

**Faculty of Science and Technology
Savitribai Phule Pune University
Maharashtra, India**



<http://unipune.ac.in>

**Curriculum
For
Third Year of Computer Science
and Engineering (Data Science)
(2019 Pattern)
(With effect from A.Y. 2025-26)**

**Third Year of Computer Science and Engineering (Data Science)
(2019 Course)
(With effect from 2025-26)**

Prologue

It is with great pleasure and honor that I share the syllabi for the Third Year of Computer Science and Engineering (Data Science) (2019 Course) on behalf of the 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 Science and Engineering in Data Science 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 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. Nilesh J. Uke

Chairman, Board of Studies (Computer Engineering), SPPU, Pune

Links for First Year and Second Year Curriculum:

1. http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt_10.012020.pdf
2. [http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2024/S.%20E.%20Computer%20Science%20and%20Engineering%20\(Data%20Science%20\)%20Syllabus_19062024.pdf](http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2024/S.%20E.%20Computer%20Science%20and%20Engineering%20(Data%20Science%20)%20Syllabus_19062024.pdf)

(With effect from Academic Year 2025-26)

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Savitribai Phule Pune University
Bachelor of Computer Science and Engineering (Data Science)

Program Outcomes (POs)

Learners are expected to know and be able to

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

Program Specific Outcomes (PSO)

A graduate of the Computer Engineering Program will demonstrate-

PSO1	Professional Skills The ability to understand, analyze and develop computer programs in the areas related to Algorithms, System Software, Machine Learning, Artificial Intelligence, Web Applications, Big Data Analytics and Networking for efficient design of computer-based systems of varying complexity.
PSO2	Problem-Solving Skills The ability to apply standard practices and strategies in software/embedded project development using Open-ended programming environments to deliver a quality product for business success.
PSO3	Successful Career and Entrepreneurship 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.

Savitribai Phule Pune University
Third Year of Computer Science and Engineering in Data Science
(2019 Course)
(With effect from Academic Year 2024-25)

Semester-III

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	In-Sem	End-Sem	Term Work	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
310641	Data Warehousing & Mining	03	-	-	30	70	-	-	-	100	03	-	-	03
310244	Computer Networks and Security	03	-	-	30	70	-	-	-	100	03	-	-	03
310643	Artificial Intelligence	03	-	-	30	70	-	-	-	100	03	-	-	03
310242	Theory of Computation	03	-	-	30	70	-	-	-	100	03	-	-	03
310645	Elective I	03	-	-	30	70	-	-	-	100	03	-	-	03
310646	Data Warehousing & Mining Laboratory	-	04	-	-	-	25	25	-	50	-	02	-	02
310247	Computer Networks and Security Laboratory	-	02	-	-	-	25	25	-	50	-	01	-	01
310648	Laboratory Practice - I (Data Warehousing & Elective I)	-	02	-	-	-	25	-	25	50	-	01	-	01
310649	Seminar -I	-	-	01	-	-	25	-	-	25	-	-	01	01
310650	Environmental Studies	-	-	01	-	-	25	-	-	25	-	-	01	01
310651	Audit Course 5												Grade	
Total Credits											15	04	02	21
Total		15	08	02	150	350	125		50	700	15	04	02	21

Elective I

- 310645A: Human Computer Interface
- 310645B Internet of Things and Embedded System
- 310645C Software Modeling and Design
- 310645D Pattern Recognition

Audit Course 5

- AC I Cyber Security
AC II Professional Ethics and Etiquette
AC III Learn New Skills -Full Stack Developer
AC IV Engineering Economics
AC V Foreign Language

Savitribai Phule Pune University
Second Year of Computer Science and Engineering in Data
Science (2019 Course)
(With effect from Academic Year 2024-25)

Semester-IV

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	In-Sem	End-Sem	Term	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
310251	Data Science and Big Data Analytics	03	-	-	30	70	-	-	-	100	03	-	-	03
310252	Web Technology	03	-	-	30	70	-	-	-	100	03	-	-	03
310652	Machine Learning	03	-	-	30	70	-	-	-	100	03	-	-	03
310653	Elective II	03	-	-	30	70	-	-	-	100	03	-	-	03
310256	Data Science and Big Data Analytics Laboratory	-	04	-	-	-	50	25	-	75	-	02	-	02
310257	Web Technology Laboratory	-	02	-	-	-	25	-	25	50	-	01	-	01
310654	Laboratory Practice II (<u>Machine Learning Laboratory</u> & Elective II)	-	04	-	-	-	50	25	-	75	-	02	-	02
310655	Internship	-	*	-	-	-	100	-	-	100	-	04	-	04
310657	<u>Audit Course 6</u>												Grade	
Total Credits											12	09	-	21
Total		12	10	-	120	280	225	50	25	700	12	09	-	21
Elective II				Audit Course 6										
310653A Robotics and Automation 310653B Natural Language Processing 310653C Cloud Computing				AC6-I Digital and Social Media Marketing AC6-II Sustainable Energy Systems AC6-III Leadership and Personality Development AC6-IV Foreign Language AC6-V MOOC- Learn New Skills										

SEMESTER-V

General Guidelines

1. Outcome-based education is targeted at achieving desirable outcomes (in terms of knowledge, skills, attitudes and behavior etc.) at the end of the program. Teaching this awareness and making the associated effort constitutes outcome-based education. This entails a regular methodology for ascertaining the attainment of outcomes and benchmarking these against the **Program Outcomes (POs)** consistent with the objective of the program. 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 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 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. For each unit, content attainment mapping is indicated with course outcome(s). Instructor may update the same.
3. @ CO & PO (Course Objectives and Program Outcomes) Attainment Mapping Table: The CO-PO mapping in the table 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 meaning of '-' is no correlation between CO and PO.
4. Exemplar/Case Studies are included at each unit to explore how the learned topics apply to real world situations and are to be designed so as to assist students to increase their understanding of particular skills, content or knowledge in any given situation and articulate. One or two sample exemplar or case study are included for each unit, instruction may extend the same with more.
5. Exemplar/Case Studies may be assigned as self-study by students and to be excluded from theory examinations.
6. For laboratory courses, a set of suggested assignments is provided for reference. Laboratory Instructors may design a suitable set of assignments for respective course at their level. Beyond curriculum assignments and mini-project may be included as 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.
7. 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.
8. For laboratory, instructions have been included about the conduction and assessment of laboratory work. These guidelines are to be strictly followed. Use of open-source software is appreciated.
9. Set of suggested Laboratory assignments is provided for reference. Laboratory Instructor may design suitable set of assignments for respective institute.
10. Laboratory conduction and assessment guidelines are to be strictly followed.
11. **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. It is recommended to conduct internal monthly practical examination as part of continuous assessment.

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.

12. **Laboratory Journal-** 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 in the 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.
13. **Tutorial** -Tutorials can never be an individual course but an additional aid to the learners. Tutorials help the learners to inculcate the contents of the course with focused efforts on small group of the learners. Tutorial conduction should concentrate more on simplifying the intricacies converging to clear understanding and application. **Assessment of tutorial work is to be done in a manner similar to assessment of term-work; do follow same guidelines.**
14. **Audit Course** - The student registered for audit course shall be awarded the grade AP/PP (Audit Course Pass) and the grade 'AP'/'PP' shall be included 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'/'PP' 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.
15. UGC has issued the UGC (Credit Framework for online learning courses through SWAYAM) Regulation 2016 advising the Universities to identify courses where credits can be transferred on to the academic record of the students for courses done on SWAYAM. AICTE has also put out gazette notification in 2016 and subsequently for adoption of these courses for credit transfer [2].
 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. This is done through a platform that facilitates hosting of the courses to be accessed by anyone, anywhere at any time. Courses delivered through SWAYAM are interactive, prepared by the best teachers in the country and are available, free of cost to any learner. However, learners wanting a SWAYAM certificate should register for the final proctored exams that come at a fee and attend in-person at designated center on specified dates. Eligibility for the certificate is generally announced on the course page. Universities/colleges approving credit transfer for these courses can use the marks/certificate obtained in these courses for the same.[2]
16. ****Internship:** Engineering internships are intended to provide students with an opportunity to apply conceptual knowledge from academics to the realities of the field work/training. The following guidelines are proposed to give academic credit for the internship undergone as a part

of the Third Year Engineering curriculum. For more rules, pattern and assessment of semester examination refer[1]

Note: For Examination rules, pattern and assessment please refer[1]

1. http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt_10.012020.pdf
2. <https://swayam.gov.in/about>

Abbreviations		
TW: Term Work	TH: Theory	PR: Practical
OR: Oral	TUT: Tutorial	Sem: Semester

Savitribai Phule Pune University
Third Year of Computer Science and Engineering (Data Science)
(2019 Course)
310641: Data Warehousing and Mining

Teaching Scheme:	Credit:	Examination Scheme:
TH: 03 Hours/Week	03	InSemester(TH): 30 Marks End Semester(TH): 70 Marks

Prerequisite Courses, if any: Database Management System

Companion Course, if any: ---

Course Objectives:

- CO1: To understand the principles of Data warehousing and Data Mining.
CO2: To understand the architecture & working of data mining system.
CO3: To introduce the task of data mining as an important phase of knowledge recovery process.
CO4: To identify the association rules in mining.
CO5: To imbibe the clustering techniques
CO6: To impart knowledge of the fundamental concepts that provide the foundation of data mining.

Course Outcomes:

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

- CO1: To Be familiar with mathematical foundations of data mining tools.. K1 , K2
CO2: To understand and implement classical models and algorithms in data warehouses and data mining
CO3: To develop skills to write queries using DMQL
CO4: To categorize the association rules, classification and clusters in large data sets
CO5: . Characterize the kinds of patterns that can be discovered by Classification and clustering.
CO6: To solve real world problems in business and scientific information using data mining .

Course Contents

Unit I	INTRODUCTION TO DATA WAREHOUSE DATA MINING	(07Hours)
Data Warehousing: Overview, Definition, Data Warehousing Components, Building a Data Warehouse, Warehouse Database, Mapping the Data Warehouse to a Multiprocessor Architecture, Difference between Database System and Data Warehouse, Multi-Dimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept, Definition of Data Mining, Kind of Data,Data Mining Functionalities, Kinds of Patterns, Classification of Data Mining Systems		
#Exemplar/Case Studies	A Case Study in Data Warehousing and Data Mining Using the SAS System	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	DATA WAREHOUSING AND ON-LINE ANALYTICAL PROCESSING	(06 Hours)
OLAP Cube, OLAP Operations, OLAP Server Architecture-ROLAP, MOLAP and HOLAP,Data Warehouse Process and Technology: Warehousing Strategy, Warehouse /management and Support Processes, Warehouse Planning and Implementation, Hardware and Operating Systems for Data Warehousing, Client/Server Computing		

Model & Data Warehousing.		
#Exemplar/Case Studies	A Case Study in Data Warehousing and Data Mining on Banking & Finance	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	DATA WAREHOUSING AND DATA CUBE TECHNOLOGY	(07 Hours)
Data Warehouse Implementation, Data Generalization by Attribute-Oriented Induction.DATA CUBE TECHNOLOGY: Efficient Methods for Data Cube Computation, Exploration And Discovery in Multidimensional Databases. PREPROCESSING: Data Quality, Major Tasks in Data Preprocessing, Data Reduction, Data Transformation and Data Discretization, Data Cleaning and Data Integration.		
#Exemplar/Case Studies	A Case Study on Banking Products	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	DATA WAREHOUSING AND ON-LINE ANALYTICAL PROCESSING	(08 Hours)
Basic Concepts, Efficient and Scalable Frequent Item set Mining Methods, Are All the Pattern Interesting, Pattern Evaluation Methods, Applications of frequent pattern and associations.Association Rules: Problem Definition, Frequent Item Set Generation, The APRIORI Principle,Support and Confidence Measures, Association Rule Generation; APRIORI Algorithm, Growth Algorithms, Compact Representation of Frequent Item Set- Maximal Frequent Item Set, Closed Frequent Item Set.		
#Exemplar/Case Studies	A Case Study on A Global Healthcare Leader	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	DATA WAREHOUSING AND ON-LINE ANALYTICAL PROCESSING	(06 Hours)
Classification: Problem Definition, General Approaches to solving a classification problem, Evaluation of Classifiers, Classification techniques, Decision Trees-Decision tree Construction, Algorithm for Decision Tree Induction; Naive-Bayes Classifier, Bayesian Belief Networks; K-Nearest Neighbour Classification-Algorithm and Characteristics		
#Exemplar/Case Studies	A Case Study on Data mining in retail banking: A case study of branch classification.	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	DATA WAREHOUSING AND ON-LINE ANALYTICAL PROCESSING	(08 Hours)
CLUSTER ANALYSIS: Basic Concepts of Cluster Analysis, Clustering structures, Major Clustering Approaches, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Model Based Clustering - The Expectation-Maximization Method, Other Clustering Techniques, Clustering. High-Dimensional Data, Constraint-Based and User-Guided Cluster Analysis, Link-Based Cluster Analysis, Semi-Supervised Clustering and Classification, Bi-Clustering, Collaborative Clustering..		

#Exemplar/Case Studies	A Case Study on clustering Case Study - Customer Segmentation with K-Means
Mapping of Course Outcomes for Unit VI	CO6

Learning Resources
Text Books: 1. Alex Berson, Stephen J. Smith “Data Warehousing, Data-Mining & OLAP”, TMH 2. Mark Humphries, Michael W. Hawkins, Michelle C. Dy, “ Data Warehousing: Architecture and Implementation”, Pearson 3. Margaret H. Dunham, S. Sridhar, “Data Mining: Introductory and Advanced Topics” Pearson Education
Reference Books: 1. Data Mining Techniques, Arun K Pujari, 3rd Edition, Universities Press 2. Data Warehousing Fundament's, Pualraj Ponnaiah, Wiley Student Edition. 3. The Data Warehouse Life Cycle Toolkit — Ralph Kimball, Wiley StudentEdition. 4. Data Mining, Vikaram Pudi, P Radha Krishna, Oxford University Press
MOOC Courses: 1. https://onlinecourses.nptel.ac.in/noc25_cs19/preview 2. https://workshop.sps.nyu.edu/~sultans/dwdm/

The CO-PO mapping table												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	2	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	-	2	3	-	-	-	-	-	-	-	-
CO4	-	-		3	-	-	-	-	-	-	-	2
CO5	2	2	-	-	-	-	-	-	-	-	-	-
CO6	2	-	3	-	-	-	-	-	-	-	2	-

Savitribai Phule Pune University

Third Year of Computer Science and Engineering (Data Science) (2019 Course)

310244: Computer Networks and Security

Teaching Scheme:	Credit:	Examination Scheme:
TH: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: --

Companion Course, if any: Computer Networks and Security Laboratory (310247)

Course Objectives:

- To understand the fundamental concepts of networking standards, protocols and technologies
- To learn different techniques for framing, error control, flow control and routing
- To learn different layer protocols in the protocol stacks
- To understand modern network architectures with respect to design and performance
- To learn the fundamental concepts of Information Security

Course Outcomes:

On completion of the course, learners should be able to

CO1: Summarize fundamental concepts of Computer Networks, architectures, protocols and technologies

CO2: Illustrate the working and functions of data link layer

CO3: Analyze the working of different routing protocols and mechanisms

CO4: Implement client-server applications using sockets

CO5: Illustrate role of application layer with its protocols, client-server architectures

CO6: Comprehend the basics of Network Security

Course Contents

Unit I	Introduction To Computer Networks	(06 Hours)
Definition, Types of Networks: Local area networks (LAN), Metropolitan area networks (MAN), Wide area networks (WAN), Wireless networks, Networks Software, Protocol, Design issues for the Network layers. Network Models: The OSI Reference Model, TCP/IP Model, Network Topologies, Types of Transmission Medium. Network Architectures: Client-Server, Peer To Peer, Hybrid. Network Devices: Bridge, Switch, Router, Gateway, Access Point. Line Coding Schemes: Manchester and Differential Manchester Encodings, Frequency Hopping (FHSS) and Direct Sequence Spread Spectrum (DSSS).		
#Exemplar/Case Studies	Study of Campus wide networking.	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Data Link Layer	(08 Hours)

Introduction, functions. Design Issues: Services to Network Layer, Framing. ARQ strategies: Error Detection and correction, Parity Bits, Hamming Codes (11/12-bits) and CRC. Flow Control Protocols: Unrestricted Simplex, Stop and Wait, Sliding Window Protocol. WAN Connectivity: PPP and HDLC. MAC Sub layer: Multiple Access Protocols: Pure and Slotted ALOHA, CSMA, WDMA, CSMA/CD, CSMA/CA, Binary Exponential Back-off algorithm, Introduction to Ethernet IEEE 802.3, IEEE 802.11 a/b/g/n, IEEE 802.15 and IEEE 802.16 Standards.		
#Exemplar/Case Studies	Demonstration of DLL protocols on Simulator	
Mapping of Course Outcomes for Unit II	CO2,	
Unit III	Network Layer	(08 Hours)
Introduction: Functions of Network layer. Switching Techniques: Circuit switching, Message Switching, Packet Switching. IP Protocol: Classes of IP (Network addressing), IPv4 , IPv6, Network Address Translation, Sub-netting , CIDR. Network layer Protocols: ARP, RARP, ICMP, IGMP. Network Routing and Algorithms: Static Routing, Dynamic Routing, Distance Vector Routing, Link State Routing, Path Vector. Routing Protocols: RIP, OSPF, BGP, MPLS. Routing in MANET: AODV, DSR, Mobile IP.		
#Exemplar/Case Studies	Demonstration of Routing Protocols on simulator.	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Transport Layer	(07 Hours)
Process to Process Delivery, Services, Socket Programming. Elements of Transport Layer Protocols: Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, Congestion Control. Transport Layer Protocols: TCP and UDP, SCTP, RTP, Congestion control and Quality of Service (QoS), Differentiated services, TCP and UDP for Wireless networks.		
#Exemplar/Case Studies	Demonstration of Transport layer protocols on Simulator.	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Application Layer	(06 Hours)
Introduction, Web and HTTP, Web Caching, DNS, Email: SMTP, MIME, POP3, Webmail, FTP, TELNET, DHCP, SNMP.		
#Exemplar/Case Studies	Study of Application Layer protocols using network protocol analyzer. e.g. Wireshark	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Security	(07

		Hours)
Introduction, Security services, Need of Security, Key Principles of Security, Threats and Vulnerabilities, Types of Attacks, ITU-T X.800 Security Architecture for OSI, Security Policy and mechanisms, Operational Model of Network Security, Symmetric and Asymmetric Key Cryptography. Security in Network, Transport and Application: Introduction of IPSec, SSL, HTTPS, S/MIME, Overview of IDS and Firewalls.		
#Exemplar/Case Studies	Study of security protocols in Network, Transport and Application Layer using network protocol analyzer. e.g. Wireshark	
Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		
Text Books:		
1. Fourauzan B., "Data Communications and Networking", 5th Edition, Tata McGraw-Hill, Publications, ISBN:0-07 - 058408 - 7		
2. Andrew S. Tanenbaum, Computer Networks, 5th Edition, Pearson India, 2012.		
1. Kurose, Ross, "Computer Networking a Top Down Approach Featuring the Internet", Pearson, ISBN-10: 0132856204		
2. L. Peterson and B. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan-Kaufmann, 2012.		
3. Douglas E. Comer & M.S Narayanan, "Computer Network & Internet", Pearson Education		
4. William Stallings, "Cryptography and Network Security: Principles and Practice", 4th Edition		
5. Pachghare V. K., "Cryptography and Information Security", 3rd Edition, PHI,		
MOOC Courses:		
nptel.ac.in/courses/106/105/106105183		
nptel.ac.in/courses/106/105/106105080		
nptel.ac.in/courses/106/105/106105081		
nptel.ac.in/courses/106/106/106106091		
nptel.ac.in/courses/106/105/106105031		
https://www.mooc-list.com/tags/computer-networking		
https://www.coursera.org/courses?query=computer%20network		
e-Books :		
https://people.cs.clemson.edu/~jmarty/courses/kurose/KuroseCh1-2.pdf		
http://eti2506.elimu.net/Introduction/Books/Data Communications and Networking By Behrouz A.Forouzan.pdf		
http://intronetworks.cs.luc.edu/current/ComputerNetworks.pdf		
https://www.tutorialspoint.com/data_communication_computer_network/data_communication_computer_network_tutorial.pdf		
Case Study:		
https://slideplayer.com/slide/6106945		
http://www.worldcolleges.info/sites/default/files/Cisco_-_Ccie_Fundamental_Network_Design_And_Case_Studies.PDF		

http://vlabs.iitb.ac.in/vlabs-dev/labs_local/computer-networks/labs/explist.php

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	2	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	-	2	3	-	-	-	-	-	-	-	-
CO4	-	-		3	-	-	-	-	-	-	-	2
CO5	2	2	-	-	-	-	-	-	-	-	-	-
CO6	2	-	3	-	-	-	-	-	-	-	2	-

Savitribai Phule Pune University

**Third Year of Computer Science and Engineering (Data Science)
(2019 Course)**

310643: Artificial Intelligence

Teaching Scheme:	Credit:	Examination Scheme:
TH: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: Programming and Problem solving (110005), Data Structures and Algorithms (210642)

Companion Course, if any: Laboratory Practice e II (310648)

Course Objectives:

- To understand the concept of Artificial Intelligence (AI) in the form of various Intellectual tasks.
- To understand Problem Solving using various peculiar search strategies for AI.
- To understand multi-agent environment in competitive environment.
- To acquaint with the fundamentals of knowledge and reasoning.
- To devise plan of action to achieve goals as a critical part of AI.
- To develop a mind to solve real world problems unconventionally with optimality.

