University of Engineering & Management, Kolkata

Department of Computer Science

Syllabi of 2020-2024 Batch

(4th Semester)

List of Program Outcomes (POs) for Computer Science Department are given below.

PO NUMBER	SUMMARY	DESCRIPTION
PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of the complex engineering problems.
PO2	**Problem analysis**	Identify, formulate, research literature, and analyze complex engineering problems reaching substantial conclusion using first principal of mathematics, natural science and engineering sciences.
PO3	**Design /development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**	Use research-based knowledge and research methods including designs of experiments analysis and interpretation of data and synthesis of information to provide valid conclusions.
PO5	**Modern tool usage**	Create, select, and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering values activities with an understanding of the limitation.
PO6	**The engineer and society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**	Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
P010	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

P011	**Project management and finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team,
P012	**Life-long learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

List of Program Educational Objectives (PEOs)

PEO 01: High Quality Engineering Design and Development Work:

Graduates of the program will engage in the effective practice of computer science to identify and solve important problems in a diverse range of application areas.

PEO 02: Real Life Problem Solving:

To educate students with proficiency in core areas of computer science and related engineering so as to comprehend engineering trade-offs, analyze, design, and synthesize data and technical concepts to create novel products and solutions for the real life problems.

PEO 03: Leadership:

Graduates of the program will engage in successful careers in industry, academia and attain positions of importance where they have impact on their business, profession and community.

PEO 04: Lifelong Learning:

Graduates of the program will adapt to contemporary technologies, tools and methodologies to remain at the frontier of computer science practice with the ability to respond to the need of a challenging environment.

UEM, KOLKATA
STRUCTURED SYLLABUS FOR ADMISSION BATCH 2020
Departments: - CSE / CSE (AI & ML) / CSE (IOT, CS with BCT) / CSBS / CSIT / CST

Semester : 4			
Sr. No	Course Code	Course Title	Credit Point
1	PCC-CS401	Discrete Mathematics	4
2	PCC-CS402	Computer Organization & Architecture	3
3	PCC-CS492	Computer Organization & Architecture Laboratory	2
4	PCC-CS403	Operating Systems	3
5	PCC-CS493	Operating Systems Laboratory	2
6	PCC-CS404	Design & Analysis of Algorithms	3
7	PCC-CS494	Design & Analysis of Algorithms Laboratory	2
8	PCC-CS405	Artificial Intelligence & Machine Learning	2
9	PCC-CS495	Artificial Intelligence & Machine Learning Laboratory	1
10	HSMC401	Management - I (Finance & Accounting)	3
11	HSMC402	Universal Human Values – IV	3
12	MC401	Environmental Sciences	0
13	MC481	Mandatory Additional Requirements (MAR)	0
14	PROJ-CS401	Innovative Project - II	1
15	MOOC 4	Massive Open Online Courses [Mandatory for B.Tech (Honours)]	1
Total Credit Points of Semester [for B.Tech]			29
Total Credit Points of Semester [for B.Tech (Hons.)]			30

Discrete Mathematics
Code: PCC-CS401
Contracts: 2L
Credit: 4

Pre-Requisite: -Secondary level Mathematics concepts.

Course Outcome:

1. Use logical notation & Perform logical proofs
2. Apply recursive functions and solve recurrence relations
3. Determine equivalent logic expressions
4. Apply deterministic and nondeterministic automata models

5. Apply basic and advanced principles of counting
6. Define sets and sequences

Topic: -

Module 1: Propositional Logic:
Logical Connectives, Conjunction, Disjunction, Negation and their truth table. Conditional Connectives, Implication, Converse, Contra positive, Inverse, Bi-conditional statements with truth table, Logical Equivalence, Tautology, Normal forms-CNF, DNF; Predicates and Logical Quantifications of propositions and related examples.

Module 2: Theory of Numbers:
Well Ordering Principle, Divisibility theory and properties of divisibility; Fundamental theorem of Arithmetic; Euclidean Algorithm for finding G.C.D and some basic properties of G.C.D with simple examples; Congruences, Residue classes of integer rmodulo ()nn Z and its examples;

Module 3: Order, Relation and Lattices:
POSET, Hasse Diagram, Minimal, Maximal, Greatest and Least elements in a POSET, Lattices and its properties, Principle of Duality, Distributive and Complemented Lattices.

