



Name of the Faculty: Science & Technology

(As per National Education Policy 2020)

Programme:- Artificial Intelligence (AI) & Data Science

Name of the Course: S. Y. B. Tech. (Semester– III & IV)

(Syllabus to be implemented from-2026-27)



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
FACULTY of SCIENCE & TECHNOLOGY

NEP 2020 Compliant Curriculum
with effect from 2025-26

Semester – I (Common for All Engineering Branches)

| Course Type | Course Code | Name of the Course | Engagement Hours | | Credits | FA | SA | | Total |
|-----------------------------|-------------------|---|----------------------|----|---------|-----|-----|-----|-------|
| | | | L | P | | ESE | ISE | ICA | |
| BSC | BSE-01 /BSE-02 | Engineering Physics / Engineering Chemistry \$ | 3 | 2 | 4 | 70 | 30 | 25 | 125 |
| | BSE-03 | Engineering Mathematics-I | 3 | 2 | 4 | 70 | 30 | 25 | 125 |
| ESC | ESC-01 ESC-02 | Basics of Civil and Mechanical Engineering / Basic Electrical & Electronics Engineering # | 3 | 2 | 4 | 70 | 30 | 25 | 125 |
| | ESC-03 | Engineering Mechanics | 3 | 2 | 4 | 70 | 30 | 25 | 125 |
| | AEC | AEC-01 | Communication Skills | 1 | 2 | 2 | | 25 | 25 |
| CC | CC-01 | Sports and Yoga or NSS / NCC / UBA (Liberal Learning Course-I) | 1 | 2 | 2 | | | 25 | 25 |
| SEC | SEC-01 | Workshop Practices | | 2 | 1 | | | 25 | 25 |
| Total | | | 14 | 14 | 21 | 280 | 145 | 175 | 600 |
| Student Induction Program** | | | | | | | | | |

Semester – II (Common for All Engineering Branches)

| Course Type | Course Code | Name of the Course | Engagement Hours | | Credits | FA | SA | | Total |
|--|-------------------|---|------------------|-----------|-----------|------------|------------|------------|------------|
| | | | L | P | | ESE | ISE | ICA | |
| BSC | BSE-01 /BSE-02 | Engineering Physics / Engineering Chemistry \$ | 3 | 2 | 4 | 70 | 30 | 25 | 125 |
| | BSE-04 | Engineering Mathematics-II | 3 | 2 | 4 | 70 | 30 | 25 | 125 |
| ESC | ESC-01 ESC-02 | Basics of Civil and Mechanical Engineering / Basic Electrical & Electronics Engineering # | 3 | 2 | 4 | 70 | 30 | 25 | 125 |
| | ESC-04 | Engineering Graphics and CAD | | 4 | 2 | | 25 | 50 | 75 |
| SEC | SEC-02 | Data Analysis and Programming Skills | 1 | 2 | 2 | | 25 | 25 | 50 |
| CC | CC-02 | Professional Personality Development (Liberal Learning Course-II) | 1 | 2 | 2 | | 25 | 25 | 50 |
| IKS | IKS-01 | Introduction to Indian Knowledge System | 2 | | 2 | | 25 | 25* | 50 |
| | Audit Course | Disaster Management | | | | | | | |
| Total | | | 14 | 14 | 20 | 210 | 190 | 200 | 600 |
| Democracy, Elections and Good Governance * | | | 1 | | | 50 | | | |

*For IKS activity report should be submitted

BSC- Basic Science Course
ESC- Engineering Science Course,
PCC- Programme Core Course ,
AEC- Ability Enhancement Course,
IKS- Indian Knowledge System,
CC- Co-curricular Courses ,
VSEC- Vocational and Skill Enhancement Course

Notations used–

L : Lecture

P : Lab Sessions

FA : Formative Assessment

SA : Summative Assessment

ESE : End Semester Examination

ISE : In Semester Evaluation

ICA : Internal Continuous

Notes-

1. \$ - Indicates student may choose Engineering Physics or Engineering Chemistry in either first or second semester. Those who have taken Engineering Physics in first semester will take Engineering Chemistry in second semester. Those who have taken Engineering Chemistry in first semester will take Engineering Physics in second semester.
2. # - Indicates student may choose Basics of Civil and Mechanical Engineering or Basic Electrical & Electronics Engineering in either first or second semester. Those who have taken Basics of Civil and Mechanical Engineering in first semester will take Basic Electrical & Electronics Engineering in second semester. Those who have taken Basic Electrical & Electronics Engineering in first semester will take Basics of Civil and Mechanical Engineering in second semester.
3. For the Course Basic Electrical & Electronics Engineering, practical of Basic Electrical Engineering and Basic Electronics Engineering will be conducted in alternate weeks.
4. For the Course Basics of Civil and Mechanical Engineering, practical of Basics of Civil Engineering and Basics of Mechanical Engineering will be conducted in alternate weeks.
5. In Semester Evaluation (ISE) marks shall be based upon student's performance in three tests conducted & evaluated at institute level.
6. Internal Continuous Assessment Marks (ICA) is calculated based upon student's performance during practical sessions.
7. *- Democracy, Elections & Good Governance is mandatory course. The marks earned by student with this course shall not be considered for calculation of SGPA/CGPA. However, student must complete End Semester Examination (ESE) of 50 marks (as prescribed by university) for fulfilment of this course. This course is not considered as a passing head for counting passing heads for ATKT. However, student must pass this subject for award of the degree.
8. Student must complete induction program of minimum five days before commencement of the regular academic schedule at the first semester.

**** GUIDELINES FOR STUDENT INDUCTION PROGRAM****

New entrants into an Engineering program come with diverse thoughts, mind set and different social, economic, regional and cultural backgrounds. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose.

An induction program for the new UG entrant students is proposed at the commencement of the first semester. It is expected to complete this induction program before commencement of the regular academic schedule.

Its purpose is to make new entrants comfortable in their new environment, open them up, set a healthy daily routine for them, create bonding amongst the peers as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The Induction Program shall encompass (but not limited to) below activity –

1. Physical Activities
2. Creative Arts
3. Exposure to Universal Human Values
4. Literary Activities
5. Proficiency Modules
6. Lectures by Experts / Eminent Persons
7. Visit to Local Establishments like Hospital /Orphanage
8. Familiarization to Department

Induction Program Course do not have any marks or credits however performance of students for Induction Program is assessed at institute level using below mandatory criteria –

1. Attendance and active participation
2. Report writing



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Semester-III

| Course Type | Course Code | Name of the Course | Engagement Hours | | | Credits | FA | SA | | | Total |
|-----------------------|-------------|--|------------------|----------|-----------|-----------|------------|------------|------------|------------|------------|
| | | | L | T | P | | ESE | ISE | ICA | OE/ POE | |
| PCC | ADPCC-01 | Discrete Mathematics Structure | 3 | | | 3 | 70 | 30 | | | 100 |
| PCC | ADPCC-02 | Data Structure | 3 | | 2 | 4 | 70 | 30 | 25 | 25 | 150 |
| PCC | ADPCC-03 | Computer Architecture and Operating System | 2 | | 2 | 3 | 70 | 30 | 25 | | 125 |
| CEP/FP | ADFP-01 | Python Programming | 1 | | 2 | 2 | | 25 | 25 | 25 | 75 |
| OE | OE-01 | Open Elective-1 | 2 | | 2 | 3 | 70 | 30 | 25 | | 125 |
| Entrepreneurship | EM-01 | Product Development and Entrepreneurship | 1 | 1 | | 2 | | 50 | 25 | | 75 |
| MDM | MDM-01 | MD Minor-1 | 2 | | 2 | 3 | 70 | 30 | 25 | | 125 |
| VEC | VEC-01 | Universal Human Values | 1 | | 2 | 2 | 50 | | 25 | | 75 |
| Total | | | 15 | 1 | 12 | 22 | 400 | 225 | 175 | 50 | 850 |
| Environmental Science | | | 1 | | | | | | | | |

PCC- Programme Core Course,

PEC-Programme Elective Course

CEP/FP – Field Project

OE- Open Elective

AEC- Ability Enhancement Course,

VSEC-Vocational and Skill Enhancement Course

MDM-Multidisciplinary Minor: It should be selected from other UG Engineering Minor Programme

Semester-IV

| Course Type | Course Code | Name of the Course | Engagement Hours | | | Credits | FA | | SA | | Total |
|-----------------------|-------------|--|------------------|---|-----------|-----------|-----|-----|-----|----------|-------|
| | | | L | T | P | | ESE | ISE | ICA | OE / POE | |
| PCC | ADPCC-04 | Mathematical Foundation for Data Science | 3 | | | 3 | 70 | 30 | | | 100 |
| PCC | ADPCC-05 | Theory of Computation | 3 | | | 3 | 70 | 30 | | | 100 |
| PCC | ADPCC-06 | Artificial Intelligence | 2 | | 2 | 3 | 70 | 30 | 25 | 25 | 150 |
| CEP/FP | ADFP-02 | Object Oriented Programming using JAVA | 1 | | 2 | 2 | | 25 | 25 | 25 | 75 |
| Economic/Management | EM-02 | Project Management and Economics | 2 | - | - | 2 | - | 25 | 25 | | 50 |
| OE | OE-02 | Open Elective-II | 3 | | 2 | 4 | 70 | 30 | 25 | | 125 |
| MDM | MDM-02 | MD Minor-II | 2 | | 2 | 3 | 70 | 30 | 25 | | 125 |
| VEC | VEC-02 | Professional Ethics | 1 | | 2 | 2 | 50* | | 25 | | 75 |
| Total | | | 17 | | 10 | 22 | 400 | 200 | 150 | 50 | 800 |
| Environmental Science | | | 1 | | | | 40 | 10 | | | 50 |

PCC- Programme Core Course,

PEC-Programme Elective Course

CEP/FP – Field Project

OE- Open Elective

VSEC-Vocational and Skill Enhancement Course

MDM-Multidisciplinary Minor: It should be selected from other UG Engineering Minor Programme



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Semester-V

| Course Type | Course Code | Name of the Course | Engagement Hours | | | Credits | FA | SA | | | Total |
|-------------|-------------|--------------------------------|------------------|---|-----------|-----------|------------|------------|------------|-----------|------------|
| | | | L | T | P | | ESE | ISE | ICA | OE/POE | |
| PCC | ADPCC-07 | Machine Learning | 3 | | 2 | 4 | 70 | 30 | 25 | | 125 |
| PCC | ADPCC-08 | Computer Network & Security | 3 | | | 3 | 70 | 30 | | | 100 |
| PCC | ADPCC-09 | Database Engineering | 3 | | 2 | 4 | 70 | 30 | 25 | 25 | 150 |
| PEC | ADPEC-01 | Programme Elective Course-I | 3 | | 2 | 4 | 70 | 30 | 25 | | 125 |
| AEC | AEC-02 | Creativity and Design Thinking | 1 | | 2 | 2 | 50* | | 25 | | 75 |
| OE | OE-03 | Interdisciplinary Mini Project | 1 | | 2 | 2 | | | 25 | 25 | 50 |
| MDM | MDM-03 | MD Minor-III | 2 | | 2 | 3 | 70 | 30 | 25 | | 125 |
| | | | 16 | | 12 | 22 | 400 | 150 | 150 | 50 | 750 |

* For AEC-02: MCQ- based examination to be conducted.

