

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



**Syllabus**

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

**(with effect from Year 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](mailto:vh_patil2003@yahoo.com)**

[This document includes Program Educational Objectives - Program Outcomes, Program Specific Outcomes (page 3-4), Semester-wise Courses (teaching scheme, examination, marks and credit) (page 5-6), Courses syllabi (page 7-63)] and Non Credit Course Contents [64-70].

## 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 consideration 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 system software, multimedia, web design, big data analytics, networking, 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 (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
510101	<a href="#">Research Methodology</a>	04	--	50	50	--	--	100	04	--
510102	<a href="#">Bio-Inspired Optimization Algorithms</a>	04	--	50	50	--	--	100	04	--
510103	<a href="#">Software Development and Version Control</a>	04	--	50	50	--	--	100	04	--
510104	<a href="#">Embedded and Real Time Operating Systems</a>	04	--	50	50	--	--	100	04	--
510105	<a href="#">Elective I</a>	05	--	50	50	--	--	100	05	-
510106	<a href="#">Laboratory Proficiency I</a>	--	08	--	--	50	50	100	--	04
<b>Total Credit</b>									21	04
<b>Total</b>		<b>21</b>	<b>08</b>	<b>250</b>	<b>250</b>	<b>50</b>	<b>50</b>	<b>600</b>	<b>25</b>	
510107	<a href="#">Non-Credit Course I</a>								Grade	
<b>Elective I</b>										
510105A	<a href="#">Advanced Digital Signal Processing</a>			510105B	<a href="#">Data Mining</a>					
510105C	<a href="#">Network Design and Analysis</a>			510105D	<a href="#">Data Algorithms</a>					
510105E	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
510108	<a href="#">Operations Research</a>	04	--	50	50	--	--	100	04	--
510109	<a href="#">System Simulation and Modeling</a>	04	--	50	50	--	--	100	04	--
510110	<a href="#">Machine Learning</a>	04	--	50	50	--	--	100	04	--
510111	<a href="#">Elective II</a>	05	--	50	50	--	--	100	05	--
510112	<a href="#">Seminar I</a>		04	--	--	50	50	100	--	04
510113	<a href="#">Laboratory Proficiency II</a>	--	08	--	--	50	50	100	--	04
<b>Total Credit</b>									17	08
<b>Total</b>		<b>17</b>	<b>12</b>	<b>200</b>	<b>200</b>	<b>100</b>	<b>100</b>	<b>600</b>	<b>25</b>	
510114	<a href="#">Non-Credit Course II</a>								Grade	
<b>Elective II</b>										
510111A	<a href="#">Image Processing</a>			510111B	<a href="#">Web Mining</a>					
510111C	<a href="#">Pervasive and Ubiquitous Computing</a>			510111D	<a href="#">Network Security</a>					
510111E	Open Elective									

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

Savitribai Phule Pune University, Pune										
Master of Computer Engineering (2017 Course)										
<u>Semester III</u>										
Course Code	Course	Teaching Scheme Hours / Week		Examination Scheme and Marks					Credit	
		Theory	Practical	In-Sem	End-Sem	TW	OR/PRE	Total	TH	PR
610101	<a href="#">Fault Tolerant Systems</a>	04	--	50	50	--	--	100	04	--
610102	<a href="#">Information Retrieval</a>	04	--	50	50	--	--	100	04	--
610103	<a href="#">Elective III</a>	05	--	50	50	--	--	100	05	--
610104	<a href="#">Seminar II</a>	--	04	--	--	50	50	100	--	04
610105	<a href="#">Dissertation Stage I</a>	--	08	--	--	50	50	100	--	08
<b>Total Credit</b>									13	12
<b>Total</b>		<b>13</b>	<b>12</b>	<b>150</b>	<b>150</b>	<b>100</b>	<b>100</b>	<b>500</b>	<b>25</b>	
610106	<a href="#">Non-Credit Course III</a>								Grade	
<u>Elective III</u>										
610103A	<a href="#">Cloud Security</a>	610103B		<a href="#">Speech Signal Processing</a>						
610103C	<a href="#">Mobile Ad-hoc Network</a>	610103D		<a href="#">Pattern Recognition</a>			610103E Open Elective			
<u>Semester IV</u>										
Course Code	Course	Teaching Scheme Hours / Week		Examination Scheme and Marks			Credit			
		Practical		TW	OR/PRE	Total	PR			
610107	<a href="#">Seminar III</a>	05		50	50	100	05			
610108	<a href="#">Dissertation Stage II</a>	20		150	50	200	20			
<b>Total</b>		<b>25</b>		<b>200</b>	<b>100</b>	<b>300</b>	<b>25</b>			
<u>Non-Credit Courses</u>										
<p>Typically curriculum is constituted by credit, non-credit and audit courses. These courses are offered as compulsory or elective. Non Credit Courses are compulsory. No grade points are associated with non-credit courses and are not accounted in the calculation of the performance indices SGPA &amp; 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, 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. <u>Result of assessment will be PP or NP</u>. 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 (Semester I, II &amp; III). The <a href="#">Contents of Non Credit Courses</a> are Provided at page 63 onwards.</p> <p><b>Open Elective:</b> 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.</p>										
<b>Recommended Set of Non-Credit Courses(510107, 510114, 610106):</b>										
<b>NCC1: <a href="#">Game Engineering</a></b>				<b>NCC2: Advanced Cognitive Computing</b>						
<b>NCC3: Reconfigurable Systems</b>				<b>NCC4: Convergence Technology</b>						
<b>NCC5: Machine Learning</b>				<b>NCC6: Storage Area Networks</b>						
<b>NCC7: Search Engine Optimization</b>				<b>NCC8: Virtual Reality</b>						
<b>NCC9: Machine Translation</b>				<b>NCC10: Infrastructure Management</b>						