Module 4: Counting Techniques:
Permutations, Combinations, Binomial coefficients, Pigeon- hole Principle, Principles of inclusion and exclusions; Generating functions, Recurrence Relations and their solutions using generating function, Recurrence relation of Fibonacci numbers and its solution, Divide-and-Conquer algorithm and its recurrence relation and its simple application in computer.

Module 5: Graph Coloring:
Chromatic Numbers and its bounds, Independence and Clique Numbers, Perfect Graphs-Definition and examples, Chromatic polynomial and its determination, Applications of Graph Coloring.

Module 6: Matchings:
Definitions and Examples of Perfect Matching, Maximal and Maximum Matching, Hall's Marriage Theorem (Statement only) and related problems.

Text Books:

1. Kenneth H.Rosen, Discrete Mathematics and Its Applications, McGrawHill.
2. Russell Merris, Combinatorics, WILEY-INTERSCIENCE SERIESINDISCRETEMATHEMATICSANDOPTIMIZATION
3. N.Chandrasekaranand, M.Umaparvathi, Discrete Mathematics, PHI
4. Gary Haggard, John Schlipfand Sue Whitesides, Discrete Mathematics for Computer Science, CENGAGE Learning.
5. Gary Chartrandand Ping Zhang–Introduction to Graph Theory, TMH

Computer Organization & Architecture

Code: PCC-CS402
Contracts: 2L
Credit: 3

Pre-Requisite: - Basic Electronics Engineering Fundamentals of computers, Introduction to programming, Basic number systems, Binary Arithmetic, Digital Electronics Minimization of logical expression using different logic gates, Detail discussion about combinational and sequential circuits

Course Outcome:
1. To develop ability to design parallel processor.

2. To develop ability to design the mechanism by which the performance of the system is enhanced.
3. To understand memory technology.
4. To understand the communication among processing elements.

Topic: -Module1:

a) Introduction to computer organization & architecture
b) Basic organization of the stored program computer and operation sequence for execution of a program. Role of operating systems and compiler/assembler.
c) Fetch, decode and execute cycle, Concept of operator, operand, register sand storage, Instruction format. Instruction sets and addressing modes
d) Quantitative techniques in computer design-Part1
e) Introduction to RISC architectures. RISC vs CISC architectures

Module2:

a) Commonly used number systems. Fixed and floating-point representation of numbers; Concept of Overflow and Underflow.
b) Design of adders-ripple carry and carry look-ahead principles.
c) Fixed point multiplication -Unsigned and Signed - Booth's algorithm.
d) Fixed point division -Restoring and non-restoring algorithms.
e) Floatingpoint-IEEE754 standard.
f) Design of ALU.
g) Design of control unit- hardwired and microprogrammed control
h) Introduction to Von-Neumann & Harvard Architecture.

Module3:

a) Memory organization, static and dynamic memory, memory hierarchy, associative memory.
b) Hierarchical memory technology: Inclusion, Coherence and locality properties
c) Cache memory organizations, Techniques for reducing cache misses;
d) Virtual memory organization, mapping and management techniques, memory replacement policies.
e) Memory unit design with special emphasis on implementation of CPU-memory interfacing. Datapath design for read /write access.
f) I/O Operations-Concept of handshaking, Polled I/O, interrupt and DMA

Module4:

a) Quantitative techniques in computer design-Part 2
b) Pipelining: Basic concepts, instruction and arithmetic pipeline, data hazards, control hazard sand structural hazards, techniques for handling hazards.
c) Pipeline optimization techniques, Compiler techniques for improving performance.
d) Instruction-level parallelism: basic concepts, techniques for increasing ILP, superscalar, super pipelined architectures. Array and vector processors.

Module5:

a) Multiprocessor architecture: taxonomy of parallel architectures-Introduction to Flynn's Classification; Centralized shared-memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared memory architecture.
b) Non von-Neumann architectures -Data flow computers.