PCC- Programme Core Course,

PEC-Programme Elective Course

CEP/FP – Field Project

OE- Open Elective

AEC- Ability Enhancement Course,

MDM-Multidisciplinary Minor: It should be selected from other UG Engineering Minor Programme

Semester-VI

| Course Type | Course Code | Name of the Course | Engagement Hours | | | Credits | FA | SA | | | Total |
|-------------|-------------|------------------------------------|------------------|---|----|---------|-----|-----|-----|------------|-------|
| | | | L | T | P | | ESE | ISE | ICA | OE/ POE | |
| PCC | ADPCC-10 | Deep Learning | 3 | | 2 | 4 | 70 | 30 | 25 | 25 | 150 |
| PCC | ADPCC-11 | Design and Analysis of Algorithms | 3 | | | 3 | 70 | 30 | | | 100 |
| PCC | ADPCC-12 | Data Science | 3 | | 2 | 4 | 70 | 30 | 25 | 25 | 150 |
| PEC | ADPEC-02 | Programme Elective Course-II | 2 | | 2 | 3 | 70 | 30 | 25 | | 125 |
| PEC | ADPEC-03 | Programme Elective Course-III | 2 | | 2 | 3 | 70 | 30 | 25 | | 125 |
| SEC | SEC-02 | Project on Industrial Applications | | | 4 | 2 | | | 25 | 50 | 75 |
| MDM | MDM-04 | MD Minor-IV | 2 | | 2 | 3 | 70 | 30 | 25 | | 125 |
| | | | 15 | | 14 | 22 | 420 | 180 | 150 | 100 | 850 |

PCC- Programme Core Course,
 PEC-Programme Elective Course
 CEP/FP – Field Project
 OE- Open Elective
 SEC- Skill Enhancement Course,
 MDM-Multidisciplinary Minor: It should be selected from other UG Engineering Minor Programme



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Semester-VII

| Course Type | Course Code | Name of the Course | Engagement Hours | | | Credits | FA | SA | | | Total |
|-------------|-------------|----------------------------------|------------------|---|----|---------|-----|-----|-----|--------|-------|
| | | | L | T | P | | ESE | ISE | ICA | OE/POE | |
| PCC | ADPCC-14 | Data Analytics and Visualisation | 3 | | | 3 | 70 | 30 | | | 100 |
| PCC | ADPCC-15 | Business Intelligence | 3 | | | 3 | 70 | 30 | | | 100 |
| PEC | ADPEC-04 | Programme Elective Course-IV | 3 | | 2 | 4 | 70 | 30 | 25 | | 125 |
| Project | ADProject | Capstone Project | | | 8 | 4 | | | 100 | 100 | 200 |
| RM | RM | Research Methodology and IPR | 3 | | 2 | 4 | 70 | 30 | 25 | | 125 |
| MDM | MDM-05 | MDM Minor-V | 2 | | | 2 | 70 | 30 | | | 100 |
| | | | 14 | | 12 | 20 | 350 | 150 | 150 | 100 | 750 |

PCC- Programme Core Course,

PEC-Programme Elective Course

RM- Research Methodology

MDM-Multidisciplinary Minor: It should be selected from other UG Engineering Minor Programme

Semester-VIII

| Course Type | Course Code | Name of the Course | Engagement Hours | | | Credits | FA | SA | | | Total |
|-------------|-------------|---|------------------|---|----|---------|-----|-----|-----|------------|-------|
| | | | L | T | P | | ESE | ISE | ICA | OE/ POE | |
| PCC | ADPCC-15 | Natural Language Processing | 4# | | | 4 | 100 | | | | 100 |
| PEC | ADPEC-05 | Self learning offered by Institute / MOOC Courses | 4# | | | 4 | 100 | | | | 100 |
| OJT | AIDSOJT | Industry Internship / Research Internship / On job training | | | 24 | 12 | | | 200 | 100 | 300 |
| | | | 8# | | 24 | 20 | 200 | | 200 | 100 | 500 |

Students will practice or attend in Self-Learning mode

List of MOOCS courses related to CSEPEC-05 will be provided by BOS time to time.

PCC- Programme Core Course,
 PEC-Programme Elective Course
 OJT- On Job Training

Bucket for Program Elective Course (PEC)

| PEC/Sem | Course Code and Name |
|---------------|---|
| ADPEC-01 /V | ADPEC-01A: Advance Network Security |
| | ADPEC-01B: Soft Computing |
| | ADPEC-01C: Image Processing & Computer Vision |
| | ADPEC-01D: Internet of Things |
| | ADPEC-01E*: Cyber Security (UDYAM) |
| ADPEC-02 /VI | ADPEC-02A: Cyber Security |
| | ADPEC-02B: High Performance Computing |
| | ADPEC-02C: Virtual and Augmented Reality |
| | ADPEC-02D: Data Mining and Warehousing |
| ADPEC-03 /VI | ADPEC-03A: Blockchain Technology |
| | ADPEC-03B: Cloud Computing |
| | ADPEC-03C: Big Data Analytics |
| | ADPEC-03D: Distributed System |
| ADPEC-04 /VII | ADPEC-04A: Software Design and Methodology |
| | ADPEC-04B: Edge Computing |
| | ADPEC-04C: DevOps |
| | ADPEC-04D: Information Retrieval |

ADPEC-01E* should be completed in online mode

Semester- III: List of Open Elective -1 (OE-1)

| Sr. No. | Course Code and Name |
|---------|--|
| 1 | OE-01A: Advanced Mathematics and Statistics |
| 2 | OE-01B Digital Marketing and E- Commerce |
| 3 | OE-01C Humanities and Social Sciences |
| 4 | OE-01D Industrial and Quality Management |
| 5 | OE-01E Mathematics for Software and Hardware |
| 6 | OE-01F Soft Skills and Personality Development |

Semester- IV: List of Open Elective -II (OE-2)

| Sr. No. | Course Code and Name |
|---------|--|
| 1 | OE-02A Entrepreneurship and Innovation |
| 2 | OE-02B Environmental Sustainability |
| 3 | OE-02C Renewable Energy |
| 4 | OE-02 D Measurement, Instrumentation and Sensors |
| 5 | OE-02E Operation Research |
| 6 | OE-02F Computational Mathematics |
| 7 | OE-02 G Professional Business Communication |

Multidisciplinary Minor in Artificial Intelligence & Data Science

| Semester | Course Code | Course Title |
|----------|-------------|--------------------------------------|
| III | ADMDM-01A | Python Programming |
| IV | ADMDM-02A | Data Preprocessing and Visualization |
| V | ADMDM-03A | Machine Learning |
| VI | ADMDM-04A | Predictive Analytics |
| VII | ADMDM-05A | Artificial Intelligence |

Multidisciplinary Minor in Artificial Intelligence and Machine Learning

| Semester | Course Code | Course Title |
|----------|-------------|-----------------------------|
| III | ADMDM-01B | Python Programming |
| IV | ADMDM-02B | Machine Learning |
| V | ADMDM-03B | Reinforcement Learning |
| VI | ADMDM-04B | Natural Language Processing |
| VII | ADMDM-05B | Deep Learning |

A. Honors in Cyber Security

| Semester | Course Code | Name of the Course | Engagement Hours | | | Credits | FA | SA | | Total |
|----------|-------------|------------------------------------|------------------|---|----|---------|-----|-----|-----|-------|
| | | | L | T | P | | ESE | ISE | ICA | |
| III | ADHON-01A | Cryptography | 3 | 1 | | 4 | 70 | 30 | 25 | 125 |
| IV | ADHON-02A | Network Security and Secure Coding | 3 | | 2 | 4 | 70 | 30 | 25 | 125 |
| V | ADHON-03A | Cyber Security | 3 | | 2 | 4 | 70 | 30 | 25 | 125 |
| VI | ADHON-04A | Blockchain Technology | 3 | | 2 | 4 | 70 | 30 | 25 | 125 |
| VII | ADHON-05A | Mini Project | | | 4* | 2 | | | 50 | 50 |
| | | | 12 | 1 | 10 | 18 | 280 | 120 | 150 | 550 |

*Contact Hours

B. Honors in Software Engineering

| Semester | Course Code | Name of the Course | Engagement Hours | | | Credits | FA | SA | | Total |
|----------|-------------|--|------------------|---|----|---------|-----|-----|-----|-------|
| | | | L | T | P | | ESE | ISE | ICA | |
| III | ADHON-01B | Software Engineering | 3 | 1 | | 4 | 70 | 30 | 25 | 125 |
| IV | ADHON-02B | Software Testing and Quality Assurance | 3 | | 2 | 4 | 70 | 30 | 25 | 125 |
| V | ADHON-03B | Object Oriented Modelling and Design | 3 | | 2 | 4 | 70 | 30 | 25 | 125 |
| VI | ADHON-04B | Management Information System | 3 | | 2 | 4 | 70 | 30 | 25 | 125 |
| VII | ADHON-05B | Mini Project | | | 4* | 2 | | | 50 | 50 |
| | | | 12 | 1 | 10 | 18 | 280 | 120 | 150 | 550 |

Semester-III



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech (Artificial Intelligence (AI) & Data Science)
Semester-III

ADPCC01 -DISCRETE MATHEMATICAL STRUCTURES

Teaching Scheme

Lectures–3 Hours/week, 3 Credits

Examination Scheme

ESE –70 Marks

ISE – 30 Marks

Introduction:

This course introduces discrete mathematics which deals with fundamentals of mathematical reasoning and set theory. The course also introduces theoretical and mathematical aspects of relations, functions, algebraic systems& Boolean algebra.

Course Prerequisite: Students shall have knowledge of basic mathematics.

Course Objectives

1. To introduce the fundamental principle of counting.
2. To get acquainted with basic connectives and find equivalent formulas and normal forms.
3. To draw implications from basic primitives.
4. To introduce set theory and relations with illustrations.
5. To introduce the concepts of functions and its types through scenarios.
6. To define types of algebraic systems and applications.

Course outcomes

Students will be able to:

1. Solve the problems related to the permutation, combination and mathematical induction
 2. Apply mathematical logic and inference rules to logical propositions and derive conclusions from given premises.
 3. Apply concepts of set theory, relations, and functions to determine relation properties and function operations.
 4. Apply concepts of algebraic structures, groups, lattices, and Boolean algebra to solve problems related to algebraic systems and Boolean functions.
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SECTION-I

UNIT-1 Introduction to Principles of Counting

(08)

Two basic counting principles, Permutations, permutations with repetition, combinations, combinations with repetition, the principles of mathematical induction, Pigeon hole Principle.

UNIT-2 Mathematical logic (06)

Introduction, statements and Notation, Connectives-negation, conjunction, disjunction, conditional, bi conditional, statement formulas and truth tables, well-formed formulas, Tautologies, Equivalence of formulas, Duality law, Tautological implications, functionally complete sets of connectives, other connectives.

UNIT-3 Representation of expressions and Set Theory (06)

Normal & Principle normal forms, completely parenthesized infix & polish notations, Theory of inference for statement calculus.

SECTION II

UNIT-4 Set Theory, Relations and Functions (08)

Basic concepts of set theory, types of operations on sets, ordered pairs, Cartesian product. Relations, Properties of binary relations, Matrix and graph representation, Partition and covering of set, Equivalence relation, Composition, POSET and Hasse diagram. Function-types, Composition of functions, Inverse functions.

UNIT-5 Algebraic systems and Groups (07)

Algebraic systems, examples and general properties, semi groups and monoids, homomorphism, isomorphism, rings. Polish expressions and their compilation, Groups, group codes.

