Faculty of Science & Technology
Savitribai Phule Pune University, Pune

Syllabus for
SY M. Sc. (Computer Applications)
(2023 Pattern)
(With effect from   A. Y. 2024-25)

Preamble

The field of computing is rapidly expanding and changing, especially, since the last decade with continuous emergence of new disruptive technologies such as artificial intelligence, data science, cyber security, Internet of things, robotics and so on.

21st Century has witnessed rapid technological developments in every sector including the field of Computing. Moreover, it has created new job roles and massive job opportunities for budding graduates.

Premium Institutes, public and private Universities, autonomous and affiliated colleges in India have always played a crucial role in producing human resources with required skill sets by capturing and monitoring these developments and offered various UG and PG programmes.

The Savitribai Phule Pune University, Pune has made its significant contribution by offering degree programmes as per the trends from time to time. In the year 1989, it started offering a degree programme Bachelor of Computer Science (BCS), now called B. Sc. (Computer Science) and was its unique offering in the state of Maharashtra. Later the University offered undergraduate and graduate programmes such as Master of Computer Management (MCM), Bachelor of Computer Applications (BCA), Master of Computer Applications (MCA), M. Sc (Computer Science), M. Sc. (Computer Applications) etc.

The Savitribai Phule Pune University, Pune has taken a leading role in design and implementation of Programmes as per the guidelines and recommendations of National Education Policy (NEP) 2020. The university decided to offer UG and PG programmes with features recommended by NEP-2020 such as Multiple-entry/exit, inter and multi-disciplinary education, focus on skilling, on-job training/field projects, research, incorporation of Indian Knowledge System etc for the holistic development of students.

The university has adopted the guidelines provided by the state Sukanu Samittee and prepared the credit structure for PG programmes vide its circular No. 122/23.

The Ad-hoc Board of Studies in Computer Applications has prepared a structure for M. Sc. (Computer Applications) with following features

- The structure of the course is designed as per National Education Policy (NEP) 2020 and is in line with University circular 122/23.
- The total credits offered for the two years (level 6.0 and level 6.5) with four semesters are 88 with 22 credits assigned for each of the four semesters.
- The programme has Multiple Entry/exit feature.
- Various types of courses includes - Mandatory Courses (MC), Mandatory Elective (ME), Research Methodology, On-job Training (OJT)/Field Project (FP) and Research Project (RP)

I am thankful to Hon. Vice-Chancellor Prof. Dr. S W. Gosavi, Hon. Dean of FoS&T, Prof. Dr. M G Chaskar for their guidance. I am thankful to all board members Prof. Dr. Rahul Patil, Prof. Dr. Razak Sayyad, Mr. Atul Kahate and Mr. Milnd Tanksale for their valuable inputs as well as the teachers from affiliated colleges for their active participation in preparing the draft syllabus.

Prof. Dr. S S Sane
Chairman,
Ad-hoc Board of Studies in Computer Applications
Faculty of Science and Technology, SPPU

M.Sc. (Computer Applications)

Objectives

The objective of the Program is to produce trained software professionals with hands-on experience on state-of-the art technologies who will be able to handle challenges in IT industry. The objectives of M.Sc. (Computer Applications) program are: -

- To produce knowledgeable and skilled human resources that is employable in IT and ITES.
- To impart knowledge required for planning, designing and building Complex Application SoftwareSystems as well as to provide support for automated systems or applications.

M.Sc. (Computer Applications) Program is of Two Years duration with four semesters. It is a Full- Time post graduate Degree Program. The program is based on credit system comprising of total 88 credit points.

It is believed that the proposed syllabus as part of the credit-based system will bring a qualitative change in the way M.Sc. (Computer Applications) is taught, which will offer a more enriched learning experience. It aims to provide students with the knowledge and ability to develop creative solutions, and better understand the effects of future developments of computer applications, systems and technology on people and society. The students shall develop self and life-long learning skills.

Eligibility
(a) Bachelor Degree in Science/Technology/Engineering OR
(b) Bachelor of Computer Applications (B.C.A.) OR
(c) B.Sc.(Computer Science) OR
(d) Bachelor of Computer Science (B.C.S.) OR
(e) B.Sc.(Information Technology) OR
(f) B.Sc.(Data Science) OR
(g) B.Sc.(Cyber and Digital Science) OR
(h) B.Sc. (Cyber Security) OR
(i) B.Sc. (Cloud Computing) OR
(j) Bachelor of Engineering(BE/B.Tech) in Computer Engg/Computer Science & Engg./ Computer Science and Design/ Information Technology/Electronics and Telecommunication/AI and Data Science/AI and Machine Learning/ equivalent OR
(k) B. Voc. in Software Development/ Information Technology OR
(l) B.Sc. with Computer Science as Principal Subject OR
(m) General B.Sc. with Computer Science as one of the subject at TYBSc level Programme

Programme Outcomes:

After successful completion of the Programme, the students shall be able to

PO 1: Demonstrate understanding of fundamental and advance concepts in emerging areas

PO 2: Design and develop innovative computer applications.