Course Outcomes:

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

CO1: Identify and apply suitable Intelligent agents for various AI applications

CO2: Build smart system using different informed search / uninformed search or heuristic approaches

CO3: Identify knowledge associated and represent it by ontological engineering to plan a strategy to solve given problem

CO4: Apply the suitable algorithms to solve AI problems

CO5: Implement ideas underlying modern logical inference systems

CO6: Represent complex problems with expressive yet carefully constrained language of representation

Course Contents

Unit I	Introduction	(07 Hours)
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Introduction to Artificial Intelligence, Foundations of Artificial Intelligence, History of Artificial Intelligence, State of the Art, Risks and Benefits of AI, Intelligent Agents, Agents and Environments, Good Behavior: Concept of Rationality, Nature of Environments, Structure of Agents.		
#Exemplar/Case Studies		Kroger: How This U.S. Retail Giant Is Using AI And Robots To Prepare For The 4th Industrial Revolution
Mapping of Course Outcomes for Unit I		CO1, CO4
Unit II	Problem-Solving	(07 Hours)
Solving Problems by Searching, Problem-Solving Agents, Example Problems, Search Algorithms, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions, Search in Complex Environments, Local Search and Optimization Problems.		
#Exemplar/Case Studies		4th Industrial Revolution Using AI, Big Data And Robotics
Mapping of Course Outcomes for Unit II		CO2, CO4
Unit III	Adversarial Search and Games	(07 Hours)
Game Theory, Optimal Decisions in Games, Heuristic Alpha–Beta Tree Search, Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, Limitations of Game Search Algorithms, Constraint Satisfaction Problems (CSP), Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs.		
#Exemplar/Case Studies		Machine Learning At Google: The Amazing Use Case Of Becoming A Fully Sustainable Business
Mapping of Course Outcomes for Unit III		CO3, CO4
Unit IV	Knowledge	(07 Hours)
Logical Agents, Knowledge-Based Agents, The Wumpus World, Logic, Propositional Logic: A Very Simple Logic, Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based on Propositional Logic, First-Order Logic, Representation Revisited, Syntax and Semantics of First-Order Logic, Using First-Order Logic, Knowledge Engineering in First-Order Logic		
#Exemplar/Case Studies		BBC To Launch AI - Enabled Interactive Radio Show For Amazon Echo And Google Home Chatbots
Mapping of Course Outcomes for Unit IV		CO3, CO4
Unit V	Reasoning	(07 Hours)
Inference in First-Order Logic, Propositional vs. First-Order Inference, Unification and First-Order Inference, Forward Chaining, Backward Chaining, Resolution, Knowledge Representation, Ontological Engineering, Categories and Objects, Events, Mental Objects and Modal Logic, Reasoning Systems for Categories, Reasoning with Default Information		

#Exemplar/Case Studies	The Amazing Ways How Wikipedia Uses Artificial Intelligence	
Mapping of Course Outcomes for Unit V	CO4, CO5	
Unit VI	Planning	(07 Hours)
Automated Planning, Classical Planning, Algorithms for Classical Planning, Heuristics for Planning, Hierarchical Planning, Planning and Acting in Nondeterministic Domains, Time, Schedules, and Resources, Analysis of Planning Approaches, Limits of AI, Ethics of AI, Future of AI, AI Components, AI Architectures.		
#Exemplar/Case Studies	The Amazing Ways Samsung Is Using Big Data, Artificial Intelligence And Robots To Drive Performance	
Mapping of Course Outcomes for Unit VI	CO4, CO6	
Learning Resources		
Text Books:		
1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Third edition, Pearson, 2003, ISBN :10: 0136042597		
2. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998-1		
3. Elaine Rich, Kevin Knight and Nair, “Artificial Intelligence”, TMH, ISBN-978-0-07-008770- 5		
Reference Books:		
1. Nilsson Nils J , “Artificial Intelligence: A new Synthesis”, Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4		
2. Patrick Henry Winston, “Artificial Intelligence”, Addison-Wesley Publishing Company, ISBN: 0-201-53377-4		
3. Andries P. Engelbrecht-Computational Intelligence: An Introduction, 2nd Edition-Wiley India- ISBN: 978-0-470-51250-0		
MOOC Courses:		
☐ https://nptel.ac.in/courses/106/102/106102220/		
☐ https://nptel.ac.in/courses/106/105/106105077/		
☐ https://nptel.ac.in/courses/106/105/106105078/		
☐ https://nptel.ac.in/courses/106/105/106105079/		

The CO-PO mapping table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	1	2	2	1	-	-	1	3	-	2	-	-
C02	1	3	3	2	3	1	-	3	1	2	-	-
C03	3	2	2	2	1	1	1	-	-	2	-	-
C04	1	2	2	1	-	-	1	3	1	2	-	-
C05	1	2	2	1	-	-	1	3	1	2	-	-
C06	1	2	2	1	-	-	1	3	1	2	-	-

Savitribai Phule Pune University

**Third Year of Computer Science and Engineering (Data Science)
(2019 Course)**

310242: Theory of Computation

Teaching Scheme:	Credit:	Examination Scheme:
TH: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: Mathematical Foundation for Data Science-I (210641), Data Structures & Algorithm (210642)

Companion Course, if any: --

Course Objectives:

- To introduce the students to basics of Theory of Computation
- To study abstract computing models to provide a formal connection between algorithmic problem solving and the theory of languages
- To learn Grammar, Pushdown Automata and Turing Machine for language processing and algorithm design
- To learn about the theory of computability and complexity for algorithm design

Course Outcomes:

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

CO1: Understand formal language, translation logic, essentials of translation, alphabets, language representation and apply it to design Finite Automata and its variants

CO2: Construct regular expression to present regular language and understand pumping lemma for RE

CO3: Design Context Free Grammars and learn to simplify the grammar

CO4: Construct Pushdown Automaton model for the Context Free Language

CO5: Design Turing Machine for the different requirements outlined by theoretical computer science

CO6: Understand different classes of problems, classify and analyze them and study concepts of NP Completeness.

Course Contents

Unit I	Formal Language Theory and Finite Automata	(07 Hours)
Finite Automata (FA): An informal picture of FA, Finite State Machine (FSM), Language accepted by FA, Definition of Regular Language. FA without output: Deterministic and Nondeterministic FA (DFA and NFA), epsilon- NFA and inter-conversion. Minimization of DFAs. FA with output: Moore and Mealy machines -Definition, models, inter-conversion.		
#Exemplar/Case Studies	FSM for vending machine, spell checker	
Mapping of Course Outcomes for Unit I	C01	
Unit II	Regular Expressions (RE)	(07 Hours)
Introduction, Operators of RE, Precedence of operators, Algebraic laws for RE, Language to Regular Expressions, Equivalence of two REs. Conversions: RE to NFA, DFA, DFA to RE using Arden's theorem, Pumping Lemma for		

Regular languages, Closure and Decision properties of Regular languages. Myhill-Nerode theorem.		
#Exemplar/Case Studies	RE in text search and replace	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	Context Free Grammar (CFG) and Context Free Language (CFL)	(07 Hours)
Basic Elements of Grammar, Formal Definition of Context Free Grammar, Sentential form, Derivation and Derivation Tree/ Parse Tree, Context Free Language (CFL), Ambiguous Grammar, writing grammar for language. Simplification of CFG: Eliminating ϵ -productions, unit productions, useless production, and useless symbols. Normal Forms: Chomsky Normal Form, Greibach Normal Form, Pumping Lemma for CFG, Closure properties of CFL, Decision properties of CFL, Chomsky Hierarchy, Cock-Younger-Kasami Algorithm.		
#Exemplar/Case Studies	Parser, CFG for Palindromes, Parenthesis Match	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Pushdown Automata (PDA)	(07 Hours)
Introduction, Formal definition of PDA, Equivalence of Acceptance by Final State and Empty stack, Non-deterministic PDA (NPDA), PDA and Context Free Language, Equivalence of PDA and CFG, PDA vs CFLs. Deterministic CFLs.		
#Exemplar/Case Studies	Parsing and PDA: Top-Down Parsing, Bottom-up Parsing simulation showing use of PDA	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Turing Machines (TM)	(07 Hours)
Turing Machine Model, Formal definition of Turing Machines, Language Acceptability by Turing Machines, Design of TM, Description of TM, Techniques for TM Construction, Computing function with Turing Machine, Variants of Turing Machines, Halting Problem of TM, Halting vs Looping, A Turing-unrecognizable language, Reducibility, Recursion Theorem. The Model of Linear Bounded Automata.		
#Exemplar/Case Studies	Algorithms using Turing Machine	
Mapping of Course Outcomes for Unit V	CO5	

Unit VI	Computability and Complexity Theory	(07 Hours)
Computability Theory: Decidable Problems and Un-decidable Problems, Church-Turing Thesis. Reducibility: Undecidable Problems that is recursively enumerable, A Simple Un-decidable. Complexity Classes: Time and Space Measures, The Class P, Examples of problems in P, The Class NP, Examples of problems in NP, P Problem Versus NP Problem, NP-completeness and hard Problems.		
#Exemplar/Case Studies	Traveling salesman problem, Post Correspondence Problem (PCP)	
Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		
Text Books: 1. John E. Hopcroft, Rajeev Motwani, Jeffrey D.Ullman,“Introduction to Automata Theory Languages and Computation”, Addison-Wesley, ISBN 0-201-44124-1 2. John Martin, “Introduction to Languages and The Theory of Computation”, 2nd Edition, McGrawHill Education, ISBN-13: 978-1-25-900558-9, ISBN-10: 1-25-900558-5		
Reference Books: 1. Sanjeev Arora and Boaz Barak, “Computational Complexity: A Modern Approach”, Cambridge University Press, ISBN: 0521424267 97805214242643. 2. Daniel Cohen, “Introduction to Computer Theory”, Wiley & Sons, ISBN 97881265133454. 3. J. Carroll & D Long, “Theory of Finite Automata”, Prentice Hall, ISBN 0-13-913708-45. 4. Kavi Mahesh, “Theory of Computation: A Problem-Solving Approach”, Wiley India, ISBN1081265331106. 5. Michael Sipser, “Introduction to the Theory of Computation”, Cengage Learning, ISBN-13: 97811331878137. 6. Vivek Kulkarni, “Theory of Computation”, Oxford University Press, ISBN 0-19-808458		
MOOC Courses: ☐ https://nptel.ac.in/courses/106/104/106104148/ ☐ https://nptel.ac.in/courses/106/104/106104028/		

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12
C01	3	3	2	2	1	-	-	-	-	-	-	2
C02	3	3	2	2	1	-	-	-	-	-	-	1
C03	3	3	2	2	1	-	-	-	-	-	-	1
C04	3	3	2	2	1	-	-	-	-	-	-	1
C05	3	3	3	2	1	-	-	-	-	-	-	2
C06	3	3	3	3	1	-	-	-	-	-	-	1

Savitribai Phule Pune University
Third Year of Computer Science and Engineering
(Data Science) (2019 Course)

Elective I

310645 (A): Human Computer Interface

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Lecture: 03 Hours/Week	03	In_Semester(TH): 30 Marks End Semester(TH): 70 Marks
Prerequisite Courses : Computer Graphics (210656), Software Engineering and Project Management (210645)		
Companion Course : Laboratory Practice I (310648)		
Course Objectives: ● To understand the importance of HCI design process in software development ● To learn fundamental aspects of designing and implementing user interfaces ● To study HCI with technical, cognitive and functional perspectives ● To acquire knowledge about variety of effective human-computer-interactions ● To co-evaluate the technology with respect to adapting changing user requirements in interacting with computer		
Course Outcomes: On completion of the course, learner will be able to- CO1: Design effective Human-Computer-Interfaces for all kinds of users CO2: Apply and analyze the user-interface with respect to golden rules of interface CO3: Analyze and evaluate the effectiveness of a user-interface design CO4: Implement the interactive designs for feasible data search and retrieval CO5: Analyze the scope of HCI in various paradigms like ubiquitous computing, virtual reality ,multi-media, World wide web related environments CO6: Analyze and identify user models, user support, and stakeholder requirements of HCI system		
Course Contents		
Unit I	Introduction and Foundation of HCI	(07 Hours)
Foundation: Human Memory. Thinking: Reasoning and Problem Solving, Emotion, Individual Difference, Psychology and design of Interactive systems, The Computer-Text Entry Device,Positioning, Pointing, Display devices, Devices for virtual reality and 3D Interaction, The Interactions-Models of Interaction, Frameworks and HCI, Ergonomics, Interaction styles,Ergonomics, Elements of WIMP Interface, Interactivity, Measurable Human Factors, The context of Interaction. Importance of User Interface: Defining user Interface, Brief History of HumanComputer Interface, Good and Poor Design- Importance of good design.		
#Exemplar/Case Studies		Paper prototype – Design elements of GUI
*Mapping of Course Outcomes for Unit I		CO1, CO6

Unit II	Human Perspective in Interaction Design Process	(07 Hours)
Know your user/client: Understanding how people interact with computers, Important human characteristics in Design, Human considerations in design of Business systems, Human Interaction speeds, Performance versus Preference, Methods of gaining an understanding of users, Miller's Law. Design Guidelines: Navigating the interface, Organizing the display, Getting user's attention, Facilitating data entry. Principles: Determine user's skill level, Identify the tasks, Choose an interaction style, Natural Language, Eight Golden rules of Interface design, Prevent errors, Ensuring Human control while increasing automation. Theories: Design-by-level, Stages of action, Consistency, Contextual Theories, Dynamic theories.		
#Exemplar/Case Studies	Registration form design	
*Mapping of Course Outcomes for Unit II	CO1,CO2	
Unit III	Interaction Styles and HCI in Software Process	(07 Hours)
Design, Process of Interaction Design. Interaction styles: Command line, Menu Selection, Form fill-in, Direct Manipulation. Graphical User Interface: Popularity of Graphics, Concept of direct manipulation, Advantages, Disadvantages and characteristics of Graphical user interface. Web User Interface: Popularity and Characteristics, Merging of Graphical business systems and the Web Characteristics of Intranet versus Internet, Web page versus application design, Principles for user interface design, Software life cycle, Usability Engineering, Iterative design and prototyping, Design Rationale.		
#Exemplar/Case Studies	Comparison - GUI and Web design with a real time example.	
*Mapping of Course Outcomes for Unit III	CO1,CO3,CO5	
Unit IV	Unit IV Usability Evaluation and Universal Design 07 Hours	(07 Hours)
User interface design process: Designing for People: Seven commandments, Usability Assessment in the Design process, Common Usability problems, Practical and Objective measures of Usability, Formative and Summative evaluation, Usability specifications for evaluation, Analytic methods, Model based analysis, GOMS model, Empirical methods, Field studies, Usability testing in Laboratory, Controlled experiments, Heuristic Evaluation, Cognitive Walkthrough. Evaluation framework: Paradigms and techniques, DECIDE: a framework to guide evaluation, Universal design principles, Multi-modal interaction, Designing for diversity.		
#Exemplar/Case Studies	GOMS model - Adding items to a cart of e-shopping website.	
*Mapping of Course Outcomes for Unit IV	CO1,CO3	
Unit V	HCI Paradigms	(07 Hours)
Paradigms for Interaction: Time sharing, Video display units, Programming toolkits, Personal computing, The metaphor, Direct manipulation, Hypertext, Computer-supported cooperative work, Agent based interfaces. Ubiquitous Computing: Sensor-based and context-aware interaction, Data Integrity versus Data immunity, Handling missing data, Data entry and fudgeability, Auditing versus Editing, Retrieval in Physical World, Retrieval in Digital world, Constrained Natural Language output, Five stage search framework, Dynamic queries and faceted search, The social aspects of search. Pattern Recognition: Introduction, Examples, Role of Machine Learning, Pattern Recognition Process, Pattern Recognition in HCI.		
#Exemplar/Case Studies	Interface Design- Pattern gesture recognition	
*Mapping of Course Outcomes for Unit V	CO1,CO3,CO4	
Unit VI	HCI for Mobile and Handheld devices	(07 Hours)
Designing for Mobile and other devices: Anatomy of a Mobile app, Mobile form factors, Handheld ormat apps, Tablet format apps, Mini-tablet format apps, Mobile Navigation, Content, and control idioms- browse controls, Navigation and toolbars, Drawers, Tap-to-reveal and direct manipulation, Searching, Sorting and Filtering, Welcome and help screens, Multi-touch gestures, Inter-app integration, Android Accessibility Guidelines. Other		

devices: Designing for kiosks, Designing for 10-foot interfaces, Designing for automotive interfaces, Designing for audible interfaces.

#Exemplar/Case Studies

GUI in Python Enlist and evaluate handled devices

*Mapping of Course Outcomes for Unit VI

CO3,CO5,CO6

Learning Resources

Text Books:

1. Alan J. Dix, Janet Finlay, Russell Beale, "Human Computer Interaction", Pearson Education, 3rd Edition, 2004, ISBN 81-297-0409-9.
2. Jenny Preece, Rogers, Sharp, "Interaction Design-beyond human-computer interaction", WILEY-INDIA, ISBN 81-265-0393-9.
3. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, "Designing the User Interface: Strategies for Effective Human- Computer Interaction", 6th Edition, Pearson Education Limited. ISBN 987-1-292-03701-1.