<b>Savitribai Phule Pune University</b> <b>Master of Computer Engineering (2017 Course)</b> <b>Elective I</b> <b>510105A : Advanced Digital Signal Processing</b>		
<b>Teaching Scheme:</b> <b>TH: 05 Hours/Week</b>	<b>Credits</b> <b>05</b>	<b>Examination Scheme:</b> <b>In- Sem: 50 Marks</b> <b>End- Sem : 50 Marks</b>
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To learn theory behind signal processing</li> <li>To Understand mathematics of signal processing</li> <li>To know the significance and use of filters</li> <li>To explore the applications DSP</li> </ul>		
<b>Course Outcomes:</b> After completion of the course, students should be able to- <ul style="list-style-type: none"> <li>Apply various transforms for Digital signal Processing</li> <li>Use appropriate filters to suit to the DSP application</li> <li>Choose the best DS Processor for the application development</li> <li>Design the DSP application for the practical use</li> </ul>		
<b>Selection of Modules:</b> Kindly note that modules 1, 2 are compulsory and select any three (03) modules from module number-3 to 7.		
<b>Course Contents</b>		
<b>Module No</b>	<b>Module Title</b>	<b>Credit</b>
<b>1</b>	<b>DSP Preliminaries</b>	<b>01</b>
Signals, Systems, and Signal Processing, Classification of Signals, Sampling of Analog Signals, The Sampling Theorem, Response of LTI Systems to Arbitrary Inputs: The Convolution Sum, Causal Linear Time-Invariant Systems, Stability of Linear Time-Invariant Systems, System with Finite-Duration and Infinite-Duration Impulse.		
<b>2</b>	<b>Transforms</b>	<b>01</b>
Efficient Computation of the DFT: FFT Algorithms, The Z-Transform, Properties of Z-Transform, Overview of Real World Applications of DSP, Audio Applications of DSP.		
<b>3</b>	<b>FIR Filter Design</b>	<b>01</b>
Introduction, FIR Filter Design, FIR Filter Specifications, FIR Coefficient Calculation Methods, Window Method, Direct-Form Structure, Cascade-Form Structures, Finite word length effects in FIR Digital Filters.		
<b>4</b>	<b>IIR Filter Design</b>	<b>01</b>
IIR Filter Design by Approximation of Derivatives, IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation, Characteristics of Commonly Used Analog Filters, Design of IIR Filter From Analog Filter, Direct-Form Structures, Cascade-Form Structures, Parallel-Form Structures.		
<b>5</b>	<b>Power Spectrum Estimation</b>	<b>01</b>

Estimation of Spectra From Finite-Duration Observations of Signals, Nonparametric Methods for Power Spectrum Estimation, Relationships Between Autocorrelation and the Model Parameters, The Yule-Walker Method for the AR Model Parameters.		
<b>6</b>	<b>Multi rate Signal Processing</b>	<b>01</b>
Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I / D, Implementation of Sampling Rate Conversion, Multistage Implementation of Sampling Rate Conversion, Sampling Rate Conversion by Arbitrary Factor, Applications of Multi rate Signal Processing, Digital Filter Banks.		
<b>7</b>	<b>Special Purpose Digital Signal Processor</b>	<b>01</b>
Introduction, Computer Architectures for signal processing, General-purpose digital signal processors, Selecting digital signal processors, Implementation of DSP algorithms on general purpose digital signal processors, Special-purpose DSP hardware.		
<b>Books:</b>		
<b>Text:</b>		
<ol style="list-style-type: none"> <li>1. Alan V. Oppenheim and Ronald W. Schaffer, “ Digital Signal Processing”, Pearson, ISBN-10: 0132146355, 13: 978-0132146357</li> <li>2. Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital Signal Processing – A Practical Approach”, 2<sup>nd</sup> Edition, Pearson Education, ISBN 10: 020154413X ISBN 13: 9780201544138</li> </ol>		
<b>References:</b>		
<ol style="list-style-type: none"> <li>1. R. E. Crochiere and L. R. Rabiner, “Multirate Digital Signal Processing”, Pearson, ISBN 0-13-605162-6</li> <li>2. A. Rabiner and Gold, “Theory and Application of Digital Signal Processing”, Prentice Hall, ISBN 10: 0139141014, 13: 9780139141010.</li> <li>3. William D. Stanley, “Digital Signal Processing”, Reston, ; ISBN-10: 083591321X, 13: 978-0835913218</li> <li>4. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing – Principles, Algorithms, and Applications”, 4<sup>th</sup> Edition, Pearson Prentice Hall, ISBN: 9788131710005, 8131710009</li> <li>5. Steven W. Smith., “The Scientist and Engineer’s and Guide”, California Technical Pub, ISBN: 10: 0966017633</li> <li>6. Dale Grover and John R. (Jack) Deller, “Digital Signal Processing and the Microcontroller”, Prentice Hall, ISBN 0-13-754920-2</li> </ol>		



