing by Annadurai, Pearson.
- 5) Digital Image Processing: A remote sensing perspective by Jensen, Pearson.
- 6) Digital Image Processing by Castleman, Pearson.
- 7) B. Chanda and D. Dutta Majumder, "Digital Image Processing and Analysis", PHI, New Delhi, 2000.

CMS-A-DSE-A--2-TH: Data Mining and its Applications
DSE-A: Choice-2: Theory, Credit:04, Contact hours: 60.

Introduction Definition of Data Mining, Data pre-processing, Data cleaning, Data transformation, Data Reduction, Data Visualization, Data extraction from large dataset, Data integration, sub-sampling, Feature selection, Scalability issues of data mining algorithms, text mining, web mining.	15hours
Classification and Prediction Structural patterns of data, Tools for pattern recognition (preliminary concept), Linear models for classification, Evaluating the accuracy of the classifier or predictor, Bayesian Classification, Training and Test sets, Parametric and Non-parametric Learning, Minimum Distance Classifiers, k-NN rule, Discriminant Analysis, Decision trees. Similarity Measure, Basic hierarchical and non-hierarchical Clustering algorithms, Some Applications, Neural Learning.	30hours
Data Warehousing (DWH) Introduction: Definition and description, need for data ware housing, need for strategic information, failures of past decision support systems, Application of DWH.	15hours

CMS-A-DSE-A--2-P: Data Mining Lab.
DSE-A: Choice-2: Practical, Credit:02, Contact hours: 40.

Data mining using PYTHON/C

Text/ Reference Books :

1. Data Mining: Practical Machine Learning Tools and Techniques, Ian H. Witten, Eibe Frank, Mark A. Hall, Morgan Kaufman.
2. Pattern Classification and Scene Analysis, R.O. Duba, P.E. Hart and D.G. Stork, Wiley.
3. Pattern Recognition Principles, J.T. Tou and R.C. Gonzalez, Addison-Wesley.
4. Data Mining Concepts and Techniques by Jiawei Han and Micheline Kamber, Morgan Kaufmann Publishers.
5. Data Warehousing, Data Mining and OLAP by Berson, Tata McGraw Hill.
6. Introduction to Data Mining by Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education.
7. Data mining: Introductory and Advanced Topics by Dunham M H,” Pearson Education.
8. Data Mining Concepts, Methods and Algorithms by Mehmed Kantardzic, John Wiley and Sons.

CMS-A-DSE-B--1-TH: Operation Research (O.R.)
DSE-B: Choice-1: Theory, Credit:04, Contact hours: 60.

Introduction Origin and development of operation research, Nature and characteristic features, models in O.R., application of O.R.	05hours
Linear Programming Problem Introduction, mathematical formulation of the problem and graphical solution method.	05hours
Simplex Method Introduction, computational procedure, artificial variable, problem of degeneracy, application of simplex method.	20hours
Duality: Concept, formulation of primal – dual, duality and simplex method, Dual Simplex method.	10hours
Transportation Problem: Introduction, mathematical formulation, finding initial basic feasible solution, optimality, degeneracy, unbalanced transportation problem.	05hours
Assignment Problem: Introduction, mathematical formulation and solution.	05hours
Game Theory: Some basic terminology, Two-person Zero-sum Game, Game without Saddle Point – Mixed strategy, Algebraic method for 2×2 Game	05hours
Network Scheduling: Introduction, Critical Path Method (CPM), PERT calculation.	05hours

CMS-A-DSE-B-1-P:Operation Research (O.R)Lab using C
DSE-B: Choice-1: Practical, Credit: 02, Contact hours: 40.

Lab sessions related to Simplex Method, Transportation Problem and Assignment Problem.

Text/ Reference Books

1. Operations Research by KantiSwarup, P.K. Gupta, Man Mohan, Sultan Chand & Sons.
2. Schaum's Outline of Operations Research, Richard Bronson and Govindasami Naadimuthu, McGraw-Hill Education.
3. Operations Research: An Introduction, Hamady. A. Taha, TMH.
4. Operations Research: Applications and Algorithms, Wayne L. Winston, Duxbury Press.
5. Operations Research Techniques for Management by V.K.Kapoor, Sultan Chand & Sons.
6. Introduction to Operation Research, Frederick S. Hillier and G. Lieberman, McGraw-Hill Higher Education.