Reference Books :

1. Alan Cooper, Robert Reiman, David Cronin, Christopher Noessel, "About Face: The Essentials of Interaction Design", 4 th edition, WILEY, ISBN 978-1-118-76658-3
2. Mary Beth Rosson and John M. Carroll, "Usability Engineering: Scenario-Based Development of Human-Computer Interaction", Morgan Kaufmann Publishers, ISBN 978-1- 558-60712-5
3. Wibert O. Galitz, "The Essential Guide to user Interface Design", WILEY India, ISBN: 978- 1-265-0280-6.
4. Jenifer Tidwell, "Designing Interfaces", O'REILLY, ISBN: 978-1-449-37970-4.
5. Julie A. Jacko (Ed), "The Human-Computer Interaction Handbook", 3rd edition, CRC Press, 2012.
6. Zou J., Nagy G. (2006) "Human-Computer Interaction for Complex Pattern Recognition Problems".
7. Basu M., Ho T.K. (eds) "Data Complexity in Pattern Recognition. Advanced Information and Knowledge Processing", Springer, London.

e-Books :

- http://www.37steps.com/data/pdf/PRIntro_medium.pdf
- https://www.ecse.rpi.edu/~nagy/PDF_chrono/2005_Zou_Nagy_complexity_05.pdf
- <https://www.raywenderlich.com/240-android-accessibility-tutorial-getting-started>

MOOCs Courses link

- <https://www.edx.org/course/human-computer-interaction-i-fundamentals-design-p>
- <https://www.edx.org/course/human-computer-interaction-ii-cognition-context-cu>

The CO-PO mapping table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	2	1	1	1	-	-	1	1	3	1
CO2	2	2	-	1	-	-	-	2	1	-	-	-
CO3	-	1	2	3	-	1	-	1	-	-	1	-
CO4	-	-	-	2	3	1	-	-	1	-	-	-
CO5	3	2	2	-	2	2	2	-	-	2	2	3
CO6	-	1	2	1	2	3	-	1	-	-	-	2

Savitribai Phule Pune University
Third Year of Computer Science and Engineering
(Data Science) (2019 Course)

Elective I

310645 (B): Internet of Things and Embedded Systems

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Lecture: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses : Computer Networks and Security (310244)

Companion Course : Laboratory Practice I (310648)

Course Objectives:

- To understand fundamentals of Internet of Things (IoT) and Embedded Systems
- To learn advances in Embedded Systems and IoT
- To learn methodologies for IoT application development
- To learn the IoT protocols, cloud platforms and security issues in IoT
- To learn real world application scenarios of IoT along with its societal and economic impact using case studies and real time examples

Course Outcomes:

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

- CO1:** Understand the fundamentals and need of Embedded Systems for the Internet of Things
- CO2:** Apply IoT enabling technologies for developing IoT systems
- CO3:** Apply design methodology for designing and implementing IoT applications
- CO4:** Analyze IoT protocols for making IoT devices communication
- CO5:** Design cloud based IoT systems
- CO6:** Design and Develop secured IoT applications

Course Contents

Unit I	Introduction to Embedded Systems	(07 Hours)
Definition, Characteristics of Embedded System, Real time systems, Real time tasks. Processor basics: General Processors in Computer Vs Embedded Processors, Microcontrollers, Microcontroller Properties, Components of Microcontrollers, System-On-Chip and its examples, Components of Embedded Systems, Introduction to embedded processor.		
#Exemplar/Case Studies	Installation of Real Time Operating System	
*Mapping of Course Outcomes for Unit I	CO1, CO2	
Unit II	Internet of Things : Concepts	(07 Hours)

Introduction to Internet of Things (IoT): Definition, Characteristics of IoT, Vision, Trends in Adoption of IoT, IoT Devices, IoT Devices Vs Computers, Societal Benefits of IoT, Technical Building Blocks. Physical Design of IoT: Things in IoT, Interoperability of IoT Devices, Sensors and Actuators, Need of Analog / Digital Conversion. Logical Design of IoT: IoT functional blocks, IoT enabling technologies, IoT levels and deployment templates, Applications in IoT.		
#Exemplar/Case Studies		Exemplary device: Raspberry Pi / Arduino: Programming: Arduino IDE/ Python, Interfacing. Other IoT Devices.
*Mapping of Course Outcomes for Unit II		CO1,CO2
Unit III	IoT: Design Methodology	(07 Hours)
IoT Design Methodology: Steps, Basics of IoT Networking, Networking Components, Internet Structure, Connectivity Technologies, IoT Communication Models and IoT Communication APIs, Sensor Networks, Four pillars of IoT: M2M, SCADA, WSN, RFID.		
#Exemplar/Case Studies		Parser, CFG for Palindromes, Parenthesis Match
*Mapping of Course Outcomes for Unit III		CO3,CO4
Unit IV	IoT Protocols	(07 Hours)
Protocol Standardization for IoT, M2M and WSN Protocols, RFID Protocol, Modbus Protocol, Zigbee Architecture. IP based Protocols: MQTT (Secure), 6LoWPAN, LoRa.		
#Exemplar/Case Studies		LoRa based Smart Irrigation System.
*Mapping of Course Outcomes for Unit IV		CO4,CO5
Unit V	Cloud Platforms for IoT	(07 Hours)
Software Defined Networking, Introduction to Cloud Storage Models, Communication API. WAMP: AutoBahn for IoT, Xively Cloud for IoT. Python Web Application Framework: Django Architecture and application development with Django, Amazon Web Services for IoT, SkyNet IoT Messaging Platform, RESTful Web Service, GRPC,SOAP.		
#Exemplar/Case Studies		CO4, CO5
*Mapping of Course Outcomes for Unit V		Smart parking, Forest Fire Detection
Unit VI	Security in IoT	(07 Hours)
Introduction, Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoT, Threat Modeling. Key elements of IoT Security: Identity establishment, Access control, Data and message security, Non-repudiation and availability, Security model for IoT, Challenges in designing IOT applications, lightweight cryptography.		

#Exemplar/Case Studies	Home Intrusion Detection
*Mapping of Course Outcomes for Unit VI	CO4, CO5

Learning Resources

Text Books:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515
2. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, 2nd Edition, Wiley Publication, ISBN: 978-1-119-99435-0

Reference Books:

1. Dawoud Shenouda Dawoud, Peter Dawoud, “Microcontroller and Smart Home Networks”, ISBN: 9788770221566, e-ISBN: 9788770221559
2. Charles Crowell, “IoT-Internet of Things for Beginners: An Easy-to-Understand Introduction to IoT”, ISBN-13 : 979-8613100194
3. David Hanes, Gonzalo Salgueiro, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Cisco Press, ISBN-13: 978-1-58714-456-1 ISBN-10: 1-58714-456-5
4. David Etter, “IoT Security: Practical guide book”, amazon kindle Page numbers, source ISBN : 1540335011.
5. Brian Russell, Drew Van Duren, “Practical Internet of Things Security”, Second Edition, Packt Publishing, ISBN: 9781788625821

E-books:

- <https://www.iotforall.com/ebooks/an-introduction-to-iot>
- <https://www.qorvo.com/design-hub/ebooks/internet-of-things-for-dummies>

MOOC/ Video Lectures available at:

- <https://www.iotforall.com/ebooks/an-introduction-to-iot>
- <https://www.qorvo.com/design-hub/ebooks/internet-of-things-for-dummies>

The CO-PO mapping table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	2	-	-	-	-	1	-	1	-
CO2	3	1	1	2	1	-	-	-	-	-	-	-
CO3	2	3	3	3	2	3	-	-	2	-	1	-
CO4	1	2	2	2	3	3	-	-	2	1	2	2
CO5	2	2	2	3	3	3	-	-	2	1	2	2
CO6	2	2	1	2	2	2	-	1	1	-	1	1

Savitribai Phule Pune University
Third Year of Computer Science and Engineering (Data Science)
(2019 Course)

Elective I

310645(C): Software Modeling and Design

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Lecture: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses : Software Engineering and Project Management (210645), Object Oriented Programming (OOP) (210643)

Companion Course : Laboratory Practice I (310648)

Course Objectives:

- To understand and apply Object Oriented concept for designing Object Oriented based model or application
- To transform Requirement document to appropriate design
- To acquaint with the interaction between quality attributes and software architecture
- To understand different architectural designs, transform them into proper model and document them
- To understand software architecture with case studies and explore with examples, use of design pattern application

Course Outcomes:

Course Outcomes: On completion of the course, learners should be able to

CO1: Analyze the problem statement (SRS) and choose proper design technique for designing web-based/ desktop application

CO2: Design and analyze an application using UML modeling as fundamental tool

CO3: Evaluate software architectures

CO4: Use appropriate architectural styles and software design patterns

CO5: Apply appropriate modern tool for designing and modeling

Course Contents

Unit I	Concepts of Software Modelling	(07 Hours)
Software Modelling: Introduction to Software Modelling, Advantages of modelling, Principles of modelling, Evolution of Software Modeling and Design Methods: Object oriented analysis and design methods, Concurrent, Distributed Design Methods and Real-Time Design Methods, Model Driven Architecture (MDA), 4+1 Architecture, Introduction to UML, UML building Blocks, COMET Use Case–Based Software Life Cycle. Requirement Study: Requirement Analysis, SRS design, Requirements Modeling. Use Case: Actor and Use case identification, Use case relationship (Include, Extend, Use case Generalization, Actor Generalization), Use case template.		
#Exemplar/Case Studies	Requirement modelling and use case modelling for Real life applications (e.g., Online shopping system)	
*Mapping of Course Outcomes for Unit I	CO1,CO2	
Unit II	Static Modelling	(07 Hours)
Study of classes (analysis level and design level classes). Methods for identification of classes: RUP (Rational Unified Process), CRC (Class, Responsibilities and Collaboration), Use of Noun Verb analysis (for identifying entity classes, controller classes and boundary classes). Class Diagram: Relationship between classes,		

Generalization/Specialization Hierarchy, Composition and Aggregation Hierarchies, Associations Classes, Constraints. Object diagram, Package diagram, Component diagram, Composite Structure diagram, Deployment Diagram.		
#Exemplar/Case Studies	UML Static Diagrams for Real life applications (e.g., Online shopping system).	
*Mapping of Course Outcomes for Unit II	CO1 ,CO2	
Unit III	Dynamic Modelling	(07 Hours)
Introduction, Objectives of Activity Planning, Project Schedules. Activities: Sequencing and Scheduling, Network Planning Models, Formulating Network Model, Activity relationships (FS,SF,SS,FF), Forward Pass and Backward Pass techniques, Critical Path concept and remedies		
#Exemplar/Case Studies	UML dynamic Diagrams of for Real life applications.	
*Mapping of Course Outcomes for Unit II	CO1 ,CO2	
Unit IV	Software Architecture and Quality Attributes	
Introduction to Software Architecture, Importance of Software Architecture, Architectural Structure and Views. Architectural Pattern: common module, Common component-and-connector, Common allocation. Quality Attributes: Architecture and Requirements, Quality Attributes and Considerations		
#Exemplar/Case Studies	Case study of any real-life application	
*Mapping of Course Outcomes for Unit II	CO3	
Unit V	Architectural Design and Documentation	
Architecture in the Life Cycle: Architecture in Agile Projects, Architecture and Requirements, Designing an Architecture. Documenting Software Architecture: Notations, Choosing and Combining views, Building the documentation Package, Documenting Behavior, Documenting Architecture in an Agile Development Project		
#Exemplar/Case Studies	Air Traffic Control.	
*Mapping of Course Outcomes for Unit II	CO4 , CO5	
Unit VI	Design Patterns	
Design Patterns: Introduction, Different approaches to select Design Patterns. Creational patterns: Singleton, Factory, Structural pattern: Adapter, Proxy. Behavioral Patterns: Iterator, Observer Pattern with applications.		
#Exemplar/Case Studies	Flight Simulation	
*Mapping of Course Outcomes for Unit II	CO4, CO5	
Learning Resources		
Text Books : 1. Jim Arlow, Ila Neustadt, “UML 2 and the unified process –practical object-oriented analysis and design”, Addison Wesley, Second edition, ISBN 978-0201770605. 2. Len Bass, Paul Clements, Rick Kazman, "Software Architecture in Practice", Second Edition, Pearson ,ISBN 978-81-775-8996-2 3. Erich Gamma, “Design Patterns”, Pearson, ISBN 0-201-63361		
e-Books : 1. https://ebookpdf.com/roger-s-pressman-software-engineering 2. https://dhomaseghanshyam.files.wordpress.com/2016/02/gomaasoftwaremodellinganddesign.pdf 3. https://balu051989.files.wordpress.com/2011/06/the-unified-modeling-language-user-guideby-grady-booch-james-rumbaugh-ivar-jacobson.pdf 4. http://index-of.co.uk/Engineering/Software%20Engineering%20(9th%20Edition).pdf		

MOOCs Courses link

1. <https://nptel.ac.in/courses/106/105/106105224/>
2. https://onlinecourses.nptel.ac.in/noc20_cs59/preview
3. https://onlinecourses.nptel.ac.in/noc20_cs84/preview

The CO-PO mapping table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	-	-	-	-	-	-	-	-	1
CO2	1	1	3	-	-	-	-	-	-	-	-	1
CO3	1	1	2	1	-	-	-	-	-	-	-	1
CO4	1	1	3	4	-	-	-	-	-	-	-	1
CO5	1	1	3	-	-	-	-	-	-	-	-	1
CO6	1	1	3	-	-	-	-	-	-	-	-	2

Savitribai Phule Pune University
Third Year of Computer Science and Engineering in (Data Science)
(2019 Course)

Elective I

310645 (D): : Pattern Recognition

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Lecture: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses : Basics of Automata Theory

Companion Course : Laboratory Practice I (310648)

Course Objectives:

- To understand fundamentals of pattern recognition.
- To Study syntactic approach in pattern recognition.
- To study statistical approach in pattern recognition
- To study artificial neural network-based pattern recognition

Course Outcomes:

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

CO1: Distinguish variety of pattern recognition, classification and combination techniques.

CO2: Apply statistical pattern recognition approaches in variety of problems.

CO3: Elaborate different approaches of syntactic pattern recognition.

CO4: Differentiate graphical approach and grammatical inferences in syntactic pattern recognition.

CO5: Illustrate the artificial neural network-based pattern recognition

CO6: Apply unsupervised learning in pattern recognition.

Course Contents

Unit I	Introduction to Pattern Recognition	(07 Hours)
Pattern Recognition, Classification and Description, Pattern and Feature Extraction with Examples: Patterns and Features, Pattern Distortions, Examples: Features Extraction Using Generalized Cylinders for 3-D object Description and Classification, Generating RST Invariant Features and Application to 2-D Figure Recognition, The Feature Vector and Feature Space, Classifiers, Decision Regions and Boundaries and Discriminant Functions, Training and Learning in PR Systems: using A Priori knowledge or Experience, Learning Curves, Training Approaches, Pattern Recognition Approaches: Statistical, Syntactic, Neural Pattern Recognition Approach, Examples of Pattern Recognition Approaches.		
#Exemplar/Case Studies	Black Box Approaches to Pattern Recognition	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Statistical Pattern Recognition	(07 Hours)

Introduction to statistical pattern recognition, The Gaussian case and class dependance, Discriminant function, Additional Examples, Extensions: Training, Alternative Classification Procedures, Unsupervised Approaches, Classifier Performance, Risk and Errors: Measurement of Classification Performance, General Measures of Classification Risk.		
#Exemplar/Case Studies	statistical pattern recognition in image processing	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Syntactic Pattern Recognition	(07 Hours)
Overview, Qualifying structure in Pattern Description and Recognition, Grammar-Based Approach and Applications, Elements of Formal Grammars, Examples of String Generation as Pattern Description, Syntactic Recognition Via Parsing and other Grammars: -Recognition of Syntactic Descriptions, Parsing, CYK Parsing Algorithm, ATN in Parsing, Higher Dimensional Grammars, Stochastic Grammars and Applications.		
#Exemplar/Case Studies	Block World Description	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Graphical Approaches & Grammatical Inference in Syntactic Pattern Recognition	(07 Hours)
Graphical Approaches: Graph Based Structural Representation, Graph Isomorphism, A Structured Strategy to Compare Attribute Graphs, Other Attributed Graph Distance or Similarity measures. Learning Via Grammatical Inference: Learning Grammars, Problem formulation, Grammatical Inference (GI) Approaches, Procedures to Generate Constrained Grammars.		
#Exemplar/Case Studies	Structural Unification Using Attributed Graphs	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Neural Pattern Recognition	(07 Hours)
Introduction to Neural Networks: Neurons and Neural Nets, Neural Network Structures for PR Applications, Physical Neural Networks, The Artificial Neural Network Model. Introduction to Neural Pattern Associators and Matrix Approaches: Neural Network Based Pattern Associators, Matrix Approaches (Linear Associative Mappings) and Examples		
#Exemplar/Case Studies	Hardware Realizations of Neural Network	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Feedforward Networks & Unsupervised Learning in Neural Pattern Recognition	(07 Hours)
Multilayer, Feedforward Network Structure, Training the Feedforward Network: The Delta Rule, Generalized Delta Rule(GDR), Extension of the DR for Units in the Hidden layers, Pattern Associator for Character Classification, Unsupervised Learning in NeurPR: Self organizing Networks: Introduction, Adaptive Resonance Architectures, Self-Organizing Feature Maps(Kohonen).		

#Exemplar/Case Studies	Examples of Content Addressable Memory Applications in PR:Character Recognition, Relational Constraint Satisfaction(Coloring)
Mapping of Course Outcomes for Unit VI	CO6
Learning Resources	
Text Books: 1. ROBBERT SCHALKOFF, “Pattern Recognition: Statistical, Structural and Neural Approaches”, Willey Publication, ISBN978-81-245-1370-3 2. R.O.Duda, P.E.Hart and D.G.Stork, “Pattern Classification”, John Wiley,ISBN-978-0-471- 05669-0 Reference Books: 1. Earl Gose, Richard Johnsonbaugh, Steve Jost, “Pattern Recognition and Image Analysis” 2. Andrew R.Webb, Keith D.Copsey,”Statistical Pattern Recognition”,3rd edition Wiely , ISBN:978-0-470-68227- Christopher M. Bishop,”Neural network for Pattern Recognition,” Oxford University Press, ISBN-978-0-19-853864-6	
1. e-Books: http://users.isr.ist.utl.pt/~wurmd/Livros/school/Bishop%20%20Pattern%20Recognition%20And%20Machine%20Learning%20-%20Springer%20%202006.pdf2. 2. https://darmanto.akakom.ac.id/pengenalampola/Pattern%20Recognition%204th%20Ed.%20(2009).pdf 3. https://www.inf.ed.ac.uk/teaching/courses/nlu/assets/reading/Gurney_et_al.pdf	
MOOC Courses: https://nptel.ac.in/courses/117105101 https://nptel.ac.in/courses/106106046	

The CO-PO mapping table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	2	-	-	-	-	-	-	-	-
CO2	2	2	3	2	-	-	-	-	-	-	-	-
CO3	2	1	1	1	-	-	-	-	-	-	-	-
CO4	2	2	2	2	-	-	-	-	-	-	-	-
CO5	2	2	2	2	-	-	-	-	-	-	-	-

Savitribai Phule Pune University

Third Year of Computer Science and Engineering (Data Science) (2019 Course)

310646:Data Warehousing & Mining Laboratory

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hrs. / week	02	Practical: 25 Marks Term work: 25 Marks

Prerequisite Courses, if any: Fundamental knowledge of programming language and basics of algorithms.

Companion Course, if any:

Course Objectives

- CO1:** To teach principles, concepts and applications of data warehousing and data mining
CO2: To introduce the task of data mining as an important phase of knowledge recovery process
CO3 : To inculcate Conceptual, Logical, and Physical design of Data Warehouses OLAP applications and OLAP deployment
CO4: To inculcate fundamental concepts that provide the foundation of data mining
CO5: Design a data warehouse or data mart to present information needed by management in a form that is usable for management client

Course Outcomes

- CO1:** Understand the functionality of the various data mining and data warehousing component.
CO2: Appreciate the strengths and limitations of various data mining and data warehousing models.
CO3: Explain the analyzing techniques of various data
CO4: Describe different methodologies used in data mining and data ware housing
CO5: Analyze the efficiency of most appropriate data structure for creating efficient solutions for engineering design situations.

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

1. The laboratory assignments are to be submitted by students in the form of journal. Journal consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, 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.
2. **Program codes with sample output of all performed assignments are to be submitted as softcopy.**
3. 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.
4. 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 at Laboratory.

Guidelines for Laboratory /Term Work Assessment

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

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. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of Hungarian notation, proper indentation and comments. Use of open-source software is to be encouraged.

In addition to these, instructor may assign one real life application in the form of a mini-project 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.

