University of Engineering and Management, Kolkata
University of Engineering and Management, Jaipur
Institute of Engineering & Management, Kolkata

B.Tech in Computer Science and Engineering (Artificial Intelligence and Machine Learning)

Admission Year: 2024

COURSE STRUCTURE

Semester IV (Second year) Curriculum								
Sl. No	Type of course	Course Code	Course Name	Hours per week				Credit Points
				Lecture	Tutorial	Practical	Sessional	
Theory Papers								
1	Professional Core Course	PCCCS401	Discrete Mathematics	3	0	0	0	3
2	Professional Core Course	PCCCS402	Computer Organization & Architecture	3	0	0	0	3
3	Professional Core Course	PCCCS403	Artificial Intelligence & Machine Learning	3	0	0	0	3
4	Professional Core Course	PCCCS404	Design & Analysis of Algorithms	3	0	0	0	3
5	Professional Core Course	PCCCS405	Advanced Programming (OOP)	3	0	0	0	3
6	Humanities & Social Sciences including Management course	HSMCS471	Management - 1 (Finance & Accounting)	3	0	0	0	3
7	Humanities &Social Sciences including Management course	ESP401	Essential Studies for Professionals - IV	2	0	0	0	0.5
8	Mandatory Course	MCC471	Sustainability, Climate Actions & Environment al Sciences	1	-	- (Field Projects)	-	2

	Total			**21**	**0**	**0**	**0**	**20.5**
Practical Papers								
1	Professional Core Course	PCCCS492	Computer Organization & Architecture Laboratory	0	0	4	0	2
2	Professional Core Course	PCCCS493	Artificial Intelligence & Machine Learning Laboratory	0	0	2	0	1
3	Professional Core Course	PCCCS494	Design & Analysis of Algorithms Laboratory	0	0	4	0	2
4	Professional Core Course	PCCCS495	Advanced Programming (OOP) Laboratory	0	0	2	0	1
	Total			**0**	**0**	**12**	**0**	**6**
Sessional Papers								
1	Humanities &Social Sciences including Management course	SDP481	Skill Development for Professionals - IV	0	0	0	2	0.5
2	Innovative Project	PRJCS481	Innovative Project – II	0	0	0	0	1
3	Professional Core Course	PCCCS481	Data Analytics	0	0	0	2	1
	Total			**0**	**0**	**0**	**4**	**2.5**
Mandatory Requirements								
Sl. No	**Type of course**	**Course Code**	**Course Name**	**Hours per week**				**Score/Credit /Count**
1	Co-curricular & Extra Curricular Activities	MAR	Mandatory Additional Requirements (Score)	-	-	-	-	-
2	Honours	MOOCs	Massive Open Online Course (Credit)	-	-	-	-	-
3	Certification	IFC	Industry and Foreign Certification (Count)	-	-	-	-	-
4			Skill Activity Report	-	-	-	-	-
Total				**21**	**0**	**12**	**4**	**29**

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Admission Year: 2024

DETAILED SYLLABUS

Course Code- PCCCS401
Course Title – Discrete Mathematics
Credit – 3
Category – Professional Core Course
Semester – IV
L:T:P:S – 3:0:0:0

Study material	Coursera	Linkedin	NPTEL

Module No.	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignments	Textbook Mapping

1	**Sets, Relation and Function, Principles of mathematical induction**	Operations and Laws of Sets, Cartesian Products, Binary Relation, Partial Ordering Relation, Equivalence Relation, Image of a Set, Sum and Product of Functions, Bijective functions, Inverse and Composite Function, Size of a Set, The Well-Ordering Principle, The Division algorithm, Prime Numbers, The Greatest Common Divisor, Euclidean Algorithm, The Fundamental Theorem of Arithmetic. Coprimality (or Euler's totient function), Chinese Remainder Theorem.	***International Academia:*** *https://ocw.mit.edu/courses/18-310-principles-of-discrete-applied-mathematics-fall-2013/pages/syllabus/* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** https://www.sagemath.org/, MATLAB	10	Implement Euclidean algorithm using C/ Python; Implement RSA algorithm using C/ Python; Implement Fermat's little theorem / Primality checking using C / Python; Check if any two given number is co-prime using Python / C.	***Discrete Mathematics and Application by Kenneth Rosen, 8th Edition.*** Chapters: 2, 4, 5, 9
2	**Basic counting techniques, Propositional Logic, Proof Techniques**	**Basic counting techniques:** Inclusion and exclusion principle, pigeon-hole principle, permutation and combination; recurrence relations, generating functions. **Propositional Logic:** Syntax, Semantics, Validity and Satisfiability, Basic	***International Standards:*** *https://ocw.mit.edu/courses/18-310-principles-of-discrete-applied-mathematics-fall-2013/pages/syllabus/* ***AICTE prescribed syllabus:***	14	Constructing n-SAT/3-SAT solver using C/ Python; Constructing propositional logic examples using Python;	***Discrete Mathematics and Application by Kenneth Rosen, 8th Edition.*** Chapters: 1, 6, 8, 12

		Connectives and Truth Tables, Logical Equivalence: The Laws of Logic, Logical Implication, Rules of Inference, The use of Quantifiers. **Proof Techniques:** Some Terminology, Proof Methods and Strategies, Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency. **Boolean Algebra**: Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form.	*https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:***			

3	**Algebraic Structures and Morphism**	Algebraic Structures with one Binary Operation, Semi Groups, Monoids, Groups, Permutation Groups, Normal Subgroups, Ring, Field, Vector spaces, Inner-product spaces	***International Standards:*** *https://ocw.mit.edu/courses/18-310-principles-of-discrete-applied-mathematics-fall-2013/pages/syllabus/* ***AICTE prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *https://www.sagemath.org/ MATLAB*	6	Conversion of First Order Logic statements to Conjunctive Normal Form using Python/ SAGEMATH; Conversion of First Order Logic statements to Disjunctive Normal Form using Python/ SAGEMATH;	***A BOOK OF ABSTRACT ALGEBRA by Charles C. Pinter*** Chapters: 1, 2, 3, 5, 7, 8, 17, 28
4	**Graphs and Trees**	Graphs and their properties, Degree, Connectivity, Path, Cycle, Sub Graph, Isomorphism, Eulerian and Hamiltonian Walks, Graph Coloring, Planar Graphs, Matching, Trees	***International Standards :*** *https://ocw.mit.edu/courses/18-310-principles-of-discrete-applied-mathematics-fall-2013/pages/syllabus/* ***AICTE prescribed syllabus:***	6	Implementation of maximum flow problem using Python; Checking a graph is Hamiltonian using Python / SAGEMATH.	***Discrete Mathematics and Application by Kenneth Rosen, 8th Edition.*** Chapter: 10

			https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf ***Industry Mapping:*** *https://www.sagemath.org/* *MATLAB*			

