Faculty of Engineering
Savitribai Phule Pune University, Pune
Maharashtra, India

Curriculum
for
Fourth Year of Computer Engineering
(2019 Course)
(With effect from 2022-23)
# Final Year of Computer Engineering  
(2019 Course)  
(With effect from 2022-23)

## Prologue

It is with great pleasure and honor that I share the syllabi for Fourth Year of Computer Engineering (2019 Course) on behalf of Board of Studies, Computer Engineering. We, members of BoS are giving our best to streamline the processes and curricula design. While revising syllabus, honest and sincere efforts are put to tune Computer Engineering program syllabus in tandem with the objectives of Higher Education of India, AICTE, UGC and affiliated University (SPPU) by keeping an eye on the technological advancements and industrial requirements globally.

Syllabus revision is materialized with sincere efforts, active participation, expert opinions and suggestions from domain professionals. Sincere efforts have been put by members of BoS, teachers, alumni, industry experts in framing the draft with guidelines and recommendations.

Case Studies are included in almost all courses. Course Instructor is recommended to discuss appropriate related recent technology/upgrade/Case Studies to encourage students to study from course to the scenario and think through the largest issues/ recent trends/ utility/ developing real world/ professional skills.

I am sincerely indebted to all the minds and hands who work adroitly to materialize these tasks. I really appreciate your contribution and suggestions in finalizing the contents.

Thanks,

Dr. Varsha H. Patil  
Chairman, Board of Studies (Computer Engineering), SPPU, Pune

## links for First Year, Second Year and Third Year Computer Engineering Curriculum 2019:

2. [http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/First%20Year%20Engineering%202019%20Patt.%20Syllabus_05.072019.pdf](http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/First%20Year%20Engineering%202019%20Patt.%20Syllabus_05.072019.pdf)
4. [http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2021/Third%20Year%20Engineering%202019%20Pattern_16022022.rar](http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2021/Third%20Year%20Engineering%202019%20Pattern_16022022.rar)
### Table of Contents

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Title</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Program Outcomes</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>Program Specific Outcomes</td>
<td>5</td>
</tr>
<tr>
<td>3.</td>
<td>Course Structure (Course titles, scheme for teaching, credit, examination and marking)</td>
<td>6</td>
</tr>
<tr>
<td>4.</td>
<td>General Guidelines</td>
<td>8</td>
</tr>
<tr>
<td>5.</td>
<td>Course Contents (Semester VII)</td>
<td>10</td>
</tr>
<tr>
<td>410241:</td>
<td>Design and Analysis of Algorithms</td>
<td></td>
</tr>
<tr>
<td>410242:</td>
<td>Machine Learning</td>
<td>13</td>
</tr>
<tr>
<td>410243:</td>
<td>Blockchain Technology</td>
<td>17</td>
</tr>
<tr>
<td>410244A:</td>
<td>Pervasive Computing</td>
<td>20</td>
</tr>
<tr>
<td>410244B:</td>
<td>Multimedia Techniques</td>
<td>23</td>
</tr>
<tr>
<td>410244C:</td>
<td>Cyber Security And Digital Forensics</td>
<td>26</td>
</tr>
<tr>
<td>410244D:</td>
<td>Object Oriented Modeling And Design</td>
<td>29</td>
</tr>
<tr>
<td>410244E:</td>
<td>Digital Signal Processing</td>
<td>32</td>
</tr>
<tr>
<td>410245A:</td>
<td>Information Retrieval</td>
<td>35</td>
</tr>
<tr>
<td>410245B:</td>
<td>GPU Programming And Architecture</td>
<td>38</td>
</tr>
<tr>
<td>410245C:</td>
<td>Mobile Computing</td>
<td>41</td>
</tr>
<tr>
<td>410245D:</td>
<td>Software Testing And Quality Assurance</td>
<td>44</td>
</tr>
<tr>
<td>410245E:</td>
<td>Compilers</td>
<td>48</td>
</tr>
<tr>
<td>410246:</td>
<td>Laboratory Practice III</td>
<td>51</td>
</tr>
<tr>
<td>410247:</td>
<td>Laboratory Practice IV</td>
<td>56</td>
</tr>
<tr>
<td>410248:</td>
<td>Project Stage I</td>
<td>64</td>
</tr>
<tr>
<td>410249:</td>
<td>Audit Course 7</td>
<td>65</td>
</tr>
<tr>
<td>6.</td>
<td>Course Contents (Semester VIII)</td>
<td>72</td>
</tr>
<tr>
<td>410250:</td>
<td>High Performance Computing</td>
<td></td>
</tr>
<tr>
<td>410251:</td>
<td>Deep Learning</td>
<td>75</td>
</tr>
<tr>
<td>410252A:</td>
<td>Natural Language Processing</td>
<td>78</td>
</tr>
<tr>
<td>410252B:</td>
<td>Image Processing</td>
<td>81</td>
</tr>
<tr>
<td>410252C:</td>
<td>Software Defined Networks</td>
<td>84</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>410252D</td>
<td>Advanced Digital Signal Processing</td>
<td>87</td>
</tr>
<tr>
<td>410252E</td>
<td>Open Elective I</td>
<td>90</td>
</tr>
<tr>
<td>410253A</td>
<td>Pattern Recognition</td>
<td>91</td>
</tr>
<tr>
<td>410253B</td>
<td>Soft Computing</td>
<td>94</td>
</tr>
<tr>
<td>410253C</td>
<td>Business Intelligence</td>
<td>97</td>
</tr>
<tr>
<td>410253D</td>
<td>Quantum Computing</td>
<td>101</td>
</tr>
<tr>
<td>410253E</td>
<td>Open Elective II</td>
<td>104</td>
</tr>
<tr>
<td>410254</td>
<td>Laboratory Practice V</td>
<td>105</td>
</tr>
<tr>
<td>410255</td>
<td>Laboratory Practice VI</td>
<td>109</td>
</tr>
<tr>
<td>410256</td>
<td>Project Stage II</td>
<td>118</td>
</tr>
<tr>
<td>410257</td>
<td>Audit Course 8</td>
<td>119</td>
</tr>
<tr>
<td>7.</td>
<td>Acknowledgement</td>
<td>125</td>
</tr>
<tr>
<td>8.</td>
<td>Task Force at Curriculum Design</td>
<td>126</td>
</tr>
</tbody>
</table>
### Program Outcomes (POs)

Learners are expected to know and be able to:

<table>
<thead>
<tr>
<th>PO1</th>
<th>Engineering knowledge</th>
<th>Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO2</td>
<td>Problem analysis</td>
<td>Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences.</td>
</tr>
<tr>
<td>PO3</td>
<td>Design / Development of Solutions</td>
<td>Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.</td>
</tr>
<tr>
<td>PO4</td>
<td>Conduct Investigations of Complex Problems</td>
<td>Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.</td>
</tr>
<tr>
<td>PO5</td>
<td>Modern Tool Usage</td>
<td>Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.</td>
</tr>
<tr>
<td>PO6</td>
<td>The Engineer and Society</td>
<td>Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.</td>
</tr>
<tr>
<td>PO7</td>
<td>Environment and Sustainability</td>
<td>Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.</td>
</tr>
<tr>
<td>PO8</td>
<td>Ethics</td>
<td>Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice.</td>
</tr>
<tr>
<td>PO9</td>
<td>Individual and Team Work</td>
<td>Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.</td>
</tr>
<tr>
<td>PO10</td>
<td>Communication Skills</td>
<td>Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.</td>
</tr>
<tr>
<td>PO11</td>
<td>Project Management and Finance</td>
<td>Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments.</td>
</tr>
<tr>
<td>PO12</td>
<td>Life-long Learning</td>
<td>Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.</td>
</tr>
</tbody>
</table>

### Program Specific Outcomes (PSO)

<table>
<thead>
<tr>
<th>PSO1</th>
<th>Professional Skills</th>
<th>The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSO2</td>
<td>Problem-Solving Skills</td>
<td>The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.</td>
</tr>
<tr>
<td>PSO3</td>
<td>Successful Career and Entrepreneurship</td>
<td>The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.</td>
</tr>
</tbody>
</table>
BE Computer Engineering 2019 Course tentative Curriculum structure:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Hours/week)</th>
<th>Examination Scheme and Marks</th>
<th>Credit Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lecture</td>
<td>Practical</td>
<td>Tutorial</td>
</tr>
<tr>
<td>410241</td>
<td>Design and Analysis of Algorithms</td>
<td>03</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>410242</td>
<td>Machine Learning</td>
<td>03</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>410243</td>
<td>Blockchain Technology</td>
<td>03</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>410244</td>
<td>Elective III</td>
<td>03</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>410245</td>
<td>Elective IV</td>
<td>03</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>410246</td>
<td>Laboratory Practice III</td>
<td>-</td>
<td>04</td>
<td>-</td>
</tr>
<tr>
<td>410247</td>
<td>Laboratory Practice IV</td>
<td>-</td>
<td>02</td>
<td>-</td>
</tr>
<tr>
<td>410248</td>
<td>Project Stage I</td>
<td>-</td>
<td>02</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>410249</td>
<td>Audit Course 7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Elective III
- 410244(A) Pervasive Computing
- 410244(B) Multimedia Techniques
- 410244(C) Cyber Security and Digital Forensics
- 410244(D) Object Oriented Modeling and Design
- 410244(E) Digital Signal Processing

Elective IV
- 410245(A) Information Retrieval
- 410245(B) GPU Programming and Architecture
- 410245(C) Mobile Computing
- 410245(D) Software Testing and Quality Assurance
- 410245(E) Compilers

Laboratory Practice III:
Laboratory assignments Courses- 410241, 410242, 410243

Laboratory Practice IV:
Laboratory assignments Courses- 410244, 410245

Audit Course 7(AC7) Options:
- AC7- I MOOC- Learn New Skills
- AC7- II Entrepreneurship Development
- AC7- III Botnet of Things
- AC7- IV 3D Printing
- AC7- V Industrial Safety and Environment Consciousness
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Hours/week)</th>
<th>Examination Scheme and Marks</th>
<th>Credit Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lecture</td>
<td>Practical</td>
<td>Tutorial</td>
</tr>
<tr>
<td>410250</td>
<td>High Performance Computing</td>
<td>03</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>410251</td>
<td>Deep Learning</td>
<td>03</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>410252</td>
<td>Elective V</td>
<td>03</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>410253</td>
<td>Elective VI</td>
<td>03</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>410254</td>
<td>Laboratory Practice V</td>
<td>-</td>
<td>02</td>
<td>-</td>
</tr>
<tr>
<td>410255</td>
<td>Laboratory Practice VI</td>
<td>-</td>
<td>02</td>
<td>-</td>
</tr>
<tr>
<td>410256</td>
<td>Project Stage II</td>
<td>-</td>
<td>06</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Credit</th>
<th>12</th>
<th>08</th>
<th>-</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>12</td>
<td>10</td>
<td>-</td>
<td>120</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Audit Course 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>410257</td>
<td>Grade</td>
</tr>
</tbody>
</table>

Elective V
- 410252(A) Natural Language Processing
- 410252(B) Image Processing
- 410252(C) Software Defined Networks
- 410252(D) Advanced Digital Signal Processing
- 410252(E) Open Elective I

Lab Practice V:
Laboratory assignments Courses- 410250, 410251

Audit Course 8(AC8) Options:
- AC8- I Usability Engineering
- AC8- II Conversational Interfaces
- AC8- III Social Media and Analytics
- AC8- IV MOOC- Learn New Skills
- AC8- V Emotional Intelligence

Elective VI
- 410253(A) Pattern Recognition
- 410253(B) Soft Computing
- 410253(C) Business Intelligence
- 410253(D) Quantum Computing
- 410253(E) Open Elective II

Lab Practice VI:
Laboratory assignments Courses- 410252, 410253
General Guidelines

1. Every undergraduate program has its own objectives and educational outcomes. These objectives and outcomes are furnished by considering various aspects and impacts of the curriculum. These Program Outcomes (POs) are categorically mentioned at the beginning of the curriculum (ref: NBA Manual). There should always be a rationale and a goal behind the inclusion of a course in the curriculum. Course Outcomes though highly rely on the contents of the course, many a times are generic and bundled. The Course Objectives, Course Outcomes and CO-PO mappings matrix justifies the motives, accomplishment and prospect behind learning the course. The Course Objectives, Course Outcomes and CO-PO Mapping Matrix are provided for reference and these are indicative only. The course instructor may modify them as per his or her perspective.

2. @CO and PO Mapping Matrix (Course Objectives and Program Outcomes) attainment mapping matrix at end of course contents, indicates the correlation levels of 3, 2, 1 and ‘-’. The notation of 3, 2 and 1 denotes substantially (high), moderately (medium) and slightly (low). The mark ‘-’ indicates that there is no correlation between CO and PO.

3. For each course, contents are divided into six units-I, II, III, IV, V and VI. Elaborated examples/Case Studies are included at each unit to explore how the learned topics apply to real world situations and need to be explored so as to assist students to increase their competencies, inculcating the specific skills, building the knowledge to be applicable in any given situation along with an articulation. One or two sample exemplars or case studies are included for each unit; instructor may extend the same with more. Exemplar/Case Studies may be assigned as self-study by students and to be excluded from theory examinations.

4. *For each unit contents, the content attainment mapping is indicated with Course Outcome(s). Instructor may revise the same as per their viewpoint.

5. For laboratory courses, set of suggested assignments is provided for reference. Laboratory Instructors may design suitable set of assignments for respective course at their level. Beyond curriculum assignments and mini-project may be included as the part of laboratory work. Inclusion of it will be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners.

6. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.

7. For each course, irrespective of the examination head, the instructor should motivate students to read articles/research papers related to recent development and invention in the field.

8. For laboratory, instructions have been included about the conduction and assessment of laboratory work. These guidelines are to be strictly followed.

9. Term Work – Term work is continuous assessment that evaluates a student's progress throughout the semester. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved. Students’ work will be evaluated typically based on the criteria like attentiveness, proficiency in execution of the task, regularity, punctuality, use of referencing, accuracy of language, use of supporting evidence in drawing conclusions, quality of critical thinking and similar performance measuring criteria.

10. Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Submission of journal/term work in the form of softcopy is desirable and appreciated. (In laboratory Practices the lab teachers can give different applications other than the indicated.)

Abbreviations

<table>
<thead>
<tr>
<th>TW: Term Work</th>
<th>TH: Theory</th>
<th>PR: Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR: Oral</td>
<td>Sem: Semester</td>
<td></td>
</tr>
</tbody>
</table>
SEMESTER VII
# Savitribai Phule Pune University

## Fourth Year of Computer Engineering (2019 Course)

### 410241: Design and Analysis of Algorithms

**Teaching Scheme:**
- TH: 03 Hours/Week
- Credit: 03

**Examination Scheme:**
- In-Sem (Paper): 30 Marks
- End-Sem (Paper): 70 Marks

**Prerequisites Courses:**
- Discrete Mathematics (210241), Fundamentals of Data Structures(210242), Data Structures and Algorithms(210252), Theory of Computation (310242)

**Companion Course:**
- Laboratory Practice III(410246)

## Course Objectives:
- To develop problem solving abilities using mathematical theories.
- To apply algorithmic strategies while solving problems.
- To analyze performance of different algorithmic strategies in terms of time and space.
- To develop time and space efficient algorithms.
- To study algorithmic examples in distributed and concurrent environments
- To Understand Multithreaded and Distributed Algorithms

## Course Outcomes:

On completion of the course, student will be able to—

- **CO1:** Formulate the problem
- **CO2:** Analyze the asymptotic performance of algorithms
- **CO3:** Decide and apply algorithmic strategies to solve given problem
- **CO4:** Find optimal solution by applying various methods
- **CO5:** Analyze and Apply Scheduling and Sorting Algorithms.
- **CO6:** Solve problems for multi-core or distributed or concurrent environments

## Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Algorithms and Problem Solving</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Towers of Hanoi</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Analysis of Algorithms and Complexity Theory</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis: Input size, best case, worst case, average case Counting Dominant operators, Growth rate, upper bounds, asymptotic growth, ( O, \Omega, \Theta, o ) and ( \omega ) notations, polynomial and non-polynomial problems, deterministic and non-deterministic algorithms, P-class problems, NP-class of problems, Polynomial problem reduction NP complete problems- vertex cover and 3-SAT and NP hard problem - Hamiltonian cycle.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Analysis of iterative and recursive algorithm</th>
</tr>
</thead>
</table>
### Unit III
**Greedy And Dynamic Programming algorithmic Strategies** | **08 Hours**
---
Dynamic Programming: Principle, control abstraction, time analysis of control abstraction, binomial coefficients, OBST, 0/1 knapsack, Chain Matrix multiplication.

*Exemplar/Case Studies*
Rail tracks connecting all the cities

*Mapping of Course Outcomes for Unit III*
CO2

### Unit IV
**Backtracking and Branch-n-Bound** | **08 Hours**
---
Branch-n-Bound: Principle, control abstraction, time analysis of control abstraction, strategies - FIFO, LIFO and LC approaches, TSP, knapsack problem.

*Exemplar/Case Studies*
Airline Crew Scheduling

*Mapping of Course Outcomes for Unit IV*
CO3, CO4

### Unit V
**Amortized Analysis** | **07 Hours**
---

*Exemplar/Case Studies*
cutting stock problem

*Mapping of Course Outcomes for Unit V*
CO3, CO5

### Unit VI
**Multithreaded And Distributed Algorithms** | **07 Hours**
---
Multithreaded Algorithms - Introduction, Performance measures, Analyzing multithreaded algorithms, Parallel loops, Race conditions.
Problem Solving using Multithreaded Algorithms - Multithreaded matrix multiplication, Multithreaded merge sort.
Distributed Algorithms - Introduction, Distributed breadth first search, Distributed Minimum Spanning Tree.

*Exemplar/Case Studies*
Plagiarism detection
Text Books:

Reference Books:

e-Books:

MOOC Courses links:
- Design and Analysis of Algorithms - https://nptel.ac.in/courses/106106131

@The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### Syllabus for Fourth Year of Computer Engineering (2019 Course)

#### 410242: Machine Learning

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

### Prerequisite Courses:
- Data Science and Big Data Analytics (310251)

### Companion Course:
- Laboratory Practice III (410246)

### Course Objectives:
- To understand the need for Machine learning
- To explore various data pre-processing methods.
- To study and understand classification methods
- To understand the need for multi-class classifiers.
- To learn the working of clustering algorithms
- To learn fundamental neural network algorithms.

### Course Outcomes:
On completion of the course, student will be able to:
- CO1: Identify the needs and challenges of machine learning for real time applications.
- CO2: Apply various data pre-processing techniques to simplify and speed up machine learning algorithms.
- CO3: Select and apply appropriately supervised machine learning algorithms for real time applications.
- CO4: Implement variants of multi-class classifier and measure its performance.
- CO5: Compare and contrast different clustering algorithms.
- CO6: Design a neural network for solving engineering problems.

### Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction To Machine Learning</th>
<th>07 Hours</th>
</tr>
</thead>
</table>


Types of learning: Supervised, Unsupervised, and semi-supervised, reinforcement learning techniques.

Models of Machine learning: Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models.

Important Elements of Machine Learning- Data formats, Learnability, Statistical learning approaches

#### #Exemplar/Case Studies
Suppose you are working for Uber where a task to increase sales is given. Understand the requirements of the client

#### *Mapping of Course Outcomes for Unit
- CO1
Concept of Feature, Preprocessing of data: Normalization and Scaling, Standardization, Managing missing values, Introduction to Dimensionality Reduction, Principal Component Analysis (PCA), Feature Extraction: Kernel PCA, Local Binary Pattern.
Introduction to various Feature Selection Techniques, Sequential Forward Selection, Sequential Backward Selection.
Statistical feature engineering: count-based, Length, Mean, Median, Mode etc. based feature vector creation.
Multidimensional Scaling, Matrix Factorization Techniques.

### Exemplar/Case Studies
You are a Data Scientist, and a client comes to you with their data. Client is running a few campaigns from the past few months, but no campaign seems effective. Client provides you the data of customers, product sales and past campaign success. They want to increase their sales and figure out which marketing strategy is working the best for them?

Questions for data scientists:
1. What data analysis approach will you follow?
2. What statistical approach do you need to follow?
How will you select important features?

*Mapping of Course Outcomes for Unit II*

<table>
<thead>
<tr>
<th>Unit III</th>
<th>Supervised Learning : Regression</th>
<th>06 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias, Variance, Generalization, Underfitting, Overfitting, Linear regression, Regression: Lasso regression, Ridge regression, Gradient descent algorithm. Evaluation Metrics: MAE, RMSE, R2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Exemplar/Case Studies
Stock market price prediction

*Mapping of Course Outcomes for Unit III*

<table>
<thead>
<tr>
<th>Unit IV</th>
<th>Supervised Learning : Classification</th>
<th>08 Hours</th>
</tr>
</thead>
</table>

### Exemplar/Case Studies
Prediction of Thyroid disorders such as Hyperthyroid, Hypothyroid, Euthyroid-sick, and Euthyroid using multiclass classifier.

*Mapping of Course Outcomes for Unit IV*

<table>
<thead>
<tr>
<th>Unit V</th>
<th>Unsupervised Learning</th>
<th>07 Hours</th>
</tr>
</thead>
</table>
### Syllabus for Fourth Year of Computer Engineering

<table>
<thead>
<tr>
<th>Exemplar/Case Studies</th>
<th>Market basket analysis/Customer Segmentation</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Mapping of Course Outcomes for Unit V</th>
<th>CO5</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Unit VI</th>
<th>Introduction To Neural Networks</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Back Propagation Learning, Functional Link Artificial Neural Network, and Radial Basis Function Network, Activation functions, Introduction to Recurrent Neural Networks and Convolutional Neural Networks

<table>
<thead>
<tr>
<th>Exemplar/Case Studies</th>
<th>Movie Recommendation System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO6</td>
</tr>
</tbody>
</table>

| Learning Resources |

#### Text Books:

#### Reference Books:

#### e-Books :
2. Foundation of Machine Learning: [https://cs.nyu.edu/~mohri/mlbook/](https://cs.nyu.edu/~mohri/mlbook/)

#### MOOC Courses Links:
- Introduction to Machine Learning: [https://nptel.ac.in/courses/106105152](https://nptel.ac.in/courses/106105152)
- Introduction to Machine Learning (IIT Madras): [https://onlinecourses.nptel.ac.in/noc22_cs29/preview](https://onlinecourses.nptel.ac.in/noc22_cs29/preview)
- Deep learning: [https://nptel.ac.in/courses/106106184](https://nptel.ac.in/courses/106106184)
### The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO/Po</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
### Syllabus for Fourth Year of Computer Engineering

**Course Code:** 410243  
**Course Name:** Blockchain Technology

#### Teaching Scheme:
- **TH:** 03 Hours/Week
- **Credit:** 03

#### Examination Scheme:
- **In-Sem (Paper):** 30 Marks
- **End-Sem (Paper):** 70 Marks

**Prerequisite Courses:** Computer Networks and Security(310244)

** Companion Course:** Laboratory Practice III(410246)

#### Course Objectives:
- Technology behind Blockchain
- Crypto currency, Bitcoin and Smart contracts
- Different consensus algorithms used in Blockchain
- Real-world applications of Blockchain
- To analyze Blockchain Ethereum Platform using Solidity
- To Describe Blockchain Case Studies

#### Course Outcomes:
On completion of the course, student will be able to:

- **CO1:** Interpret the fundamentals and basic concepts in Blockchain
- **CO2:** Compare the working of different blockchain platforms
- **CO3:** Use Crypto wallet for cryptocurrency based transactions
- **CO4:** Analyze the importance of blockchain in finding the solution to the real-world problems.
- **CO5:** Illustrate the Ethereum public block chain platform
- **CO6:** Identify relative application where block chain technology can be effectively used and implemented.

#### Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Mathematical Foundation for Blockchain</th>
<th>06 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cryptography: Symmetric Key Cryptography and Asymmetric Key Cryptography, Elliptic Curve Cryptography (ECC), Cryptographic Hash Functions: SHA256, Digital Signature Algorithm (DSA), Merkel Trees.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>#Exemplar/Case Studies</strong></td>
<td>Compare the Symmetric and Asymmetric Cryptography algorithms</td>
</tr>
<tr>
<td></td>
<td><strong>#Mapping of Course Outcomes for Unit I</strong></td>
<td>CO1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Feature Engineering</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>#Exemplar/CaseStudies</strong></td>
<td>Study of a research paper based on Blockchain.</td>
</tr>
<tr>
<td>Unit III</td>
<td><strong>Blockchain Platforms and Consensus in Blockchain</strong></td>
<td>06 Hours</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td><strong>#Exemplar/Case Studies</strong></td>
<td>Compare different consensus algorithms used in Blockchain Technology.</td>
</tr>
<tr>
<td></td>
<td><strong>CO2</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit IV</th>
<th><strong>Cryptocurrency – Bitcoin, and Token</strong></th>
<th>06 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Introduction, Bitcoin and the Cryptocurrency, Cryptocurrency Basics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Types of Cryptocurrency, Cryptocurrency Usage, Cryptowallets: Metamask, Coinbase, Binance</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>#Exemplar/Case Studies</strong></td>
<td>Create your own wallet for crypto currency using any of the Blockchain Platforms.</td>
</tr>
<tr>
<td></td>
<td><strong>CO3</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit V</th>
<th><strong>Blockchain Ethereum Platform using Solidity</strong></th>
<th>06 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What is Ethereum, Types of Ethereum Networks, EVM (Ethereum Virtual Machine), Introduction to smart contracts, Purpose and types of Smart Contracts, Implementing and deploying smart contracts using Solidity, Swarm (Decentralized Storage Platform), Whisper (Decentralized Messaging Platform)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>#Exemplar/Case Studies</strong></td>
<td>Study Truffle Development Environment.</td>
</tr>
<tr>
<td></td>
<td><strong>CO4</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit VI</th>
<th><strong>Blockchain Case Studies</strong></th>
<th>06 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prominent Blockchain Applications, Retail, Banking and Financial Services, Government Sector, Healthcare, IOT, Energy and Utilities, Blockchain Integration with other Domains</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>#Exemplar/Case Studies</strong></td>
<td>Study 2 uses cases of Blockchain and write a detailed report on every aspect implemented in the same</td>
</tr>
<tr>
<td></td>
<td><strong>CO5, CO6</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Learning Resources**
Text Books:

Reference Books:
2. Chris Dannen, "Introducing Ethereum and Solidity", Foundations of Crypto currency andBlockchain Programming for Beginners

E-Books:

MOOC Courses Links:
1. NPTEL Course on “Introduction to Blockchain Technology & Applications”
   https://nptel.ac.in/courses/106/104/106104220/
2. NPTEL Course on b
   https://nptel.ac.in/courses/106/105/106105184/

@The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
**Savitribai Phule Pune University**

**Fourth Year of Computer Engineering (2019 Course)**

**Elective III**

**410244(A): Pervasive Computing**

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

**Prerequisite Courses:** Internet of Things and Embedded Systems (310245A)

**Companion Course:** Laboratory Practice IV (410247)

**Course Objectives:**
- To introduce the characteristics, basic concepts and systems issues in pervasive computing.
- To illustrate smart devices and architectures in pervasive computing.
- To introduce intelligent systems and interactions in Pervasive computing.
- To identify the trends and latest development of the technologies in the area.
- To identify Security Challenges & Ethics in Pervasive Computing

**Course Outcomes:**
On completion of the course, student will be able to—
- CO1. Demonstrate fundamental concepts in pervasive computing.
- CO2. Explain pervasive devices and decide appropriate one as per the need of real-time applications.
- CO3. Classify and analyze context aware systems for their efficiency in different ICT systems.
- CO4. Illustrate intelligent systems and generic intelligent interactive applications.
- CO5. Design HCI systems in pervasive computing environment.
- CO6. Explore the security challenges and know the role of ethics in the context of pervasive computing.

## Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction To Pervasive Computing</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pervasive Computing Applications: Pervasive computing devices and interfaces, Device technology trends, Connecting issues and protocols</td>
<td></td>
</tr>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Pervasive Computing for Personalized medicine</td>
<td></td>
</tr>
</tbody>
</table>

*Mapping of Course Outcomes for Unit I*

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Smart Computing with Pervasive Computing Devices</th>
<th>07 Hours</th>
</tr>
</thead>
</table>
# Exemplar/Case Studies  | Amazon Alexa
---|---

**Mapping of Course Outcomes for Unit II**  

<table>
<thead>
<tr>
<th>Unit III</th>
<th>Context Aware Systems</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction, Types of Context, Context Aware Computing and Applications, Modelling Context-Aware Systems, Mobility awareness, spatial awareness, temporal awareness: Coordinating and scheduling, ICT system awareness, Middleware Support</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

# Exemplar/Case Studies  | Mobile Hanging Services systems
---|---

**Mapping of Course Outcomes for Unit III**  

<table>
<thead>
<tr>
<th>Unit IV</th>
<th>Intelligent Systems and Interaction</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

# Exemplar/Case Studies  | Curious information displays: A motivated reinforcement learning IE application.
---|---

**Mapping of Course Outcomes for Unit IV**  

<table>
<thead>
<tr>
<th>Unit V</th>
<th>User Interaction Design – HCI and Wearable Computing</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

# Exemplar/Case Studies  | Smart Fabric/ Textile, Sensory Fabric for Ubiquitous interfaces
---|---

**Mapping of Course Outcomes for Unit V**  

<table>
<thead>
<tr>
<th>Unit VI</th>
<th>Security Challenges &amp; Ethics in Pervasive Computing</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

# Exemplar/Case Studies  | Pervasive Computing Security Gaia Project
---|---

**Mapping of Course Outcomes for Unit VI**  

<p>| Learning Resources |</p>
<table>
<thead>
<tr>
<th>---</th>
<th>---</th>
<th>---</th>
</tr>
</thead>
</table>
Text Books:

Reference Books:

e-Books:

MOOC Courses Links:
https://www.georgiancollege.ca/academics/part-time-studies/courses/mobile-and-pervasive-computing-comp-3025/

<table>
<thead>
<tr>
<th>CO1</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>C01</td>
<td>2</td>
<td>2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>C02</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>C03</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>C04</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>C05</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>C06</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

@The CO-PO Mapping Matrix
### Savitribai Phule Pune University
#### Fourth Year of Computer Engineering (2019 Course)
##### Elective III

**410244(B): Multimedia Techniques**

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

**Prerequisite Courses:** Computer Graphics (210241)

**Companion Course:** Laboratory Practice IV(410247)

**Course Objectives:**
- To understand input and output devices, device drivers, control signals and protocols, DSPs
- To study and use standards (e.g., audio, graphics, video)
- To implement applications, media editors, authoring systems, and authoring by studying streams/structures, capture/represent/transform, spaces/domains, compression/coding
- To design and develop content-based analysis, indexing, and retrieval of audio, images, animation, and video
- To demonstrate presentation, rendering, synchronization, multi-modal integration/interfaces
- To understand IoT architecture’s and Multimedia Internet of things

**Course Outcomes:**

On completion of the course, student will be able to—

- **CO1:** Describe the media and supporting devices commonly associated with multimedia information and systems.
- **CO2:** Demonstrate the use of content-based information analysis in a multimedia information system.
- **CO3:** Critique multimedia presentations in terms of their appropriate use of audio, video, graphics, color, and other information presentation concepts.
- **CO4:** Implement a multimedia application using an authoring system.
- **CO5:** Understanding of technologies for tracking, navigation and gestural control.
- **CO6:** Implement Multimedia Internet of Things Architectures.

### Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction to multimedia</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What is Multimedia and their Components, History of Multimedia; Hypermedia, WWW, and Internet; Multimedia Tools: Static (text, graphics, and still images), Active (sound, animation, and video, etc.); Multimedia Sharing and Distribution; Multimedia Authoring Tools: Adobe Premiere, Adobe Director, Adobe Flash.</td>
<td></td>
</tr>
</tbody>
</table>

**#Exemplar/Case Studies** To study and install open-source multimedia Tools

**Mapping of Course Outcomes for Unit I**

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Graphics and Data Representation Techniques</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>CO1</strong></td>
<td></td>
</tr>
</tbody>
</table>
What are Graphics data types, 1-bit Images, 8 –bit grey level ,16-bit grey level images, Image data type,Image data type:8 bit & 24-bit color images, Higher bit depth images, Color Lookup tables. 
File Formats: GIF, JPEG, PNG, TIFF, PSD, APS, AI, INDD, RAW, Windows BMP, Windows WMF, Netpbm format, EXIF, PTM, Text file format: RTF, TGA 

Applications/Use of text in Multimedia

* Exemplar/Case Studies
To study conversion of image file formats from one to Other.

* Mapping of Course Outcomes for Unit II
CO2

Unit III Multimedia Representations Techniques 07 Hours
Principal concepts for the analog video: CRT, NTSC Video (National Television System Committee), PAL Video (Phase Alternating Line), SECAM Video (System Electronic Couleur Avec Memoire), Digital Video: Chroma Subsampling, High-Definition TV, Ultra High Definition TV (UHDTV), Component Video: High-Definition Multimedia Interface (HDMI),3D Video and TV: various cues, Basics of Digital Audio: What is Sound?, Nyquist Theorem, SNR, SQNR, Audio Filtering, Synthetic Sounds, MIDI Overview: Hardware, Structure, Conversion to WAV, Coding of Audio: PCM, DPCM, DM (Delta Modulation)

* Exemplar/Case Studies
Install and use Handbrake (link is https://handbrake.fr) software to understand the concept of interlaced, deinterlace, noise filters, bitrate, and frame rate for any sample 30 min video, and note down the observations from the output video.

* Mapping of Course Outcomes for Unit III
CO3

Unit IV Compression Algorithms 07 Hours

* Exemplar/Case Studies
Implementation of compression algorithms

* Mapping of Course Outcomes for Unit IV
CO3, CO4

Unit V Augmented Reality(AR), Virtual Reality (VR) and Mixed Reality (MR) 07 Hours
VRML Programming Modeling objects and virtual environments Domain Dependent applications:
# Exemplar/Case Studies | Navigation Assistance System

### Unit VI: Multimedia Internet of Things | 07 Hours

IoT and Multimedia IoT Architecture: IoT Architecture; M-IoT Architectures: Multi-Agent Based, AI-Based Software-Defined, Big Data Layered; Applications of M-IoT: Road Management System, Multimedia IoT in Industrial Applications, Health Monitoring

### Exemplar/Case Studies

<table>
<thead>
<tr>
<th>CO5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation Assistance System</td>
</tr>
</tbody>
</table>

### Mapping of Course Outcomes for Unit VI

<table>
<thead>
<tr>
<th>CO5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mapping of Course Outcomes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CO6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Monitoring System</td>
</tr>
</tbody>
</table>

### Learning Resources

#### Text Books:


#### Reference Books:


#### e-Books:


#### MOOC Courses Links:

- [https://nptel.ac.in/courses/117105083](https://nptel.ac.in/courses/117105083)
Savitribai Phule Pune University  
Fourth Year of Computer Engineering (2019 Course)  
Elective III  
410244(C): Cyber Security and Digital Forensics

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

**Prerequisite Courses:** Computer Networks and Security(310244), Information Security(310254(A))

**Companion Course:** 410246: Laboratory Practice IV

**Course Objectives:**
- To enhance awareness cyber forensics.
- To understand issues in cyber crime and different attacks
- To understand underlying principles and many of the techniques associated with the digital forensic practices
- To know the process and methods of evidence collection
- To analyze and validate forensic data collected.
- To apply digital forensic knowledge to use computer forensic tools and investigation report writing.

**Course Outcomes:** At the end of the course, the student should be able to:
- CO1: Analyze threats in order to protect or defend it in cyberspace from cyber-attacks.
- CO2: Build appropriate security solutions against cyber-attacks.
- CO3: Underline the need of digital forensic and role of digital evidences.
- CO4: Explain rules and types of evidence collection
- CO5: Analyze, validate and process crime scenes
- CO6: Identify the methods to generate legal evidence and supporting investigation reports.

**Course Contents**

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Introduction to Cyber Security</th>
<th>06 Hours</th>
</tr>
</thead>
</table>

**#Exemplar/Case Studies**

**#Mapping of Course Outcome for Unit I**
- CO1

<table>
<thead>
<tr>
<th>Unit 2</th>
<th>Cyber Crime Issues and Cyber attacks</th>
<th>06 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unauthorized Access to Computers, Computer Intrusions, Viruses, and Malicious Code, Internet Hacking and Cracking, Virus and worms, Software Piracy, Intellectual Property, Mail Bombs, Exploitation, Stalking and Obscenity in Internet, Cybercrime prevention methods, Application security (Database, E-mail, and Internet), Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall and VPNs, Hardware protection mechanisms, OS Security</td>
<td></td>
</tr>
</tbody>
</table>

**#Exemplar/Case Studies**
- Cyber Stalking types & their cases respectively

**#Mapping of Course Outcome for Unit II**
- CO2

<table>
<thead>
<tr>
<th>Unit 3</th>
<th>Introduction to Digital Forensics</th>
<th>06 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What is Computer Forensics?, Use of Computer Forensics in Law Enforcement, Computer Forensics Assistance to Human Resources/Employment Proceedings, Computer Forensics Services, Benefits of</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Demonstrate practice Linux networking security recovery commands. &amp; Study Tools viz; FTK &amp; The Sleuth Kit</th>
</tr>
</thead>
</table>

**#Exemplar/Case Studies**

<table>
<thead>
<tr>
<th>*Mapping of Course Outcome for Unit III</th>
<th>CO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence Collection and Data Seizure</td>
<td>06 Hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Understand how computer forensics works by visiting: <a href="http://computer.howstuffworks.com/computer-forensic.htm/printable">http://computer.howstuffworks.com/computer-forensic.htm/printable</a> (23 December 2010)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>*Mapping of Course Outcome for Unit IV</th>
<th>CO4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Forensics analysis and validation</td>
<td>06 Hours</td>
</tr>
<tr>
<td>Determining what data to collect and analyze, validating forensic data, addressing data-hiding techniques, and performing remote acquisitions Network Forensics: Network forensics overview, performing live acquisitions, developing standard procedures for network forensics, using network tools, examining the honeynet project. Processing Crime and Incident Scenes: Identifying digital evidence, collecting evidence in private-sector incident scenes, processing law enforcement crime scenes, preparing for a search, securing a computer incident or crime scene, seizing digital evidence at the scene, storing digital evidence, obtaining a digital hash, reviewing a case</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Discuss cases under Financial Frauds, Matrimonial Frauds, Job Frauds, Spoofing, and Social media. Then write down safety tips, precautionary measures for the discussed fraud cases.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>*Mapping of Course Outcomes for Unit V</th>
<th>CO5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Computer Forensic tools</td>
<td>06 Hours</td>
</tr>
<tr>
<td>Evaluating computer forensic tool needs, computer forensics software tools, computer forensics hardware tools, validating and testing forensics software E-Mail Investigations: Exploring the role of e-mail in investigation, exploring the roles of the client and server in e-mail, investigating e-mail crimes and violations, understanding e-mail servers, using specialized e-mail forensic tools.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Install Kali Linux &amp; practice following examples: 1. <a href="https://www.youtube.com/watch?time_continue=6&amp;v=MZXZctqIUbw&amp;feature=emb_logo">https://www.youtube.com/watch?time_continue=6&amp;v=MZXZctqIUbw&amp;feature=emb_logo</a></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>*Mapping of Course Outcome for Unit VI</th>
<th>CO6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Resources</td>
<td></td>
</tr>
<tr>
<td>Reference Books:</td>
<td></td>
</tr>
</tbody>
</table>

Syllabus for Fourth Year of Computer Engineering

#27/128

e books:

MOOC Courses Links:
• MIT Open CourseWare: https://ocw.mit.edu/courses/

@The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>
### Elective III
410244(D): Object oriented Modeling and Design

#### Teaching Scheme:
- **TH:** 03 Hours/Week
- **Credit:** 03

#### Examination Scheme:
- **In-Sem (Paper):** 30 Marks
- **End-Sem (Paper):** 70 Marks

#### Prerequisite Courses:
Software Engineering (210245)

#### Companion Course:
Laboratory Practice IV (410247)

#### Course Objectives:
- Describe the concepts involved in Object-Oriented modelling and their benefits.
- Demonstrate concept of use-case model, sequence model and state chart model for a given problem.
- Explain the facets of the unified process approach to design and build a Software system.
- Translate the requirements into implementation for Object Oriented design.
- Choose an appropriate design pattern to facilitate development procedure. Select suitable design pattern depending on nature of application.
- To describe Designing and Management of Patterns.

#### Course Outcomes:
On completion of the course, student will be able to–
- **CO1:** Describe the concepts of object-oriented and basic class modelling.
- **CO2:** Draw class diagrams, sequence diagrams and interaction diagrams to solve problems.
- **CO3:** Choose and apply a befitting design pattern for the given problem
- **CO4:** To Analyze applications, architectural Styles & software control strategies
- **CO5:** To develop Class design Models & choose Legacy Systems.
- **CO6:** To Understand Design Patterns

#### Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction To Modeling</th>
<th>06 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is Object Orientation? What is OO development? OO themes; Evidence for usefulness of OO development; OO modeling history Modeling as Design Technique: Modeling; abstraction; The three models. Class Modeling: Object and class concepts; Link and associations concepts; Generalization and inheritance; A sample class model; Navigation of class models; Practical tips.

**#Exemplar/Case Studies**
- Case Study of ATM System

**#Mapping of Course Outcomes for Unit I**
- CO1

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Advanced Class Modeling and State Modeling</th>
<th>06 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Advanced object and class concepts; Association ends; N-ary associations; Aggregation; Abstract classes; Multiple inheritance; Metadata; Reification; Constraints; Derived data; Packages; Practical tips. State Modeling: Events, States, Transitions and Conditions; State diagrams; State diagram
### Unit III | Advanced State Modeling and Interaction Modeling | 06 Hours
---
Advanced State Modeling: Nested state diagrams; Nested states; Signal generalization; Concurrency; A sample state model; Relation of class and state models; Practical tips. Interaction Modeling: Use case models; Sequence models; Activity models. Use case relationships; Procedural sequence models; Special constructs for activity models.

#### Mapping of Course Outcomes for Unit III

| CO2 |

---

### Unit IV | User Application Analysis : System Design | 06 Hours
---
Application Analysis: Application interaction model; Application class model; Application state model; Adding operations. Overview of system design; Estimating performance; Making a reuse plan; Breaking a system into sub-systems; Identifying concurrency; Allocation of sub-systems; Management of data storage; Handling global resources; Choosing a software control strategy; Handling boundary conditions; Setting the trade-off priorities; Common architectural styles; Architecture of the ATM system as the example.

#### Mapping of Course Outcomes for Unit IV

| CO2, CO3 |

---

### Unit V | Class Design ,Implementation Modeling, Legacy Systems | 06 Hours
---
Class Design: Overview of class design; Bridging the gap; Realizing use cases; Designing algorithms; Recursing downwards, Refactoring; Design optimization; Reification of behavior; Adjustment of inheritance; Organizing a class design; ATM example. Implementation Modeling: Overview of implementation; Fine-tuning classes; Fine-tuning generalizations; Realizing associations; Testing. Legacy Systems: Reverse engineering; Building the class models; Building the interaction model; Building the state model; Reverse engineering tips; Wrapping; Maintenance.

#### Mapping of Course Outcomes for Unit V

| CO3, CO4 |

---

### Unit VI | Design Pattern | 06 Hours
---
What is a pattern and what makes a pattern? Pattern categories; Relationships between patterns; Pattern description Communication Patterns: Forwarder-Receiver; Client-Dispatcher-Server; Publisher-Subscriber. Management Patterns: Command processor; View handler. Idioms: Introduction; what can idioms provide? Idioms and style; Where to find idioms; Counted Pointer example.
### Exemplar/Case Studies
Design Pattern for Any suitable System

### Mapping of Course Outcomes for Unit VI
<table>
<thead>
<tr>
<th>CO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CO6</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

### Learning Resources

**Text Books:**
2. Frank Buchmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Michael Stal, “Pattern-Oriented Software Architecture, A System of Patterns”, Volume 1, John Wiley and Sons, 2007

**Reference Books:**

**e-Books:**

**MOOC Lectures Links:**
- [https://nptel.ac.in/courses/106105153](https://nptel.ac.in/courses/106105153)
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
Elective III
410244(E): Digital Signal Processing

Teaching Scheme:
TH: 03 Hours/Week
Credit: 03

Examination Scheme:
In-Sem (Paper): 30 Marks
End-Sem (Paper): 70 Marks

Prerequisite Courses: Engineering Mathematics III(207003)
Companion Course: Laboratory Practice IV(410247)

Course Objectives:
- To Study and understand representation and properties of signals and systems.
- To learn methodology to analyze signals and systems
- To study transformed domain representation of signals and systems
- To explore Design and analysis of Discrete Time (DT) signals and systems
- To Understand Design of filters as DT systems
- To get acquainted with the DSP Processors and DSP applications

Course Outcomes:
On completion of the course, student will be able to—

CO1: Understand the mathematical models and representations of DT Signals and Systems
CO2: Apply different transforms like Fourier and Z-Transform from applications point of view.
CO3: Understand the design and implementation of DT systems as DT filters with filter structures and different transforms.
CO4: Demonstrate the knowledge of signals and systems for design and analysis of systems
CO5: Apply knowledge and use the signal transforms for digital processing applications
CO6: To understand Filtering and Different Filter Structures

Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Signals and Systems</th>
<th>08 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continuous time (CT), Discrete-time (DT) and Digital signals, Basic DT signals and Operations. Discrete-time Systems, Properties of DT Systems and Classification, Linear Time Invariant (LTI) Systems, Impulse response, Linear convolution, Linear constant coefficient difference equations, FIR and IIR systems, Periodic Sampling, Relationship between Analog and DT frequencies, Aliasing, Sampling Theorem, A to D conversion Process: Sampling, quantization and encoding</td>
<td></td>
</tr>
</tbody>
</table>

#Exemplar/Case Studies
Audio/Music Sampling

*Mapping of Course Outcomes for Unit I

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Frequency Domain Representation of Signal</th>
<th>08 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Introduction to Fourier Series, Representation of DT signal by Fourier Transform (FT), Properties of FT: Linearity, periodicity, time shifting, frequency shifting, time reversal, differentiation, convolution theorem, windowing theorem Discrete Fourier Transform (DFT), DFT</td>
<td></td>
</tr>
</tbody>
</table>
and FT, IDFT, Twiddle factor, DFT as linear transformation matrix, Properties of DFT, circular shifting, Circular Convolution, DFT as Linear filtering, overlap save and add, DFT spectral leakage

**#Exemplar/Case Studies**  |  Spectral Analysis using FFT  
**CO1**

**Unit III**  |  **Fast Fourier Transform (FFT) and Z-Transform(ZT)**  |  08 Hours  
Effective computation of DFT, Radix-2 FFT algorithms: DIT FFT, DIF FFT, Inverse DFT using FFT, Z-transform (ZT), ZT and FT, ZT and DFT, ROC and its properties, ZT Properties, convolution, initial value theorem, Rational ZT, Pole Zero Plot, Behavior of causal DT signals, Inverse Z Transform (IZT): power series method, partial fraction expansion (PFE), Residue method.

**#Exemplar/Case Studies**  |  Discrete Hilbert Algorithm  
**CO2**

**Unit IV**  |  **Analysis of DT - LTI Systems**  |  08 Hours  
System function $H(z)$, $H(z)$ in terms of Nth order general difference equation, all poll and all zero systems, Analysis of LTI system using $H(Z)$, Unilateral Z-transform: solution of difference equation, Impulse and Step response from difference equation, Pole zero plot of $H(Z)$ and difference equation, Frequency response of system, Frequency response from pole-zero plot using Simple geometric construction.

**#Exemplar/Case Studies**  |  Schur Algorithm  
**CO3**

**Unit V**  |  **Digital Filter Design**  |  08 Hours  

**#Exemplar/Case Studies**  |  Realization of an Analogue  
**CO5** Second-order Differentiator

**Unit VI**  |  **Filter Structures and DSP Processors**  |  08 Hours  

**#Exemplar/Case Studies**  |  Architectures and Design techniques for energy efficient embedded DSP
**Syllabus for Fourth Year of Computer Engineering**

And multimedia processing

<table>
<thead>
<tr>
<th>Mapping of Course Outcomes for Unit VI</th>
<th>CO6</th>
</tr>
</thead>
</table>

## Learning Resources

**Text Books:**

**Reference Books:**

**e-Books:**
1. An Introduction to Digital Signal Processing: A Focus on Implementation

**MOOC Courses Links:**
- Digital signal Processing Introduction- [https://nptel.ac.in/courses/117102060](https://nptel.ac.in/courses/117102060)

<table>
<thead>
<tr>
<th>CO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### Syllabus for Fourth Year of Computer Engineering

**Faculty of Engineering**

**Savitribai Phule Pune University**

**Fourth Year of Computer Engineering (2019 Course)**

**Elective IV**

**410245(A): Information Retrieval**

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

**Prerequisite Courses:** Database Management Systems (310241)

**Companion Course:** Laboratory Practice IV (410247)

**Course Objectives:**

- To study basic concepts of Information Retrieval.
- To study concepts of Indexing for Information Retrieval.
- To analyze the performance of information retrieval using advanced techniques such as classification, clustering, and filtering over multimedia.
- To provide comprehensive details about various Evaluation methods.
- To understand the changes necessary to transfer a Basic IR system into large scale search service system.
- To understand Parallel Information retrieval and Web structures.