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

Programming tools recommended: - Open-Source Weka Tool

Suggested List of Laboratory Experiments/Assignments

Sr. No.	Group A
1.	Explore WEKA Data Mining/Machine Learning Toolkit.
2.	Perform data preprocessing tasks and Demonstrate performing association rule mining on data sets.
3.	Demonstrate performing classification on data sets.
4.	Data cube construction – OLAP operations.
5.	Implementation of Apriori algorithm
6.	Implementation of Decision Tree Induction
7.	Classification of data using Bayesian approach.
8.	To apply the web mining technique clustering algorithm for the given dataset
9.	To find association between data and to find the frequent item set for text mining.
10.	To design fact and dimension tables.

@The CO-PO Mapping Matrix

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	1	2	2	-	-	-	-	-	-	-	-	-
C02	-	2	2	-	-	-	-	-	-	-	-	-
C03	-	2	2	1	-	-	-	-	-	-	-	-
C04	1	2	1	1	-	-	-	-	-	-	-	-
C05	1	1	2	2	-	-	-	-	-	-	-	-

Savitribai Phule Pune University

**Third Year of Computer Science and Engineering(Data Science)
(2019 Course)**

310247: Computer Networks and Security Laboratory

Teaching Scheme:	Credit:	Examination Scheme:
PR: 02 Hours/Week	01	Term Work: 25 Marks Oral Exam: 25 Marks

Companion Course, if any: Computer Network and Security (310244)

Course Objectives:

CO1: To learn computer network hardware and software components.

CO2: To learn computer network topologies and types of network.

CO3: To develop an understanding of various protocols, modern technologies and applications.

CO4: To learn modern tools for network traffic analysis.

CO5: To learn network programming

Course Outcomes:

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

CO1: Analyze the requirements of network types, topology and transmission media

CO2: Demonstrate error control, flow control techniques and protocols and analyze them

CO3: Demonstrate the subnet formation with IP allocation mechanism and apply various routing algorithms

CO4: Develop Client-Server architectures and prototypes

CO5: Implement web applications and services using application layer protocols

CO6: Use network security services and mechanisms

Guidelines for Instructors 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 Students 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, punctuality and

Guidelines for Oral Examination

Oral examination should be jointly conducted by the internal examiner and external examiner. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementations in term work. 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. Operating System recommended: -64-bit Open-source Linux or its derivative Programming tools recommended: - Open-Source /C/C++/JAVA Programming tool like G++/GCC, Wireshark/Ethereal and Packet Tracer

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

Sr. No.	Group A (Unit I and II): Attempt any two assignments from Sr. No. 1 to 3. Assignments 4 and 5 are compulsory.
1	Setup a wired LAN using Layer 2 Switch. It includes preparation of cable, testing of cable using line tester, configuration machine using IP addresses, testing using PING utility and demonstrating the PING packets captured traces using Wireshark Packet Analyzer Tool.
2	Demonstrate the different types of topologies and types of transmission media by using a packet tracer tool.
3	Setup a WAN which contains wired as well as wireless LAN by using a packet tracer tool. Demonstrate transfer of a packet from LAN 1 (wired LAN) to LAN2 (Wireless LAN).
Group B (Unit III and IV)	
6	Write a program to demonstrate Sub-netting and find subnet masks.
7	Write a program to implement link state /Distance vector routing protocol to find suitable path for transmission.
8	Use packet Tracer tool for configuration of 3 router network using one of the following protocol RIP/OSPF/BGP.
9	Write a program using TCP socket for wired network for following a. Say Hello to Each other b. File transfer c. Calculator
10	Write a program using UDP Sockets to enable file transfer (Script, Text, Audio and Video one file each) between two machines.
Group C (Unit V and VI): Assignment Sr. No. 11 is Compulsory and attempt any four from Assignments Sr. No 12 to 17.	

11	Write a program for DNS lookup. Given an IP address as input, it should return URL and vice-versa
12	Installing and configure DHCP server and write a program to install the software on remote machine
13	Capture packets using Wireshark, write the exact packet capture filter expressions to accomplish the following and save the output in file: 1. Capture all TCP traffic to/from Facebook, during the time when you log in to your Facebook account 2. Capture all HTTP traffic to/from Facebook, when you log in to your Facebook account 3. Write a DISPLAY filter expression to count all TCP packets (captured under item #1) that have the flags SYN, PSH, and RST set. Show the fraction of packets that had each flag set. 4. Count how many TCP packets you received from / sent to Face book, and how many of each were also HTTP packets.
14	Study and Analyze the performance of HTTP, HTTPS and FTP protocol using Packet tracer tool.
15	To study the SSL protocol by capturing the packets using Wireshark tool while visiting any SSL secured website (banking, e-commerce etc.).
16	Illustrate the steps for implementation of S/MIME email security through Microsoft® Office Outlook.
17	To study the IPsec (ESP and AH) protocol by capturing the packets using Wireshark tool.

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	2	-	2	1	1	-	-	-	1	1
CO2	-	3	-	1	1	-	-	1	-	-	-	-
CO3	3	2	1	1	-	-	-	1	-	-	-	1
CO4	-	1	2	1	1	1	-	-	-	-	-	1
CO5	2	3	-	-	1	-	-	-	1	-	-	-
CO6	-	1	3	1	1	-	1	-	2	-	-	1

Savitribai Phule Pune University

Third Year of Computer Science and Engineering (Data Science) (2019 Course)
310648: Laboratory Practice- I

Teaching Scheme:	Credit:	Examination Scheme:
Practical: 02 Hrs. / week	01	Oral: 25 Marks Term work: 25 Marks

Prerequisite Courses, if any: Basic Electronics Engineering

Companion Course, if any: -

Course Objectives:

- To learn and apply various search strategies for AI
- To learn various techniques, tools, applications in IoT and Embedded Systems /Human Computer Interaction/ IoT/Software Modeling and Design

Course Outcomes:

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

● **Artificial Intelligence**

- CO1:** Design system using different informed search / uninformed search or heuristic approaches
- CO2:** Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge Representation, and learning.
- CO3:** Design and develop an expert system

● **Human Computer Interface**

- CO4:** Implement the interactive designs for feasible data search and retrieval.
- CO5:** Analyze the scope of HCI in various paradigms like ubiquitous computing, virtual Reality and ,multimedia, World wide web related environments.
- CO6:** Analyze and identify user models, user support, socio-organizational issues, and stakeholder Requirements of HCI systems.

OR

● **Internet of Things and Embedded Systems**

- CO7:** Design IoT and Embedded Systems based application
- CO8:** Develop smart applications using IoT
- CO9:** Develop IoT applications based on cloud environment

OR

● **Software Modeling and Design**

- CO10:** Use tools and techniques in the area Software Modeling and Architectures
- CO11:** Use the knowledge of Software Modeling and Architectures for problem solving
- CO12:** Apply the concepts Software Modeling and Architectures to design and develop applications

OR • Pattern Recognition	
CO13: Developing a comprehensive skill set that includes coding, data preprocessing, model evaluation, problem-solving, teamwork, and applying machine learning techniques to real-world problems.	
Guidelines for Instructor's Manual	
The faculty member should prepare the laboratory manual for all the experiments and it should be made available to students and laboratory instructor/assistant. The instructor's manual should include prologue, university syllabus, conduction& Assessment guidelines, topics under consideration concept, objectives, outcomes, algorithms, sample test cases, data sheets of various elements of computer system, ICs, tools 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 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, circuit diagram, pin configuration, conclusion/analysis).	
As a conscious effort and little contribution towards Green IT and environment awareness, attaching papers as part of write-ups and program listing to journal may be avoided.	
Guidelines for Laboratory /Term Work Assessment	
Continuous assessment of laboratory work is done based on overall performance and Laboratory Performance of student. Each Laboratory assignment assessment should assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each Laboratory assignment assessment include- timely completion, performance, innovation, efficiency, punctuality and neatness.	
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. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. Artificial Intelligence: Human computer Interface-GUI in python Internet of Things and Embedded System- Raspberry Pi/Arduino Programming; Arduino IDE/Python Interfacing. Other IoT devices Software Modeling and Design –Rational Rose/Star UML/Any Open Source Software Modeling Software	
Virtual Laboratory: • http://cse18-iiith.vlabs.ac.in/Introduction.html?domain=Computer%20Science • http://vlabs.iitb.ac.in/vlabs-dev/labs/cglab/index.php	
Suggested List of Laboratory Experiments/Assignments	
PART –I Artificial Intelligence	
Sr. No.	Group A All assignments are compulsory
1.	Implement depth first search algorithm and Breadth First Search algorithm, Use an undirected graph and develop a recursive algorithm for searching all the vertices of a graph or tree data structure.
2.	Implement A star Algorithm for any game search problem.
3.	Implement Greedy search algorithm for any of the following application: I. Selection Sort II. Minimum Spanning Tree III. Single-Source Shortest Path Problem IV. Job Scheduling Problem V. Prim's Minimal Spanning Tree Algorithm VI. Kruskal's Minimal Spanning Tree Algorithm VII. Dijkstra's Minimal Spanning Tree Algorithm
Group B	

4.	Implement a solution for a Constraint Satisfaction Problem using Branch and Bound and Backtracking for n-queens problem or a graph coloring problem.
5.	Develop an elementary chatbot for any suitable customer interaction application.
Group C	
	Implement any one of the following Expert System I. Information management II. Hospitals and medical facilities III. Help desks management IV. Employee performance evaluation V. Stock market trading VI. Airline scheduling and cargo schedules
PART-II (Elective –I)	
Human Computer Interface	
1	Design a paper prototype for selected Graphical User Interface.
2	Implement GOMS (Goals, Operators, Methods and Selection rules) modeling technique to model user's behavior in given scenario.
3	Design a User Interface in Python.
4	To redesign existing Graphical User Interface with screen complexity.
Internet of Things and Embedded Systems	
1	Understanding the connectivity of Raspberry-Pi / Adriano with IR sensor. Write an application to detect obstacle and notify user using LEDs
2	Understanding the connectivity of Raspberry-Pi /Beagle board circuit with temperature sensor. Write an application to read the environment temperature. If temperature crosses a threshold value, generate alerts using LEDs.
3	Understanding and connectivity of Raspberry-Pi /Beagle board with camera. Write an application to capture and store the image.
Software Modeling and Design	
1	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 scenario
2	Draw basic class diagrams, to identify and describe key concepts like classes, types in your system and their relationships.
3	Draw basic diagrams of Dynamic Modeling.
4	Draw a state model for any application, with various activities.
5	Draw activity diagrams to display either business flows or like flow charts
6	Draw component diagrams assuming that you will build your system reusing existing components along with a few new ones
7	Draw deployment diagrams to model the runtime architecture of your system.

Pattern Recognition	
1	For face Recognition • Implemented PCA and multiclass LDA. • Using Eigen Faces and Fisher Faces to recognize faces in the orl faces data set.
2	Perform sentiment analysis on the IMDB movie reviews dataset
3	Perform a classification task on a dataset of modulated radio signals.
4.	Perform image segmentation on the Berkley Segmentation dataset

@The CO-PO Mapping Matrix												
CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	2	3	-	-	-	-	-	-	1
CO2	1	2	2	2	2	-	-	-	-	-	-	1
CO3	1	2	2	2	2	-	-	-	-	-	-	1
CO4	1	2	3	2	-	2	-	-	2	1	2	-
CO5	1	2	2	1	-	2	-	-	3	2	1	-
CO6	2	2	2	1	-	2	-	-	2	-	2	1
CO7												
CO8												
CO9												
CO10												

Savitribai Phule Pune University

Third Year of Computer Science and Engineering (Data Science) (2019 Course)

310649: Seminar

Teaching Scheme	Credit Scheme	Examination Scheme and Marks Term Work
Practical: 01 Hours/Week	01	50

Course Objectives:

- To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques
- To explore the latest technologies
- To enhance the communication skills
- To develop problem analysis skills

Course Outcomes:

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

CO1: Analyze a latest topic of professional interest

CO2: Enhance technical writing skills

CO3: Identify an engineering problem, analyze it and propose a work plan to solve it

CO4: Communicate with professional technical presentation skills

Guidelines

- Each student will select a topic in the area of Computer Engineering and Technology preferably keeping track
- with recent technological trends and development beyond scope of syllabus avoiding repetition in
- Consecutive years.
- The topic must be selected in consultation with the Institute guide.
- Each student will make a seminar presentation using audio/visual aids for a duration of 20-25 minutes and
- Submit the seminar report prepared in Latex only.
- Active participation at classmate seminars is essential.
- BoS has circulated the Seminar Log book and it is recommended to use it.

Guidelines for Assessment

Panel of staff members along with a guide would be assessing the seminar work based on these parameters-Topic, Contents and Presentation, regularity, Punctuality and Timely Completion, Question and Answers, Report, Paper presentation/Publication, Attendance and Active Participation.

Recommended Format of the Seminar Report

- ☐ Title Page with Title of the topic, Name of the candidate with Exam Seat Number / Roll Number, Name of the Guide, Name of the Department, Institution and Year and University
- ☐ Seminar Approval Sheet/Certificate
- ☐ Abstract and Keywords
- ☐ Acknowledgements
- ☐ Table of Contents, List of Figures, List of Tables and Nomenclature

☐ Chapters Covering topic of discussion- Introduction with section including organization of the report, Literature Survey/Details of design/technology/Analytical and/or experimental work, if any/,Discussions and Conclusions ,Bibliography/References

☐ Plagiarism Check report

☐ Report Documentation page

Reference Books :

1. Rebecca Stott, Cordelia Bryan, Tory Young, “Speaking Your Mind: Oral Presentation and Seminar Skills (Speak-Write Series)”, Longman, ISBN-13: 978-0582382435
2. Johnson-Sheehan, Richard, “Technical Communication”, Longman. ISBN 0-321-11764-6
3. Vikas Shirodka, “Fundamental skills for building Professionals”, SPD, ISBN 978-93-5213- 146-5

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	2	1	-	-	-	-	-	-	-	-
CO2	-	1	2	1	-	-	-	-	-	-	-	-
CO3	-	1	1	-	-	-	-	-	-	-	-	-
CO4	2	2	2	1	-	-	-	-	-	-	-	-

Savitribai Phule Pune University

Third Year of Computer Science and Engineering (Data Science) (2019 Course)

310650: Environmental Studies

Teaching Scheme	Credit Scheme	Examination Scheme and Marks Term Work
Practical: 01 Hours/Week	– 01	50

Prerequisite Courses, if any:

Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere.

Companion Course, if any: -

Preamble:

An environmental study is a multidisciplinary academic field which systematically studies human interaction with the environment. Environmental studies connect principles from the physical sciences, commerce/economics, the humanities, and social sciences to address complex contemporary environmental issues. Imparting basic knowledge about the environment and its allied problems. Developing an attitude of concern for the environment

Course Objectives:

- To gain an understanding of the Environment where we live
- Understanding the importance of water
- To educate about Air and Noise pollution
- To explain the concepts of E- waste and Green Computing

Course Outcomes:

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

CO1: To gain an understanding of the Environment where we live

CO2: Understanding the importance of water

CO3: To educate about Air and Noise pollution

CO4: To explain the concepts of E- waste and Green Computing

UNIT I	Introduction to Environmental Pollution	(03 Hours)
Environmental pollution: Environment and its importance, Definition, Types. Effect of environmental pollution on Plants, Non-living things.		
UNIT II	Water Pollution	(03 Hours)
Water Pollution: Definition, Sources of water Pollution, Types of wastewater-Domestic and industrial wastewater		
UNIT III	Air Pollution and Noise Pollution	(03 Hours)
Air pollution: Definition, Sources/causes of air pollution. Atmospheric layers, Effects on human. Noise Pollution: Definition of Noise Pollution, Types of Noise Pollution		
UNIT IV	E-waste Management and Green computing	(03 Hours)
E-waste management: Definition of E-waste, Sources of E-waste, Types of E-waste Green computing: Definition, Objectives of Green Computing, Necessity, Environmental benefits		
Abstract and Keywords		

Tutorial Conduction and Term work Guidelines (Set of Suggested Activities)

The students are expected to submit 1) Report/Presentation on the effect of Environmental Pollution on any world famous Structure/ monument. 2) Report/Presentation on importance of different sources of water available nearby them. 3) Report/Presentation based on the data collected from the local authorities on air pollution and noise pollution. 4) Report/Presentation on the E-Waste generated in the campus.

Learning Resources

Text Books:

1. “The text book of Environmental studies”, Dr. P. D. Raut, Shivaji University, 2013.
2. “A Text Book of Environmental Studies”, Dr. D. K. Asthana, S. Chand.
3. “Environmental Pollution, monitoring and control”, S. M. Khopkar, New Age Publication

Reference Books :

1. “Air Pollution”, M. N. Rao, McGrawHill, Publication.
2. “E-waste Management and Procurement of Environment”, Dr. Suresh Kumar, Authorspress, 2021.
3. “Green Computing Approach towards sustainable development”, M. Afshar Alam, Dreamtech Press. 2020.

Web Links:

1. Prof. Mukesh Sharma, IIT Kanpur <https://archive.nptel.ac.in/courses/105/102/105102089>
2. Prof. J. Bhattacharyya, IIT Kharagpur, <https://archive.nptel.ac.in/courses/123/105/123105001>
3. Prof. Bhola Ram Gurjar, IIT Roorkee, <https://archive.nptel.ac.in/courses/105/107/105107213>

e-Books:

1. Bharucha, Erach (2005): “Text Book of Environmental Studies for Undergraduate Courses”, University Press (India) pvt ltd, Hyderabad, India
2. Kothari Dr Milind- 2005- Environmental Education- Universal Publication Agra.
3. IGNOU 1995- FST- 1/4 Foundation course in Science and Technology “Environment and Resource” – Indira Gandhi Open University, New Delhi.

MOOC Courses: https://onlinecourses.swayam2.ac.in/cec21_ge21/preview

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University

Third Year of Computer Science and Engineering in (Data Science) (2019 Course) 310651: Audit Course 5

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 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

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

- | | |
|---|---|
| <ul style="list-style-type: none">• Lectures/ Guest Lectures• Visits (Social/Field) and reports• Demonstrations | <ul style="list-style-type: none">• 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
- Presentations, IPR/Publication and Report

Audit Course 5 Options

Audit Course Code	Audit Course Title
AC5-I	Cyber Security
AC5-II	Professional Ethics and Etiquette
AC5-III	Learn New Skills -Full Stack Developer
AC5-IV	Engineering Economics
AC5-V	Foreign Language (one of Japanese/ Spanish/ French/ German). Course contents for Japanese (Module 3) are provided. For other languages institute may design suitably.

Note: It is permitted to opt one of the audit courses listed at SPPU website too, if not opted earlier.

<http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202017/Forms/AllItems.aspx>

http://www.unipune.ac.in/university_files/syllabi.htm

AC5-I: Cyber Security

Prerequisites: Computer Network and Security (310244)

Course Objectives:

1. To motivate students for understanding the various scenarios of cybercrimes
2. To increase awareness about the cybercrimes and ways to be more secure in online activities
3. To learn about various methods and tools used in cybercrimes
4. To analyze the system for various vulnerabilities

Course Outcomes:

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

- CO1:** Understand and classify various cybercrimes
CO 2: Understand how criminals plan for the cybercrimes
CO 3: Apply tools and methods used in cybercrime
CO 4: Analyze the examples of few case studies of cybercrimes

Course Contents

1. Introduction to Cybercrime: Introduction, Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Cybercriminals, Classifications of Cybercrimes, Cybercrime: The Legal Perspectives, Cybercrimes: An Indian Perspective.
2. Cyber offenses: How Criminals Plan Them: Introduction, How Criminals Plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.
3. Tools and Methods Used in Cybercrime : Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks (Expected to cover the introduction to all these terms).
4. Cybercrime: Illustrations, Examples and Mini-Cases : Introduction, Real-Life Examples, Mini-Cases, Illustrations of Financial Frauds in Cyber Domain, Digital Signature-Related Crime Scenarios, Digital Forensics Case Illustrations, Online Scams.