CMS-A-DSE-B--2-TH: Programming using Python 3
DSE-B: Choice-2: Theory, Credit: 04, Contact hour: 60.

Introduction to the Python Interpreted vs. compiled languages. Bytecodes. The importance of whitespace. Variables and the lack of explicit data types and how Python uses the concepts of duck, strong, and static typing, to figure out data types in runtime. The assignment operator, the binding of names to objects, and aliasing. Keywords and their significance.	04 hours
Strings: definition, declaration, and immutability, string constants, declaration, and the equivalence of single and double quotes. Multi-line strings. Raw strings. String formatting using the format function and the % operator. f-strings in Python 3.6+. Built-in functions: count, find, replace, upper, lower, strip, etc. Time and space complexities of the functions and operations. Lists: definition, declaration, and mutability. Nested lists. Indexing and slicing: same as strings. List comprehensions. The split and join methods. Built-in list functions – append, extend, count, find, index, etc. Time and space complexities of the functions and operations. Tuples: definition, declaration, and immutability. Packing and unpacking lists and tuples. The + and * operators on strings, lists, and tuples. Indexing and slicing strings, lists, and tuples.	06 hours
Conditionals, Iterators, and Generators Conditionals: If, elif, and else statements. Nested conditionals. Containment checking in containers using the in keyword. Looping constructs: while and for loops. Flow control using break, continue, and pass. Nested loops. Generators: range, zip, sorted, reversed, and enumerate.	15 hours
User-defined Functions and Recursion Functions: definition, function signature, positional, default, and keyword arguments. Documentation strings. Unnamed functions – lambda, filter, and map. Recursion: basic idea, implementing recursion, sharing variables across the recursion stack, modifying the size of the recursion stack.	10 hours
File Handling and Exception Handling File handling: open and close methods, the different read and write modes. Using the with open approach to files. read, readline, readlines functions. The csv module for efficient read/write of structured data. The pickle module for persistent storage of variables in a program. Exception handling: the popular errors- Name Error, Value Error, Syntax Error, Key Error, Attribute Error, etc, and their cause and effects. Using try-except blocks for graceful handling of exceptions.	05 hours
Unordered data types - Sets and Dictionaries Basic concepts of hashing: hash functions, open chain, closed chain, advantages and disadvantages compared to conventional ordered data types. The hash() function in Python. Sets and frozensets: definition, declaration, mutability, and advantages over lists / tuples.	05 hours

<p>Insertion, deletion, union, intersection, and other built-in operations. Time and space complexities of the functions and operations.</p> <p>Dictionaries: Concept of keys and values. Immutability requirement for keys. Basic operations on dictionaries. Iterating over the keys and key, value pairs of a dictionary. Dictionary inversions</p>	
<p>Intro to Object Oriented Programming</p> <p>The Python data model, magic methods (<code>__init__</code>, <code>__str__</code>, <code>__eq__</code>, etc) and their utilities, accessing and mutating data, constructors, class methods, and the lack of explicit access modifiers of class methods – naming conventions of private, protected, and public variables and methods.</p> <p>Inheritance: inheriting a parent class, the <code>super()</code> method. Basic multiple inheritance.</p>	15 hours

CMS-A-DSE-B--2-P: Python 3 Programming Lab.

DSE-B: Choice-2, Practical, Credit: 02, Contact hours: 40 hours.

Use Python 3.6 or above. Use a text editor sensitive to whitespace like Notepad++, gedit, vim, Sublime Text, and NOT Notepad / WordPad. The following exercises are suggestive in nature.