Text Books:

1. Computer Organization and Architecture: Designing for Performance, William Stallings, Prentice-Hall India
2. Computer Organization, Carl Hamacher, Zvonko Vranesicand Safwat Zaky, Tata McGrawHill
3. Computer Architecture A Quantitative Approach, John L Hennessy and David Patterson, Morgan Kaufman

4. Structured Computer Organization, Andrew S. Tanenbaum, Prentice-Hall India
5. Computer Architecture & Parallel Processing. Kai Hwang & Briggs, Tata McGrawHill
6. Computer System Architecture, M.M. Mano, PHI.
7. Computer Organization & Architecture, PN Basu, Vikas Publication

Computer Organization & Architecture Laboratory

Code: PCC-CS492
Contracts: 2L
Credit: 2

Pre-Requisite: - Basic Electronics Engineering Fundamentals of computers, Introduction to programming, Basic number systems, Binary Arithmetic, Digital Electronics Minimization of logical expression using different logic gates, Detail discussion about combinational and sequential circuits

Course Outcome:

1. To develop ability to design the mechanism by which the performance of the system can be enhanced.
2. To understand memory storage & connections.
3. To understand the communication among processing elements inside the computer architecture.
4. To understand how to simulate the electronic circuits and measure their functionalities.

Topic: -

Module1: Hardware Experiments:

1. Design a 3-bit carry save adder circuit
2. Design a 2-bit Serial adder circuit
3. Design a 3 bit Carry skip adder
4. Design a 3-bit Manchester chain adder
5. Design a 3-bit Carry select adders
6. Design a 3bit Pre-Fix Adders
7. Design a 3bit Multi-operand adder
8. Design a 3bit Pipelined parallel adder
9. Design a circuit to construct an-bit common bus using 4n-bit registers and no. of MUX each of 4×1
10. Design a circuit to construct a 2-bit common bus using Tristate buffer and decoder
11. Design a circuit to construct a 4-bitbinary Incremental unit
12. Design a circuit to construct a 4-bitbinary Decrementor unit
13. Design a circuit to construct a 3-bit combinational shifter unit
14. Design a circuit to construct a 16 bit processor composed 44-bitslices
15. Design a 4×4 array multiplier to perform multiplication of 2 unsigned integer
16. Design a digital circuit to perform Sequential multiplication method for unsigned integer
17. Design a digital circuit to perform Booth's multiplication procedure for signed number
18. Design a digital circuit to perform Restoring division method based on 2 unsigned integer
19. Design a digital circuit to perform Non-restoring division method based on 2 unsigned integer
20. Design a single error detecting and correcting circuit using hamming code approach
21. Design a Multiplier control unit by using hard wired control design approach
22. Design a control unit by using multi-program control design approach
23. Design a micro program sequencer unit
24. Design a16-bit CPA using 4-bit CPA
25. HDL introduction
26. Basic digital logic base programming with HDL
27. 8-bit Addition, Multiplication, Division
28. 8-bit Register design
29. Memory unit design and perform memory operations.

30. 8-bit simple ALU design
31. 8-bit simple CPU design
32. Interfacing of CPU and Memory

Text Books:

1. Computer Organization and Architecture: Designing for Performance, William Stallings, Prentice-Hall India
2. Computer Organization, Carl Hamacher, Zvonko Vranesicand Safwat Zaky,Tata McGrawHill
3. Computer Architecture A Quantitative Approach, John L Hennessy and David Patterson, Morgan Kaufman
4. Structured Computer Organization, Andrew S. Tanenbaum, Prentice-HallIndia
5. Computer Architecture & Parallel Processing. Kai H wang & Briggs, Tata McGrawHill
6. Computer System Architecture, M.M. Mano, PHI.

Operating Systems

Code: PCC-CS403
Contracts: 2L
Credit: 3

Pre-Requisite: -

- Basic idea about hardware and software.
- Basic idea about steps of instruction execution.
- Basic knowledge of programming and data structure & algorithm.

Co-Requisite: Computer Organization & Architecture.

Course Outcome:

1. A student will learn about structure and use of different types of operating systems.
2. A student will learn how hard disk is being partitioned.
3. A student will learn how computer starts (booting).
4. A student will learn how computer operates at each event.
5. A student will learn how operating system is giving protection to all the stored data and procedure.

Topic: -

Module 1: Introduction to OS. Operating system functions, evaluation of O.S, Different types of O.S: batch, multi-programmed, time-sharing, real-time, distributed, parallel.
Module 2: Computer system operation, I/O structure, storage structure, storage hierarchy, different types of protections, operating system structure (simple, layered, virtual machine), O/S services, system calls.
Module 3: Processes: Concept of processes, process scheduling, operations on processes, co-operating processes, inter-process communication.
Module 4: Threads: Overview, benefits of threads, user and kernel threads.
Module 5: CPU scheduling: scheduling criteria, preemptive & non-preemptive scheduling, scheduling algorithms (FCFS, SJF, RR, priority), algorithm evaluation, multi-processor scheduling.
Module 6: Process Synchronization: background, critical section problem, critical region, synchronization hardware, classical problems of synchronization, semaphores.
Module 7: Deadlocks: system model, deadlock characterization, methods for handling deadlocks, dead lock prevention, dead lock avoidance, dead lock detection, recovery from deadlock.
Module 8: Memory Management: background, logical vs. physical address space, swapping, contiguous memory allocation, paging, segmentation, segmentation with paging.
Module 9: Virtual Memory: background, demand paging, performance, page replacement, page replacement algorithms (FCFS, LRU), allocation of frames, thrashing.