PO 3: Analyze existing research reported in the literature

PO 4: Propose alternate solutions by undertaking research work.

PO 5: Create efficient, reliable, readable and maintainable code.

PO 6: Demonstrate a deeper understanding of the chosen domain.

PO 7: Select appropriate method to solve the given problem

PO 8: Explain complex technical concepts clearly and effectively, both in written and oral forms.

PO 9: Demonstrate ability to collaborate effectively with team members, understand different perspectives, and contribute productively to become successful professional.

PO 10: Demonstrate ability to work with integrity and a sense of social responsibility.

PO 11: Demonstrate self and life-long learning skills

PO 12: Solve computational problems innovatively

PO 13: Apply knowledge gained and critical thinking to develop real-world applications.

Table of Contents

STRUCTURE FOR M. Sc. (Computer Applications) 2023 Pattern
AS PER NEP GUIDELINES

Abbreviations

TH: Theory
CE: Continuous Evaluation
CA: Computer Applications
ME: Mandatory Elective
OJT/FP: On-job Training / Field Project

PR: Practical
EE: End Semester Examination
MC: Mandatory Core
RM: Research Methodology
RP: Research Project

SEMESTER I

Level	Course Type	Course Code	Course Name	Teaching Scheme		Exam Scheme			Credits		
				TH	PR	CE	EE	Total	TH	PR	Total
6.0	MC	CA 501 MJ	Database Systems and SQL	04	--	30	70	100	04	--	**04**
		CA 502 MJ	Python Programming and Data Structures	04	--	30	70	100	04	--	**04**
		CA 503 MJ	Operating Systems	02	--	15	35	50	02	--	**02**
		CA 504 MJP	Lab course based on CA501 MJ & CA 503 MJ	--	04	15	35	50	--	02	**02**
		CA 505 MJP	Lab course based on CA 502 MJ	--	04	15	35	50	--	02	**02**
	ME	CA 510 MJ	Java Programming	02	--	15	35	50	02	--	**02**
		CA 511 MJP	Lab Course based on CA 510 MJ	--	04	15	35	50	--	02	**02**
		OR									
		CA 512 MJ	Cloud Computing	02	--	15	35	50	02	--	**02**
		CA 513 MJP	Lab Course based on CA 512 MJ	--	04	15	35	50	--	02	**02**
	RM	CA 541 RM	Research Methodology	04	--	30	70	100	04	--	**04**
			Total	16	12	165	385	550	16	06	**22**

SEMESTER II

Level	Course Type	Course Code	Course Name	Teaching Scheme		Exam Scheme			Credits		
				TH	PR	CE	EE	Total	TH	PR	Total
6.0	MC	CA 551 MJ	Web Technologies	04	--	30	70	100	04	--	**04**
		CA 552 MJ	Introduction to Data Science	04	--	30	70	100	04	--	**04**
		CA 553 MJ	Computer Networks	02	--	15	35	50	02	--	**02**
		CA 554 MJP	Lab course based on CA 551 MJ	--	04	15	35	50	--	02	**02**
		CA 555 MJP	Lab course based on CA 552 MJ	--	04	15	35	50	--	02	**02**
	ME	CA 560 MJ	Advanced Java Programming	02	--	15	35	50	02	--	**02**
		CA 561 MJP	Lab Course on based on CA 560 MJ	--	04	15	35	50	--	02	**02**
		OR									
		CA 562 MJ	C# .NET	02	--	15	35	50	02	--	**02**
		CA 563 MJP	Lab Course based on based CA 562 MJ	--	04	15	35	50	--	02	**02**
	OJT/FP	CA 581 OJT/FP	Industry Internship/Field Project ^	--	--	30	70	100	--	04	**04**
			Total	12	12	165	385	550	12	10	**22**

^Institutes should follow the procedures/guidelines provided by the University/UGC/State Governments from time-to-time for smooth conduction of Industry Internship/Field Projects