**Course Outcomes:**

On completion of the course, student will be able to—

- CO1: Implement the concept of Information Retrieval
- CO2: Generate quality information out of retrieved information
- CO3: Apply techniques such as classification, clustering, and filtering over multimedia to analyze the information
- CO4: Evaluate and analyze retrieved information
- CO5: Understand the data in various Application and Extensions of information retrieval
- CO6: Understand Parallel information retrieving and web structure.

**Course Contents**

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction , Basic techniques, &amp; Token</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction:</strong></td>
<td>The IR System, The Software Architecture Of The IR System.</td>
<td></td>
</tr>
<tr>
<td><strong>Basic Tokenizing:</strong></td>
<td>Simple Tokenizing, Stop-Word Removal and Stemming.</td>
<td></td>
</tr>
<tr>
<td><strong>#Exemplar/Case Studies</strong></td>
<td>A Case Study Of Onitsha Divisional Library Which Aims At Finding The Causes And Solutions To The Problems Of Information Retrieval Methods By The Library.</td>
<td></td>
</tr>
<tr>
<td><strong>Mapping of Course Outcomes for Unit I</strong></td>
<td>CO 1</td>
<td></td>
</tr>
</tbody>
</table>

**Unit II**

**Static Inverted Indices and Query Processing**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit II</strong></td>
<td><strong>Static Inverted Indices and Query Processing</strong></td>
<td><strong>07 Hours</strong></td>
</tr>
</tbody>
</table>

---

Syllabus for Fourth Year of Computer Engineering

#35/128
**Index Construction:** Different types of Index Construction, In-Memory Index Construction, Sort-Based Index Construction, Merge-Based Index Construction, Disk-Based Index Construction.

**Other types of Indices.**

**Query Processing:** Query Processing for Ranked Retrieval, Document-at-a-Time Query Processing, Term-at-a-Time Query Processing, Pre-computing Score Contributions, Impact Ordering

**Query optimization, Lightweight Structure:** Generalized Concordance Lists, Operators, Implementation & Examples

---

<table>
<thead>
<tr>
<th>#Exemplar/CaseStudies</th>
<th>Match the search statement with the stored database</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mapping of Course Outcomes for Unit II</em></td>
<td>CO2</td>
</tr>
</tbody>
</table>

**Unit III**  
**Index Compression and Dynamic Inverted Indices**  
07 Hours

General-Purpose Data Compression,

**Data Compression:** Modeling and Coding, Huffman Coding, Arithmetic Coding, Symbolwise Text Compression

**Compressing Postings Lists:**
Nonparametric Gap Compression, Parametric Gap Compression, Context-Aware Compression Methods, Index Compression for High Query Performance, Compression Effectiveness, DecodingPerformance, Document Reordering.

**Dynamic Inverted Indices:**
Incremental Index Updates, Contiguous Inverted Lists, Noncontiguous Inverted,

**Document Deletions:** Invalidation List, Garbage Collection, Document Modifications,

---

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Translating Short Segments with NMT: A Case Study in English-to-Hindi</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mapping of Course Outcomes for Unit III</em></td>
<td>CO2</td>
</tr>
</tbody>
</table>

**Unit IV**  
**Probabilistic Retrieval and Language Modeling & Related Methods, Categorization & Filtering**  
07 Hours

**Probabilistic Retrieval:** Modeling Relevance, The Binary Independence Model, Term Frequency, Document Length:BM25, Relevance Feedback, Field Weights; **Language Modeling and Related Methods:** Generating Queries from Documents, Language Models and Smoothing, Ranking with Language Models, Divergence from Randomness, Passage Retrieval and Ranking **Categorization and Filtering:** Detailed Examples, Classification, Linear, Similarity- Based, Probabilistic Classifiers, Generalized Linear Models. Information-Theoretic Model.

---

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>E-Mail on the Move: Study of E-mail Categorization, Filtering, and Alerting on Mobile Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mapping of Course Outcomes for Unit IV</em></td>
<td>CO3</td>
</tr>
</tbody>
</table>

**Unit V**  
**Measuring Effectiveness and Measuring Efficiency**  
07 Hours

**Measuring Effectiveness** - Traditional effectiveness measure, The Text Retrieval Conference (TREC), Using statistics in evaluation, Minimizing adjudication Effort, Nontraditional effectiveness measures, **Measuring Efficiency** – Efficiency criteria, Query Scheduling, Caching, Introduction to Redisand Memcached
<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Study of API Handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Mapping of Course Outcomes for Unit VI</td>
<td>CO4</td>
</tr>
</tbody>
</table>

**Unit VI**  
**Parallel Information retrieval , Web Search**  
**07 Hours**

**Parallel Information retrieval** - Parallel Query Processing, MapReduce  
**Web Search** - The structure of the web, Quires and Users, Static ranking, Dynamic ranking, Evaluation web search, Web Crawlers, Web crawler libraries, Python Scrapy, Beautiful Soup

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Study of Google Map / Facebook information retrieval</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Mapping of Course Outcomes for Unit VI</td>
<td>CO5, CO6</td>
</tr>
</tbody>
</table>

### Learning Resources

#### Text Books:

#### Reference Books:
1. C.J. Rijsbergen, "Information Retrieval", (http://www.dcs.gla.ac.uk/Keith/Preface.html)

#### e-Books:
1. Information Retrieval- [www.informationretrieval.org](http://www.informationretrieval.org)

#### MOOC Courses Links:
- [https://nptel.ac.in/courses/117102060](https://nptel.ac.in/courses/117102060)

<table>
<thead>
<tr>
<th>COPO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
Elective IV
410245(B): GPU Programming and Architecture

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

**Prerequisites Courses:** Computer Graphics(210244)

**Companion Course:** Laboratory Practice IV(410247)

**Course Objectives:**
- To understand Graphics Processing Unit (GPU) Concepts.
- To understand the basics of GPU architectures
- To write programs for massively parallel processors
- To understand the issues in mapping algorithms for GPUs
- To introduce different GPU programming models
- To examine the architecture and capabilities of modern GPUs.

**Course Outcomes:**
After completion of the course, students should be able to-

**CO1:** Describe GPU architecture  
**CO2:** Write programs using CUDA, identify issues and debug them.  
**CO3:** Implement efficient algorithms in GPUs for common application kernels, such as matrix multiplication  
**CO4:** Write simple programs using OpenCL  
**CO5:** Identify efficient parallel programming patterns to solve problems  
**CO6:** Explore the modern GPUs architecture and its Applications.

**Course Contents**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Introduction to Graphics Processing Unit (GPU)</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Review of traditional Computer Architecture</td>
<td></td>
</tr>
<tr>
<td>*Mapping of Course Outcomes for Unit I</td>
<td>CO 1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Cuda Programming</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Write basic CUDA programs.</td>
<td></td>
</tr>
<tr>
<td>*Mapping of Course Outcomes for Unit II</td>
<td>CO 2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit III</th>
<th>Programming Issues</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Exemplar/Case Studies
- Study of various CUDA errors

### Mapping of Course Outcomes for Unit III
- CO 3

#### Unit IV | Opencl Basics | 07 Hours
---|---|---
OpenCL Standard, Kernels, Host Device Interaction, Execution Environment, Memory Model, Basic OpenCL Examples.

### Exemplar/Case Studies
- Write OpenCL basic program

### Mapping of Course Outcomes for Unit IV
- CO 4

#### Unit V | Algorithms on GPU | 07 Hours
---|---|---
Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix – Matrix Multiplication – Programming Heterogeneous Cluster

### Exemplar/Case Studies
- Describe multi-dimensional mapping of dataspace.

### Mapping of Course Outcomes for Unit V
- CO 5

#### Unit VI | OpenCL and Application Design | 07 Hours
---|---|---
OpenCL for Heterogeneous Computing, Application Design: Efficient Neural Network Training/Inferencing

### Exemplar/Case Studies
- Describe OpenCL for Heterogeneous computing

### Mapping of Course Outcomes for Unit VI
- CO6

### Learning Resources

#### Text Books:

#### Reference Books:
**e-Books:**

**NPTEL/YouTube video lecture link**
- https://onlinecourses.nptel.ac.in/noc20_cs41/preview

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Savitribai Phule Pune University  
Fourth Year of Computer Engineering (2019 Course)  
Elective IV  
410245(C): Mobile Computing

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 3 Hours/Week</td>
<td>3</td>
<td>In-Sem (TH): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (TH): 70 Marks</td>
</tr>
</tbody>
</table>

**Prerequisites Courses:** Computer Networks and Security(310244)  
**Companion Course:** Laboratory Practice IV(410247)  

**Course Objectives:**  
- To introduce the basic concepts and principles in mobile computing. This includes major techniques involved, and networks & systems issues for the design and implementation of mobile computing systems and applications  
- To demonstrate the protocols of mobile communication.  
- To know GSM architecture and support services  
- To Study on location, handoff management and wireless fundamentals.  
- To summarize VLR and HLR identification algorithms  
- To learn current technologies being used on field and design and development of various network protocol using simulation tools.

**Course Outcomes:**  
- CO1: Develop a strong grounding in the fundamentals of mobile Networks  
- CO2: Apply knowledge in MAC, Network, and Transport Layer protocols of Wireless Network  
- CO3: Illustrate Global System for Mobile Communications  
- CO4: Use the 3G/4G technology based network with bandwidth capacity planning, VLR and HLR identification algorithms  
- CO5: Classify network and transport layer of mobile communication  
- CO6: Design & development of various wireless network protocols using simulation tools

**Course Contents**

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction to Mobile Computing</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Introduction to Mobile computing, Constraints in mobile computing, Application of mobile computing, Generations of mobile wireless 1G to 5G, Future of mobile computing, Radio frequency Technology, Public Switched Telephone network, (PSTN), Public Communication service (PCS), PCS Architecture, Blue tooth, Ad-hoc Networks.</td>
<td></td>
</tr>
</tbody>
</table>

*Exemplar/Case Studies*  
5G Network, Spectrum sharing for D2D communication in 5G cellular networks

**Unit II**  
Mobile Wireless protocols  
07 Hours

and their characteristics.

### Exemplar/Case Studies
- IPoC: A New Core Networking Protocol for 5G Networks.

### Mapping of Course Outcomes for Unit II
- CO2

### Unit III
- **Global System for Mobile Communication**
  - 07 Hours
  - Global System for Mobile Communications (GSM) architecture, Mobile Station, Base Station System, Switching subsystem, Security, Data Services, HSCSD, GPRS - GPRS system and protocol architecture 2.3 UTRAN, UMTS core network; Improvements on Core Network, 802.11 Architecture 802.11a, 802.11b standard

### Exemplar/Case Studies
- 5G mobile communications

### Mapping of Course Outcomes for Unit III
- CO3

### Unit IV
- **GSM Networking Signaling and Mobile Management**
  - 07 Hours
  - GSM MAP Service framework, MAP protocol machine, GSM location management, Transaction management, Mobile database, Introduction to location management HLR and LR, VLR and HLR Failure restoration, VLR identification algorithm, O-I, O-II algorithm etc. Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).

### Exemplar/Case Studies
- 5G Mobility Management, Micro Mobility: CellularIP, HAWAII, HMIPv6

### Mapping of Course Outcomes for Unit IV
- CO4

### Unit V
- **Mobile Network and Transport Layers**
  - 07 Hours
  - Mobile IP, IP packet delivery, Tunnelling and encapsulation, IPv6, DHCP, Vehicular Ad Hoc networks (VANET), MANET, Traditional TCP, Snooping TCP, Mobile TCP, 3G wireless network, Wireless Application Protocol, WDP WTP, WML, WTA architecture, Cellular IP

### Exemplar/Case Studies
- 5G Network and Transport Layers

### Mapping of Course Outcomes for Unit V
- CO5

### Unit VI
- **3G and 4G Technologies**
  - 07 Hours
  - 3G and 4G Technologies for GSM and CDMA: W-CDMA, UMTS, HSPA (High Speed Packet Access), HSDPA, HSUPA, HSPA+, TD-SCDMA, LTE (E-UTRA) 3GPP2 family CDMA2000 1x, 1xRTT, EV-DO (Evolution-Data Optimized), Long Term Evolution (LTE) in 4G. Architecture of 5G. Role of 5G in IoT.
**Learning Resources**

### Text Books:

### Reference Books:

### e-Books:
1. [http://www.dauniv.ac.in/downloads/Mobilecomputing/Microsoft%20%20MobileCompChap02L2Ha ndhelCompandMobileOSes.pdf](http://www.dauniv.ac.in/downloads/Mobilecomputing/Microsoft%20%20MobileCompChap02L2HandhelCompandMobileOSes.pdf)

### MOOC Courses Links:
- [https://nptel.ac.in/courses/106106147](https://nptel.ac.in/courses/106106147)

### @The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
Elective IV
410245 (D): Software Testing and Quality Assurance

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

Prerequisite Courses: Software Engineering (210253), Software Project Management(310245(D))
Companion Course: Lab Practice IV

Course Objectives:
- Introduce basic concepts of software testing.
- Understand the best way to increase the effectiveness, test coverage, and execution speed in software testing.
- Understand white box, block box, object oriented, web based and cloud testing.
- Understand the importance of software quality and assurance software systems development.
- Know in details automation testing and tools used for automation testing.
- To learn and understand the combination of practices and tools that are designed to help QA professionals test more efficiently.

Course Outcomes:
On completion of the course, student will be able to—

CO1: **Describe** fundamental concepts in software testing such as manual testing, automation testing and software quality assurance.

CO2: **Design and Develop** project test plan, design test cases, test data, and conduct test operations.

CO3: **Apply** recent automation tool for various software testing for testing software.

CO4: **Apply** different approaches of quality management, assurance, and quality standard to software system.

CO5: **Apply** and analyze effectiveness Software Quality Tools.

CO6: **Apply** tools necessary for efficient testing framework.

Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction to Software Testing</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

#Exemplar/Case Studies

2. SAP test automation CoE for Financial Service Provider.
### Mapping of Course Outcomes for Unit I

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Test Planning and Quality Management</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

#### Exemplar/Case Studies

1. Online Recommendation System
2. Quality Engineering services for Medical Devices company | Case Study (cigniti.com)

### Mapping of Course Outcomes for Unit II

<table>
<thead>
<tr>
<th>Unit III</th>
<th>Test Case Design Techniques</th>
<th>07 Hours</th>
</tr>
</thead>
</table>


#### Exemplar/Case Studies

1. Case Study: Manual Testing (Online Marketing Software Platform)
   Link: [https://www.360logica.com/blog/case-study-manual-testing-online-marketing-software-platform/](https://www.360logica.com/blog/case-study-manual-testing-online-marketing-software-platform/)
2. Case Study: Decision Table Testing (transferring money online to an account which is already added and approved.)

### Mapping of Course Outcomes for Unit III

<table>
<thead>
<tr>
<th>Unit IV</th>
<th>Software Quality Assurance and Quality Control</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Software Quality Assurance:</strong></td>
<td>Introduction, Constraints of Software Product Quality Assessment, Quality and Productivity Relationship, Requirements of a Product, Characteristics of Software,</td>
<td></td>
</tr>
</tbody>
</table>

---

**Software Quality Control:** Software quality models, Quality measurement and metrics, Quality plan, implementation and documentation, Quality tools including CASE tools, Quality control and reliability of quality process, Quality management system models, Complexity metrics and Customer Satisfaction, International quality standards – ISO, CMM

### Exemplar/Case Studies
1. Case Study #1 – Android Application Acceptance Test Suite
2. Case Study #2 – API Acceptance Test Suite

Link for above case studies - [Software Quality Assurance Case Studies - Beta Breakers](link)

### Mapping of Course Outcomes for Unit IV

<table>
<thead>
<tr>
<th>Unit IV</th>
<th>Automation Testing Tools/Performance Testing Tools</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO4</strong></td>
<td><strong>Automation Testing</strong></td>
<td></td>
</tr>
</tbody>
</table>


**Performance Testing:** What is Performance Testing what is use of it? Tools used for performance testing - Apache Jmeter.

### Exemplar/Case Studies
1. Case Study: Cucumber open-source automation testing framework.
2. Case Study: [PDF] Automated Software Testing—A Case Study (researchgate.net)

### Mapping of Course Outcomes for Unit V

<table>
<thead>
<tr>
<th>Unit V</th>
<th>Testing Framework</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO5</strong></td>
<td><strong>Testing Framework</strong></td>
<td></td>
</tr>
</tbody>
</table>


### Exemplar/Case Studies

### Mapping of Course Outcomes for Unit VI

<table>
<thead>
<tr>
<th>Unit VI</th>
<th>Learning Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO6</strong></td>
<td></td>
</tr>
</tbody>
</table>
Text Books:

Reference Books:

e-Books:
   https://books.google.co.in/books?id=zUm8My7SiakC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
   https://kupdf.net/queue/software-testing-principles-and-practices-by-srinivasan_5b0ae8eae2b6f5f7d862d26_pdf?queue_id=1&x=1656562364&z=MTE1LjI0Mi4yNDIuNzA=
   https://pdfcoffee.com/download/se-4-pdf-free.html

MOOC Courses Links:
   • https://nptel.ac.in/courses/106105150
   • NPTEL : NOC: Software Testing (2017) (Computer Science and Engineering) (digimat.in)

@The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>
### Elective IV

**410245(E): Compilers**

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

**Prerequisite Courses:** Theory of Computation(310241), Systems Programming and Operating System (310251)

**Companion Course:** Laboratory Practice IV (410247)

**Course Objectives:**
- To aware about language translation theories and compiler design stages
- To illustrate the various parser configurations
- To exemplify the use of syntax directed translation in intermediate code
- To Understand Storage Management and Control Structure Environment.
- Learn to develop a Code generator
- To demonstrate the numerous optimization methods used in the creation of different optimizing compilers

**Course Outcomes:**
On completion of the course, student will be able to—
- **CO1:** **Design** and **implement** a lexical analyzer using LEX tools
- **CO2:** **Design** and **implement** a syntax analyzer using YACC tools
- **CO3:** **Understand** syntax-directed translation and run-time environment
- **CO4:** **Generate** intermediate codes for high-level statements.
- **CO5:** **Construct** algorithms to produce computer code.
- **CO6:** **Analyze and transform** programs to improve their time and memory efficiency

### Course Contents

#### Unit I

**Notion and Concepts**

- Introduction to compilers
- Design issues, passes, phases, symbol table
- Preliminaries Memory management, Operating system support for compiler, Lexical Analysis Tokens, Regular Expressions, Process of Lexical analysis, Block Schematic, Automatic construction of lexical analyzer using LEX, LEX features and specification.

**#Exemplar/Case Studies**

- Study of LEX Compiler

**Mapping of Course Outcomes for Unit**

- **CO1**

#### Unit II

**Parsing**

- Syntax Analysis CFG, top-down and bottom-up parsers, RDP, Predictive parser, SLR, LR(1), LALR parsers, using ambiguous grammar, Error detection and recovery, automatic construction of parsers using YACC, Introduction to Semantic analysis, Need of semantic analysis, type checking and type conversion.
**Faculty of Engineering**  
**Savitribai Phule Pune University**

<table>
<thead>
<tr>
<th><strong>Unit III</strong></th>
<th><strong>Syntax Translation Schemes</strong></th>
<th><strong>08 Hours</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Unit IV</strong></th>
<th><strong>Run-time Storage Management</strong></th>
<th><strong>08 Hours</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Storage Management – Static, Stack and Heap, Activation Record, static and control links, parameter passing, return value, passing array and variable number of arguments, Static and Dynamic scope, Dangling Pointers, translation of control structures – if, if-else statement, Switch-case, while, do -while statements, for, nested blocks, display mechanism, array assignment, pointers, function call and return. Translation of OO constructs: Class, members and Methods.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Unit V</strong></th>
<th><strong>Code Generation</strong></th>
<th><strong>07 Hours</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Code Generation - Issues in code generation, basic blocks, flow graphs, DAG representation of basic blocks, Target machine description, peephole optimization, Register allocation and Assignment, Simple code generator, Code generation from labeled tree, Concept of code generator.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Unit VI</strong></th>
<th><strong>Code Optimization</strong></th>
<th><strong>07 Hours</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Need for Optimization, local, global and loop optimization, Optimizing transformations, compile time evaluation, common sub-expression elimination, variable propagation, code movement, strength reduction, dead code elimination, DAG based local optimization, Introduction to global data flow analysis, Data flow equations and iterative data flow analysis.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Learning Resources</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>#Exemplar/Case Studies</strong></th>
<th>Study of YAAC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>#Mapping of Course Outcomes for Unit II</strong></td>
<td>CO2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>#Exemplar/Case Studies</strong></th>
<th>Applications of Syntax Directed Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>#Mapping of Course Outcomes for Unit III</strong></td>
<td>CO3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>#Exemplar/Case Studies</strong></th>
<th>CARAT - Compiler and runtime based address translation model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>#Mapping of Course Outcomes for Unit IV</strong></td>
<td>CO4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>#Exemplar/Case Studies</strong></th>
<th>Code Generator for a Virtual Machine Code based JavaScript Compiler (<a href="http://article.nadiapub.com/IJAST/vol119/11.pdf">http://article.nadiapub.com/IJAST/vol119/11.pdf</a>)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>#Mapping of Course Outcomes for Unit V</strong></td>
<td>CO5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>#Exemplar/Case Studies</strong></th>
<th>Execution of super-scalar processors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>#Mapping of Course Outcomes for Unit VI</strong></td>
<td>CO6</td>
</tr>
</tbody>
</table>

| **Syllabus for Fourth Year of Computer Engineering** | **#49/128** |
Text Books:

Reference Books:

eBooks:
1. Basics of Compiler Design
   http://hjemmesider.diku.dk/~torbenm/Basics/basics_lulu2.pdf
2. Modern Compiler Design
   http://160592857366.free.fr/joe/ebooks/ShareData/Modern%20Compiler%20Design%202e.pdf

MOOC Courses Links:
• https://nptel.ac.in/courses/106105190

@The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
410246: Laboratory Practice III

Teaching Scheme:
Practical: 04
Hours/Week
Credit
02

Examination Scheme:
Term work: 50 Marks
Practical: 50 Marks

Companion Course: Design and Analysis of Algorithms (410241), Machine Learning(410242), Blockchain Technology(410243)

Course Objectives:
- Learn effect of data preprocessing on the performance of machine learning algorithms
- Develop in depth understanding for implementation of the regression models.
- Implement and evaluate supervised and unsupervised machine learning algorithms.
- Analyze performance of an algorithm.
- Learn how to implement algorithms that follow algorithm design strategies namely divide and conquer, greedy, dynamic programming, backtracking, branch and bound.
- Understand and explore the working of Blockchain technology and its applications.

Course Outcomes:
After completion of the course, students will be able to
CO1: Apply preprocessing techniques on datasets.
CO2: Implement and evaluate linear regression and random forest regression models.
CO3: Apply and evaluate classification and clustering techniques.
CO4: Analyze performance of an algorithm.
CO5: Implement an algorithm that follows one of the following algorithm design strategies: divide and conquer, greedy, dynamic programming, backtracking, branch and bound.
CO6: Interpret the basic concepts in Blockchain technology and its applications

Guidelines for Instructor's Manual
The instructor’s manual is to be developed as a reference and hands-on resource. It should include prologue (about University/program/ institute/ department/foreword/ preface), curriculum of the course, conduction and assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal
The laboratory assignments are to be submitted by students in the form of a journal. Journal consists of Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments are to be submitted as a softcopy. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to a journal must be avoided. Use of DVD containing student programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.
Guidelines for Laboratory /Term Work Assessment
Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Assessment of each Laboratory assignment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes, punctuality, documentation and neatness.

Guidelines for Practical Examination
Problem statements must be decided jointly by the internal examiner and external examiner. During practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student’s understanding of the fundamentals, effective and efficient implementation. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student’s academics.