Module 10: File Systems: file concept, access methods, directory structure, file system structure, allocation methods (contiguous, linked, indexed), free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency & performance.
Module 11: I/O Management: I/O hardware, polling, interrupts, DMA, application I/O interface (block and character devices, network devices, clocks and timers, blocking and non-blocking I/O), kernel I/O subsystem(scheduling, buffering, caching, spooling and device reservation, error handling), performance.
Module 12: Disk Management, disk structure, disk scheduling (FCFS, SSTF, SCAN,C-SCAN) , disk reliability, disk formatting, boot block, bad blocks.
Module 13: Goals of protection, domain of protection, security problem, authentication, one time password, program threats, system threats, threat monitoring, encryption.

Text Books:

1. Milenkovie M., "Operating System: Concept & Design", McGraHill.
2. Tanenbaum A.S., "Operating System Design & Implementation", Practice Hall NJ.
3. Silbersehatz A. and Peterson J.L., "Operating System Concepts", Wiley.
4. Dhamdhere: Operating System TMH
5. Stalling, William, "Operating Systems", Maxwell Mc Millan International Editions,1992.
6. DietelH. N.,"An Introduction to Operating Systems", Addison Wesley

Operating Systems Laboratory
Code: PCC-CS493
Contracts: 2L
Credit: 2

Pre-Requisite: - i) Basic idea about hard ware and software.
ii) Basic idea about steps of instruction execution.
iii) Basic knowledge of programming and data structure & algorithm.

Co-Requisite: Computer Organization & Architecture.

Course Outcome:

1. To develop conceptual understanding of Unix commands and various filters
2. To implement various operating system concepts through programming (such as, Process, Scheduling etc.).
3. To develop understanding about shell Programming and AWK scripting
4. To develop skill to solve various unix system administration problems with the application of shell programming

Topic:-
Module 1: Shell programming: creating a script, making a script executable, shell syntax (variables, conditions, control structures, functions, commands).
Module 2: Process: starting new process, replacing a process image, duplicating a process image, waiting for a process, zombie process.
Module 3: Signal: signal handling, sending signals, signal interface, signal sets.
Module 4: Semaphore: programming with semaphores (use functions semctl, semget, semop, set_semvalue, del_semvalue, semaphore_p, semaphore_v).
Module 5: POSIX Threads: programming with pthread functions (viz. pthread_create, pthread_join, pthread_exit, pthread_attr_init, pthread_cancel)
Module 6: Inter-process communication: pipes (use functions pipe, popen, pclose), named pipes (FIFOs, accessing FIFO)

Text Books:

1. "UNIX – Concepts and Applications", Sumitabha Das, 4th Edition, Tata McGraw.
2. Milenkovie M., "Operating System: Concept & Design", McGrawHill.
3. Tanenbaum A.S.,"Operating System Design & Implementation", Practice Hall NJ.
4. Silbersehatz A. and Peterson J.L., "Operating System Concepts", Wiley.
5. Dhamdhere: Operating System TMH
6. Stalling, William, "Operating Systems", Maxwell McMillan International Editions,1992.
7. Dietel H. N., "An Introduction to Operating Systems", Addison Wesley

Design & Analysis of Algorithms

Code: PCC-CS404
Contracts: 2L
Credit: 3

Pre-Requisite: - PCC-CS301, Data Structure and Algorithm

Course Outcome:

1. Reinforce basic design concepts (e.g., pseudo code, specifications, top-down design)
2. Knowledge of algorithm design strategies
3. Familiarity with an assortment of important algorithms
4. Ability to analyze time and space complexity

Topic:-

Module 1: Introduction: Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds– best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Master's theorem; Divide and Conquer algorithms – Merge Sort, Quick Sort, finding lower bound of comparison-based sorting algorithms, Strassen's algorithm for multiplying matrices.