<p style="text-align: center;"><b>Savitribai Phule Pune University</b>  <b>Master of Computer Engineering (2017 Course)</b>  <b>Elective I</b>  <b>510105B : Data Mining</b></p>		
<b>Teaching Scheme:</b> <b>TH: 05 Hours/Week</b>	<b>Credit</b> <b>05</b>	<b>Examination Scheme:</b> <b>In-Sem : 50 Marks</b> <b>End-Sem : 50 Marks</b>
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>To understand the fundamentals of Data Mining</li> <li>To identify the appropriateness and need of mining the data</li> <li>To learn the preprocessing, mining and post processing of the data</li> <li>To understand various methods, techniques and algorithms in data mining</li> </ul>		
<p><b>Course Outcomes:</b></p> <p>On completion of the course the student should be able to-</p> <ul style="list-style-type: none"> <li>Apply basic, intermediate and advanced techniques to mine the data</li> <li>Analyze the output generated by the process of data mining</li> <li>Explore the hidden patterns in the data</li> <li>Optimize the mining process by choosing best data mining technique</li> </ul>		
<p><b>Selection of Modules:</b></p> <p>Kindly note that modules 1, 2, 3 are compulsory and select any one module from module number- 4 to 10.</p>		
<b>Course Contents</b>		
<b>Module No.</b>	<b>Module Title</b>	<b>Credit</b>
<b>1</b>	<b>Introduction</b>	<b>01</b>
<p>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.</p> <p>Concept of class: Characterization and Discrimination, basics /Introduction to: Classification and Regression for Predictive Analysis, Mining Frequent Patterns, Associations, and Correlations, Cluster Analysis.</p>		
<b>2</b>		<b>01</b>
<p>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</p>		
<b>3</b>		<b>01</b>
<p>Dissimilarity of Numeric Data: Minkowski Distance, Euclidean distance and Manhattan distance, Proximity Measures for Ordinal Attributes, Dissimilarity for Attributes of Mixed Types, Cosine Similarity.</p>		
<p><b>Book:</b></p> <p>1. <u>Han, Jiawei Kamber, Micheline Pei and Jian</u>, “Data Mining: Concepts and Techniques” Elsevier Publishers Third Edition/Second Edition, ISBN: 9780123814791, 9780123814807</p>		

4	Classification	02
<p>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.</p> <p>Study of open source/Commercial tool (WEKA/MEKA/Mulan/Panthalo), open source is desirable)</p>		
<p><b>Book:</b></p> <ol style="list-style-type: none"> <li>1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques” Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807.</li> </ol>		
5	Content Classification	02
<p>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.</p> <p>Study of open source/Commercial tool (WEKA/MEKA/ Mulan/ Panthalo), open source is desirable)</p>		
<p><b>Book:</b></p> <ol style="list-style-type: none"> <li>1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques” Elsevier Publishers Third Edition/Second Edition, ISBN: 9780123814791, 9780123814807</li> <li>2. Parag Kulkarni, “Reinforcement and Systemic Machine Learning for Decision Making.” Wiley-IEEE Press, ISBN: 978-0-470-91999-6.</li> </ol>		
6	ANN and Data Mining	02
<p>Deep Feed forward Networks: Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms. Convolution 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.</p> <p>Study of open source/Commercial tool (like Tensor Flow Lib., Caffé Lib., Theano.), open source is desirable)</p>		

**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.

**Books:**

1. Mohammed J. Zaki, Ching-Tien Ho, “Large-Scale Parallel Data Mining”, LCNS, Springer Publishers, ISBN: 978-3-540-46502-7
2. Sanguthevar Rajasekaran and John Reif, “Handbook of Parallel Computing Models Algorithms and Applications”, CRC Book Press, **ISBN 9781584886235**
3. Liu, Wei-keng Liao, Alok Choudhary, and Jianwei Li, “Parallel Data Mining Algorithms for Association Rules and Clustering”
4. Kimito Funatsu, “New Fundamental Technologies in Data Mining” , 978-953-307-547-1
5. Jason Sanders ,Edward Kandrot, “CUDA by Example - An Introduction to General-Purpose GPU Programming”, ISBN-10: 0-13-138768-5
6. Addison Wesley, Shane cook,, “ CUDA Programming: A Developer's Guide to Parallel Computing with GPUs by, Elsevier Publishers, ISBN: 978-0201000238