UNIT-6 Lattices and Boolean algebra (06)

Lattice as POSETs, definition, examples and Properties, Special Lattices, Boolean algebra definition and examples, Boolean functions

Text books:

1. Discrete mathematical structures with applications to computer science -- J. P. Tremblay & R. Manohar (MGH International)
2. Discrete Mathematics with combinatorics and graph theory-S.SNTHA (CENGAGE Learning)

Reference Books:

1. Discrete Mathematical Structures –Bernard Kolman, Robert C. Busby (Pearson Education)
2. Discrete Mathematics-Liu (MGH)
3. Theory and problems in Abstract algebra--Schaums outline series (MGH)
4. Discrete Mathematical Structures-Y N Singh (WILEY)
5. Discrete Mathematics and Its Applications, Chakraborty&Sarkar, Oxford

6. Discrete Structures, S.B.Singh, Khanna Book Publishing, Delhi
7. Discrete Mathematics, T.Veerarajan, TataMcGraw-Hill



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Semester-III

ADPCC-02 DATA STRUCTURE

Teaching Scheme

Lectures: 3 Hours / Week
Practical: 2 Hours / Week

Examination Scheme

ESE: 70 Marks
ISE: 30 Marks
ICA: 25 Marks
POE: 25 Marks

Course Introduction:

This course introduces fundamental and advanced data structures required for efficient data organization and problem solving. It covers searching and sorting techniques, linear and non-linear data structures such as stacks, queues, linked lists, trees and graphs. The course focuses on implementation using Python and includes applications relevant to Artificial Intelligence and Data Science such as network analysis and graph based data representation.

Course Prerequisites:

Basic knowledge of programming using Python.

Course Objectives:

1. To study fundamental data structures and algorithms, including searching and sorting techniques, and analyze their performance using time and space complexity.
2. To implement linear data structures such as stacks, queues, and linked lists using Python, and apply them to solve computational problems like expression evaluation and polynomial operations.
3. To understand tree-based data structures such as Binary Trees, Binary Search Trees, AVL Trees, and B-Trees, and perform operations like traversal, insertion, deletion, and balancing.
4. To represent and analyze graph structures and implement graph traversal and shortest path algorithms.

Course Outcomes:

Students will be able to:

1. Implement searching and sorting algorithms in Python.
2. Develop programs using linear data structures such as stack, queue, and linked list.
3. Construct and perform operations on tree data structures such as Binary Trees, BST, and AVL Trees.

4. Apply graph representations and algorithms like BFS, DFS, and shortest path to solve problems.

SECTION –I

UNIT 1: Introduction to Data Structures & Searching-Sorting (06)

What is Data Structure, types of data structures – static, dynamic, primitive, non-primitive, linear, non-linear data structure, Arrays in python, Study and Implementation of Searching Algorithms- Linear search and Binary search, Study and Implementation of Sorting, Algorithms-Bubble sort, Selection sort, Insertion sort, Merge sort, Quick sort, Shell sort, Radix sort and Heap sort, Time Complexity, Space Complexity.

UNIT 2: Stack and Queue (06)

Stack: Definition, representation, Operations, Implementation and applications like conversion of polish notations, evaluation of postfix expressions, Queue: Definition, representation, Operations, Implementation of Linear Queue, Circular Queue, Priority Queue.

UNIT 3: Lists (06)

Definition, representation, Operations, Types of Lists: Singly Linked list, Doubly Linked list, Circular Linked list, Stack using linked list, Queue using Linked list, Application of Linked list: Addition and Subtraction of two polynomials

UNIT 4: Hashing (04)

Different Hash Functions, choosing a hash function Collision Resolution by Open Addressing: Linear probing, quadratic probing, double hashing, Collision Resolution by Chaining.

SECTION –II

Unit 5: Trees (05)

Tree Definition, Tree terminology, Binary Trees, Binary Search Trees, tree traversal techniques (Inorder, Preorder, Postorder), Operations on: Binary trees and Binary Search Trees, linked implementation and introduction to Threaded Binary Trees.

Unit 6: Advanced Trees (07)

Multiway search trees, balanced multiway trees, traversal and insertion in multiway trees: B-Trees and B+ Trees, AVL Trees: definition, height of AVL tree, insertion, deletion and Single and Double rotation of AVL Trees.

Unit 7: Graph Fundamentals (03)

Definition, Graph terminology, directed and undirected graphs, graph representation using adjacency matrix and adjacency list. Graph traversal methods: BFS and DFS.

Unit 8: Graph Algorithms and Applications (05)

Dijkstra shortest path algorithm. Minimum Spanning Trees: Prim's and Kruskal's algorithms. Applications of graphs in social networks, recommendation systems and knowledge graphs.

Internal Continuous Assessment (ICA)

ICA shall consist of minimum 12 practical assignments covering all topics and implemented using Python.

Text Books :

1. Problem Solving with Algorithms and Data Structures Using Python – Bradley N. Miller & David L. Ranum.
2. Data Structures and Algorithms in Python – Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser.
3. Python Data Structures and Algorithms – Benjamin Baka.

Reference Books :

1. Grokking Algorithms – Aditya Bhargava.
2. Hands-On Data Structures and Algorithms with Python – Dr. Basant Agarwal & Benjamin Baka.
3. Learning Python – Mark Lutz.



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Semester-III

ADPCC03- COMPUTER ARCHITECTURE AND OPERATING SYSTEM

Teaching Scheme

Lectures–2 Hours/week, 2 Credits
Practical – 2 Hours/Week, 1 Credits

Examination Scheme

ESE –70 Marks
ISE – 30 Marks
ICA – 25

Introduction:

This course introduces the fundamental concepts of computer organization and operating systems that form the foundation of modern computing systems. It covers the internal architecture of computers, instruction sets, memory hierarchy, and input/output organization. The course also explores parallel programming models, pipelining, and instruction-level parallelism to understand system performance. Additionally, it provides knowledge of operating system mechanisms including process management, memory management, and file systems.

Prerequisite:

Students should have basic knowledge of computer fundamentals, digital logic, and programming concepts.

Course Objectives:

1. To introduce the fundamental concepts of computer organization including instruction sets, memory hierarchy, and system bus architecture.
2. To explain parallel programming models, pipelining techniques, and instruction-level parallelism for improving system performance.
3. To understand input/output organization and communication between processor, memory, and peripheral devices.
4. To study operating system concepts including process management, synchronization, and scheduling algorithms.
5. To analyze memory management and file system structures used in modern operating systems.

Course Outcomes:

At the end of course student will able to:

1. Understand computer organization and its architectures
2. Apply parallel programming and pipelining structures for utility operations
3. Implement process scheduling algorithms.

4. Simulate memory and file management.

SECTION – I

Unit 1 - Fundamentals of Computer Organization, Instruction Sets, and Memory (06)

History and generations of computers. Von Neumann model and basic computer components, System bus model, Instruction set architecture & Basic Computer Instructions, RISC vs CISC, Number System and Base Conversions, Memory-Addressing Modes, Memory hierarchy.

Unit 2 – Parallel Programming Models and I/O Organization (06)

Parallel Programming Models, External devices, I/O module, Programmed I/O, Interrupt driven I/O, Direct memory access, I/O channels and processors, External interface

Unit 3 - Pipelining and Instruction Level Parallelism (06)

Introduction to pipelining, Pipeline hazards, linear and nonlinear pipelines, MESI protocol, ILP concepts and challenges, Branch prediction, Dynamic scheduling, Hardware speculation, Multiple issue and static scheduling.

SECTION-II

Unit 4 Process Management in Operating System (06)

Introduction to OS, Process Concept, Process Scheduling and algorithms, Threads, Multiple processor scheduling, Inter-Process communication, The critical section problem, Semaphores, Classical problems of synchronization.

Unit 5 Memory Management in Operating System (06)

Logical Versus Physical Address space, Swapping, Contiguous Allocation, Paging, Segmentation, Segmentation with paging, Virtual Memory, Mass Storage Structure – Disk Scheduling.

Unit 6 File Management in Operating System (06)

File Concept, Access methods, Directory and Disk Structure, File System Structure, File System Implementation, Directory Implementation. Allocation Methods

Internal Continuous Assessment (ICA)

ICA shall consist of minimum 8 practical assignments covering all topics.

Text Books:

1. Computer System Architecture by M. Morris Mano

2. Computer Organization and Design: The Hardware/Software Interface by David A. Patterson & John L. Hennessy
 3. Operating System concepts, Silberschatz, Galvin, 7th or 8th Edition (John Wiley).
 4. Operating Systems: Internals and Design Principles by William Stallings, 5th Edition (PHI).
 5. The design of Unix Operating Systems- Maurice J. Bach(PHI)
-

Reference Books:

1. Computer Organization by Carl Hamacher, Zvonko Vranesic, & Safwat Zaky
2. Computer Architecture: A Quantitative Approach by John L. Hennessy & David A. Patterson.
3. Operating system with case studies in UNIX, Netware and Windows NT by Achyut Godbole (TMGH).
4. Operating Systems, Deitel, Deitel, Choffnes, 3rd Edition, by Pearson Education.



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech (Artificial Intelligence (AI) & Data Science)
Semester-III

ADFP-01: PYTHON PROGRAMMING

Teaching Scheme

Lectures–1 Hours/week, 1 Credits
Practical – 2 Hours/Week, 1 Credits

Examination Scheme

ISE – 25 Marks
ICA – 25 Marks
POE – 25 Marks

Introduction :

Python is a popular, general-purpose, multi-paradigm, open-source, scripting language. It is designed to emphasize code readability – has a clean syntax with high level data types. It is suited for interactive work and quick prototyping, while being powerful enough to write large applications. This course introduces the python language which has simple syntax, powerful set of libraries and robust debugger and profiler.

Course Prerequisite:

Students should have knowledge of basic programming.

Course Objectives:

1. To introduce the core components of the Python programming language.
 2. To study library packages to write applications using python
 3. To study GUI, exception handling and debugging python programs.
-

Course Outcomes :

At the end of this course, students will be able to

1. Apply Python programming constructs such as data types, control structures, functions, modules, and exception handling to develop programs.
 2. Implement object-oriented programming concepts in Python.
 3. Use Python standard library modules and packages to perform mathematical, date-time, random number, and array-based computations.
 4. Design and Implementation GUI Applications.
-

SECTION-I

Unit 1 - Introduction to Python (02)

History, feature of Python, Python Interpreter, Program Execution, Execution Model Variations, The Interactive Prompt.

Unit 2 – Python Programming Construct (08)

Data types and variables, Control structures, loops and functions, Lambdas, Generators, Exception Handling, String handling, Scope of variables, Modules, Packages.

Unit 3 - Introduction to Object Oriented Programming in Python (05)

Classes, Instance Objects, Method Objects, Class and Instance Variables, Attributes and methods, Inheritance and polymorphism.

SECTION - II

Unit 4 - Python Standard Library Modules and Packages (08)

Regular expression operations, Basic date and time types, General calendar-related functions, NumPy, Shallow and deep copy operations, Mathematical functions, Generate pseudo-random numbers. Data Persistence: CSV File Reading and Writing, Logging facility for Python.

Unit 5 – Multithreading and Introduction to MySQL Database (04)

Concurrent Execution: Thread-based parallelism, Process-based parallelism, Context Variables, Introduction of MySQL Database basic operations ,Python Database connectivity.

Unit 6 – Testing and Debugging (03)

Testing output, Unit tests in Python, Debugging programs, Measure execution time of small code snippets.

ISE Evaluation for the course will consist of two programming (hands on) tests.

Internal Continuous Assessment (ICA):

Minimum 12 practical's based on above topics.