Textbooks:

1. Discrete Mathematics and Application by Kenneth Rosen, 8th Edition
2. A BOOK OF ABSTRACT ALGEBRA by Charles C. Pinter, 2nd Edition

Reference books:

1. Introductory Discrete Mathematics by V. K. Balakrishnan, Prentice Hall

Course Code- PCCCS402
Course Title – Computer Organization & Architecture
Credit – 3
Category – Professional Core Course
Semester – IV
L:T: P:S– 3:0:0:0
Pre-requisite – Digital Electronics, Basic Electronics

Course Outcomes:

CO1	Ability to design the Instruction set Architecture of a Computer System
CO2	Ability to design Arithmetic Logic Unit and Control Unit to execute the instructions
CO3	Ability to apply the concepts in Memory Organization
CO4	Ability to understand parallel processing

Relevant Links:

Study Material	Coursera	NPTEL	LinkedIn Learning	Infosys Springboard

Module No.	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignments	Textbook Mapping
1	**Introduction and Performance Evaluation**	Role of abstraction, basic functional units of a computer, Stored Program Architecture, Von-Neumann model of computation, A note on Moore's law, clocking methodology, Amdahl's law, Notion of IPC, and performance.	***International Academia:*** *https://ocw.mit.edu/courses/6-823-computer-system-architecture-fall-2005/pages/lecture-notes/* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/Updated-AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *SPEC (https://www.spec.org*	3	1. Familiarization of Hardware assembling for a digital computer. 2. Familiarization of SPEC Benchmark Application for CPU.	***Computer Organization and Design: The Hardware/Software Interface", David A. Patterson and John L. Hennessy, 5th Edition, Elsevier.*** Chapter: 1

2	**Data representation and basic operations**	Fixed and floating point (IEEE 754 Single and double precision format) representation of numbers; Overflow; Design of Adders - Ripple Carry Adder, Carry Look Ahead Adder, multiplication - shift-and-add, Booth multiplier, carry save multiplier, etc. Division - non-restoring and restoring techniques, floating point arithmetic.	***International Academia:*** *https://web.stanford.edu/class/cs107/* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/Updated-AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *VHDL - online platform (https://www.edaplayground.com/)* *VHDL- Xilinx ISE* *Hardware Chipsets (TTl IC Chipsets 7400, 7402, 7404, 7408, 7432,7486, 74151, 74153, 7483; CMOS IC Chipsets*	7	1. Implementation of Half Adder, Half Subtractor, Full Adder, Full Subtractor using VHDL (Dataflow Model). 2.a) Implementation of Full Adder using VHDL (Behavioral Model). 2.b) Implementation of n-bit Carry propagation adder in VHDL (Behavioral Model). 3. Implementation of 4:1 MUX using 2:1 MUX (using Structural Method) in VHDL. 4. Implementation of signed	**1. Computer System Architecture: Third Edition, Morris Mano.** Chapter: 3 **2. Computer Organization : Fifth Edition Carl Hamacher, Zvonko Vranesic and Safwat Zaky.** Chapter: 6

					multiplier using VHDL. 5. Implementation of signed multiplier using VHDL. 6. Implementation of Non-Restoring Division algorithm using VHDL. 7. Realization of Boolean Expressions Using Basic Gates (IC Chips). 8. Design an 8 to 1 multiplexer unit (MUX) using basic gates and using IC 74151. 9. Design of A 4-Bit Parallel Binary Adder Circuit Using The IC-Chip7483. 10. Use a	

					multiplexer unit to design a composite ALU [ALU Logic circuit, shift circuit and arithmetic circuit].11. Implementation of Full adder using FPGA kit.	
3	**Instruction Set Architecture**	CPU registers, instruction format and encoding, addressing modes, instruction set, instruction types, instruction decoding and execution, basic instruction cycle, Reduced Instruction Set Computer (RISC), Complex Instruction Set Computer (CISC), Case study - instruction sets of some common CPUs.	***International Academia:*** *https://ocw.mit.edu/courses/6-823-computer-system-architecture-fall-2005* *https://www.cse.iitd.ac.in/~srsarangi* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/Updated-AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *Keil MDK (https://www.keil.com)*	6	1. Generate Happy numbers. 2. Generate Autonomic numbers 3. Generate Hardy-Ramanujan number 4. Implement a 4-function calculator.	**Computer System Architecture: Third Edition, Morris Mano.** Chapter: 8

			TRACE32 Simulator (https://www.lauterbach.com) *Arm Instruction Emulator (https://developer.arm.com/Tools%20and%20Software/Arm%20Instruction%20Emulator)*			
4	**Processor Design**	Hardwired and micro-programmed design approaches, Case study - design of a simple hypothetical CPU	***International Academia:*** *https://ocw.mit.edu/courses/6-823-computer-system-architecture-fall-2005* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/Updated-AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *Keil MDK (https://www.keil.co*	3	Design a primitive CPU for the given instruction subset- i) data transfer ii) arithmetic operations iii) logical operations iv) branch statements	**1. Computer System Architecture: Third Edition, Morris Mano.** Chapter: 7 **2. Computer Organization : Fifth Edition Carl Hamacher, Zvonko Vranesic and Safwat Zaky.**

			m *TRACE32 Simulator https://www.lauterbach.com* *Arm Instruction Emulator https://developer.arm.com/Tools%20and%20Software/Arm%20Instruction%20Emulator*			Chapter: 7
5	**Memory hierarchy**	Memory hierarchy; Main memory organization - paging, segmentation, virtual memory; Cache memory- different indexing mechanisms, Trade-offs related to block size, associativity, and cache size, Processor-cache interactions for a read/write request, basic optimizations like write through/write-back caches, Average memory access time, Cache replacement policies (LRU), locality of reference, Memory interleaving; introduction to magnetic disks (notion of tracks, sectors).	***International Academia:*** *https://ocw.mit.edu/courses/6-823-computer-system-architecture-fall-2005* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/Updated-AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *VHDL - online platform (https://www.edapla*	7	1. Implementation of memory unit consisting of 16X4 RAM and 8X 4 ROM. 2. Implement Read Write operation using 16X4 RAM.	**Computer System Architecture: Third Edition, Morris Mano.** Chapter: 12

