Faculty of Engineering
Savitribai Phule Pune University, Pune

Syllabus

Master of Computer Engineering
(Computer Networks)
(Course 2017)

(with effect from 2017-18)

Prologue

It is with great pleasure and honor that I present the syllabus for Master of Computer Engineering (2017 Course) on behalf of Board of Studies (BoS), Computer Engineering. We, members of BoS are giving our best to streamline the processes and curricula design.

While revising syllabus, honest and sincere efforts are put to tune curriculum for post graduate program in Computer Engineering in tandem with the objectives of Higher Education of India, AICTE, UGC and affiliated University- Savitribai Phule Pune University (SPPU) by keeping an eye on the technological advancements and industrial requirements globally.

The basic motives of designing the contents of various courses is to focus on independent learning convergence to special domains, development of research attitude and comprehensive coverage of technologies. Elective courses with choice for module selection provide flexibility and opportunity to explore the domain specific knowledge.

The open elective is to invite the attention to multidisciplinary, interdisciplinary, exotic, employability or update to technology course. The institute may design the syllabus accordingly. However such designed syllabus needs to be approved by SPPU authority before implementation.

While framing each course contents, Course advisor, Course Coordinators and Team Members have put arduous efforts in meeting the standards of the Courses at PG level. Everybody in the team has meticulously stuck to the guidelines and recommendations to materialize the team efforts. The fruition is only due to sincere efforts, active participation, expert opinions and suggestions from domain professionals.

I am sincerely indebted to all the minds and hands who work dexterously and synchronously to materialize the huge task.

Thanks.

Dr. Varsha H. Patil
Coordinator, Board of Studies (Computer Engineering), SPPU, Pune
Tuesday, March 28, 2017. Mail-id: vh_patil2003@yahoo.com

[This document includes Program Educational Objectives - Program Outcomes, Program Specific Outcomes (page 3-4), Courses (teaching scheme, examination, marks and credit) (page 5-6), Courses syllabi (page 7-61] and Non Credit Course Contents [62-67].

Program Educational Objectives

PEO1: To prepare globally competent post graduates with enhanced domain knowledge and skills attaining professional excellence and updated with modern technology to provide effective solutions for engineering and research problems.

PEO2: To prepare the post graduates to work as a committed professionals with strong professional ethics and values, sense of responsibilities, understanding of legal, safety, health, societal, cultural and environmental issues.

PEO3: To prepare motivated post graduates with research attitude, lifelong learning, investigative approach, and multidisciplinary thinking to succeed in the career in industry/academia/research

PEO4: To prepare post graduates with strong managerial and communication skills to work effectively as an individual as well as in teams.

Program Outcomes

Students are expected to know and be able –

PO1: Scholarship of Knowledge

Acquire in-depth knowledge of Computer Science and Engineering, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

PO2: Critical Thinking

Analyze complex engineering problems critically; apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO3: Problem Solving

Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO4: Research Skills

Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

PO5: Usage of Modern Tools

Create, select, learn 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: Collaborative and Multidisciplinary work

Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

PO7: Project Management and Finance

Demonstrate knowledge and understanding of Computer Science & Engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after considerisation of economical and financial factors.

PO8: Communication

Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

PO9: Life-long Learning

Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO10: Ethical Practices and Social Responsibility

Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PO11: Independent and Reflective Learning

Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

Program Specific Outcomes (PSO)

A post graduate of the Computer Engineering Program will demonstrate-

PSO1: **Professional Skills**

The ability to understand, analyze and develop software in the areas related to networking, system software, multimedia, web design, big data analytics, and algorithms for efficient design of computer-based systems of varying complexities.

PSO2: Problem-Solving Skills

The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.

PSO3: Successful Career and Entrepreneurship

The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, with zest for research.

PSO4: Research Skills

The ability to study, experiment, interpret, analyze and explore the solutions to the engineering problems which are effective, efficient, optimized and feasible.

Savitribai Phule Pune University, Pune
Master of Computer Engineering(Computer Networks) (2017 Course)
(with effect from June 2017)

Semester I

Course Code	Course	Teaching Scheme Hours / Week		Examination Scheme and Marks					Credit	
		Theory	Practical	In-Sem	End-Sem	TW	OR/ PRE	Total	TH	PR
510201	Research Methodology	04	--	50	50	--	--	100	04	--
510202	Network Security	04	--	50	50	--	--	100	04	--
510203	Wireless Sensor Networks	04	--	50	50	--	--	100	04	--
510204	High Performance Networks	04	--	50	50	--	--	100	04	--
510205	Elective I	05	--	50	50	--	--	100	05	-
510206	Laboratory Proficiency I	--	08	--	--	50	50	100	--	04
								Total Credit	21	04
	Total	**21**	**08**	**250**	**250**	**50**	**50**	**600**	**25**	
510207	Non-Credit Course I								Grade	

Elective I

510205A	Mobile Communication	510205B	Software Defined Networks
510205C	Bio-Inspired Optimization Algorithms	510205D	Data Mining
510205E	**Open Elective**		

Semester II

Course Code	Course	Teaching Scheme Hours / Week		Examination Scheme and Marks					Credit	
		Theory	Practical	In-Sem	End-Sem	TW	OR/ PRE	Total	TH	PR
510208	Operations Research	04	--	50	50	--	--	100	04	--
510209	Network Design and Analysis	04	--	50	50	--	--	100	04	--
510210	Data Algorithms	04	--	50	50	--	--	100	04	--
510211	Elective II	05	--	50	50	--	--	100	05	--
510212	Seminar I	--	04	--	--	50	50	100	--	04
510213	Laboratory Proficiency II	--	08	--	--	50	50	100	--	04
								Total Credit	17	08
	Total	**17**	**12**	**200**	**200**	**100**	**100**	**600**	**25**	
510214	Non-Credit Course II								Grade	

Elective II

510211A	Pervasive and Ubiquitous Computing	510211B	WiMAX Network Planning and Optimization
510211C	Machine Learning	510211D	System Simulation and Modeling
510211E	Open Elective		

Abbreviations: TW: Term Work, **TH:** Theory, **OR:** Oral, **PRE**: Presentation, **Sem:** Semester

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Semester III

Course Code	Course	Teaching Scheme Hours / Week		Examination Scheme and Marks					Credit	
		Theory	Practical	In-Sem	End-Sem	TW	OR/PRE	Total	TH	PR
610201	Fault Tolerant Systems	04	--	50	50	--	--	100	04	--
610202	Mobile Ad hoc Networks	04	--	50	50	--	--	100	04	--
610203	Elective III	05	--	50	50	--	--	100	05	--
610204	Seminar II	--	04	--	--	50	50	100	--	04
610205	Dissertation Stage I	--	08	--	--	50	50	100	--	08
								Total Credit	13	12
Total		**13**	**12**	**150**	**150**	**100**	**100**	**500**	**25**	
610206	Non-Credit Course III								Grade	

Elective III

610203A	Information Retrieval	610203B	Pattern Recognition
610203C	Real Time and Embedded Systems	610203D	Data Networks
610203E	**Open Elective**		

Semester IV

Course Code	Course	Teaching Scheme Hours / Week	Examination Scheme and Marks			Credit
		Practical	TW	OR/PRE	Total	PR
610207	Seminar III	05	50	50	100	05
610208	Dissertation Stage II	20	150	50	200	20
Total		**25**	**200**	**100**	**300**	**25**

Non-Credit Courses

Typically curriculum is constituted by credit, non-credit and audit courses. These courses are offered as compulsory or elective. Non Credit course is compulsory. No grade points are associated with non-credit courses and are not accounted in the calculation of the performance indices SGPA & CGPA. However, the award of the degree is subject to obtain a PP grade for non credit courses. Conduction and assessment of performance in said course is to be done at institute level. The mode of the conduction and assessment can be decided by respective course instructor. Recommended but not limited to- (one or combination of) seminar, workshop, MOOC Course certification, mini project, lab assignments, lab/oral/written examination, field visit and field training. Examinee should submit report/journal of the same. Reports and documents of conduction and assessment in appropriate format are to be maintained at institute. Result of assessment will be PP or NP. Set of non-credit courses offered is provided. The Examinee has to select the relevant course from pool of courses offered. Course Instructor may offer beyond this list by seeking recommendation from SPPU authority. The selection of 3 distinct non-credit courses, one per semester (Sem I, II & III). The Contents of Non Credit Courses are provided at page 63 onwards.

Open Elective: The open elective is to invite the attention to multidisciplinary, interdisciplinary, exotic, employability or update to technology course. The institute may design the syllabus accordingly. However such designed syllabus needs to be approved by SPPU authority before implementation.

Recommended Set of Non-Credit Courses for 510207, 510214, & 610206-

NCC1: Game Engineering
NCC2: Advanced Cognitive Computing
NCC3: Reconfigurable Systems
NCC4: Convergence Technology
NCC5: Machine Learning
NCC6: Storage Area Networks
NCC7: Search Engine Optimization
NCC8: Virtual Reality
NCC9: Machine Translation
NCC10: Infrastructure Management

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
510201: Research Methodology

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To understand the philosophy of research in general
- To understand basic concepts of research and its methodologies
- To learn the methodology to conduct the Literature Survey
- To acquaint with the tools, techniques, and processes of doing research
- To learn the effective report writing skills and allied documentations
- To become aware of the ethics in research, academic integrity and plagiarism

Course Outcomes:

After completion of the course, students should be able to-

- Carry out Literature Survey
- Identify appropriate topics for research work in Computer Engineering
- Select and define appropriate research problem and parameters
- Design the use of major experimental methods for research
- Use appropriate tools, techniques, and processes of doing research in Computer science
- Demonstrate own contribution to the body of knowledge
- Become aware of the ethics in research, academic integrity and plagiarism
- Write a research report and thesis

Course Contents

Unit I	Introduction	08 Hours

Evolution of Research Methodology: Meaning, nature, scope, and significance of research; Research paradigm; The purpose and Products of Research; Reasons for doing research, Objectives of research, Motivation for research; Postulates underlying scientific investigations; Types of research; Research process and work flow.

Engineering Research-Why? Research Questions, Engineering Ethics, conclusive proof-what constitutes A research project-Why take on?

Case Study- Code of Ethics, IEEE Code of Ethics, ACM Software Engineering Code of Ethics and Professional Practice, Code of Ethics especially covering Engineering discipline, various aspects-environment, sustainable outcomes, employer, general public, & Nation, Engineering Disasters.

Unit II	Literature Search and Review, Developing Research Plan	08 Hours

Archival Literature, Why should engineers be ethical? Types of publications- Journal papers, conference papers, books, standards, patents, theses, trade magazine, newspaper article, infomercials, advertisement, Wikipedia & websites, Measures of research impact, Literature review, publication cost.

Case Study- Engineering dictionary, Shodhganga, The Library of Congress, Research gate, Google Scholar, Bibliometrics, Citations, Impact Factor, h-index, I-index, plagiarism, copyright infringement.

Developing Research Plan: Research Proposals, Finding a suitable research questions, The elements of research proposals-title, details, budget, Design for outcomes-1D data, 2D data, 3D

data, N-D data, The research tools- Experimental measurements, numerical modeling, theoretical derivations & Calculations, curve matching.

Case Study- Various Research grants and funding resources

Unit III	Statistical Analysis	08 Hours

Statistical Analysis: Introduction, Sources of error and uncertainty, One-Dimensional Statistics: combining errors and uncertainties, t-test, ANOVA statistics, example, Two-Dimensional Statistics: example, Multi-Dimensional Statistics: partial correlation coefficients, example, Null hypothesis testing. **Case Study-** GNU PSPP Tool, SOFA, NOST-Data plot

Unit IV	Optimization Techniques	08 Hours

Optimization Techniques: Introduction, Two-parameter optimization methods: sequential uniform sampling, Monte Carlo optimization, Simplex Optimization method, Gradient Optimization method, Multi-parameter optimization methods, The cost function.

Case Study- Google Optimization Tools, OpenMDAO

Unit V	Survey Research Methods	08 Hours

Survey Research Methods: Why undertake a survey, Ergonomics and human factors, Ethics approval, General survey guidelines, Survey statements, Survey delivery, Respondent selection, Survey timelines, Statistical analysis, Reporting.

Case Study- Qualitative Analysis Tools- AQUAD, CAT

Unit VI	Research Presentation	08 Hours

Research presentation: Introduction, Standard terms, Standard research methods and experimental techniques, Paper title and keywords, Writing an abstract, Paper presentation and review, Conference presentations, Poster presentations, IPR, Copyright, Patents.

Reporting Research: Thesis, Structure and Style for writing thesis, Dissemination of research findings; Reporting and interpretation of results; cautions in interpretations, Type of reports, Typical report outlines.

The path forward: Publication trends, Getting started in research, Quality Assurance (QA) Occupational health and safety.

Case Study: Intellectual Property India- services, In PASS - Indian Patent Advanced Search System, US patent, IEEE / ACM Paper templates.

A glimpse into the future of Engineering Research.

Books:

Text:

1. David V Thiel, “Research Methods- for Engineers”, Cambridge University Press, ISBN-978-1-107-61019-4
2. Kothari C.R., Research Methodology (2nd Ed.), New Age International, (2004); ISBN(13): 978-81-224-1522-3.

References:

1. Caroline Whitbeck, “Ethics in Engineering Practice and Research”, 2nd Ed., Cambridge University Press; ISBN 978-1-107-66847-8
2. Gordana DODIG-CRNKOVIC, “Scientific Methods in Computer Science”, Department of Computer Science Mälardalen University, Västerås, Sweden

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
510202 : Network Security

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To understand the concept of security and its applications
- To learn various vulnerabilities, threats and attacks
- To know various detection and prevention techniques in diversified environments
- To study different algorithms for network security

Course Outcomes:

After completion of the course, students should be able to

- Design and choose appropriate security model
- Apply security means to various applications
- Apply security algorithms in various environments for network security
- Design network security solutions
- Select appropriate tools to thwart network attacks

Course Contents

Unit I	Classification of Network Attacks and Countermeasures of Attacks	08 Hours

Basic Security Concepts, History Of Network Security, Data Security Vs. Network Security, Computer And Network Attacks, Introduction To Vulnerabilities, Threats And Attacks, Layers Of Attacks, Counter Measure Of Different Attacks Counter Measures For Various Attacks Case Study: How To Detect And Prevent Black Hole Attack In Mobile Ad Hoc Network

Review Of WSN Attacks- Challenges On Detection Of WSN Attacks, Approaches For Securing WSN

Unit II	Hackers & Sniffing	08 Hours

Hacker tools, The hacking process, Ethical hacking issues, Current technologies, Recent events and statistics of network attacks, Wi-Fi vulnerabilities, What is network sniffing? Why network sniffing is important, Scan a single IP, Scan a host, Scan a range of IPs, and Scan a subnet.

Nmap port selection: Scan a single port, Scan a range of ports, Scan 100 most common ports (fast), and Scan all 65535 ports, scanning a subnet: Spoofing and decoy scans, Evading firewalls.