Guidelines for Laboratory Conduction
The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy needs to address the average students and inclusive of an element to attract and promote the intelligent students. Use of open source software is encouraged. Based on the concepts learned. Instructors may also set one assignment or mini-project that is suitable to each branch beyond the scope of the syllabus.
Operating System recommended: 64-bit Open source Linux or its derivative
Programming tools recommended: - C++, Java, Python, Solidity, etc.

Virtual Laboratory:
- http://cse01-iiith.vlabs.ac.in/

Suggested List of Laboratory Experiments/Assignments.
Assignments from all the Groups (A, B, C) are compulsory.

Course Contents

Group A: Design and Analysis of Algorithms

Any 5 assignments and 1 mini project are mandatory.

1. Write a program non-recursive and recursive program to calculate Fibonacci numbers and analyze their time and space complexity.

2. Write a program to implement Huffman Encoding using a greedy strategy.

3. Write a program to solve a fractional Knapsack problem using a greedy method.

4. Write a program to solve a 0-1 Knapsack problem using dynamic programming or branch and bound strategy.

5. Design n-Queens matrix having first Queen placed. Use backtracking to place remaining Queens to generate the final n-queens’s matrix.

6. Write a program for analysis of quick sort by using deterministic and randomized variant.
### Mini Projects

<table>
<thead>
<tr>
<th>Mini Project</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>Write a program to implement matrix multiplication. Also implement multithreaded matrix multiplication with either one thread per row or one thread per cell. Analyze and compare their performance.</td>
</tr>
<tr>
<td>8.</td>
<td>Implement merge sort and multithreaded merge sort. Compare time required by both the algorithms. Also analyze the performance of each algorithm for the best case and the worst case.</td>
</tr>
<tr>
<td>9.</td>
<td>Implement the Naive string matching algorithm and Rabin-Karp algorithm for string matching. Observe difference in working of both the algorithms for the same input.</td>
</tr>
<tr>
<td>10.</td>
<td>Different exact and approximation algorithms for Travelling-Sales-Person Problem</td>
</tr>
</tbody>
</table>

---

### Group B: Machine Learning

Any 5 assignments and 1 Mini project are mandatory.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
</table>
| 1. | Predict the price of the Uber ride from a given pickup point to the agreed drop-off location. Perform following tasks:  
1. Pre-process the dataset.  
2. Identify outliers.  
3. Check the correlation.  
4. Implement linear regression and random forest regression models.  
5. Evaluate the models and compare their respective scores like R2, RMSE, etc.  
Dataset link: [https://www.kaggle.com/datasets/yasserh/uber-fares-dataset](https://www.kaggle.com/datasets/yasserh/uber-fares-dataset) |
Dataset link: The emails.csv dataset on the Kaggle [https://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv](https://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv) |
| 3. | Given a bank customer, build a neural network-based classifier that can determine whether they will leave or not in the next 6 months.  
Dataset Description: The case study is from an open-source dataset from Kaggle. The dataset contains 10,000 sample points with 14 distinct features such as CustomerId, CreditScore, Geography, Gender, Age, Tenure, Balance, etc.  
Link to the Kaggle project: [https://www.kaggle.com/barelydedicated/bank-customer-churn-modeling](https://www.kaggle.com/barelydedicated/bank-customer-churn-modeling)  
Perform following steps:  
1. Read the dataset.  
2. Distinguish the feature and target set and divide the data set into training and test sets.  
3. Normalize the train and test data.  
4. Initialize and build the model. Identify the points of improvement and implement the same.  
5. Print the accuracy score and confusion matrix (5 points). |
| 4. | Implement Gradient Descent Algorithm to find the local minima of a function. For example, find the local minima of the function \( y = (x+3)^2 \) starting from the point \( x = 2 \). |

Dataset link: https://www.kaggle.com/datasets/abdallamahgoub/diabetes


Dataset link: https://www.kaggle.com/datasets/kyanyoga/sample-sales-data

7. **Mini Project**

**Mini Project** - Use the following dataset to analyze ups and downs in the market and predict future stock price returns based on Indian Market data from 2000 to 2020.

Dataset Link: https://www.kaggle.com/datasets/sagara9595/stock-data

8. **Mini Project** - Build a machine learning model that predicts the type of people who survived the Titanic shipwreck using passenger data (i.e. name, age, gender, socio-economic class, etc.).

Dataset Link: https://www.kaggle.com/competitions/titanic/data

9. **Mini Project** - Develop an application for signature identification by creating your own dataset of your college student

---

**Group C: Blockchain Technology**

Any 5 assignments and 1 Mini project are mandatory.

1. Installation of MetaMask and study spending Ether per transaction.

2. Create your own wallet using Metamask for crypto transactions.

3. Write a smart contract on a test network, for Bank account of a customer for following operations:
   - Deposit money
   - Withdraw Money
   - Show balance

4. Write a program in solidity to create Student data. Use the following constructs:
   - Structures
   - Arrays
   - Fallback

Deploy this as smart contract on Ethereum and Observe the transaction fee and Gas values.

5. Write a survey report on types of Blockchains and its real time use cases.

6. Write a program to create a Business Network using Hyperledger

7. **Mini Projects**

**Mini Project** - Develop a Blockchain based application dApp (de-centralized app) for e-voting system.
8. **Mini Project** - Develop a Blockchain based application for transparent and genuine charity

9. **Mini Project** - Develop a Blockchain based application for health related medical records

10. **Mini Project** - Develop a Blockchain based application for mental health

@The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>
# Syllabus for Fourth Year of Computer Engineering(2019 Course)

## 410247: Laboratory Practice IV

<table>
<thead>
<tr>
<th>Teaching Scheme</th>
<th>Credit</th>
<th>Examination Scheme: Term Work</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Practical:</strong> 02 Hours/Week</td>
<td>01</td>
<td></td>
<td>50</td>
</tr>
</tbody>
</table>

**Companion Course:** Elective III (410244), Elective IV (410245)

## Course Objectives:
- Learn android application development related to pervasive computing
- Understand various multimedia file formats
- Understand various vulnerabilities and use of various tools for assessment of vulnerabilities
- Understand information retrieval process using standard tools available
- Learn GPU programming and implementation of same using open source libraries
- Learn installation and use of open source software testing tools

## Course Outcomes:
After completion of the course, students will be able to:
- CO1: Apply android application development for solving real life problems
- CO2: Design and develop system using various multimedia components.
- CO3: Identify various vulnerabilities and demonstrate using various tools.
- CO4: Apply information retrieval tools for natural language processing
- CO5: Develop an application using open source GPU programming languages
- CO6: Apply software testing tools to perform automated testing

## Guidelines for Instructor's Manual
The instructor's manual is to be developed as a reference and hands-on resource. It should include prologue (about University/program/institute/department/foreword/preface), curriculum of the course, conduction and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/guidelines, and references.

## Guidelines for Student's Laboratory Journal
The laboratory assignments are to be submitted by student in the form of journal. Journal consists of Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory-Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments are to be submitted as softcopy. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal must be avoided. Use of DVD containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.

## Guidelines for Laboratory/Term Work Assessment
Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Each Laboratory assignment assessment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes and punctuality.

## Guidelines for Practical Examination
Problem statements must be decided jointly by the internal examiner and external examiner. During practical assessment, maximum weightage should be given to satisfactory implementation of the
problem statement. Relevant questions may be asked at the time of evaluation to test the student’s understanding of the fundamentals, effective and efficient implementation. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. Use of open source software is encouraged. Based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

Virtual Laboratory:
- https://hci-iitg.vlabs.ac.in/
- http://vlabs.iitkgp.ernet.in/se/
- https://vlab.amrita.edu/?sub=3&brch=179&sim=1293&cnt=2

410244(A): Pervasive Computing

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.

Group 1

1. Develop an indoor location system to Library guide system where it can direct a user to the bookshelf from a mobile device.
2. Design a pervasive application in which remote computer monitors our health statistics & will determine when one is in trouble & will take appropriate action for rescue.
3. Develop an Android application in which car will use the Internet to find nearby open parking space.
4. Android User Activity Recognition – Still, Walking, Running, Driving etc.
5. Design and build a sensing system using micro-controllers like - Arduino / Raspberry Pi / Intel Galileo to sense the environment around them and act accordingly.
6. Smart Mobile Application with orientation sensing for users to put the phone in meeting / silent mode- OR- outdoor/ loud mode based on the orientation of the device.

Group 2

7. PMini project: Develop Food Ordering System which uses the GPS of an Android-based Smartphone to record and analyze various locations that could give alert to the user, then asking the user to select particular food from given hotel list and place an order.
8. Mini Project: Design a mobile sensing platform mounted on a glove that integrates several sensors, such as touch pressure, imaging, inertial measurements, localization and a Radio Frequency Identification (RFID) reader for fruit classification and grading system.
9. Mini Project: Sensor-Based Assistive Devices for Visually Impaired People. It should cover following points:
   - Determining obstacles around the user body from the ground to the head;
   - Affording some instructions to the user about the movement surface consists of gaps or textures;
   - Finding items surrounding the obstacles;
   - Providing information about the distance between the user and the obstacle with essential direction instructions.
10. **Mini Project:** Develop a Real time application like a smart home with following requirements: If anyone comes at door the camera module automatically captures his image and send it to the email account of user or send notification to the user. Door will open only after user’s approval.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>410244(B)</td>
<td>Multimedia Techniques</td>
</tr>
</tbody>
</table>

**Group 1**

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.

1. To study and install open-source multimedia tools and create an application using appropriate tool to design the college webpage.

2. To create JPEG Image that demonstrates various features of an Image editing tool.

3. Create or play a sample MIDI format sound file using LMMS / MuseScore / Tuxguitar software tool. Edit the sample file by applying effects like bend, slide, vibrato, and hammer-on/pull-off. Export / Convert final MIDI to WAV file format.

4. Implement transform coding, quantization, and hierarchical coding for the encoder and decoder of three-level Hierarchical JPEG.

5. Create an immersive environment (living room/battlefield/tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models.

6. Create a web page for a clothing company which contains all the details of that company and at least five links to other web pages.

**Group 2**

Group 2

7. **Mini Project:** Design and develop a Navigation Assistance System.

8. **Mini Project:** Design and Develop a Traffic Monitoring System.

9. **Mini Project:** Design and develop a Tool for converting image format (e.g. bmp to jpeg).

10. **Mini Project:** Design and develop a Tool for converting audio format (e.g. wav to mp3).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>410244(C)</td>
<td>Cyber Security and Digital Forensics</td>
</tr>
</tbody>
</table>

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.

**Group 1**

1. Write a program for Tracking Emails and Investigating Email Crimes. i.e. Write a program to analyze e-mail header.

2. Implement a program to generate and verify CAPTCHA image.

3. A person on a nearby road is trying to enter into a WiFi network by trying to crack the Password to use the IP Printer resource; write a program detect such attempt and prohibit the access. Develop the necessary scenario by Using an IEEE 802.11, configure a Wi-Fi adapter and Access Point.
### 4. Write a computer forensic application program for Recovering permanent Deleted Files and Deleted Partitions

### 5. Write a program for Log Capturing and Event Correlation

### 6. Configure and demonstrate use of vulnerability assessment tool like Wireshark or SNORT

### 7. Study of Honeypot

#### Group 2

### 8. Mini-project - Design and develop a tool for digital forensic of images

### 9. Mini Project - Design and develop a tool for digital forensic of audio

### 10. Mini Project - Design and develop a tool for digital forensic of video

### 11. Mini Project - Design a system for the analysis of cyber crime using various cyber forensic techniques and compare each technique with respect to integrity, confidentiality, availability

#### 410244(D): Object Oriented Modeling And Design

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.

#### Group 1

1. Draw state model for telephone line, with various activities.

2. Draw basic class diagrams to identify and describe key concepts like classes, types in your system and their relationships.

3. Draw one or more Use Case diagrams for capturing and representing requirements of the system. Use case diagrams must include template showing description and steps of the Use Case for various scenarios.

4. Draw activity diagrams to display either business flows or like flow charts.

5. Draw component diagrams assuming that you will build your system reusing existing components along with a few new ones.

6. Draw deployment diagrams to model the runtime architecture of your system.

7. Draw all UML diagrams for your project work.

8. **Mini Project**: Develop a Blockchain based application for health related medical records

   Draw following UML Diagrams for Bank Management application
   a. Class Diagram
   b. Object Diagram
   c. ER Diagram
   d. Component Diagram

#### 410244(E): Digital Signal Processing

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

#### Group 1

1. Develop a program to generate samples of sine, Cosine and exponential signals at specified sampling frequency and signal parameters. (Test the results for different analog frequency (F) and
2. Find the output of a system described by given difference equation and initial conditions for given input sequence. (Solution of difference equation) (Obtain the response for different systems by changing Degree of difference equation (N) and coefficients and also for different input sequence x(n). Observe the response by considering system as FIR and IIR system).

3. Write a program to plot the magnitude and phase response of a Fourier Transform (FT). (Observe the spectrum for different inputs. Observe the Periodicity).

4. Find the N point DFT / IDFT of the given sequence x (n). Plot the magnitude spectrum |X(K)| Vs K. (Analyze the output for different N and the same input sequence x(n). Also observe the periodicity and symmetry property).

5. Find the N point circular convolution of given two sequences. Test it for Linear convolution. Compute the circular convolution of given two sequences using DFT and IDFT.

6. Develop a program to plot the magnitude and phase response of a given system ( given: h(n): impulse response of system S) (Observe the frequency response for different systems. Compare the frequency response of a system (filter) for different length h(n) i.e filter coefficients).

Group 2:

7. **Mini-Project:** Design and Develop the N-point radix-2 DIT or DIF FFT algorithm to find DFT or IDFT of given sequence x (n). (Analyze the output for different N. Program should work for any value of N and output should be generated for all intermediate stages.) 8 9.

8. **Mini-Project:** Obtain the Fourier transform of different window functions to plot the magnitude and phase spectrums. (Window functions: Rectangular, Triangular, Bartlett, Hamming, Henning, Kaiser. Observe and compare the desirable features of window sequences for different length. Observe the main and side lobes).

9. **Mini-Project:** Design an FIR filter from given specifications using windowing method. (Application should work for different types of filter specifications i.e. LPF, HPF, BPF etc and all window sequences. Plot the frequency response for different frequency terms i.e. analog and DT frequency). 10.

10. **Mini-Project:** Design of IIR filter for given specifications using Bilinear Transformation. (Generalized code to accept any filter length for a transfer function H(Z). Application should work for different types of filter specifications that is LPF, HPF, BPF etc. and for different transfer functions of an analog filter).

### 410245(A): Information Retrieval

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

**Group 1**

1. Write a program to Compute Similarity between two text documents.

2. Implement Page Rank Algorithm.

3. Write a program for Pre-processing of a Text Document: stop word removal.

4. Write a map-reduce program to count the number of occurrences of each alphabetic character in the given dataset. The count for each letter should be case-insensitive (i.e., include both upper-case and lower-case versions of the letter; Ignore non-alphabetic characters).

5. Write a program to implement simple web crawler.

6. Write a program to parse XML text, generate Web graph and compute topic specific page

**Group 2**
<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini project: Develop Document summarization system</td>
<td>Mini Project: Huge data computation</td>
</tr>
<tr>
<td>Mini Project: Develop Tweet sentiment analysis system</td>
<td>Mini Project: Visualization to develop project for image processing and then video processing</td>
</tr>
<tr>
<td>Mini Project: Develop Fake news detection system</td>
<td>Mini Project: Parallel Algorithm for Searching</td>
</tr>
<tr>
<td>Mini Project: Develop a Abstractive summarization system</td>
<td>Mini Project: Parallel Algorithm for Sorting</td>
</tr>
<tr>
<td>410245(B): GPU Programing And Architecture</td>
<td></td>
</tr>
<tr>
<td>Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory</td>
<td></td>
</tr>
</tbody>
</table>

**410245(C): Mobile Computing**

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

<table>
<thead>
<tr>
<th>Group 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>To implement a basic function of Code Division Multiple Access (CDMA) to test the orthogonally and autocorrelation of a code to be used for CDMA operation. Write an application based on the above concept.</td>
</tr>
<tr>
<td>Implementation of GSM security algorithms (A3/A5/A8)</td>
</tr>
<tr>
<td>Write an application that draws basic graphical primitives on the screen.</td>
</tr>
<tr>
<td>Develop a native application that uses GPS location information.</td>
</tr>
<tr>
<td>Design an android Application for Frame Animation</td>
</tr>
<tr>
<td>Create a simulation to show working of 3G Mobile network</td>
</tr>
<tr>
<td>Create a simulation to show working of 4G Mobile network</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini Project: Huge data computation</td>
<td></td>
</tr>
<tr>
<td>Mini Project: Visualization to develop project for image processing and then video processing</td>
<td></td>
</tr>
<tr>
<td>Mini Project: Parallel Algorithm for Searching</td>
<td></td>
</tr>
<tr>
<td>Mini Project: Parallel Algorithm for Sorting</td>
<td></td>
</tr>
</tbody>
</table>
## Syllabus for Fourth Year of Computer Engineering

**8. Mini Project:** Create an application for Bank using spinner, intent
   i) Form 1: Create a new account for customer
   ii) Form 2: Deposit money in customer account.
   iii) Link both forms, after completing of first form the user should be directed to second form
   iv) Provide different menu options

**9. Mini Project:** Create the module for collecting cellular mobile network performance parameters using telephony API Manager
   i) Nearest Base Station
   ii) Signal Strengths
   iii) SIM Module Details
   iv) Mobility Management Information

**10. Mini Project:** Create the module for payment of fees for College by demonstrating the following methods.
   i) FeesMethod() - for calculation of fees
   ii) Use customized Toast for successful payment of fees
   iii) Implement an alarm in case someone misses out on the fee submission deadline
   iv) Demonstrate the online payment gateway

**11. Mini Project:** Create an app to add of a product to SQLite database and make sure to add following features
   i) SMS messaging and email provision
   ii) Bluetooth options
   iii) Accessing Web services
   iv) Asynchronous remote method call
   v) Use Alert box for user notification

### 410245(D): Software Testing and Quality Assurance

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

**Group 1:**

1. Write TEST Scenario for Gmail Login Page
2. Test Scenario for Gmail Login Page
3. Write Test cases in excel sheet for Social Media application or website
4. Create Defect Report for Any application or web application
5. Installation of Selenium grid and selenium Web driver java eclipse (automation tools).
6. Prepare Software requirement specification for any project or problem statement

**Group 2:**

7. **Mini Project:** Software Testing and Quality Assurance Mini Project Dynamic website of covid-19 information using HTML, CSS, JAVASCRIPT And PHP, MySQL database used to store user account, comment, and registration form details. Regular Expression testcases for testing purpose

8. **Mini Project:** Create a small application by selecting relevant system environment / platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Prepare Test Cases inclusive of Test Procedures for identified Test Scenarios.
Perform selective Black-box and White-box testing covering Unit and Integration test by using suitable Testing tools. Prepare Test Reports based on Test Pass/Fail Criteria and judge the acceptance of application developed

9. **Mini Project**: Create a small web-based application by selecting relevant system environment/platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Narrate scripts in order to perform regression tests. Identify the bugs using Selenium WebDriver and IDE and generate test reports encompassing exploratory testing.

### 410245(E) : Compilers

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

#### Group 1

1. Implement a Lexical Analyzer using LEX for a subset of C. Cross check your output with Stanford LEX.
2. Implement a parser for an expression grammar using YACC and LEX for the subset of C. Cross check your output with Stanford LEX and YACC.
3. Generate and populate appropriate Symbol Table.
4. Implement Semantic Analysis Operations like type checking, verification of function parameters, variable declarations and coercions possibly using an Attributed Translation Grammar.
5. Implement the front end of a compiler that generates the three address code for a simple language.
6. Implementation of Instruction Scheduling Algorithm.
7. Implement Local and Global Code Optimizations such as Common Sub-expression Elimination, Copy Propagation, Dead-Code Elimination, Loop and Basic-Block Optimizations. (Optional)
8. Implement a Lexical Analyzer using LEX for a subset of C. Cross check your output with Stanford LEX.

#### Group 2:

9. **Mini-Project 1**: Implement POS tagging for simple sentences written Hindi or any Indian Language

<table>
<thead>
<tr>
<th>@TheCO-POMappingMatrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO/PO</td>
</tr>
<tr>
<td>CO1</td>
</tr>
<tr>
<td>CO2</td>
</tr>
<tr>
<td>CO3</td>
</tr>
<tr>
<td>CO4</td>
</tr>
<tr>
<td>CO5</td>
</tr>
<tr>
<td>CO6</td>
</tr>
</tbody>
</table>
# 410248: Project Work Stage I

<table>
<thead>
<tr>
<th>Teaching Scheme: Practical</th>
<th>Credit</th>
<th>Examination Scheme: Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>02 Hours/Week</td>
<td>02</td>
<td>50 Marks</td>
</tr>
</tbody>
</table>

**Course Objectives:**
- To Apply the knowledge for solving realistic problem
- To develop problem solving ability
- To Organize, sustain and report on a substantial piece of team work over a period of several months
- To Evaluate alternative approaches, and justify the use of selected tools and methods
- To Reflect upon the experience gained and lessons learned
- To Consider relevant social, ethical and legal issues
- To find information for yourself from appropriate sources such as manuals, books, research journals and from other sources, and in turn increase analytical skills.
- To Work in Team and learn professionalism

**Course Outcomes:**
On completion of the course, student will be able to–
- Solve real life problems by applying knowledge.
- Analyze alternative approaches, apply and use most appropriate one for feasible solution.
- Write precise reports and technical documents in a nutshell.
- Participate effectively in multi-disciplinary and heterogeneous teams exhibiting team work
- Inter-personal relationships, conflict management and leadership quality.

**Guidelines**

Project work Stage – I is an integral part of the Project work. In this, the student shall complete the partial work of the Project which will consist of problem statement, literature review, SRS, Model and Design. The student is expected to complete the project at least up to the design phase. As a part of the progress report of project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected project topic. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute. The examinee will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers and report.

**Follow guidelines and formats as mentioned in Project Workbook recommended by Board of Studies**
In addition to credits, it is recommended that there should be audit course, in preferably in each semester starting from second year in order to supplement students' knowledge and skills. Student will be awarded the bachelor’s degree if he/she earns specified total credit [1] and clears all the audit courses specified in the curriculum. The student will be awarded grade as AP on successful completion of audit course. The student may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, such a selection of the audit courses helps the learner to explore the subject of interest in greater detail resulting in achieving the very objective of audit course's inclusion. List of options offered is provided. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at Institute level itself. Method of conduction and method of assessment for audit courses are suggested.

### Criteria

The student registered for audit course shall be awarded the grade AP (Audit Course Pass) and shall be included such AP grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory performance and secured a passing grade in that audit course. No grade points are associated with this ‘AP’ grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at Institute level itself [1]

### Guidelines for Conduction and Assessment

(Any one or more of following but not limited to):

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations or presentations
- Surveys
- Mini-Project
- Hands on experience on focused topic

### Course Guidelines for Assessment

(Any one or more of following but not limited to):

- Written Test
- Demonstrations/ Practical Test
- Presentation or Report

### Audit Course 5 Options

<table>
<thead>
<tr>
<th>Audit Course Code</th>
<th>Audit Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC7-I</td>
<td>MOOC- Learn New Skills</td>
</tr>
<tr>
<td>AC7-II</td>
<td>Entrepreneurship Development</td>
</tr>
<tr>
<td>AC7-III</td>
<td>Botnet of Things</td>
</tr>
<tr>
<td>AC7-IV</td>
<td>3D Printing</td>
</tr>
<tr>
<td>AC7-V</td>
<td>Industrial Safety and Environment Consciousness</td>
</tr>
</tbody>
</table>
This course aims to create awareness among the students regarding various courses available under MOOC and learn new skills through these courses.

**Course Objectives:**

- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online

**Course Outcomes:**

On completion of the course, students will be able to

CO1: To acquire additional knowledge and skill.

**About Course**

MOOCs (Massive Open Online Courses) provide affordable and flexible way to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. Whether you're reinterested in learning for yourself, advancing your career or leveraging online courses to educate your workforce, SWYAM, NPTEL, edx or similar ones can help. World's largest SWAYAM MOOCs, a new paradigm of education for anyone, anywhere, anytime, as per your convenience, aimed to provide digital education free of cost and to facilitate hosting of all the interactive courses prepared by the best more than 1000 specially chosen faculty and teachers in the country. SWAYAM MOOCs enhances active learning for improving lifelong learning skills by providing easy access to global resources.

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy. This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses.

The courses hosted on SWAYAM is generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology. In order to ensure best quality content are produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education.