			yground.com/) *VHDL- Xilinx ISE*			
6	**Input/Output Organization**	Programmed I/O, Interrupt-driven I/O, and DMA	***International Academia:*** *https://ocw.mit.edu/courses/6-823-computer-system-architecture-fall-2005* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/Updated-AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *ATMEGA 16 Microcontroller*	2	1. Interface LCD with ATmega16 and display your name continuously. 2. Interface LCD with ATmega16 to display any string with a blinking cursor at the end.	**Computer System Architecture: Third Edition, Morris Mano.** Chapter: 11
7	**Parallel Processing**	Pipelining - Basic concepts, instruction and arithmetic pipeline, different types of dependencies and hazards, techniques for handling hazards, Pipeline optimization techniques - reservation table; Superscalar, super pipelined and VLIW	***International Academia:*** *https://ocw.mit.edu/courses/6-823-computer-system-architecture-fall-2005* ***AICTE-prescribed syllabus:*** *https://www.aicte-*	6	1) Implement a Pipelined Multiplier using VHDL and FPGA Kit. 2. Implement a Pipeline Control Unit using RIPES	**"Computer Organization and Design: The Hardware/Software Interface", David A. Patterson and John L. Hennessy,**

		processor architectures; Array and vector processors; Multiprocessor architecture: taxonomy of parallel architectures; Centralized shared-memory architecture and distributed shared memory architecture; Cache Coherence;	india.org/sites/default/files/Model_Curriculum/Updated-AICTE%20-%20UG%20CSE.pdf ***Industry Mapping:*** RIPES https://github.com/mortbopet/Ripes VHDL - online platform https://www.edaplayground.com, VHDL- Xilinx ISE			**5th Edition, Elsevier.** Chapters: 4 and 6

Textbooks:

1. Computer System Architecture: Third Edition, Morris Mano.
2. Computer Organization: Fifth Edition Carl Hamacher, Zvonko Vranesic and Safwat Zaky.
3. Computer Organization and Design: The Hardware/Software Interface: David A. Patterson and John L. Hennessy.

Reference books:

1. Computer Organization and Architecture – Designing for Performance: William Stallings
2. Computer Architecture and Organization: John P Hayes
3. Computer Architecture and Parallel Processing: K. Hwang, F. A. Briggs

List of Assignments:

1) Familiarization of Hardware assembling for a digital computer.
2) Familiarization of SPEC Benchmark Application for CPU.
3) Realization of Boolean Expressions Using Basic Gates (IC Chips).
4) Design an 8 to 1 multiplexer unit (MUX) using basic gates and using IC 74151.
5) Design of A 4-Bit Parallel Binary Adder Circuit Using The IC-Chip7483.
6) Implementation of Half Adder, Half Subtractor, Full Adder, Full Subtractor using VHDL and Verilog (Dataflow Model).
7) a) Implementation of Full Adder using Verilog (Behavioral Model). b) Implementation of n-bit Carry propagation adder in VHDL (Behavioral Model).
8) Implementation of 4:1 MUX using 2:1 MUX (using Structural Method) in VHDL.
9) Implementation of signed multiplier using VHDL.
10) Implementation of Non-Restoring Division algorithm using VHDL.
11) Use a multiplexer unit to design a composite ALU [ALU Logic circuit, shift circuit and arithmetic circuit].
12) Implementation of Full adder using FPGA kit.
13) Design a primitive CPU for the given instruction subset-
    i) data transfer
    ii) arithmetic operations
    iii) logical operations
    iv) branch statements
14. Interface LCD with ATmega16 and display your name continuously.
15. Interface LCD with ATmega16 to display any string with a blinking cursor at the end.
16. Implementation of memory unit consisting of 16X4 RAM and 8X 4 ROM.
17. Implement Read Write operation using 16X4 RAM.
18. Implement a Pipelined Multiplier using VHDL and FPGA Kit.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	2	2	2	3	2	2	3
CO2	3	3	3	3	3	2	2	2	3	2	2	3
CO3	3	3	3	3	3	2	2	2	3	2	2	3
CO4	3	3	2	3	2	2	2	2	3	2	2	3

Course Code- PCCCS403
Course Title – Artificial Intelligence & Machine Learning
Credit – 3
Category – Professional Core Course
Semester – IV
L:T:P – 3:0:0

Module No.	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignments	Textbook Mapping
1	**Introduction to Artificial Intelligence**	**Definition and Scope of AI** - History & Evolution of AI, Sub fields of AI, Ethical Considerations **Problem Solving in AI** – Searching, Optimization, Planning, Game Theory	***International Academia:*** *https://ocw.mit.edu/courses/6-867-machine-learning-fall-2006/pages/syllabus/* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *AI using Python*	5	1. Basic Practice programs using Python. 2. Introduction to Weka Toolkit.	

		Knowledge Representation – Propositional Logic, Predicate Logic				
2	**Problem solving techniques**	State space search, control strategies, heuristic search, problem characteristics, production system characteristics., Generate and test, Hill climbing, best first search, A* search, Constraint satisfaction problem, Mean- end analysis, Min-Max	***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/UG_Emerging.pdf* ***International Academia:*** *https://ocw.mit.edu/courses/6-034-artificial-intelligence-fall-2010/resources/lecture-1-introduction-and-scope/* ***Industry Mapping:*** *Python*		1. Python programming, symbolic algebra, Water Jug Problem 2. Perform BFS and DFS analysis on Facebook SN Dataset 3. Implementation of A* search 4. N-Queens Problem	

		Search, Alpha-Beta Pruning, Additional refinements, Iterative Deepening.				
3	**Introduction to Machine Learning**	**Machine Learning Definition & Scope** – Evolution of Learning Systems **Data Representation** – Features, Covariance, Orthogonality, Feature Selection vs Feature Extraction overview, Missing Data, Outliers, Noise, Normalization, Standardization,	***International Academia:*** *https://ocw.mit.edu/courses/6-867-machine-learning-fall-2006/pages/syllabus/* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *Python, Weka Toolkit*		1. Load and Interpret Data with Weka in the arff format or csv format using Python. 2. Distinguish between normalization and standardization of datasets. 3. Implement an algorithm in Python to handle missing data.	

		Training Validation and Testing. **Model Selection-** Holdout, Cross validation, k-fold Cross validation, random sampling, Bias-Variance tradeoff, overfitting, underfitting. **Machine Learning Types –** Supervised, Unsupervised, Reinforcement, Adversarial, Meta-Learning - Zero-shot & One-shot Learning, Transfer			4. Data visualization using- Histogram Plot, Scatter Plot etc.	