Team Projects:

Students will be formed into groups to research green construction and design in a particular construction context and report their results to the class. What are the particular obstacles and opportunities to integrating green construction techniques into the following sectors? Be sure to consider technical, social, political and economic issues:

Hotels (economy, luxury, resorts), Hospitals, Retail (big box, malls, small scale downtown retail), Office, Government, ,Schools, Universities, Housing, Transportation Stations (Airport Terminals, Train Stations).

Text Books :

1. Nina Godbole, Sunit Belapure , “Cyber Security- Understanding Cyber Crimes”, Computer Forensics and Legal Perspectives, Wiely India Pvt. Ltd, ISBN- 978-81-265-2179-1
2. William Stallings, “Computer Security: Principles and Practices”, Pearson 6thEd, ISBN 978-013-335469-0

Reference Books :

1. Berouz Forouzan, “Cryptography and Network Security”, TMH, 2 edition, ISBN -978-00-7070208-0. 5.
2. Mark Merkow, “Information Security-Principles and Practices”, Pearson Ed., ISBN- 978-81317-1288-7
3. CK Shyamala et el., “Cryptography and Security”, Wiley India Pvt. Ltd, ISBN-978-81-2652285-9

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	2	1	-	3	-	1	-	2
CO2	1	1	1	1	1	1	-	3	-	1	-	2
CO3	1	1	1	1	1	1	-	3	-	1	-	2
CO4	1	1	1	1	1	1	-	3	-	1	-	2

AC5-II: Professional Ethics and Etiquettes

Prerequisites: Business Communication Skill

Course Objectives:

1. To learn importance of ethics and the rules of good behavior for today's most common social and business situations.
2. To acquire basic knowledge of ethics to make informed ethical decisions when confronted with problems in the working environment.
3. To develop an understanding towards business etiquettes and the proper etiquette practices for different business scenarios.
4. To learn the etiquette requirements for meetings, entertaining, telephone, email and Internet business interaction scenario.

Course Outcomes:

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

CO1: Summarize the principles of proper courtesy as they are practiced in the workplace.

CO2: Apply proper courtesy in different professional situations.

CO3: Practice and apply appropriate etiquettes in the working environment and day to day life.

CO4: Build proper practices personal and business communications of Ethics and Etiquettes.

Course Contents

1. **Introduction to Ethics:** Basics, Difference Between Morals, Ethics, and Laws, Engineering Ethics: Purpose of Engineering Ethics-Professional and Professionalism, Professional Roles to be played by an Engineer, Uses of Ethical Theories, Professional Ethics, Development of Ethics.
2. **Professional Ethics:** IT Professional Ethics, Ethics in the Business World, Corporate Social Responsibility, Improving Corporate Ethics, Creating an Ethical Work Environment, Including Ethical Considerations in Decision Making, Ethics in Information Technology, Common Ethical issues for IT Users, Supporting the Ethical Practices of IT users.
3. **Business Etiquette:** ABC's of Etiquette, Developing a Culture of Excellence, The Role of Good Manners in Business, Enduring Words Making Introductions and Greeting People: Greeting Components, The Protocol of Shaking Hands, Introductions, Introductory Scenarios, Addressing Individuals Meeting and Board Room Protocol: Guidelines for Planning a Meeting, Guidelines for Attending a Meeting.
4. **Professional Etiquette:** Etiquette at Dining, Involuntary Awkward Actions, How to Network, Networking Etiquette, Public Relations Office(PRO)'s Etiquettes, Technology Etiquette : Phone Etiquette, Email Etiquette, Social Media Etiquette, Video Conferencing Etiquette, interview Etiquette, Dressing Etiquettes : for interview, offices and social functions.

References Books:

1. Ghillyer, “Business Ethics Now”, 3rd Edition, McGraw-Hill.
2. George Reynolds, “Ethics in information Technology”, Cengage Learning, ISBN- 10:1285197151.
3. Charles E Harris, Micheat J. Rabins, “Engineering Ethics”, Cengage Learning, ISBN- 13:9781133934684,4th Edition.

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	-	-	-	-	-	1	1	3	1	2	-	2
CO2	-	-	-	-	-	1	1	3	1	2	-	2
CO3	-	-	-	-	-	1	1	3	1	2	-	2
CO4	-	-	-	-	-	1	1	3	1	2	-	2

AC5-III: Learn New Skills- Full Stack Developer

Prerequisites: Programming Skills

Course Objectives:

1. To understand the fundamental concepts in designing web based applications and applying
2. frontend and backend technologies
3. To understand the fundamental concepts in applying database techniques in application
4. To progress the student towards term "industry ready engineer"

Course Outcomes:

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

CO1: Design and develop web application using frontend and backend technologies.

CO2: Design and develop dynamic and scalable web applications

CO3: Develop server side scripts

CO4: Design and develop projects applying various database techniques

Course Contents

1. Full stack Developer
2. HTML5
3. CSS3
4. Bootstrap
5. Vanilla JS (ES6+)
6. Flask or Django
7. Wagtail CMS
8. Node.js
9. MySQL
10. jQuery

Team Projects: Design and develop an e-commerce a dynamic, scalable and responsive web application. (Sample Project similar problem statements and be formulated).

Reference Books:

1. Bharucha, E.,—Textbook of “Environmental Studies”, Universities Press(2005),ISBN 10:8173715408
2. Mahua Basu, ”Environmental Studies”, Cambridge University Press, ISBN-978-1-107-5317- 3

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	1	1	1	1
CO2	3	3	3	3	3	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1	1	1

AC5-IV: Engineering Economics

Engineering economics is one of the most practical subject matters in the engineering curriculum, but it is an always challenging, ever-changing discipline. Engineers are planners and builders. They are also problem solvers, manager, decision makers. Engineering economics touches of these activities. .

Course Objectives

- To understand engineering economics and money management
- To understand financial project analysis
- To estimate project cost and apply for business
- To understand making financial decisions when acting as team member or manager in the engineering project

Course Outcomes

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

- CO1:** Understand economics, the cost money and management in engineering
CO2: Analyze business economics and engineering assets evaluation
CO3: Evaluate project cost and its elements for business
CO4: Develop financial statements and make business decisions

Course Contents

- 1. Understanding money and its management:** Engineering Economic Decisions, Time value of money, Money management, Equivalence calculations.
- 2. Evaluating business and engineering assets:** Present worth analysis, Annual equivalence Analysis, Rate of Return Analysis, Benefit Cost Analysis.
- 3. Development project cash flow:** Accounting of Income Taxes, Project cash flow Analysis, Handling Project Uncertainty.
- 4. Special topics in Engineering Economics:** Replacement decisions, understanding financial statements.

References Books:

1. Chan S Park, “Fundamentals of Engineering Economics”, Pearson, ISBN-13: 9780134870076
2. James Riggs, “Engineering Economics”, Tata McGraw-Hill, ISBN – 13: 9780070586703

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	-	-	-	2	2	3	1
CO2	3	3	3	-	-	-	-	-	2	2	3	1
CO3	3	3	3	-	-	-	-	-	2	2	3	1
CO4	3	3	3	-	-	-	-	-	2	2	3	1

AC5-V: Foreign Language (Japanese)-Module 3

Prerequisites: We recommend that candidates should have previously completed AC3-V(210251) and AC4-V (210260)

Course Objectives:

- To open up more doors and job opportunities
- To introduce to Japanese society, culture and entertainment

Course Outcomes:

On completion of the course learner will able to

CO1: Apply language to communicate confidently and clearly in the Japanese language

CO2: Understand and use Japanese script to read and write

CO3: Apply knowledge for next advance level reading, writing and listening skills

CO4: Develop interest to pursue further study, work and leisure

Course Contents

1. The Kanji: Brief Historical Outline, Introduction to Kanji, From Pictures to characters
2. Read and Write 58 Kanji Characters, talk about yourself/family/others, things, time, events, and activities- in the present, future, and past tense; shop at stores and order food at restaurants;
3. Lessons: Karate, Park(Playground), The Grandpa's Inaka, The Sun and the Moon, My little sister, Rice Fields, My Teacher, People who Exit and People who Enter.

Reference:

1. Japanese Kanji and Kana, “A complete guide to the Japanese writing system”, Wolfgang Hadamitzky & Mark Spahn, Tuttle Publishing, Third edition ISBN: 978-1-4629-1018 2(eBook)
2. Banno, Eri, Yoko Ikeda, et al. Genki I, “An Integrated Course in Elementary Japanese”, 2nd ed. Japan Times/Tsai Fong Books, 2011. ISBN: 9784789014403.
3. Anna Sato and Eriko Sato, “My First Japanese Kanji Book, Learning kanji the fun and easy way”, TUTTLE PUBLISHING, First Edition ISBN: 978-1-4629-1369-5 (eBook)

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	-	-	-	-	-	-	-	-	1	3	1	1
CO2	-	-	-	-	1	-	-	-	-	3	1	1
CO3	-	-	-	-	1	-	-	-	-	3	2	2
CO4	-	-	-	-	-	-	-	-	-	1	-	1

Semester VI

Savitribai Phule Pune University

Third Year of Computer Science and Engineering in (Data Science) (2019 Course)

310251: Data Science and Big Data Analytics

Teaching Scheme:	Credit:	Examination Scheme:
TH: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks
Prerequisite Courses, if any: Mathematical Foundation for Data Science –I (210641), Database Management Systems (210655)		
Companion Course, if any: Data Science and Big Data Analytics Laboratory (310256)		
Course Objectives: CO1: To understand the need of Data Science and Big Data CO2: To understand computational statistics in Data Science CO3: To study and understand the different technologies used for Big Data processing CO4: To understand and apply data modelling strategies CO5: To learn Data Analytics using Python programming CO6: To be conversant with advances in analytics		
Course Outcomes: On completion of the course, learner will be able to— CO1: Analyze needs and challenges for Data Science Big Data Analytics CO2: Apply statistics for Big Data Analytics CO3: Apply the lifecycle of Big Data analytics to real world problems CO4: Implement Big Data Analytics using Python programming CO5: Implement data visualization using visualization tools in Python programming CO6: Design and implement Big Databases using the Hadoop ecosystem		
Course Contents		
Unit I	Introduction to Data Science and Big Data	(07 Hours)
Basics and need of Data Science and Big Data, Applications of Data Science, Data explosion, 5 V's of Big Data, Relationship between Data Science and Information Science, Business intelligence versus Data Science, Data Science Life Cycle, Data: Data Types, Data Collection. Need of Data wrangling, Methods: Data Cleaning, Data Integration, Data Reduction, Data Transformation, Data Discretization.		
#Exemplar/Case Studies	Create academic performance dataset of students and perform data preprocessing using techniques of data cleaning and data transformation	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Statistical Inference	(07 Hours)
Need of statistics in Data Science and Big Data Analytics, Measures of Central Tendency: Mean, Median, Mode, Mid-range. Measures of Dispersion: Range, Variance, Mean Deviation, Standard Deviation. Bayes theorem, Basics and need of hypothesis and hypothesis testing, Pearson Correlation, Sample Hypothesis testing, Chi-Square Tests. t-test		

#Exemplar/Case Studies	For an employee dataset, create measure of central tendency and its measure of dispersion for statistical analysis of given data.
Mapping of Course Outcomes for Unit II	CO2
Unit III	Big Data Analytics Life Cycle (07 Hours)
Introduction to Big Data, sources of Big Data, Data Analytic Lifecycle: Introduction, Phase 1: Discovery, Phase 2: Data Preparation, Phase 3: Model Planning, Phase 4: Model Building, Phase 5: Communication results, Phase 6: Operationalize.	
#Exemplar/Case Studies	Case study: Global Innovation Social Network and Analysis (GINA).

Mapping of Course Outcomes for Unit III	CO3
Unit IV	Predictive Big Data Analytics with Python (07 Hours)
Introduction , Essential Python Libraries, Basic examples. Data Preprocessing: Removing Duplicates, Transformation of Data using function or mapping, replacing values, Handling Missing Data. Analytics Types: Predictive, Descriptive and Prescriptive. Association Rules: Apriori Algorithm, FP growth. Regression: Linear Regression, Logistic Regression. Classification: Naïve Bayes, Decision Trees. Introduction to Scikit-learn , Installations, Dataset, matplotlib, filling missing values, Regression and Classification using Scikit-learn.	
#Exemplar/Case Studies	Use IRIS dataset from Scikit and apply data preprocessing methods
Mapping of Course Outcomes for Unit IV	CO4, CO2
Unit V	Big Data Analytics and Model Evaluation (07 Hours)
Clustering Algorithms: K-Means, Hierarchical Clustering, Time-series analysis. Introduction to Text Analysis: Text-preprocessing, Bag of words, TF-IDF and topics. Need and Introduction to social network analysis, Introduction to business analysis. Model Evaluation and Selection: Metrics for Evaluating Classifier Performance, Holdout Method and Random Subsampling, Parameter Tuning and Optimization, Result Interpretation, Clustering and Time-series analysis using Scikit-learn, sklearn.metrics, Confusion matrix, AUC-ROC Curves, Elbow plot.	
#Exemplar/Case Studies	Use IRIS dataset from Scikit and apply K-means clustering methods
Mapping of Course Outcomes for Unit V	CO4, CO2
Unit VI	Data Visualization and Hadoop (07 Hours)
Introduction to Data Visualization, Challenges to Big data visualization, Types of data visualization, Data Visualization Techniques, Visualizing Big Data, Tools used in Data Visualization, Hadoop ecosystem, Map Reduce, Pig, Hive, Analytical techniques used in Big data visualization. Data Visualization using Python: Line plot, Scatter plot, Histogram, Density plot, Box- plot.	
#Exemplar/Case Studies	Use IRIS dataset from Scikit and plot 2D views of the dataset
Mapping of Course Outcomes for Unit V	CO5, CO6

Learning Resources

Text Books:

1. David Dietrich, Barry Hiller, “Data Science and Big Data Analytics”, EMC education services, Wiley publication, 2012, ISBN0-07-120413-X.
2. Jiawei Han, Micheline Kamber, and Jian Pie, “Data Mining: Concepts and Techniques” Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807

Reference Books:

1. EMC Education Services, “Data Science and Big Data Analytics- Discovering, analyzing Visualizing and Presenting Data”
2. DT Editorial Services, “Big Data, Black Book”, DT Editorial Services, ISBN: 9789351197577, 2016 Edition.
3. Chirag Shah, “A Hands-On Introduction To Data Science”, Cambridge University Press, (2020), ISBN : ISBN 978-1-108-47244-9.
4. Wes McKinney, “Python for Data Analysis” O' Reilly media, ISBN: 978-1-449-31979-3.
5. “Scikit-learn Cookbook”, Trent hawk, Packt Publishing, ISBN: 9781787286382
6. Jenny Kim, Benjamin Bengfort, “Data Analytics with Hadoop”, O'Reilly Media, Inc., ISBN: 9781491913703.
7. Venkat Ankam, “Big Data Analytics”, Packt Publishing, ISBN: 9781785884696

MOOCs Courses links:

- Computer Science and Engineering - NOC:Data Science for Engineers
- Computer Science and Engineering - NOC:Python for Data Science
- Computer Science and Engineering - NOC:Data Mining
- Computer Science and Engineering - NOC:Big Data Computing
- Big Data Computing - Course

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	1	3	2	1	-	-	-	-	1	-	-	1
C02	1	2	1	2	-	1	-	-	1	-	-	1
C03	2	1	2	1	-	1	-	-	1	-	-	1
C04	1	2	2	2	2	-	-	-	1	-	-	1
C05	1	2	2	1	2	-	-	-	1	-	-	1
C06	1	2	1	2	2	-	-	-	1	-	-	1

Savitribai Phule Pune University Third Year of Computer Science and Engineering (Data Science) (2019 Course) 310252: Web Technology		
Teaching Scheme:	Credit:	Examination Scheme:
TH: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks
Prerequisite Courses, if any: Database Management Systems (310341), Computer Networks and Security (310244)		
Companion Course, if any: Web Technology Laboratory (310257)		
Course Objectives: 1. To learn the fundamentals of web essentials and markup languages 2. To use the Client side technologies in web development 3. To use the Server side technologies in web development 4. To understand the web services and frameworks		
Course Outcomes: On completion of the course, learner will be able to– CO1: Implement and analyze behavior of web pages using HTML and CSS CO2: Apply the client side technologies for web development CO3: Analyze the concepts of Servlet and JSP CO4: Analyze the Web services and frameworks CO5: Apply the server side technologies for web development CO6: Create the effective web applications for business functionalities using latest web development platforms		
Course Contents		
Unit I	Web Essentials and Mark-up language HTML	(07 Hours)
The Internet, basic internet protocols, the world wide web, HTTP Request message, HTTP response message, web clients, web servers. HTML: Introduction, history and versions. HTML elements: headings, paragraphs, line break, colors and fonts, links, frames, lists, tables, images and forms, Difference between HTML and HTML5. CSS: Introduction to Style Sheet, CSS features, CSS core syntax, Style sheets and HTML, Style rule cascading and inheritance, text properties. Bootstrap		
#Exemplar/Case Studies	Create a style sheet suitable for blogging application using HTML and using style sheet	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Client Side Technologies: JavaScript and DOM	(07 Hours)

JavaScript: Introduction to JavaScript, JavaScript in perspective, basic syntax, variables and data types, statements, operators, literals, functions, objects, arrays, built in objects, JavaScript debuggers. DOM: Introduction to Document Object Model, DOM history and levels, intrinsic event handling, modifying element style, the document tree, DOM event handling, jQuery, Overview of Angular JS.	
#Exemplar/Case Studies	Enhancement in created blogging application using JavaScript (Add Entry feature)

Mapping of Course Outcomes for Unit II		CO2
Unit III	Java Servlets and XML	(07 Hours)
Servlet: Servlet architecture overview, A “Hello World” servlet, Servlets generating dynamic content, Servlet life cycle, parameter data, sessions, cookies, URL rewriting, other Servlet capabilities, data storage, Servlets concurrency, databases (MySQL) and Java Servlets. XML: XML documents and vocabularies, XML declaration, XML Namespaces, DOM based XML processing, transforming XML documents, DTD: Schema, elements, attributes. AJAX: Introduction, Working of AJAX.		
#Exemplar/Case Studies	Develop server-side code for blogging application	
Mapping of Course Outcomes for Unit III		CO3
Unit IV	JSP and Web Services	(07 Hours)
JSP: Introduction to Java Server Pages, JSP and Servlets, running JSP applications, Basic JSP, JavaBeans classes and JSP, Support for the Model-view-controller paradigm, JSP related technologies. Web Services: Web Service concepts, Writing a Java Web Service, Writing a Java web service client, Describing Web Services: WSDL, Communicating Object data: SOAP. Struts: Overview, architecture, configuration, actions, interceptors, result types, validations, localization, exception handling, annotations.		
#Exemplar/Case Studies	Transform the blogging application from a loose collection of various resources (servlets, HTML documents, etc.) to an integrated web application that follows the MVC paradigm	
Mapping of Course Outcomes for Unit IV		CO3, CO4
Unit V	Server Side Scripting Languages	(07 Hours)
PHP: Introduction to PHP, uses of PHP, general syntactic characteristics, Primitives, operations and expressions, output, control statements, arrays, functions, pattern matching, form handling, files, cookies, session tracking, using MySQL with PHP, WAP and WML. Introduction to ASP.NET: Overview of the .NET Framework, Overview of C#, Introduction to ASP.NET, ASP.NET Controls, Web Services. Overview of Node JS.		