1. The Interpreter as a calculator. Basic arithmetic operations. Introduction to the simple numeric data types – integers, floating point numbers, Boolean, complex numbers. Inter conversion of data types.
 - a. Use the Python prompt as a basic calculator. Explore the order of operations using parentheses.
 - b. Explore the various functions in the math module. Eg: find GCD of two numbers, area and perimeter of circle using `math.pi`, etc.
 - c. Exploring the complex data type and their operations, eg: finding the modulus and phase angle of a complex number.
 - d. The print function – Printing values. Repeat the previous experiments now using the print function
2. Basic user interactions using the `print()` and `input()` functions.
 - a. Write a simple python script using the print function in a text editor, save it with the extension “.py”. Run it in the terminal / command prompt.
 - b. Take input two strings from the user, and print the first one twice, and the other one thrice.
 - c. Ask the user to enter two numbers, and output the sum, product, difference, and the GCD.
 - d. More programs that test concepts learned in week 1 which involves the usage of the print and input functions.
3. Strings, List, Tuples, the `re` (regular expression) module
 - a. Ask the user for two strings, print a new string where the first string is reversed, and the second string is converted to upper case. Sample strings: “Pets“, “party”, output: “steP PARTY”. Only use string slicing and + operators.
 - b. From a list of words, join all the words in the odd and even indices to form two strings. Use list slicing and join methods.
 - c. Simulate a stack and a queue using lists. Note that the queue deletion operation won’t run in $O(1)$ time.
 - d. Explore the ‘re’ module, especially `re.split`, `re.join`, `re.search` and `re.match` methods.
4. Conditionals, looping constructs, and generators

- a. Use list comprehension to find all the odd numbers and numbers divisible by 3 from a list of numbers.
 - b. Using while loops to do Gaussian addition on a list having an even number of numbers. Print each partial sum. Eg: if the list is [1, 2, 3, 4, 5, 6], the program should output “1 + 6”, “2 + 5”, and “3+4” in separate lines, and the result of the addition “21”. Extend it to handle lists of odd length.
 - c. Primarily testing using for and while loops.
 - d. Use (c) to generate a list of primes within a user-given range.
 - e. Explore the ‘key’ function of sum(), min(), max(), and sort() functions using lambdas.
5. User defined functions
 - a. Implement popular sorting algorithms like quick sort and merge sort to sort lists of numbers.
 - b. Implement the Pascal’s triangle.
 - c. Three positive integers a, b, and c are Pythagorean triples if $a^2 + b^2 = c^2$. Write a function to generate all Pythagorean triples in a certain range.
 - d. Write two functions that simulate the toss of a fair coin, and the roll of an unbiased ‘n’ sided die using the random module.
 - e. Like (d), but now the coin and the die are not fair, with each outcome having a given probability.
6. File handling, sys, pickle and csv modules
 - a. Basic file operations. Explore the different file modes.
 - b. Emulate the unix ‘cp’, ‘grep’, ‘cat’ programs in Python. In each case, the user should pass the arguments to the program as command line arguments.
 - c. Use pickle for persistent storage of variables
7. Sets and dictionaries
 - a. Use sets to de-duplicate a list of numbers, and a string such that they contain only the unique elements
 - b. Use the set union and intersection operations to implement the Jaccard and Cosine similarity of two sets.
 - c. Use dictionaries to count the word and letter occurrences in a long string of text.
 - d. Invert a dictionary such the previous keys become values and values keys. Eg: if the initial and inverted dictionaries are d1 and d2, where $d1 = \{1: 'a', 2: 'b', 3: 120\}$, then $d2 = \{'a': 1, 2: 'b', 120: 3\}$.
 - e. What if the values in (d) are not immutable? Use frozensets. For repeated values, use lists. Eg: if $d1 = \{1: 'a', 2: 'a', 4: [1, 2]\}$, then $d2 = \{'a': [1, 2], \text{frozenset}([1, 2]): 4\}$.
 - f. Write a function to generate the Fibonacci numbers in (a) exponential time using the naïve algorithm, and (b) in linear time using dynamic programming (memorization) with a dictionary.
8. Object Oriented Programming
 - a. Create a ‘Graph’ class to store and manipulate graphs. It should have the following functions:
 - i. Read an edge list file, where each edge (u, v) appears exactly once in the file as space separated values.
 - ii. Add and remove nodes and edges
 - iii. Print nodes, and edges in a user readable format
 - iv. Computes basic statistics of the graph like degree distribution, clustering coefficient, and the number of connected components.
 - v. Finding all the neighbors of a node
 - vi. Finding all the connected components and storing them as individual Graph objects inside the class

- vii. Finding single source shortest paths using Breadth First Search
- b. Make a 'DiGraph' class to handle directed graphs which inherits from the 'Graph' class. In addition to all of the functionalities of (a), it should support the following operations
 - i. Finding the predecessors and successors of a node
 - ii. Creating a new 'DiGraph' object where all the edges are reversed.
 - iii. Finding the strongly connected components
- c. Extend (a) and (b) to handle weighted graphs, and implement Dijkstra's and Floyd-Warshall algorithms to compute the single source and all pairs shortest paths.
- d. Use the graph containers in (a), (b), and (c) to implement additional graph algorithms.