		Learning, Ensemble Learning – Bagging and Boosting.				
4	**Supervised Learning**	**Regression** – Linear Regression, Polynomial Regression, regularization **Classification** – Logistic Regression, Decision Trees, Bayesian Classifier, Parametric and Non-parametric estimation of probability densities (Maximum Likelihood Estimate, Bayesian Estimation),	***International Academia:*** *https://ocw.mit.edu/courses/6-867-machine-learning-fall-2006/pages/syllabus/* *https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/syllabus/* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *Python and Weka Toolkit, Sci-kit Learning and Matplotlib Visualization*		1. Using Weka and Python compare the performance of Decision Trees, Random Forest, Naïve Bayes and K-Nearest Neighbor algorithms. 2. Using LibSVM implement support vector machines and compare the different kernel	

		Naïve Bayes Classifier, K- Nearest Neighbours, Support Vector Machines **Representation Learning** – Perceptron, activation functions, XOR problem, Multi-layered Perceptron, Gradient Descent, Backpropagation **Performance Metrics** – Confusion Matrix, Precision, Recall, F-Measure, Area under ROC Curve.			functions. 3. Implement K Nearest Neighbor Algorithm 4. Implement a perceptron using python and develop the perceptron training rule. **Project 1 -** Write a code in python to create a multi-layered perceptron which can be trained using backpropagation using Numpy and	

					visualize the training using Matplotlib	
5	**Unsupervised Learning**	**Dimensionality Reduction:** Eigen Value Decomposition, Principal Component Analysis, Linear Discriminant Analysis, Singular Value Decomposition **Clustering:** Gaussian Mixture Models, Expectation Maximization, K-	***International Academia:*** *https://ocw.mit.edu/courses/6-867-machine-learning-fall-2006/pages/syllabus/* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *Weka Toolkit, Sci-kit Learning and Matplotlib Visualization*		1. Use Weka and Python to implement various feature extraction techniques 2. Visualize data clusters using t-SNE visualization and silhouette coefficient 3. Implement K-Means Clustering 4. Find the correct value of K in K Means Clustering using Cluster Validity Indices. **Project 2:**	

		Means Algorithms , Hierarchical Clustering (AGNES) **Metrics:** Similarity Measures, silhouette coefficient, Cluster Linkage Metrics, Cluster Validity Indices.			Compare various clustering algorithms to cluster aerial images and visualize the results.	
6	**Reinforcement Learning**	**Definition and Key Concepts:** Agent, Environment, Reward, Policy, Value Function **Algorithms :** Q-Learning, Exploration vs Exploitation	***International Academia:*** *https://ocw.mit.edu/courses/6-867-machine-learning-fall-2006/pages/syllabus/* *https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/syllabus/* ***AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *Open AI Gymnasium*		**Project 3:** Use the OpenAI Gymnasium to train a Reinforcement Learning Bot.	

		, Convergence, Issues and Challenges				

Textbooks:

1. Machine Learning by Tom Mitchell. – Mc Graw Hill
2. Machine Learning by S. Sridhar, M. Vijayalakshmi – Oxford University Press
3. Machine Learning: The Art and Science of Algorithms That Make Sense Of Data – Peter Flach, Cambridge
4. Pattern Recognition and Machine Learning by Christopher Bishop - Springer NP Exclusive (CBS)
5. Machine Learning: Theory and Practice - M.N. Murty, V.S. Ananthanarayana, Universities Press
6. Artificial Intelligence: A Modern Approach - Russell, Norvig, Pearson
7. Artificial Intelligence - George Luger, Pearson (Indian Edition)
8. First Course In Artificial Intelligence - Deepak Khemani, McGraw-Hill
9. An Introduction to Statistical Learning - James, Witten, Hastie, Tibshirani, Springer

Course Code- PCCCS404
Course Title – Design & Analysis of Algorithm
Credit – 3
Category – Professional Core Course
Semester – IV
L:T:P:S – 3:0:0:0

Module No.	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignments	Textbook Mapping
1	**Introduction**	Characteristics of algorithm. Analysis	***International Academia:*** *https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/syllabus/****AICTE-prescribed syllabus:***	5	1. Verify the different input case	

		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	*https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf***Industry Mapping:** *GNU C Compiler*		scenario with insertion sort, Selection sort and Bubble sort. 2. Verify the different input case scenario with linear search and binary search.	

		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..				
2	**Fundamental Algorithmic Strategies**	Brute-force, Greedy, Dynamic Programming, Branch and Bound and Backtracki	***International Academia:*** *https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/syllabus/****AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf****Industry Mapping:*** *Hardware Chipsets (IC 7408, 7432,7404),* *Software- Tinker Cad*	5	1. Find maximum and Minimum using the divide & conquer approach and verify its	

		ng 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.			efficiency. 2. Verify the different input case scenario with Quick sort, Merge sort and heap sort. 3. Verify quick sort with different pivot position. 4. Verify Strassen's matrix multiplication.	
3	**Graph and Tree Algorithms**	Graph and Tree Algorithms: Traversal algorithms: Depth	***International Academia:*** *https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/syllabus/****AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf****Industry Mapping:*** *Hardware Chipset (IC 7408, 7432,7404, 74153, 74155,*	6	1. Review of BFS/DFS. 2. Checking if a graph is	

		First Search (DFS) and Breadth First Search (BFS), Disjoint Set Data Structures, Shortest paths algorithms , Minimum Spanning Tree, Topological sorting, Network Flow Problem.	*74180)* *Software: LogiSim and VHDL*		biconnected. 3. Review of Spanning Tree. 4. Verify Knapsack problem. 5. Job sequence with deadline.	
4	**Tractable and Intractable Problems**	Tractable and Intractable Problems: Computability of Algorithms, Computability classes –	***International Academia:*** *https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/syllabus/****AICTE-prescribed syllabus:*** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf****Industry Mapping:*** *Hardware Chipset (IC 7476, 7474)* *Software: LogiSim and VHDL*	6		

		P, NP, NP-complete and NP-hard, Cook's theorem, Standard NP-complete problems and Reduction techniques.				

5	**Advanced Topics**	Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE.	***International Academia:*** *https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/pages/syllabus/***AICTE-prescribed syllabus:** *https://www.aicte-india.org/sites/default/files/Model_Curriculum/AICTE%20-%20UG%20CSE.pdf***Industry Mapping:** *Hardware Chipset (IC 7408, 7432,7404), FPGA Kit*	4		

Textbooks:

1. Introduction to Algorithms, 4th Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.
2. Algorithms In A Nutshell, George T. Heineman, Gary Pollice and Stanley Selkow, O'Reilly.
3. Fundamental pf Algorithms – E. Horowitz et al.
4. Algorithm Design, 1st Edition, Jon Kleinberg and EvaTardos, 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, UdiManber, Addison-Wesley, Reading, MA.

7. Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing Housh (AICTE Recommended Textbook – 2018).