- The assignments should test and develop student's practical proficiency and ability to use Python standard library modules and packages efficiently in writing effective code for varied applications scenarios & requirements, use cases.
-

Text Book:

Programming in Python 3, Mark Summerfield, Second Edition

Reference Books:

1. Python Cookbook, David Beazley and Brian K. Jones, Third Edition, Shroff Publishers & Distributors Pvt. Ltd., ISBN :978-93-5110-140-6
 2. Learning Python, MarkLutz, 5th edition
 3. Programming Python (English), MarkLutz, 4th Edition
 4. Testing Python, David Sale, Wiley India (P) Ltd., ISBN :978-81-265-5277-1
-

e-resources:

1. Python 2.7.16 documentation - <https://docs.python.org/2/>
2. Python 3.7.3 documentation - <https://docs.python.org/3/>



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech (Artificial Intelligence (AI) & Data Science)
Semester-III

EM-01 PRODUCT DEVELOPMENT AND ENTERPRENEURSHIP

Teaching Scheme

Theory – 1 Hrs./Week, 1 Credit

Tutorial -1 Hr/Week,1Credit

Examination Scheme

Theory- ISE-50Marks

ICA – 25 Marks

Course Outcomes:

1. Understand the concept of product development
2. Identify the market strategies
3. Frame the idea and convert it into a concept
4. Identify the TRL, MRL and IRL level of product
5. Demonstrate the business canvas model and lean canvas model
6. Develop the strategies for launching the product in market

SECTION - I

Unit No. 1: Product development and entrepreneurship (04)

- a. Product development: Concept and necessity
- b. Entrepreneurship: Definition, characteristics of entrepreneur, types of entrepreneurship
- c. Market research and fundamentals: Techniques for conducting market research to identify customer needs and market opportunities

Unit No. 2: Ideation and concept development (03)

- a. Steps/process of product development
- b. Idea generation: Techniques for idea generation, such as brainstorming, mind mapping and general problem identification exercise etc.
- c. concept development for the problem identified

SECTION - II

Unit No. 3: Business fundamentals for entrepreneurs (03)

- a. Technical readiness level in bracket. TRL market readiness level in bracket. MRL and IRL
- b. Business canvas model, Lean canvas model

Unit No. 4: Introduction to IPR for Entrepreneurship (04)

- a. Developing strategies for launching products to market
- b. Resources and risk management: Planning, execution and risk

- management (financial, technical, market)
- c. Market and Sustainability and scalability

Term Work:

Term work should be based on assignments (Case studies) based on above topics.

Reference Books:

- a. Product Design for Engineers, By Devdas Shetty, Cengage Learning
- b. Product Design, by Kevin Otto, Kristin wood, Pearson Education Inc.
- c. Product design and development, by K.T. Ulrich and S.D. Eppinger, Tata McGraw Hill
- d. Product Development, by Chitale & Gupta, Tata McGraw Hill
- e. Product design & process Engineering by Niebel & deeper, McGraw hill
- f. Entrepreneurship, Hisrich, Robert D., Michael Peters and Dean Shepherded, , Tata McGraw Hill, ND
- g. Entrepreneurship, , Brace R., and R., Duane Ireland, , Pearson Prentice Hall, New Jersey (USA).
- h. Entrepreneurship Development and Small Business Enterprises, Charantimath, Poornima, Pearson Education, New Delhi.



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech (Artificial Intelligence (AI) & Data Science)
Semester-III

VEC-01: UNIVERSAL HUMAN VALUES

Teaching Scheme

Theory – 1 Hrs./Week, 1 Credit

Practical - 2 Hr/Week, 1Credit

Examination Scheme

Theory- ESE-50Marks

ICA – 25 Marks

Course Outcomes:

Upon completion of this course, students will be able to,

1. Appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings.
2. Develop holistic perspective towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence.
3. Appreciate the Universal Human Values and movement towards value-based living in a natural way.
4. Highlight ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

SECTION-I

Unit: 1 Course Introduction, Need, Basic Guidelines, Content and Process for Value Education (07)

- a. Understanding the need, basic guidelines, content and process for Value Education
- b. Self-Exploration–what is it? - its content and process; “Natural Acceptance” and Experiential Validation- as the mechanism for self-exploration
- c. Continuous Happiness and Prosperity- A look at basic Human Aspirations.
- d. Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority.
- e. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
- f. Method to fulfill the above human aspirations understanding and living in harmony at various levels

Unit 2: Understanding Harmony in the Human Being - Harmony in Myself (07)

- a. Understanding human being as a co-existence of the sentient “I” and the material Body
- b. Understanding the needs of Self (I) and Body–Sukh and Suvidha
- c. Understanding the Body as an instrument of I (I being the doer, seer and enjoyer)
- d. Understanding the characteristics and activities of I and harmony in I
- e. Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail.
- f. Programs to ensure Sanyam and Swasthya

SECTION-II

Unit 3: Understanding Harmony in Family and Society- Harmony in Human- Human Relationship (08)

- a. Understanding Harmony in the family – the basic unit of human interaction
- b. Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship
- c. Understanding the meaning of Vishwas; Difference between intention and competence
- d. Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship
- e. Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals
- f. Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha)- from family to world family

Unit 4: Understanding Harmony in the Nature and Existence - Whole existence as Co-existence (08)

- a. Understanding the harmony in the Nature
- b. Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self- regulation in nature
- c. Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space
- d. Holistic perception of harmony at all levels of existence

ICA: ICA marks should give on a weekly activity basis, depending upon completed activities and reports.

Text Books:

1. R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2
2. The teachers manual: R.R Gaur, R Sangal, G P Bagaria, A foundation course in human Values and professional Ethics – Teachers Manual, Excel books, New Delhi, 2010 Briggs, Britain.

Reference Books:

1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow.Reprinted2008.
2. PL Dhar, RR Gaur, 1990, Science and Humanism, CommonwealthPurblishers.
3. 3Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits toGrowth, Club of Rome’s Report, UniverseBooks.
6. SubhasPalekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) KrishiTantraShodh,Amravati.
7. A Nagraj, 1998, JeevanVidyaekParichay, Divya Path Sansthan,Amarkantak.
8. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs,Britain.
9. A.N. Tripathy, 2003, Human Values, New Age International Publishers.

Relevant websites, movies and documentaries

- a. Value Education websites, <http://uhv.ac.in>,<http://www.uptu.ac.in>
- b. Story of Stuff, <http://www.storyofstuff.com>
- c. Al Gore, An Inconvenient Truth, Paramount Classics, USA
- d. Charlie Chaplin, Modern Times, United Artists, USA
- e. IIT Delhi, Modern Technology – the Untold Story
- f. Gandhi A., Right Here Right Now, Cyclewala Productions
- g. AICTE On-line Workshop on Universal Human Values Refresher Course-I Handouts

UHV-I handouts

<https://drive.google.com/drive/folders/16eOka8AoBpLGICDajRvk4MXgfXQWzFCB?usp=sharing>

UHV-II handouts

<https://drive.google.com/drive/folders/15eHkMVguzRBDrb65GFi7jMN6UEP5JEk1?usp=sharing>

Multidisciplinary Minor in “Artificial Intelligence & Data Science”

| Semester | Course Code | Course Title |
|----------|-------------|--------------------|
| III | ADMMDM-01A | Python Programming |



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech (Artificial Intelligence (AI) & Data Science)
Multidisciplinary Minor in Artificial Intelligence and Data Science
Semester-III

ADMDM-01A - PYTHON PROGRAMMING

Teaching Scheme

Lectures : - 2 Hrs/Week, 2 credits

Practical : - 2 Hrs/Week, 1 credit

Examination Scheme

ESE: 70 Marks

ISE : 30 Marks

ICA :25 Marks

Introduction: Python is a popular, general-purpose, multi-paradigm, open-source, scripting language. It is designed to emphasize code readability – has a clean syntax with high level data types. It is suited for interactive work and quick prototyping, while being powerful enough to write large applications. This course introduces the python language which has simple syntax, powerful set of libraries and robust debugger and profiler.

Course Prerequisite:

Students should have knowledge of basic programming.

Course Objectives:

1. To introduce the core components of the Python programming language.
2. To study library packages to write applications using python
3. To study GUI, exception handling and debugging python programs.

Course Outcomes :

At the end of this course, students will be able to

1. Write Python scripts using the procedure-oriented approach including data types, control structures, functions, and exception handling.
2. Develop Python programs using object-oriented programming concepts such as classes, objects, inheritance, and polymorphism.
3. Apply Python standard library modules and packages (NumPy, date & time, mathematical functions, random numbers) to solve computational problems.
4. Develop and test Python applications using GUI programming, CSV file handling, logging, debugging, and performance measurement techniques

SECTION – I

Unit 1 - Introduction to Python (02)

Introducing the Python Interpreter, Program Execution, Execution Model Variations.

Unit 2 - Introduction to Python Programming Constructs (06)

Data types and variables, Control structures, loops and functions, Exception Handling, String handling, Scope of variables..

Unit 3 - Object Oriented Programming in Python (05)

Classes, Instance Objects, Method Objects, Class and Instance Variables, Attributes and methods, Inheritance and polymorphism.

SECTION II

Unit 4 - Python Standard Library Modules and Packages (07)

Basic date and time types, General calendar-related functions, NumPy, Shallow and deep copy operations, Mathematical functions, Generate pseudo-random numbers,

Unit 5 – Introduction to GUI programming and CSV Files (07)

Data Persistence: CSV File Reading and Writing, file handling Logging facility for Python. Introduction to GUI programming.

Unit 6 – Testing and Debugging (03)

Unit tests in Python, Debugging programs, Measure execution time of small code snippets.

ISE Evaluation for the course will consist of three programming (hands on) tests.

Internal Continuous Assessment (ICA):

Minimum 12 assignments based on above topics.

- The assignments should test and develop student's practical proficiency and ability to use Python standard library modules and packages efficiently in writing effective code for varied applications scenarios & requirements, use cases.
- Use of IDEs like VScode PyCharm, Eclipse with PyDev, Jupyter Notebook for Interactive development and debugging of Python applications is highly recommended to enhance hands on skills in Python Programming of Students.

Text Book:

Programming in Python 3, Mark Summerfield, Second Edition

Multidisciplinary Minor in Artificial Intelligence and Machine Learning

| Semester | Course Code | Course Title |
|----------|-------------|--------------------|
| III | ADMDM-01B | Python Programming |



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech (Artificial Intelligence (AI) & Data Science)
Multidisciplinary Minor in Artificial Intelligence and Machine Learning
Semester-III

ADMDM-01B - PYTHON PROGRAMMING

Teaching Scheme

Lectures : - 2 Hrs/Week, 2 credits

Practical : - 2 Hrs/Week, 1 credit

Examination Scheme

ESE: 70 Marks

ISE : 30 Marks

ICA :25 Marks

Introduction: Python is a popular, general-purpose, multi-paradigm, open-source, scripting language. It is designed to emphasize code readability – has a clean syntax with high level data types. It is suited for interactive work and quick prototyping, while being powerful enough to write large applications. This course introduces the python language which has simple syntax, powerful set of libraries and robust debugger and profiler.

Course Prerequisite:

Students should have knowledge of basic programming.

Course Objectives:

4. To introduce the core components of the Python programming language.
5. To study library packages to write applications using python
6. To study GUI, exception handling and debugging python programs.

Course Outcomes :

At the end of this course, students will be able to

5. Write Python scripts using the procedure-oriented approach including data types, control structures, functions, and exception handling.
6. Develop Python programs using object-oriented programming concepts such as classes, objects, inheritance, and polymorphism.
7. Apply Python standard library modules and packages (NumPy, date & time, mathematical functions, random numbers) to solve computational problems.
8. Develop and test Python applications using GUI programming, CSV file handling, logging, debugging, and performance measurement techniques.

SECTION – I

Unit 1 - Introduction to Python (02)

Introducing the Python Interpreter, Program Execution, Execution Model Variations.

Unit 2 - Introduction to Python Programming Constructs (06)

Data types and variables, Control structures, loops and functions, Exception Handling, String handling, Scope of variables..

Unit 3 - Object Oriented Programming in Python (05)

Classes, Instance Objects, Method Objects, Class and Instance Variables, Attributes and methods, Inheritance and polymorphism.