Nmap port scan types : Scan using TCP SYN scan (default), Scan using TCP connect

Unit III	Information gathering & Browser Exploitation	08 Hours

Gathering version information: UDP scan, The reason switch, Using a list, Output to a, file Commands, Starting the listener, Countermeasures, Social Engineering Toolkit and Browser Exploitation: Social engineering, what are web injections? How SQL injections work, Cross site scripting (XSS) attacks: Preventative measures against XSS attacks, How to reduce your chances of being attacked, Browser exploitation with BeEF : Browser hijacking, BeEF with Better Cap, BeEF with man-in-the-middle framework (MITMF), BeEF with SET

Unit IV	MITM attacks & Advanced attacks	08 Hours
Advanced Network Attacks :What is an MITM attack?, Related types of attacks, Examples of MITM, Tools for MITM attacks, Installing MITMF using Kali Linux, Passing and Cracking the Hash, What is a hash? Authentication protocols, Cryptographic hash functions: How do hackers obtain the hash? What tools are used to get the hash? How are hashes cracked? How do pass the hash attacks impact businesses? What defenses are there against hash password attacks? SQL Injection- Examples of SQL injection attacks, Ways to defend against SQL injection attacks, Attack vectors for web applications, Bypassing authentication, Bypass blocked and filtered websites, finding vulnerabilities from a targeted sites, Extracting data with SQLmap, Hunting for web app vulnerabilities with Open Web Application Security Project (OWASP) ZAP		
Unit V	**Malformed Packets & Scanning**	**08 Hours**
Malformed packets- Ping of death, Teardrop attack (aka Nestea), ARP cache poisoning, ARP poisoning commands , ACK scan, TCP port scanning, VLAN hopping, Wireless sniffing, OS fingerprinting ISN, Sniffing, Passive OS detection, Web application exploits		
Unit VI	**Spoofing and Detection Systems**	**08 Hours**
What tools are used for web application penetration testing? Evil Twins and Spoofing : What is an evil twin? What is address spoofing? What is DNS spoofing? What tools are used for setting up an evil twin? The dangers of public Wi-Fi and evil twins, How to detect an evil twin? Detection Systems: IDS, IPS, Host based, Network-based, Physical Threat hunting platforms		

Books:

Text:

1. Dileep Kumar G.; Manoj Kumar Singh; M.K. Jayanthi, “Network Security Attacks and Countermeasures”, IGI Global, ISBN-13: 978-1-4666-8761-5
2. Arthur Salmon; Warun Levesque; Michael McLafferty, “Applied Network Security”, Packt Publishing, ISBN-13: 978-1-78646-627-3

Reference:

1. William Stallings, ‘Cryptography and Network Security: Principle and Practice’, 5th Edition, Pearson, ISBN: 978-81-317-6166-3.
2. Bruce Schneier, “Applied Cryptography”, Wiley, ISBN:978-1-1119-09672-6
3. Bernard Menezes, ‘Network Security and Cryptography’, Cengage Learning, ISBN: 978-81-315-1349-1.
4. Matt Bishop, Sathyanarayana, S. Venkatramanayya, “Introduction to Computer Security”, Pearson Education, ISBN: 978-81-7758-425-7.
4. Timothy Gallo, Allan Liska, "Ransomware: Defending Against Digital Extortion", Shroff Publishers ISBN 9789352134892

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
510203 : Wireless Sensor Networks

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	In- Sem : 50 Marks End-Sem : 50 Marks

Course Objectives :

- To understand the concept of wireless sensor network
- To grasp the functionalities of specialized protocols used in WSN
- To understand the parameters related to QoS in WSN
- to familiarize the security issues related to WSN

Course Outcomes:

After completion of the course, students should be able to-

- Use appropriate model of WSN
- Apply the knowledge of W SN to solve any engineering problem related to WSN
- Analyze WSN to meet QoS
- Develop secure solutions for identified WSN

Course Contents

Unit I	Data-centric and content-based networking	08 Hours

Introduction, The publish/subscribe interaction paradigm, Addressing data, Implementation options ,Distribution versus gathering of data – In-network processing . Data-centric routing, One-shot interactions, Repeated interactions. Data aggregation, Categories of aggregation operations, Placement of aggregation points, Aggregation as an optimization problem, Broadcasting an aggregated value, Information-directed routing and aggregation, data aggregation , Data-centric storage.

Unit II	Fundamentals of WSN	08 Hours

Definitions and Background, Challenges and Constraints, Node Architecture, The Sensing Subsystem, The Processor Subsystem, Communication Interfaces - Serial Peripheral Interface , Inter-Integrated Circuit, Prototypes - The IMote Node Architecture, The XYZ Node Architecture and The Hogthrob Node Architecture

Unit III	Medium Access Control Protocols	08 Hours

Contention-Free and Contention-Based Medium Access , Wireless MAC Protocols, CSMA, MACA and MACAW, IEEE 802.11, IEEE 802.15.4 and ZigBee, Characteristics of MAC Protocols in Sensor Networks , Contention-Free MAC Protocols, Traffic-Adaptive Medium Access, Y-MAC, DESYNC-TDMA, Low-Energy Adaptive Clustering Hierarchy, Lightweight Medium Access Control , Contention-Based MAC Protocols , Power Aware Multi-Access with Signaling, Sensor MAC, Timeout MAC, Pattern MAC, Routing-Enhanced MAC, Data-Gathering MAC, Preamble Sampling and Wise MAC, Receiver-Initiated MAC, Hybrid MAC Protocols, Zebra MAC, Mobility Adaptive Hybrid MAC

Unit IV	Localization and Positioning	08 Hours

Properties of localization and positioning procedures , Possible approaches - Proximity, Trilateration and triangulation and Scene analysis , Mathematical basics for the lateration problem - Solution with three anchors and correct distance values , Solving with distance errors . Single-hop localization - Active Badge, Active office, RADAR, Cricket, Overlapping

connectivity, Approximate point in triangle, Using angle of arrival information. Positioning in multihop environments - Connectivity in a multihop network, Multihop range estimation, Iterative and collaborative multilateration, Probabilistic positioning description and propagation, Impact of anchor placement.

Unit V	QoS, Data Gathering and Management	08 Hours

Quality of service/reliability, Transport protocols, Coverage and deployment - Sensing models, Coverage measures, Uniform random deployments: Poisson point processes, Coverage of random deployments: Boolean sensing model, Coverage of random deployments: general sensing model , Coverage determination, Coverage of grid deployments, Reliable data transport, Single packet delivery, Block delivery, Congestion control and rate control.

Unit VI	Privacy and Security in WSN	08 Hours

Fundamentals of Network Security , Challenges of Security in Wireless Sensor Networks , Security Attacks in Sensor Networks , Denial-of-Service , Attacks on Routing , Attacks on Transport Layer, Attacks on Data Aggregation , Privacy Attacks , Protocols and Mechanisms for Security , Symmetric and Public Key Cryptography , Key Management , Defenses Against DoS Attacks , Defenses Against Aggregation Attacks , Defenses Against Routing Attacks , Security Protocols for Sensor Networks TinySec , Localized Encryption and Authentication Protocol , IEEE 802.15.4 and ZigBee Security.

Books:

Text:

1. Holger Karl, Andreas Willig, “Protocols and Architectures For Wireless Sensor Networks”, ISBN: 0-470-09510-5
2. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks”, ISBN 978-0-470-99765-9

Reference:

1. Edgar H. Callaway, Jr. and Edgar H. Callaway, "Wireless Sensor Networks: Architectures and Protocols", CRC Press, ISBN 9780849318238
2. Anna Hac, "Wireless Sensor Network Designs," John Wiley & Sons, ISBN 0-470-86736-1
3. Robert Faludi, "Building Wireless Sensor Networks:A Practical Guide to the ZigBee Mesh Networking Protocol" , Shroff Publishers, ISBN: 9789350232897

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
510204: High Performance Networks

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To develop a comprehensive understanding of High Performance Networks
- To learn estimation of network requirements.
- To learn Enterprise network design.
- To understand various issues hindering the performance of the network

Course Outcomes:

After completion of the course, students should be able to-

- Apply the knowledge to design high performance networks
- Analyze the performance of high performance networks
- Design routing schemes for optimized routing
- Choose appropriate and advanced techniques to build the computer network

Course Contents

Unit I	Introduction	08 Hours

TCP/IP, ISO-OSI, Fast Ethernet, Gigabit Ethernet, X.25, Frame relay, SONET, ISDN, DSL, ATM, MPLS, wireless networks such as 802.11, 802.16, Design considerations in high performance networking.

Unit II	Gigabit Ethernet	08 Hours

Foundations of gigabit Ethernet: Ethernet frame format, flow control, automatic configuration, and architecture of Gigabit Ethernet, Gigabit Ethernet physical layer, MAC layer and devices, applications of Gigabit Ethernet, performance considerations, Ethernet 10/100/1000.

Unit III	Advanced Router and Switch Architectures	08 Hours

Overview of Router Architecture, Input Port Processor (IPP), Output Port Processor (OPP), Central Controller, Switch Fabric, Multicasting Packets in Routers, Quality of Service and Scheduling in Routers : Overview of Quality of Service (QoS), Integrated Services QoS, Differentiated Services QoS, Resource Allocation, Packet Scheduling

Unit IV	MPLS	08 Hours

Introduction to MPLS, considerations in the choice of cells Vs frames, IP over MPLS architecture & terminology, MPLS forwarding operations, MPLS encapsulation standards, MPLs signaling and routing protocols

Unit V	All-Optical Networks, WDM, and GMPLS	08 Hours

Overview of Optical Networks, Basic Optical Networking Devices, Large-Scale Optical Switches, Structure of Optical Cross Connects (OXCs), Routing in All-Optical Networks, Wavelength Allocation in Networks, Case Study: An All-Optical Switch

Unit VI	Enterprise Campus Infrastructure	08 Hours

Borderless Network Architecture, Borderless Campus Network Design, Campus Network Design Principles, Campus Network Design Models, Multi-Tier Borderless Campus Design Models, Campus Distribution Layer Network Design, Distribution-Layer Network Design Recommendations.

Books:

Text:

1. Nader F. Mir, “Computer and Communication Networks, Second Edition”, Prentice Hall: ISBN-13: 978-0-13-381474-3, 10: 0-13-381474-2
2. Rich Seifert, "Gigabit Ethernet: Technology and Applications for High-Speed LANs" Addison- Wesley ISBN: 9780201185539.
3. Konstantinos Samdanis, Peter Rost, Maeder, Meo (Editors), “Green Communications: Principles, Concepts and Practice”, Wiley, ISBN: 1118759265

References:

1. Sumit Kasera,Tata, “ATM Networks Concepts and Protocols”, McGraw-Hill Professional, Networking series,ISBN-13:978-0-07-058353-5
2. Charles E. Spurgeon & Joann Zimmerman, "Ethernet: The Definitive Guide, Designing and Managing Local Area Networks”, 2nd Ed "Shroff Publishers, ISBN: 978-1449361846
3. David E. McDysan, Dave Paw, “ATM & MPLs Theory & Application: Foundations of Multi Service Networking”, McGraw-Hill publication, ISBN-13, 9780072222562
4. Frank Ohrtman, “WiMAX Handbook Building 802.16 Wireless Networks” McGraw-Hill Communications, ISBN 9780071454018
5. Kevin Roebuck, “4G Standards: High Impact Emerging Technology”, Tebbo, ISBN 1743042760 21
6. Stallings W., “High Speed Networks and Internet : Performance and Quality of Service”, Prentice- Hall, ISBN 0-13-032221-0
7. http://www.cisco.com/c/en/us/td/docs/solutions/Enterprise/Borderless_Networks/Unified_Access/Unified_Access_Book/UA_Design.htmlUnified Access Design Guide, Cisco Enterprise Campus Infrastructure Best Practices Guide, Unified Access Design Guide Campus Network for High Availability Design Guide, High Availability Campus Network Design— Routed Access Layer using EIGRP or OSPF.

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective I
510205A: Mobile Communication

Teaching Scheme:	Credit	Examination Scheme :
TH: 05 Hours/week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To understand the basics of Mobile Communication
- To understand the fundamentals involved in technologies of Mobile Communication
- To identify the requirements of mobile communication
- To know the technological advancements in communication

Course Outcomes:

After completion of the course, students should be able to

- Apply the knowledge Mobile Communication to solve a problem related to mobile communication
- Analyze the performance of Mobile Communication network
- Propose optimized solution to build a mobile communication network
- Become familiar with 3G,4G and upcoming Cellular Network Technologies for Data Connections

Selection of Modules:

Kindly note that modules 1, 2 are compulsory and select any three (03) modules from modules 3 to 8.

Course Contents

Module No	Module Title	Credits
1	Introduction	01
Digital Mobile Radio Communication System, The Purpose of Digitization of Mobile Radio Communications, Signal and Systems: Signal Analysis, Noise Analysis, Linear System, Discrete time System, Optimization and Adaptive Signal Processing		
2	The Elements of Digital Communication System	01
Pulse Shaping, Line Coding, Signal Detection, Synchronization, Scrambling, Public Key Cryptosystem, Multiplexing and Multiple Access, The Channel Capacity **Mobile Radio Channels-** Path Loss, Shadowing , Fast Fading, Delay Spread and Frequency Selective Fading, The Near-Far Problem, Co channel Interference, Receive Power Distribution and Radio Channel Design		
3	Elements of Digital Modulation	01
Digitally Modulated Signals, Linear Modulation Versus Constant Envelope Modulation, Digital Modulations, Power Spectral Density of Digitally Modulated Signals, Demodulation, Computer Simulation of Transmission Systems		
4	Digital Modulation/Demodulation for Mobile Radio Communication	01
Digital Modulation for Analog FM Mobile Radio Systems, Constant Envelope Modulation, Linear Modulation, Spread Spectrum System, Multicarrier Transmission, Single Carrier Frequency Division Modulation		

5	Elements of Digital Modulation	01
Diversity Transmission System, Multi Input Multi Output Systems, Adaptive Automatic Equalizer, Error Control Techniques, Trellis Coded Modulation, Adaptive Interference Cancellation, Voice Coding		
6	Equipment and Circuits for Digital Mobile Radio	01
Base Station, Mobile Station, Super heterodyne and Direct Conversion Receivers, Transmit and Receive Duplexing, Frequency Synthesizer, Transmitter Circuits Receiver Circuits, Countermeasures against dc Blocking and dc Offset		
7	Digital Mobile Radio Communication Systems	01
Fundamental Concepts, Digital Transmission in Analog Mobile Communication Systems Paging Systems, Two Way Digital Mobile Radio, Mobile Data Service Systems Digital Cordless Telephone, Digital Mobile Telephone Systems, Wireless Local Area Network: IEEE 802.11 Series, Bluetooth, UWB, ZigBee, BWN, MBWA		
8	3G Cellular Network Technologies for Data Connections	01
EDGE, W-CDMA: Wideband CDMA, CDMA2000, UMTS, HSPA (High Speed Packet Access), HSDPA, HSUPA, HSPA+, LTE (E-UTRA) 3GPP2 family CDMA2000 1x, 1xRTT, EV-DO (Evolution-Data Optimized), Long Term Evolution (LTE) in 4G		

Books:

Text:

1. Yoshihiko Akaiwa, "Introduction to Digital Mobile Communication", Wiley Publication, 2nd Edition, 2015, ISBN: 10: 1119041104
2. Jochen Schiller, Mobile Communications, "Pearson Education, Second Edition", 2004. ISBN-10: 0321123816, ISBN-13: 9780321123817.

References:

1. Upena Dalal, "Wireless Communication", Oxford University Press, ISBN-10: 0198060661, ISBN-13: 978-0198060666
2. Stüber, Gordon L., "Principles of Mobile Communication", Springer Publication, 978-1-4899-8703-7
3. Manuel Castells, Mireia Fernández-Ardèvol, Jack Linchuan Qiu and Araba Sey, "Mobile Communication and Society-A Global Perspective", MIT Press, ISBN: 9780262251129
4. Arumita Biswas & Mainak Chowdhury, "Wireless Communication- Theory and Applications", Cambridge University Press, ISBN : 9781316628362
5. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, ISBN: 13 978-0-521-84527-4
6. Mario Gerla & Dipankar, "Emerging Wireless Technologies & Future Mobile Networks", Cambridge University Press, ISBN :978-1-107-67864-4

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective I
510205B : Software Defined Networks

Teaching Scheme:	Credit	Examination Scheme:
TH:05 Hours/Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To understand fundamentals of SDN
- To understand programmability of network elements and its security
- To learn simulation tool for building SDN applications
- To study industrial deployment use-cases of SDN and IoT
- Understand best practices about how to design, deploy and troubleshoot next generation networks.

Course Outcomes:

After completion of the course, students should be able to

- Develop conceptual design of SDN solutions
- Apply network virtualisation for industry standard solutions
- Develop programmability of network elements
- Develop SDN-IoT integration for application building

Selection of Modules:

Kindly note that modules 1, 2 are compulsory and select any three (03) modules from modules 3 to 6.