Course Code- PCCCS405
Course Title – Advanced Programming (OOP)
Credit – 3
Category – Professional Core Course
Semester – IV
L:T:P :S – 3:0:0:0

Desirable/Advanced outcome:

1. Ability to implement basic event-driven programming.
2. Understanding of the fundamentals of parallel programming.

Module No.	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignments	Textbook Mapping
1	**Familiarity with the programming environment**	Understanding the build system, IDE, debugging, profiling and source code	***International Academia:*** *https://drive.google.com/file/d/10z00dMd26WjiPThhCercGbsi6u3ciE62/view* *https://drive.google.com/file/d/1k3qrfDL9p5_IJR_iP2mt6c6AzwmByNtf/view* ***AICTE-prescribed syllabus:*** *https://www.aicteindia.org/sites/default/files/Model_Curricul um/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:***	3	Familiarity with terminal/command prompt, using git commands and github to pull/ commit/ push/ merge code, writing, compiling and running simple programs,	**Herbert Schildt, Java: The Complete Reference, 11th edition** Chapters: 1,2

		management. Introduction to various programming paradigms, advantages of OOP, comparison of OOP with Procedural Paradigm	*Hackerrank, TCS Codevita projects, GitHub platform. NetBeans and Eclipse IDE will be used.*		debugging by setting breakpoints	**E. Balagurusami, Programming with Java, 6th edition** Chapters: 1,2,3
2	**Basic principles of the object-oriented development process**	Introduction to Object Oriented Paradigm: Data encapsulation, modularity, code reuse, identifying classes, attributes, methods and	***International Academia:*** *https://ocw.mit.edu/courses/6-096-introduction-to-c-january-iap-2011/270def7b1f68535b7c3846c606b220eb_MIT6_096IAP11_lec07.pdf* *https://ocw.mit.edu/courses/6-00sc-introduction-to-computer-science-and-programming-spring-2011/resources/lecture-11-oop-and-inheritance/* ***AICTE-prescribed syllabus:*** *https://www.aicteindia.org/sites/default/files/Model_Curricul um/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:***	4	Importing pre-written classes using the this keyword, calling and defining methods, writing and instantiating classes, setter/getter methods, instance variables, returning values, debugging using	**Herbert Schildt, Java: The Complete Reference, 11st edition** Chapters: 3,4,5 **E. Balagurusw ami, Programmin g with Java, 6th edition**

		objects, class relationships	*Hackerrank,TCS Codevita projects, GitHub platform. NetBeans and Eclipse IDE will be used.*		print function, containment and association, scope and parameter passing	Chapters: 6,7,8
3	**Advanced features of OOP**	Polymorphism, Inheritance, abstract classes & Interfaces, copying and cloning objects, Wrapper class, Stream, I/O operations	***International Academia:*** *International Standards Mapping (MIT Open Courseware): String: immutability, BufferReader, StringBuilder* *https://ocw.mit.edu/courses/6-088-introduction-to-c-memory-management-and-c-object-oriented-programming-january-iap-2010/resources/mit6_088iap10_lec05/* *Polymorphism: Methods: Overloading and overriding Methods, overloading constructors* *https://ocw.mit.edu/courses/6-092-introduction-to-programming-in-java-january-iap-2010/download/* ***AICTE-prescribed syllabus:*** *https://www.aicteindia.org/sites/default/files/Model_Curricul um/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *Hackerrank,TCS Codevita projects, GitHub platform. NetBeans and Eclipse IDE will be used.*	8	Parameter polymorphism, method resolution, declared v/s actual type, partially and fully overriding methods, calling superclass constructor from child class constructor, protected fields and methods, using an abstract parent class v/s an interface with default and abstract methods, object equality check, object comparison (Comparable/Comparator interface),	**Herbert Schildt, Java: The Complete Reference, 11th edition** Chapters: 7,8,20 **E. Balaguruswami, Programming with Java, 6th edition** Chapters: 9,10

					Cloneable interface/copy constructor	
4	**Access modifiers, Exceptions & Multithreading**	Access modifiers, packages, Java APIs, Exception handling, Java Thread Programming	***International Academia:*** *https://drive.google.com/file/d/1yFNf2IBXgy6ch47hR6TGHzddvCPfVm8p/view* ***AICTE-prescribed syllabus*** *https://www.aicteindia.org/sites/default/files/Model_Curricul um/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *Hackerrank, TCS Codevita projects, GitHub platform. NetBeans and Eclipse IDE will be used.*	6	Exception handling using try/catch block, nesting try/catch blocks, throw and throws keywords, rethrowing exceptions, handling checked exception, user defined exceptions. Thread Synchronization and Thread Communication	**Herbert Schildt, Java: The Complete Reference, 11th edition** Chapters: 9, 10 **E. Balaguruswami, Programming with Java, 6th edition** Chapters: 11, 12, 13
5	**Collection Framework**	Language supported libraries for handling advanced data structures (Hierarch	***International Academia:*** *https://drive.google.com/file/d/1kbRGF396sQPdQbA4w-N81ElKU_bdGgFs/view* ***AICTE prescribed syllabus:*** *https://www.aicteindia.org/sites/default/files/Model_Curricul um/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:***	4	Time complexity analysis, Java collection framework (or Boost libraries), sorting objects, iterating	**Herbert Schildt, Java: The Complete Reference, 11th edition** Chapters: 18, 19

		y of Collection Framework, ArrayList, LinkedList, Vector, HashSet)	*Hackerrank, TCS Codevita projects, GitHub platform.* *NetBeans and Eclipse IDE will be used.*		over objects	**E. Balaguruswami, Programming with Java, 6th edition** Chapters: 17, 18
6	**Modeling and Design patterns**	Basic modeling techniques – e.g. Class diagram, sequence diagram, use case diagrams, etc. Introduction to design patterns: iterator, singleton, flyweight, adapter, strategy,	***International Academia:*** *https://drive.google.com/file/d/1DQVPfhmcyKog-PryPdZ-bxufUC7D0Cfl/view* ***AICTE-prescribed syllabus*** *https://www.aicteindia.org/sites/default/files/Model_Curricul um/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *Hackerrank,TCS Codevita projects, GitHub platform. NetBeans and Eclipse IDE will be used.*	4	UML modeling using Rational rose, draw.io, Edraw Max, . www.starUML.io, argouml.tigris.org/	**Herbert Schildt, Java: The Complete Reference, 11th edition** Chapters: 18, 19 **E. Balaguruswami, Programming with Java, 6th edition** Chapters: 19

		template, prototype, factory, façade, decorator, composite, proxy, chain of responsibility, observer, state) Model View Controller				
7	**Basic Android Programming & UI Design**	Android Components – Activity, Services, Content Provider, Broadcast Receiver; Simple UI Design, Applet and Swing	***International Academia:*** *https://online.stanford.edu/courses/cs108-object-oriented-systems-design* ***AICTE-prescribed syllabus:*** *https://www.aicteindia.org/sites/default/files/Model_Curricul um/AICTE%20-%20UG%20CSE.pdf* ***Industry Mapping:*** *Hackerrank, TCS Codevita projects, GitHub platform, Android Studio will be used.*	7	Android app making, stand alone and web app development.	**Barry A. Burd and John Mueller, Android Application Development All-in-One For Dummies** Chapters: 1,2,3,4 **Rick Rogers,**