SECTION II

Unit 4 - Python Standard Library Modules and Packages (07)

Basic date and time types, General calendar-related functions, NumPy, Shallow and deep copy operations, Mathematical functions, Generate pseudo-random numbers

Unit 5 – Introduction to GUI programming and CSV Files (07)

Data Persistence: CSV File Reading and Writing, file handling Logging facility for Python. Introduction to GUI programming.

Unit 6 – Testing and Debugging (03)

Unit tests in Python, Debugging programs, Measure execution time of small code snippets.

ISE Evaluation for the course will consist of three programming (hands on) tests.

Internal Continuous Assessment (ICA):

Minimum 12 assignments based on above topics.

- The assignments should test and develop student's practical proficiency and ability to use Python standard library modules and packages efficiently in writing effective code for varied applications scenarios & requirements, use cases.
- Use of IDEs like VScode PyCharm, Eclipse with PyDev, Jupyter Notebook for Interactive development and debugging of Python applications is highly recommended to enhance hands on skills in Python Programming of Students.

Text Book:

Programming in Python 3, Mark Summerfield, Second Edition

Semester-IV



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech (Artificial Intelligence (AI) & Data Science)
SEMESTER - IV

ADPCC-04: MATHEMATICAL FOUNDATION OF DATA SCIENCE

Teaching Scheme

Lectures: 3 Hours /Week, 3 credits

Examination Scheme

ESE - 70 Marks

ISE - 30 marks

COURSE OUTCOMES:

At the end of this course, students will be able to

1. Understand the fundamental concepts of probability.
2. Apply discrete and continuous probability distributions.
3. Understand vector spaces and analyze quadratic forms.
4. Analyze networks using graph theory concepts.
5. Apply game theory strategies in decision making.
6. Use complex analysis techniques to solve integrals and study analytic functions.

SECTION – I

Unit 1: Elementary Statistics

(8)

Definition of sample space and discrete sample space (finite and countably infinite). Concept of event, elementary event, compound event and favourable event. Definitions of mutually exclusive events, exhaustive events, impossible event and certain event. Power set $P(\Omega)$ for sample spaces having at most three sample points with illustrative examples. Equally likely outcomes and events. Classical (a priori) definition of probability of an event. Axiomatic definition of probability with reference to finite and countably infinite sample spaces. Properties of probability, Definition of conditional probability and multiplication theorem for two events (Without Proof). Concept of partition of sample space. Statement of Bayes' theorem (Without Proof) with examples and problems. Concept of independence of two events. Pairwise and mutual independence of three events with examples and problems.

Unit 2: Distributions – Discrete and Continuous

(7)

Random variables and probability distributions, Discrete probability distributions - Bernoulli distribution, Binomial distribution, Poisson distribution. Continuous probability distributions - Uniform distribution, Exponential distribution, Normal distribution.

Unit 3: Vector Space with Quadratic Form

(7)

Vector spaces and subspaces, Linear independence, basis and dimension, Inner product spaces, Gram Schmidt Orthogonalisation process, Quadratic forms: definition and examples, Matrix representation of quadratic forms, Reduction of quadratic forms to canonical form, Positive definite, negative definite and indefinite quadratic forms.

SECTION – II

Unit 4: Graph Theory (8)

Definition of a graph, vertex degrees, simple and multigraph, graph isomorphism, regular, complete and bipartite graphs, subgraphs, paths and cycles in a graph, connected graphs, Handshaking Lemma, Sum of degrees theorem, eccentricity, radius and diameter of graph, The matrix representation of a graph, Fusion.

Unit 5: Game Theory (7)

Introduction, strategic game, Mixed strategy, Nash Equilibrium, Auctions.

Unit 6: Complex Analysis (8)

Introduction of Analytic function and Cauchy Riemann equation, Cauchy's integral theorem, Cauchy's integral formula Taylor's, Maclaurin's series, Laurent series, Zeros, Singularities of complex functions, Residues and residue theorem.

Text Book :

1. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, 8th Edition, Sultan Chand and Sons Publishers, New Delhi.
 2. B.L.S. Prakas Rao, (2008). A First Course in Probability and Statistics, World Scientific Publishing Company.
 3. William Mendenhall, Robert J. Beaver and Barbara M. Beaver, *Introduction to Probability and Statistics*, 14th Edition, Cengage Learning, 2013.
 4. K. Hoffman and Ray Kunze: Linear Algebra, Prentice Hall of India, Pvt Ltd. 1989.
 5. Clark, J., & Holton, D.A. A First Look at Graph Theory. Applied Publishers Ltd.
 6. Steven Tadelis, *Game Theory: An Introduction*, Princeton University Press, 2013.
 7. Elias M. Stein and Rami Shakarchi, *Complex Analysis*, Princeton University Press, 2013.
 8. H.K. Dass, Advanced Engineering Mathematics, S. Chand Publications, Delhi.
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Reference Book :

1. Mayer, P. (1972). Introductory Probability and Statistical Applications, Addison Wesley Publishing Co., London.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, *Probability and Statistics for Engineers and Scientists*, 9th Edition, Pearson Education, 2012.
3. Sharma, Vasistha & vasistha: Linear Algebra, Krishna prakashan ltd. Meerut. 2005.
4. Liu, C.L.: Elements of Discrete Mathematics.
5. Hamdy A. Taha, *Operations Research: An Introduction*, 9th Edition, Pearson Education, 2011.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publications, Delhi.



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech. (Artificial Intelligence(AI) & Data Science)
Semester – IV

ADPCC-05 THEORY OF COMPUTATION

Teaching Scheme

Lectures: 3 Hrs/Week, 3 Credits

Examination Scheme

ESE: 70 Marks

ISE: 30 Marks

Introduction:

Theory of computation lays a strong foundation for a lot of abstract areas of computer science. TOC teaches you about the elementary ways in which a computer can be made to think. Any algorithm can be expressed in the form of a finite state machine and can serve as a really helpful visual representation of the same. Sometimes, the finite state machines are easier to understand thus helping the cause furthermore.

Prerequisite: Students should have prior knowledge of Discrete Mathematical Structure

Course Objectives:

1. To introduce the computational principles to build regular expressions for given regular language.
2. To introduce different types of automata.
3. To explain regular and non-regular languages.
4. To introduce context free grammar.
5. To introduce different types of Pushdown automata and Turing machine.

Course Outcome:

Students will be able to

1. Build regular expressions for a given language.
2. Design different types of automata.
3. Detect ambiguity in a grammar and convert into unambiguous grammar and normal forms.
4. Classify languages as regular and non-regular languages.
5. Design pushdown automata and Turing machines for a given language.

SECTION-I

UNIT-1 Regular Expressions

(06)

Regular expressions & corresponding regular languages, examples and applications, unions, intersection & complements of regular languages

UNIT-2 Finite Automata

(10)

Finite automata definition and representation, Non-deterministic F.A., NFA with ϵ transitions, Equivalence of DFA & NFA, Kleen's theorem: Statements & proofs, minimizing number of states in an FA, Basics of Moore and Mealy Machines

UNIT– 3 Grammars & Languages (07)

Definition and types of grammars and languages, derivation trees and ambiguity, CNF notations, Union, Concatenation and $*$'s of CFLs, Eliminating production and unit productions from a CFG, Eliminating useless variables from a Context Free Grammar.

SECTION-II

UNIT– 4 Pushdown Automata (06)

Definition, deterministic PDA & types of acceptance, equivalence of CFGs & PDAs.

UNIT– 5 CFL's & Non CFL's (05)

Pumping Lemma & examples, intersection and complements.

UNIT– 6 Turing machines (07)

Models of computation, definition of TM as language Acceptors, Combining Turing machines

UNIT-7 Variations in TM (04)

TMs with doubly infinite tapes, Multitape, Non-deterministic TM and universal TM. Undecidability theory, Time and Space bounded computation

Text Books:

1. Introduction to languages & theory of computation--John C.Martin(MGH)
 2. Formal Languages & Automata Theory-- Basavraj S. Anami, Karibasappa K.G., Wiley Precise Textbook-Wiley India.
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References:

1. Theory of Computation—Rajesh K Shukla (CENGAGE Learning)
2. Introduction to Automata theory, languages and computations – John E. Hopcraft, Rajeev Motwani, Jeffrey D. Ullman (Pearson Edition).
3. Discrete mathematical structures with applications to Computer science - J.P.Tremblay&R.Manohar (MGH)
4. Theory of Computer Science:Automata, Languages and Computation, Mishra, Phi
5. Theory of Computation, R B Patel &PremNath, Khanna Publications



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech. (Artificial Intelligence(AI) & Data Science)
Semester – IV

ADPCC-06 ARTIFICIAL INTELLIGENCE

Teaching Scheme

Lectures: 2 Hrs/Week, 2 Credits

Practical: 2 Hrs/Week, 1 Credits

Examination Scheme

ESE: 70 Marks

ISE: 30 Marks

ICA: 25 Marks

POE: 25 Marks

Course Prerequisite:

A solid foundation in discrete mathematics, programming (preferably Python), logical reasoning, probability, and basic algorithms. Familiarity with mathematical concepts such as graph theory, probability distributions, and linear algebra will aid in understanding AI techniques.

Course Objectives:

1. To introduce fundamental concepts and techniques of artificial intelligence.
2. To analyze intelligent agent architectures, problem-solving methods, and knowledge representation.
3. To explore advanced AI topics including machine learning, natural language processing, and robotics.
4. To develop skills for designing, implementing, and evaluating intelligent systems and algorithms.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Describe the principles of intelligent agent design and problem-solving strategies.
2. Apply search algorithms, logical reasoning, and planning techniques to AI problems.
3. Implement knowledge representation and inference methods for intelligent decision-making.
4. Critically evaluate current AI technologies, including machine learning, natural language processing, and robotics, assessing their capabilities and limitations.

SECTION-I

Unit 1 Introduction to AI and Intelligent Agents (6)

Understanding the nature of AI, the concept of rational agents, and the structure of intelligent agents. Discussing the AI problem-solving cycle, types of environments, and agent architectures.

Unit 2 Problem Solving and Search Strategies (6)

Exploring uninformed search methods (Breadth-first, Depth-first, Uniform Cost), informed

search (A*, greedy algorithms), local search algorithms, and optimization techniques. Emphasizing problem formulation and heuristic design.

Unit 3 Knowledge Representation and Reasoning (6)

Studying propositional and first-order logic, inference algorithms (resolution, forward and backward chaining), and knowledge bases. Covering semantic networks, frames, and ontologies.

SECTION-II

Unit 4 Planning and Decision-Making (6)

Analyzing classical planning algorithms, STRIPS, planning graphs, and decision-theoretic approaches. Covering Markov Decision Processes (MDPs) and POMDPs.

Unit 5 Machine Learning and Learning from Data (6)

Introducing supervised, unsupervised, and reinforcement learning. Covering decision trees, neural networks, clustering, and value-based methods like Q-learning.

Unit 6 Natural Language Processing and Robotics (6)

Exploring language understanding, parsing, speech recognition, and dialogue systems. Discussing robotics, sensor integration, and autonomous agents.

Internal Continuous Assessment (ICA) :

Minimum 6 to 7 assignments based on above topics.

Text books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, Pearson, 2020.
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Reference Books:

1. Nils J. Nilsson, Principles of Artificial Intelligence, Morgan Kaufmann, 1998.
 2. David L. Poole and Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.
 3. Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, Addison-Wesley, 2002.
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Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech. (Artificial Intelligence(AI) & Data Science)
Semester – IV

ADFP-02 OBJECT ORIENTED PROGRAMMING USING JAVA

Teaching Scheme

Lectures: 1 Hrs/Week, 1 Credits

Practical: 2 Hrs/Week, 1 Credits

Examination Scheme

ISE: 25 Marks

ICA: 25 Marks

POE: 25 Marks

Introduction:

The course introduces Java language syntax and object-oriented programming paradigms. It focuses on applying object-oriented principles using Java and using standard Java libraries to develop problem solving applications.