#Exemplar/Case Studies	Use of PHP in developing blogging application.	
Mapping of Course Outcomes for Unit V	CO5, CO6	
Unit VI	Ruby and Rail	(07 Hours)
Introduction to Ruby: Origins & uses of Ruby, scalar types and their operations, simple input and output, control statements, fundamentals of arrays, hashes, methods, classes, code blocks and iterators, pattern matching. Introduction to Rails: Overview of Rails, Document Requests, Processing Forms, Rails Applications and Databases, Layouts, Rails with Ajax. Introduction to EJB.		
#Exemplar/Case Studies	Study of dynamic web product development using ruby and rails	
Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		
Text Books:		
1. Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.		
2. Robert W. Sebesta, “Programming the World Wide Web”, 4th Edition, Pearson education, 2008.		
Reference Books:		
1. Marty Hall, Larry Brown,"Core Web Programming", Second Edition, Pearson Education, 2001, ISBN 978-0130897930.		
2. H.M. Deitel, P.J. Deitel and A.B. Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006, ISBN 978-0131752429.		
3. Chris Bates, “Web Programming Building Internet Applications”, 3rd Edition, Wiley India, 2006.		
4. Xue Bai et al, “The web Warrior Guide to Web Programming”, Thomson, 2003.		
MOOC Courses:		
□ http://www.nptelvideos.in/2012/11/internet-technologies.html		
□ https://freevideolectures.com/course/2308/internet-technology/25 video lecture by Prof. Indranil Sengupta, IIT, Kharagpur		
□ https://www.digimat.in/nptel/courses/video/106105191/L01.html		
□ http://www.nptelvideos.com/php/php_video_tutorials.php		

The CO-PO mapping table												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	1	1	-	-	-	-	-	-	-
CO2	-	2	1	3	1	-	-	-	1	-	-	-
CO3	2	-	2	1	-	1	-	-	-	-	1	
CO4	1	3	1	2	2	1	-	1	-	-	-	1
CO5	1	1	2	-	3	-	1	1	-	1	-	-
CO6	2	1	-	2	1	1	-	1	-	-	-	-

Savitribai Phule Pune University

**Second Year of Computer Science and Engineering
(Data Science)(2019 Course)**

310652:Machine Learning

Teaching Scheme:	Credit:	Examination Scheme:
TH: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: Data Science and Big Data Analytics(310251)

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:

After 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

Unit I	Introduction To Machine Learning	(06 Hours)
Introduction to Machine Learning, Comparison of Machine learning with traditional programming, ML vs AI vs Data Science.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 learningapproaches.		
#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 VI	CO1	
Unit II	Feature Engineering	(07Hours)

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 vectorcreation. 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 seemseffective. 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 isworking 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 VI	CO2	
Unit III	Supervised Learning: Regression	(06 Hours)
Classification: K-nearest neighbour, Support vector machine.Ensemble Learning: Bagging, Boosting, Random Forest,Adaboost. Binary-vs-Multiclass Classification, Balanced and Imbalanced Multiclass Classification Problems,Variants of Multiclass Classification: One-vs-One and One-vs-All Evaluation Metrics and Score: Accuracy, Precision Recall, Fscore, Cross-validation, MicroAverage Precision and Recall, Micro-Average F-score, Macro-Average Precision and Recall,Macro-Average F-score.		
#Exemplar/Case Studies	Stock market price prediction	
*Mapping of Course Outcomes for Unit VI	CO3	
Unit IV	Supervised Learning: Classification	(08Hours)
Classification: K-nearest neighbour, Support vector machine.Ensemble Learning: Bagging, Boosting, Random Forest, Adaboost. Binary-vs-Multiclass Classification, Balanced and Imbalanced Multiclass Classification Problems,Variants of Multiclass Classification: One-vs-One and One-vs-All Evaluation Metrics and Score: Accuracy, Precision, Recall, Fscore, Cross-validation, MicroAverage Precision and Recall, Micro-Average F-score, Macro-Average Precision and Recall,Macro-Average F-score.		
#Exemplar/Case Studies	Prediction of Thyroid disorders such as Hyperthyroid,Hypothyroid, Euthyroid-sick,and Euthyroid using multiclass classifier.	
*Mapping of Course Outcomes for Unit VI	CO4	
Unit V	Unsupervised Learning	(07 Hours)
K-Means, K-medoids, Hierarchical, and Density-based Clustering, Spectral Clustering. Outlier analysis: introduction of isolation factor, local outlier factor. Evaluation metrics and score: elbow method, extrinsic and intrinsic methods		
#Exemplar/Case Studies	Environmental monitoring and conservation, Epidemiological analysis and	

	disease surveillance.
*Mapping of Course Outcomes for Unit V	CO5
Unit VI	Introduction To Neural Networks (07 Hours)
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	
#Exemplar/Case Studies	Movie Recommendation System
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources	
Text Books:	
1. Bishop, Christopher M., and Nasser M. Nasrabadi, “Pattern recognition and machine learning”, Vol. 4.No. 4. New York: springer, 2006. 2. Ethem Alpaydin, “ Introduction to Machine Learning”, PHI 2nd Edition-2013	
Reference Books:	
1. Tom Mitchell, “ Machine learning”, McGraw-Hill series in Computer Science, 1997 2. Shalev-Shwartz, Shai, and Shai Ben-David, “Understanding machine learning: From theory to algorithms”, Cambridge university press, 2014. 3. Jiawei Han, Micheline Kamber, and Jian Pie, “Data Mining: Concepts and Techniques”, Elsevier Publishers Third Edition, ISBN: 9780123814791,9780123814807 4. Hastie, Trevor, et al., “The elements of statistical learning: data mining, inference, and prediction”, Vol. 2. New York: springer, 2009. 5. McKinney, “Python for Data Analysis “,O' Reilly media, ISBN : 978-1-449-31979-3 6. Trent hauk, “Scikit-learn”, Cookbook , Packt Publishing, ISBN: 9781787286382 7. Goodfellow I.,Bengio Y. and Courville, “ A Deep Learning”, MIT Press, 2016	
MOOC Courses:	
• Introduction to Machine Learning : https://nptel.ac.in/courses/106105152 • Introduction to Machine Learning (IIT Madras): • https://onlinecourses.nptel.ac.in/noc22_cs29/preview • Deep learning: https://nptel.ac.in/courses/106106184	

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	1	2	-	-	-	-	-	-	-
CO2	1	1	1	1	1	-	-	-	-	-	-	-
CO3	1	2	1	1	1	-	-	-	-	-	-	-
CO4	2	2	2	1	1	-	-	-	-	-	-	-
CO5	2	2	2	2	1	-	-	-	-	-	-	-
CO6	-	1	-	1	1	-	-	-	-	-	-	-

**Third Year of Computer Science and Engineering
(Data Science) (2019 Course)**

Elective II

310653(A): Robotics and Automation

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks
Prerequisite Courses, if any: Artificial Intelligence (610643)		
Companion Course, if any: Laboratory Practice II (310654)		
Course Objectives: CO1: To impart knowledge about basic mathematics related to industrial robots CO2: To Design and control application in robotics & automation Industries		
Course Outcomes: On completion of the course, learners should be able to CO1 : Demonstrate the Sensors, actuators, End effectors CO2 : Analyze Robot Kinematics and Dynamics with simulation CO3 : Summarize control laws for simple robot CO4 : Develop robot program for robot application		
Course Contents		
Unit I	Introduction to Automation and Robotics	(06 Hours)
Introduction to Automation, Types, Strategies, Automated Flow Lines, Automated Guided Vehicles, Automated Storage and Retrieval Systems, Introduction to CAD/ CAM/ CIM, Industry 4.0 Introduction to Robotics – Laws of Robotics, Robot Anatomy, Classification of Robots, Robots Links and Joints, Degrees of Freedom, Robot Configurations, Work Envelope		
#Exemplar/Case Studies	Robot Specifications	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Robot Sensors and Vision	(07 Hours)
Sensors – Contact and Proximity, Position, Force, velocity, Touch, Range, Tactile, Acoustic, Light Curtain, Sensor Selection Robot Vision – Components of vision system, image acquisition, Cameras, Image Storage and Image Processing, feature Extraction, Object recognition.		
#Exemplar/Case Studies	Open Source/ Free/ Trial Tools: crypt tool	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	Robot Kinematics and Dynamics	(07 Hours)
3 Robot Kinematics – Translation and Rotation representation, Coordinate Transformation, Denavit Hartenberg parameters, Forward and Inverse Kinematics, Jacobian, Singularity and Statics Robot Dynamics – Forward and Inverse Dynamics, Equation of Motion using Euler – Lagrange Formulation and Newton – Euler Formulation		
#Exemplar/Case Studies	Case study on kinematic and dynamics of Industrial robot	
Mapping of Course Outcomes for Unit III	CO3	

Unit IV	Robot End Effectors and actuation systems	(07 Hours)
Robot End Effectors – Grippers - Mechanical, Pneumatic, Hydraulic, Magnetic, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers Actuators - Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives - Servo Motors, Stepper Motors, BLDC motor, Micro actuators, selection of actuators, Power transmission systems for robot, Motion conversion.		
#Exemplar/Case Studies	Casestudy on Gripper design	
Mapping of Course Outcomes for Unit IV	CO1	
Unit V	Robot Control System	(07 Hours)
Embedded Systems – microcontroller architecture, Integration of Sensors and Actuators Basics of Control – Open and Closed Loop, Transfer Functions, Control Law Partitioning, PID Control, Linear and Nonlinear control, Force / Position Control, Adaptive control Introduction to Trajectory Planning, Artificial Intelligence in Robotics, Robotic Simulation		
#Exemplar/Case Studies	Casestudy on Robot controller	
Mapping of Course Outcomes for Unit V	CO3	
Unit VI	Robot Performance, Applications and programming	(07 Hours)
Robot Performance – Resolution, repeatability, accuracy, dexterity, Compliance, RCC Applications of Robots – in Unmanned systems, Defense, medical, Industries Robot Programming – Methods of Robot Programming, Lead through Programming, Motion Interpolation, Robot Language Structure, Programming in VAL II, motion commands, End effector and Sensor Commands, Monitor mode commands		
#Exemplar/Case Studies	Robot program on palletizing and Depalletizing	
Mapping of Course Outcomes for Unit VI	CO4	
Learning Resources		
Text Books: 1. Text Books: – Groover M.P.- Automation, production systems and computer integrated manufacturing‘ - Prentice Hall of India. 2. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009 3. R K Mittal & I J Nagrath, Robotics and Control, McGraw Hill Publication, 2015 4. Ganesh Hegde, Industrial Robotics, Laxmi publication 5. S. K. Saha, Introduction to Robotics, TMH International 6. Groover, Industrial Robotics, Tata McGraw-Hill Education		
Reference Books: 1. Mark W Spong, M. Vidyasagar, Robot Dynamics And Control, John Wiley & Sons 2. Richard D. Klafter, Robotics Engineering: An Integrated Approach, Pearson		

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	2	2	1	-	-	1	-	-	2
CO2	2	3	2	2	2	-	-	-	1	-	-	2
CO3	2	3	2	2	2	-	-	-	1	-	-	2
CO4	2	-	-	2	2	1	-	-	1	-	-	2

Savitribai Phule Pune University
Second Year of Computer Science and Engineering
(Data Science) (2019 Course)
Elective II
310653(B):Natural Language Processing

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: Mathematical Foundation for Data Science (), Data Structures and Algorithms (), Artificial Intelligence ()

Companion Course, if any: Laboratory Practice II (310654)

Course Objectives:

- To understand the basic concepts of Natural Language Processing (NLP)
- To understand use of morphological aspect in NLP
- To learn and implement syntax parsing techniques
- To learn and implement semantics parsing techniques
- To learn and implement Machine Translation techniques
- To design and develop different application using NLP

Course Outcomes:

On completion of the course, learners should be able to

CO1: Understand the fundamental concepts in field of NLP

CO2: Understand morphological aspect and processing in NLP

CO3: Distinguish among various techniques of syntax parsing

CO4: Understand use of various parsing techniques to parse sentence and extract meaning from its structure.

CO5: Apply different Machine translation techniques for translating a source to target language(s)

CO6: Design and implement different application using NLP

Course Contents

Unit I	Fundamentals of Natural Language Processing	(06Hours)
History of NLP, Generic NLP system, levels of NLP, Knowledge in language processing, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP, Approaches of NLP: Rule based, Data Based, Knowledge Based approaches		
#Exemplar/Case Studies	Comparative study of available libraries for Natural Language processing with respect to functionalities provided, platform dependence, supported NLP approaches, supported NLP tasks, advantages and disadvantages etc.	

Mapping of Course Outcomes for Unit I		CO1
Unit II	Word level processing	(08 Hours)
Types of Morphology: English and Indian Languages, Finite-State Morphological Parsing, building a Finite-State Lexicon, Finite-State Transducers, FSTs for Morphological Parsing, Transducers and Orthographic rules, The Porter Stemmer, Word and Sentence Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance, Human Morphological Processing N-Grams: Building N-gram for spelling corrections, N-gram for language model.		
#Exemplar/Case Studies		Study the use of Virtual Reality at NASA
Mapping of Course Outcomes for Unit II		CO2
Unit III	Syntax Parsing	(08 Hours)
Constituency Grammars: Context free grammar, grammar rules for English, treebanks, grammar equivalence and normal forms, lexicalized grammar. Constituency Parsing: Ambiguity, CKY parsing, span based neural constituency parsing, evaluation parsers, partial parsing, CCG parsing, Dependency parsing: dependency relations, dependency formalism, dependency treebank, transition and graph based dependency parsing, evaluations.		
#Exemplar/Case Studies		Dialogue systems and summarization
Mapping of Course Outcomes for Unit III		CO3
Unit IV	Semantic Parsing	(08 Hours)
Word Senses and WordNet: Word senses, relation between senses, WordNet, wordsense disambiguation, WSD algorithm and task, Word sense inductions Semantic role labelling: semantic roles, diathesis alteration, problems with thematic roles, proposition bank, frameNet, semantic role labelling, selection restrictions, decomposition of predicates, Lexicon for sentiment, affect and connotation: emotions, sentiment and affect lexicons, Creating Affect Lexicons by Human Labeling, Semi-supervised Induction of Affect Lexicons, Supervised Learning of Word Sentiment, Using Lexicons for Sentiment Recognition, Other tasks: Personality, Affect Recognition, Lexicon-based methods for Entity-Centric Affect, Connotation Frames		
#Exemplar/Case Studies		Semantic Parsing Using Content and Context
Mapping of Course Outcomes for Unit IV		CO4
Unit V	Machine Translation (MT)	(08 Hours)
Need of MT, Problems of Machine Translation, MT Approaches, Direct Machine Translations, RuleBased Machine Translation, Knowledge Based MT System, Statistical Machine Translation (SMT), Parameter learning in SMT (IBM models) using EM), Encoder-decoder architecture, Neural Machine Translation		
#Exemplar/Case Studies		ANN, RNN
Mapping of Course Outcomes for Unit V		CO5

Unit VI	Applications of NLP Applications of NLP	(07 Hours)
Information retrieval-Vector Space Model, Information Extraction using sequence labelling, Question answers system, categorization, summarization, sentiment analysis, Named Entity Recognition. Analyzing text with NLTK, Chatbot using Dialogflow.		
#Exemplar/Case Studies	Amazon Lex ,NLTK	
Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		
Text Books:		
1. Daniel Jurafsky, James H. Martin, “Speech and Language Processing”, Second Edition, Prentice Hall, 2008. 2. Christopher D.Manning and Hinrich Schutze,, “Foundations of Statistical Natural Language Processing” , MIT Press, 1999		
Reference Books:		
1. Steven Bird,Ewan Klein and Edword Loper,” NLP with Python:Analyzing text with the Natural Language Toolkit”, O’Reilly Media,Inc 2. Nitin Indurkha and Fred J. Damerau, “Handbook of Natural Language Processing”, 2nd ed. CRC press.		
e-Books:		
1. Yoav Goldberg. A primer on neural network models for natural language processing, 2015. URL http://u.cs.biu.ac.il/~yogo/nnlp.pdf.		

The CO-PO mapping table												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	-	-	-	-	-	-	-	-
CO2	2	3	3	2	-	-	-	-	-	-	-	-
CO3	2	2	3	2	-	-	-	-	-	-	-	-
CO4	2	3	3	3	-	-	-	-	-	-	-	-
CO5	2	3	3	3	-	-	-	-	-	2	2	1
CO6	2	3	-	3	-	-	-	-	-	2	2	2

Savitribai Phule Pune University

**Third Year of Computer Science and Engineering
(Data Science) (2019 Course)**

Elective II

310653(C): Cloud Computing

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: Computer Networks and Security (310244), Distributed System (310245C)

Companion Course, if any: Laboratory Practice II (310654)

Course Objectives:

- CO1:** To study fundamental concepts of cloud computing
CO2: To learn various data storage methods on cloud
CO3: To understand the implementation of Virtualization in Cloud Computing
CO4: To learn the application and security on cloud computing
CO5: To study risk management in cloud computing
CO6: To understand the advanced technologies in cloud computing

Course Outcomes:

On completion of the course, learners should be able to

- CO1:** Understand the different Cloud Computing environment
CO2: Use appropriate data storage technique on Cloud, based on Cloud application
CO3: Analyze virtualization technology and install virtualization software
CO4: Develop and deploy applications on Cloud
CO5: Apply security in cloud applications
CO6: Use advance techniques in Cloud Computing

Course Contents

Unit I	Introduction to Cloud Computing	(07 Hours)
Importance of Cloud Computing, Characteristics, Pros and Cons of Cloud Computing, Migrating into the Cloud, Seven-step model of migration into a Cloud, Trends in Computing. Cloud Service Models: SaaS, PaaS, IaaS, Storage. Cloud Architecture: Cloud Computing Logical Architecture, Developing Holistic Cloud Computing Reference Model, Cloud System Architecture, Cloud Deployment Models.		
#Exemplar/Case Studies	Cloud Computing Model of IBM	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Data Storage and Cloud Computing	(07 Hours)

Data Storage: Introduction to Enterprise Data Storage, Direct Attached Storage, Storage Area Network, Network Attached Storage, Data Storage Management, File System, Cloud Data Stores, Using Grids for Data Storage. Cloud Storage: Data Management, Provisioning Cloud storage, Data Intensive Technologies for Cloud Computing. Cloud Storage from LANs to WANs: Cloud Characteristics, Distributed Data Storage.		
#Exemplar/Case Studies		Online Book Marketing Service, Online Photo Editing Service
Mapping of Course Outcomes for Unit II		CO2
Unit III	Virtualization in Cloud Computing	(07 Hours)
Introduction: Definition of Virtualization, Adopting Virtualization, Types of Virtualization, Virtualization Architecture and Software, Virtual Clustering, Virtualization Application, Pitfalls of Virtualization. Grid, Cloud and Virtualization: Virtualization in Grid, Virtualization in Cloud, Virtualization and Cloud Security. Virtualization and Cloud Computing: Anatomy of Cloud Infrastructure, Virtual infrastructures, CPU Virtualization, Network and Storage Virtualization.		
#Exemplar/Case Studies		Xen: Para virtualization, VMware: Full Virtualization, Microsoft Hyper-V
Mapping of Course Outcomes for Unit III		CO3
Unit IV	Security in Cloud Computing	(07 Hours)
Amazon Web Services (AWS): Amazon Web Services and Components, Amazon Simple DB, Elastic Cloud Computing (EC2), Amazon Storage System, Amazon Database services (Dynamo DB). Microsoft Cloud Services: Azure core concepts, SQL Azure, Windows Azure Platform Appliance. Cloud Computing Applications: Healthcare: ECG Analysis in the Cloud, Biology: Protein Structure Prediction, Geosciences: Satellite Image Processing, Business and Consumer Applications: CRM and ERP, Social Networking, Google Cloud Application: Google App Engine. Overview of OpenStack architecture.		
#Exemplar/Case Studies		Multiplayer Online Gaming
Mapping of Course Outcomes for Unit IV		CO4
Unit V	Advanced Techniques in Cloud Computing	(07 Hours)
Risks in Cloud Computing: Risk Management, Enterprise-Wide Risk Management, Types of Risks in Cloud Computing. Data Security in Cloud: Security Issues, Challenges, advantages, Disadvantages, Cloud Digital persona and Data security, Content Level Security. Cloud Security Services: Confidentiality, Integrity and Availability, Security Authorization Challenges in the Cloud, Secure Cloud Software Requirements, Secure Cloud Software Testing.		
#Exemplar/Case Studies		Cloud Security Tool: Acunetix.
Mapping of Course Outcomes for Unit V		CO5