Text/ Reference Books

1. Introduction to Computation and Programming Using Python: With Application to Understanding Data, Guttag, John V. MIT Press.
2. Learn Python 3 the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code, Shaw, Zed A, Addison-Wesley Professional.
3. Think Python 2e. Green Tea Books, Downey, Allen B.
4. Practical Programming: An Introduction to Computer Science Using Python 3.6. Pragmatic Bookshelf, Gries, Paul, Jennifer Campbell, and Jason Montojo.

Semester - VI				
Course	Type	Course Code	Course Name	Credit
Core Course -13	Theory	CMS-A-CC-6-13-TH	Software Engineering	4
Core Course -14	Theory	CMS-A-CC-6-14-TH	Theory of Computation	4
	Practical	CMS-A-CC-6-14-P	Project Work	4
Semester - VI (DSE)				
Discipline Specific Elective Course - DSE-A(3&4)& DSE-B (3&4) (Candidates have to opt one course from DSE-A & one course from DSE-B)				
Course	Type	Course Code	Course Name	Credit
DSE-A-3	Theory	CMS-A-DSE-A-3-TH	Embedded Systems	4
	Practical	CMS-A-DSE-A-3-P	Embedded Systems Lab	2
DSE-A-4	Theory	CMS-A-DSE-A-4-TH	Multimedia and its Application	4
	Practical	CMS-A-DSE-A-4-P	Multimedia and its Application Lab	2
DSE-B-3	Theory	CMS-A-DSE-B-3-TH	Introduction to Computational Intelligence	4
	Practical	CMS-A-DSE-B-3-P	Computational Intelligence Lab	2
DSE-B-4	Theory	CMS-A-DSE-B-4-TH	Advance Java	4
	Practical	CMS-A-DSE-B-4-P	Advance Java Lab	2

CMS-A-CC-6-13-TH: Software Engineering.

Core Course-13: Theory, Credit:04, Contact hours 60.

Introduction Defining system, open and closed system, modeling of system through computer hardware, communication systems, external agents and software systems; Importance of Engineering Methodology towards computerization of a system.	03 hours
Software Life Cycle Classical and Iterative Waterfall Model; Spiral Model; Prototype Model; Evolutionary model and its importance towards application for different system representations, Comparative Studies.	07 hours
Software Requirement and Specification Analysis Requirements Principles and its analysis principles; Specification Principles and its representations Software Design Analysis – Different level of DFD Design, Physical and Logical DFD, Use and Conversions between them, Decision Tables and Trees, Structured analysis, Coupling and Cohesion of different modules Software Cost Estimation Modeling –COCOMO.	23 hours
Software Testing Software Verification and Validation; Testing objectives, Testing Principles, Testability; Error and Faults; Unit Testing, White Box and Blank Box Testing, Test Case Design: Test Vector, Test Stub.	17 hours
Software Quality Assurances Concepts of Quality, Quality Control, Quality Assurance, IEEE Standard for Statistical Software Quality Assurances (SSQA) criterions.	10 hours

Text/ Reference Books

1. Software Engineering: A Practitioner's Approach by R.S. Pressman, McGraw-Hill.
2. An Integrated Approach to Software Engineering by P. Jalote, Narosa Publishing House.
3. Software Engineering by K.K. Aggarwal and Y. Singh, New Age International Publishers.
4. Software Engineering by I. Sommerville, Addison Wesley.
5. Software Engineering for Students by D. Bell, Addison-Wesley.
6. Fundamentals of Software Engineering by R. Mall, PHI.