**Guidelines:**

Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructural and facilities for the learners.

**References:**

1. [https://swayam.gov.in/](https://swayam.gov.in/)
2. [https://onlinecourses.nptel.ac.in/](https://onlinecourses.nptel.ac.in/)
3. [https://www.edx.org](https://www.edx.org)
This Course aims at instituting Entrepreneurial skills in the students by giving an overview of, who the entrepreneurs are and what competences are needed to become an entrepreneur.

### Course Objectives:
- To introduce the aspects of Entrepreneurship
- To acquaint with legalities in product development
- To understand IPR, Trademarks, Copyright and patenting
- To know the facets of functional plans, Entrepreneurial Finance and Enterprise Management

### Course Outcomes:
On completion of the course, learner will be able to–
- CO1: Understand the legalities in product development
- CO2: Undertake the process of IPR, Trademarks, Copyright and patenting
- CO3: Understand and apply functional plans
- CO4: Manage Entrepreneurial Finance
- CO5: Inculcate managerial skill as an entrepreneur

### Course Contents

1. **Introduction:** Concept and Definitions, Entrepreneur v/s Intrapreneur; Role of entrepreneurship in economic development; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Managerial versus entrepreneurial Decision Making; Entrepreneur v/s Investors; Entrepreneurial attributes and characteristics; Entrepreneurs versus inventors; Entrepreneurial Culture; Women Entrepreneurs; Social Entrepreneurship; Classification and Types of Entrepreneurs; EDP Programmers; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs.

2. **Creating Entrepreneurial Venture:** Generating Business idea- Sources of Innovation, methods of generating ideas, Creativity and Entrepreneurship; Business planning process; Drawing business plan; Business plan failures; Entrepreneurial leadership – components of entrepreneurial leadership; Entrepreneurial Challenges; Legal issues – forming business entity, considerations and Criteria, requirements for formation of a Private/Public Limited Company, Intellectual Property Protection - Patents Trademarks and Copyrights.

3. **Functional plans:** Marketing plan–for the new venture, environmental analysis, steps in preparing marketing plan, marketing mix, contingency planning; Organizational plan – designing organization structure and Systems; Financial plan – pro forma income statements, Ratio Analysis.

4. **Entrepreneurial Finance:** Debt or equity financing, Sources of Finance - Commercial banks, private placements, venture capital, financial institutions supporting entrepreneurs; Lease Financing; Funding opportunities for Startups in India. 5. Enterprise Management: Managing growth and sustenance - growth norms; Factors for growth; Time management, Negotiations, Joint ventures, Mergers and acquisition

Books:
This course aims to provide an understanding of the various security attacks and knowledge to recognize and remove common coding errors that lead to vulnerabilities. It gives an outline of the techniques for developing a secure application.

**Course Objectives:**

- To Understand the various IoT Protocols
- To Understand the IoT Reference Architecture and Real World Design Constraints
- To learn the concept of Botnet

**Course Outcomes:**

On completion of the course, learner will be able to—

CO1: Implement security as a culture and show mistakes that make applications vulnerable to attacks.
CO2: Understand various attacks like DoS, buffer overflow, web specific, database specific, web -spoofing attacks.
CO3: Demonstrate skills needed to deal with common programming errors that lead to most security problems and to learn how to develop secure applications

### Course Contents

1. Introduction
2. IRC-Based Bot Networks
3. Anatomy of a Botnet: The Gaobot Worm
4. IoT Sensors and Security: Sensors and actuators in IoT, Communication and networking in IoT, Real-time data collection in IoT, Data analytics in IoT, IoT applications and requirements, Security threats and techniques in IoT, Data trustworthiness and privacy in IoT, Balancing utility and other design goals in IoT, Future of Botnets in the Internet of Things, Thingbots, Elements of Typical IRC Bot Attack, Malicious use of Bots and Botnet

**Books:**

2. Threat Modeling, Frank Swiderski and Window Snyder, Microsoft Professional, 1st Edition 2004

Savitribai Phule Pune University  
Fourth Year of Engineering (2019 Course)  
410249: Audit Course 7  
AC7 – IV: 3D Printing

This course aims to provide knowledge of 3D printing devices and explore the business side of 3D printing.

**Course Objectives:**
- To **acquire** basic knowledge of drafting terminology and construction of geometrical figures using drawing instruments, procedure to prepare a drawing sheet as per SP-46:2003
- To **inculcate** skill of technical sketching, multi-view drawings, Lettering, tolerance, and metric construction
- To **impart** practical aspects to generate detailed and assembly views with dimensions, annotations, in 3D Modeling software.
- To **develop** prototype/ end use product for 3D Printing

**Course Outcomes:**
On completion of the course, learner will be able to–
CO1: **Understand** the basic knowledge of Shop Floor Safety rules and regulations basics of Machinetools and 3D printing machines
CO2: **Understand** the concept of concept of technical sketching, multi-view drawings, Lettering, tolerance, and metric construction
CO3: **Identify and Distinguish** drafting terminologies and construction of geometrical figures using drawing instruments, procedure to prepare a drawing sheet as per SP-46:2003
CO4: **Describe and Explain** practical aspects to generate detailed and assembly views with dimensions, annotations, in 3D Modeling software.
CO5: **Apply** concepts and **Fabricate** the simple mechanical parts, prototype/ end use product for 3D Printing

**Course Contents**

1. **Getting Started with 3D Printing:** How 3D Printers Fit into Modern Manufacturing, Exploring the Types of 3D Printing, Exploring Applications of 3D Printing.
2. **Outlining 3D Printing Resources:** Identifying Available Materials for 3D Printing, Identifying Available Sources for 3D Printable Objects.
3. **Exploring the Business Side of 3D Printing:** Commoditizing 3D Printing, Understanding 3D Printing's Effect on Traditional lines of Business, Reviewing 3D Printing Research.
4. **Employing Personal 3D printing Devices:** Exploring 3D printed Artwork, Considering Consumer level 3D Printers, Deciding on RepEap of Your Own.

**Books:**
# AC7 – V: Industrial Safety and Environment Consciousness

This course aims to provide knowledge of industrial safety performance planning and accident prevention.

## Course Objectives:

- To understand Industrial hazards and Safety requirements with norms
- To learn the basics of Safety performance planning
- To know the means of accident prevention
- To understand the impact of industrialization on environment
- To know the diversified industrial requirements of safety and security

## Course Outcomes:

On completion of the course, learner will be able to—

- CO1: Develop the plan for Safety performance
- CO2: Demonstrate the action plan for accidents and hazards
- CO3: Apply the safety and security norms in the industry
- CO4: Evaluate the environmental issues of Industrialization

## Course Contents

1. **Introduction:** Elements of safety programming, safety management, Upgrading developmental programmers: safety procedures and performance measures, education, training and development in safety.

2. **Safety Performance Planning**
   
   Safety Performance: An overview of an accident, It is an accident, injury or incident, The safety professional, Occupational health and industrial hygiene. Understanding the risk: Emergency preparedness and response, prevention of accidents involving hazardous substances.

3. **Accident Prevention**
   
   What is accident prevention?, Maintenance and Inspection, Monitoring Techniques, General Accident Prevention, Safety Education and Training.

4. **Organization Safety**
   

5. **Industrial Pollution**
   
   Introduction, Work Environment, Remedy, pollution of Marine Environment and Prevention, Basic Environmental Protection Procedures, Protection of Environment in Global Scenario, Greenhouse Gases, Climate Change Impacts, GHG Mitigation Options, Sinks and Barriers.

6. **Industrial Security (Industry wise)**
   

## Books:

SEMESTER
VIII
## Syllabus for Fourth Year of Computer Engineering

### 410250: High Performance Computing

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 3 Hours/Week</td>
<td>3</td>
<td>In- Sem (TH): 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End- Sem (TH): 70</td>
</tr>
</tbody>
</table>

### Prerequisites Courses:
- Microprocessor (210254), Principles of Programming (210255), Computer Networks and Security (310244)

### Companion Course:
Laboratory Practice V(410254)

### Course Objectives:
- To understand different parallel programming models
- To analyze the performance and modeling of parallel programs
- To illustrate the various techniques to parallelize the algorithm
- To implement parallel communication operations.
- To discriminate CUDA Architecture and its components.
- To understand the scope of parallel computing and its search algorithms.

### Course Outcomes:

| CO1: Understand various Parallel Paradigm |
| CO2: Design and Develop an efficient parallel algorithm to solve given problem |
| CO3: Illustrate data communication operations on various parallel architecture |
| CO4: Analyze and measure performance of modern parallel computing systems |
| CO5: Apply CUDA architecture for parallel programming |
| CO6: Analyze the performance of HPC applications |

### Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction to Parallel Computing</th>
<th>09 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Case study: Multi-core System</td>
<td></td>
</tr>
<tr>
<td>*Mapping of Course Outcomes for Unit I</td>
<td>CO1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Parallel Algorithm Design</th>
<th>09 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Principles of Parallel Algorithm Design:</strong> Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, <strong>Parallel Algorithm Models:</strong> Data, Task, Work Pool and Master Slave Model, <strong>Complexities:</strong> Sequential and Parallel Computational Complexity, Anomalies in Parallel Algorithms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Foster's parallel algorithm design methodology. (<a href="http://compsci.hunter.cuny.edu/~sweiss/course_materials/csci493.65/lecture_n">http://compsci.hunter.cuny.edu/~sweiss/course_materials/csci493.65/lecture_n</a></td>
<td></td>
</tr>
</tbody>
</table>
## Syllabus for Fourth Year of Computer Engineering

### Unit III: Parallel Communication

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>09 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic Communication:</strong> One-to-All Broadcast, All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Collective <strong>Communication using MPI:</strong> Scatter, Gather, Broadcast, Blocking and non blocking MPI, All-to-All Personalized Communication, Circular Shift, Improving the speed of some communication operations.</td>
<td></td>
</tr>
<tr>
<td><strong>Exemplar/Case Studies</strong></td>
<td>Case study: Monte-Carlo Pi computing using MPI</td>
</tr>
</tbody>
</table>

### Unit IV: Analytical Modeling of Parallel Programs

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>09 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sources of Overhead in Parallel Programs, <strong>Performance Measures and Analysis:</strong> Amdahl's and Gustafson's Laws, Speedup Factor and Efficiency, Cost and Utilization, Execution Rate and Redundancy, The Effect of Granularity on Performance, Scalability of Parallel Systems, Minimum Execution Time and Minimum Cost, Optimal Execution Time, Asymptotic Analysis of Parallel Programs, <strong>Matrix Computation:</strong> Matrix-Vector Multiplication, Matrix-Matrix Multiplication.</td>
<td></td>
</tr>
<tr>
<td><strong>Exemplar/Case Studies</strong></td>
<td>Case study: The DAG Model of parallel computation</td>
</tr>
<tr>
<td><strong>Exemplar/Case Studies</strong></td>
<td>Case study: GPU applications using SYCL and CUDA on NVIDIA</td>
</tr>
</tbody>
</table>

### Unit V: CUDA Architecture

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>09 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction to GPU:</strong> Introduction to GPU Architecture overview, Introduction to CUDA C–CUDA programming model, write and launch a CUDA kernel, Handling Errors, CUDA memory model, Manage communication and synchronization, Parallel programming in CUDA-C.</td>
<td></td>
</tr>
<tr>
<td><strong>Exemplar/Case Studies</strong></td>
<td>Case study: GPU applications using SYCL and CUDA on NVIDIA</td>
</tr>
<tr>
<td><strong>Exemplar/Case Studies</strong></td>
<td>Case study: Disaster detection and management/ Smart Mobility/Urban planning</td>
</tr>
</tbody>
</table>

### Unit VI: High Performance Computing Applications

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>09 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope of Parallel Computing, <strong>Parallel Search Algorithms:</strong> Depth First Search(DFS), Breadth First Search(BFS), <strong>Parallel Sorting:</strong> Bubble and Merge, <strong>Distributed Computing:</strong> Document classification, Frameworks – Kuberbets, GPU Applications, Parallel Computing for AI/ML</td>
<td></td>
</tr>
<tr>
<td><strong>Exemplar/Case Studies</strong></td>
<td>Case study: Disaster detection and management/ Smart Mobility/Urban planning</td>
</tr>
<tr>
<td><strong>Exemplar/Case Studies</strong></td>
<td>Case study: GPU applications using SYCL and CUDA on NVIDIA</td>
</tr>
<tr>
<td><strong>Exemplar/Case Studies</strong></td>
<td>Case study: Disaster detection and management/ Smart Mobility/Urban planning</td>
</tr>
</tbody>
</table>
Learning Resources

**Text Books:**


**Reference Books:**


**e Books:**

2. [https://www.vssut.ac.in/lecture_notes/lecture1428643084.pdf](https://www.vssut.ac.in/lecture_notes/lecture1428643084.pdf)

**NPTEL/YouTube video lecture link**

- [https://nptel.ac.in/courses/106108055](https://nptel.ac.in/courses/106108055)
- [https://www.digimat.in/nptel/courses/video/106104120/L01.html](https://www.digimat.in/nptel/courses/video/106104120/L01.html)

---

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>
Faculty of Engineering
Savitribai Phule Pune University

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
410251: Deep Learning

Teaching Scheme: TH: 03 Hours/Week
Credit: 03

Examination Scheme:
In-Sem (Paper): 30 Marks
End-Sem (Paper): 70 Marks

Prerequisite Courses: Machine Learning (410242)
Companion Course: Laboratory Practice V(410254)

Course Objectives:
- To understand the basics of neural networks.
- Comparing different deep learning models.
- To understand the Recurrent and Recursive nets in Deep Learning
- To understand the basics of deep reinforcement Learning models.
- To analyze Types of Networks.
- To Describe Reinforcement Learning.

Course Outcomes:
On completion of the course, student will be able to–

CO1: Understand the basics of Deep Learning and apply the tools to implement deep learning applications

CO2: Evaluate the performance of deep learning models (e.g., with respect to the bias-variance trade-off, overfitting and underfitting, estimation of test error).

CO3: To apply the technique of Convolution (CNN) and Recurrent Neural Network (RNN) for implementing Deep Learning models

CO4: To implement and apply deep generative models.

CO5: Construct and apply on-policy reinforcement learning algorithms

CO6: To Understand Reinforcement Learning Process

Course Contents

Unit I  Foundations of Deep learning  07 Hours

#Exemplar/Case Studies  Deep Mind, AlphaGo, Boston Dynamics

*Mapping of Course Outcomes for Unit I  CO1

Unit II  Deep Neural Networks(DNNs)  07 Hours
**Introduction to Neural Networks**: The Biological Neuron, The Perceptron, Multilayer Feed-Forward Networks, **Training Neural Networks**: Backpropagation and Forward propagation **Activation Functions**: Linear, Sigmoid, Tanh, Hard Tanh, Softmax, Rectified Linear, **Loss Functions**: Loss Function Notation, Loss Functions for Regression, Loss Functions for Classification, Loss Functions for Reconstruction, **Hyperparameters**: Learning Rate, Regularization, Momentum, Sparsity, Deep Feedforward Networks – Example of Ex OR, Hidden Units, cost functions, error backpropagation, Gradient-Based Learning, Implementing Gradient Descent, vanishing and Exploding gradient descent, Sentiment Analysis, Deep Learning with Pytorch, Jupyter, colab.

<table>
<thead>
<tr>
<th><em>Exemplar/Case Studies</em></th>
<th>A Case Study for Music Genre Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mapping of Course Outcomes for Unit II</em></td>
<td>CO2</td>
</tr>
<tr>
<td><strong>Unit III</strong></td>
<td><strong>Convolution Neural Network (CNN)</strong></td>
</tr>
<tr>
<td><em>Exemplar/Case Studies</em></td>
<td>AlexNet, VGG</td>
</tr>
<tr>
<td><em>Mapping of Course Outcomes for Unit III</em></td>
<td>CO3</td>
</tr>
<tr>
<td><strong>Unit IV</strong></td>
<td><strong>Convolution Neural Network (CNN)</strong></td>
</tr>
<tr>
<td><strong>Recurrent and Recursive Nets</strong>: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies, Explicit Memory. <strong>Practical Methodology</strong>: Performance Metrics, Default Baseline Models, Determining Whether to Gather More Data, Selecting Hyper parameters.</td>
<td></td>
</tr>
<tr>
<td><em>Exemplar/Case Studies</em></td>
<td>Multi-Digit Number Recognition</td>
</tr>
<tr>
<td><em>Mapping of Course Outcomes for Unit IV</em></td>
<td>CO3</td>
</tr>
<tr>
<td><strong>Unit V</strong></td>
<td><strong>Deep Generative Models</strong></td>
</tr>
<tr>
<td>Introduction to deep generative model, Boltzmann Machine, Deep Belief Networks, Generative adversarial network (GAN), discriminator network, generator network, types of GAN, Applications of GAN networks</td>
<td></td>
</tr>
<tr>
<td><em>Exemplar/Case Studies</em></td>
<td>GAN for detection of real or fake images</td>
</tr>
<tr>
<td><em>Mapping of Course Outcomes for Unit V</em></td>
<td>CO4</td>
</tr>
<tr>
<td><strong>Unit VI</strong></td>
<td><strong>Reinforcement Learning</strong></td>
</tr>
<tr>
<td>Introduction of deep reinforcement learning, Markov Decision Process, basic framework of reinforcement learning, challenges of reinforcement learning, Dynamic programming algorithms for reinforcement learning, Q Learning and Deep Q-Networks, Deep Q recurrent networks, Simple reinforcement learning for Tic-Tac-Toe.</td>
<td></td>
</tr>
</tbody>
</table>
### Exemplar/Case Studies
Self driving cars, Deep learning for chatbots

### Mapping of Course Outcomes for Unit VI
CO5

### Learning Resources

#### Text Books:
3. Charu Agarwal, “Neural Networks and deep learning”, A textbook
5. Francois chollet, “Deep Learning with Python”

#### Reference Books:
2. by Seth Weidman, “Deep Learning from Scratch: Building with Python from First Principles” O’Reily

#### e-Books:

#### MOOC Courses Links:

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
Elective V
410252(A): Natural Language Processing

Teaching Scheme: TH: 03 Hours/Week
Credit: 03

Examination Scheme: In-Sem (Paper): 30 Marks
End-Sem (Paper): 70 Marks

Prerequisite Courses: Discrete Mathematics (210241), Theory of Computation (310242), Data Science and Big Data Analytics (310251)

Companion Course: Laboratory Practice VI(410255)

Course Objectives:
- To be familiar with fundamental concepts and techniques of natural language processing (NLP)
- To acquire the knowledge of various morphological, syntactic, and semantic NLP tasks
- To develop the various language modeling techniques for NLP
- To use appropriate tools and techniques for processing natural languages
- To comprehend the advance real world applications in NLP domain.
- To Describe Applications of NLP and Machine Translations.

Course Outcomes:
On completion of the course, student will be able to--

CO1: Describe the fundamental concepts of NLP, challenges and issues in NLP

CO2: Analyze Natural languages morphologically, syntactical and semantically OR
Describe the concepts of morphology, syntax, semantics of natural language

CO3: Illustrate various language modelling techniques

CO4: Integrate the NLP techniques for the information retrieval task

CO5: Demonstrate the use of NLP tools and techniques for text-based processing of natural languages

CO6: Develop real world NLP applications

Course Contents

Unit I | Introduction to Natural Language Processing | 07 Hours

Introduction: Natural Language Processing, Why NLP is hard? Programming languages Vs Natural Languages, Are natural languages regular? Finite automata for NLP, Stages of NLP, Challenges and Issues(Open Problems) in NLP

Basics of text processing: Tokenization, Stemming, Lemmatization, Part of Speech Tagging

#Exemplar/Case Studies
Why English is not a regular language:
http://cs.haifa.ac.il/~shuly/teaching/08/nlp_COMPLEXITY.PDF#page=20

*Mapping of Course Outcomes for Unit I

CO1

Unit II | Language Syntax and Semantics | 07 Hours
<table>
<thead>
<tr>
<th><strong>Morphological Analysis</strong></th>
<th>What is Morphology? Types of Morphemes, Inflectional morphology &amp; Derivational morphology, Morphological parsing with Finite State Transducers (FST)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Syntactic Analysis</strong></td>
<td>Syntactic Representations of Natural Language, Parsing Algorithms, Probabilistic context-free grammars, and Statistical parsing</td>
</tr>
<tr>
<td><strong>Semantic Analysis</strong></td>
<td>Lexical Semantic, Relations among lexemes &amp; their senses – Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Word Sense Disambiguation (WSD), Dictionary based approach, Latent Semantic Analysis</td>
</tr>
</tbody>
</table>

### Exemplar/Case Studies
- Study of Stanford Parser and POS Tagger
  - [https://nlp.stanford.edu/software/lex-parser.html](https://nlp.stanford.edu/software/lex-parser.html)
  - [https://nlp.stanford.edu/software/tagger.html](https://nlp.stanford.edu/software/tagger.html)

### Mapping of Course Outcomes for Unit II
- CO2

### Unit III | Language Modelling | 07 Hours
---|---|---
Probabilistic language modeling, Markov models, Generative models of language, Log-Liner Models, Graph-based Models
**N-gram models**: Simple n-gram models, Estimation parameters and smoothing, Evaluating language models, **Word Embeddings/ Vector Semantics**: Bag-of-words, TFIDF, word2vec, doc2vec, Contextualized representations (BERT)
**Topic Modelling**: Latent Dirichlet Allocation (LDA), Latent Semantic Analysis, Non Negative Matrix Factorization

### Exemplar/Case Studies
- Study of language modelling for Indian languages.

### Mapping of Course Outcomes for Unit III
- CO3

### Unit IV | Information Retrieval using NLP | 07 Hours
---|---|---
**Information Retrieval**: Introduction, Vector Space Model
**Named Entity Recognition**: NER System Building Process, Evaluating NER System, Entity Extraction, Relation Extraction, Reference Resolution, Coreference resolution, Cross Lingual Information Retrieval

### Exemplar/Case Studies
- Natural Language Processing based Information Extraction & Retrieval:
  - [https://www.cdac.in/index.aspx?id=mc_cl_cross_lingual_info](https://www.cdac.in/index.aspx?id=mc_cl_cross_lingual_info)

### Mapping of Course Outcomes for Unit IV
- CO4

### Unit V | NLP Tools and Techniques | 08 Hours
---|---|---
**Prominent NLP Libraries**: Natural Language Tool Kit (NLTK), spaCy, TextBlob, Gensim etc.
**Linguistic Resources**: Lexical Knowledge Networks, WordNets, Indian Language WordNet (IndoWordnet), VerbNets, PropBank, Treebanks, Universal Dependency Treebanks
Word Sense Disambiguation: Lesk Algorithm Walker’s algorithm, WordNets for Word Sense Disambiguation

### Exemplar/Case Studies
- Hindi Wordnet: [https://www.cfilt.iitb.ac.in/wordnet/webhwn/](https://www.cfilt.iitb.ac.in/wordnet/webhwn/)
- Sanskrit WordNet: [https://www.cfilt.iitb.ac.in/wordnet/webswn/](https://www.cfilt.iitb.ac.in/wordnet/webswn/)
### Machine Translation
- Rule based techniques, Statistical Machine Translation (SMT), Cross Lingual Translation
- Sentiment Analysis, Question Answering, Text Entailment, Discourse Processing, Dialog and Conversational Agents, Natural Language Generation

**#Exemplar/Case Studies**
- Study working of Google Translate
- Study working of IBM Watson Natural Language Processing

### Learning Resources

**Text Books:**
1. Jurafsky, David, and James H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing”, Computational Linguistics and Speech Recognition, PEARSON Publication
2. Manning, Christopher D., and Mr. Schütze, Foundations of Statistical Natural Language Processing”, Cambridge, MA: MIT Press

**Reference Books:**
1. Steven Bird, Ewan Klein, Edward Loper, “Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit”, O’Reilly Publication
4. Jacob Eisenstein, “Natural Language Processing”, MIT Press

**e-Books:**

**NPTEL Courses links:**
- https://nptel.ac.in/courses/106101007
- https://nptel.ac.in/courses/106106211

---

**@The CO-PO Mapping Matrix**

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
Elective V
410252 (B): Image Processing

Teaching Scheme:
TH: 03 Hours/Week
Credit: 03

Examination Scheme:
In-Sem (Paper): 30 Marks
End-Sem (Paper): 70 Marks

Prerequisites Courses: Discrete Mathematics (210241)
Companion Course: Laboratory Practice VI (410255)

Course Objectives:
- To Understand Digital Image Processing Concepts.
- To Learn Classification Techniques for Image Segmentation.
- To Understand Image Compression and Object Recognition.
- To Study Various Image Restoration Techniques.
- To Understand various Medical and Satellite Image Processing Applications.