Course Prerequisites:

Students should have basic knowledge of:

1. Fundamentals of programming such as variables, operators, and control structures.
2. Basic problem-solving and algorithmic thinking.
3. Basic understanding of computer systems and programming environment.

Course Objectives:

The objectives of this course are to:

1. Introduce the fundamental concepts of object-oriented programming using Java.
2. Develop the ability to design and implement classes, objects, inheritance, and interfaces in Java.
3. Familiarize students with exception handling, file handling, and Java runtime libraries.
4. Provide an understanding of Java collections, multithreading, and networking concepts for developing robust applications.

Course Outcomes:

At the end of this course, students will be able to

1. Apply basic programming constructs of Java Programming such as array & strings.
2. Implement object-oriented features such as constructors, methods, inheritance, and interfaces for solving programming problems.
3. Implementation of exception handling and Input/Output.
4. Implement the features of Java Collections Framework,
5. Develop multithreading and networking applications.

UNIT 1 - Basics of Java and Strings

(04)

Basics: Java Runtime Environment (Oracle JDK, OpenJDK), naming conventions, Variables, operators, expressions, control flow statements, Input/output operations, data types, arrays and type casting.

Fundamentals: String class and methods, immutability of strings, StringBuffer and StringBuilder classes.

UNIT 2 - Classes, Objects and Methods (04)

Class and object concepts, new operator, object references, Constructors and constructor overloading, Methods and Method overloading, recursion, Passing and returning objects from methods, this and static keywords, Access control and modifiers, Nested class, inner class and wrapper classes, Object lifecycle and garbage collection, Understanding of Java Object Class, packages in java, importing package, creation of user defined packages.

UNIT 3 - Inheritance and Interfaces (06)

Inheritance and code reusability, Multilevel inheritance and method overriding, Handling constructors in inheritance using super keyword, Final keyword, Abstract class, Creation and implementation of interfaces, Interface inheritance and instanceof operator, Dynamic method dispatch, Comparison between abstract class and interface.

UNIT 4 - Exceptions, Error Handling and Basic IO (06)

Exceptions and Error Handling: Exceptions and Errors, Catching and Handling Exceptions, The try Block, The catch Blocks, The finally Block, Throwing Exceptions, Chained Exceptions, Custom Exceptions.

Basic I/O: I/O Streams, Byte Streams, Character Streams, Buffered Streams, Scanning and Formatting, Data Streams, Object Streams ,

File I/O Classes: Reading, Writing, and Creating Files and Directories.

UNIT 5 - Java Collections Framework (06)

Introduction, The Arrays Class, Searching and sorting arrays of primitive data types, Sorting Arrays of Objects, The Comparable and Comparator Interfaces, Sorting using Comparable & Comparator, Collections: Lists, Sets, Maps, Trees, Iterators and Collections, The Collection Class.

UNIT 6 - Multithreading and Networking (04)

Multithreading: Creating Threads, Thread scheduling and priority, Thread interruptions and synchronization.

Network Programming: InetAddress, URLs, Socket (TCP & UDP) communication in Java.

ISE Evaluation

ISE evaluation shall consist of two programming (hands-on) tests.

Internal Continuous Assessment (ICA)

ICA shall consist of a minimum of 12 practical assignments designed to improve programming skills and the ability to use Java API classes effectively.

Text Books:

1. Head First Java – Kathy Sierra & Bert Bates, O’Reilly.
 2. The Java Programming Language – Ken Arnold, James Gosling, David Holmes.
 3. Core Java for Beginners – Rashmi Kanta Das.
 4. Programming with Java – Balaguruswamy.
 5. Internet and Java Programming – Tanweer Alam.
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Reference Books:

1. The Java Language Specification, Java SE 8 Edition Book by James Gosling, Oracle Inc.
 2. Java: The Complete Reference 8 Edition - Herbert Schildt , Tata McGraw - Hill Education.
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Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech. (Artificial Intelligence(AI) & Data Science)
Semester – IV

EM-02: PROJECT MANAGEMENT AND ECONOMICS

Teaching Scheme

Theory – 2 Hrs./Week, 2 Credit

Examination Theory

ISE-25Marks

ICA -25 Marks

Course Outcomes:

On completion of the course students will be able to:

1. Demonstrate decision making and communication as a member of a team as well as Lead a team for effective management of construction projects.
2. Apply the Optimization techniques for decision making in construction industry.
3. Carry out ABC analysis, Break even analysis and calculate EOQ and Inventory costs for construction project.
4. Demonstrate the decision making abilities based on economics in projects and to appraise alternative projects.

SECTION-I

Unit 1: (6)

Definition and Functions of Management; Planning: Process of planning, Management by objectives; Organizing: Formal and informal organization, centralization, decentralization, line, line and staff, functional organization; Leading, directing, controlling and coordination; Communication process, motivation.

Unit 2: (5)

Importance of Decision Making, steps in decision making. Decision under certainty: Linear Programming, Formulation of simple L-P model, Graphical method, Duality. Application of Linear Programming in “Transportation Problems”: North-West corner method, Least cost method, Vogel’s Approximation method (Only Initial Basic Feasible Solution) and Application of Linear Programming in „Assignment problems“.

Unit 3:

(4)

Decision under uncertainty: Wald's, Savage, Horvitz and Laplace criterion of optimism and regret, expected monetary value, Theory of games (dominance pure and mixed strategy.)

SECTION-II

Unit 4: (5)

Inventory control: Introduction, inventory cost, EOQ analysis, ABC analysis, safety stocks. Break even analysis.

Unit 5: (5)

Engineering economics: Importance, demand and supply, types of costs, Interest-Simple, compound, continuous, and effective interest. Value of money - time and equivalence, Introduction to inflation. Cash flow diagram.

Unit 6: (6)

Economic comparisons: Discontinuing methods- Present Worth method, equivalent annual cost method, capitalized cost method, Net Present Value, Internal Rate of Return and Benefit Cost ratio.

In Semester Evaluation (ISE)

ISE shall be based upon students' performance in minimum three tests conducted and evaluated at institute level.

Internal Continuous Assessment (ICA)

Internal Continuous Assessment (ICA) shall consist of minimum six assignments based on the entire curriculum.

TEXT BOOKS:

1. A Textbook of Organizational Behaviour, CB Gupta, S. Chand Publications
2. Construction Engineering & Management, S.C. Sharma & S.V. Deodhar, Khanna Book Publishing
3. Optimization Techniques, S.S. Rao, Wiley Eastern India
4. Operation Research, Hamdy A. Taha, Operation Research, Prentice Hall of India, New Delhi 8th Ed.2011
5. Store Management, Menon K. S., Store Management, McMillan Co. New Delhi, 2nd Ed. 1998.
6. Principles of Construction Management: Roy Pilcher , Tata McGraw Hill Publications.
7. Principles of Engineering Economy- E. L. Grant, W. G. Ireson, R. S. Leavenworth, Wiley International Education, 7th Ed.

REFERENCE BOOKS:

1. Total Quality Management, Ponia & Sharma, Khanna Publishing House, Delhi
2. Engineering Management: Industrial Engineering & Management, S.C. Sharma, Khanna Publishing House, Delhi
3. Principles and Practice of Management, Prasad, L.M, Sultan Chand
4. Organizational Behaviour, L.M. Prasad, Sutan Chand and Sons.
5. Handbook of Construction Management, Joy PK, Macmillan
6. Construction Project Management, Jha, Pearson
7. Total Quality Management, Gopal, PHI Publications
8. Industrial Engineering & Operations Management, S.K. Sharma. S.K. Kataria & Sons
9. Principles of Operation Research: Prentice Hall of India, 2nd Ed.1925, Wagner H. M.
10. Operation Research: Shaum's outline series, Richard Bronson Govindsami N., Tata McGraw
11. Hill , 2nd Ed.2004
12. Material Management, Gopal Krishnan, Sudeshan,
13. Engineering Economics - L.P. DeGarmo, W.G.Sullivan, J.A.Bantadelli, McMillan India Co. New Delhi, 8th Ed. 1984.
14. Manual of Construction Project Management- S. K. Guha, Thakurti, K. R. Shah, MultiTech Publishers.
15. Management Information System- Gupta R.C., CBS, New Delhi.
16. Value Engineering in the Construction Industry: Dell'Isola, A. J., Construction Publication Company.



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech. (Artificial Intelligence(AI) & Data Science)
Semester – IV

VEC-02: PROFESSIONAL ETHICS

Teaching Scheme

Theory– 1Hrs. /Week, 1Credits
Practical–2Hrs. /Week, 1 Credit

Examination Scheme

Theory –ESE-50Marks
ICA-25Marks

Course Outcomes:

After successful completion of the course, students will be able to

1. Inculcate the human values in their behavior.
 2. Demonstrate the Engineering ethics in their professional practice.
 3. Practice the safety and responsibility and professional rights in their professional practice.
 4. Incorporate the code of ethics of Global organizations such as ASME, ASCE, and IEEE.
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SECTION-I

Unit 1: Human Values Morals, Values and Ethics, Integrity, Work Ethics, Service Learning, Civic Virtue, Respect for others, Living Peacefully, Caring, sharing, Honesty, Courage, Valuing Time, Cooperation, Commitment, Empathy, Self-Confidence, Character, spirituality

Unit 2: Engineering Ethics Senses of engineering ethics, Variety of Moral Issues, Types of inquiry, Moral Dilemmas Moral Autonomy, Kohlberg's Theory, Gilligan's Theory, Consensus and Controversy, Models of Professional Roles, Theories about Right Action, Self Interest , Customs and Religion.

SECTION-II

Unit 3: Safety, Responsibilities and Rights Safety and Risk, Assessment of safety and Risk, Risk Benefit Analysis and Reducing Risk, The Three Mile Island and Chernobyl Case Studies. Collegiality and Loyalty, Respect for Authority, Collective Bargaining, Confidentiality, Conflicts of Interest, Occupational Crime, Whistle Blowing, Professional Rights – Employee Rights, Intellectual Property Rights (IPR) – Discrimination.

Unit 4: Global Issues Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and

Advisors, Sample Code of Ethics of ASME, ASCE, IEEE, Institution of Engineers (India), etc.

ASSIGNMENTS

Students shall complete five assignments, based on the syllabus (One assignment for every unit of the syllabus). In addition to the above, the institute may prescribe additional modes of assessment such as Unit test, Quiz, Presentation, Course seminar etc. for ensuring continuous assessment of the students.

TEXT BOOKS:

1. Bayles, M.D.: Professional Ethics, California: Wadsworth Publishing Company, 1981.
 2. Koehn, D.: The Ground of Professional Ethics, Routledge, 1995.
 3. R.S. Naagarazan, A Text Book of Professional Ethics & Human Values, New Age International, 2006.
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Multidisciplinary Minor in “Artificial Intelligence & Data Science”

| Semester | Course Code | Course Title |
|----------|-------------|--------------------------------------|
| IV | ADMDM-02A | Data Preprocessing and Visualization |



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech (Artificial Intelligence (AI) & Data Science)
Multidisciplinary Minor in Artificial Intelligence and Data Science
Semester-IV

ADMDM-02A DATA PRE-PROCESSING AND VISUALIZATION

Teaching Scheme

Lectures–2 Hours/week, 2 Credits
Practical- 2 Hours/Week , 1 Credit

Examination Scheme

ESE –70 Marks
ISE – 30 Marks
ICA- 25 Marks

Course Prerequisite:

Basic knowledge of programming (preferably Python), data analysis, and fundamental statistics. Familiarity with data structures and plotting libraries will be advantageous.