CMS-A-CC-6-14-TH: Theory of Computation.**Core Course-14: Theory, Credit:04, Contact hours: 60.**

Finite Automata Definition of a Finite Automaton, Model, Representation, Classification – with respect to output function Mealy and Moore Machines, with respect to State Transition – Deterministic and Non-Deterministic Machine, Examples, conversion algorithms Mealy to Moore and Moore to Mealy, Finite and Infinite state machines, Finite Automaton, Deterministic and Non-Deterministic Finite automaton, Non-Deterministic to equivalent Deterministic Automaton-Optimized and Non-optimized technique ideas and algorithms, Acceptability of String by a Finite Automaton.	15 hours
Formal Languages and Grammar Introduction to Formal Grammar and Language, Chomsky's Classification of Grammar – Type-0, Type-1 or Context Sensitive, Type-2 or Context Free and Type-3 or Regular Grammar, Illustration of each of these classes with example, Sentential form, Sentences – Languages or strings, Derivations, Ambiguous Grammar and Language, Designing of Grammar for a language, Find the Language for given Grammar, Definition and basic idea about Push Down Automaton.	15 hours
Regular Expression: Basic Idea and Definition, Regular Expression basic Identities, Arden's Theorem – Statement (without Proof) and application for reduction of equivalent regular expressions, Regular expression to Finite Automata conversion, State Transition System to Regular Expression conversion algorithm by Arden's Algebraic Method, FA to Regular Grammar and Regular Grammar to FA conversion algorithms and applications.	15 hours
Turing Machine Concepts of Turing Machine, Formal Definitions, Classifications – Deterministic and Non-Deterministic Turing Machines, Simple Design of Turing Machines: Odd / even count and concepts of Universal Turing Machines, Difference and Similarities between Turing Machine and a General Purpose Computer, Definition and significance of Halting Problem in Turing Machine.	15 hours

Text/ Reference Books:

1. Introduction to Automata Theory, Languages, and Computation by John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, 3rd Edition, Pearson.
2. Theory of Computer Science (Automata, Languages & Computation) by K L P Misra&

N Chandrasekharan, 3rd Edition, PHI.

3. Introduction to Theory of Computation by Micheal Sipser, 3rd Edition, Cengage Learning.

4. Switching and Finite Automata Theory by Zvi Kohavi, Niraj.K.Jha, 3rd Edition, TMH.

5. Formal Language and Automata, P. Linz, Narosa

CMS-A-CC-6-14-P: Project Work

Core Course-14, Practical, Credit:04, Contact hours: 60.

Candidates have to do their project in any relevant topic, under the supervision of teachers.

Discipline Specific Elective Course A: DSE-A

CMS-A-DSE-A--3-TH: Embedded Systems

DSE-A: Choice-3: Theory, Credit:04, Contact hours: 60.

Introduction to 8051 Overview of Microcontroller, Memory, I/O interface Intel Microcontroller 8051: Architecture, Peripheral Interface Controller (PIC).	15 hours
Assembly Language Programming Instruction set, Addressing Modes, Jump, Loop and Call instructions, I/O Manipulation, Serial communication, Arithmetic and logical instructions.	10 hours
Introduction to Embedded System Programming Data types and time delays, I/O programming, Logic operations, Data conversions, Data serialization, Interrupt programming, LCD and Keyboard interfacing, ADC, DAC, sensors interfacing, interfacing 8255, I/O interfacing for 8051, interfacing 8255, 8257, 8259/ 8279, ADC, DAC, Motor control using 8051 C.	15 hours
Programmable logic devices and Hardware description Language PAL, PLA, PLD, ASIC, FPGA (Qualitative study).	10 hours
Hardware Description Language (VHDL): Basic Terminology, Entity Declaration, Architecture body, Configuration and package declaration, Package body, Model analysis and Simulation. Basic Language elements, Behavioral Model, Dataflow Model, Structural Model, Subprogram and overloading, Applications.	15 hours

CMS-A-DSE-A--3-P: Embedded Systems Lab.

DSE-A: Choice-3, Practical, Credit: 02, Contact hours: 40 hours

Practical: Sample practical problems can be included related to theory.