Course Outcomes:
On completion of the course, student will be able to–
CO3: Apply algorithmic approaches for Image segmentation.
CO4: Summarize the Concept of Image Compression and Object Recognition.
CO5: Explore the Image Restoration Techniques.
CO6: Explore the Medical and Satellite Image Processing Applications.

Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction to Digital Image Processing</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Introduction, Fundamental steps in Digital Image Processing, Components, Elements of visual perception, Image Sensing and Acquisition, Image Sampling and Quantization, Relationships between pixels, different Color Models, Image Types, Image File Formats, Component Labeling algorithm. Introduction to OpenCV tool to Open and Display Images using Python or Eclipse C/C++.</td>
<td></td>
</tr>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Write a program to create a simple image file, save the same in .jpg, .tiff, .bmp format and display it.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Image Enhancement</th>
<th>08 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spatial Domain Image Enhancement: Intensity Transformations, Contrast Stretching, Histogram Equalization, Correlation and Convolution, Smoothing Filters, Sharpening Filters, Gradient and Laplacian</td>
<td></td>
</tr>
<tr>
<td>*Mapping of Course Outcomes for Unit I</td>
<td>CO1</td>
<td></td>
</tr>
<tr>
<td>Frequency Domain Image Enhancement: Low Pass filtering in Frequency Domain (Ideal,</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Butterworth, Gaussian), High Pass filter in Frequency Domain (Ideal, Butterworth, Gaussian).

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Write a program for image enhancement using suitable algorithm for Histogram equalization, Local enhancement, Smoothing and Sharpening.</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Study the different image segmentation techniques for image segmentation</td>
</tr>
<tr>
<td>*Mapping of Course Outcomes for Unit II</td>
<td>CO2</td>
</tr>
<tr>
<td>Unit III</td>
<td>Image Segmentation and Analysis</td>
</tr>
<tr>
<td>Introduction to Image Segmentation and its need. <strong>Classification of Image Segmentation Techniques</strong>: Threshold Based Image Segmentation, Edge Based Segmentation, Edge Detection, Edge Linking, Hough Transform, Watershed Transform, Clustering Techniques, region approach</td>
<td></td>
</tr>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Explain image compression and object recognition techniques.</td>
</tr>
<tr>
<td>*Mapping of Course Outcomes for Unit III</td>
<td>CO3</td>
</tr>
<tr>
<td>Unit IV</td>
<td>Image Compression and Object Recognition</td>
</tr>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Explain classification of image restoration techniques.</td>
</tr>
<tr>
<td>*Mapping of Course Outcomes for Unit IV</td>
<td>CO4</td>
</tr>
<tr>
<td>Unit V</td>
<td>Image Restoration and Reconstruction</td>
</tr>
<tr>
<td>Introduction, Model of Image degradation, Noise Models, Classification of image restoration techniques, Blind-deconvolution techniques, Lucy Richardson Filtering, Wiener Filtering</td>
<td></td>
</tr>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Implement application for medical image processing or satellite image processing using OpenCV or Python.</td>
</tr>
<tr>
<td>*Mapping of Course Outcomes for Unit V</td>
<td>CO5</td>
</tr>
<tr>
<td>Unit VI</td>
<td>Medical and Satellite Image Processing</td>
</tr>
<tr>
<td>#Exemplar/Case Studies</td>
<td>Implement application for medical image processing or satellite image processing using OpenCV or Python.</td>
</tr>
</tbody>
</table>
**Syllabus for Fourth Year of Computer Engineering**

**Faculty of Engineering**

**Savitribai Phule Pune University**

<table>
<thead>
<tr>
<th><em>Mapping of Course Outcomes for Unit VI</em></th>
<th>CO6</th>
</tr>
</thead>
</table>

**Learning Resources**

**Text Books:**

**Reference Books :**

**e-Books :**

**MOOC Courses links :**
- [http://nptel.ac.in/courses/117105079.](http://nptel.ac.in/courses/117105079.)

---

**@The CO-PO Mapping Matrix**

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

---
**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective V**  
**410252(C): Software Defined Networks**

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 3 Hours/Week</td>
<td>3</td>
<td>In-Sem (Paper):30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem(Paper):70 Marks</td>
</tr>
</tbody>
</table>

**Prerequisites Courses:** Computer Networks and Security(310244)  
**Companion Course:** Laboratory Practice VI(410255)

**Course Objectives:**
- To learn the fundamentals of software defined networks and understand differentiation between traditional networks and software defined networks.
- To gain conceptual understanding of Software Defined Networking (SDN) and its role in Data Center.
- To study about the SDN Programming.
- To study industrial deployment use-cases of SDN.
- To study about the various applications of SDN.
- To describe SDN Framework.

**Course Outcomes:**

On completion of the course, student will be able to—

- **CO1:** Interpret the need of Software Defined networking solutions.
- **CO2:** Analyze different methodologies for sustainable Software Defined Networkingsolutions.
- **CO3:** Select best practices for design, deploy and troubleshoot of next generation networks.
- **CO4:** Develop programmability of network elements.
- **CO5:** Demonstrate virtualization and SDN Controllers using Open Flow protocol.
- **CO6:** Design and develop various applications of SDN.

**Course Contents**

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

**#Exemplar/Case Studies**

- Video Streaming  
  https://kempsdn.com/what-is-sdn-and-use-cases/video-streaming/  

**#Mapping of Course Outcomes for Unit I**

- CO1, CO2

<table>
<thead>
<tr>
<th>Unit II</th>
<th>OPEN FLOW &amp; SDN CONTROLLERS</th>
<th>07 Hours</th>
</tr>
</thead>
</table>
### Exemplar/Case Studies
- Behavior Anomaly Detection in SDN Control Plane: A Case Study of Topology Discovery Attacks
  https://www.hindawi.com/journals/wcmc/2020/8898949/

### Mapping of Course Outcomes for Unit II
- CO2, CO3

<table>
<thead>
<tr>
<th>Unit III</th>
<th>DATA CENTERS</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data Center Definition, Data Center Demands (Adding, Moving, Deleting Resources, Failure Recovery, Multitenancy, Traffic Engineering and Path Efficiency), Tunneling Technologies for the Data Center, SDN Use Cases in the Data Center, SDN Solutions for the Data Center Network – VLANs – EVPN – VxLAN – NVGRE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The World’s Second Largest Tier IV Data Center</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A Yotta Infrastructure case study</td>
<td></td>
</tr>
</tbody>
</table>

### Mapping of Course Outcomes for Unit III
- CO2

<table>
<thead>
<tr>
<th>Unit IV</th>
<th>SDN PROGRAMMING</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs – Introduction of Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Case study: Ballarat Grammar uses SDN to fight malware</td>
<td></td>
</tr>
</tbody>
</table>

### Mapping of Course Outcomes for Unit IV
- CO4

<table>
<thead>
<tr>
<th>Unit V</th>
<th>Network Functions Virtualization (NFV)</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Definition of NFV, SDN Vs NFV, In-line network functions, Benefits of Network Functions Virtualization, Challenges for Network Functions Virtualization, Leading NFV Vendors, Comparison of NFV and NV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NFV deployment case study failure migrate</td>
<td></td>
</tr>
</tbody>
</table>

### Mapping of Course Outcomes for Unit V
- CO5

<table>
<thead>
<tr>
<th>Unit VI</th>
<th>SDN Use Cases</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Juniper SDN Framework – IETF SDN Framework – Open Daylight Controller – Floodlight Controller – Bandwidth Calendaring – Data Center Orchestration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CloudSeeds automate IaaS using SDN and a high-performance network from Juniper.</td>
<td></td>
</tr>
</tbody>
</table>

### Mapping of Course Outcomes for Unit VI
- CO6
Learning Resources

Text Books:

Reference Books :

e-Books :

MOOC Courses Links:
• https://nptel.ac.in/courses/108107107

@The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Elective V
410252(D): Advanced Digital Signal Processing

Teaching Scheme:
TH: 03 Hours/Week
Credit
03

Examination Scheme:
In-Sem (Paper): 30 Marks
End-Sem (Paper): 70 Marks

Prerequisite Courses: 410244(A) Digital Signal Processing

Companion Course: Laboratory Practice VI(410255)

Course Objectives:
- To study the parametric methods for power spectrum estimation.
- To study adaptive filtering techniques and applications of adaptive filtering.
- To learn and understand Multi-rate DSP and applications
- To explore appropriate transforms
- Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech
- Acquire knowledge about different methods used for speech coding and understand various applications of speech processing
- Learn and understand basics of Image Processing and various image filters with its applications

Course Outcomes:
On completion of the course, student will be able to–

CO1: Understand and apply different transforms for the design of DT/Digital systems
CO2: Explore the knowledge of adaptive filtering and Multi-rate DSP
CO3: Design DT systems in the field/area of adaptive filtering, spectral estimation and multi-rate DSP
CO4: Explore use of DCT and WT in speech and image processing
CO5: Develop algorithms in the field of speech, image processing and other DSP applications
CO6: Identify Image Processing Techniques

Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>DFT and Applications</th>
<th>08 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DFT and Applications – Linear filtering, spectral leakage, Spectral resolution and selection of Window Length, Frequency analysis, 2-D DFT, applications in Image and Speech Processing

#Exemplar/Case Studies | Case Study of Image / Speech Processing Application

*Mapping of Course Outcomes for Unit I | CO1

Unit II | Adaptive FIR and IIR filter Design | 08 Hours

|        |                        |          |
Adaptive FIR and IIR filter Design – DT Filters, FIR and IIR filters, Adaptive FIR Filter design: Steepest descent and Newton method, LMS method, Applications, Adaptive IIR Filter design: Padé Approximation, Least square design, Applications

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Demonstration of DT filter and FIR filter with suitable application</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Mapping of Course Outcomes for Unit II</td>
<td>CO2</td>
</tr>
</tbody>
</table>

**Unit III**

**Multi-rate DSP and applications**

| 08 Hours |
|------------------------|--------------------------------------------------|
| Implementation for sampling rate Conversion Multi-rate Digital Signal Processing |
| *Mapping of Course Outcomes for Unit II | CO3 |

**Unit IV**

**Spectral Estimation**

| 08 Hours |
|------------------------|--------------------------------------------------|
| A spectral estimation case study in frequency-domain by subspace methods |
| *Mapping of Course Outcomes for Unit II | CO4 |

**Unit V**

**Speech processing**

| 08 Hours |
|------------------------|--------------------------------------------------|
| Investigation of data augmentation techniques for disordered speech recognition |
| *Mapping of Course Outcomes for Unit II | CO5 |

**Unit VI**

**Image Processing**

| 08 Hours |
|------------------------|--------------------------------------------------|
| Medical image processing for coronavirus (COVID-19) pandemic: A survey |
| *Mapping of Course Outcomes for Unit II | CO6 |
### Books:


### References:


### e-Books:


### MOOC Courses Links:

- https://onlinecourses.nptel.ac.in/noc22_ee86/preview

<table>
<thead>
<tr>
<th>CO/Po</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>C01</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C02</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C03</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C04</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C05</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C06</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

@The CO-PQ Mapping Matrix
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
Elective V
410252(E): Open Elective I

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

The open elective included, so as to give the student a wide choice of subjects from other Engineering Programs. To inculcate the out of box thinking and to feed the inquisitive minds of the learners the idea of open elective is need of the time. Flexibility is extended with the choice of open elective allows the learner to choose interdisciplinary/exotic/future technology related courses to expand the knowledge horizons. With this idea learner opts for the course without any boundaries to choose the approved by academic council and Board of Studies.
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
Elective VI
410253(A): Pattern Recognition

Teaching Scheme:
TH: 03 Hours/Week
Credit: 03

Examination Scheme:
In-Sem (Paper): 30 Marks
End-Sem (Paper): 70 Marks

Prerequisite Courses: Fundamentals of Data Structures(210242), Data Structures and Algorithms(210252)

Companion Course: Laboratory Practice VI(410255)

Course Objectives:
- To learn the basic concept of Pattern recognition
- To study different approaches of pattern recognition
- To learn various pattern classification techniques
- To survey on recent advances and applications in pattern recognition
- To implement Optimal Path Searching techniques.
- To Illustrate Pattern Recognition Techniques.

Course Outcomes:
On completion of the course, student will be able to–
- CO1: Analyze various type of pattern recognition techniques
- CO2: Identify and apply various pattern recognition and classification approaches to solve the problems
- CO3: Evaluate statistical and structural pattern recognition
- CO4: Percept recent advances in pattern recognition confined to various applications
- CO5: Implement Bellman’s optimality principle and dynamic programming

Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Pattern Recognition</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Introduction of Pattern Recognition with its application, Pattern Recognition system, Design cycle of pattern recognition, Learning and adaption, Representation of Patterns and classes, Feature Extraction, pattern recognition models/approaches.</td>
<td></td>
</tr>
</tbody>
</table>

#Exemplar/Case Studies
Evaluation on spatial and temporal variations in water quality by pattern recognition techniques.

*Mapping of Course Outcomes for Unit I
CO1

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Error Estimation &amp; Decision Theory</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Introduction, Error estimation methods, various distance measures (Euclidean, Manhattan, cosine, Mahalanobis) and distance based classifier, Feature selection based on statistical hypothesis testing, ROC curve. Introduction, Bayesian decision theory-continuous and discrete features, two-category classification, minimum error rate classification, discriminant functions,</td>
<td></td>
</tr>
</tbody>
</table>
### Parametric Techniques:
- Maximum Likelihood Estimation, Bayesian Parameter Estimation, Sufficient Statistics; Problems of dimensionality.
- Non-Parametric Techniques: Density estimation, Parzen Window, Metrics and Nearest-Neighbor classification; Fuzzy classification

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Spatial and temporal air quality pattern recognition using environ metric techniques</th>
</tr>
</thead>
</table>

### Unit III | Structural Pattern Recognition | 06 Hours |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree Classifiers: Decision Trees, Random Forests, <strong>Structural Pattern recognition</strong>: Elements of formal grammars, String generation as pattern description, Recognition of syntactic description, Parsing, Stochastic grammars and applications, Graph based structural representation, <strong>Stochastic method</strong>: Boltzmann Learning.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Case Study on spoken word recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mapping of Course Outcomes for Unit II</strong></td>
<td>CO2</td>
</tr>
</tbody>
</table>

### Unit IV | Clustering | 08 Hours |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction, Hierarchical Clustering, agglomerative clustering algorithm, the single linkage, complete, linkage and average, linkage algorithm, Ward's method, Partition clustering, K-means algorithm, clustering algorithms based on graph theory(Minimum spanning tree algorithm), Optimization methods used in clustering: clustering using simulating Annealing.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Case Study on disease recognition from a list of symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mapping of Course Outcomes for Unit III</strong></td>
<td>CO3</td>
</tr>
</tbody>
</table>

### Unit V | Template Matching and Unsupervised Learning | 07 Hours |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures based on Optimal Path Searching techniques: Bellman’s optimality principle and dynamic programming, The Edit distance, Dynamic time Warping, Measures based on correlations, Deformable template models</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Pattern recognition in time series database: A case study on financial database.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mapping of Course Outcomes for Unit IV</strong></td>
<td>CO3</td>
</tr>
</tbody>
</table>

### Unit VI | Fuzzy Logic and Pattern Recognition | 07 Hours |
|-------------|-----------------------------------|---------|

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Study of fingerprint recognition</th>
</tr>
</thead>
</table>
# Mapping of Course Outcomes for Unit VI

## Learning Resources

### Text Books:

### Reference Books:
4. eMedia at NPTEL: [http://nptel.ac.in/courses/106108057/33](http://nptel.ac.in/courses/106108057/33)

### e-Books:
2. [https://cds.cern.ch/record/998831/files/9780387310732_TOC.pdf](https://cds.cern.ch/record/998831/files/9780387310732_TOC.pdf)

### MOOC Courses Links:
- [https://nptel.ac.in/courses/117105101](https://nptel.ac.in/courses/117105101)

---

### The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Faculty of Engineering  
Savitribai Phule Pune University  

**Syllabus for Fourth Year of Computer Engineering (2019 Course)**  
Elective VI  
410253(B): Soft Computing

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

**Prerequisite Courses:** Computer Graphics(210244)

**Companion Course:** Laboratory Practice VI(410255)

**Course Objectives:**
- To study the various soft computing approaches.
- To understand the soft computing techniques and algorithms for problem solving.
- To be familiar with the various application areas of soft computing.
- To apply the soft computing techniques for developing intelligent systems.
- To Explore and solve problems using genetic Algorithms.
- To Understand hybrid systems paradigm and Application Areas of Soft Computing.

**Course Outcomes:**
On completion of the course, student will be able to–

**CO1:** Understand requirement of soft computing and be aware of various soft computing techniques.

**CO2:** Understand Artificial Neural Network and its characteristics and implement ANN algorithms.

**CO3:** Understand and Implement Evolutionary Computing Techniques.

**CO4:** Understand the Fuzzy logic and Implement fuzzy algorithms for solving real life problems.

**CO5:** Apply knowledge of Genetic algorithms for problem solving.

**CO6:** Develop hybrid systems for problem solving.

**Course Contents**

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction To Soft Computing</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

**#Exemplar/Case Studies**
2. Study of IBM Research Neuro-symbolic AI- a new look for neuromorphic computing

**Mapping of Course Outcomes for Unit**

<table>
<thead>
<tr>
<th>CO1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Artificial Neural Network</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation, functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory, perceptron model, single layer artificial neural network, multilayer perceptron model; back propagation learning methods, effect of learning rule coefficient; back propagation algorithm, factors affecting backpropagation training, applications.

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Study of Handwriting recognition using ANN.</th>
</tr>
</thead>
</table>

**Mapping of Course Outcomes for Unit II**

<table>
<thead>
<tr>
<th>Unit III</th>
<th>Evolutionary Computing</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Study of Engineering application of Artificial hummingbird algorithm</th>
</tr>
</thead>
</table>

| CO2 |

**Mapping of Course Outcomes for Unit III**

<table>
<thead>
<tr>
<th>Unit IV</th>
<th>Fuzzy logic</th>
<th>08 Hours</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Study of Object Detection Robot Using Fuzzy Logic Controller</th>
</tr>
</thead>
</table>

| CO3 |

**Mapping of Course Outcomes for Unit IV**

<table>
<thead>
<tr>
<th>Unit V</th>
<th>Genetic Algorithm</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Use Genetic Algorithm to design a solution to the Traveling Salesman Problem. <strong>Solution</strong>: 1. Use Permutation Encoding 2. Define Objective Function. 3. Apply Selection Method 4. Crossover 5. Mutation 6. Repeat Until stopping criteria is met. 7. Stop</th>
</tr>
</thead>
</table>

| CO4 |

**Mapping of Course Outcomes for Unit V**

<table>
<thead>
<tr>
<th>Unit VI</th>
<th>Hybrid System and Application Areas of Soft Computing</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

| CO5 |
Hybrid System towards comprehensive Soft Computing: The hybrid systems paradigm, Hybrid connectionist production systems, Hybrid connectionist logic programming systems, Hybrid fuzzy connectionist production systems, Hybrid systems for speech and language processing, Hybrid systems for decision making.


#Exemplar/Case Studies: Study of Hybrid models for disease prediction.

*Mapping of Course Outcomes for Unit VI: CO6

Learning Resources:

Text Books:


Reference Books:


e-Books:

3. https://ctb.iar.ir/Files/%D9%88%D8%A8%20%D8%B3%D8%A7%DB%8C%D8%AA%20%D8%A7%D8%B3%D8%AA%DB%8C%D8%AF/fuzzy%20logic%20with%20engineering%20application-3rdEdition.pdf

MOOC Courses Links:

- NPTEL Course – Introduction of Soft Computing, IIT Kharagpur by Prof. Debidas Samanta, https://nptel.ac.in/courses/106105173
- NPTEL Course – Neural Network and Applications, IIT Kharagpur by Prof. Somnath Sengupta, https://nptel.ac.in/courses/117105084
- NPTEL Course – Fuzzy Logic and Neural Networks, IIT Kharagpur by Dilip Kumar Pratihar, https://nptel.ac.in/courses/127105006

Syllabus for Fourth Year of Computer Engineering
# The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO1</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>
## Syllabus for Fourth Year of Computer Engineering

### Elective VI

**410253(C): Business Intelligence**

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

**Prerequisites Courses:** Database Management System (310241), Data Science & Big data Analytics (310251), Machine Learning (410242)

**Companion Course:** Laboratory Practice VI (410256)

**Course Objectives:**
- To introduce the concepts and components of Business Intelligence (BI)
- To evaluate the technologies that make up BI (data warehousing, OLAP)
- To identify the technological architecture of BI systems
- To explain different data preprocessing techniques
- To identify machine learning model as per business need
- To understand the BI applications in marketing, logistics, finance and telecommunication sector

**Course Outcomes:** On completion of this course, the students will be able to

- CO1: Differentiate the concepts of Decision Support System & Business Intelligence
- CO2: Use Data Warehouse & Business Architecture to design a BI system
- CO3: Build graphical reports
- CO4: Apply different data preprocessing techniques on dataset
- CO5: Implement machine learning algorithms as per business needs
- CO6: Identify role of BI in marketing, logistics, and finance and telecommunication sector

### Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction to Decision support systems and Business intelligence</th>
<th>07 Hours</th>
</tr>
</thead>
</table>

**Decision support systems:** Definition of system, representation of the decision-making process, evolution of information systems, Decision Support System, Development of a decision support system, the four stages of Simon’s decision-making process, and common strategies and approaches of decision makers

**Business Intelligence:** BI, its components & architecture, previewing the future of BI, crafting a better experience for all business users, End user assumptions, setting up data for BI, data, information and knowledge, The role of mathematical models, Business intelligence architectures, Ethics and business intelligence

**#Exemplar/Case Studies**

- Decision support system in business intelligence:
  [https://www.riverlogic.com/blog/five-decision-support-system-examples](https://www.riverlogic.com/blog/five-decision-support-system-examples)

**Mapping of Course Outcomes for Unit I**

- CO1

<table>
<thead>
<tr>
<th>Unit II</th>
<th>The Architecture of DW and BI</th>
<th>07 Hours</th>
</tr>
</thead>
</table>
BI and DW architectures and its types - Relation between BI and DW - OLAP (Online analytical processing) definitions - Different OLAP Architectures-Data Models-Tools in Business Intelligence-Role of DSS, EIS, MIS and digital Dash boards – Need for Business Intelligence
Difference between OLAP and OLTP - Dimensional analysis - What are cubes? Drill-down and roll-up - slice and dice or rotation - OLAP models - ROLAP versus MOLAP - defining schemas: Stars, snowflakes and fact constellations.

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>A case study on Retail Industry : <a href="https://www.diva-portal.org/smash/get/diva2:831050/FULLTEXT01.pdf">https://www.diva-portal.org/smash/get/diva2:831050/FULLTEXT01.pdf</a></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>*Mapping of Course Outcomes for Unit II</th>
<th>CO2</th>
</tr>
</thead>
</table>

### Unit III Reporting Authoring 07 Hours
Building reports with relational vs Multidimensional data models; Types of Reports – List, crosstabs, Statistics, Chart, map, financial etc; Data Grouping & Sorting, Filtering Reports, Adding Calculations to Reports, Conditional formatting, Adding Summary Lines to Reports. Drill up, drill- down, drill-through capabilities. Run or schedule report, different output forms – PDF, excel, csv, xml etc.