Course Objectives:

1. To introduce fundamental concepts and principles of data analysis and visualization.
2. To explore various techniques for analyzing and presenting univariate and multivariate data.
3. To develop practical skills in data cleaning, manipulation, and visualization using Python libraries.
4. To enable students to design clear, informative, and aesthetically pleasing visual representations of data.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Describe the data analysis process and types of data.
 2. Prepare and clean datasets effectively.
 3. Perform data manipulation using NumPy and Pandas.
 4. Create various visualizations for data insights using Matplotlib and Seaborn.
 5. Critically evaluate visualizations using Tableau and PowerBI for clarity, accuracy, and storytelling effectiveness.
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SECTION-I

Unit 1 Introduction and Describing Data (5)

Overview, Sources of Data, Process for Making Sense of Data, Observations and Variables, Types of Variables, Central Tendency, Distribution of the Data, Confidence Intervals, Hypothesis Tests

Unit 2 Preparing Data Tables (6)

Overview, Cleaning the Data, Removing Observations and Variables, Generating Consistent Scales Across Variables, New Frequency Distribution, Converting Text to Numbers, Converting Continuous Data to Categories, Combining Variables, Generating Groups

Unit 3 Introduction to NumPy (6)

Understanding Data Types in Python, The Basics of NumPy Arrays, Computation on NumPy Arrays: Universal Functions, Aggregations: Min, Max, and Everything in Between, Computation on Arrays: Broadcasting, Comparisons, Masks, and Boolean Logic.

SECTION-II

Unit 4 Data Manipulation with Pandas (5)

Installing and Using Pandas, Introducing Pandas Objects, Data Indexing and Selection, Operating on Data in Pandas, Handling Missing Data, Hierarchical Indexing, Combining Datasets: Concat and Append, Combining Datasets: Merge and Join, Aggregation and Grouping

Unit 5 Data Visualization Concepts and Techniques (6)

Overview of data visualization, principles of visualization design, and best practices. Covering tables, univariate data visualization, multivariate data visualization, visualizing groups, and dynamic techniques to enhance interactivity and storytelling with data.

Unit 6 Visualization with Matplotlib and Seaborn (6)

General Matplotlib Tips, Two Interfaces for the Price of One, Simple Line Plots, Visualizing Errors, Density and Contour Plots, Histograms, Binnings, and Density, Customizing Plot Legends, Customizing Colorbars, Multiple Subplots, Text and Annotation.

Internal Continuous Assessment (ICA) :

Minimum 8 to 10 assignments based on above topics.

- Objective of assignments should be to test students understanding and assess their ability to put into practice the concepts and terminologies learned.
- Assignments must be of nature, which require students to identify the use case scenarios for using technologies mentioned in syllabus.
- It should consist of the 08-10 practical based on following guidelines
- Load a dataset and identify observations and variables, and classify variables (categorical, numerical).
- Plot data distribution using histograms and boxplots to understand spread and variability.
- Perform data cleaning: remove duplicate records, handle inconsistent data values.
- Convert text data to numeric form and categorize continuous data into groups (binning).
- Handle missing data and remove unnecessary observations or variables using Pandas.
- Create and manipulate NumPy arrays and explore different data types using NumPy.
- Perform array operations, broadcasting, aggregations (min, max, sum, mean) on datasets.
- Handle missing data, dataset merging, joining, concatenation, and perform grouping and aggregation operations.
- Create univariate and multivariate visualizations such as bar charts, histograms, scatter plots, and boxplots using Matplotlib and Seaborn.Simple MongoDB and its CRUD Operations
- Design a dashboard and data story using Tableau or Microsoft Power BI with a real-world dataset (Mini Project).

Text books:

1. Glenn J. Myatt, Making sense of Data: A practical Guide to Exploratory Data Analysis and DataMining, John Wiley Publishers, 2014. (Unit- I and II)
2. Glenn J. Myatt, Making sense of Data: A practical Guide to Data Visualization, Advanced DataMining Methods and Applications, John Wiley Publishers, 2009.(Unit-V)
3. Python Data Science Handbook – Essential Tools for working with Data : Jake VanderPlas,O’rielly (Unit III, IV, VI)

Multidisciplinary Minor in Artificial Intelligence and Machine Learning

| Semester | Course Code | Course Title |
|----------|-------------|------------------|
| IV | ADMMDM-02B | Machine Learning |



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech (Artificial Intelligence (AI) & Data Science)
Multidisciplinary Minor in Artificial Intelligence and Machine Learning
Semester-IV

MDM-02 MACHINE LEARNING

Teaching Scheme

Lectures–2 Hours/week, 2 Credits
Practical-2 Hours/week 1 Credit

Examination Scheme

ESE –70 Marks
ISE – 30 Marks
ICA– 25 Marks

Introduction:

This course introduces Machine Learning which deals with fundamentals of machine learning and its types. The course also introduces how to validate and evaluate the performance of machine learning model.

Course Prerequisite: Students should have prior knowledge of statistics, linear algebra, probability, and data preprocessing.

Course Objectives:

1. To introduce various types of machine learning algorithms.
 2. To enable designing of a model selecting appropriate machine learning algorithms for a given problem.
 3. To study methods to validate previously designed machine learning models.
 4. To introduce methods to evaluate and tune machine learning models.
-

Course Outcomes:

At the end of the course students will be able to

1. Demonstrate various types of machine learning algorithms and their applications.
2. Design classification and regression models by selecting appropriate machine learning algorithms for given problems.
3. Apply unsupervised learning techniques for data clustering and analysis.
4. Evaluate and optimize the performance of machine learning models using validation techniques, evaluation metrics, and hyperparameter tuning.

SECTION-I

UNIT-1 Introduction to Machine Learning (06)

What is Machine Learning? How do machine learn, Well-posed learning problem, Types of Machine Learning: Supervised learning, unsupervised learning, Reinforcement learning, Comparison – supervised, unsupervised and reinforcement learning, Problems not to be solved using Machine Learning, Applications of Machine Learning.

UNIT-2 Supervised Learning- Classification (06)

Classification: Introduction, Examples of Supervised Learning, Classification model, Classification learning steps, Common Classification ,conditional Probability Bayes theorem, Algorithms-Naïve Bayes classifier- Applications of Bayes classifier, Handling continues numeric features in Bayes classifier, k-Nearest Neighbors (k-NN), Decision tree, Random Forest model, Support vector machine.

UNIT-3 Supervised Learning- Regression (06)

Regression: Introduction, Examples of regression, Common regression algorithms-Simple linear

regression, Multiple linear regression, Assumptions in regression analysis, Main problems in regression analysis, Improving accuracy of the linear regression model, polynomial regression model, logistic regression model.

SECTION II

UNIT-4 Unsupervised Learning (08)

Introduction, Unsupervised vs Supervised learning, Applications of Unsupervised learning, Clustering: Clustering as a Machine learning task, different types of clustering techniques,

Partitioning methods, k-means algorithm, k-medoids, Hierarchical clustering, Association rule, Apriorism algorithm.

UNIT-5 Validating Machine Learning Models (06)

Introduction: Bias, Variance, Underfitting, Overfitting, cost function, types of cost function, cross validation, Types of cross validation Training, Testing, Validation

UNIT-6 Modeling and Evaluation (06)

Introduction, selecting a Model, training a Model, Model, Representation and Interpretability, Evaluating Performance of a Model, Improving Performance of a Model. Applications of Machine Learning, future of Machine learning.

Text books:

1. Machine Learning - Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Pearson Publication.
 2. Machine Learning for Dummies by John Paul Mueller, Luca Massaron (Published by For Dummies; First edition).
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Reference Books:

1. Machine Learning by Tom M. Mitchell (Publisher: McGraw Hill Education; First edition + NewChapters from Second edition).
2. Introduction to Machine Learning (Second Edition) by Ethem Alpaydm (published by The MIT Press Cambridge, Massachusetts London, England
3. Machine Learning with Python for Everyone by Mark E. Fenner , Pearson Publication

Internal Continuous Assessment (ICA): Minimum 8 assignments requiring students to develop machine learning applications for real world problem/use-case/scenario based on any of the following topics:

1. Linear and Multilinear Regression
2. Decision Tree regressor
3. K-Nearest Neighbour (KNN) classifier
4. Logistic Regression classifier
5. Support vector machine (SVM)
6. Decision Tree classifier
7. Naive-Bayes classifier
8. Ensemble Models
9. K-means clustering (Unsupervised Learning)
10. Improving Machine Learning models using cross-validation and Hyper parameters tuning

Honors in Cyber Security



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech. (Artificial Intelligence(AI) & Data Science)
Honors Degree in Cyber Security

ADHON-01A CRYPTOGRAPHY

Teaching Scheme

Lectures: 3 Hrs/Week, 3 Credits

Tutorial: 1 Hrs/Week, 1 Credits

Examination Scheme

ESE: 70 Marks

ISE: 30 Marks

ICA: 25 Marks

SECTION – I

Unit 1 : Overview

(06)

Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, A model for Network Security

Unit 2 : Classical Encryption Techniques

(06)

Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography

Unit 3 : Block Cipher and Data Encryption Standard

(07)

Traditional Block Cipher Structure, The Data Encryption Standard, A DES Example, The Strength of DES, Block Cipher Design Principles

AES: Finite field arithmetic, AES structure, AES transformation function, AES key expansion, An AES example.

SECTION – II

Unit 4 : Public Key Cryptography and RSA

(08)

Principles of Public-Key Cryptosystem: Public Key Cryptosystems, Applications for Public-Key Cryptosystems, Requirements of Public-Key Cryptosystems

RSA Algorithm: Description of Algorithm, Computational aspects, The Security of RSA Diffie Hellman Key Exchange: The Algorithm, Key Exchange Protocols, Man-in-middle Attack

Unit 5 : Cryptographic Hash Functions and Message Authentication Codes

(08)

Cryptographic Hash Functions: Applications, Two Simple Hash Functions, Requirements and Security, Secure Hash Algorithm (SHA)

Message Authentication Codes: Requirements for Message Authentication Codes, Security of MACs, MACs based on Hash Functions (HMAC), Digital Signatures.

Unit 6 :User Authentication

(07)

Remote user authentication principles, Remote user authentication using symmetric encryption, Kerberos, Remote user authentication using asymmetric encryption, Federated Identity management, Personal identity Verification

Internal Continuous Assessment (ICA) :

Student should implement the following:

1. Implementation of Substitution Cipher
 2. Implementation of Poly alphabetic Cipher (Vigenere Cipher and Vernam Cipher)
 3. Implementation of Transposition Cipher
 4. Implementation of Play fair Cipher
 5. Implementation of Secure file transfer in Client/Server environment (use any one of above method for encryption and decryption).
 6. Write a program to simulate RSA algorithm.
 7. Implement Cryptographic Hash function
 8. Simulate Kerberos authentication system
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Text Book:

1. Williams Stallings–Cryptography and Network security principles and practices. Pearson Education (LPE) 6th Edition (Covers all above Units)
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Reference Books:

1. Menezes, A.J., P.C.Van Oorschot, and S.A.Vanstone, “Handbook of Applied Cryptography”
2. Schneir, Bruce, “Applied Cryptography: Protocols and Algorithms”
3. Nina Godbole --Information systems security-Security management, metrics, frameworks and best practices (WILEY)



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech. (Artificial Intelligence(AI) & Data Science)
Honors Degree in Cyber Security

ADHON-02A NETWORK SECURITY AND SECURE CODING

Teaching Scheme

Lectures: 3 Hrs/Week, 3 Credits

Practical: 2 Hrs/Week, 1 Credits

Examination Scheme

ESE: 70 Marks

ISE: 30 Marks

ICA: 25 Marks

Introduction:

This course introduces the fundamental concepts of network and information security, focusing on various security attacks, services, and mechanisms used to protect computer systems and communication networks. It covers cryptographic techniques including conventional encryption, public key cryptography, digital signatures, and authentication protocols used for secure communication. The course also discusses network security applications, intrusion detection, firewall design, and secure coding practices to safeguard modern computing systems.