Unit VI	Data Warehousing and Data Mining	(07 Hours)
Future Trends in cloud Computing, Mobile Cloud, Automatic Cloud Computing: Comet Cloud. Multimedia Cloud: IPTV, Energy Aware Cloud Computing, Jungle Computing, Distributed Cloud Computing Vs Edge Computing, Containers, Docker, and Kubernetes, Introduction to DevOps. IOT and Cloud Convergence: The Cloud and IoT in your Home, The IOT and cloud in your Automobile, PERSONAL: IoT in Healthcare.		
#Exemplar/Case Studies	Case studies on DevOps: DocuSign, Forter, Gengo.	
Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		
Text Books:		
1. A. Srinivasan, J. Suresh, “Cloud Computing: A Practical Approach for Learning and Implementation”, Pearson, ISBN: 978-81-317-7651-3		
2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, “Mastering Cloud Computing”, McGraw Hill Education, ISBN-13:978-1-25-902995-0		
Reference Books:		
3. James Bond ,“The Enterprise Cloud”, O'Reilly Media, Inc. ISBN: 9781491907627		
4. Dr. Kris Jamsa, “Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more”, Wiley Publications, ISBN: 978-0-470-97389-9		
5. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, “Cloud Computing: A Practical Approach”, 2010, The McGraw-Hill.		
6. Gautam Shrof, “ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications”, Cambridge University Press, ISBN: 9780511778476		
7. Tim Mather, Subra K, Shahid L.,”Cloud Security and Privacy”, Oreilly, ISBN-13 978-81- 8404-815-5		
MOOC Courses:		
☐ Cloud Computing https://onlinecourses.nptel.ac.in/noc21_cs14/preview?		
☐ Cloud Computing and Distributed System: https://onlinecourses.nptel.ac.in/noc21_cs15/preview?		
☐ https://www.digimat.in/nptel/courses/video/106105167/L01.html		
☐ https://www.digimat.in/nptel/courses/video/106105167/L03.html		
☐ https://www.digimat.in/nptel/courses/video/106105167/L20.html		

The CO-PO mapping table												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	-	-	-	-	-	-	-	-	1
CO2	1	2	1	-	-	-	-	-	-	-	-	-
CO3	1	2	1	-	2	-	-	-	-	-	-	-
CO4	1	2	2	1	-	-	-	-	-	-	-	1
CO5	1	2	2	2	-	-	-	-	-	-	-	-
CO6	1	2	2	1	1	-	-	-	-	-	-	1

Savitribai Phule Pune University
Second Year of Computer Science and Engineering
(Data Science) (2019 Course)

310256: Data Science and Big Data Analytics Laboratory

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hrs. / week	02	Term work: 50 Marks Practical: 25 Marks

Prerequisite Courses, if any: - Data Science and Big Data Analytics (310251)

Course Objectives:

CO1: To understand principles of Data Science for the analysis of real time problems

CO2: To develop in depth understanding and implementation of the key technologies in Data Science and Big Data Analytics

CO3: To analyze and demonstrate knowledge of statistical data analysis techniques for decision-making

CO4: To gain practical, hands-on experience with statistics programming languages and Big Data tools

Course Outcomes:

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

CO1: Apply principles of Data Science for the analysis of real time problems

CO2: Implement data representation using statistical methods

CO3: Implement and evaluate data analytics algorithms

CO4: Perform text preprocessing

CO5: Implement data visualization techniques

CO6: Use cutting edge tools and technologies to analyze Big Data

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.

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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.

Set of suggested assignment list is provided in groups- A and B. Each student must perform 13 assignments (10 from group A, 3 from group B), 2 mini project from Group C

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

Programming tools recommended: - JAVA/Python/R/Scala

Virtual Laboratory:

- ☐ "Welcome to Virtual Labs - A MHRD Govt of india Initiative"
- ☐ <http://cse20-iiith.vlabs.ac.in/List%20of%20Experiments.html?domain=Computer%20Science>

Suggested List of Laboratory Experiments/Assignments

Assignments from all Groups (A,B,C) are compulsory.

Sr. No.	Group A : Data Science
1.	Data Wrangling, I Perform the following operations using Python on any open source dataset (e.g., data.csv) 1. Import all the required Python Libraries. 2. Locate an open source data from the web (e.g., https://www.kaggle.com). Provide a clear description of the data and its source (i.e., URL of the web site). 3. Load the Dataset into pandas dataframe. 4. Data Preprocessing: check for missing values in the data using pandas isnull(), describe() function to get some initial statistics. Provide variable descriptions. Types of variables etc. Check the dimensions of the data frame. 5. Data Formatting and Data Normalization: Summarize the types of variables by checking the data types (i.e., character, numeric, integer, factor, and logical) of the variables in the data set. If variables are not in the correct data type, apply proper type conversions. 6. Turn categorical variables into quantitative variables in Python. In addition to the codes and outputs, explain every operation that you do in the above steps and explain everything that you do to import/read/scrape the data set.
2.	Data Wrangling II Create an “Academic performance” dataset of students and perform the following operations using Python. 1. Scan all variables for missing values and inconsistencies. If there are missing values and/or inconsistencies, use any of the suitable techniques to deal with them. 2. Scan all numeric variables for outliers. If there are outliers, use any of the suitable techniques

	to deal with them. 3. Apply data transformations on at least one of the variables. The purpose of this transformation should be one of the following reasons: to change the scale for better understanding of the variable, to convert a non-linear relation into a linear one, or to decrease the skewness and convert the distribution into a normal distribution. Reason and document your approach properly.
3.	Descriptive Statistics - Measures of Central Tendency and variability Perform the following operations on any open source dataset (e.g., data.csv) 1. Provide summary statistics (mean, median, minimum, maximum, standard deviation) for a dataset (age, income etc.) with numeric variables grouped by one of the qualitative (categorical) variable. For example, if your categorical variable is age groups and quantitative variable is income, then provide summary statistics of income grouped by the age groups. Create a list that contains a numeric value for each response to the categorical variable. 2. Write a Python program to display some basic statistical details like percentile, mean, standard deviation etc. of the species of 'Iris-setosa', 'Iris-versicolor' and 'Iris-versicolor' of iris.csv dataset. Provide the codes with outputs and explain everything that you do in this step.
4.	Data Analytics I Create a Linear Regression Model using Python/R to predict home prices using Boston Housing Dataset (https://www.kaggle.com/c/boston-housing). The Boston Housing dataset contains information about various houses in Boston through different parameters. There are 506 samples and 14 feature variables in this dataset. The objective is to predict the value of prices of the house using the given features.
5.	Data Analytics II 1. Implement logistic regression using Python/R to perform classification on Social_Network_Ads.csv dataset. 2. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset.
6.	Data Analytics II 1. Implement logistic regression using Python/R to perform classification on Social_Network_Ads.csv dataset. 2. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset.
7.	Text Analytics 1. Extract Sample document and apply following document preprocessing methods: Tokenization, POS Tagging, stop words removal, Stemming and Lemmatization. 2. Create representation of document by calculating Term Frequency and Inverse Document Frequency
8.	Data Visualization I 1. Use the inbuilt dataset 'titanic'. The dataset contains 891 rows and contains information about the passengers who boarded the unfortunate Titanic ship. Use the Seaborn library

	to see if we can find any patterns in the data. 2. Write a code to check how the price of the ticket (column name: 'fare') for each passenger is distributed by plotting a histogram.
9.	Data Visualization II 1. Use the inbuilt dataset 'titanic' as used in the above problem. Plot a box plot for distribution of age with respect to each gender along with the information about whether they survived or not. (Column names : 'sex' and 'age') 2. Write observations on the inference from the above statistics.
10.	Data Visualization III Download the Iris flower dataset or any other dataset into a DataFrame. (e.g., https://archive.ics.uci.edu/ml/datasets/Iris). Scan the dataset and give the inference as: 1. List down the features and their types (e.g., numeric, nominal) available in the dataset. 2. Create a histogram for each feature in the dataset to illustrate the feature distributions. 3. Create a boxplot for each feature in the dataset. 4. Compare distributions and identify outliers
Sr. No.	Group B- Big Data Analytics – JAVA/SCALA (Any three)
1	Write a code in JAVA for a simple WordCount application that counts the number of occurrences of each word in a given input set using the Hadoop MapReduce framework on local-standalone set-up.
2	Design a distributed application using MapReduce which processes a log file of a system.
3	Locate dataset (e.g., sample_weather.txt) for working on weather data which reads the text input files and finds average for temperature, dew point and wind speed.
4	Locate dataset (e.g., sample_weather.txt) for working on weather data which reads the text input files and finds average for temperature, dew point and wind speed.
Sr. No.	Group C- Mini Projects/ Case Study – PYTHON/R (Any TWO Mini Project)
1	Write a case study on Global Innovation Network and Analysis (GINA). Components of analytic plan are 1. Discovery business problem framed, 2. Data, 3. Model planning analytic technique and 4. Results and Key findings.
2	Use the following dataset and classify tweets into positive and negative tweets. https://www.kaggle.com/ruchi798/data-science-tweets
3	Develop a movie recommendation model using the scikit-learn library in python. Refer dataset https://github.com/rashida048/Some-NLP-Projects/blob/master/movie_dataset.csv
4	Use the following covid_vaccine_statewise.csv dataset and perform following analytics on the given dataset https://www.kaggle.com/sudalairajkumar/covid19-in-india?select=covid_vaccine_statewise.csv a. Describe the dataset b. Number of persons state wise vaccinated for first dose in India c. Number of persons state wise vaccinated for second dose in India d. Number of Males vaccinated d. Number of females vaccinated
5	Write a case study to process data driven for Digital Marketing OR Health care systems with Hadoop

	Ecosystem components as shown. (Mandatory) ● HDFS: Hadoop Distributed File System ● YARN: Yet Another Resource Negotiator ● MapReduce: Programming based Data Processing ● Spark: In-Memory data processing ● PIG, HIVE: Query based processing of data services ● HBase: NoSQL Database (Provides real-time reads and writes) ● Mahout, Spark MLlib: (Provides analytical tools) Machine Learning algorithm libraries ● Solar, Lucene: Searching and Indexing
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Reference Books :

1. Chirag Shah, “A Hands-On Introduction To Data Science”, Cambridge University Press,(2020), ISBN : ISBN 978-1-108-47244-9.
2. Wes McKinney, “Python for Data Analysis”, O' Reilly media, ISBN : 978-1-449-31979-3.
3. “Scikit-learn Cookbook”, Trent hauk, Packt Publishing, ISBN: 9781787286382
4. R Kent Dybvig, “The Scheme Programming Language”, MIT Press, ISBN 978-0-262-51298-5.
5. Jenny Kim, Benjamin Bengfort, “Data Analytics with Hadoop”, O'Reilly Media, Inc.
6. Jake VanderPlas, “Python Data Science Handbook”
7. <https://tanthiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf>
8. Gareth James, “An Introduction to Statistical Learning”
9. <https://www.ime.unicamp.br/~dias/Intoduction%20to%20Statistical%20Learning.pdf>
10. Cay S Horstmann, “Scala for the Impatient”, Pearson, ISBN: 978-81-317-9605-4,
11. Alvin Alexander, “Scala Cookbook”, O'Reilly, SPD, ISBN: 978-93-5110-263-2

References:

- <https://www.simplilearn.com/data-science-vs-big-data-vs-data-analytics-article>
- <https://hadoop.apache.org/docs/current/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html>
- <https://www.edureka.co/blog/hadoop-ecosystem>
- https://www.edureka.co/blog/mapreduce-tutorial/#mapreduce_word_count_example
- <https://github.com/vasanth-mahendran/weather-data-hadoop>
- <https://spark.apache.org/docs/latest/quick-start.html#more-on-dataset-operations>
- <https://www.scala-lang.org>

MOOCs Courses link:

- <https://nptel.ac.in/courses/106/106/106106212/>
- https://onlinecourses.nptel.ac.in/noc21_cs33/preview
- <https://nptel.ac.in/courses/106/104/106104189/>
- https://onlinecourses.nptel.ac.in/noc20_cs92/preview

The CO-PO mapping table												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	-	-	-	-	3	-
CO2	2	2	2	2	3	-	-	-	-	-	-	-
CO3	2	2	2	-	2	-	-	-	-	-	-	-
CO4	2	2	2	2	2	2	-	-	-	-	-	-
CO5	2	2	2	2	2	2	-	-	-	-	-	-
CO6	2	2	2	2	2	2	-	-	-	-	-	-
CO7	2	2	2	2	3	2	-	-	-	-	-	-
CO8	2	2	2	2	3	2	-	-	-	-	3	-

Savitribai Phule Pune University

**Third Year of Computer Science and Engineering
(Data Science) (2019 Course)**

310257: Web Technology Laboratory

Teaching Scheme:	Credit:	Examination Scheme:
Practical: 02 Hrs. / week	01	Term Work: 25 Oral: 25 Marks

Prerequisite Courses, if any:

Companion Course, if any: Web Technology (310252)

Course Objectives:

- To learn the web based development environment
- To use client side and server side web technologies
- To design and develop web applications using front end technologies and backend databases

Course Outcomes:

On completion of the course, learners will be able to

- CO1:** Understand the importance of website planning and website design issues
- CO2:** Apply the client side and server side technologies for web application development
- CO3:** Analyze the web technology languages, frameworks and services
- CO4:** Create three tier web based 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 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 Oral Examination

Oral examination should be jointly conducted by the internal examiner and external examiner. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementations in term work. 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. Mini project should be implemented by the students in a group of 2-3 students.

Suggested List of Laboratory Experiments/Assignments (All assignments are compulsory)

Sr. No	Assignment Title					
1.	Case study: Before coding of the website, planning is important, students should visit different websites (Min. 5) for the different client projects and note down the evaluation results for these websites, either good website or bad website in following format:					
	Sr. No.	Website URL	Purpose of Website	Things liked in the website	Things disliked in the website	Overall evaluation of the website (Good/Bad)
	From the evaluation, students should learn and conclude different website design issues, which should be considered while developing a website.					
2.	Implement a web page index.htm for any client website (e.g., a restaurant website project) using following: a. HTML syntax: heading tags, basic tags and attributes, frames, tables, images, lists, links for text and images, forms etc. b. Use of Internal CSS, Inline CSS, External CS					
3.	Design the XML document to store the information of the employees of any business organization and demonstrate the use of: a) DTD b) XML Schema And display the content in (e.g., tabular format) by using CSS/XSL.					
4.	Implement an application in Java Script using following: a) Design UI of application using HTML, CSS etc. b) Include Java script validation					

	c) Use of prompt and alert window using Java Script e.g., Design and implement a simple calculator using Java Script for operations like addition, multiplication, subtraction, division, square of number etc. a) Design calculator interface like text field for input and output, buttons for numbers and operators etc. b) Validate input values c) Prompt/alerts for invalid values etc.
5.	Implement the sample program demonstrating the use of Servlet. e.g., Create a database table ebookshop (book_id, book_title, book_author, book_price, quantity) using database like Oracle/MySQL etc. and display (use SQL select query) the table content using servlet.
6.	Implement the program demonstrating the use of JSP. e.g., Create a database table students_info (stud_id, stud_name, class, division, city) using database like Oracle/MySQL etc. and display (use SQL select query) the table content using JSP.
7.	Build a dynamic web application using PHP and MySQL. a. Create database tables in MySQL and create connection with PHP. b. Create the add, update, delete and retrieve functions in the PHP web app interacting with MySQL database
8.	Design a login page with entries for name, mobile number email id and login button. Use struts and perform following validations a. Validation for correct names b. Validation for mobile numbers c. Validation for email id d. Validation if no entered any value e. Re-display for wrongly entered values with message f. Congratulations and welcome page upon successful entries
9.	Design an application using Angular JS. e.g., Design registration (first name, last name, username, password) and login page using Angular JS.
10.	Design and implement a business interface with necessary business logic for any web application using EJB. e.g., Design and implement the web application logic for deposit and withdraw amount transactions using EJB.
11.	Mini Project: Design and implement a dynamic web application for any business functionality by using web development technologies that you have learnt in the above given assignments.

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	-	1	3	1	-	1	1	-	-	1	-	-
C02	2	2	-	2	1	-	-	-	1	-	-	-
C03	2	-	3	-	-	1	-	-	-	1	1	-
C04	1	2	2	1	2	1	1	-	-	-	-	1

Savitribai Phule Pune University
Second Year of Computer Science and Engineering
(Data Science) (2019 Course)
310654:Laboratory Practical II

Teaching Scheme	Credit Scheme	Examination Scheme and Marks Term Work:
Practical: 04 Hours/Week	02	50 Marks
Companion Course: Machine Learning(310253), Elective II (310254)		

Course Objectives:

- To learn and apply various machine learning algorithms and methods.
- To Study open and closed chain mechanism as well as simulation of some industrial robots.
- To study and survey recent trends in NLP
- Reality/Cloud Computing/Software Modeling and Architectures

Course Outcomes:

Machine Learning

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 Block chain technology and its applications.

• Robotics and Automation

CO1: To identify the geometric relationship between input and output motion parameters of KGP 50 robot.

CO2: Formation of the transformation matrix through which a relationship is established between different links of the manipulator.

CO3: To have a brief idea about the workspace through a 3D graph plot of manipulator position for various inputs.

CO4: Simulate the robot motion for various inputs of the joint angular value.

OR

• Natural Language Processing

CO1: Understand recent trends in NLP

CO2: Implement different pre-processing techniques

CO3: Design and develop various application using NLP

OR

• Cloud Computing

CO1: Use tools and techniques in the area of Cloud Computing

CO2: Use cloud computing services for problem solving

CO3: Design and develop applications on cloud

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

Programming tools recommended: -

Machine Learning : - Python/R

Automation and Robotics :- Robo Analyzer/ MATLAB or Open Source, computer vision programming tool / Matlab, Open CV

Natural Language Processing: Python/R

Cloud Computing : - Ape, Salesforce Cloud etc.