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Power BI Case Study – How the tool reduced hassles of Heathrow &amp; Edsby: <a href="https://data-flair.training/blogs/power-bi-case-study/">https://data-flair.training/blogs/power-bi-case-study/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>*Mapping of Course Outcomes for Unit III</td>
<td>CO3</td>
</tr>
</tbody>
</table>

### Unit IV Data preparation 07 Hours

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Case study on Data preparation phase of BI system <a href="https://blog.panoply.io/load-and-transform-how-to-prepare-your-data-for-business-intelligence">https://blog.panoply.io/load-and-transform-how-to-prepare-your-data-for-business-intelligence</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>*Mapping of Course Outcomes for Unit IV</td>
<td>CO4</td>
</tr>
</tbody>
</table>

### Unit V Impact of Machine learning in Business Intelligence Process 07 Hours

<table>
<thead>
<tr>
<th>#Exemplar/Case Studies</th>
<th>Business applications for comparing the performance of a stock over a period of time <a href="https://cleartax.in/s/stock-market-analysis">https://cleartax.in/s/stock-market-analysis</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>*Mapping of Course Outcomes for Unit V</td>
<td>CO5</td>
</tr>
</tbody>
</table>

### Unit VI BI Applications 07 Hours
Tools for Business Intelligence, Role of analytical tools in BI, Case study of Analytical Tools: WEKA, KNIME, Rapid Miner, R; Data analytics, Business analytics, ERP and Business Intelligence, BI and operation management, BI in inventory management system, BI and human resource management, BI Applications in CRM, BI Applications in Marketing, BI Applications in Logistics and Production, Role of BI in Finance, BI Applications in Banking, BI Applications in Telecommunications, BI in salesforce management

#Exemplar/Case Studies
Logistics planning in the food industry
https://www.foodlogistics.com/case-studies
https://www.barrettdistribution.com/food-distribution-case-study

*Mapping of Course Outcomes for Unit VI
CO6

Learning Resources

Text Books:

Reference Books:
2. Introduction to business Intelligence and data warehousing, IBM, PHI
3. Business Intelligence: Data Mining and Optimization for Decision Making, Carlo Vercellis, Wiley,2019
4. Data Mining for Business Intelligence, Wiley
5. EMC Educational Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley ISBN-13 978 1118876138
6. Ken W. Collier, Agile Analytics: A value driven Approach to Business Intelligence and Data

e-Books:

NPTEL/YouTube video lecture links:
• Business Analytics for management decision : https://nptel.ac.in/courses/110105089
• Business analytics and data mining modeling using R : https://nptel.ac.in/courses/110107092
• Business Analysis for Engineers : https://nptel.ac.in/courses/110106050

@The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Syllabus for Fourth Year of Computer Engineering

#100/128
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
Elective VI

410253(D): Quantum Computing

Teaching Scheme:
TH: 03 Hours/Week

Credit
03

Examination Scheme:
In-Sem (Paper): 30 Marks
End-Sem (Paper): 70 Marks

Prerequisite Courses: Data Structures and Algorithms(210243), Data Science and Big Data Analytics (310251)
Companion Course: Laboratory Practice IV(410247)

Course Objectives:

- To provide introduction and necessary expertise to the learner in the upcoming discipline of Quantum Computing and Machine Learning.
- To enable the students to learn Quantum Computing and Quantum Machine Learning in practical-oriented learning sessions so that he/she can independently use existing open-source Quantum Computing Hardware and Software Frameworks.
- To teach the students to develop hybrid solutions by applying Quantum Machine Learning to potential business application areas.
- To study Quantum Information Theory and Quantum Computing Programming Model of Computation.
- To study Quantum Algorithms and apply these to develop hybrid solutions.
- To study Quantum Concepts necessary for understanding the Quantum Computing Paradigm and compare the available hardware and software infrastructure and frameworks made available open source by major players in the Industry and Academia.

Course Outcomes:

On completion of the course, student will be able to—

CO1: To understand the concepts of Quantum Computing
CO2: To understand and get exposure to mathematical foundation and quantum mechanics
CO3: To understand and implement building blocks of Quantum circuits
CO4: To understand quantum information, its processing and Simulation tools
CO5: To understand basic signal processing algorithms FT, DFT and FFT
CO6: To study and solve examples of Quantum Fourier Transforms and their applications

Course Contents

<table>
<thead>
<tr>
<th>Unit I</th>
<th>Introduction to Quantum Computing</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fundamental Concepts of Quantum computing: Introduction and Overview, Global Perspective, Quantum Bits, Quantum Computation, Quantum Algorithms, Quantum information and Quantum information processing,</td>
<td></td>
</tr>
</tbody>
</table>

*Mapping of Course Outcomes for Unit I*

<table>
<thead>
<tr>
<th>Unit I</th>
<th>CO1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Unit II</th>
<th>Mathematical foundation of Quantum Computing</th>
<th>07 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantum Mechanics: Linear Algebra and Quantum mechanics, Postulates of Quantum mechanics, state space, evolution, Quantum measurement, distinguishing quantum states, projective measurements, POVM measurements, Phase, Composite systems, Global view and applications, Density operator</td>
<td></td>
</tr>
</tbody>
</table>
### Unit III: Building Blocks for Quantum Program

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>07 Hours</td>
</tr>
</tbody>
</table>

Quantum Computations: Quantum circuits, Quantum algorithms and qubit operations, Controlled operations, Principal deferred and Principal implicit Measurements, Universal Quantum Gates, Two level unitary gates, single qubit and CNOT, discrete set of universal operations, Quantum computational complexity

### Unit IV: Quantum Simulation Algorithms and Fourier Transform

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO3, CO4</td>
<td>07 Hours</td>
</tr>
</tbody>
</table>


### Unit V: Quantum Fourier Transform and Applications

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO5</td>
<td>07 Hours</td>
</tr>
</tbody>
</table>

Quantum Fourier Transform, Phase estimation performance and requirements, order finding application, factoring application, General applications of Quantum Fourier transform, period finding, discrete algorithms, Other Quantum Algorithms

### Unit VI: Quantum Machine Learning

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO6</td>
<td>07 Hours</td>
</tr>
</tbody>
</table>

Quantum Machine Learning and Quantum AI, Quantum Neural Networks, Quantum Natural Language Understanding, Quantum Cryptography, Application Domains for Quantum Machine Learning: Chemistry/Material Science, Space Tech, Finance related Optimization Problems, Swarm Robotics, Cyber security

### Learning Resources

**Text Books:**

2. Wittek, “Quantum Machine Learning (What Quantum Computing Means to Data Mining)”, Peter University of Boras, Sweden - Elsevier Publications
Reference Books:


e-Books:

MOOC Courses Links:
- https://onlinecourses.nptel.ac.in/noc21_cs103/preview
- https://www.coursera.org/learn/introduction-to-quantum-information

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### Elective IV

#### 410253(E): Open Elective II

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 03 Hours/Week</td>
<td>03</td>
<td>In-Sem (Paper): 30 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-Sem (Paper): 70 Marks</td>
</tr>
</tbody>
</table>

**Companion Course:** Laboratory Practice VI (410255)

The open elective included, so as to give the student a wide choice of subjects from other Engineering Programs. To inculcate the out of box thinking and to feed the inquisitive minds of the learners the idea of open elective is need of the time.

Flexibility is extended with the choice of open elective allows the learner to choose interdisciplinary/exotic/future technology related courses to expand the knowledge horizons.

With this idea learner opts for the course without any boundaries to choose the approved by academic council and Board of Studies.
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
410255: Laboratory Practice V

<table>
<thead>
<tr>
<th>Teaching Scheme: Practical: 2 Hours/Week</th>
<th>Credit</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>01</td>
<td>Term Work: 50 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Practical: 50 Marks</td>
</tr>
</tbody>
</table>

Companion Course: High Performance Computing(410250), Deep Learning(410251)

Course Objectives:
- To understand and implement searching and sorting algorithms.
- To learn the fundamentals of GPU Computing in the CUDA environment.
- To illustrate the concepts of Artificial Intelligence/Machine Learning (AI/ML).
- To understand Hardware acceleration.
- To implement different deep learning models.

Course Outcomes:
- **CO1: Analyze and measure** performance of sequential and parallel algorithms.
- **CO2: Design and Implement** solutions for multicore/Distributed/parallel environment.
- **CO3: Identify and apply** the suitable algorithms to solve AI/ML problems.
- **CO4: Apply** the technique of Deep Neural network for implementing Linear regression and classification.
- **CO5: Apply** the technique of Convolution (CNN) for implementing Deep Learning models.
- **CO6: Design and develop** Recurrent Neural Network (RNN) for prediction.

Guidelines for Instructor's Manual
Laboratory Practice V is for practical hands on for core courses High Performance Computing and Data Learning. The instructor’s manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/institute/department/foreword/preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/guidelines, references among others.

Guidelines for Student's Laboratory Journal
The laboratory assignments are to be submitted by student in the form of journal. Journal may
consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, Algorithm/Database design, test cases, conclusion/analysis). Program codes with sample output of all performed assignments are to be submitted as softcopy.

### Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work is to be done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness reserving weightage for successful mini-project completion and related documentation.

### Guidelines for Practical Examination

- Both internal and external examiners should jointly frame suitable problem statements for practical examination based on the term work completed.
- During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement.
- The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding of the fundamentals, effective and efficient implementation.
- Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising boost to the student's academics.

### Guidelines for Laboratory Conduction

- List of recommended programming assignments and sample mini-projects is provided for reference.
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.
● Software Engineering approach with proper documentation is to be strictly followed.
● Use of open source software is to be encouraged.
● Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

Operating System recommended: - 64-bit Open source Linux or its derivative

Programming Languages: Object Oriented Languages C++/JAVA/PYTHON/R

Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend: MongoDB/MYSQL/oracle, Database Connectivity : ODBC/JDBC

<table>
<thead>
<tr>
<th>Suggested List of Laboratory Experiments/Assignments</th>
</tr>
</thead>
</table>

### 410250 : High Performance Computing

Any 4 Assignments and 1 Mini Project are Mandatory

**Group 1**

1. Design and implement Parallel Breadth First Search and Depth First Search based on existing algorithms using OpenMP. Use a Tree or an undirected graph for BFS and DFS.

2. Write a program to implement Parallel Bubble Sort and Merge sort using OpenMP. Use existing algorithms and measure the performance of sequential and parallel algorithms.

3. Implement Min, Max, Sum and Average operations using Parallel Reduction.

4. Write a CUDA Program for:
   1. Addition of two large vectors
   2. Matrix Multiplication using CUDA C

5. Implement HPC application for AI/ML domain.

**Group 2**


7. Mini Project: Implement Huffman Encoding on GPU

8. Mini Project: Implement Parallelization of Database Query optimization


### 410251 : Deep Learning

Any 3 Assignments and 1 Mini Project are Mandatory

**Group 1**
1. **Linear regression by using Deep Neural network**: Implement Boston housing price prediction problem by Linear regression using Deep Neural network. Use Boston House price prediction dataset.

2. **Classification using Deep neural network** (Any One from the following)
   2. Binary classification using Deep Neural Networks Example: Classify movie reviews into positive" reviews and "negative" reviews, just based on the text content of the reviews. Use IMDB dataset

3. **Convolutional neural network (CNN)** (Any One from the following)
   - Use any dataset of plant disease and design a plant disease detection system using CNN.
   - Use MNIST Fashion Dataset and create a classifier to classify fashion clothing into categories.

4. **Recurrent neural network (RNN)** Use the Google stock prices dataset and design a time series analysis and prediction system using RNN.

**Group 2**

5. **Mini Project**: Human Face Recognition

6. **Mini Project**: Gender and Age Detection: predict if a person is a male or female and also their age

7. **Mini Project**: Colorizing Old B&W Images: color old black and white images to colorful images

---

@**The CO-PO Mapping Matrix**

<table>
<thead>
<tr>
<th>CO/PO</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO7</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
**Faculty of Engineering**

**Savitribai Phule Pune University**

**Fourth Year of Computer Engineering (2019 Course)**

**410256: Laboratory Practice VI**

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical: 2 Hours/Week</td>
<td>01</td>
<td>Term Work: 50 Marks</td>
</tr>
</tbody>
</table>

**Companion Course:** Elective V (410252), Elective VI (410253)

**Course Objectives:**
- To understand the fundamental concepts and techniques of natural language processing (NLP)
- To understand Digital Image Processing Concepts
- To learn the fundamentals of software defined networks
- Explore the knowledge of adaptive filtering and Multi-rate DSP
- To be familiar with the various application areas of soft computing.
- To introduce the concepts and components of Business Intelligence (BI)
- To study Quantum Algorithms and apply these to develop hybrid solutions

**Course Outcomes:**
On completion of this course, the students will be able to
CO1: Apply basic principles of elective subjects to problem solving and modeling.
CO2: Use tools and techniques in the area of software development to build mini projects
CO3: Design and develop applications on subjects of their choice.
CO4: Generate and manage deployment, administration & security.

**Guidelines for Instructor's Manual**
List of recommended programming assignments and sample mini-projects is provided for reference. Referring to these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses. Preferably there should be multiple sets of assignments/mini-project and distributed among batches of students. Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects. Mini-project can be completed in group of 2 to 3 students. Software Engineering approach with proper documentation is to be strictly followed. Use of open source software is to be encouraged. Instructor may also set one assignment or mini-project that is suitable to the respective course beyond the scope of syllabus.

**Operating System recommended:** - 64-bit Open source Linux or its derivative **Programming Languages:** C+/JAVA/PYTHON/R

**Programming tools recommended:** Front End: Java/Perl/PHP/Python/Ruby/.net, **Backend:** MongoDB/MYSQL/Oracle, Database Connectivity: ODBC/JDBC, **Additional Tools:** Octave, Matlab, WEKA, powerBI

---

**Syllabus for Fourth Year of Computer Engineering** #109/128
## Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by students in the form of a journal. Journal may consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, Algorithm/Database design, test cases, conclusion/analysis). Program codes with sample output of all performed assignments are to be submitted as softcopy.

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of digital storage media/DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

## Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work is to be done based on overall performance and lab Home Faculty of Engineering Savitribai Phule Pune University Syllabus for Fourth Year of Computer Engineering assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness reserving weightage for successful mini-project completion and related documentation.

## Guidelines for Practical Examination

It is recommended to conduct examination based on Mini-Project(s) Demonstration and related skill learned. Team of 2 to 3 students may work on mini-project. During the assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation and software engineering approach followed. The supplementary and relevant questions may be asked at the time of evaluation to test the student’s for advanced learning, understanding, effective and efficient implementation and demonstration skills. Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of the student's academics.

## Guidelines for Laboratory Conduction

The instructor’s manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.

### Recommended / Sample set of assignments and mini projects for reference for four courses offered for Elective III and for four courses offered for Elective IV. Respective Student has to complete laboratory work for elective III and IV that he/she has opted.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>410252(A)</td>
<td>Natural Language Processing</td>
</tr>
</tbody>
</table>

Any 5 Assignments and 1 Mini Project are mandatory.
### Group 1

| 1. | Perform tokenization (Whitespace, Punctuation-based, Treebank, Tweet, MWE) using NLTK library. Use porter stemmer and snowball stemmer for stemming. Use any technique for lemmatization.  
**Input / Dataset** – use any sample sentence |
| 2. | Perform bag-of-words approach (count occurrence, normalized count occurrence), TF-IDF on data. Create embeddings using Word2Vec.  
**Dataset to be used:** [https://www.kaggle.com/datasets/CooperUnion/cardataset](https://www.kaggle.com/datasets/CooperUnion/cardataset) |
| 3. | Perform text cleaning, perform lemmatization (any method), remove stop words (any method), label encoding. Create representations using TF-IDF. Save outputs.  
| 4. | Create a transformer from scratch using the Pytorch library |
| 5. | Morphology is the study of the way words are built up from smaller meaning bearing units. Study and understand the concepts of morphology by the use of add delete table |

### Group 2

| 6. | **Mini Project** (Fine tune transformers on your preferred task)  
Finetune a pretrained transformer for any of the following tasks on any relevant dataset of your choice:  
- Neural Machine Translation  
- Classification  
- Summarization |
| 7. | **Mini Project** - POS Taggers For Indian Languages |
| 8. | **Mini Project** - Feature Extraction using seven moment variants |
| 9. | **Mini Project** - Feature Extraction using Zernike Moments |

Virtual Lab: [https://nlp-iiith.vlabs.ac.in/](https://nlp-iiith.vlabs.ac.in/)

410252(B) Image Processing

Any 5 Assignments and 1 Mini Project are mandatory

Group 1

**Programming language:** Python/C/C++ using OpenCV
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Consider any image with size 1024<em>1024. Modify the image to the sizes 512</em>512, 256<em>256, 128</em>128, 64<em>64 and 32</em>32 using subsampling technique. Create the original image from all the above subsampled images using resampling technique. Read any image. Display the histogram, Equalized histogram, and image with equalized histogram.</td>
</tr>
<tr>
<td>2.</td>
<td>Consider any image with size 1024<em>1024. Modify the image to the sizes 512</em>512, 256<em>256, 128</em>128, 64<em>64 and 32</em>32 using subsampling technique. Create the original image from all the above subsampled images using resampling technique.</td>
</tr>
<tr>
<td>3.</td>
<td>Read any image. Display the histogram, Equalized histogram, and image with equalized histogram.</td>
</tr>
<tr>
<td>4.</td>
<td>Read any image. Display the outputs of contrast stretching, intensity level slicing.</td>
</tr>
<tr>
<td>5.</td>
<td>Compare the results of any three edge detection algorithms on the same image dataset and do the analysis of the result.</td>
</tr>
<tr>
<td>6.</td>
<td>Compare the result of any two image segmentation algorithm on the same image data set.</td>
</tr>
<tr>
<td>7.</td>
<td>Write a program for image compression using any three compression techniques and compare the results.</td>
</tr>
</tbody>
</table>

**Group 2**

| 8. | **Mini project**: Implement visual surveillance applications and detect moving objects using object detection and tracking algorithm.  
Or  
Implement any medical image processing application for freely available medical image dataset. |
| 9. | **Mini Project** - Implement image segmentation to detect object in the background of image. |

**410252(C) : Software Defined Networks**

Any 5 Assignments and 1 Mini Project are mandatory.

**Group 1**

| 1. | Prepare setup for Mininet network emulation environment with the help of Virtual box and Mininet. Demonstrate the basic commands in Mininet and emulate different custom network topology (Simple, Linear, and Tree). View flow tables. |
| 2. | After studying open source POX and Floodlight controller, Install controller and run custom topology using remote controller like POX and floodlight controller. Recognize inserted flows by controllers. |
| 3. | Create a SDN environment on Mininet and configure a switch to provide a firewall functionality using POX controller.  
Ref: https://github.com/mininet/openflow-tutorial/wiki/Create- Firewall |
| 4 | Using Mininet as an Emulator and POX controller, build your own internet router. Write simple outer with a static routing table. The router will receive raw Ethernet frames and process the packet forwarding them to correct outgoing interface. You must check the Ethernet frames are received and the forwarding logic is created so packets go to the correct interface.
Ref: https://github.com/mininet/mininet/wiki/SimpleRouter |
|---|---|
| 5 | Emulate and manage a Data Center via a Cloud Network Controller: create a multi-rooted tree-like (Clos) topology in Mininet to emulate a data center. Implement specific SDN applications on top of the network controller in order to orchestrate multiple network tenants within a data center environment, in the context of network virtualization and management.
Ref: https://opencourses.uoc.gr/courses/pluginfile.php/13576/mod_resource/content/2/exercise5.pdf |
| 6 | Study Experiment: Study in details Cloud seeds automates IAAS using SDN and a high-performance network from Juniper SDN Framework. |

**410252(D) : Advanced Digital Signal Processing**

Any 5 Assignments and 1 Mini Project are mandatory

**Group 1**

Use
A] MATLAB or other equivalent software working with speech and image signals/files and for analysis purpose.
B] C++ or JAVA for working with sampled data (n – point data samples of DT/Digital signal)
C] JAVA or other for image processing assignments

1. Apply 1-D DFT to observe spectral leakage and frequency analysis of different window sequences, plot the frequency spectrums.
2. Adaptive FIR and IIR filter design:
   A] Steepest descent and Newton method, LMS method,
   B] Adaptive IIR Filter design: Pade Approximation, Least square design
3. Power spectrum estimation and analysis:
   Take a speech signal and perform
   A] Non parametric method: DFT and window sequences
   B] Parametric methods: AR model parameters
4. Multi-rate DSP and applications – Decimation, Interpolation, sampling rate conversion
   A] Take a speech signal with specified sampling frequency. Decimate by factor D(e.g. factor
   B] Take a speech signal with specified sampling frequency. Interpolate by factor I(e.g. factor)
   C] Sampling rate conversion by factor of I/D
5. Write a program to calculate LPC coefficients, reflection coefficients using Levinson Durbin algorithm
### 6. Feature Extraction of speech signal
- A) Using LPC and other methods
- B) Apply different coding methods: harmonic coding, vector quantization

### Group 2:

| 7 | **Mini-Project**: Discrete Cosine Transform (DCT)  
A) To find DCT of N x N image block  
B) To plot spectrum of the speech signal using DCT and find the correlation of DCT transformed signal  
C) Image filtering using DCT: LPF, edge detection  
D) Image compression using DCT, Image resizing  
|  
|  | **OR**  
|  | **Mini-Project**: Image Processing  
A) Histogram and Equalization  
B) Image Enhancement Techniques  
C) Image Filtering: LPF, HPF, Sobel/Prewitt Masks  
D) Image Smoothing with special filters: Median, Weiner, Homomorphic filters

**410252(E) : Open Elective**

1. Suitable set of programming assignments/Mini-projects for open elective Opted.

### PART II 410253 : Elective VI

**410253(A) Pattern Recognition**

Any 5 Assignments and 1 Mini Project are mandatory

#### Group 1

| 1 | Extraction of features using structural and feature space methods for Indian Fruits |
| 2 | Face Recognition using PCA and multiclass LDA. |
| 3 | Fruit shape recognition using Eigen Faces and Fisher Faces |
| 4 | Perform sentiment analysis on the IMDB movie reviews dataset |
| 5 | Perform a classification task on a dataset of modulated radio signals. |
| 6 | Perform image segmentation on the Berkley Segmentation dataset |

#### Group 2

| 6 | **Mini Project** - Real-time face detection in multi-scale images with an attentional cascade of boosted classifiers. |
## Syllabus for Fourth Year of Computer Engineering

**Faculty of Engineering**
**Savitribai Phule Pune University**

### Mini Project - Printed Devanagari Text Recognition using structural approach.

### 410253(B) : Soft Computing

Any 5 Assignments and 1 Mini Project are mandatory

**Group 1**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design an X-OR Gate with feed-forward neural network (also popularly known as a Multilayer Perceptron) classifier.</td>
</tr>
<tr>
<td>2</td>
<td>Symmetric and Asymmetric implementation of Particle Swarm Optimization for Traveling Salesman Problem.</td>
</tr>
<tr>
<td>3</td>
<td>Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.</td>
</tr>
<tr>
<td>4</td>
<td>Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.</td>
</tr>
</tbody>
</table>
| 5 | Implement genetic algorithm for benchmark function (eg. Square, Rosenbrock function etc) Initialize the population from the Standard Normal Distribution. Evaluate the fitness of all its individuals. Then you will do multiple generation of a genetic algorithm. A generation consists of applying selection, crossover, mutation, and replacement. Use:  
  • Tournament selection without replacement with tournament size s  
  • One point crossover with probability Pc  
  • bit-flip mutation with probability Pm  
  • use full replacement strategy |

**Group 2**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
| 6 | **Mini Project** - Create a small hybrid system for solving a chosen problem by following the given steps below.  
  1. Explain on one page the main characteristics of hybrid systems.  
  2. For the task chosen from the list below, create a multimodular block diagram of a possible solution to the problem.  
  3. Choose appropriate techniques for solving each sub problem represented as a module. What alternatives are there for each of them?  
  4. Create subsystems for solving each of the sub problems. Compile the whole hybrid system.  
  5. Make experiments with the hybrid system and validate the results. |
**Mini Project**:
- Handwritten digits recognition
- Bank loan approval decision-making system
- Stock market prediction
- Unemployment prediction
- Spoken words recognition, for example, "on"/"off"; "yes"/"no"; "stop"/"go."
- Loan approval

**410253(C) : Business Intelligence**

Any 5 Assignments and 1 Mini Project are mandatory

**Group 1**

1. Import the legacy data from different sources such as (Excel, Sql Server, Oracle etc.) and load in the target system. (You can download sample database such as Adventure works, Northwind, foodmart etc.)

2. Perform the Extraction Transformation and Loading (ETL) process to construct the database in the Sql server.

3. Create the cube with suitable dimension and fact tables based on ROLAP, MOLAP and HOLAP model.

4. Import the data warehouse data in Microsoft Excel and create the Pivot table and Pivot Chart.

5. Perform the data classification using classification algorithm. Or Perform the data clustering using clustering algorithm.

**Group 2**

6. **Mini Project**: Each group of 4 Students (max) assigned one case study for this; A BI report must be prepared outlining the following steps:
   a) Problem definition, identifying which data mining task is needed.
   b) Identify and use a standard data mining dataset available for the problem.