1. Assembly Language Programming related to Microcontroller 8051.

2. Programming Using Embedded C for 8051.

3. VHDL programs for construction and simulation of various digital circuits.

Text/ Reference Books:

1. An Embedded software primer, David E. Simon, Pearson Education.
2. The 8051 Microcontroller, Kenneth J. Ayala, Thomson.
3. Embedded Systems, Raj Kamal, TMH.
4. Microcontroller, Raj Kamal, Pearson Education.
5. A VHDL Primer, J. Bhasker, Prentice Hall
6. FPGA Prototyping by VHDL Examples: Xilinx Spartan-3 Version, Pong P. Chu, Wiley-Interscience.

CMS-A-DSE-A--4-TH: Multimedia and its Applications**DSE-A: Choice-4, Theory, Credit:04, Contact hours: 60.**

Multimedia Introduction to multimedia, Components, uses of multimedia.	04 hours
Making Multimedia Stages of a multimedia project, requirements to make good multimedia, Multimedia Hardware - Macintosh and Windows production Platforms, Hardware peripherals - Connections, Memory and storage devices, Multimedia software and Authoring tools.	06 hours
Text Fonts & Faces, Using Text in Multimedia, Font Editing & Design Tools, Hypermedia & Hypertext.	04 hours
Images Still Images – Bitmaps, Vector Drawing, 3D Drawing & rendering, Natural Light & Colors, Computerized Colors, Color Palettes, Image File Formats.	06 hours
Sound Digital Audio, MIDI Audio, MIDI vs Digital Audio, Audio File Formats.	06 hours
Video How Video Works, Analog Video, Digital Video, Video File Formats, Video Shooting and Editing.	06 hours
Animation Principle of Animations. Animation Techniques, Animation File Formats.	08 hours
Multimedia System An overview of multimedia system and media streams, Source representation and compression techniques text, speech and audio, still image and video, Graphics and animation.	10 hours
Multi-modal Communication Video conferencing, networking support, Trans-coding.	10 hours

CMS-A-DSE-A--4-P: Multimedia and its Applications Lab.**DSE-A: Choice-4: Practical, Credit:02, Contact hour: 40.**

Sample practical problems can be included related to theory.

Text/ Reference Books:

1. Multimedia: Making it work by Tay Vaughan, TMH.
2. Multimedia: Computing, Communications Applications by R Steinmetz and K Naharstedt, Pearson.
3. Multimedia Handbook by Keyes, TMH.
4. Multimedia System Design by K. Andleigh and K. Thakkar, PHI.

Discipline Specific Elective Course B: DSE-B.**Introduction to Computational Intelligence/ Advanced Java.****CMS-A-DSE-B--3-TH:Introduction to Computational Intelligence****DSE-B: Choice-3, Theory, Credit:04, Contact hours: 60.**

Introduction Introduction to Artificial Intelligence, Brief History and Application, Structures and Strategies for state space search- Data driven and goal driven search, Heuristic search, Depth First and Breadth First search, Iterative deepening, A* algorithm, Game playing (Minimax), Rule-based system, Semantic Nets, Frames, Scripts, Conceptual Dependency, Introduction to PROLOG.	20 hours
Neural Network Basics of Artificial Neural Network, Characteristics and Comparison with biological neural network, Basic model of Artificial Neural Network: Single layer Perceptron model, Learning, Feed Forward Neural Network, Error, Back Propagation and weight updation, Perceptron, Bayesian Networks, Neural computational model- Hopfield Nets. .	20 hours
Rough sets Basic difference between Rough sets and Fuzzy sets	02 hours
Fuzzy Logic and Application Fuzzy sets, application – basic operations, Properties, Fuzzy Relations, Fuzzy inference, Notion of Fuzziness, Operations on Fuzzy sets, Fuzzy Numbers, Brief overview of crisp sets, Crisp relations, Fuzzy relations, Max*-composition of fuzzy relation, Max*-transitive closure, Probability measures of fuzzy events, Fuzzy expected value, Approximate reasoning, Different methods of role aggregation and defuzzification.	18 hours

CMS-A-DSE-B-3-P:Computational Intelligence Laboratory**DSE-B: Choice 3, Practical, Credit: 02, Contact hours: 40.**

Computational intelligence lab using Prolog / LISP

Text/ Reference Books:

1. Pattern Recognition and Machine Learning, Christopher M. Bishop.
2. Artificial Intelligence, E, Rich and K. Knight, Tata McGraw Hill.
3. A Brief Introduction to Neural Network, David Kriesel.
4. Fuzzy Set Theory – and its Applications, H.J. Zimmermann.
5. Rough Set Data Analysis : A road to Non-invasive Knowledge Discovery, Methods, Ivo Duntsch & Gunther Gediga.