						John Lombardo, Zigurd Mednieks and Blake Meike Android Application Developme nt Chapters: 1,2,3,5

Textbooks:

1. Herbert Schildt, Java: The Complete Reference, 11th edition
2. E. Balaguruswami, Programming with Java, 6th edition
3. Barry A. Burd and John Mueller, Android Application Development All-in-One For Dummies
4. Rick Rogers, John Lombardo, Zigurd Mednieks and Blake Meike, Android Application Development, O REILLY
5. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim Conallen, Kelli A. Houston. Object-Oriented Analysis and Design with Applications
6. Paul Deitel, Harvey Deitel, Java How to Program: Early Objects, 11e, Pearson Education

Reference books:

1. J. Rumbaugh et al. The Unified Modeling Language Reference Manual.
2. P. Van Roy and S. Haridi. Concepts, Techniques, and Models of Computer Programming.
3. Horton, I. (2005). Ivor Horton's Beginning Java 2. John Wiley & Sons.

Online Resources:

https://missing.csail.mit.edu/
https://www.baeldung.com/junit

https://www.tutorialspoint.com/junit/index.htm

Course Code- HSMCS471
Course Title – Management - 1 (Finance & Accounting)
Credit – 3
Category – Humanities & Social Sciences including Management Course
Semester – IV
L:T:P:S – 3:0:0:0

Module No.	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignments	Textbook Mapping
1	**Introduction to Finance and Accounting**	The principles of financial and cost accounting Financial Management, Financial Planning and Capitalization-definitions, objectives, changing roles and functions, Financial Decision. Basic accounting concepts, important definitions, uses,	***International Academia:*** *(Accounting, Finance & Valuation Course I Stanford Online)* ***AICTE-prescribed*** *syllabus: (Microsoft Word - Information_Technology_Syllabus.doc (makautwb.ac.in))* ***Industry Mapping:*** *Designing an accounting system*	8	1. Easy Tally 2. Preparation of Basic financial and accounting statements 3. Analysis of Financial statements of listed companies	

		limitations, advantages; types of Accounting, Financial statements, introduction to Journal Accounting; double entry bookkeeping, different types of transactions related to Financial Accounting.				
2	**Capital Budgeting**	Managerial accounting tools and practices Nature of Investment decision, Importance of Capital Budgeting, The Capital. Budgeting Process - Investment Criterion, Pay-back period, Accounting, ROR (Rate of Return) Method, Discounting Cash flow	***International Academia:*** *(Accounting, Finance & Valuation Course I Stanford Online)* ***AICTE-prescribed*** *syllabus: (Microsoft Word - Information_Technology_Syllabus.doc (makautwb.ac.in))* ***Industry Mapping:*** *Financial long term forecasting*	6	Mapping and Techniques using Excel and Tally 1. Analysis of Financial statements of listed companies (International & India) comparison 2. Oracle netsuite	

		method, Net – present value method, IRR (Internal Rate of Return) method, The Benefit-Cost Ratio method. Related module				
3	**Management of Working Capital**	Various concepts, Elements, Classification, Financing and importance of working capital, Investment analysis, Cash flow determination, cost of capital, capital budgeting methods.	***International Academia:*** *(Accounting, Finance & Valuation Course I Stanford Online)* ***AICTE-prescribed*** *syllabus: (Microsoft Word - Information_Technology_Syllabus.doc (makautwb.ac.in))* ***Industry Mapping:*** *Financial daily or short term fund planning and management*	8	Mapping Techniques using Tally and Excel	
4	**Cost – Volume – Profit Analysis**	Analysis of Costing and Classification of costs, Allocation, apportionment and absorption, Cost centers, different costing systems, Cost analysis for	***International Academia:*** *(Accounting, Finance & Valuation Course I Stanford Online)* ***AICTE-prescribed*** *syllabus: (Microsoft Word - Information_Technology_Syllabus.doc (makautwb.ac.in))* ***Industry Mapping:***	8	Mapping and solving Techniques using Tally and Excel Power BI	

		managerial decisions, Meaning of Linear CVP analysis, Objectives, Assumptions, Break – Even analysis, determining the Break-Even point profit, Volume graph profit, Volume ratios margin of Safety.	*Analysis of sales and cost dependency on profit margin using cost analysis methods.*			
5	**Financial Control**	Posting of Ledgers and preparation of Trial Balance; preparation of Balance Sheet and Profit and Loss Accounts; Controlling other departments by Financial Accounting (A practical Approach).	***AICTE-prescribed*** *syllabus: (Microsoft Word - Information_Technology_Syllabus.doc (makautwb.ac.in))* ***Industry Mapping:*** *Design and analysis of company health using Balance sheet using available tools and techniques.*	6		

Course Code- MCC471

Course Title – Sustainability, Climate Actions & Environmental Sciences
Credit – 2
Category – Mandatory Course
Semester – IV
L:T:P:S – 1:0:2:0
Course Outcomes:

CO1	Understand fundamental concepts of environmental systems, sustainability, United Nations Sustainable Development Goals (UNSDGs) and their interrelationship with human society.
CO2	Apply knowledge of sustainable practices, different technical tools and existing frameworks to address environmental and societal challenges.
CO3	Analyze the challenges and strategies associated with climate change mitigation, sustainable cities, and waste management within the context of international agreements and frameworks.
CO4	Evaluate and design innovative approaches to energy, water, and waste management, considering the principles of the circular economy and global SDG progress reports.

Study Material	**LinkedIn**	**NPTEL**	**Coursera**

Module No.	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignments	Textbook Mapping
1	**Overview - United Nations Sustainable**	Basic ideas of environment, basic concepts: man, society &	***International Academia:*** ***https://unccelearn.org/course/view.php?id=170&page=overview*** ***https://unccelearn.org/course/view.php?id=181&page=overview*** ***AICTE prescribed syllabus:***	4	Assess the college campus alignment	Field work will be assigned for

	Development Goals (UNSDGs)	environment, their interrelationship. Significance of sustainability in today's world. 17 United Nations Sustainable Development Goals (UNSDGs) - background, significance, interconnectedness of goals, global challenges and recent progress. Climate change and mitigation. Explain and evaluate the evidence	***Industry Mapping:***		with the United Nations Sustainable Development Goals (SDGs) and rank the performance across selected goals mentioning the actionable strategies for improvement.	each and every student/ group of students, on completion of which they have to give a presentation along with a model display if possible.