**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

<b>Book:</b>		
1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques” Elsevier Publishers Second Edition, ISBN: 9780123814791, 9780123814807.		
<b>9</b>	<b>Data Mining Applications</b>	<b>02</b>
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.		
<b>Book:</b>		
1. <u>Han, Jiawei Kamber, Micheline Pei and Jian</u> , “Data Mining: Concepts and techniques” Elsevier Publishers Second Edition, ISBN: 9780123814791, 9780123814807.		
<b>10</b>	<b>Pattern Discovery and Social Networks Mining</b>	<b>02</b>
<b>Graph Mining: Methods for Mining Frequent Subgraphs:</b> A priori-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		
<b>Social Network Analysis:</b> 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.		
<b>Books:</b>		
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		

<b>Savitribai Phule Pune University</b> <b>Master of Computer Engineering (2017 Course)</b> <b>Elective I</b> <b>510105C : Network Design and Analysis</b>		
<b>Teaching Scheme:</b> <b>TH: 05 Hours/Week</b>	<b>Credit</b> <b>05</b>	<b>Examination Scheme:</b> <b>In- Sem: 50 Marks</b> <b>End- Sem: 50 Marks</b>
<b>Course Objectives :</b> <ul style="list-style-type: none"> <li>• To develop a comprehensive understanding of computer Networks</li> <li>• To study design issues in networks.</li> <li>• To learn estimation of network requirements.</li> <li>• To learn Enterprise network design.</li> <li>• To understand various issues hindering the performance of the network.</li> </ul>		
<b>Course Outcomes:</b> After completion of the course, students should be able to <ul style="list-style-type: none"> <li>• Apply the knowledge to design computer networks</li> <li>• Analyze the performance of networks based on chosen metrics</li> <li>• Design routing schemes for optimized routing</li> <li>• Choose appropriate and advanced techniques to build the computer network</li> </ul>		
<b>Selection of Modules:</b> All modules 1 to 5 are compulsory.		
<b>Course Contents</b>		
<b>1</b>	<b>Introduction</b>	<b>01</b>
Overview of network analysis and design process, Network design issues, requirement analysis (user, application, device, network) concepts, Routing and forwarding, resource allocation, general principles of network design, network characteristics, performance metric in networks		
<b>2</b>	<b>Physical and Logical network design</b>	<b>01</b>
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		
<b>3</b>	<b>Queuing Theory</b>	<b>01</b>
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.		
<b>4</b>	<b>Modelling N/W as Graph</b>	<b>01</b>
Graph terminology, representation of networks, fundamental graph algorithms, shortest path, link prediction algorithms-Dijkstra's, Bellman's, Floyd's, Incremental shortest path algorithm.		
<b>5</b>	<b>Methods of Ensuring Quality of Service</b>	<b>01</b>
Methods of ensuring quality of service – introduction, applications and QoS, QoS mechanisms, Queue management algorithms, feedback, resource reservation, traffic engineering, IP QoS Next generation networks, cyber physical systems, smart mobiles, cards and device networks, smart devices and services, network testing, testing tool – wireshark		
<b>Books:</b>		
<ol style="list-style-type: none"> <li>1. Aaron Kershenbaum, "Telecommunications Network Design Algorithm", McGraw Hill education (India), Edition 2014, ISBN-10: 0070342288</li> <li>2. James McCabe, "N/W analysis, Architecture and Design", Elsevier, 978-0-12-370480-1</li> <li>3. Pablo Pavon Marino, "Optimization of Computer Networks : Modeling and algorithms – A hands on approach", Wiley Publication, ISBN: 9781119013358</li> <li>4. Olifer, Victor Olifer, "Computer Networks, Principles, Technologies and Protocols for network design", Wiley India, ISBN: 13: 9788126509171.</li> </ol>		