Course Contents

Module No	Module Title	Credits
1	Architecture of SDN	01
Challenges of traditional Networks; History and evolution of SDN; Fundamental Characteristics of SDN, Architecture of SDN; SDN Operations, Centralized and Distributed Control and Data Planes, Moving Information between Planes, Distributed Control Planes – IP and MPLS – Creating IP Underlay – Convergence Time – Load Balancing – High availability – creating the MPLS overlay – Replication – Centralized Control Planes – ATM/LANE – Route Servers		
2	Open Flow and Controllers	01
Introduction to Open Flow – Building Blocks – Open Flow Messages – Northbound Interface- Implementing Open Flow Switch – Open Flow Reference Switch – Hardware Implementations – Software based Switches – Open flow in Cloud Computing. Network Emulator – Mininet, SDN Controllers - NOX, POX, Beacon, Maestro, Floodlight, Floodlight – plus, Ryu, Open Daylight.		
3	Network Virtualization	01
Introduction to NFV, Need, Relationship with SDN, Benefits of NFV, Enablers for NFV - Cloud Computing, Industry Standard High Volume Servers, Challenges of NFV, Virtualization and Data Plane I/O, Data Plane I/O, Services Engineered Path, Service Locations and Chaining, Metadata, Application Level Approach, Scale, Non-ETSI NFV Work, Middle box Studies, Embrane /Line Rate, Platform Virtualization.		

4	SDN Security	01
SDN-Specific Security Challenges, Security Principles, Threat vectors in SDN architecture - Attacks at Data Plane Layer, Attacks at Controller Layer, Attacks at SDN Layer, SDN Security framework - Securing the Data Plane Layer, Securing the Controller Layer, Securing the SDN Layer. General Security Hardening Components, Security Techniques- Firewall, Intrusion Detection System.		
5	**Building SDN Framework**	**01**
The Juniper SDN Framework, IETF SDN Framework(s) – SDP (P), Application-Based Network Operations (ABNO), Open Daylight Controller/Framework, API, High Availability and State Storage, Analytics, Policy.		
6	**Integration**	**01**
SDN – IoT Integration Overview, IoT Architecture, SDN based LTE Architecture, SDN-IoT use cases –SDN for wireless sensor based IoT devices, SDN-Based IoT Operating System/controllers , SDN security framework for IoT, SDN use cases in –Data Center, Wide Area Networks, Service Provider and Carrier Networks, Campus Networks, Hospitality Networks, Mobile Networks, Big data, and Network Function Virtualization, SDN with 5G.		

Books:

Text:

1. Thomas D.Nadeau and Ken Gray, “Software Defined Networks”, O’reilly, 2013, ISBN: 10: 1449342302
2. Paul Goransson and Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann, 2014, ISBN: 9780124166752
3. Siamak Azodolmolky, “Software Defined Networking with Open Flow”, PACKT Publishing, 2013, ISBN: 9781483427249.

Reference:

1. Rajesh Kumar Sundarrajan, “Software Defined Networking (SDN)- a definitive guide”, e-book, March 2014,ISBN: :0123705215
2. Kingston Smiler, “OpenFlow® Cookbook”, Packt Publishing, 2015, ISBN: 9781783987948
3. Doug Marschke, Jeff Doyle, Pete Moyer, “Software Defined Networking (SDN): Anatomy of OpenFlow® Volume I”. Lulu Publishing Services, 2015, ISBN: 10: 1483427234,13: 9781483427232

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective I
510205C: Bio-Inspired Optimization Algorithms

Teaching Scheme:	Credit	Examination Scheme :
TH: 05 Hours/Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives :

- To learn how natural and biological systems influence computational field
- To understand the strengths and weaknesses of nature-inspired algorithms
- To learn the functionalities of various Bio-inspired optimization algorithms

Course Outcomes:

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

- Describe the natural phenomena that motivate the algorithms
- Apply nature-inspired algorithms to optimization
- Select the appropriate strategy or optimal solution based on bio-inspired algorithms

Selection of Modules:

Kindly note modules 1 and 2 are compulsory and select any three (03) modules from modules 3 to 8.

Course Contents

Module No	Module Title	Credit
1	Natural computing	01
From nature to natural computing, Introduction, sample idea, Philosophy of natural computing, Natural computing approaches, Conceptualization – introduction, general concept, Problem solving as a search track, Hill climbing, Simulated annealing.		
2	Evolutionary computing	01
Evolutionary computing : Evolutionary biology, Evolutionary computing – standard evolutionary algorithm; Genetic algorithm, evolutionary strategies, Evolutionary programming		
3	Swarm intelligence	01
Swarm intelligence-biological motivation, from natural to artificial, standard algorithm of Ant colony optimization, Ant clustering algorithm, Particle swarm optimization		
4	Biological Motivation	01
Biological motivation, from natural to artificial, standard algorithm of cuckoo search, bat algorithm, flower pollination, firefly algorithm, framework for self tuning algorithms - case study of firefly algorithm		
5	Immune Systems	01
Immune system, Artificial immune systems - biological motivation, Design principles, main types of algorithms - Bone marrow, Negative selection, Clonal selection, Continuous immune network models, Discrete immune network models, Scope of artificial immune systems		
6	Artificial Life	01
The essence of life, Examples of ALife projects- flocks, herds and schools, computer viruses, synthesizing emotional behavior, AIBO robot, Turtles, termites, and traffic jams, framsticks, Scope of artificial life, Current trends and open problems		
7	Fuzzy Logic	01
Overview -Applying truth values, Linguistic variables, Forming a consensus of inputs and fuzzy rules, Process, Synthesis of fuzzy logic functions given in tabular form, Early applications, Example - Hard science with IF-THEN rules, Define with multiply, Define with		

sigmoid. Logical analysis - Propositional fuzzy logics, Predicate fuzzy logics, Decidability issues for fuzzy logic		
8	**Genetic Logic**	**01**
Initialization, selection, genetic operators, termination, variants- Chromosome representation, Elitism, Parallel implementations, Adaptive GAs. Extended compact genetic programming (ECGP), Embedded Cartesian genetic programming (ECGP), Probabilistic incremental program evolution (PIPE), Strongly typed genetic programming (STGP)		

Books:

Text:

1. L. N. de Castro, "Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications", 2006, CRC Press, ISBN-13: 978-1584886433
2. D. Floreano and C. Mattiussi, " Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", 2008, MIT Press, ISBN-13: 978-0262062718

References:

1. Sam Jones (Editor), "Bio Inspired Computing-Recent Innovations and Applications", Clanrye International; 2 edition (2 January 2015), ISBN-10: 1632400812
2. Yang Xiao (Editor), "Bio-Inspired Computing and Networking", CRC Press,
3. "Machine Nature: The Coming Age of Bio-Inspired Computing", New York: McGraw-Hill, 2002)
4. Adries Engelbrecht, " Computational Intelligence", Wiley, ISBN:978-0-470-03561-0
5. D. Simon, "Evolutionary Optimization Algorithms", 2013, Wiley, ISBN: 10: 0470937416;13: 978-0470937419
6. Russell C. Eberhart , Yuhui Shi , James Kennedy, " Swarm Intelligence: The Morgan Kaufmann Series in Evolutionary Computation", 1st Edition, ISBN-13: 978-1558605954
7. M. Goodrich, Tamassia, "Algorithm Design & Applications", Wiley, ISBN:978-1-118-33591-8

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective I
510205 D : Data Mining

Teaching Scheme:	Credit	Examination Scheme:
TH: 05 Hours/Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To understand the fundamentals of Data Mining
- To identify the appropriateness and need of mining the data
- To learn the preprocessing, mining and post processing of the data
- To understand various methods, techniques and algorithms in data mining

Course Outcomes:

On completion of the course the student should be able to-

- Apply basic, intermediate and advanced techniques to mine the data
- Analyze the output generated by the process of data mining
- Explore the hidden patterns in the data
- Optimize the mining process by choosing best data mining technique

Selection of Modules:

Kindly note that modules 1, 2, 3 are compulsory and select any one (01) module from modules number 4 to 10.

Course Contents

Module No.	Module Title	Credit
1	Introduction	01

Data: Data, Information and Knowledge, Attribute Types: Nominal, Binary, Ordinal and Numeric attributes, Discrete versus Continuous Attributes, Introduction to Data Preprocessing, Data Cleaning, Data integration, data reduction, transformation and Data Descritization.

Clustering: Concept of class: Characterization and Discrimination, basics /Introduction to: Classification and Regression for Predictive Analysis, Mining Frequent Patterns, Associations, and Correlations, Cluster Analysis.

2	Statistical Analysis	01

Measuring the Central Tendency: Basics of Mean, Median, and Mode, Measuring the Dispersion of Data, Variance and Standard Deviation. Measuring Data Similarity and Dissimilarity, Data Matrix versus Dissimilarity Matrix, Proximity Measures for Nominal Attributes and Binary Attributes

3	Dissimilarity Measure	01

Dissimilarity of Numeric Data: Minkowski Distance, Euclidean distance and Manhattan distance, Proximity Measures for Ordinal Attributes, Dissimilarity for Attributes of Mixed Types, Cosine Similarity.

Book:

1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques” Elsevier Publishers Third Edition/Second Edition, ISBN: 9780123814791, 9780123814807

4	Classification	02
Basic Concepts, General Approach to Classification, Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Scalability and Decision Tree Induction, Visual Mining for Decision Tree Induction, Bayes Classification Methods, Baye's Theorem, Naive Bayesian Classification, Rule-Based Classification, Using IF-THEN Rules for Classification, Rule Extraction from a Decision Tree, Rule Induction Using a Sequential Covering Algorithm, Model Evaluation and Selection: Metrics for Evaluating Classifier Performance, Holdout Method and Random Sub sampling, Cross-Validation, Bootstrap, Model Selection Using Statistical Tests of Significance, Comparing Classifiers Based on Cost–Benefit and ROC Curves, Techniques to Improve Classification Accuracy: Introducing Ensemble Methods, Bagging, Boosting and Ada Boost, Random Forests, Improving Classification Accuracy of Class-Imbalanced Data. Study of open source/Commercial tool (WEKA/MEKA/Mulan/Panthalo), open source is desirable)		
Reference: **1.** Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and Techniques" Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807.		
5	**Classification**	**02**
Bayesian Belief Networks, Concepts and Mechanisms, Training Bayesian Belief Networks, Classification by Back propagation, A Multilayer Feed-Forward Neural Network, Defining a Network Topology, Back propagation, Inside the Black Box: Back propagation and Interpretability, Support Vector Machines: The Case When the Data Are Linearly Separable, The Case When the Data Are Linearly Inseparable, Classification Using Frequent Patterns, Associative Classification, Discriminative Frequent Pattern–Based Classification, Lazy Learners (or Learning from Your Neighbors), k-Nearest-Neighbor Classifiers, Case-Based Reasoning, Other Classification Methods, Genetic Algorithms, Rough Set Approach, Fuzzy Set Approaches, Additional Topics Regarding Classification: Multiclass Classification, Semi-Supervised Classification Active Learning, Transfer Learning, Reinforcement learning, Systematic Learning, Holistic learning and multi-perspective learning. Study of open source/Commercial tool (WEKA/MEKA/Mulan/Panthalo), open source is desirable)		
Reference: **1.** Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and Techniques" Elsevier Publishers Third Edition/Second Edition, ISBN: 9780123814791, 9780123814807 **2.** Parag Kulkarni, "Reinforcement and Systemic Machine Learning for Decision Making." , Wiley-IEEE Press, ISBN: 978-0-470-91999-6.		
6	**ANN and Data Mining**	**02**
Deep Feed forward Networks: Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms. Convolutional Networks: The Convolution Operation, Pooling, Variants of the Basic Convolution Function. Recurrent Neural Networks: Recurrent Neural Networks, Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, The Long Short-Term Memory and RNNs. Auto-Encoders: Under complete Auto encoders, Regularized Auto encoders, Stochastic Encoders and Decoders, Denoising Auto encoders Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing. Study of open source/Commercial tool (like Tensor Flow Lib., Caffé Lib., Theano), open source is desirable)		
References: **1.** Ian Goodfellow, Yoshua Bengio, Aaron Courville , "Deep Learning ", MIT Press, ISBN: 9780262337434 **2.** Online Course: http://cs224d.stanford.edu/syllabus.html		

7	Parallel and Distributed Data Mining	02

Parallel and Distributed Data Mining: Introduction Parallel and Distributed Data Mining, Parallel Design Space: Distributed Memory Machines vs. Shared Memory Systems, Task vs. Data Parallelism, Static vs. Dynamic Load Balancing, Horizontal vs. Vertical Data Layout, Complete vs. Heuristic Candidate Generation.

Algorithms in parallel and distributed data mining: Count Distribution, Data Distribution, Candidate Distribution, Eclat,

Algorithms: Parallel Association Rule Mining: a priori-based Algorithms, Vertical Mining, Pattern-Growth Method,

Parallel Clustering Algorithms: Parallel k-means, Parallel Hierarchical Clustering, Parallel HOP: Clustering Spatial Data, Clustering High-Dimensional Data,

Research Issues and Challenges: High dimensionality, Large size, Data Location, data Types, Data Skew, Dynamic Load Balancing, Incremental Methods, Multi-table Mining, Data Layout, and Indexing Schemes, Parallel DBMS/File systems, Interaction, Pattern Management, and Meta-level Mining.

Distributed Mining Frameworks/Architectures: JAM, PADMA, BODHI, APACHE SPARK.

Introduction to CUDA Parallel programming language: Parallel Programming in CUDA C - CUDA Parallel Programming, Splitting Parallel Blocks, Shared Memory and Synchronization, Constant Memory, Texture Memory, CUDA events, Measuring Performance with Events, Parallel Matrix multiplication, Cuda KNN.

Reference:

1. Mohammed J. Zaki, Ching-Tien Ho , “Large-Scale Parallel Data Mining”, LCNS, Springer Publishers.
2. Sanguthevar Rajasekaran and John Reif, “Handbook of Parallel Computing Models Algorithms and Applications”
3. Liu, Wei-keng Liao, Alok Choudhary, and Jianwei Li, “Parallel Data Mining Algorithms for Association Rules and Clustering”
4. Prof. Kimito Funatsu, “New Fundamental Technologies in Data Mining”
5. Jason Sanders ,Edward Kandrot, “CUDA by Example - An Introduction to General-Purpose GPU Programming”
6. Addison Wesley, Shane cook,, “ CUDA Programming: A Developer's Guide to Parallel Computing with GPUs by, Elsevier Publishers

8	Spatial and Multimedia Data Mining	02

Data Objects: Generalization of Structured Data, Aggregation and Approximation in Spatial and Multimedia Data Generalization, Generalization of Object Identifiers and Class/Subclass, Hierarchies, Generalization of Class Composition Hierarchies, Construction and Mining of Object Cubes, Generalization-Based Mining of Plan Databases by Divide-and-Conquer.

Spatial Data Mining: Spatial Data Cube Construction and Spatial OLAP, Mining Spatial Association and Co-location Patterns, Spatial Clustering Methods, Spatial Classification and Spatial Trend Analysis, Mining Raster Databases,

Multimedia Data Mining: Similarity Search in Multimedia Data, Multidimensional Analysis of Multimedia Data, Classification and Prediction Analysis of Multimedia Data, Mining Associations in Multimedia Data, Audio and Video Data Mining

Reference:

1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques” Elsevier Publishers Second Edition, ISBN: 9780123814791, 9780123814807.