Module2: Fundamental Algorithmic Strategies: Brute-force, Greedy, Dynamic Programming, Branch and Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem solving, Bin Packing, Knapsack, TSP, Heuristics – characteristics and their application domains, KMP algorithm.

Module 3: Graph and Tree Algorithms: Traversal algorithms: Depth First Search(DFS) and Breadth First Search (BFS), Disjoint Set Data Structures, Shortest paths algorithms, Minimum Spanning Tree, Topological sorting, Network Flow Problem.

Module 4: Tractable and Intractable Problems: Computability of Algorithms, Computability classes– P, NP, NP-complete and NP-hard, Cook's theorem, Standard NP-complete problems and Reduction techniques.

Module 5: Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP –P SPACE.

Text Books:

1. Introduction to Algorithms,4th Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivestand Clifford Stein, MIT Press/McGraw-Hill.
2. Algorithms, 4th Edition, Robert Sedge wick and Kevin Wayne, Princeton University.
3. Fundamental of Algorithms– E. Horowitzetal.

4. Algorithm Design, 1st Edition, Jon Kleinbergand Eva Tardos, Pearson.
5. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.
6. Algorithms –A Creative Approach, 3rd Edition, Udi Manber, Addison- Wesley, Reading, MA.
7. Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House (AICTE Recommended Textbook– 2018)
8. Algorithms Design and Analysis, Udit Agarwal, Dhanpat Rai.

Design & Analysis of Algorithms Laboratory

Code: PCC-CS494

Contracts: 2L

Credit: 2

Pre-Requisite: - PCC-CS301, Data Structure and Algorithm

Course Outcome:

1. To apply knowledge of computing and mathematics to algorithm design
2. To analyze a problem and identify the computing requirements appropriate for its solution
3. To design, implement, and evaluate an algorithm to meet desired needs
4. To apply mathematical foundations, algorithmic principles, and computer science theory to the modeling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices.

Topic: -

Module 1: Divide and Conquer Algorithm:
Implement Binary Search using Divide and Conquer approach, Implement Merge Sort using Divide and Conquer approach, Implement Quick Sort using Divide and Conquer approach, Find the Maximum and the Minimum element from a given array of integers using Divide and Conquer approach, Find the Median of two sorted arraysusing Divide and Conquer approach, Find the Bitonic point in Bitonic sequence using Divide and Conquer approach, Implement the Multiplication of two matrices using Strassen's Divide and Conquer approach, Find the neighbors of the Median element using the partitioning strategy of Quick Sorting method.

Module2: Linear-time Sorting Algorithm:
Implement Count Sort, Implement Dictionary Sorting Strategy.

Module 3: Dynamic Programming:

Implement the Coin-exchange problem using Dynamic Programming, Find the minimum number of scalar multiplications needed for a given chain of matrices using Dynamic Programming, Implement the Single Source Shortest Paths problem for a given directed graph (Bellman-Ford algorithm), Implement the All-Pair Shortest Paths problem for a given directed graph (Floyd-Warshall algorithm), Implement the Traveling Salesman Problem using Held-Karp algorithm, Find the minimum edit distances to convert one string into another string using Dynamic Programming, Implement the 0-1Knapsack problem using Dynamic Programming, Implement the Subset-Sum problem using Dynamic Programming.

Module 4: Branch and Bound:
Implementthe15-Puzzle Problem using Branch and Bound algorithm.

Module 5: Backtracking:
Implement the 8-Queen Problem using Backtracking, Implement the Graph Coloring Problem using Backtracking, and Implement the Hamiltonian Problem using Backtracking.

Module 6: Greedy Algorithm:

Implement the Fractional Knapsack Problem using greedy method, Implement the Job sequencing with deadlines using greedy method, Implement the Single Source Shortest Paths problem for a given directed graph (Dijkstra's algorithm), Implement

the Minimum Cost Spanning Tree using Prim's algorithm, Implement the Minimum Cost Spanning Tree using Kruskal's algorithm.

Module7: Fundamental Graph Algorithm:
Implement Breadth First Search (BFS), Implement Depth First Search (DFS), Findall Strongly Connected components of a given directed graph using Kisarazu's algorithm, Implement the Union-Find algorithm, Find the Max-Flow of a given Flow network using Ford-Fulkerson method.

Module 8: String Matching Problem:
Implement the String- Matching Problem using Knuth-Morris-Pratt algorithm.