Prerequisite:

Students should have basic knowledge of computer networks and programming fundamentals to understand network security mechanisms and cryptographic techniques.

Course Outcomes:

After the completion of this course the student should be able to

1. Gain a complete knowledge on types of security attacks, services and mechanisms.
 2. Understand the implementation of Internetwork security model and its standards and vulnerabilities.
 3. Demonstrate the Conventional Encryption Principles and the Public key cryptography principles
 4. Identify the vulnerable points for attacks in simple networks.
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SECTION-I

Unit 1 : Security Attacks (08)

Interruption, Interception, Modification and Fabrication, Security Services (Confidentiality, Authentication, Integrity, Non-repudiation, access Control and Availability) and Mechanisms, A model for Internetwork security, Internet Standards and RFCs, Buffer overflow & format string vulnerabilities, TCP session hijacking, ARP attacks, route table modification, UDP hijacking, and man-in-the-middle attacks.

Unit 2 : Conventional Encryption Principles (07)

Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, key distribution Approaches of Message Authentication, Secure Hash Functions and HMAC.

Unit 3 : Public key cryptography principles (07)

Public key cryptography algorithms, digital signatures, digital Certificates, Certificate Authority and key management Kerberos, X.509 Directory Authentication Service.

SECTION-II

Unit 4 : Email privacy (08)

Pretty Good Privacy (PGP) and S/MIME. IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management.

Unit 5 : Basic concepts of SNMP (07)

SNMPv1 Community facility and SNMPv3. Intruders, Viruses and related threats. Firewall Design principles, Trusted Systems. Intrusion Detection Systems.

Unit 6: Secure Coding (07)

Memory safety and vulnerabilities: attacks and defences, Memory safety and vulnerabilities: attacks and defences, Fuzzing, Symbolic execution and static analysis, Secure Architecture Concepts and Principles

Internal Continuous Assessment (ICA):

Minimum 8-10 Practical assignments based on above topics.

Text Books:

1. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.
 2. Hack Proofing your network by Ryan Russell, Dan Kaminsky, Rain Forest Puppy, Joe Grand, David Ahmad, Hal Flynn Ido Dubrawsky, Steve W.Manzuik and Ryan Permech, Wiley Dreamtech
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Reference Books:

1. Network Security and Cryptography: Bernard Menezes, CENGAGE Learning.
2. Network Security - Private Communication in a Public World by Charlien Kaufman, Radia Perlman and Mike Speciner, Pearson/PHI.
3. Cryptography and network Security, Third edition, Stallings, PHI/Pearson
4. Principles of Information Security, Whitman, Cengage Learn

Honors in Software Engineering



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech. (Artificial Intelligence(AI) & Data Science)
Honors Degree in Software Engineering

ADHON-01B SOFTWARE ENGINEERING

Teaching Scheme

Lectures: 3 Hrs/Week, 3 Credits

Tutorial: 1 Hrs/Week, 1 Credits

Examination Scheme

ESE: 70 Marks

ISE: 30 Marks

ICA: 25 Marks

Introduction : Current Software engineering methods and techniques have made us much better at building large and complex systems than we were. However, there are still too many projects that are late, over budget, and do not deliver the software that meets customer's needs. The main aim of introducing this course is to understand the methods, processes, techniques, and approaches which are required to develop high-quality software products within schedule and budget. On top of that this course ensures understanding of the complete Software Development Life Cycle (SDLC) for the development of software products as per the customer's needs. Further, it ensures the knowledge of various quality standards used in the software system and the Agile Project Management Process.

Course Prerequisite:

An understanding of Programming skills.

Course Outcomes:

At the end of the course Student will be able to

1. Apply the appropriate lifecycle model for software development.
 2. Prepare SRS and SDS accordingly for a given problem.
 3. Apply appropriate software testing method.
 4. Ensure the quality of a product by applying the quality management process.
-

SECTION-I

Unit 1 - Introduction to Software Engineering (5)

Introduction, The Problem Domain, Software Engineering Challenges and Approach, Software Process, Characteristics of Software Process, Software Development Process Models: Waterfall model, Prototype model, Agile process model.

Unit 2 - Software Requirement Analysis & Specification (5)

Need of SRS, Characteristics of Good SRS, Requirement Process, Requirements specification, Functional Specification with Use Cases, Other Approaches for Analysis: Data Flow Diagram, Entity Relationship Diagram,

Unit 3 - Software Architecture and Design (6)

Introduction to Software Design, Software Architecture: Role of Software Architecture, Architecture Views, Component & Connector View, Architecture Style for Component & Connector view, Documenting Architecture Design, Function- Oriented Design, Object Oriented Design, High Level Design, Detailed Design, Verification, Metrics.

SECTION-II

Unit 4 - Testing (04)

Testing Fundamentals, Testing Process, Black-Box Testing, White-Box Testing, Object Oriented Software testing methods, Functional testing, Unit testing, System testing, User satisfaction testing.

Unit 5 - Project Planning and Management (6)

Project management process, The Inspection and Audit Process, Software Configuration Management process, Effort estimation, Project Schedule and Staffing, Quality planning: Quality Concepts, Qualitative quality management planning. CMM project management process, Risk Management Planning, Project Monitoring Plan, Detailed Scheduling.

Unit 6 - Agile Project Management (5)

Introduction to APM, Implementation, Iterative Project Management Life Cycle, Adaptive Project Management Life Cycle, Adaptive & Integrating the APM toolkit, The Science of Scrum, New Management Responsibilities.

Internal Continuous Assessment (ICA)

Minimum 7 to 10 Practical Assignments based on above topics.

Text Books:

1. An Integrated Approach to Software Engineering, Pankaj Jalote, 3rd Edition (Narosa Publishers)
 2. Effective Project Management Traditional, 6th Edition, WILEY INDIA
 3. Software project management in practice, Pankaj Jalote Pearson India Ltd.
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Reference Books :

1. Software Engineering, Ian Sommerville, 6th edition, Pearson education Asia. Robert K. Wysocki,
2. Software Engineering Fundamentals, Ali Behforooz and Frederick j. Hudson (Oxford University Press).
3. Project Management with Scrum, Ken Schwaber. 4. Software Engineering-A precise approach, Pankaj Jalote Wiley Precise Precise Textbook.



Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.Tech. (Artificial Intelligence(AI) & Data Science)
Honors Degree in Software Engineering

ADHON-02B SOFTWARE TESTING AND QUALITY ASSURANCE

Teaching Scheme

Lectures: 3 Hrs/Week, 3 Credits

Practical: 2 Hrs/Week, 1 Credits

Examination Scheme

ESE: 70 Marks

ISE: 30 Marks

ICA: 25 Marks

Introduction:

This course introduces the fundamental concepts, principles, and methodologies of software testing used to ensure the quality and reliability of software systems. It covers various testing approaches, testing levels, verification and validation techniques, and the processes involved in test planning, documentation, and quality assurance. The course also explores automated testing techniques and modern testing tools to support efficient and effective software testing practices.

Prerequisite

Students should have basic knowledge of software development processes and programming concepts to understand software testing techniques and practices.

Course Outcomes:

At the end of this course, students will be able to

1. Compare the different software testing methods and select the suitable one for a given scenario.
 2. Design test strategy & test plan for software testing.
 3. Apply different approaches of management, quality assurance and standards for software engineering processes.
 4. Demonstrate automated testing tools to test software
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SECTION-I

Unit 1: Fundamentals of Software Testing

(06)

Introduction, Basics of Software Testing, Approaches to Testing, Testing During Development Life Cycle, Essential of Software Testing, Features of Testing, Misconceptions About Testing, Principles of Software Testing, Test Policy, Strategy, Planning, Process, Challenges in Testing, Test Team Approach, Methods.

Unit 2: Methods of Testing

(06)

Software Verification and Validation, Black-Box and White-Box Testing, Static and Dynamic Testing, Black-Box Testing Techniques-Equivalence Partitioning, Data Testing, State Testing, Other Black Box Test Techniques. White-Box Testing Techniques.

Unit 3: Levels of Testing (05)

Verification and Validation Model, Levels of Testing, Proposal Testing, Requirement Testing, Design Testing, Code Review, Unit Testing, Module Testing, Integration Testing, Big-Bang Testing, Sandwich Testing, System Testing- GUI Testing, Compatibility Testing.

SECTION II

Unit 4: Test Planning & Documentation (06)

Test Planning-The goal of Test Planning, Test Planning Topics, Writing and Tracking Test Cases-The Goal of Test Case Planning, Test Case Planning Overview, Test Case Organization and Tracking, Reporting Bugs- Getting Your Bugs Fixed,

Unit 5: Quality Concepts & Software Quality Assurance (06)

Quality Concepts-What is Quality?, Software Quality, The Software Quality Dilemma, Achieving Software Quality, Software Quality Assurance-Background Issues, Elements of Software Quality Assurance.

Unit 6: Automated Testing and Testing Tools (05)

Introduction, The Benefits of Automation and Tools, Test Tools, Software Test Automation, Random Testing, Realities of Using Test Tools and Automation, Open-Source Testing Tools, Case Studies on Testing Tools-Selenium. give introduction of this course in three sentences

Internal Continuous Assessment (ICA):

Assignments: • Minimum 8- 10 assignments based on each topic of above syllabus. Two assignments on use of Selenium for software testing.

Text books:

1. Software Testing Principles, Techniques and Tools By M G Limaye, Published by Tata McGraw-Hill Education Private Limited, Published 2009, ISBN (13): 978-0-07-013990-9, ISBN (10): 0-07-013990-3 (Chapter 1 & 3)
 2. Software Testing, Second Edition By: Ron Patton, Published by SAMS, ISBN-13: 9780672327988 ISBN-10: 0672327988 (Chapter 2, 4 & 6)
 3. Software Engineering: A Practitioner's Approach by Roger S Pressman, 8th Edition 4. Publisher McGraw Hill (Chapter 5)
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Reference books:

1. Software Testing Principle and Practices By Ramesh Desikan, Gopaldaswamy Ramesh, Pearson Education, ISBN 978-81-7758-121-8
2. Software Testing Principles and Practices By Naresh Chauhan, Publisher OXFORD UNIVERSITY PRESS-NEW DELHI, ISBN 0-19-806184-6
3. Beautiful Testing: Leading Professionals Reveal How They Improve Software By Adam Goucher, Tim Riley, Publisher O'reilly
4. Foundations of Software Testing By Rex Black, Dorothy Graham, Erik Van Veenendaal IsabelEvans, Published by Cengage Learning India Pvt Ltd.
5. Lessons Learned in Software Testing by Cem Kaner , James Bach , Bret Pettichord, Publisher Wiley
6. Testing Computer Software Cem Kaner, Jack Falk, Hung Q. Nguyen, Publisher Wiley
7. Selenium Testing Tools Cookbook By Unmesh Gundecha Published by Packt, ISBN: 9781-84951-574-0
8. Dr. K.V.K.K. Prasad, "Software Testing Tools: Covering WinRunner, Silk Test, LoadRunner, JMeter and TestDirector With Case Studies", Dreamtech Publications ISBN: 10:81-7722-532-4