9	Data Mining Applications	02
Mining Complex Data Types, Mining Sequence Data: Time-Series, Symbolic Sequences, and Biological Sequences, Mining Graphs and Networks, Mining Other Kinds of Data, Other Methodologies of Data Mining, Statistical Data Mining, Views on Data Mining Foundations, Visual and Audio Data Mining, Data Mining Applications, Data Mining for Financial Data Analysis, Data Mining for Retail and Telecommunication Industries, Data Mining in Science and Engineering, Data Mining for Intrusion Detection and Prevention, Data Mining and Recommender Systems, Data Mining and Society, Ubiquitous and Invisible Data Mining, Privacy, Security, and Social Impacts of Data Mining, Data Mining Trends.		
Reference: 1. Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and techniques", Elsevier Publishers Second Edition, ISBN: 9780123814791, 9780123814807.		
10	**Pattern Discovery and Social Networks Mining**	**02**
Methods for Mining Frequent Subgraphs: Apriori-based Approach, Pattern-Growth Approach, Mining Variant and Constrained Substructure Patterns: Mining Closed Frequent Substructures Extension of Pattern-Growth Approach: Mining, Alternative Substructure Patterns, Constraint-Based Mining of Substructure Patterns, Mining Approximate Frequent Substructures, Mining Coherent Substructures Mining Dense Substructures, Applications: Graph Indexing with Discriminative Frequent Substructures Substructure Similarity Search in Graph Databases Classification and Cluster Analysis Using Graph Patterns **Social Network Analysis:** Introduction Social Network, Characteristics of Social Networks, Link Mining: Tasks and Challenges, Mining on Social Networks: Link Prediction, Mining Customer Networks for Viral Marketing, Mining Newsgroups Using Networks, Community Mining from Multi relational Networks Multi relational Data Mining: Introduction Multi relational Data Mining ILP Approach to Multi relational Classification Tuple ID Propagation, Multi relational Classification Using Tuple ID Propagation Multi relational Clustering with User Guidance.		
Reference: 1. Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and Techniques", Elsevier Publishers Second Edition, ISBN: 9780123814791, 9780123814807. 2. Matthew A. Russell, "Mining the Social Web,:Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More" , Shroff Publishers, 2nd Edition 3. Maksim Tsvetovat, Alexander Kouznetsov, "Social Network Analysis for Startups: Finding connections on the social web" Shroff Publishers , ISBN: 10: 1449306462		

Savitribai Phule Pune University
Master of Computer Engineering(Computer Networks) (2017 Course)
510206 : Laboratory Proficiency I

Teaching Scheme:	Credit	Examination Scheme:
Practical: 08 Hours/week	04	Presentation: 50 Marks TW: 50 Marks

Laboratory Proficiency I (LP I) is companion course of theory courses (core and elective) in Semester I. It is recommended that set of assignments or at least one mini-project/study project per course is to be completed. Set of problem statements are suggested. Course/ Laboratory instructor may frame suitable problem statements. Student has to submit a report/Journal consisting of appropriate documents - prologue, Certificate, table of contents, and other suitable write up like (Introduction, motivation, aim and objectives, outcomes, brief theory, requirements analysis, design aspects, algorithms, mathematical model, results, analysis and conclusions). Softcopy of report /journal and code is to be maintained by department/institute in digital repository.
Suitable platform/framework/language is to be used for completing mini-project/assignments.

Guidelines for Term Work Assessment

Continuous assessment of laboratory work is to be done based on performance of student. Each assignment/ mini project assessment to be done based on parameters with appropriate weightages. Suggested parameters for overall assessment as well as mini project assessment include- timely completion, performance, innovation, efficient codes, usability, documentation and adhering to SDLC comprehensively.

Guidelines for Examination

It is recommended that examination should be conducted as presentation by student based on one of the mini projects completed and the content understanding of laboratory work.

Suggested List of Laboratory assignments

A. Research Methodology

1. Use an academic web search to locate a journal paper which describes a design outcome in your field of interest (i.e. your engineering discipline).You must enter several keywords which relate to your topic. Read the paper and, using your own words, demonstrate your understanding of the paper by:
   - Brief Contribution
   - Performance Metric, data set used and design
   - Writing out the major conclusions of the paper;
   - Outlining the verification method(s) used to support these conclusions
   - Describing the author's reflective comments on the quality of the design (positive and negative).
   - The positive and negative environmental impacts of the new design;

   After reading a published research paper, write down the research question you think the author have addressed in undertaking this research. Do you think the paper adequately supports the conclusions reached in addressing the question?

2.	Consider a journal article in your discipline that was published approximately five years ago. Note the keywords and type them into one of the web-based academic search engines (e.g. googlescholar.com). Does the original article appear in the search results? How many citations does this article have? Have the same authors published further work in this field? Compare the citations of this paper with those from the most highly cited paper in the search results? How many citations does this highly cited article have? If this paper was published before your original article, is it cited in your article? Do you think this high-cited paper should have been listed as a reference in your original article? Give reasons for your decision. Read a journal paper from your discipline. Following the format of patents, write out one or more important outcomes from the paper in terms of one or more Patent Claims 1, 2…. These claims must not only be new, they must be not-obvious from previous work
3.	a) Literature Review Quality: Using a Journal paper selected in your engineering discipline of interest, write a 400 word evaluation of the quality of Literature Review. In particular, review the quality and relevance of cited papers, the comments made on those papers contribution to the general field, and any omission of papers which are of major importance in the field. b) Develop a new research proposal from a published paper: From selected published Journal paper, read the paper. In particular read the discussion and conclusion section and find Suggestions for further work. Apply one of the question words (How?, Why?, What?, When?) and write one or more research questions arising from this paper. This can be used as guide to help you to develop your own research project proposal.
4.	a) Download a set of weather data from the Internet covering the temperature and atmospheric pressure over a four day period. Present the data using 2D and 3D plots, and so deduce if the weather conditions are trending either higher or lower over this four day period. b) Numerical modeling: Find a paper in which numerical modeling has been used to verify the experimental results. Comment on the differences between the experimental and modeling results. Have the authors commented on the accuracy of the experimental and modeling procedures? What suggestions do you have to improve the quality of the modeling reported in the paper? c) Statistical review: In your engineering discipline review a published paper which includes a statistical analysis. Write a brief report on the statistical methods used. Can you suggest an improved statistical analysis? Suggest some additional parameters that might have been measured during the data acquisition stage and so explain how you would analyze the total data set to deduce the influence (and statistical significance) of these additional measurements.

B. Network Security

1.	Stage I (Obtaining Footprints): Gathering the information about a network. Use Ping, Whois, Nslookup, Netbrute or NMAP utilities to identify the domains, the IP addresses, IP classes, IP addresses of servers, administrator's contact information, online hosts, active and passive ports available for carrying out ethical intrusion demonstration.

	Stage II (Protocol Classification) : Protocol classification with subfields. Select any two machines from the LAN say A and B. Make machine A as server equipped with http, ftp and smtp services. Make machine B as client equipped with wireshark/ethereal protocol analyzer. Use different utilities and tools on machine B to access different TCP/IP based services on machine A. Capture all the responses on machine B using wireshark/ethereal protocol analyzer and do the classification of protocols along with their subfields. Stage III (Attack Classification) : Identification and classification of Attacks. Make machine A as server equipped with http, ftp, SMTP services as well as wireshark/ethereal protocol analyzer. Carry out the various attacks such as Ping Death, IP Spoofing, ARP Spoofing, Session Hijacking, SQL Injection, DOS and DDOS on machine A from different machines in the network. Identify the nature of attack and classify each attack to separate out packets and prepare intrusion database on machine A
C. Wireless Sensor Networks	
1.	**Case Study I: Heart Beats Rate Detection** A normal resting heart rate for adult ranges from 60 to 100 beats a minute. Generally, a lower heart rate at rest implies more efficient heart function and better cardiovascular fitness. For example, a well-trained athlete might have a normal resting heart rate closer to 40 beats a minute. Design a sensor network to detect heart rate with the suitable interval of say 1 or 2 or 3 minutes (use heartbeat sensor). If heart rate reaches or crosses 100, then generate a SMS/mail alert and send it to the family member as well as doctor. **Case Study II: Gas Leak Detection** A home fire almost always starts in the kitchen, an area of your home with no dearth of combustible, explosive materials. More often than not, the reason for a kitchen fire is a leaking of LPG/Natural gas cylinder which can go unnoticed for long periods of time. Design a sensor network to detect LPG/ Natural gas leak within the range of 4-6 meters. In case of smallest gas leak it should automatically detect the leak and generate a SMS/ mail alert to family members within the response time of 30 seconds. **Case Study III:** On the similar line, instructor can frame the case studies on Temperature Detection, Forest Fire Detection, Water Leakage Detection, Flood Warning, Volcano Monitoring.
D. High Performance Networks	
1.	Design a simulation model of 14 node network for the use of WDM technology over OC-192/768 in m number of OC-n channels.
E. Elective I	
1.	Course instructor is authorized to frame suitable problem statements for mini project

SEMESTER II

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
510208 : Operations Research

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To introduce students to use quantitative methods and techniques for effective analysis of decisions making
- To understand the model formulation and applications that is used in solving business decision problems.
- To introduce students to optimization approaches and fundamental solution.
- To learn a variety of ways in which deterministic and stochastic models in Operations Research can be used

Course Outcomes:

After completion of the course, students should be able to

- Identify the characteristics of different types of decision-making environments
- Use appropriate decision making approaches and tools
- Build various dynamic and adaptive models
- Develop critical thinking and objective analysis of decision problems
- Apply the OR techniques for efficacy

Course Contents

Unit I	Linear Programming	08 Hours

Introduction, Modeling with Liner Programming, Two variable LP model, Graphical LP solutions for both maximization and minimization models with various application examples, LP model in equation form, simplex method, special case in simplex method, artificial starting solution, Degeneracy in LPP, Unbounded and Infeasible solutions.

Unit II	Duality in Linear Programming and Revised Simplex Method	08 Hours

Duality theory: a fundamental insight. The essence of duality theory, Economic interpretation of duality, Primal dual relationship; Adapting to other primal forms, The revised simplex method- development of optimality and feasibility conditions, Revised Simplex Algorithms.

Unit III	The Transportation Problem and Assignment Problem :	08 Hours

Finding an initial feasible solution - North West corner method, Least cost method, Vogel's Approximation method, Finding the optimal solution, optimal solution by stepping stone and MODI methods, Special cases in Transportation problems - Unbalanced Transportation problem. Assignment Problem: Hungarian method of Assignment problem, Maximization in Assignment problem, unbalanced problem, problems with restrictions, travelling salesman problems.

Unit IV	Game Theory and Dynamic Programming	08 Hours

Introduction, 2 person zero sum games, Maximi - Minimax principle, Principle of Dominance, Solution for mixed strategy problems, Graphical method for 2 x n and m x 2 games. Recursive nature of computations in Dynamic Programming, Forward and backward recursion, Dynamic Programming Applications – Knapsack, Equipment replacement, Investment models

Unit V	Integer Programming Problem and Project Management	08 Hours
Integer Programming Algorithms – B&B Algorithms, cutting plane algorithm, Gomory's All-IPP Method, Project Management: Rules for drawing the network diagram, Application of CPM and PERT techniques in project planning and control; Crashing and resource leveling of operations Simulation and its uses in Queuing theory & Materials Management.		
Unit VI	**Decision Theory and Sensitivity Analysis**	**08 Hours**
Decision making under certainty, uncertainty and risk, sensitivity analysis, Goal programming formulation and algorithms – The weights method, The preemptive method.		

Books:

Text

1. Hamdy A. Taha, "Operations Research" , Pearson Education, 8th Edition, ISBN: 978-81-317-1104-0
2. Gillett, "Introduction to Operation Research", TMH, ISBN: 0070232458

References:

1. S.D. Sharma, Kedarnath, Ramnath & Co, "Operations Research", Meerut,2009, ISBN: 978-81-224-2288-7
2. Hrvey M. Wagner, "Principles of Operations Research", Second Edition, Prentice Hall of India Ltd., 1980, ISBN: 10: 0137095767 ,13: 9780137095766 ..
3. V.K. Kapoor, " Operations Research", S. Chand Publishers, New Delhi, 2004, ISBN: 9788180548543, 8180548546 .
4. R. Paneer Selvam, "Operations Research", Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2008, ISBN: 10: 8120329287,: 9788120329287.

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
510209 : Network Design and Analysis

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives :

- To develop a comprehensive understanding of computer Networks
- To study design issues in networks.
- To learn estimation of network requirements.
- To learn Enterprise network design.
- To understand various issues hindering the performance of the network

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

- Apply the knowledge to design computer networks
- Analyze the performance of networks based on chosen metrics
- Design routing schemes for optimized routing
- Choose appropriate and advanced techniques to build the computer network

Course Contents

Unit I	Introduction	08 Hours

Overview of network analysis and design process, Network design issues, requirement analysis (user, application, device, network, other) concepts, Routing and forwarding, resource allocation, general principles of network design, network characteristics, performance metric

Unit II	Physical and Logical network design	08 Hours

Topologies, Physical addressing, switching, IP packet format, IP routing method, routing using masks, fragmentation of IP packet, IPv6, advanced features of IP routers: filtering, IP QoS, NAT, routers

Unit III	Queuing Theory	08 Hours

Delay Models in Data Networks, Queuing Models- Little's Theorem, Application of Little's Theorem, Queuing Systems: M/M/1, M/M/2, M/M/m, M/M/∞, M/M/m/m, M/M/m/q, M/M/1/N, D/D/1, M/G/1 System, M/G/1 Queues with Vacations, Priority Queuing.

Unit IV	Modelling N/W as Graph	08 Hours

Graph terminology, representation of networks, fundamental graph algorithms, shortest path, link prediction algorithms - Dijkstra's Algorithm, Bellman's Algorithm, Floyd's algorithm, Incremental shortest path algorithm.

Unit V	Methods of Ensuring Quality of Service	08 Hours

Methods of ensuring quality of service – introduction, applications and QoS, QoS mechanisms, Queue management algorithms, feedback, resource reservation, traffic engineering, IP QoS

Unit VI	Advanced Topics in Computer Networks	08 Hours

Next generation networks, cyber physical systems, smart mobiles, cards and device networks, smart devices and services, network testing, testing tool – wire shark

Books :

1. Aaron Kershenbaum, " Telecommunications Network Design Algorithms ",McGraw Hill education (India) Edition 2014, ISBN: 10: 0070342288
2. James McCabe, "N/W analysis, Architecture and Design", Elsevier, 978-0-12-370480-1
3. Pablo Pavon Marino, "Optimization of Computer Networks: Modeling and algorithms – A hands on approach", Wiley Publication, ISBN: 10. 1119013356.
4. Natalia Olifer, Victor Olifer, "Computer Networks, Principles, Technologies and Protocols for network design", Wiley India, ISBN: 13, : 9788126509171

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
510210 : Data Algorithms

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives :

- To study concepts of sorting and searching for voluminous data
- To learn functionalities of advanced network algorithms
- To understand the means for data and market prediction
- To study various Algorithmic strategies.

Course Outcomes:

After completion of the course, students should be able to-

- Apply the concept of advanced algorithms related to searching, sorting and network related algorithms
- Estimate the complexity of various algorithms and Measure the performance of the data algorithms
- Choose appropriate algorithm to solve data centric problems

Course Contents

Unit I	Secondary Sorting Algorithm	08 Hours

Secondary Sort: Introduction, Solutions to the Secondary Sort Problem, Map Reduce Solution to Secondary Sort, Spark Solution to Secondary Sort, Secondary Sorting Techniques, Complete Example of Secondary Sorting, Top N, Formalized Map Reduce Implementation: Unique Keys & Non unique Keys, Spark Implementation: Unique Keys, Non unique Keys.

Unit II	Left Outer Join Algorithms	08 Hours

Left Outer Join: Implementation of Left Outer Join in Map Reduce with Example, Spark Implementation of Left Outer Join ().

Unit III	Order Inversion	08 Hours

Order Inversion: Example of the Order Inversion Pattern, Map Reduce Implementation of the Order Inversion Pattern, Formal Definition of Moving Average.

Unit IV	Market Basket Analysis	08 Hours

Market Basket Analysis: MBA Goals, Application Areas for MBA, Market Basket Analysis Using Map Reduce, Spark Solution, POJO Common Friends Solution.

Unit V	Scatter Search Algorithms	08 Hours

Introduction of SS algorithms, working principle of SS algorithms / scatter search methodology and basic scatter search design and advance designs, SS Algorithm, Diversification Method, Reference set update method, Improvement Methods, Subset Generation, training method.