Text Books:

1. Introduction to Algorithms,4th Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivestand Clifford Stein, MIT Press/McGraw-Hill.
2. Algorithms In A Nutshell, George T. Heineman, Gary Pollice and Stanley Selkow,O'Reilly.
3. Fundamental of Algorithms–E. Horowitzetal.
4. Algorithm Design, 1stEdition, Jon Kleinberg and Eva Tardos, Pearson.
5. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michae lT Goodrichand Roberto Tamassia, Wiley.
6. Algorithms –A Creative Approach, 3rd Edition, Udi Manber, Addison-Wesley, Reading, MA.
7. Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House (AICTE Recommended Textbook–2018).

Artificial Intelligence & Machine Learning

Code: PCC-CS405
Contracts: 2L
Credit: 2

Pre-Requisite: -Mathematics-III(DifferentialCalculus,Probability,Statistics),BSC301
Co-requisite: Design & Analysis of Algorithms, PCC-CS404

Course Outcome:
1. To develop an understanding of artificial intelligence and knowledge representation.
2. To develop concepts regarding search techniques.
3. To develop concepts related to machine learning and its types.
4. To develop skill to solve problems associated with supervised and unsupervised learning.

Topic: -
Module1: Introduction to Artificial Intelligence, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, and the State of the Art.
Knowledge Representation A Knowledge Based Agent, Knowledge Representation, Reasoning & Logic, Propositional Logic, Inference in First-Order Logic
Search techniques: AI-Problem formulation, solving problems by searching, uninformed search strategies: depth first search, breadth first search, depth limited search, iterative deepening search, bi-directional search.
Module2: Heuristic search strategies [4L]: Basics of heuristics, hill climbing strategy, simulated annealing strategy, best-first search, A*search, constraint satisfaction problem solving strategy.
Adversarial search [2L]:AI-based interactive game playing scheme using the minimax strategy, alpha-beta pruning. Concept of XAI and types.
Module3: Introduction to Machine Learning[2L]: Machine learning and it'stypes; Applications of machine learning; Issues in machine learning.

Module4: Recapitulation of Linear Algebra, Bayes Theorem, Expectation, Variance, Matrix Calculus– Numerical Optimization–Gradient Descent
Module5: Linear Regression–Least Square Gradient Descent Method–Derivations–Goodness of Fit–Bias-Variance Trade off.
Module6: Logistic Regression–Sigmoid–Gradient of Logistic Regression–Binary classification, Cross Entropy cost function.

Module7: Artificial Neural Networks–Multinomial Classification–Backpropagation–Derivations, Realization of Gates (AND, OR, XOR, NAND)
Module 8: Introduction to Convolutional Neural Networks – Regularization - CNN architectures – LeNet – VGG Net– Google Net–ResNet.Imageclassification–Hyperparameteroptimization–Transferlearning–casestudies
Module 9: Introduction to Recurrent Neural Networks – Deep RNNs – Bi-RNNs – Long Short-Term Memory –Vanishing gradient
Module 10: Recap - Data preprocessing – Normalization – Feature Selection – Feature Reduction – PCA – local linear embedding, ISO map, multidimensional scaling, Performance Evaluation of Classifiers – Cross Validation –Receiver Operating Characteristics Curve
Module 11: Lazy Learners – nearest neighbors – Decision Tree – CART – Ensemble Methods – Bagging –Boosting– Random Forest– Semi Supervised Learning
Module12: Clustering–Partitioning Methods– K-means– K-medoids– Fuzzy Clustering– Hierarchical methods– Agglomerative Nesting (AGNES)– Performance Evaluation
Module 13: Introduction to Convolutional Neural Networks – Regularization - CNN architectures – LeNet – VGGNet– Google Net– ResNet. Image classification–Hyper parameter optimization–Transfer learning–case studies
Module 14: Introduction to Recurrent Neural Networks – Deep RNNs – Bi-RNNs – Long Short-Term Memory –Vanishing gradient
Module 15: Recap - Data preprocessing – Normalization – Feature Selection – Feature Reduction – PCA – local linear embedding, ISO map, multidimensional scaling, Performance Evaluation of Classifiers – Cross Validation –Receiver Operating Characteristics Curve
Module 16: Lazy Learners – nearest neighbors – Decision Tree – CART – Ensemble Methods – Bagging –Boosting– Random Forest– Semi Supervised Learning
Module17: Clustering–Partitioning Methods– K-means– K-medoids– Fuzzy Clustering– Hierarchical methods– Agglomerative Nesting (AGNES)– Performance Evaluation.