		for human-caused climate change, in the context of historical climate change, as well as the relevant scientific uncertainties and possible evidence to the contrary.				
2	**Sustainable Management**	Sustainable management of water and sanitation-introduction, key components, challenges and innovative approache	***International Standards:*** ***https://ocw.mit.edu/courses/res-env-006-teaching-with-sustainability-january-iap-2022/*** ***AICTE prescribed syllabus:*** ***Industry Mapping:***	4	Design and propose innovative, sustainable solutions for managing water, energy, and	

		s. Ensure access to affordable, reliable, sustainable, and modern energy-introduction, importance, key targets, challenges and strategies. Sustainable Cities and Communities-Definition of sustainable cities, current challenges, strategies, innovative solution,			urban systems, inspired by the principles of SDG 6, SDG 7 and SDG 11.	

		smart city				
3	**Climate Action**	Climate change and its consequences, international agreements on climate change, strategies and actionable step, Life Below Water- Importance of water bodies and marine ecosystem, strategies for protecting aquatic life and water bodies, Life on Land- importance of biodiversity, carbon	***International Standards:*** ***https://unccelearn.org/course/view.php?id=7&page=overview&lang=en*** ***https://unccelearn.org/course/view.php?id=145&page=overview*** ***https://unccelearn.org/course/view.php?id=48&page=overview*** ***https://ocw.mit.edu/courses/res-env-001-climate-action-hands-on-harnessing-science-with-communities-to-cut-carbon-january-iap-2017/*** ***AICTE prescribed syllabus:*** ***Industry Mapping:***	4	Using data analytics and modeling tools - evaluate climate change impacts, assess ecosystem health, and propose technical solutions for mitigation and	

		sequestration, Food security, Strategies for Conservation and Restoration of Ecosystems, Sustainable Land Management, Biodiversity Conservation, Accountable steps for life on land. The successes and failures of past national and international efforts to address climate change,and evaluate			conservation efforts.	

		prospects for future management of climate change. Provisions of the United Nations Framework Convention on Climate Change, Paris Agreement				
4	**UN-call for Action**	Focus on **annual SDG Goals Report** and the **United Nations Secretary-General's calls for action** to accelerate the progress on the Sustainable Development Goals (SDGs). Examine	***International Standards:*** ***https://unccelearn.org/course/view.php?id=175&page=overview*** ***AICTE prescribed syllabus:*** ***Industry Mapping:***	4	Using quantitative analysis, strategic planning, and innovative approaches, evaluate the global progress on	

		the global progress trends, challenges highlighted in recent reports, and key priorities proposed by the Secretary-General to achieve the 2030 Agenda.			the Sustainable Development Goals (SDGs) as highlighted in the annual SDG Goals Report.	
5	**Environmental Systems Analysis**	Environmental impact assessment - lifecycle assessment (LCA), Using of LCA software tools – OpenLCA, Environmental, social, and governance (ESG), Integrated	***International Academia:*** https://www.lse.ac.uk/united-states/Assets/Documents/Syllabus-Hub-PDFs/Michael-Carbajales-Dale-Clemson-Environmental-Systems-Analysis.PDF https://www.igmpi.ac.in/environmental-social-governance?gad_source=1 https://www.iso.org/standard/60857.html#:~:text=ISO%2014001%20is%20the%20internationally,continually%20improve%20their%20environmental%20performance. ***Industry Mapping:***	4	Life Cycle Assessment of a college building using OpenLCA software.	

		Impact Assessment of ESG, Carbon Management, Green Hydrogen, Importance of green building (LEED, IGBC etc.) certification. Environmental Management System (EMS) in industry - ISO 14001.				
6	**Waste Management**	Waste Management Rules - Hazardous Waste, E-waste, Municipal Solid Waste, Bio-medical waste, Plastic	***International Academia:*** ***https://cpcb.nic.in/rules-6/*** ***https://ocw.mit.edu/courses/ec-716-d-lab-waste-fall-2015/*** ***https://unccelearn.org/course/view.php?id=131&page=overview*** ***https://unccelearn.org/course/view.php?id=87&page=overview*** ***Industry Mapping:***	5	Mapping the supply chain of different waste mana	

		Waste & Construction and Demolition Waste. Management of different waste streams – collection, transportation, treatment, storage and disposal. Basel Convention, Extended producer responsibility (EPR) Energy & Resource Recovery - Incineration, Co-processing, Composting, Bio-methanation, Manageme			gement systems and finding the issues & challenges.	

		nt of solar photo-voltaic modules or panels or cells, Battery Waste Management Rules, Circular Economy				

Textbooks:

This syllabus has been designed for the United Nations Sustainability Development Goals, so there are no prescribed textbooks. Please refer to the study material and online courses.

Course Code- PCCCS481
Course Title – Data Analytics
Credit – 1
Category – Professional Core Course (Sessional)
Semester – IV
L:T:P:S – 0:0:0:2

Module No.	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture	Corresponding Lab	Textbook

				Hours	Assignments	Mapping
1	**Introduction to Data Analytics**	Definition and Importance of Data Analytics, Types of Data (Structured, Unstructured, Semi-structured), Applications of Data Analytics in Real-world Scenarios (e.g., fraud detection, recommendation systems, precision agriculture) Data Analytics Workflow: Data Collection, Cleaning, Analysis, and Reporting Overview of Data Analytics Tools (Excel, Python,	***International Academia:*** How to Process, Analyze and Visualize Data: *https://ocw.mit.edu/courses/res-6-009-how-to-process-analyze-and-visualize-data-january-iap-2012/* Introduction to R and Geographic Information Systems (GIS) *https://ocw.mit.edu/courses/introduction-to-r-and-gis-fall-2023/* ***Industry Mapping:*** Power BI, R, Excel	5	1. Basic dataset exploration using tools using Excel. Basic Excel functions like VLOOKUP, HLOOKUP, INDEX etc. Creation of Pivot table. 2. Reading data from text, web, and Excel files and exploring various commands for descriptive analysis. 3. Basic Power BI functions (Aggregation, text, logical, filter, ranking, statistical, data visualization, table manipulation)	

		Tableau, Power BI, and R)			4. Basic data handling using R: importing, exploring, and manipulating datasets	
2	**Data Preprocessing and Cleaning**	Data Quality Issues and Handling Missing Data in R, Techniques for Data Cleaning (Removing duplicates, fixing invalid entries), Data Transformation and Standardization (Normalization, Encoding), Introduction to Python Libraries for Data Preprocessing (Pandas, NumPy), Handling Outliers and Imbalanced Data	***International Academia:*** How to Process, Analyze and Visualize Data: *https://ocw.mit.edu/courses/res-6-009-how-to-process-analyze-and-visualize-data-january-iap-2012/* Introduction to R and Geographic Information Systems (GIS) *https://ocw.mit.edu/courses/introduction-to-r-and-gis-fall-2023/* ***Industry Mapping:*** Power BI, R, Excel	5	1. Hands-on exercises on data cleaning and preprocessing using R. 2. Working on datasets with missing and noisy data.	