Unit VI	Network Algorithms	08 Hours

Bellman's equation and acyclic networks, The Network Simplex Algorithm - The minimum cost flow problem, Bipartite matching, Reflections on Augmenting path, Transshipment, Tree solutions, Constructing an admissible tree structure, Cycle detection, map coloring

Books :

1. Mahmoud Parsian, "Data Algorithms", O'Reilly, ISBN-10 1491906189
2. Manuel Laguna, Rafael Martí, "Metaheuristic Procedures for Training Neutral Networks" , Springer 2006 ,ISBN - 978-0-387-33415-8
3. Dieter Jungnickel, "Graphs, Networks and Algorithms" Springer,ISBN 978-3-540-72779
4. Steele, Brian, Chandler, John, Reddy, Swarna , "Algorithms for Data Science", Springer International Publishing, ISBN 978-3-319-45797-0
5. John Cheney-Lippold, " We Are Data- Algorithms and The Making of Our Digital Selves", NYU Press, ISBN: 9781479857593

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective II
510211A : Pervasive and Ubiquitous Computing

Teaching Scheme:	Credit	Examination Scheme:
TH: 05 Hours/Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives :

- To understand the characteristics and principles of Pervasive computing
- To introduce to the enabling technologies of pervasive computing
- To understand the basic issues and performance requirements of pervasive computing applications
- To learn the trends of pervasive computing

Course Outcomes :

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

- Design and implement primitive pervasive applications
- Analyze and estimate the impact of pervasive computing on future computing applications and society
- Develop skill sets to propose solutions for problems related to pervasive computing system
- Design a preliminary system to meet desired needs within the constraints of a particular problem space

Selection of Modules:

Kindly note that modules 1, 2 are compulsory and select any three (03) modules from modules 3 to 6.

Course Contents

Module No	Module Title	Credit
1	Introduction	01
Pervasive Computing, Applications, Pervasive Computing devices and Interfaces, Device technology trends, Connecting issues and protocols. Pervasive Computing- Principles, Characteristics, interaction transparency, context aware, automated experience capture. Architecture for pervasive computing. Charting Past, Present, and Future Research in Ubiquitous Computing.		
2	Protocols	01
Open protocols, Service discovery technologies- SDP, Jini, SLP, UpnP protocols, data Synchronization, SyncML framework, Context aware mobile services, Context aware sensor networks, addressing and communications- Context aware security. Pervasive Computing and web based Applications - XML and its role in Pervasive Computing, Wireless Application Protocol (WAP) Architecture and Security, Wireless Mark-Up language (WML) – Introduction. Moving on from Weiser's Vision of Calm Computing: Engaging UbiComp Experiences		
3	Voice Enabling Pervasive Computing	01
Voice Enabling Pervasive Computing , Voice Standards , Speech Applications in Pervasive Computing and security. Device Connectivity, Web application Concepts, WAP and Beyond.		

Voice Technology – Basis of speech Recognition, Voice Standards, Speech Applications, Speech and Pervasive Computing, Security, The Hitchhiker's Guide to UbiComp: Using techniques from Literary and Critical Theory to Reframe Scientific Agendas.		
4	**Personal Digital Assistant**	**01**
Personal Digital Assistant – History, Device Categories, Device Characteristics, Software Components, Standards. Server side programming in Java, Pervasive Web application Architecture, Example Application, Access via PCs, Access via WAP, Access via PDA, and Access via Voice, PinchWatch: A Wearable Device for One-Handed Micro interactions., Interfaces - Enabling mobile micro-interactions with physiological computing.		
5	**Wearable Computing Architecture**	**01**
User Interface Issues in Pervasive Computing, Architecture, and Smart Card based Authentication Mechanisms, Wearable computing Architecture. Touche: Enhancing Touch Interaction on Humans, Screens, Liquids, and Everyday Objects		
6	**Applications**	**01**
Smart Tokens, Heating Ventilation and Air Conditioning, Set Top Boxes, Appliances and Home Networking, Residential Gateway, Automotive Computing, On Board Computing Systems, In Vehicle networks, Entertainment Systems, Emerging Sites of HCI Innovation: Hacker spaces, Hardware Startups & Incubators		

Books :

Text :

1. Jochen Burkhardt, Horst Henn, Stefan Hepper, Thomas Schaec & Klaus Rindtorff, " Pervasive Computing Technology and Architecture of Mobile Internet Applications", Addision Wesley, Reading, 2002. ISBN:13: 978-0-201-72215-4
2. Uwe Hansman, Lothat Merk, Martin S Nicklous & Thomas Stober, "Principles of Mobile Computing", Second Edition, Springer- Verlag, New Delhi, 2003, ISBN: 9783662043189

References :

1. Mohammads, Obaidait, Denko, Woungang, " Pervasive Computing and Networking", Wiley, ISBN:978-0-470-74772-8
2. Seng Loke, "Context-Aware Computing Pervasive Systems", Auerbach Pub., New York, 2007, ISBN: 978-1-4471-5006-0
3. Uwe Hansmann etl, "Pervasive Computing", Springer, New York,2001., ISBN: 10: 3540002189
4. Jochen Burkhardt, Stefan Hepper, Klaus Rindtorff, Thomas Schaeck , "Pervasive Computing-Technology and Architecture of Mobile Internet Application", Pearson Education, Sixth Edition 2009, ISBN:
5. John Krumm, "Ubiquitous Computing Fundamentals", Shroff Publishers, ISBN: 9781420093605 .

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective II
510211B: WiMAX Network Planning and Optimization

Teaching Scheme:	Credit	Examination Scheme:
TH: 05 Hours/Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To acquire the fundamentals of WiMax networking
- To understand quality issues regarding the performance of WiMax network
- To learn the optimization methods for performance enhancement in WiMax networks
- To know various applications of WiMax network

Course Outcomes:

On completion of the course the student will be able to

- Plan the Wireless networks based on Quality of Service parameters
- Use the principles of optimization for development of networks based on various parameters
- Analyze the performance of WiMax networks
- Estimate and predict the performance of wireless / WiMax networks.

Selection of Modules:

Kindly note that modules 1,2 ,3 are compulsory and select any two (02) modules from modules 3 to 9.

Course Contents

Module No.	Module Title	Credit
1	QoS in WiMAX	01
Quality of Service in WiMAX, Scheduling in WiMAX, QoS and Fairness in WiMAX.		
2	Strategies in WiMAX	01
Random Access and Contention Strategies in WiMAX Enhanced Hybrid ARQ for WiMAX.		
3	Resource Management in WiMAX	01
Resource Allocation in OFDM-Based WiMAX, Handoff Management in WiMAX.		
4	Routing in WiMAX	01
Power Management in MobileWiMAX, Multimedia over Mobile WiMAX.		
5	WiMAX Architecture	01
Relay-Assisted Mobile WiMAX, Routing and Scheduling for WiMAX Mesh Networks.		
6	Configuration Planning	01
WiMAX: Architecture, Planning, and Business Model, WiMAX Networks Dimensioning.		
7	Capacity Planning in WiMAX	01
Network Planning for IEEE 802.16j Relay Networks, Automatic Configuration and Optimization of WiMAX Networks.		
8	Optimization in WiMAX	01
Automatic and Optimized Cell-Mesh Planning in WiMAX, Capacity Planning and Design of WiMAX Access Networks.		
9		01
An Optimization Model for WiMAX Network Planning, Adaptions for Optimized Performance in WiMAX Networks, Performance Evaluation and Dimensioning of WiMAX.		

Books :

Text:

1. Taylor and Fransis Group(Editors), “WiMAX Network planning and optimization” , CRC Press, ISBN: 9781420066623
2. Taylor and Fransis Group, “WiMAX / Mobilefi Advanced Research and Technology”, Auerbach Publications, New York, ISBN: 0-8493-2212-X

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective II
510211C : Machine Learning

Teaching Scheme:	Credit	Examination Scheme:
TH: 05 Hours/Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives :

- To understand Human learning aspects
- To learn the primitives in learning process by computer
- To Understand nature of problems solved with Machine Learning
- To acquaint with the basic concepts and techniques of Machine Learning.
- To learn the means for categorization of the information

Course Outcomes:

On completion of the course the student will be able to-

- Acquire fundamental knowledge of learning theory
- Design and evaluate various machine learning algorithms
- Use machine learning methods for multivariate data analysis in various scientific fields
- Choose and apply appropriate Machine Learning Techniques for analysis, forecasting, categorization and clustering of the data

Selection of Modules: Kindly note that modules 1,2 are compulsory and select any three (03) modules from modules 3 to 6.

Course Contents

Module No	Module Title	Credit
1	**Machine Learning Concepts**	01
Introduction to Machine Learning, Machine Learning applications, 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, Predictive and descriptive learning, Classification concepts, Binary and multi-class classification		
2	**Learning Theory**	01
Features: Feature Extraction, Feature Construction and Transformation, Feature Selection, Dimensionality Reduction: Subset selection, the Curse of dimensionality, Principle Components analysis, Independent Component analysis, Factor analysis, Multidimensional scaling, Linear discriminant analysis, Bias/Variance trade off, Union and chernoff /Hoeffding bounds, VC dimension, Probably Approximately Correct (PAC) learning, Concept learning, the hypothesis space, Least general generalization, Internal disjunction, Paths through the hypothesis space, model Evaluation and selection		
3	**Geometric Models**	01
Regression, Logistic regression , Assessing performance of regression - Error measures, Over fitting, Least square method, Multivariate Linear regression, Regression for Classification, Perceptron, Muli-layer perceptron, Simple neural network, Kernel based methods, Support vector machines(SVM), Soft margin SVM, Support Vector Machines as a linear and non-linear classifier, Limitations of SVM, Concept of Relevance Vector, K-nearest neighbor algorithm		
4	**Logical, Grouping And Grading Models**	01
Decision Tree Representation, Alternative measures for selecting attributes, Decision tree		

algorithm: ID3, Minimum Description length decision trees, Ranking and probability estimation trees, Regression trees, Clustering trees, Rule learning for subgroup discovery, Association rule mining, Distance based clustering- K-means algorithm, Choosing number of clusters, Clustering around medoids – silhouettes, Hierarchical clustering, Ensemble methods: Bagging and Boosting

5	Probabilistic Models	01

Uncertainty, Normal distribution and its geometric interpretations, Baye's theorem, Naïve Bayes Classifier, Bayesian network, Discriminative learning with maximum likelihood, Probabilistic models with hidden variables, Hidden Markov model, Expectation Maximization methods, Gaussian Mixtures and compression based models

6	Case Studies on Advanced Machine Learning Techniques	01

Profiling the online storefronts of counterfeit merchandise, Detecting malicious websites in adversarial classification, Credit card fraud detection, Topic models of the underground Internet economy, Learning to rate vulnerabilities and predict exploits

Books:

Text:

1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that make sense of data", Cambridge University Press, 1st Edition, 2012, ISBN : 978-1-316-50611-0
2. Ethem Alpaydin, "Introduction to Machine Learning", PHI, 2nd edition, 2013,ISBN: 978-0-262-01243-0
3. Kevin Murphy, "Machine Learning: a Probabilistic Approach", MIT Press, 1st Edition, 2012, ISBN : 978-0262-30616-4

Reference:

1. Shai Shalev-Shwartz , " Understanding Machine Learning: From Theory to Algorithms" , Cambridge University Press, ISBN: 9781107512825
2. C.M. Bishop, " Recognition and Machine learning, Springer", 1st Edition, 2013, ISBN: 978-81-322-0906-5
3. Hastie, Tibshirani, Friedman, "Introduction to statistical machine learning with applications in R", Springer, 2nd Edition, 2013, ISBN : 978-1-4614-7138-7
4. Tom Mitchell, " Machine Learning", McGraw Hill, 1997, ISBN :0-07-042807-7
5. Darren Cook, "Practical Machine Learning with H2O:Powerful, Scalable Techniques for Deep Learning and AI" , Shroff Publishers, ISBN: -13 : 9781491964606
6. Parag Kulkarni, "Reinforcement and Systemic Machine learning for Decision Making", Wiley-IEEE Press, 2012, 978-0-470-91999-6
7. M. F. Der, Saul, Savage, and Voelker , "Knock it off: profiling the online storefronts of counterfeit merchandise",In Proceedings of the Twentieth ACM Conference on Knowledge Discovery and Data Mining, pages 1759-1768. New York, NY.
8. J. T. Ma, L. K. Saul, S. Savage, and G. M. Voelker, "Learning to detect malicious URLs. ACM Transactions on Intelligent Systems and Technology", 2(3), pages 30:1-24.
9. D.-K. Kim, G. M. Voelker, and L. K. Saul, "A variational approximation for topic modeling of hierarchical corpora", (ICML-13). Atlanta, GA.
10. M. Bozorgi, L. K. Saul, S. Savage, and G. M. Voelker, "Beyond heuristics: learning to classify vulnerabilities and predict exploits", Proceedings of the Sixteenth ACM Conference on Knowledge Discovery and Data Mining (KDD-10), pages 105-113.

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective II
510211D : System Simulation and Modeling

Teaching Scheme:	Credit	Examination Scheme:
TH: 05 Hours/Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To learn the concepts of Systems behavior
- To understand various Modeling schemes
- To acquaint with the theory of simulation
- To learn applications to simulate the systems

Course Outcomes:

On completion of the course the student will be able to-

- Apply modeling to understand system behavior
- Design the simulation scheme for particular system
- Analyze the modeled and simulated systems
- Compare the results of simulations confined to real world application

Selection of Modules:

Kindly note that modules 1,2 are compulsory and select any three (03) modules from modules 3 to 6.

Course Contents

Module No	Module Title	Credit
1	Introduction	01
The Nature of Systems, Event-Driven Model, Characterizing Systems, Simulation Diagrams, The Systems Approach. Dynamical Systems: Initial-Value Problems, Higher-Order Systems, Autonomous Dynamic Systems, Multiple-Time-Based Systems, Handling Empirical Data.		
2	System Models	01
Uniformly Distributed Random Numbers, Statistical Properties of U[0,1] Generators, Generation of Non-Uniform Random Variates, Generation of Arbitrary Random Variates, Random Processes, Characterizing Random Processes, Generating Random Processes, Random Walks, White Noise. Stochastic Data Representation: Random Process Models, Moving-Average (MA) processes, Autoregressive (AR) processes, Big-Z notation, Autoregressive Moving-Average (ARMA) models, additive noise.		
3	Spatial Distributions	01
Sampled Systems, Spatial Systems, Finite-Difference Formulae, Partial Differential Equations, Finite Differences for Partial Derivatives, Constraint Propagation. Exhogenous Signals and Events: Disturbance Signals, State Machines, Petri Nets, Analysis of Petri Nets, System Encapsulation.		
4	Modelling Input Signals	01
Modeling Input Signals, Nomenclature, Discrete Delays, Distributed Delays, System Integration, Linear Systems, Motion Control Models, Numerical Experimentation. Event-Driven Models: Simulation Diagrams, Queuing Theory, M/M/1 Queues, Simulating Queuing Systems, Finite-Capacity Queues, Multiple Servers, M/M/c Queues.		

5	Output Data Analysis	01
Transient and Steady-State Behavior of a Stochastic Process, Types of Simulations with Regard to Output Analysis, Statistical Analysis for Terminating Simulations, Statistical Analysis for Steady-State Parameters, Statistical Analysis for Steady-State Cycle Parameters, Multiple Measures of Performance, Time Plots of Important Variables		
6	**Simulation of Manufacturing System**	**01**
Simulation of Manufacturing System: Introduction, Objectives of Simulation in Manufacturing, Simulation Software for Manufacturing, Modeling System Randomness with extended example, A simulation case study of a Metal-Parts Manufacturing Facility.		

Books:

Text:

1. Frank L. Severance, "System Modeling and Simulation a Introduction", Severance, John Wiley & Sons Ltd., ISBN 9812-53-175-0.
2. Averill M Law, "Simulation Modeling and Analysis", McGraw Hill Education, ISBN-13: 978-0-07- 066733-4.