<b>Savitribai Phule Pune University</b> <b>Master of Computer Engineering (2017 Course)</b> <b>Elective I</b> <b>510105 D : Data Algorithms</b>		
<b>Teaching Scheme:</b> <b>TH: 05 Hours/Week</b>	<b>Credit</b> <b>05</b>	<b>Examination Scheme:</b> <b>Internal Assessment : 50 Marks</b> <b>End- Sem: 50 Marks</b>
<b>Course Objectives :</b> <ul style="list-style-type: none"> <li>• To study concepts of sorting and searching for voluminous data</li> <li>• To learn functionalities of advanced network algorithms</li> <li>• To understand the means for data and market prediction</li> <li>• To study various performance parameters for algorithmic</li> </ul>		
<b>Course Outcomes:</b> After completion of the course, students should be able to- <ul style="list-style-type: none"> <li>• Apply the concept of advanced algorithms for searching, sorting and network algorithms</li> <li>• Estimate the complexity of various algorithms and Measure the Choose appropriate algorithm to solve data centric problems</li> </ul>		
<b>Selection of Modules:</b> Modules 1 to 4 are compulsory and select any one from modules 5 and 6.		
<b>Course Contents</b>		
Module No	Module Title	Credit
<b>1</b>	<b>Secondary Sorting Algorithm</b>	<b>01</b>
Secondary Sort: Introduction, Solutions to the Secondary Sort Problem, Map Reduce Solution to Secondary Sort, Spark Solution to Secondary Sort, Secondary Sorting Technique, Complete Example of Secondary Sorting, Top N, Formalized Map Reduce Implementation: Unique Keys & Non unique Keys, Spark Implementation: Unique Keys, Non unique Keys.		
<b>2</b>	<b>Left Outer Join Algorithms</b>	<b>01</b>
Left Outer Join: Implementation of Left Outer Join in Map Reduce with Example, Spark Implementation of Left Outer Join().		
<b>3</b>	<b>Order Inversion</b>	<b>01</b>
Order Inversion : Example of the Order Inversion Pattern, Map Reduce Implementation of the Order Inversion Pattern, Formal Definition of Moving Average.		
<b>4</b>	<b>Market Basket Analysis</b>	<b>01</b>
Market Basket Analysis : MBA Goals, Application Areas for MBA, Market Basket Analysis Using MapReduce, Spark Solution, POJO Common Friends Solution.		
<b>5</b>	<b>Scatter Search Algorithms</b>	<b>01</b>
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.		
<b>6</b>	<b>Network Algorithms</b>	<b>01</b>
Bellman's equation and acyclic networks, The Network Simplex Algorithm - The minimum cost flow problem, Tree solutions, Constructing an admissible tree structure.		
<b>Books :</b> <ol style="list-style-type: none"> <li>1. Mahmoud Parsian, "Data Algorithms", O'Reilly, ISBN: 10 1491906189</li> <li>2. Manuel Laguna, Rafael Martí, "Metaheuristic Procedures for Training Neural Networks" Springer (2006) ISBN - 978-0-387-33415-8</li> <li>3. Dieter Jungnickel, "Graphs, Networks and Algorithms", Springer, 978-3-540-72779-8</li> </ol>		

<p style="text-align: center;"><b>Savitribai Phule Pune University</b>  <b>Master of Computer Engineering (2017 Course)</b>  <b>Elective III</b>  <b>610103A : Cloud Security</b></p>		
<b>Teaching Scheme:</b> TH: 05 Hours/Week	<b>Credit</b> 05	<b>Examination Scheme:</b> In- Sem: 50 Marks End- Sem : 50 Marks
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• To study concepts of Cloud Computing;</li> <li>• To learn and Explore Cloud Infrastructures</li> <li>• To study cloud Security Fundamentals</li> <li>• To know various issues related to the security of information in cloud environment</li> </ul>		
<p><b>Course Outcomes:</b></p> <ul style="list-style-type: none"> <li>• Use various services offered for cloud environment</li> <li>• Apply computing security fundamentals confined to cloud environment</li> <li>• Analyze the cloud system for vulnerabilities, threats and attacks</li> <li>• Propose feasible security solution for cloud security</li> </ul>		
<b>Course Contents</b>		
<b>Selection of Modules:</b> Module 1 is compulsory and select any four(04) modules from 2 to 7.		
Module No.	Module Title	Credit
1	<b>Introduction</b>	<b>01</b>
<p>Cloud Computing Fundamentals, Essential Characteristics, Architectural Influences, Technological Influences, Operational Influences, Outsourcing, IT Service Management, Cloud Computing Architecture, Cloud Delivery Models, Cloud Deployment Models, Alternative Deployment Models, Expected Benefits.</p> <p>Understanding Abstraction and Virtualization, Capacity Planning, Exploring Platform as a Service, Using Google Web Services, Using Amazon Web Services, Using Microsoft Cloud Services.</p>		
2	<b>Cloud Security</b>	<b>01</b>
<p>Cloud Information Security Objectives, Confidentiality, Integrity, and Availability, Cloud Security Services, Relevant Cloud Security Design Principles, Secure Cloud Software Requirements, Approaches to Cloud Software Requirements Engineering, Cloud Security Policy Implementation and Decomposition, Secure Cloud Software Testing, Testing for Security Quality Assurance, Cloud Penetration Testing, Regression Testing, Cloud Computing and Business Continuity Planning/Disaster Recovery</p>		
3	<b>Cloud Computing Risk Issues</b>	<b>01</b>
<p>The CIA Triad, Privacy and Compliance Risks, Threats to Infrastructure, Data, and Access Control, Common Threats and Vulnerabilities, Cloud Access Control Issues, Cloud Service Provider Risks, Cloud Computing Security Challenges, Security Policy Implementation, Policy Types, Computer Security Incident Response Team (CSIRT), Virtualization Security Management.</p>		