Text Books:

1. The Hundred-page Machine Learning Book by Andriy Burkov, 2019, ISBN 978-1999579500
2. Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, ISBN 978-0262035613
3. Hands on Machine Learning with Scikit Learn and Tensorflow by Aurélien Géron, 2017, ISBN 978-14919622

Artificial Intelligence & Machine Learning Laboratory

Code: PCC-CS495
Contracts: 2L
Credit: 1

Pre-Requisite:-Mathematics-III (Differential Calculus, Probability, Statistics), BSC301
Co-requisite: Design & Analysis of Algorithms, PCC-CS404

Course Outcome:

1. To develop an understanding of artificial intelligence and knowledge representation.
2. To develop concepts regarding search techniques.
3. To develop concepts related to machine learning and it's types.
4. To develop skill to solve problems associated with supervised and unsupervised learning

Topic:-

Module 1:

- Introduction to LOGIC programming problems (using PROLOG)

Module 2:

- Familiarization with Numpy module in python
- Familiarization with Pandas module in python
- Data visualization and plotting using Matplotlib module in python

Module 3:

- Implementation of Linear Regression using python
- Implementation of Ridge Regression in python
- Implementation of Lasso Regression in python
- Implementation of Decision Tree Regression in python
- Implementation of Random Forest Regression in python

Module 4:

- Implementation of Logistic Regression in python
- Implementation of Decision Tree based classification in python
- Implementation of Random Forest based classification in python
- Implementation of Bagging method using python
- Implementation of Boosting method in python

Module 5:

- Implementation of unsupervised dimensionality reduction using Principal Component Analysis in python
- Implementation of k-Means clustering using python
- Implement Locally linear embedding (LLE) using python
- Implement Isometric Mapping algorithm using python
- Implementation of Multi-dimensional Scaling (MDS) using python
- Implementation of t-distributed Stochastic Neighbor Embedding (t-SNE) algorithm in python

Module 6:

- Implementation of Multi-Layer Perceptron in python
- Implementation of an Image classifier using 2-D Convolutional Neural Network (CNN) using python
- Implementation of Long Short Term Memory (LSTM) network using python

Module 7:

- Familiarization with Confusion Matrix-based model evaluation metrics using python
- Familiarization with Regression model evaluation metrics using python
- Familiarization with Clustering model evaluation metrics using python

Module 8:

- Implementation of Label Propagation using python
- Implementation of Label Spreading using python

Text Books:

1. The Hundred-page Machine Learning Book by Andriy Burkov, 2019, ISBN 978-1999579500
2. Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, ISBN 978-0262035613

3. Hands on Machine Learning with Scikit Learn and Tensorflow by Aurélien Géron, 2017, ISBN 978-1491962299

Management-I (Finance & Accounting)
Code: HSMC401
Contracts: 1L
Credit: 3

Pre-Requisite: -MOOC201, HSMC181, High School Maths

Course Outcome:
1. The students will be able to understand the concepts related to business
2. The students will be able to apply the financial statement analysis associated with financial Data in the organization
3. The students will be able to analyse the complexities associated with the management of cost of product and services in the organization
4. The students will be able to understand the concepts of accounting of managerial decisions and financial statements.
5. The students will be able to analyse the complexities associated with the management of cost of funds /capital in the organization
6. The students will be able to apply the concepts of capital budgeting decisions and corporate capital structures.

Topic: -
Module I: Meaning and Scope of Accounting (3L)
Need, development and definition of accounting, Accounting Principles: GAAP; Accounting Transactions: Accounting Equation, Concepts & Conventions of Accounting.

Module II: Journal & Ledger (6L)
Journal; Rules of debit and credit; Characteristics &Advantages,
Ledger-Ledger Preparation & Balancing of Account.

Module III: Trial Balance (4L)
Trial Balance; Capital and Revenue. Concept of Suspense Account

Module IV: Cost Accounting-Introduction (6L)
Nature and scope of cost accounting; Cost concepts and classification: direct, indirect, Preparation of Cost Sheet

Module V:
Meaning and Scope of Financial Management: (6L)
Profit vs wealth maximization; financial functions–investment, financing, and dividend decisions. Role of a CFO.