Reference:

1. Daniele Gianni, Andrea D'Ambrogio, and Andreas Tolk (editors), "Modeling and Simulation-Based Systems Engineering Handbook", CRC Press, 2014., ISBN: 1466571462
2. Gould, H. and Tobochnik, J., "Computer Simulation Methods part I and II", Addison Wesley, 1987, ISBN:0-691-13744-7

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
510212: Seminar I

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hours/week	04	TW: 50 Marks Presentation: 50 Marks

Course Objectives:

- To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.
- To Identify, understand and discuss current, real-world issues, new technologies, research, products, algorithms, and services.

Course Outcomes:

On completion of the course, student will be able–

- To use multiple thinking strategies to examine real-world issues and explore creative avenues of expression,
- To acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication.
- To learn and integrate, through independent learning in sciences and technologies, with disciplinary specialization and the ability to integrate information across.

The student shall have to deliver the seminar I in semester II on a topic approved by guide and authorities. It is recommended to allot guide to the student since the commencement of semester I. The guide allotment preferably needs to be carried out in synchronization with mutual domains of interest. It is recommended that seminar shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected or domain of interest.

It is appreciated and strongly recommended that the student will select the domain of his/her dissertation and identify the literature confined to the domain in semester I. Thorough literature study based on the broad identified topic has to be carried out. This practice will eventually lead to convergence of the efforts for the dissertation work to be completed in Semester III and IV.

The relevant literature then be explored as state-of-the-art, exotic, recent technological advancements, future trends, applications and research & innovations. Multidisciplinary topics are encouraged. The student shall submit the duly approved and certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute. The student will be assessed based on his/her presentation and preparations by the panel of examiners out of them one has to be an external examiner.

The students are expected to validate their study undertaken by publishing it at standard platforms.

The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.

The continuous assessment of the progress need to be documented unambiguously. For standardization and documentation, follow the guidelines circulated / as in seminar logbook approved by Board of Studies.

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
510213: Laboratory Proficiency II

Teaching Scheme:	Credit	Examination Scheme:
Practical:08 Hours/Week	04	TW: 50 Marks Presentation: 50 Marks

Laboratory Proficiency II (LP II) is companion course of theory courses (core and elective) in Semester II. It is recommended that set of assignments or at least one mini-project/study project per course is to be completed. Set of problem statements are suggested. Course/ Laboratory instructor may frame suitable problem statements. Student has to submit a report/Journal consisting of appropriate documents - prologue, Certificate, table of contents, and other suitable write up like (Introduction, motivation, aim and objectives, outcomes, brief theory, requirements analysis, design aspects, algorithms, mathematical model, results, analysis and conclusions). Softcopy of report /journal and code is to be maintained by department/institute in digital repository.

Suitable platform/framework/language is to be used for completing mini-project/assignments.

Guidelines for Term Work Assessment

Continuous assessment of laboratory work is to be done based on performance of student. Each assignment/ mini project assessment to be done based on parameters with appropriate weightages. Suggested parameters for overall assessment as well as mini project assessment include- timely completion, performance, innovation, efficient codes, usability, documentation and adhering to SDLC comprehensively.

Guidelines for Examination

It is recommended that examination should be conducted as presentation by student based on one of the mini projects completed and the content understanding of laboratory work.

Suggested List of Laboratory Assignments

A. Operations Research

1. The Transportation Problem:

Milk in a milk shed area is collected on three routes A, B and C. There are four chilling centers P, Q, R and S where milk is kept before transporting it to a milk plant. Each route is able to supply on an average one thousand liters of milk per day. The supply of milk on routes A, B and C are 150, 160 and 90 thousand liters respectively. Daily capacity in thousand liters of chilling centers is 140, 120, 90 and 50 respectively. The cost of transporting 1000 liters of milk from each route (source) to each chilling center (destination) differs according to the distance. These costs (in Rs.) are shown in the following table:

2.

Routes	Chilling centers			
	P	Q	R	S
A	16	18	21	12
B	17	19	14	13
C	32	11	15	10

The problem is to determine how many thousand liters of milk is to be transported from each route on daily basis in order to minimize the total cost of transportation

3. **Investment Problem:**

A portfolio manager with a fixed budget of $100 million is considering the eight investment opportunities shown in Table 1. The manager must choose an investment level for each alternative ranging from $0 to $40 million. Although an acceptable investment may assume any value within the range, we discretize the permissible allocations to intervals of $10 million to facilitate the modeling. This restriction is important to what follows. For convenience we define a unit of investment to be $10 million. In these terms, the budget is 10 and the amounts to invest are the integers in the range from 0 to 4. Following table provides the net annual returns from the investment opportunities expressed in millions of dollars. A ninth opportunity, not shown in the table, is available for funds left over from the first eight investments. The return is 5% per year for the amount invested, or equivalently, $0.5 million for each $10 million invested. The manager's goal is to maximize the total annual return without exceeding the budget

Returns from Investment Opportunities

Amount Invested ($10 million)	*Opportunity*							
	1	2	3	4	5	6	7	8
0	0	0	0	0	0	0	0	0
1	4.1	1.8	1.5	2.2	1.3	4.2	2.2	1.0
2	5.8	3.0	2.5	3.8	2.4	5.9	3.5	1.7
3	6.5	3.9	3.3	4.8	3.2	6.6	4.2	2.3
4	6.8	4.5	3.8	5.5	3.9	6.8	4.6	2.8

B. Network Design and Analysis

1. Create a client server model where server has M/M/1 queuing system providing service to N-clients. Convert M/M/1 queuing system to M/M/m queuing system. It can be implemented either by using web technology tools or NS3 /OMNet Tool.

C. Data Algorithms (Any One)

1.	**Social Network Analysis** Analyze small/large scale social network's structure through various graph theoretic properties of the underlying network graph. Graph theoretic properties which can be studied for network graph may include: diameter of a graph, degree distribution of vertices, spectral gap and expansion properties of the graph, sub-graph centrality, clusters in the graph for suitably chosen metric, Euler number of a graph, conductance of graph. It is interesting to explore these properties as a function of size of the graph. Understanding whether any of these properties show limiting behavior as network size grows would also be interesting. Following are some useful references: A mini project would comprise of two parts 1. Study of some graph theoretic properties of social network from mathematical perspective 2. Practical Application. Practical applications may include: community detection, friend suggestion, malicious activity detection, rumor spreading.
2.	**Effective scheduling/Time Table Generation** Design an effective schedule for trains, flights, buses. Design an effective time-table for a college, or exam schedule. The underlying decision problems for scheduling and time table generation in most of the cases are NP-hard so we do not hope to get an efficient deterministic algorithm for these problems. Most of these problems can be modeled as integer linear program. Interesting problem is to design Genetic/scatter search based algorithm for these optimization problems. A mini project would comprise of coming up with a natural definition for "effectivity" (this would vary depending upon the application) and design an effective schedule/timetable using Genetic/scatter-search based or Ant-Colony optimization algorithms. It will also be interesting to explore connection between effective time-table generation/scheduling based on the given constraints and the stable marriage problem
3.	Netflix Challenge and Movie suggestion
4.	Sport Analytics
5.	Movie Suggestion
6.	Perform Market Basket Analysis or Scatter Search or Network Algorithm or Order Inversion for the selected case study.
	D. Elective II
1.	Course instructor is authorized to frame suitable problem statements for mini project

SEMESTER III

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
610201: Fault Tolerant Systems

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives :

- To identify and understand the need of redundancies in the systems
- To understand reliability and accountability in the systems
- To know the instances where fault tolerance is inevitable
- To understand the concept of fault tolerance in detail

Course Outcomes :

On completion of the course the student should be able to-

- Analyze the system for the requirement of fault tolerance
- Simulate the fault tolerance algorithms
- Implement diagnosis and recovery of the system
- Assess the reliability of the system

Course Contents

Unit I	Fault Tolerance and Reliability Analysis	08 Hours

Introduction, Redundancy Techniques- Hardware Redundancy, Software Redundancy, Information Redundancy, Time Redundancy, Reliability Modeling and Evaluation - Empirical Models, Analytical Techniques.

Unit II	Fault Modelling, Simulation and Diagnosis	08 Hours

Fault Modeling, Fault Simulation, Fault Simulation Algorithms- Serial Fault Simulation Algorithm, Parallel Fault Simulation, Deductive Fault Simulation, Concurrent Fault Simulation, Critical Path Tracing, Fault Diagnosis- Combinational Fault Diagnosis, Sequential Fault Diagnosis Methods.

Unit III	Fault-Tolerant Routing in Multi-Computer Networks	08 Hours

Fault-Tolerant Routing Algorithms in Hypercube- Depth-First Search Approach, Iterative-Based Heuristic Routing Algorithm, Routing in Faulty Mesh Networks- Node Labeling Technique, A FT Routing Scheme for Meshes with Non-convex Faults.

Unit IV	Fault Tolerance and Reliability in Hierarchical Interconnection Networks	08 Hours

Block-Shift Network (BSN)- BSN Edges Groups, BSN Construction, BSN Degree and Diameter, BSN Connectivity, BSN Fault Diameter, BSN Reliability, Hierarchical Cubic Network (HCN)- HCN Degree and Diameter, HINs versus HCNs, The Hyper-Torus Network (HTN).

Unit V	Fault Tolerance and Reliability of Computer Networks	08 Hours

Fault Tolerance in Loop Networks - Reliability of Token-Ring Networks, Reliability of Bypass-Switch Networks, Double Loop Architectures, Multi-Drop Architectures, Daisy-Chain Architectures, Fault Tolerance in High Speed Switching Networks - Classification of Fault-Tolerant Switching Architectures, Architecture-Dependent Fault Tolerance.

Unit VI	Fault Tolerance in Distributed System and Mobile Networks	08 Hours

Faults, Errors and Failures, failure models, process resilience, RELIABLE CLIENT-SERVER COMMUNICATION, RELIABLE GROUP COMMUNICATION, Check pointing Techniques in Mobile Networks- Minimal Snapshot Collection Algorithm, Mutable Checkpoints, Adaptive Recovery, Message Logging Based Checkpoints, Hybrid Checkpoints.

Books:

Text:

1. Mostafa Abd-El-Barr, "Design and Analysis of Reliable and Fault-Tolerant Computer Systems", World Scientific Publishing , ISBN 1281867497
2. Andrew Tanenbaum, "Distributed Systems Principles and Paradigms", Pearson Prentice Hall, ISBN: 978-15-302817-5-6

Reference:

1. Dhraj K. Pradhan, " Fault Tolerant Computer System Design", Prentice Hall, **ISBN**-13: 978-0130578877
2. Martin L. Shooman, "Reliability of Computer Systems and Networks: Fault Tolerance", ISBN: 471464066
3. Jan Vytopil, "Formal Techniques in Real-Time and Fault-Tolerant Systems", ISBN: 1461532205

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
610202: Mobile Ad-hoc Networks

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives :

- To study the concepts of Ad hoc Networks
- To learn the concepts of Mobility and Mobility Prediction
- To understand the functionalities of various Protocols in MANET
- To know the technological advancements in wireless networks

Course Outcomes :

On completion of the course the student should be able to-

- Assess Quality of Service in MANET
- Evaluate the performance of various Protocols in MANET
- Choose appropriate constituents and parameters to build MANET
- Analyze the performance of MANET

Course Contents

Unit I	Introduction	08 Hours

Fundamentals of Wireless Communication, Characteristics of Wireless channel, IEEE 802 Networking Standard, 802.3, 803.11, 802.15, 802.16, HIPERLAN Standard, HIPERACCESS, Wireless Internet, TCP in Wireless Domain, WAP, ADHOC Wireless Network, Issues in ADHOC Wireless Network.

Unit II	MAC Protocols	08 Hours

Design issues, goals and classification. Contention based protocols, Contention based protocols with reservation mechanisms, scheduling mechanisms, protocols using directional antennas, other protocols. Routing Protocols: Design Issues, Classification, Table Driven, On-Demand, Hybrid, Efficient Flooding Mechanism, Hierarchical, Power-Aware Routing Protocols.

Unit III	Multicast Routing	08 Hours

Design Issues, Architecture Reference Model, Classification, Tree-Based, Mesh-Based, Energy Efficient, Application Dependent, Multicasting with QOS-Guarantees. Transport layer: Design Issues and Design Goals, Classification, TCP over Ad Hoc Networks, Transport Layer protocols. Network Security Attacks, Key Management, Secure Routing.

Unit IV	Quality of Service	08 Hours

Issues and Challenges, Classification, MAC Layer Solutions, Network Layer Solutions, QOS Frame work. Energy Management: Need, Classification, Schemes for: Battery Management, Transmission Power Management, System Power Management.

Unit V	Wireless Sensor Networks	08 Hours

Introduction, Sensor network Architecture, Data Dissemination, Data Gathering, MAC Protocols for WSN, Quality of WSN. Hybrid Wireless Networks: Introduction, Next Generation Hybrid Wireless Architectures, Routing, Pricing in Multi-hop Wireless Network, Power Control Schemes, Load Balancing.

Unit VI	Recent Advances in Wireless Networks	08 Hours
Ultra Wide-Band Radio Communication, Wireless Fidelity, Optical Wireless Networks, Multimode 802.11, Meghadoot Architecture.		

Books:

Text:

1. C. Siva Ram Murthy and B.S.Manoj, "Ad hoc Wireless Networks Architectures and protocols", 2nd edition, Pearson Education. 2007, ISBN: 9788131706886, 8131706885
2. Charles E. Perkins, "Ad hoc Networking", Addison–Wesley, 2000, ISBN: 0201309769

Reference:

1. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, "Mobile ad hoc networking", Wiley-IEEE press, 2004, ISBN: 978-0-471-65688-3.
2. Mohammad Ilyas, "The handbook of ad hoc wireless networks", CRC press, 2002, ISBN: 0-8493-1332-5
3. T. Camp, J. Boleng, and V. Davies "A Survey of Mobility Models for Ad Hoc Network Research", Wireless Communication. and Mobile Comp., Special Issue on Mobile Ad Hoc Networking Research, Trends and Applications, vol. 2, no. 5, 2002, pp. 483–502,
4. Fekri M. Abduljalil, "A survey of integrating IP mobility protocols and Mobile Ad hoc networks"., ISBN: 10 : 0750675993

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective III
610203 A: Information Retrieval

Teaching Scheme:	Credit	Examination Scheme:
TH: 05 Hours/Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To study concepts of Information Retrieval
- To visualize the data in the form of XML
- To study and Evaluate retrieved information
- To understand classification and clustering

Course Outcomes:

On completion of the course the student should be able to-

- Implement the concept of Information Retrieval
- Evaluate and Analyze retrieved information
- Generate quality information
- Apply clustering and classification algorithms to analyze the information

Selection of Modules:

Kindly note that modules 1, 2 are compulsory and select any three (03) modules from modules 3 to 6.

Course Contents

Module No	Module Title	Credit
1	**Dictionaries and tolerant retrieval**	01
Search structures for dictionaries, Wildcard queries: General wildcard queries ,k-gram indexes for wildcard queries, Spelling correction: Implementing spelling correction, Forms of spelling correction, Edit distance, k-gram indexes for spelling correction, Context sensitive spelling correction, Phonetic correction.		
2	**Index Compression**	01
Index compression, Searching, Sequential Searching and Pattern Matching, Hardware basics, Types of indexes, Statistical properties of terms in information retrieval: Heaps' law: Estimating the number of terms, Zipf's law: Modeling the distribution of terms, Dictionary compression: Dictionary as a string ,Blocked storage Postings file compression :Variable byte codes, Gamma codes		
3	**Scoring, term weighting & the vector space model**	01
Parametric and zone indexes: Weighted zone scoring, Learning weights, The optimal weighting Term frequency and weighting: Inverse document frequency, Tf- idf weighting. The vector space model for scoring: Dot products, Queries as vectors, Computing vector scores Variant tf-idf functions: Sub-linear tf scaling Maximum tf normalization, Document and query weighting schemes, Pivoted normalized document length		
4	**XML Retrieval**	01
Basic XML concepts ,Challenges in XML retrieval, A vector space model for XML retrieval Evaluation of XML retrieval ,Text-centric vs. data-centric XML retrieval.		