<b>4</b>	<b>Cloud Computing Security Architecture</b>	<b>01</b>
Architectural Considerations, General Issues, Trusted Cloud Computing, Secure Execution Environments and Communications, Identity Management and Access Control, Identity Management, Access Control, Autonomic Security.		
<b>5</b>	<b>Cloud Computing Life Cycle Issues</b>	<b>01</b>
Standards, The Distributed Management Task Force (DMTF), The International Organization for Standardization (ISO), The European Telecommunications Standards Institute (ETSI), The Organization for the Advancement of Structured Information Standards (OASIS), Storage Networking Industry Association (SNIA), Open Grid Forum (OGF), The Open Web Application Security Project (OWASP), Incident Response, Encryption and Key Management, VM Architecture, Retirement		
<b>6</b>	<b>Cloud storage Security</b>	<b>01</b>
Who wants your data? Legal issues, criminals and authorization. Government and friends, legal responsibility, US Federal Law and regulations affecting cloud storage. Cloud storage provider and compliance. Laws and regulations of other countries.		
<b>7</b>	<b>Privacy Tools and Best Practices</b>	<b>01</b>
Privacy Tools and Best Practices, 2-factor authentication, secure email for cloud storage, Deletion of private data, security as service, distributed cloud storage, what are best practices, cloud data security and check list, Future of cloud data security.		
<b>Books:</b>		
<ol style="list-style-type: none"> <li>1. Tim Mather, Shahed Latif, Subra Kumaraswamy, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance", O'Reilly Media, SBN-13: 978-0596802769, ISBN-10: 0596802765</li> <li>2. Ronald L Krutz and Russell Dean Vines , "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", ISBN:0470938943</li> </ol>		
<b>References:</b>		
<ol style="list-style-type: none"> <li>1. Vic (J.R.) Winkler , "Securing the Cloud: Cloud Computer Security Techniques and Tactics", ISBN:159749593X</li> <li>2. Imad M. Abbadi, "Cloud Management and Security", ISBN: 1118817079</li> <li>3. Sumner Blount, Rob Zanella, "Cloud Security and Governance: Who's on Your Cloud?", ISBN: 1849280908</li> <li>4. Ryan Ko, Raymond Choo, "The Cloud Security Ecosystem: Technical, Legal, Business", ISBN: 0128017805</li> </ol>		



<p style="text-align: center;"><b>Savitribai Phule Pune University</b>  <b>Master of Computer Network Engineering (2017 Course)</b>  <b>Elective III</b>  <b>610103B : Speech Signal Processing</b></p>		
<b>Teaching Scheme:</b> TH: 05 Hours/Week	<b>Credit</b> 05	<b>Examination Scheme:</b> In-Sem: 50 Marks End-Sem: 50 Marks
<p><b>Course Objectives:</b></p> <ul style="list-style-type: none"> <li>• To understand basic characteristics of speech signal</li> <li>• To learn speech signal production and hearing of speech by humans</li> <li>• To be familiar with the techniques for the analysis of speech signals</li> <li>• To understand different speech modeling procedures</li> <li>• To know the applications of speech signal processing</li> </ul>		
<p><b>Course Outcomes:</b></p> <ul style="list-style-type: none"> <li>• Inculcate the characteristics of speech signal in relation to production and hearing of speech by humans</li> <li>• Apply various algorithms of speech analysis common to many applications</li> <li>• The students will be able to design a simple system for speech processing</li> <li>• Analyze the performance of speech signal processing system</li> </ul>		
<p><b>Selection of Modules:</b> Kindly note that modules 1, 2, 3 are compulsory and select any two (02) modules from modules 4-8.</p>		
<b>Course Contents</b>		
<b>Module No.</b>	<b>Module Title</b>	<b>Credit</b>
<b>1</b>	<b>Basic Concepts</b>	<b>01</b>
Introduction, mechanism of speech production. Articulatory Phonetics – Production and Classification of Speech Sounds Acoustic phonetics: vowels, diphthongs, semivowels, nasals, fricatives, stops and affricates.; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.		
<b>2</b>	<b>Speech Analysis</b>	<b>01</b>
Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures–mathematical and perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.		
<b>3</b>	<b>Speech Modeling</b>	<b>01</b>
Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.		
<b>4</b>	<b>Applications of Speech Processing</b>	<b>01</b>
Brief applications of speech processing in voice response systems, hearing aid design and recognition system.		
<b>5</b>	<b>Statistical Models for Speech Recognition</b>	<b>01</b>
(i)Vector quantization models and applications in speaker recognition. (ii)Gaussian mixture modeling for speaker and speech recognition. (iii) Discrete and Continuous Hidden Markov modeling for isolated word and continuous speech recognition.		