3	**Data Visualization and Exploratory Data Analysis (EDA)**	Importance of Data Visualization in Decision-making, Visualization Tools and Libraries (Matplotlib, Seaborn, Tableau Overview), Plotting Techniques: Bar Charts, Line Charts, Pie Charts, Histograms, Scatter Plots, Heatmaps, Basics of Exploratory Data Analysis (EDA), Identifying Trends, Patterns, and Outliers in Data	***International Academia:*** Statistics and Visualization for Data Analysis and Inference: *https://ocw.mit.edu/courses/res-9-0002-statistics-and-visualization-for-data-analysis-and-inference-january-iap-2009/* Introduction to R and Geographic Information Systems (GIS) *https://ocw.mit.edu/courses/introduction-to-r-and-gis-fall-2023/* ***Industry Mapping:*** Power BI, R, Tableau	8	1. Creating visualizations to interpret datasets using Matplotlib and Seaborn. 2. Conducting EDA on sample datasets (e.g., sales data, sensor data). 3. Apply and explore various plotting functions on a dataset. (a) Normal curve (b) Density and contour plot (c) Correlation and scatter plot (d) Histogram (e) Three dimensional plotting	

					4. Create visualizations: histograms, scatter plots, boxplots, and bar plots using `ggplot2` using R and using Power BI.	
4	**Basic Statistical and Machine Learning Techniques**	Descriptive Statistics (Mean, Median, Mode, Standard Deviation, Variance, Correlation), Basics of Probability in Data Analytics, Introduction to Regression (Linear, Polynomial) and Classification, Basics of Machine Learning Workflow: Training, Testing, and Validation, Evaluating	***International Academia:*** Statistics and Visualization for Data Analysis and Inference: *https://ocw.mit.edu/courses/res-9-0002-statistics-and-visualization-for-data-analysis-and-inference-january-iap-2009/* Introduction to R and Geographic Information Systems (GIS) *https://ocw.mit.edu/courses/introduction-to-r-and-gis-fall-2023/*	6	1. Implement basic statistical functions in Excel. 2. Implementing simple regression models (Linear Regression) using R. 3. Building a basic classification model (e.g., Logistic Regression) in R. 4. (a) Compute mean, median, mode, variance,	

		Model Performance (Accuracy, Precision, Recall, F1-Score, Confusion Matrix), Introduction to Python's Scikit-learn Library. Analyze datasets using basic statistical measures and visualization tools in R.			and standard deviation using R, (b) Analyze distributions and correlations. 5. Creating data analysis dashboard using Power BI.	

Projects: The projects will be performed by groups of students.
1. Sales and Customer Analysis Dashboard creation using Power BI. 2. Scrape IMDB movie ratings and details using R and save the details of top movies to .csv file. 3. Create a dashboard for COVID-19 Data Analysis using Power BI. **Tasks:** Import a public COVID-19 dataset with columns like Date, Country, New Cases, New Deaths, and Total Vaccinations, **Transform data:** Group data by Country or Region, Calculate daily growth rates for cases and deaths. **Visualizations:** Global Cases and Deaths Trends (Line Chart), Cases by Country (Map Visualization), Vaccination Progress (Clustered Column Chart). **Outcome:** An interactive dashboard presenting global COVID-19 trends. 4. Exploratory Data Analysis on Iris Dataset using R/Python.

5. Create a simple dashboard to analyze sales performance using Power BI. Import a sample sales dataset with columns like `Order ID`, `Date`, `Sales`, `Profit`, `Category`, and `Region`, perform basic data cleaning in Power Query (e.g., handle null values, format dates), create visualizations as follows:
    - Total Sales (Card).
    - Sales by Region (Map).
    - Monthly Sales Trends (Line Chart).
    - Sales by Category (Bar Chart or Pie Chart).

    Then add a slicer for filtering by year or region. The outcome will be a basic dashboard showcasing sales performance across regions and categories.
6. House Price Prediction using Machine Learning in Python/R.
7. Create a dashboard for **Employee Performance Analysis using Power BI.** Import an employee dataset with columns like Employee ID, Name, Department, Salary, Performance Score, and Joining Date, Create calculated columns:
    - Years of Service = DATEDIFF(Joining Date, TODAY(), YEAR).
    - Performance Tier = IF(Performance Score > 80, "High", IF(Performance Score > 50, "Medium", "Low")).

    Visualizations:
    - Salary Distribution (Histogram).
    - Performance by Department (Clustered Bar Chart).
    - Employee Count by Performance Tier (Pie Chart).

    It will output a report highlighting employee performance and salary distribution.
8. Zomato Data Analysis using Python/R.
9. Analyze sales performance and trends using Excel operations. **Tasks**: Import a sales dataset with columns like Order ID, Date, Product, Category, Sales Amount, Quantity, and Region.
    - Calculate Total Sales, Average Sales, and Quantity Sold using basic formulas.
    - Use **Filters** and **Sort** to analyze sales for specific categories or regions.
    - Create a **Pivot Table** to show total sales by product category and region.
    - Visualize:
        - Monthly sales trends (Line Chart).
        - Sales by region (Bar Chart or Pie Chart).
    - Identify the top-performing product and region.
10. Loan Approval Prediction including visualization of data and data preprocessing using Python/R.

11. Explore customer data to understand demographics and spending behaviour using Excel operations. **Tasks**: Dataset includes Customer ID, Name, Age, Gender, Location, Total Spend.
    - Calculate average customer spend and age using basic formulas.
    - Use **COUNTIF** to calculate the number of male vs. female customers.
    - Create a **Pivot Table** to summarize total spend by location.
    - Visualize:
        - Age distribution (Histogram).
        - Spending by gender (Bar Chart).
    - Use **Slicers** in Pivot Tables to filter data by gender or location

    Uber Rides Data Analysis using Python/R.

Textbooks:

1. "Data Analytics for Beginners" by Aileen Nielsen
2. "Practical Statistics for Data Scientists" by Peter Bruce and Andrew Bruce, O'Reilly Media, Inc.
3. "Data Analytics Using R", Seema Acharya, Mc Graw Hill.
4. "Fundamentals of Data Visualization", Claus O. Wilke. O'Reilly Media, Inc.

Online Learning Resources:

- Complete Guide to Power BI for Data Analysts by Microsoft Press: http://surl.li/gmcctm
- Excel Data Visualization: https://shorturl.at/IQwfM
- Creating Interactive Tableau Dashboards: https://shorturl.at/HqeeT
- R for Data Science: Analysis and Visualization: https://shorturl.at/oUI8H