6. An Introduction to Neural Computing: Theory and Practice, P.D. Wassermann, Van Nostrand Reinhold, New York, 1989.
7. Artificial Neural Networks, B. Yegnarayana, Prentice Hall of India.

CMS-A-DSE-B--4-TH: Advanced Java

DSE-B: Choice-4, Theory, Credit:04, Contact hours: 60.

Basics of Servlet Servlet: What and Why? Servlet API, Servlet interface, Generic Servlet, Http Servlet, Servlet life cycle, Servlet request methods, Servlet collaboration, Servlet config.	10 hours
Session Management What is a session? Why is it required? Creating a session? Session information passing mechanisms between client and server - Cookies, Rewriting; Destroying a session.	04 hours
Basics of JSP Life cycle of JSP; JSP API; JSP tags, directives, scripting elements, implicit objects, exception handling, action elements; MVC.	10 hours
Design Pattern Singleton; DAO; DTO; MVC; Front controller; Factory method; Collection framework.	10 hours
Javascript Introduction to Javascript; Ways to use Javascript; Working with events; Client-side validation.	10 hours
JQuery Introduction to JQuery; Validation using JQuery; JQuery forms; JQuery examples; Key services of the application server.	06 hours
Spring Framework Spring Core (Basic Concepts); Spring AOP; Spring JDBC; Spring MVC; Spring Boot and Spring Data; Spring ORM.	10 hours

Text/ Reference Books:

1. Object-Oriented Software Development Using Java. Xiaoping Jia. Addison Wesley,
2. Head First Object-Oriented Analysis and Design. Brett D. McLaughlin, Gary Pollice, and Dave West. O'Reilly.
3. Head First Design Patterns. Eric Freeman and Elizabeth Freeman. O'Reilly
4. Head First Servlets & JSP, O'Reilly.
5. Murach's Java Servlets and JSP, Murach.
6. Core Servlets and Javasever Pages: Core Technologies, Marty Hall and Larry Brown, Prentice Hall.
7. Enterprise JavaBeans 3.0, Richard Monson-Haefel and Bill Burke, O'Reilly.
8. Java Design Pattern Essentials, Tony Bevis, Ability First Limited
9. Design Patterns: Elements of Reusable Object-Oriented Software, Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides, Addison-Wesley Professional

10. Getting started with Spring Framework – Ashish Sarin, J Sharma, Createspace
11. Spring in Action - Craig Walls, Manning Publications

CMS-A-DSE-B-4-P: Advanced Java Laboratory

DSE-B: Choice 4, Practical, Credit:02, Contact hours: 40.

Advanced Java Laboratory based on the following:

- (i) Write programs in Java using Servlets:
 - a. To invoke servlets from HTML forms.
 - b. To invoke servlets from Applet Programs using cookies.
- (ii) Programs with session tracking.
- (iii) Create dynamic web pages, using Servlets and JSP.
- (iv) Programs using JDBC with create, insert table data.
- (v) Implementing MVC with Request Dispatcher.
- (vi) Writing a web service.

Text/ Reference Books

1. Core Servlets and Javasever Pages: Core Technologies, Marty Hall and Larry Brown, Prentice Hall.
2. JavaScript: The Definitive Guide, David Flanagan, O'Reilly.
3. Enterprise JavaBeans 3.0, Richard Monson-Haefel and Bill Burke, O'Reilly.
4. JavaScript and JQuery: Interactive Front-End Web Development, Jon Duckett, Wiley.
5. Professional JavaScript for Web Developers, Nicholas C. Zakas, Wrox.
6. Java Design Pattern Essentials, Tony Bevis, Ability First Limited.
7. Design Patterns: Elements of Reusable Object-Oriented Software, Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides, Addison-Wesley Professional.