<b>6</b>	<b>Speech Recognition</b>	<b>01</b>
Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – n-grams, context dependent sub-word Units; Applications and present status.		
<b>7</b>	<b>Speech Synthesis</b>	<b>01</b>
Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word Units for TTS, intelligibility and naturalness – role of prosody, Applications and present		
<b>8</b>	<b>Linear Predictive Analysis of Speech</b>	<b>01</b>
Formulation of Linear Prediction problem in Time Domain-Basic Principle, Auto correlation method, Covariance method, Solution of LPC equations, Cholesky method, Durbin's recursive algorithm, lattice formation and solutions, comparison of different VELP, CELP		
<b>Books:</b>		
<b>Text:</b>		
<ol style="list-style-type: none"> <li>1. Lawrence Rabiner and Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Edu, 2003.</li> <li>2. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons, 1999, isbn: 13: 978-0471977308</li> <li>3. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education, 2002.</li> </ol>		
<b>References:</b>		
<ol style="list-style-type: none"> <li>1. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing, 1997. ISBN:0-9660176-4-1</li> <li>2. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education, 2004, ISBN: 9788129703187.</li> <li>3. Ben Gold and Nelson Morgan, “Speech and Audio Signal Processing, Processing and Perception of Speech and Music”, Wiley- India Edition, 2006, ISBN: 10: 8126508221</li> <li>4. UdoZolzer, " Digital Audio Signal Processing", Second Edition, John Wiley &amp; sons Ltd, ISBN: 9780470680018</li> <li>5. Lawrence R. Rabiner and R. W. Schaffer," Digital Processing of Speech Signals", Prentice Hall – 1978, ISBN: 0-13-213603-1</li> <li>6. Frederick Jelinek, “Statistical Methods of Speech Recognition”, MIT Press, 1997.</li> </ol>		

<b>Savitribai Phule Pune University</b> <b>Master of Computer Engineering (2017 Course)</b> <b>Elective III</b> <b>610103C :Mobile Ad-hoc Networks</b>		
<b>Teaching Scheme:</b> <b>TH: 05 Hours/Week</b>	<b>Credit</b> <b>05</b>	<b>Examination Scheme:</b> <b>In-Sem : 50 Marks</b> <b>End-Sem : 50 Marks</b>
<b>Course Objectives :</b> <ul style="list-style-type: none"> <li>To study the concepts of Ad hoc Networks</li> <li>To learn the concepts of Mobility and Mobility Prediction</li> <li>To understand the functionalities of various Protocols in MANET</li> <li>To know the technological advancements in wireless networks</li> </ul>		
<b>Course Outcomes :</b> <ul style="list-style-type: none"> <li>Assess Quality of Service in MANET</li> <li>Evaluate the performance of various Protocols in MANET</li> <li>Choose appropriate constituents and parameters to build MANET</li> <li>Analyze the performance of MANET</li> </ul>		
<b>Selection of Modules:</b> <b>Note that</b> modules 1, 2, 3 are compulsory and select any two (02) from modules 4 to 8.		
<b>Course Contents</b>		
<b>Module No.</b>	<b>Module Title</b>	<b>Credit</b>
<b>1</b>	<b>Introduction</b>	<b>01</b>
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. <b>Recent Advances in Wireless Networks:</b> Ultra Wide-Band Radio Communication, Wireless Fidelity, Optical Wireless Networks, Multimode 802.11, Meghadoot Architecture.		
<b>2</b>	<b>MAC Protocols</b>	<b>01</b>
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.		
<b>3</b>	<b>Multicast Routing</b>	<b>01</b>
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.		
<b>4</b>	<b>Quality of Service</b>	<b>01</b>
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.		
<b>5</b>	<b>Wireless Sensor Networks</b>	<b>01</b>

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.		
<b>6</b>	<b>Algorithms for Mobile Ad-hoc Networks</b>	<b>01</b>
Hierarchical routing and clustering, routing with virtual coordinates, relative location determination, overview and classification of NWB algorithms, Robustness control, NWB robustness solutions.		
<b>7</b>	<b>Encoding for Data Distribution&amp; Power Control Protocols</b>	<b>01</b>
Erasure codes, Network coding, Design principles for power control, single layer approach, the systematic approach, energy oriented perspective.		
<b>8</b>	<b>Vehicular Ad-hoc Networks</b>	<b>01</b>
VANET, characteristics, Connectivity, Dynamic transmission range assignment, routing applications, vehicle mobility, VANET vs MANET.		
<b>Books:</b>		
<b>Text:</b>		
<ol style="list-style-type: none"> <li>1. C. Siva Ram Murthy and B.S. Manoj, “Ad hoc Wireless Networks Architectures and protocols”, 2nd edition, Pearson Education. 2007, ISBN: 9788131706886, 8131706885</li> <li>2. Charles E. Perkins, “Ad hoc Networking”, Addison–Wesley, 2000, ISBN: 0201309769</li> </ol>		
<b>Reference:</b>		
<ol style="list-style-type: none"> <li>1. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, “Mobile ad hoc networking”, Wiley-IEEE press, 2004, ISBN: 978-0-471-65688-3.</li> <li>2. Mohammad Ilyas, “The handbook of ad hoc wireless networks”, CRC press, 2002, ISBN: 0-8493-1332-5</li> <li>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, ISBN:</li> <li>4. Fekri M. Abduljalil, “A survey of integrating IP mobility protocols and Mobile Ad hoc networks”., ISBN: 10 : 0750675993</li> </ol>		