**410253(D) : Quantum Computing**

Any 4 Assignments and 1 Mini Project are mandatory

**Group 1**

1. Analyze simple states of superposition and the effect of doing the measurement in different basis states.

2. Build simple quantum circuits with single and two-qubit gates.

3. Install Setup for running quantum programs on IBM machines.
<table>
<thead>
<tr>
<th></th>
<th>Analyze the effectiveness of simple error correction scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Implement quantum programs in NISQ model of computing</td>
</tr>
<tr>
<td>6</td>
<td>Make a script for visualizing the energy levels of Hamiltonians.</td>
</tr>
</tbody>
</table>

### Group 2

<table>
<thead>
<tr>
<th></th>
<th>Mini Project: Build a Quantum Random Number Generator.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Mini Project: Implement Grover's Search Algorithm.</td>
</tr>
<tr>
<td>7</td>
<td>Mini Project: Use Shor's Algorithm to Factor a Number.</td>
</tr>
</tbody>
</table>

### 410253(E) : Open Elective

1. Suitable set of programming assignments/Mini-projects for open elective Opted.

### @The CO-PO Mapping Matrix

<table>
<thead>
<tr>
<th>CO/P O</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
410256: Project Work Stage II

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Credit</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH: 06 Hours/Week</td>
<td>06</td>
<td>Term work: 100 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presentation: 50 Marks</td>
</tr>
</tbody>
</table>

**Prerequisite Courses: Project Stage I(410248)**

**Course Objectives:**
- To follow SDLC meticulously and meet the objectives of proposed work
- To test rigorously before deployment of system
- To validate the work undertaken
- To consolidate the work as furnished report

**Course Outcomes:**

On completion of the course, student will be able to—
- CO1: Show evidence of independent investigation
- CO2: Critically analyze the results and their interpretation.
- CO3: Report and present the original results in an orderly way and placing the open questions in the right perspective.
- CO4: Link techniques and results from literature as well as actual research and future research lines with the research.
- CO5: Appreciate practical implications and constraints of the specialist subject

**Guidelines**

In Project Work Stage–II, the student shall complete the remaining project work which consists of Selection of Technology and Tools, Installations, UML implementations, testing, Results, performance discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems and comparative analysis and validation of results and conclusions. The student shall prepare and submit the report of Project work in standard format for satisfactory completion of the work that is the duly certified by the concerned guide and head of the Department/Institute.

Follow guidelines and formats as mentioned in Project Workbook recommended by Board of Studies.
In addition to credits, it is recommended that there should be audit course, in preferably in each semester starting from second year in order to supplement students’ knowledge and skills. Student will be awarded the bachelor’s degree if he/she earns specified total credit [1] and clears all the audit courses specified in the curriculum. The student will be awarded grade as AP on successful completion of audit course. The student may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, such a selection of the audit courses helps the learner to explore the subject of interest in greater detail resulting in achieving the very objective of audit course’s inclusion. List of options offered is provided. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at Institute level itself. Method of conduction and method of assessment for audit courses are suggested.

Criteria

The student registered for audit course shall be awarded the grade AP (Audit Course Pass) and shall be included such AP grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory performance and secured a passing grade in that audit course. No grade points are associated with this ‘AP’ grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at Institute level itself [1]

Guidelines for Conduction and Assessment (Any one or more of following but not limited to):

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations or presentations
- Surveys
- Mini-Project
- Hands on experience on focused topic

Course Guidelines for Assessment (Any one or more of following but not limited to):

- Written Test
- Demonstrations/ Practical Test
- Presentation or Report

Audit Course 5 Options

<table>
<thead>
<tr>
<th>Audit Course Code</th>
<th>Audit Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC8-I</td>
<td>Usability Engineering</td>
</tr>
<tr>
<td>AC8-II</td>
<td>Conversational Interface</td>
</tr>
<tr>
<td>AC8-III</td>
<td>Social Media and Analytics</td>
</tr>
<tr>
<td>AC8-IV</td>
<td>MOCC-Learn New Skills</td>
</tr>
<tr>
<td>AC8-V</td>
<td>Emotional Intelligence</td>
</tr>
</tbody>
</table>
In this course you will have a hands-on experience with usability evaluation and user-centered design. This course will not help to learn how to implement user interfaces, but rather how to design based on the needs of users, which you will determine, and learn how to evaluate your designs rigorously. This help in knowing more about the usability; human computer interaction, the psychological aspects of computing, evaluation.

### Course Objectives:
- To understand the human centered design process and usability engineering process and their roles in system design and development.
- To know usability design guidelines, their foundations, assumptions, advantages, and weaknesses
- Understand the user interface based on analysis of human needs and prepare a prototype system

### Course Outcome:
On completion of the course, learner will be able to—
- CO1: Describe the human centered design process and usability engineering process and their roles in system design and development.
- CO2: Discuss usability design guidelines, their foundations, assumptions, advantages, and weaknesses.
- CO3: Design a user interface based on analysis of human needs and prepare a prototype system.
- CO4: Assess user interfaces using different usability engineering techniques.
- CO5: Present the design decisions

### Course Contents:
1. What Is Usability?: Usability and Other Considerations, Definition of Usability, Example: Measuring the Usability of Icons, Usability Trade-Offs, Categories of Users and Individual User Differences
2. Usability in Software Development: The Emergence of Usability, Human Computer Interaction, Usability Engineering
3. The Usability Engineering Lifecycle: Requirement Analysis, Design, Testing, Development
4. Usability Assessment Methods beyond Testing
5. International User Interfaces

### Books:
1. Mary Beth Rosson, John Millar Carroll, “Usability Engineering: Scenario-based Development of Human-Computer Interaction”
2. Jakob Nielsen, “Usability Engineering”
3. Deborah J. Mayhew, “The usability engineering lifecycle”
Effective information security at the enterprise level requires participation, planning, and practice. It is an ongoing effort that requires management and staff to work together from the same script. Fortunately, the information security community has developed a variety of resources, methods, and best practices to help modern enterprises address the challenge. Unfortunately, employing these tools demands a high degree of commitment, understanding, and skill attributes that must be sustained through constant awareness and training.

**Course Objectives:**
- To understand the basics of conversation
- To know the interactive environments for conversational skills
- To acquaint with the speech to text and text to speech techniques

**Course Outcome:**
On completion of the course, learner will be able to--
- CO1: Develop an effective interface for conversation
- CO2: Explore advanced concepts in user interface

**Course Contents:**

1. **Introduction to Conversational Interface:** Preliminaries, Developing a speech based Conversational Interface, Conversational Interface and devices.
2. **A technology of Conversation:** Introduction, Conversation as Action, The structure of Conversation, The language of Conversation.
4. **Advanced voice user interface design**

**Books:**

1. Cathy Pearl, “Designing Voice User Interfaces: Principles of Conversational Experiences”
3. Martin Mitrevski, “Developing Conversational Interfaces for iOS: Add Responsive Voice Control”
This course aims to create awareness among the students regarding social media and analytics.

**Course Objectives:**

- Get strategic understanding of Digital Marketing and Social Media Marketing.
- Understand how to use it for branding and sales.
- Understand its advantages & limitations.
- Become familiar with Best Practices, Tools & Technologies.
- Blend digital and social marketing with offline marketing.
- Plan and manage digital marketing budget.
- Manage Reporting & Tracking Metrics.
- Understand the future of Digital Marketing and prepare for it.

**Course Outcome:**

On completion of the course, learner will be able to–

CO1: Develop a far deeper understanding of the changing digital landscape.
CO2: Identify some of the latest digital marketing trends and skill sets needed for today's marketer.
CO3: Successful planning, prediction, and management of digital marketing campaigns
CO4: Assess user interfaces using different usability engineering techniques.
CO5: Implement smart management of different digital assets for marketing needs.
CO6: Assess digital marketing as a long term career opportunity.

**Course Contents:**

2. Techniques for effective Email Marketing and pitfalls, Various online email marketing platforms such as Campaign Monitor and Mail Chimp, Web content, web usability, navigation and design, Bookmarking and News Aggregators, Really Simple Syndication (RSS), Blogging, Live Chat, User Generated Content (Wikipedia etc), Multi-media - Video (Video Streaming, YouTube etc), Multi-media - Audio & Podcasting (iTunes etc), Multi-media - Photos/Images (Flickr etc), Google Alerts and Giga Alert (Brand, product and service monitoring online), Crowd sourcing, Virtual Worlds.
3. Search Engine Optimization (SEO), Search Engine Optimization (SEO) tips and techniques, Google Adwords, Google various applications such as 'Google Analytics', Maps, Places etc to enhance a brand's products, services and operations.
4. Facebook & LinkedIn and other Social Media for area marketing, Utilizing Facebook and LinkedIn's Advertising functionality and Applications, Brand reputation management techniques, Systems for 'buzzmonitoring' for brands, products and services, Effective Public Relations (PR) online and business development.

**References:**

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)
410257: Audit Course 8
AC8 – IV: MOOC-learn New Skill

This course aims to create awareness among the students regarding various courses available under MOOC and learn new skills through these courses.

Course Objectives:
- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online

Course Outcomes:
On completion of the course, students will be able to
CO1: To acquire additional knowledge and skill.

About Course
MOOCs (Massive Open Online Courses) provide affordable and flexible way to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. Whether you're reinterested in learning for yourself, advancing your career or leveraging online courses to educate your workforce, SWYAM, NPTEL, edx or similar ones can help. World’s largest SWAYAM MOOCs, a new paradigm of education for anyone, anywhere, anytime, as per your convenience, aimed to provide digital education free of cost and to facilitate hosting of all the interactive courses prepared by the best more than 1000 specially chosen faculty and teachers in the country. SWAYAM MOOCs enhances active learning for improving lifelong learning skills by providing easy access to global resources.

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy. This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses.

The courses hosted on SWAYAM is generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology. In order to ensure best quality content are produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education.

Guidelines:
Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructural and facilities for the learners.

References:
5. https://onlinecourses.nptel.ac.in/
6. https://www.edx.org
### Savitribai Phule Pune University, Pune
**Fourth Year of Computer Engineering (2019 Course)**
**410249: Audit Course 8**
**AC8 – V: Emotional Intelligence**

This Emotional Intelligence (EI) training course will focus on the five core competencies of emotional intelligence: self-awareness, self-regulation, motivation, empathy and interpersonal skills. Participants will learn to develop and implement these to enhance their relationships in work and life by increasing their understanding of social and emotional behaviors, and learning how to adapt and manage their responses to particular situations. Various models of emotional intelligence will be covered.

#### Course Objectives:
- To develop an awareness of EI models
- To recognize the benefits of EI
- To understand how you use emotion to facilitate thought and behavior
- To know and utilize the difference between reaction and considered response

#### Course Outcomes:
On completion of the course, learner will be able to—
- CO1: Expand your knowledge of emotional patterns in yourself and others
- CO2: Discover how you can manage your emotions, and positively influence yourself and others
- CO3: Build more effective relationships with people at work and at home
- CO4: Positively influence and motivate colleagues, team members, managers
- CO5: Increase the leadership effectiveness by creating an atmosphere that engages others

#### Course Contents

1. **Introduction to Emotional Intelligence (EI)**: Emotional Intelligence and various EI models, The EQ competencies of self-awareness, self-regulation, motivation, empathy, and interpersonal skills, Understand EQ and its importance in life and the workplace

2. **Know and manage your emotions**: emotions, The different levels of emotional awareness, Increase your emotional knowledge of yourself, Recognize „negative“ and „positive“ emotions. The relationship between emotions, thought and behavior, Discover the importance of values, The impact of not managing and processing „negative“ emotions, Techniques to manage your emotions in challenging situations

3. **Recognize emotions in others**: The universality of emotional expression, Learn tools to enhance your ability to recognize and appropriately respond to others' emotions, Perceiving emotions accurately in others to build empathy

4. **Relate to others**: Applying EI in the workplace, the role of empathy and trust in relationships, Increase your ability to create effective working relationships with others (peers, subordinates, managers, clients), Find out how to deal with conflict, Tools to lead, motivate others and create a high performing team.

#### Books:

Acknowledgement

It is with great pleasure and honor that I share the curriculum for Fourth Year of Computer Engineering (2019 Course) on behalf of Board of Studies (BoS), Computer Engineering. We, members of BoS are giving our best to streamline the processes and curricula design at both UG and PG programs. It is always the strenuous task to balance the curriculum with the blend of core courses, current developments and courses to understand social and human values. By considering all the aspects with adequate prudence the contents are designed satisfying most of the necessities as per AICTE guidelines and to make the graduate competent enough as far as employability is concerned. I sincerely thank all the minds and hands who work adroitly to materialize these tasks. I really appreciate everyone’s contribution and suggestions in finalizing the contents.

Success is sweet. But it’s sweeter when it’s achieved thorough co-ordination, cooperation and collaboration. I am overwhelmed and I feel very fortunate to be working with such a fabulous team- the Members of Board of Studies, Computer Engineering!

Even in these anxious situation, during the time of this unfortunate pandemic, each and every person, including the course coordinators and their team members, have worked seamlessly to come up with this all-inclusive curriculum for Fourth Year of Computer Engineering.

Thank you to all of you for delivering such great teamwork. I don’t think it would have been possible to achieve the goal without each and every one of your efforts! I would like to express my deep gratitude to Dr. Pramod D. Patil (Dr. D. Y. Patil Institute of Technology, Pimpri), member BoS, Computer Engineering, for coordinating the complete activity and getting it to completion in a smooth manner.

I deeply appreciate and thank the managements of various colleges affiliated to SPPU for helping us in this work. These colleges have helped us by arranging sessions for preliminary discussion in the initial stage and at the same time in conducting Faculty Development Programs for various courses of the revised curriculum. All your support is warmly appreciated.

I sincerely appreciate, the hard work put in by the course coordinators and their team members, without your intellectual work and creative mind, and it would have not been possible to complete this draft. You have been a valuable member of our team!

Special thanks are due to Dr. Santosh Kumar Chobe, Dr. Jyoti Rao, Dr. Swati Nikam, Dr. C. R. Jadhav, Dr. S. S. Das, Dr. Rachna Somkunwar, Prof. Rajesh D. Bharati, Prof. Rupesh Mahajan, Prof. Yogesh S. Sapnar for helping with the formatting and crisp presentation of this draft. I would like to thank you from the core of my heart. Thank you for always being your best selves and contributing to the work.

I am thankful to Prof. Yogesh Shivaji Sapnar SCTR’s Pune Institute of Computer Technology, Pune for the time he has spent in critically reading the draft and giving the final touches. I appreciate his initiative and thank him for his time, patience and hard work!

Thank you all, for not only your good work but also for all the support you have given each other throughout the drafting process, that’s what makes the team stronger! You took the meaning of teamwork to a whole new level. Thank you for all your efforts!

Professor (Mrs.) Dr. Varsha H. Patil, Chairman, and Members- Dr. Shirish Sane, Dr. Sunil Bhirud, Dr. Manik Dhore, Dr. Pramod Patil, Dr. Girish Khilari, Dr. Sachin Lodha, Dr. Parikshit Mahalle, Dr. Venkatesharan, Dr. Geetanjali Kale, Dr. Suhasini Itkar, Dr. R. V. Patil, Dr. P. M. Yawalkar, and Dr. Swati A. Bhavsar.

Board of Studies (BoS), Computer Engineering, Faculty of Science and Technology, Savitribai Phule Pune University
**Task Force at Curriculum Design**

1. **Advisors, the Team of Board of Studies**-
   Dr. Varsha Patil (Chairman), Dr. Shirish Sane, Dr. Sunil Bhirud, Dr. Manik Dhore, Dr. Pramod Patil, Dr. Rajesh Prasad, Dr. Girish Khilari, Dr. Sachin Lodha, Dr. Parikshit Mahalle, Dr. Venkatesharan, Dr. Geetanjali Kale, Dr. Suhasini Itkar, Dr. R. V. Patil Dr. P. M. Yawalkar, and Dr. Swati A. Bhavsar.

2. **Team Leader**- Dr. Pramod D. Patil, Dr. D. Y. Patil Institute of Technology, Pimpri

3. **Teams, Course Design** -

<table>
<thead>
<tr>
<th>Name of Course</th>
<th>Team Coordinator</th>
<th>Team Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and Analysis of Algorithms</td>
<td>Dr. Santosh V. Chobe</td>
<td>Dr. Sunil Dhore Dr. Rachna Somkunwar Prof. S. P. Pingat Mrs.Pragati Chaudhari</td>
</tr>
<tr>
<td>Machine Learning</td>
<td>Dr. Sheetal Sonawane</td>
<td>Mr. Rajesh Bharati Mr. Abhijit D. Jadhav Dr. K. V. Metre Mr.Pratik Ratadiya</td>
</tr>
<tr>
<td>Blockchain Technology</td>
<td>Dr. Sonali Patil</td>
<td>Dr. Geeta.S.Navale Dr. Aparna A. Junnarkar Dr. Amar Buchade Mr.Amit Shitole</td>
</tr>
<tr>
<td>Elective III: Pervasive Computing</td>
<td>Prof.R.L.Paikrao</td>
<td>Prof.Sagar B. Shinde Prof. Dhondiram D. Pukale Mr. B.B.Gite Prof.Sanjay Agrawal</td>
</tr>
<tr>
<td>Elective III : Multimedia Techniques</td>
<td>Dr. B.A.Sonkamble</td>
<td>Dr.Madhuri P. Boraware Prof Gosavi Mr. Ranjit M. Gawande Prof.Shweta Koparde</td>
</tr>
<tr>
<td>Elective III : Cyber Security and Digital Forensics</td>
<td>Dr. Girtja G. Chiddarwar</td>
<td>Prof. B.L.Dhote Prof. N. D. Kale Dr.Nikita Kulkarni Dr.Uma Godase P.A. jain</td>
</tr>
<tr>
<td>Elective III: Object Oriented Modeling and Design</td>
<td>Prof. Rahul Patil</td>
<td>Mr.Balasaheb S. Tarle Mr.Kishor R. Pathak Mr. Santosh Sambare Prof.Ashwini A. Jarali</td>
</tr>
<tr>
<td>Elective III: Digital Signal Processing</td>
<td>Prof. M.S. Wakode</td>
<td>Prof. P.A. Jain Prof.Yogesh S. Sapnar Prof.Ashwini A. Jarali Mrs.Neelam Patil</td>
</tr>
<tr>
<td>Elective IV: Information Retrieval</td>
<td>Dr. Sharmila Wagh</td>
<td>Dr. Jayadevan R. Mr. Prashant Ahire Dr. Dinesh Hanchate Mr.Devidas Thosar</td>
</tr>
<tr>
<td>Elective IV: GPU Programming and Architecture</td>
<td>Mrs.Jayshree R. Pansare</td>
<td>Mr. S. A. Thanekar Mrs.Asha Sathe Dr.sandip kadam Dr.Deepak Mane Mr. D.D.Sapkal</td>
</tr>
</tbody>
</table>

Syllabus for Fourth Year of Computer Engineering

#126/128
| Elective IV: Mobile Computing | Dr. Manisha Bhende | Dr. R. M. Wahul  
Dr. Archana Kale  
Ms. S. V. Bodake | Dr. D. P. Gaikwad  
Mrs. Nadaph A. Gulab  
Dr. M. L. Dhore  
Prof. Yogesh S. Sapnar |
|-------------------------------|------------------|-------------------|----------------------|
| Elective IV: Software Testing and Quality Assurance | Dr. Uday C. Patkar | Dr. S. K. Sonkar  
Dr. S. U. Kadam  
Mr. Rahul G. Teni  
Prof. Vina M. Lomte | Dr. Sunil Khatal  
Ms. Ila Shridhar Savant  
Prof. Vandana S. Rupnar  
Prof. Yogesh S. Sapnar |
| Elective IV: Quantum Computing | Dr. M. U. Kharat | Dr. M. U. Kharat | Prof. Yogesh S. Sapnar |
| Lab Practice III | Dr. Vaihsali Tidake | Dr. Santosh V. Chobe  
Dr. Sheetal Sonawane  
Dr. S. D. Babar |  |
| Lab Practice IV | Mr. Rajesh Bharati | Prof. R. L. Paikrao  
Dr. B. A. Sonkamble  
Dr. Jyoti Rao  
Prof. Rahul Patil  
Dr. Sharmila Wagh | Dr. A. V. Dhumane  
Dr. Manisha Bhende  
Dr. Uday C. Patkar |
| Project Stage I | Dr. Swati A. Bhavsar | Dr. Swati A. Bhavsar |  |
| Audit Course 7 | Prof. Satish S. Banait | Prof. Satish S. Banait |  |
| High Performance Computing | Dr. Rachna Somkunwar | Mrs. Archana S. Vaidya  
Mrs. Rushali Patil  
Prof. S. P. Khedkar | Dr. G. R. Shinde  
Mrs. B. Mahalakshmi |
| Deep Learning | Dr. Archana Chaugule | Mr. Abhijit D. Jadhav  
Prof. A. G. Phakatkar  
Dr. N. K. Bansode | Dr. Kamini A. Shirsath  
Mr. Jameer Kotwal |
| Natural Language Processing | Dr. M. S. Takalikar | Dr. Pankaj Agarkar  
Prof. S. V. Shinde  
S. B. Chaudhari | Prof. Deptii Chaudhari  
Mrs. Dipalee D. Rane |
| Image Processing | Dr. Sudeep D. Thepade | Prof. M. P. Wankhade  
Dr. S. R. Dhore | Dr. B. D. Phulpagar  
Dr. Jayshree Pansare |
| Software Defined Networks | Dr. S. D. Babar | Dr. A. A. Dandavate  
Dr. K. S. Wagh  
Dr. Vinod V. Kimbahune | Dr. Geetika Narang  
Ms. D. B. Gothwal |
| Advanced Digital Signal Processing | Dr. P. A. Khadkikar | Prof. Yogesh S. Sapnar  
Prof. M. S. Wakode |  |
| Compiler Construction | Prof. Yogesh S Sapnar | Dr. Swati A. Bhavsar  
Ms. Kainjan Sanghavi |  |
| Pattern Recognition | Dr. A. S. Ghotkar | Dr. Amol Potgantwar  
Dr. Sable N. Popat | Mr. P. M. Kamde  
Dr. V. S. Pawar  
Dr. P. A. Khadkikar |
<table>
<thead>
<tr>
<th>Subject</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Computing</td>
<td>Dr. Madhuri A. Potey</td>
</tr>
<tr>
<td></td>
<td>Prof. Dr. D. V. Patil</td>
</tr>
<tr>
<td></td>
<td>Dr. Sandeep Patil</td>
</tr>
<tr>
<td></td>
<td>Dr. D. V. Medhane</td>
</tr>
<tr>
<td></td>
<td>Prof. P.S. Game</td>
</tr>
<tr>
<td></td>
<td>Dr. Archana Kollu</td>
</tr>
<tr>
<td>Business Intelligence</td>
<td>Dr. K. Rajeswari</td>
</tr>
<tr>
<td></td>
<td>Dr. Zaware S. Nitin</td>
</tr>
<tr>
<td></td>
<td>Prof. Y. A. Handage</td>
</tr>
<tr>
<td></td>
<td>Dr. M. R. Sanghavi</td>
</tr>
<tr>
<td></td>
<td>Mr. D. G. Modani</td>
</tr>
<tr>
<td></td>
<td>Mr. Subhash G. Rathod</td>
</tr>
<tr>
<td>Lab Practice V</td>
<td>Dr. G. R. Shinde</td>
</tr>
<tr>
<td></td>
<td>Dr. Rachna Somkunwar</td>
</tr>
<tr>
<td></td>
<td>Dr. Archana Chaugule</td>
</tr>
<tr>
<td>Lab Practice VI</td>
<td>Dr. Kamini A. Shirsath</td>
</tr>
<tr>
<td></td>
<td>Dr. M. S. Takalikar</td>
</tr>
<tr>
<td></td>
<td>Dr. Sudeep D. Thepade</td>
</tr>
<tr>
<td></td>
<td>Dr. Sonali Patil</td>
</tr>
<tr>
<td></td>
<td>Dr. S. D. Babar</td>
</tr>
<tr>
<td></td>
<td>Dr. A. S. Ghotkar</td>
</tr>
<tr>
<td></td>
<td>Dr. Sulochana Sonkamble</td>
</tr>
<tr>
<td></td>
<td>Dr. Madhuri A. Potey</td>
</tr>
<tr>
<td></td>
<td>Prof. Dr. K. Rajeswari</td>
</tr>
<tr>
<td>Project Stage II</td>
<td>Dr. Swati A. Bhavsar</td>
</tr>
<tr>
<td></td>
<td>Dr. Swati A. Bhavsar</td>
</tr>
<tr>
<td>Audit Course 8</td>
<td>Dr. Shaikh Nuzhat Faiz</td>
</tr>
<tr>
<td></td>
<td>Dr. Shaikh N. Faiz</td>
</tr>
</tbody>
</table>