Virtual Laboratory:

http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

<https://nlp-iiith.vlabs.ac.in/>

<https://mr-iitkgp.vlabs.ac.in/>

Suggested List of Laboratory Experiments/Assignments	
Assignments from all Groups (A,B,C) are compulsory.	
Sr. No.	Group A : Machine Learning
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
2.	Classify the email using the binary classification method. Email Spam detection has two states: a) Normal State – Not Spam, b) Abnormal State – Spam. Use K-Nearest Neighbors and Support Vector Machine for classification. Analyze their performance. Dataset link: The emails.csv dataset on the Kaggle https://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv
3.	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 $x=2$.
4.	Implement K-Nearest Neighbors algorithm on diabetes.csv dataset. Compute confusion matrix, accuracy, error rate, precision and recall on the given dataset. Dataset link : https://www.kaggle.com/datasets/abdallamahgoub/diabetes
5.	Implement K-Means clustering/ hierarchical clustering on sales_data_sample.csv dataset. Determine the number of clusters using the elbow method. Dataset link : https://www.kaggle.com/datasets/kyanyoga/sample-sales-data
Sr. No.	Part-II: Group B- Robotics and Automation (Note: Choose any 4 assignments from Assignment 1 to Assignment 5 and any 1 assignment)
1	Study Components of Industrial Robot (PUMA, KUKA, FANUC, Motomanetc) and its DH parameters.
2	Design and selection of Gripper / End effector
3	Two Programming exercise on lead through programming for Industrial Application
4	Program for Forward and Inverse kinematics of simple robot configuration (Robo Analyzer/ MATLAB or Open Source)
5	Control experiment using available Hardware or Software (Open Source or MATLAB)
6	Study of robotic system design.
7	Study of sensor integration.
8	Use of open source computer vision programming tool / Matlab, Open CV
9	Report on industrial application of robot /Industrial visit
Sr. No.	Part-II: Group B- Natural Language Processing
1	Survey of Recent Advances in NLP: Detailed survey of recent efforts being taken in the field of NLP with respect to approaches, applications, problems etc.
2	To perform various preprocessing tasks in NLP: Perform various basic pre-processing tasks like tokenization, stemming, lemmatization, stop word removal etc. using inbuilt functions and using regular

	expressions.
3	Perform Spelling Correction: Apply minimum edit distance between two strings for spelling correction.
4	Implement a system to detect different types of toxicity like threats, obscenity, insults, and identity-based hate from comments. (Dataset: Wikipedia comments which have been labeled by human raters for toxic behavior. you can download dataset from https://www.kaggle.com/competitions/jigsaw-toxic-comment-classification-challenge/data) .
5	Recommendation system using Voice Chabot. (Use of Google speech engine)
6	Examiner less oral examination system (Speech to text and answer matching)
Sr. No.	Cloud Computing (All assignments are compulsory)
1	Case study on Microsoft azure to learn about Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, for building, deploying and managing applications and services through a global network of Microsoft-managed data centers. OR Case study on Amazon EC2 and learn about Amazon EC2 web services.
2	Installation and configure Google App Engine. OR Installation and Configuration of virtualization using KVM
3	Creating an Application in Salesforce.com using Apex programming Language.
4	Design and develop custom Application (Mini Project) using Sales force Cloud
5	Mini-Project Setup your own cloud for Software as a Service (SaaS) over the existing LAN in your laboratory. In this assignment you have to write your own code for cloud controller using open source technologies to implement with HDFS. Implement the basic operations may be like to divide the file in segments/blocks and upload/ download file on/from cloud in encrypted form

Machine Learning:

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2	1	-	1	2	-	2	3
CO2	3	3	3	2	2	1	-	1	2	-	2	3
CO3	3	3	3	2	2	2	-	1	2	-	2	3
CO4	3	2	2	-	1	-	-	1	2	-	2	3
CO5	3	2	3	-	1	-	-	1	2	-	-	2
CO6	3	3	2	2	2	-	-	1	2	-	-	2

Automation and Robotics:

The CO-PO mapping table												
	PO1	PO ₂	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO1 ₂
CO1	1	1	-	2	-	-	-	-	1	-	-	1
CO2	1	1	1	1	2	2	-	-	1	-	-	1
CO3	2	2	2	2	2	2	-	-	1	-	-	1
CO4	2	2	2	2	2	2	-	-	1	-	-	1

Cloud Computing:

The CO-PO mapping table												
	PO1	PO ₂	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO1 ₂
CO1	3	3	2	-	-	-	-	-	-	-	-	-
CO2	2	3	3	-	-	-	-	-	-	-	-	-
CO3	2	3	3	-	-	-	-	-	-	-	-	-

Natural Language Processing:

The CO-PO mapping table												
	PO1	PO ₂	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO1 ₂
CO1	2	-	2	-	3	-	-	2	2	2	1	2
CO2	1	-	2	-	3	-	-	2	2	2	1	2
CO3	1	-	2	2	3	2	-	2	2	2	2	2

Savitribai Phule Pune University
Third Year of Computer Science and Engineering
(Data Science) (2019 Course)
310655: Internship**

Teaching Scheme	Credit Scheme	Examination Scheme
**	04	Term work: 100 Marks

Course Objectives:

Internship provides an excellent opportunity to learner to see how the conceptual aspects learned in classes are integrated into the practical world. Industry/on project experience provides much more professional experience as value addition to classroom teaching.

- To encourage and provide opportunities for students to get professional/personal experience through internships.
- To learn and understand real life/industrial situations.
- To get familiar with various tools and technologies used in industries and their applications.
- To nurture professional and societal ethics.
- To create awareness of social, economic and administrative considerations in the working environment of industry organizations.

Course Outcomes:

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

CO1: To demonstrate professional competence through industry internship.

CO2: To apply knowledge gained through internships to complete academic activities in a professional manner.

CO3: To choose appropriate technology and tools to solve given problem.

CO4: To demonstrate abilities of a responsible professional and use ethical practices in day to day life.

CO5: Creating network and social circle, and developing relationships with industry people.

CO6: To analyze various career opportunities and decide carrier goals.

**** Guidelines:**

Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment, practices and culture. Internship is structured, short-term, supervised training often focused around particular tasks or projects with defined time scales.

Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

Engineering internships are intended to provide students with an opportunity to apply conceptual knowledge from academics to the realities of the field work/training. The following guidelines are proposed to give academic credit for the internship undergone as a part of the Third Year Engineering curriculum.

Duration:

Internship is to be completed after semester 5 and before commencement of semester 6 of at least 4 to 6 weeks; and it is to be assessed and evaluated in semester 6.

Internship work Identification:

Student may choose to undergo Internship at Industry/Govt. Organizations/NGO/MSME/Rural Internship/Innovation/IPR/Entrepreneurship. Student may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/NGO's/Government organizations/Micro/Small/ Medium enterprises to make themselves ready for the industry [1].

Students must register at Internshala [2]. Students must get Internship proposals sanctioned from college authority well in advance. Internship work identification process should be initiated in the Vth semester in coordination with training and placement cell/ industry institute cell/ internship cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their Vth semester examination and before academic schedule of semester VI. Student can take internship work in the form of the following but not limited to:

- Working for consultancy/ research project,
- Contribution in Incubation/ Innovation/ Entrepreneurship Cell/ Institutional Innovation Council/ startups cells of institute /
- Learning at Departmental Lab/Tinkering Lab/ Institutional workshop,
- Development of new product/ Business Plan/ registration of start-up,
- Industry / Government Organization Internship,
- Internship through Internshala,
- In-house product development, intercollegiate, inter department research internship under research lab/group, micro/small/medium enterprise/online internship,
- Research internship under professors, IISC, IIT's, Research organizations,
- NGOs or Social Internships, rural internship,
- Participate in open source development.

Internship Diary/ Internship Workbook:

Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any. The training diary/workbook should be signed every day by the supervisor. Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.

Internship Work Evaluation:

Every student is required to prepare a maintain documentary proofs of the activities done by him as internship diary or as workbook. The evaluation of these activities will be done by Programmed Head/Cell In-charge/ Project Head/ faculty mentor or Industry Supervisor based on- Overall compilation of internship activities, sub-activities, the level of achievement expected, evidence needed to assign the points and the duration for certain activities.

Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External – a supervisor from place of internship).

Recommended evaluation parameters-Post Internship Internal Evaluation -50 Marks + Internship Diary/Workbook and Internship Report - 50 Marks

Evaluation through Seminar Presentation/Viva-Voce at the Institute-

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

- Depth of knowledge and skills: Communication and Presentation Skills
 - ☐ Team Work
 - ☐ Creativity
 - ☐ Planning and Organizational skills
 - ☐ Adaptability
 - ☐ Analytical Skills
 - ☐ Attitude and Behavior at work
 - ☐ Societal Understanding
 - ☐ Ethics
 - ☐ Regularity and punctuality
 - ☐ Attendance record
 - ☐ Diary/Work book
 - ☐ Student's Feedback from External Internship Supervisor

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. Internship Diary/workbook may be evaluated on the basis of the following criteria:

- Proper and timely documented entries
- Adequacy & quality of information recorded
- Data recorded
- Thought process and recording techniques used
- Organization of the information

The report shall be presented covering following recommended fields but limited to,

- ☐ Title/Cover Page
- ☐ Internship completion certificate
- ☐ Internship Place Details- Company background-organization and activities/Scope and object of the study / Supervisor details
- ☐ Index/Table of Contents
- ☐ Introduction
- ☐ Title/Problem statement/objectives
- ☐ Motivation/Scope and rationale of the study
- ☐ Methodological details

- ☐ Results / Analysis /inferences and conclusion
- ☐ Suggestions / Recommendations for improvement to industry, if any
- ☐ Attendance Record
- ☐ Acknowledgement
- ☐ List of reference (Library books, magazines and other sources)

Feedback from internship supervisor(External and Internal)

Post internship, faculty coordinator should collect feedback about student with following recommended parameters-

Technical knowledge, Discipline, Punctuality, Commitment, Willingness to do the work, Communication skill, individual work, Team work, Leadership.....

Reference:

[1] <https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf>

[2] <https://internship.aicte-india.org/>

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	1	1	1	1	2	1	1
CO2	1	2	2	2	3	2	1	1	1	2	2	1
CO3	-	-	-	-	-	1	-	-	2	2	1	1
CO4	2	-	-	-	-	2	2	3	-	1	-	2
CO5	-	-	-	-	-	1	2	1	1	1	2	1
CO6	-	-	-	-	-	1	-	-	2	1	-	1

Savitribai Phule Pune University
Second Year of Computer Science and Engineering
(Data science) (2019 Course)
310656: Audit Course 6

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 student's knowledge and skills. Student will be awarded the bachelor's degree if he/she earns specified total credits and clears all the audit courses specified in the syllabus. 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):

- | | |
|---|---|
| <ul style="list-style-type: none"> ● Lectures/ Guest Lectures ● Visits (Social/Field) and reports ● Demonstrations | <ul style="list-style-type: none"> ● 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
- Presentations, IPR/Publication and Report

Audit Course 4 Options

Audit Course Code	Audit Course Title
AC6-I	Digital and Social Media Marketing
AC6-II	Sustainable Energy Systems
AC6-III	Leadership and Personality Development
AC6-IV	Foreign Language
AC6-V	MOOC- LearnNew Skills

AC5-I: : Digital and Social Media Marketing

Course Objectives

- To understand the importance of digital marketing
- To understand the social media and marketing
- To understand the effective marketing strategies and ways

Course Outcomes

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

CO1: Understand the fundamentals and importance of digital marketing

CO2: Use the power of social media for business marketing

CO3: Analyze the effectiveness of digital marketing and social media over traditional process

Course Contents

1. A Framework for Digital Marketing
2. Domain Names, Email, and Hosting
3. Yes, You need a Website
4. The Three Components of a Modern Website: Mobile, Fast, and Accessible
5. Lock It Down: Digital Privacy, Data Security, and the Law
6. Social Media
7. Email Marketing
8. Online Advertising

References:

1. Avery Swartz, “See You on the Internet: building your small business with Digital Marketing”, ISBN 978-1-989603-08-6.
2. Social Media Marketing Workbook (2021): How to Use Social Media for Business (2021 Social Media Marketing 1). @The CO

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	1	-	1	-	1	-	-	-	-
CO2	-	1	2	-	-	-	-	-	-	-	1	-
CO3	2	-	2	2	2	-	1	-	-	-	-	-

Course Objectives:

- CO1:** To understand the importance of sustainable energy systems development
CO2: To create awareness about renewable energy sources and technologies
CO3: To learn about adequate inputs on a variety of issues in harnessing renewable energy
CO4: To recognize current and possible future role of renewable energy sources

Course Outcomes:

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

- CO1:** Comprehend the importance of Sustainable Energy Systems
CO2: Correlate the human population growth and its trend to the natural resource degradation and develop the awareness about his/her role towards Sustainable Energy Systems protection
CO3: Identify different types of natural resource pollution and control measures
CO4: Correlate the exploitation and utilization of conventional and non-conventional resources

Course Contents

1. Wind Energy: Power in the Wind, Types of Wind Power Plants (WPPs), Components of WPPs, Working of WPPs, Siting of WPPs, Grid integration issues of WPPs.
2. Solar Pv and Thermal Systems: Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds, Thermal Energy storage system with PCM, Solar Photovoltaic systems: Basic Principle of SPV conversion, Types of PV Systems, Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array, PV Module IV Characteristics, Efficiency and Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.
3. Other Energy Sources: Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC), Hydrogen Production and Storage. Fuel cell: Principle of working, various types, construction and applications. Energy Storage System, Hybrid Energy Systems.

Reference:

1. Joshua Earnest, Tore Wizeliu, “Wind Power Plants and Project Development”, PHI Learning Pvt.Ltd, New Delhi, 2011.
2. D.P.Kothari, K.C Singal, Rakesh Ranjan, “Renewable Energy Sources and Emerging Technologies”, PHI Learning Pvt .Ltd, New Delhi, 2013.
3. A.K.Mukerjee and Nivedita Thakur, “Photovoltaic Systems: Analysis and Design”, PHI Learning Private Limited, New Delhi, 2011

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	1	-	-	-	1
CO2	-	-	-	-	-	-	-	2	-	-	-	1
CO3	-	-	-	-	-	2	-	1	-	-	-	1

AC4-III: Leadership and Personality Development

Prerequisites: General awareness of communication and relationship.

Course Objectives

- CO1:** To understand the importance of communication
- CO2:** To create awareness about teamwork and people skills
- CO3:** To know thyself
- CO4:** To recognize current and possible future of new-age thinking

Course Outcomes

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

- CO1:** Express effectively through communication and improve listening skills
- CO2:** Develop effective team leadership abilities.
- CO3:** Explore self-motivation and practicing creative/new age thinking.
- CO4:** Operate effectively in heterogeneous teams through the knowledge of team work, people skills and leadership qualities.

Course Contents

1. Communication :
Listening Skills, Communication - 7 C's, Vision and Charisma, Planning and Organizing - Complex Tasks and Ideas --> Actionable Tasks, Presentation Skills.
2. Teamwork and People Skills :
Talent Picking skills, Strong networking and Employee engagement, Coach and Mentor the team, Influencing, Delegate and Empower, Generous, open communicator, Patience and Clarity of Mind, Inspire and Motivate, Ensure Team Cohesion, Empathy, Trust and Reliability.
3. New-age Thinking :
Strategic Thinking, Critical and Lateral Thinking, Problem Solving Skills, Flexibility, Change Management – VUCA.
4. Self-Awareness :
What is Self? – Real, Ideal and Social Self, Concepts related to Self - Self Concept, Self Presentation, Self-Regulation and Impression Management, Definition and Causes of Prejudice, Relationship between Prejudice, Discrimination and Exclusion, Application – Attitudinal Change and Reducing Prejudices, Self Esteem and Self Awareness, SWOT – JOHARI, Self Esteem Quiz, Introduce Your Partner, Self Introduction - How to sell yourself?-appearance, voice modulation, verbal(simple language), Motivation and Optimism, Positive Emotions and Success.

References:

1. Paul Sloane, “The Leader's Guide to Lateral Thinking Skills Unlocking the Creativity and Innovation in You and Your Team”, 2006
2. Ronald Bennett, Elaine Millam, “Leadership for engineers : the magic of mindset”
3. Urmila Rai and S.M. Rai, “Business Communication”, Himalay Publication House
4. Baron R, Byrne D, Branscombe N, Bharadwaj G (2009), “Social Psychology, Indian adaptation” , Pearson , New Delhi
5. Baumgartner S.R, Crothers M.K. (2009) “Positive Psychology”, Pearson Education.

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	2	-	1	1	3	-	2
CO2	-	-	-	-	-	-	-	1	-	2	1	2
CO3	-	-	-	-	-	1	-	-	2	1	-	1
CO4	-	-	-	-	-	-	-	1	-	-	2	1

AC4-IV: Foreign Language (Japanese) Module 4

Prerequisites: We recommend that candidates should have previously completed AC3-V(210651) , AC4-V (210661) and AC-5(310651)

Course Objectives:

- To open up more doors and job opportunities
- To introduce to Japanese society, culture and entertainment

Course Outcomes:

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

CO1: Have the ability to communicate confidently and clearly in the Japanese language

CO2: Understand the nature of Japanese script

CO3: Get introduced to reading, writing and listening skills

CO4: Develop interest to pursue further study, work and leisure

Course Contents

1. Introduction to types of adjectives (i and na)
2. Formation of adjectives (according to tense / negative / affirmative)
3. Introduction to more particles
4. Making sentences using various particles / verbs / adjectives
5. Topic based vocabulary (Places / Train travel related / Technical Katakana words)
6. More verb forms (te form, ta form, nai form, root verb etc.)
7. Question words
8. Further 25 Kanjis
9. Scenario based conversation practice / skits / role plays (At the market, At the hospital etc.)

References:

1. Minna No Nihongo, “JapaneseforEveryone”,ElementaryMainTextbook1 -(IndianEdition),GoyalPublishers and Distributors Pvt.Ltd.
2. [http://www.tcs.com\(http://www.tcs.com/news_events/press_releases/Pages/TCS-InauguratesJapan-centric-Delivery-Center-Pune.aspx\)](http://www.tcs.com(http://www.tcs.com/news_events/press_releases/Pages/TCS-InauguratesJapan-centric-Delivery-Center-Pune.aspx))
3. Kazuko Karasawa, Mikiko Shibuya, “Nihongo Challenge N4 N5 Kannji Tomoko Kigami”, ISBN-10 4872177576,Ask Publishing Co.,Ltd.

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	1	3	1	1
CO2	-	-	-	-	1	-	-	-	-	3	1	1
CO3	-	-	-	-	1	-	-	-	-	3	2	2
CO4	-	-	-	-	-	-	-	-	-	1	-	1

AC4-V: Foreign Language (Japanese) Module 2

With changing times, the competitiveness has gotten into the nerves and 'Being the Best' at all times is only the proof of it. Nonetheless, 'being the best differs significantly from 'Communicating the best'! The best can merely be communicated whilst using the best... suited Language!!

Course Objectives:

- To meet the needs of ever-growing industry with respect to language support.
- To get introduced to Japanese society and culture through language.

Course Outcomes:

On completion of the course learner will-

1. have ability of basic communication.
2. have the knowledge of Japanese script.
3. get introduced to reading, writing and listening skills
4. develop interest to pursue professional Japanese Language course

Course Contents

1. Katakana basic Script, Denoting things (nominal and pre nominal demonstratives), Purchasing at the Market / in a shop / mall (asking and stating price)
2. Katakana: Modified kana, double consonant, letters with ya, yu, yo, Long vowels, Describing time, describing starting and finishing time (kara ~ made), Point in time (denoting the time when any action or the movement occurs)
3. Means of transport (Vehicles), Places, Countries, Stating Birth date, Indicating movement to a certain place by a vehicle.

References:

1. Minna No Nihongo, "Japanese for Everyone", (Indian Edition), Goyal Publishers and Distributors Pvt. Ltd.
2. <http://www.tcs.com> (http://www.tcs.com/news_events/press_releases/Pages/TCS- Inaugurates-Japan-centric-Delivery-Center-Pune.aspx)

@The CO-PO Mapping Matrix

CO\ P O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	1	3	1	1
CO2	-	-	-	-	1	-	-	-	-	3	1	1
CO3	-	-	-	-	1	-	-	-	-	3	2	2
CO4	-	-	-	-	-	-	-	-	-	1	-	1

Acknowledgement

It is with great pleasure and honor that I present the curriculum for the Third Year of **Computer Science and Engineering (Data Science)** on behalf of the **Board of Studies (BoS), Computer Engineering**. As members of BoS, we are committed to streamlining the processes and curriculum design for both UG and PG programs.

Balancing the curriculum to integrate core courses, current developments, and courses that emphasize social and human values is always a challenging task. After careful consideration of all these aspects, we have designed the contents to meet AICTE guidelines and ensure that our graduates are competent and employable.

I sincerely thank everyone who has contributed their expertise to this effort. Your hard work and input were invaluable in finalizing the curriculum. I deeply appreciate the contributions and suggestions that helped shape this comprehensive design.

Success is sweet, but it is even sweeter when achieved through coordination, cooperation, and collaboration. I am truly fortunate to be working with such a dedicated and talented team—the Members of the **Board of Studies, Computer Engineering!**

I would like to extend my heartfelt thanks to all of you for delivering such exceptional teamwork. I firmly believe that the achievement of this goal would not have been possible without each and every one of your dedicated efforts.

A special mention goes to **Dr. Vaishali P. Vikhe** (Pravara Rural Engineering College, Loni), Member of BoS, Computer Engineering, whose leadership and coordination played a key role in ensuring the successful completion of this activity. Your efforts have been instrumental in bringing everything together seamlessly.

Lastly, I sincerely appreciate the hard work and dedication of the **course coordinators** and **their team members**. Without your intellectual contributions and creative insights, this draft would not have been possible. You have truly been a vital part of this team, and your contributions are deeply valued!