<b>Savitribai Phule Pune University</b> <b>Master of Computer Engineering (2017 Course)</b> <b>Elective III</b> <b>610103 D : Pattern Recognition</b>		
<b>Teaching Scheme:</b> <b>TH: 05 Hours/Week</b>	<b>Credit</b> <b>05</b>	<b>Examination Scheme:</b> <b>In-Sem : 50 Marks</b> <b>End- Sem: 50 Marks</b>
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To learn the basic concept of Pattern recognition</li> <li>To study different approaches of pattern recognition</li> <li>To learn various pattern classification techniques</li> <li>To survey on recent advances and applications in pattern recognition</li> </ul>		
<b>Course Outcomes:</b> On completion of the course, student will be able to- <ul style="list-style-type: none"> <li>Analyze various type of pattern recognition techniques</li> <li>Identify and apply various pattern recognition and classification approaches to solve the problems</li> <li>Evaluate statistical and structural pattern recognition</li> <li>Percept recent advances in pattern recognition confined to various applications</li> </ul>		
<b>Selection of Modules:</b> Kindly note that modules 1,2,3 and module 9 are compulsory and select any two (02) modules from remaining modules.		
<b>Course Contents</b>		
<b>Module No.</b>	<b>Module Title</b>	<b>Credit</b>
<b>1</b>	<b>Pattern Recognition</b>	<b>01</b>
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.		
<b>2</b>	<b>Error Estimation</b>	<b>01</b>
Introduction, Error estimation methods, various distance measures (Euclidean, Manhattan, cosine, Mahalanobis) and distance based classifier, Feature selection based on statistical hypothesis testing, ROC curve.		
<b>3</b>	<b>Decision Theory</b>	<b>01</b>
Introduction, Bayesian decision theory-continuous and discrete features, two- category classification, minimum error rate classification, discriminant functions, 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.		
<b>4</b>	<b>Non Metric and structural pattern recognition</b>	<b>01</b>

<b>Tree Classifiers</b> -Decision Trees, Random Forests, <b>Structural Pattern recognition:</b> Elements of formal grammars ,String generation as pattern description ,Recognition of syntactic description ,Parsing ,Stochastic grammars and applications ,Graph based structural representation, <b>Stochastic method:</b> Boltzmann Learning.		
<b>5</b>	<b>Clustering</b>	<b>01</b>
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.		
<b>6</b>	<b>Template Matching</b>	<b>01</b>
Measures based on Optimal Path Searching techniques: Bellman's optimality principle and dynamic programming, The Edit distance, Dynamic time Warping, Measures based on correlations, Deformable template models		
<b>7</b>	<b>Unsupervised Learning</b>	<b>01</b>
Neural network structures for pattern recognition, Unsupervised learning in neural pattern recognition , deep learning ,Self-organizing networks		
<b>8</b>	<b>Fuzzy Logic and Pattern Recognition</b>	<b>01</b>
Fuzzy logic ,Fuzzy pattern classifiers, Pattern classification using Genetic Algorithms		
<b>9</b>	<b>Applications</b>	
Pattern recognition applications: Application of pattern recognition techniques in object recognition, biometric, facial recognition, IRIS scanner, Finger prints, 3D object recognition.		
<b>Books:</b>		
<b>Text :</b>		
<ol style="list-style-type: none"> <li>1. R. O. Duda, P. E. Hart, D. G. Stork, "Pattern Classification", 2nd Edition, Wiley-Inter- science, John Wiley &amp; Sons, 2001</li> <li>2. S. Theodoridis and K. Koutroumbas, "Pattern Recognition", 4<sup>th</sup> Edition, Elsevier, Academic Press, ISBN: 978-1-59749-272-0</li> <li>3. B.D. Ripley, "Pattern Recognition and Neural Networks", Cambridge University Press. ISBN 0 521 46086 7</li> </ol>		
<b>Reference :</b>		
<ol style="list-style-type: none"> <li>1. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.</li> <li>2. David G. Stork and Elad Yom-Tov, "Computer Manual in MATLAB to accompany Pattern Classification", Wiley Inter-science, 2004, ISBN-10: 0471429775</li> <li>3. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", PHI, ISBN-978- 81-203-4091-6</li> <li>4. eMedia at NPTEL : <a href="http://nptel.ac.in/courses/106108057/33">http://nptel.ac.in/courses/106108057/33</a></li> </ol>		