5	Language models for information retrieval	01
Language models: Finite automata and language models, Types of language models, Multinomial distributions over words. The query likelihood model: Using query likelihood language models in IR ,Estimating the query generation probability ,Ponte and Croft's Experiments ,Language modeling versus other approaches in IR ,Extended language modeling approaches.		
6	**Classification & clustering searches**	**01**
Text Classification and Naïve Bayes ,Vector Space Classification, Support vector machines and Machine learning on documents. Flat Clustering , Hierarchical Clustering , Matrix decompositions and latent semantic indexing ,Fusion and Meta learning, Searching the Web Structure of the Web IR and web search		

Books:

Text

1. C. Manning, P. Raghavan, and H. Schütze, "Introduction to Information Retrieval" , Cambridge University Press, 2008, -13: 9780521865715
2. Ricardo Baeza -Yates and Berthier Ribeiro – Neto, "Modern Information Retrieval: The Concepts and Technology behind Search" 2nd Edition, ACM Press Books 2011.
3. Bruce Croft, Donald Metzler and Trevor Strohman, Search Engines: Information Retrieval in Practice, 1st Edition Addison Wesley, 2009, ISBN: 9780135756324.

Reference :

1. S. Buttcher, C. Clarke and G. Cormack, "Information Retrieval: Implementing and Evaluating Search Engines", MIT Press, 2010, ISBN: 0-408-70929-4.
2. C.J. Rijsbergen, "Information Retrieval", (http://www.dcs.gla.ac.uk/Keith/Preface.html)
3. W.R. Hersh, "Information Retrieval: A Health and Biomedical Perspective", Springer, 2002.
4. G. Kowalski, M.T. Maybury. Information Storage and Retrieval System" ,Springer, 2005
5. W.B. Croft, J. Lafferty, "Language Modeling for Information Retrieval", Springer, 2003.

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective III
610203 B: Pattern Recognition

Teaching Scheme:	Credit	Examination
TH : 05 Hours/ Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives :

- To learn the basic concept of Pattern recognition
- To study different approaches of pattern recognition
- To learn various pattern classification techniques
- To survey on recent advances and applications in pattern recognition

Course Outcomes:

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

- Analyze various type of pattern recognition techniques
- Identify and apply various pattern recognition and classification approaches to solve the problems
- Evaluate statistical and structural pattern recognition
- Percept recent advances in pattern recognition confined to various applications

Selection of Modules:

Kindly note that modules 1, 2, 3 are compulsory and select any two (02) modules from modules 4 to 9.

Course Contents

Module No.	Module Title	Credit
1	Introduction	01
Introduction of Pattern Recognition with its application, Pattern Recognition system, Design cycle of pattern recognition, Learning and adaption, Representation of Patterns and classes, Feature Extraction, pattern recognition models/approaches		
2	Error Estimation	01
Introduction, Error estimation methods, various distance measures -Euclidean, Manhattan, cosine, Mahalanobis, and distance based classifier, Feature selection based on statistical hypothesis testing, ROC curve		
3	Parametric Techniques & Non- Parametric Techniques	01
Parametric Techniques:- Maximum Likelihood Estimation, Bayesian Parameter Estimation, Sufficient Statistics; Problems of dimensionality Non-Parametric Techniques:-Density estimation, Parzen Window, Metrics and Nearest-Neighbor classification; Fuzzy classification.		
4	Non Metric and structural pattern recognition	01
Tree Classifiers-Decision Trees, Random Forests, Structural Pattern recognition: Elements of formal grammars ,String generation as pattern description ,Recognition of syntactic description ,Parsing ,Stochastic grammars and applications ,Graph based structural representation, Stochastic method: Boltzmann Learning.		

5	Clustering	01
Introduction, Hierarchical Clustering, agglomerative clustering algorithm, the single linkage, complete, linkage and average, linkage algorithm. Ward's method ,Partition clustering, , K-means algorithm, clustering algorithms based on graph theory(Minimum spanning tree algorithm)Optimization methods used in clustering: clustering using simulating Annealing		
6	**Template Matching: Measures based on Optimal Path Searching techniques**	**01**
Bellman's optimality principle and dynamic programming, The Edit distance, Dynamic time Warping, Measures based on correlations, Deformable template models Others: linear and non-linear support vector machine, nearest mean classifier, Context dependent classifier-Hidden Markov Models		
7	**Unsupervised learning**	**01**
Neural network structures for pattern recognition, Unsupervised learning in neural pattern recognition , deep learning ,Self-organizing networks		
8	**Fuzzy logic**	**01**
Fuzzy logic ,Fuzzy pattern classifiers, Pattern classification using Genetic Algorithms		
9	**Applications**	**01**
Pattern recognition applications: Application of pattern recognition techniques in object recognition, biometric, facial recognition, IRIS scanner, Finger prints, 3D object recognition.		

Books :

Text :

1. R. O. Duda, P. E. Hart, D. G. Stork, "Pattern Classification", 2nd Edition, Wiley-Inter-science, John Wiley &Sons, 2001
2. S. Theodoridis and K. Koutroumbas, "Pattern Recognition", 4th Edition, Elsevier, Academic Press
3. eMedia at NPTEL : http://nptel.ac.in/courses/106108057/33

Reference:

1. Devi V.S., Murty, M.N, "Pattern Recognition: An Introduction", Universities Press, Hyderabad, 2011, ISBN: 978-81-7371-740-6
2. Dr. Ramesh R. Manza, Yogesh M. Rajput, Dr. Pravin L. Yannawar, Dnyaneshwari D. Patil, "Understanding Programming Aspects of Pattern Recognition Using MATLAB", Shroff Publishers, ISBN: 9789352133307
3. David G. Stork and Elad Yom-Tov, "Computer Manual in MATLAB to accompany Pattern Classification", Wiley Inter-science, 2004
4. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", PHI, ISBN:978- 81-203-4091-6

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
Elective III
610203C: Real Time and Embedded Systems

Teaching Scheme:	Credit	Examination Scheme:
TH:05 Hours/Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To understand a typical embedded system and its constituents
- To learn the selection process of processor and memory for the embedded systems
- To learn communication buses and protocols used in the embedded and real-time systems
- To understand real-time operating system (RTOS) and the types of RTOS
- To learn various approaches to real-time scheduling
- To understand resource access control and inter-process communication for RTOS tasks
- To learn software development process and tools for RTOS applications

Course Outcomes:

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

- Recognize and classify embedded and real-time systems
- Explain communication bus protocols used for embedded and real-time systems
- Classify and exemplify scheduling algorithms
- Apply software development process to a given RTOS application
- Design a given RTOS based application

Course Contents

Selection of Modules:

Kindly note that modules 1 and 5 are compulsory and select any three (03) modules from remaining modules.

Module No.	Module Title	Credit
1	Introduction	01
Introduction to Embedded systems, Characteristics, Challenges, Processors in Embedded systems, hardware Units and devices in an embedded system – Power source, memory, real-time clocks, timers, reset circuits, watchdog-timer reset, Input-output ports, buses and interfaces, ADC, DAC, LCD, LED, Keypad, pulse dialer, modem, transceivers. embedded software, software tools for designing an embedded system		
2	Embedded SOC	01
Embedded SOC, ASIC, IP core, ASIP, ASSP, examples of embedded systems. Advanced architectures/processors for embedded systems- ARM, SHARC, DSP, Superscalar Units. Processor organization, Memory organization, Performance metrics for a processor, memory map and addresses, Processor selection and memory selection for real-time applications		
3	I/O Communication	01
Devices and communication buses: Types of I/O communication, types of serial communication, Serial protocols, Devices and buses- RS-232C, RS-485, HDLC, SPI, SCI, SI, SDIO. Parallel ports and interfacing. Parallel device protocols: ISA, PCI, PCI/X, ARM bus, Wireless devices		
4	Networked embedded systems	01
Networked embedded systems- I^2C, CAN, USB, Firewire. Internet enabled systems- TCP, IP, UDP. Wireless and mobile system Protocols- IrDA, Bluetooth, 802.11, ZigBee		

5	RTOS –Introduction	01
Introduction to real-time operating systems (RTOS). Hard versus soft real-time systems and theirtiming constraints. Temporal parameters of real-time process: Fixed, Jittered and sporadic release times, execution time. Types of real-time tasks, Precedence constraints and data dependency among real-time tasks, other types of dependencies for real-time tasks. Functional parameters and Resource parameters of real-time process, Real-time applications: Guidance and control, Signal processing, Multimedia, real-time databases.		
6	**Real Time Task Scheduling**	**01**
Real-time task and task states, task and data. Approaches to real-time scheduling: clock driver, weighted round-robin, priority-driven- Fixed priority and dynamic priority algorithms –Rate Monotonic (RM), Earliest-Deadline-First (EDF), Latest-Release-Time (LRT), Least-Slack-Time-First (LST). Static and Dynamic systems, on-line and off-line scheduling, Scheduling aperiodic and sporadic real-time tasks.		
7	**Resource access control**	**01**
Resources and resource access control-Assumption on resources and their usage, Enforcing mutual exclusion and critical sections, resource conflicts and blocking, Effects of resource contention and resource access control - priority inversion, priority inheritance.		
8	**Inter-process communication**	**01**
Inter-process communication-semaphores, message queues, mailboxes and pipes. Other RTOS services-Timer function, events, Interrupts - enabling and disabling interrupts, saving and restoring context, interrupt latency, shared data problem while handling interrupts. Interrupt routines in an RTOS environment.		
9	**Multiprocessor Scheduling in RTOS**	**01**
Multiprocessor Scheduling, resource access control and synchronization in Real-time Operating system. Real-time communication: Model, priority-based service disciplines for switched networks, weighted round-robin service disciplines, Medium access-control protocols for broadcast networks, internet and resource reservation protocols, real-time protocols.		
10	**Software development process for embedded system**	**01**
Software development process for embedded system: Requirements engineering, Architecture and design of an embedded system, Implementation aspects in an embedded system, estimation modeling in embedded software. Validation and debugging of embedded systems. Embedded software development tools. Debugging techniques.		
11	**RTOS Examples**	**01**
Real-time operating systems(RTOS): Capabilities of commercial real-time operating systems, QNX/Neutrino, Microc/OS-II, VxWorks, Windows CE and RTLinux.		
12	**RTOS Based Designs**	**01**
Basic design using a real-time operating system: Design considerations, Design Examples and case studies of real-time systems: Design Examples: Automatic Chocolate vending machine, adaptive cruise control system in a car, Orchestra robots, smart card.		

Books :

Text:

1. Raj Kamal, "Embedded Systems: Architecture, programming and Design", 2nd Edition, McGraw-Hill, ISBN: 13: 9780070151253
2. Jane W. S. Liu, "Real-Time Systems", Pearson Education, ISBN:
3. David E. Simon, "An Embedded Software Primer", Pearson Education, ISBN: 8177581546
4. Sriram V. Iyer, Pankaj Gupta, "Embedded Real-time Systems Programming", Tata McGraw-Hill, ISBN: 13: 9780070482845
5. Dr. K. V. K. K. Prasad, "Embedded Real-Time Systems: Concepts: Design and Programming", Black Book, Dream tech Press, ISBN: 10: 8177224611,13: 9788177224610

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
ELECTIVE III
610203D: Data Networks

Teaching Scheme:	Credit	Examination Scheme:
TH: 05 Hours/Week	05	In-Sem : 50 Marks End-Sem : 50 Marks

Course Objectives :

- To know basics regarding various types of data networks
- To understand queuing theory for networks
- To explore routing techniques and algorithms used in data networks
- To percept flow control in data networks

Course Outcomes:

On completion of the course the student should be able to-

- Develop solution for routing in the data networks
- Evaluate the performance of various routing alternatives in data networks
- Optimize the routing in data networks
- Analyze the performance of data networks

Selection of Modules: All modules 1 to 5 are compulsory.

Course Contents

Module No.	Module Title	Credit
1	**Introduction and Layered Network Architecture**	01
Historical Overview, Messages and Switching, Layering, A Simple Distributed Algorithm Problem. **Point-To-Point Protocols and Links :** Introduction, the Physical Layer: Channels and Modems, Error Detection, ARQ: Retransmission Strategies, Framing, Standard DLCs, Initialization and Disconnect for ARQ Protocols, Point-to-Point Protocols at the Network Layer, the Transport Layer, Broadband ISDN and the Asynchronous Transfer Mode		
2	**Delay Models In Data Networks**	01
Queuing Models: Little's Theorem, the M/ M /1 Queueing System, the M/M/m, M/ M/ x. M/M/ m /m, and Other Markov Systems, The M/G/1 System, Networks of Transmission Lines, Time Reversibility-Burke's Theorem, Networks of Queues-Jackson's Theorem		
3	**Multi access Communication**	01
Slotted Multi-access and the Aloha System, Splitting Algorithms, Carrier Sensing, Multi-access Reservations, Packet Radio Networks		
4	**Routing In Data Networks**	01
Network Algorithms and Shortest Path Routing, Broadcasting Routing Information: Coping with Link Failures, Flow Models, Optimal Routing, and Topological Design, Characterization of Optimal Routing, Feasible Direction Methods for Optimal Routing, Projection Methods for Optimal Routing, Routing in the Codex Network		
5	**Flow Control**	01
Window Flow Control, Rate Control Schemes, Overview of Flow Control in Practice, Rate Adjustment Algorithms.		

Books :

Text:

1. Dimitri P. Bertsekas and Robert G. Gallager , “Data Networks”, 2nd Edition, ISBN: 0-13-200916-1
2. Moshe Zukerman, “Introduction to Queuing Theory and Stochastic Tele traffic Models”, ISBN: 3-540-19805-9

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
610204: Seminar II

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hours/Week	04	TW: 50 Marks Presentation: 50 Marks

Course Objectives:

- To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.
- To Identify, understand and discuss current, real-world issues, new technologies, research, products, algorithms, and services.

Course Outcomes:

On completion of the course, student will be able –

- To use multiple thinking strategies to examine real-world issues and explore creative avenues of expression,.
- To acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication.
- To learn and integrate, through independent learning in sciences and technologies, with disciplinary specialization and the ability to integrate information across.

The student shall have to deliver the seminar II in semester III on a topic approved by guide and authorities.

It is appreciated if student has already selected the domain of his/her dissertation work and identified the literature confined to the domain and thorough literature study based on identified topic has been carried out. This practice will eventually lead to convergence of the efforts for the dissertation work. The meticulous analyses of the literature can be part of seminar.

The relevant literature then be explored as state-of-the-art, exotic, recent technological advancements, future trends, applications and research & innovations. The student shall submit the duly approved and certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute. The student will be assessed based on his/her presentation and preparations by the panel of examiners out of them one has to be an external examiner.

The students are expected to validate their study undertaken by publishing it at standard platforms.

The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.

The continuous assessment of the progress need to be documented unambiguously. For standardization and documentation, follow the guidelines circulated / as in seminar logbook approved by Board of Studies.

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
610205: Dissertation Stage I

Teaching Scheme:	Credit	Examination Scheme:
Practical: 08 Hours/Week	08	TW: 50 Marks Presentation: 50 Marks

Course Objectives:

- To identify the domain of research
- To learn to communicate in a scientific language through collaboration with guide.
- To understand the various means of technical publications and terminologies associated with publications
- To categorize the research material confined to the domain of choice
- To formulate research problem with the help of the guide/mentor elaborating the research.
- To Acquire information independently and assessing its relevance for answering the research questions.

Course Outcomes:

On completion of the course the student should be able to-

- Conduct thorough literature survey confined to the domain of choice
- Develop presentation skills to deliver the technical contents
- Furnish the report of the technical research domain
- Analyze the findings and work of various authors confined to the chosen domain

Guidelines:

Dissertation Stage – I is an integral part of the Dissertation work. In this, the student shall complete the partial work of the Dissertation which will consist of problem statement, literature review, design, scheme of implementation (Mathematical Model/SRS/UML/ERD/block diagram/ PERT chart) and Layout & Design of the Set-up.

The student is expected to complete the dissertation at least up to the design phase. As a part of the progress report of Dissertation work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The student shall submit the duly approved and certified progress report of Dissertation Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

The examiner will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation and report.