Module VI:
Capital Budgeting I: (5L) Basic Concept, Payback Period, Accounting rate of Return

Text Books:

1. Hanif & Mukherjee: Financial Accounting-1, McGraw hill.
2. Basu & Das: Cost & Management Accounting-1, Rabindra Library.
3. Dey, Dutta & Mukherjee: Cost & Management Accounting-1, Bhattacharjee Brothers.
4. Kar & Bagchi: Financial Management, Dey Book Concern.

Universal Human Values– IV

Code: HSMC402
Contracts: 2L
Credit: 3

Pre-Requisite: -Fundamental knowledge of humanities & social science subjects till class 10th standard and knowledge of Economics up to class 11th standard.

Course Outcome:
1. The Course will give a holistic approach towards learning engineering.
2. It will encourage multi-disciplinary thoughts among budding engineers and make them more responsible citizens.
3. Students will get sensitized their students towards larger socio-economic, human, environmental and geographical concerns.

Topic: -
Module 1
Laws of Society:
Central Legislative System of India, State Legislative System of India, Indian Judiciary

Module 2
Heritage of India:
Islamand Early Muslim Invaders, Delhi Sultanate, Bhakti and Sufi Movement.

Module 3
Know Our Country:
Rivers of India, Vegetation of India, Climate of India, Transport of India

Module 4
Revenue and Expenditure of India:
Tax System of India, Balance of Payment, Industrial Reforms

Module 5
India and World:
Monthly Current Affairs Magazine

Module 6:
Universal Human Values:
Realizing existence and co-existence at all levels, Holistic perception of Harmony inexistence.

Text Books: None

Environmental Sciences
Code: MC401
Contracts: 1
Credit: 0

Pre-Requisite: -High School Environmental Education Knowledge

Course Outcome: -

1. Understand core concepts and methods from ecological and physical sciences and the application in environmental problem-solving.
2. Appreciate key concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
3. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Appreciatethatonecanapplysystemsconceptsandmethodologiestoanalyzeandunderstandinteractionsbetweensocial and environmental processes.

Topic: -

Module 1: Basic ideas of environment, basic concepts, man, society & environment, their interrelationship Mathematics of population growth and associated problems, Importance of population study in environmental engineering, definition of resource, types of resource, renewable, non-renewable, potentially renewable, effect of excessive use vis-à-vis population growth, Sustainable Development. (2L) Materials balance: Steady state conservation system, steady state system with non-conservative pollutants, step function. (1L) Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide causes, effects and control/ management; Anthropogenic degradation like Acid rain-cause, effects and control. Nature and scope of Environmental Science and Engineering. (2L)

Module 2: Elements of ecology: System, open system, closed system, definition of ecology, species, population, community, definition of ecosystem- components types and function. (1L) Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundar ban); Food chain [definition and one example of each food chain], Food web. (2L) Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur]. (1L) Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity. (2L)

Module 3: Atmospheric Composition: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause. (1L) Energy balance: Conductive and Convective heat transfer, radiation heat transfer, simple global temperature model [Earth as a black body, earth as albedo], Problems. (1L) Greenhouse effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Global warming and its consequence, Control of Global warming. Earth's heat budget. (1L) Lapse rate: Ambient lapse rate Adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion). (2L) Atmospheric dispersion: Maximum mixing depth, ventilation coefficient, effective stack height, smoke stack plumes and Gaussian plume model. (2L) Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants - Suspended particulate matter, oxides of carbon, oxide s of nitrogen, oxides of sulphur, particulate, PAN. (2L) Smog, Photochemical smog and London smog. Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green- house gases, effect of ozone modification. (1L) Standard sand control measures: Industrial, commercial and residential air quality standard, control measure (ESP. cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference). (1L)

Module 4: Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds. (2L) River/Lake/ground water pollution: River: DO, 5-day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river [deoxygenation, reaeration], COD, Oil, Greases, pH. (2L) Lake: Eutrophication [Definition, source and effect]. (1L) Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only)(1L) Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition.(2L) Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury,

Cadmium, and Arsenic (1L)

Module 5: Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds. (2L) River/Lake/ground water pollution: River: DO, 5-day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river [deoxygenation, reaeration], COD, Oil, Greases, pH. (2L) Lake: Eutrophication [Definition, source and effect]. (1L) Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only) (1L) Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition.(2L) Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic (1L)

Text Books:

1. M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House (AICTE Recommended Textbook–2018)
2. Masters, G.M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt.Ltd., 1991.
3. De, A. K., "Environmental Chemistry", New Age International