The students are expected to validate their study undertaken by publishing it at standard platforms.

The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal.

The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.

The continuous assessment of the progress need to be documented unambiguously. For standardization and documentation, it is recommended to follow the formats and guidelines circulated / as in dissertation workbook approved by Board of Studies. Follow guidelines and formats as mentioned in Dissertation Workbook.

SEMESTER IV

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
610207: Seminar III

Teaching Scheme:	Credit	Examination Scheme:
Practical: 05 Hours/Week	05	TW: 50 Marks Presentation: 50 Marks

Course Objectives:

- To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.
- To Identify, understand and discuss current, real-world issues, new technologies, research, products, algorithms, and services.

Course Outcomes:

On completion of the course, student will be able–

- To use multiple thinking strategies to examine real-world issues and explore creative avenues of expression.
- To acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication.
- To learn and integrate, through independent learning in sciences and technologies, with disciplinary specialization and the ability to integrate information across.

The student shall have to deliver the seminar III in semester IV on a topic approved by guide and authorities. Preferably the seminar III may be extension of seminar II. The relevant literature then be explored as state-of-the-art, exotic, recent technological advancement, future trend, application and research & innovation. The student shall submit the duly certified seminar report in standard format, for satisfactory completion by the concerned Guide and head of the department/institute. The student will be assessed based on his/her presentation and preparations by the panel of examiners out of them one has to be an external examiner.

The students are expected to validate their study undertaken by publishing it at standard platforms.

The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.

The continuous assessment of the progress need to be documented unambiguously. For standardization and documentation, the department will follow the seminar guidelines circulated / as in logbook approved by Board of Studies.

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
610208: Dissertation Stage II

Teaching Scheme:	Credit	Examination Scheme:
Practical: 20 Hours/Week	20	TW: 150 Marks Presentation: 50 Marks

Course Objectives:

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

Course Outcomes:

On completion of the course the student shall be able to-

- Show evidence of independent investigation
- Critically analyze the results and their interpretation; infer findings.
- Report and present the original results in an orderly way and placing the open questions in the right perspective.
- Link techniques and results from literature as well as actual research and future research lines with the research.
- Appreciate practical implications and constraints of the specialist subject

Guidelines:

In Dissertation Stage–II, the student shall consolidate and complete the remaining part of the dissertation work which will consist of Selection of Technology, Installations, UML implementations, testing, Results, measuring performance, discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems, comparative analysis, validation of results and conclusions. The student shall prepare the duly certified final report of Dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

The students are expected to validate their study undertaken by publishing it at standard platforms.

The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal.

The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.

The continuous assessment of the progress need to be documented unambiguously.

It is recommended to continue with guidelines and formats as mentioned in Dissertation Workbook approved by Board of Studies.

Non Credit Courses

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
NCC1: Game Engineering

Course Contents

1. Introduction to Unity 3D Game Engines
- Introduction to game industry ,Unity Basic (Interface Intro), Intro to tools & navigation, The Main Windows, Game Objects , Scenes ,Cameras and Types, The assets store, Intro to Asset Work flow

2. Basic Photoshop
- File types, size and resolution, Cropping and Editing sprite sheet

3. C# programming in unity

4. 2D Game Development Using Unity 3D
- Intro to 2D Game system in unity, Sprite Editor in Unity, Sprite Animation in Unity
- 2D Physics in Unity

5. 3D Game Development Using Unity 3D
- UI system in Unity, Artificial Intelligence for 3D Game
- Object Oriented Design & Programming for 3D Games
- Multiplayer Game in unity, Creating 3D Game For PC

Books

1. Fabian Birzele, "The Java Game Development Tutorial
2. Sean M. Tracey, "Make Games with Python on Raspberry Pi"

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
NCC2: Advanced Cognitive Computing

Course Contents

1. The Foundation of Cognitive Computing
Interdisciplinary Nature of Cognitive Science, Cognitive Computing Systems, Representations for Information and Knowledge, Principal Technology Enablers of Cognitive Computing, Cognitive Computing Architectures and Approaches, Cognitive Computing Resources

2. Cognitive Computing and Neural Networks: Reverse Engineering the Brain
Brain Scalability, Neocortical Brain Organization, The Concept of a Basic Circuit, Abstractions of Cortical Basic Circuits, Large-Scale Cortical Simulations, Hardware Support for Brain Simulation, Deep Learning Networks

3. The Relationship Between Big Data Analytics and Cognitive Computing
Evolution of Analytics and Core Themes, Types of Learning, Machine Learning Algorithms, Cognitive Analytics: A Coveted Goal, Cognitive Analytics Applications

4. Applications of Cognitive Computing
Applications in expert systems, Natural language programming, neural networks, robotics, virtual reality, Future applications

Books

1. Judith Hurwitz, Marcia Kaufman, Adrian Bowle "Cognitive Computing and Big Data Analytics", Wiley publications, ISBN: 978-1-118-89662-4
2. Vijay Raghvan, Venu Govindaraju, C.R. Rao, "Cognitive Computing: Theory and Applications", Elsevier publications, eBook ISBN: 9780444637512, Hardcover ISBN: 9780444637444
3. https://www.research.ibm.com/software/IBMResearch/multimedia/Computing_Cognition_WhitePaper.pdf

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
NCC3: Reconfigurable Systems

Course Contents

1. Introduction to reconfigurable systems: Reconfigurable system (RS), Reconfigurable computing (RC), Architectural components of a configurable computer, primary methods in conventional computing: Application Specific Integrated Circuit (ASIC), software-programmed microprocessors,

2. Reconfigurable computing: Theories:-Tredennick's Classification, Hartenstein's Xputer, High-performance computing, Partial re-configuration, Current systems Computer emulation,COPACOBANA, Mitrionics, National Instruments, Xilinx, Intel,

3. Advanced Applications and Technologies: Reconfigurability mechanisms, Reconfigurable devices and fabrics, Programmable pathways, Reconfigurability enablers,

4. The Future of Reconfigurable Systems: Introduction, Multi-million gate FPGA Architectures, future Field Programmable System-on-a-Chip (FPSC), FPGA Architectures for Reconfigurable Computing, CAD Support for Reconfigurable Systems, Applications

Books

1. Gokhale, Maya, B., Graham, Paul S.,“ Reconfigurable Computing Accelerating Computation with Field-Programmable Gate Arrays”, 2005, 238 p., Springer Netherland, Hardcover ISBN: 0-387-26105-2
2. Bobda Ch, “Introduction to Reconfigurable Computing Architectures, Algorithms, and Applications”, Springer Netherlands, 2007, ISBN 978-1-4020-6088-5, 5 (Print) 978-1-4020-6100-4 359 3. Papers on the web page of the course Reconfigurable Circuits
3. Katherine Compton and Ccott hauck, “Reconfigurable Computing: A Survey of Systems and Software”, ACM Computing Surveys, Vol. 34, No. 2, June 2002, pp. 171–210.

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
NCC4: Convergence Technology

Course Contents

1. Introduction-Convergence continues to gain momentum Worldwide, Responding to convergence, Thinking Strategies about ICT Convergences

2. Security Convergence Types of convergence, Security convergence collaboration, Categories of Convergence Convergence Trends: Value of technology, Convergence in design

3. Security Planning Convergence Initiatives, Convergence and Layers of Security, Levels of Security Need of Technology roadmap

4. Convergence in Practice The Nimble Giants: How converged business models drive successful large enterprises The New face of public sector Small Enterprises Benefits from Strategic Investment management

Books

1. Rajendra Singh and Siddhartha Raja, “Convergence in Information and Communication Technology”, World Bank, ISBN-*10:* 0821381695.
2. Faisal Hoque, “The power of Convergence”, I*SBN*-13: 978-0-8144-1695-2.
3. Richard Baldwin, “The Great Convergence”, Harvard University Press, ISBN 9780674660489
4. Ray Bernard, “Security Technology Convergence Insights”, Elsevier, 2015. ISBN, 0128030011, 9780128030011.

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
NCC5: Machine Intelligence

Course Contents

1. **Introduction to Machine Intelligence**
   What is MI?, Background/history, Spin-offs, High-level overview, State of the art.
2. **Representation of Knowledge**
   Knowledge Representation, Knowledge Representation using predicate logic, introduction to predicate calculus, resolution, Knowledge Representation using other logic-structured Knowledge Representation.
3. **Planning and Machine Learning**
   Basic Plan generation systems-strips, Advanced Plan generation systems-K strips, Strategic explanations-why? Why not? And how? Machine learning, Adaptive Learning
4. **Expert Systems**
   Architecture of Expert Systems, Roles of Expert Systems, Knowledge acquisition-Meta knowledge heuristics.

Books

1. Stefan Edelkamp and Stefan Schroedl, "Heuristic Search: Theory and Applications", Morgan Kaufmann, 2011.
2. John Haugeland, "Artificial Intelligence: The Very Idea", A Bradford Book, The MIT Press, 1985.
3. Judea Pearl, "Heuristics: Intelligent Search Strategies for Computer Problem Solving", Addison-Wesley, 1984.

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
NCC6: Storage Area Networks

Course Contents

1. **Introduction to Information Storage Technology, Storage System Environment and Data protection:** Evolution, Key Challenges in Managing Information, Information Lifecycle Components, Disk Drive Components & Performance,
2. **Different Storage Technologies and Virtualization**
   Introduction to **Networked Storage**, Overview of FC-SAN, NAS, and IP-SAN. Network-Attached Storage (NAS) & its Components, File Sharing, I/O operations, Performance and Availability. Content Addressed Storage, Storage Virtualization
3. **Content-Addressed Storage, Business Continuity, Backup and Recovery, Local Replication, Remote Replication**
   BC Terminology, Failure Analysis, Business Impact Analysis, Solutions, Backup Granularity, Recovery Considerations, Backup Methods, Process & Topologies, Backup in NAS Environments, Local Replication Technologies,
4. **Securing & Managing the Storage Infrastructure**
   Storage Security Framework, Risk Triad, Storage Security Domains, Security Implementations in Storage Networking Monitoring the Storage Infrastructure, Storage Management Activities, Storage Infrastructure Management Challenges,

Books

1. Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill, Osborne, 2003.
2. Marc Farley, "Building Storage Networks", Tata McGraw Hill, Osborne, 2001.
3. EMC Educational Services, "Information Storage and Management", Wiley India
4. Meet Gupta, "Storage Area Network Fundamentals", Pearson Education Limited,

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
NCC7: Search Engine Optimization

Course Contents

1. **Basics for SEO, SEO Research & Analysis**
   Basic Knowledge of Domain & World Wide Web, Difference between Portal and Search Engines, need of SEO, Types of SEO Techniques: Black hat techniques & White Hat techniques, Search Engine working Process, Keyword Research and Analysis, Keyword opportunity, Competitors Website Analysis, SWOT, On-page Optimization & Off-page Optimization
2. **On-page Optimization**: Meta Descriptions & Meta Keywords, Headings, Bold Text, Domain Names & Suggestions, Canonical Tag, Meta Tags, Images and Alt Text, Internal Link Building, Server and Hosting Check, Robots Meta Tag, 301 Redirects, 404 Error , Duplicate content
3. **Off-page Optimization**: Page Rank, Link Popularity, Link Building in Detail, Directory Submission, Blog Submission, Links Exchange, Reciprocal Linking, Posting to Forums, RSS Feeds Submissions, Competitor Link Analysis
4. **Analytics & SEO Tools**
   Study of Google Analytics, How Google Analytics can Help SEO, Webmaster Central & Bing/Yahoo; Website Analysis using various SEO Tools available : Keyword Density Analyzer Tools, Google Tools, Yahoo / Bing Tools, Rich Snippet Text Tools, Comparison Tools, Link Popularity Tools, search Engines Tools, Site Tools
5. **SEO Reporting**
   Google analysis, Tracking and Reporting, Reports Submission, Securing Ranks

Books

1. Jason McDonald, "SEO Fitness Workbook: The Seven Steps to Search Engine Optimization Success". *SBN*-10: 1537120034*;* ISBN-13: 978-1537120034;
2. Caimin Jone, "SEO Step-by-Step: The Complete Beginner's Guide to Getting Traffic", create space, I*SBN*: 1497415020, 9781497415027.
3. Bruce Clay, "By Search Engine Optimization All-in-One for Dummies"
4. Adam Clarke, "SEO 2017: Learn search engine optimization with smart internet marketing strategies", ISBN 10: 153915114X , 13: 9781539151142

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
NCC8: Virtual Reality

Course Contents

1. **Introduction and Background**
   What VR is and why it is so different from other mediums. Its history and different forms of reality, ranging from the real world to fully immersive VR. Its various hardware and components, which composes those realities.
2. **Perception**
   Understanding the human brain and how we perceive real and virtual worlds, real-world examples that prove reality is not always what we think it is, explanations of perceptual models and processes, the physiology of the different sensory modalities, theories of how we perceive space and time, and a discussion of how perception relates to action.
3. **Designing in VR**
   Fundamentals of VR design including ergonomics, user testing, interface design, scale and scene setting, graphical user interfaces, and motion mechanics for mobile VR, simulator sickness, its causes.
4. **VR Platforms and Applications**
   Understand what is happening in the VR industry, surveying current trends and technology in VR, the hardware: Mobile Performance & 360 Media, High-Immersion Unity, or High-Immersion Unreal.

Books

1. Jason Jerald, "The VR Book: Human-Centered Design for Virtual Reality", Association for Computing Machinery and Morgan & Claypool New York, NY, USA©2016, ISBN: 978-1-97000-112-9
2. John Vince, "Virtual Reality Systems", Pearson Prentice Hall, ISBN 10: 0201876876 or ISBN 13: 9780201876871
3. Grigore C. Burdea, Philippe Coiffet, **"**Virtual Reality Technology", 2nd Edition, ISBN: 978-0-471-36089-6

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
NCC9: Machine Translation

Course Contents

1. **Introduction**
   Concept and translation process. Approaches viz rule based, statistical, example based hybrid and neural MT.
2. **Learning and inference for translation models**
   Maximum likelihood, Expectation maximization, Discriminative learning, Stochastic methods, Dynamic programming, Approximate search.
3. **Linguistic phenomena and their associated modeling problems**
   Morphology, syntax and semantics.
4. **Applications & Evaluation**
   Scaling, approximation and efficient data structures

Books

1. P. Koehn, " Statistical Machine Translation" , Cambridge University Press, ISBN-13: 978-0521874151
2. Pushpak Bhatacharyya, " Machine Translation" 2015
3. John Hutchines, " Milestone in Machine Translation", Elsevier Publishers, ISBN: 978-0201000238

Savitribai Phule Pune University
Master of Computer Engineering (Computer Network) (2017 Course)
NCC10: Infrastructure Management

Course Contents

1.Introduction to Infrastructure Management

What is Infrastructure Management, Basic Framework, Policy Issues, Types of Infrastructure Management: Systems Management, Network Management, Storage Management, Objectives, Benefits of Infrastructure Management system

2. IT Infrastructure Management

Components of IT Infrastructure, Hardware resources, Data storage, Input-output Technologies used in Businesses, Types of Computer Softwares used for Infrastructure Management in Business, Principle Issues, Foundations of Business Intelligence: Databases and Information Management, Telecommunications, Wireless Technology, Security

3. Key System Applications for the Digital Age

Achieving Operational Excellence and Customer Intimacy: Enterprise Applications, E-Commerce: Digital Markets, Digital Goods, Improving Decision Making and Managing Knowledge

4. Building and Managing Systems

Building Information Systems, Ethical and Social Issues in Information Systems

Books

1. Jane P. Laudon, Azimuth, "'Essentials of Business Information Systems', Pearson, ISBN-10: 0132277816, 13: 9780132277815
2. Barbara Klein, Richard Alan Long, Kenneth Ray Blackman, "Introduction to IMS, An: Your Complete Guide to IBM Information Management System", IBM Press, ISBN-10: 0132886871, ISBN-13: 9780132886871
3. David Boddy, Albert Boonstra, "Managing Information Systems: Strategy and Organisation", Financial Times Press, ISBN-10: 0273716816, 13: 9780273716815