STRUCTURE FOR M. Sc. (Computer Applications) AS PER NEP GUIDELINES

SEMESTER III

Level	Course Type	Course Code	Course Name	Teaching Scheme		Exam Scheme			Credits		
				TH	PR	CE	EE	Total	TH	PR	Total
6.5	MC	CA 601 MJ	Artificial Intelligence	04	--	30	70	100	04	--	**04**
		CA 602 MJ	Machine Learning	04	--	30	70	100	04	--	**04**
		CA 603 MJ	Software Engineering	02	--	15	35	50	02	--	**02**
		CA 604 MJP	Lab Course based on CA 601 MJ	--	04	15	35	50	--	02	**02**
		CA 605 MJP	Lab Course based on CA 602 MJ	--	04	15	35	50	--	02	**02**
	ME	CA 610 MJ	Mobile Application Development	02	--	15	35	50	02	--	**02**
		CA 611 MJP	Lab Course based on CA 610 MJ	--	04	15	35	50	--	02	**02**
		OR									
		CA 612 MJ	Software Testing	02	--	15	35	50	02	--	**02**
		CA 613 MJP	Lab Course based on CA 612 MJ	--	04	15	35	50	--	02	**02**
	RP	CA 631 RP	Research work – I	--	08	30	70	100	--	04	**04**
			Total	12	20	165	385	550	12	10	**22**

PROPOSED STRUCTURE FOR M. Sc. (Computer Applications) AS PER NEP GUIDELINES

SEMESTER IV

Level	Course Type	Course Code	Course Name	Teaching Scheme		Exam Scheme			Credits		
				TH	PR	CE	EE	Total	TH	PR	Total
6.5	MC	CA 651 MJP	Industrial Training #	--	--	100	200	300	--	12	**12**
	ME	CA 660 MJ	Management Information System *	02	--	15	35	50	02	--	**02**
		OR									
		CA 661 MJ	Digital Marketing *	02	--	15	35	50	02	--	**02**
		CA 662 MJ	ERP *	02	--	15	35	50	02	--	**02**
		OR									
		CA 663 MJ	Information Security *	02	--	15	35	50	02	--	**02**
	RP	CA 681 RP	Research Work – II $	--	12	50	100	150	--	06	**06**
			Total	04	12	180	370	550	04	18	**22**

#Institutes should follow the procedures/guidelines provided by the University/UGC/State Governments from time-to-time for smooth conduction of Industrial Training

*These courses may be conducted by the respective colleges in online/offline/hybrid mode

$ Refer the details mentioned in the syllabus

SEMESTER III

SAVITRIBAI PHULE PUNE UNIVERSITY
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SAVITRIBAI PHULE PUNE UNIVERSITY
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)
SEMESTER III
CA 601 MJ: Artificial Intelligence

Teaching Scheme: Theory: 4 Hrs./Week	Credits 04	Examination Scheme: Continuous Evaluation: 30 Marks End-Semester : 70 Marks

Course Objectives:
- To learn various types of algorithms useful in Artificial Intelligence (AI).
- To convey the ideas in AI research related to emerging technology.
- To introduce ideas and techniques underlying the design of intelligent computer systems

Course Outcomes:

After successful completion of this course, learner will be able to:

- Apply the suitable algorithms to solve AI problems

- Identify and apply suitable Intelligent agents for various AI applications

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

- Represent complex problems with expressive language of representation

	Course Contents	
Unit I	**Introduction to Artificial Intelligence**	12 Hrs
	Introduction to Artificial Intelligence, Foundations of Artificial Intelligence, History of Artificial Intelligence, State of the Art, Intelligent Agents, Agents and Environments, Good Behavior: Concept of Rationality, Nature of Environments, Structure of Agents, Benefits and limitation of AI, Ethics in AI, AI Components, AI Architectures	
Unit II	**Searching**	12 Hrs
	Uninformed Search Algorithms/Blind Search Techniques - Breadth-first Search, Depth-first Search Informed (Heuristic) search Techniques: Generate-and-test, Simple Hill Climbing, Best First Search, Constraint Satisfaction, Means End Analysis, A* and AO*	
Unit III	**Gaming**	12 Hrs
	Game Theory, Optimal Decisions in Games, Heuristic Alpha–Beta Tree Search, Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, Limitations of Game Search Algorithms	
Unit IV	**Knowledge Representation**	12 Hrs
	Definition of Knowledge, Types of knowledge (Procedural and Declarative knowledge), Approaches to Knowledge Representation Knowledge representation using Propositional and Predicate logic - Conversion to clause form, Resolution in Propositional logic, Resolution in Predicate logic	
Unit V	**Reasoning**	12 Hrs

| | Inference in First-Order Logic, Propositional vs. First-Order Inference, Unification and First-Order Inference, Forward Chaining, Backward Chaining, Resolution, Knowledge Representation, Ontological Engineering, Categories and Objects, Events, Mental Objects and Modal Logic, Reasoning Systems for Categories, Reasoning with Default Information | |

Reference Books:

1. Artificial Intelligence, Tata McGraw Hill, Elaine Rich and Kevin Knight
2. Computational Intelligence, Eberhart, Elsevier, ISBN 9788131217832
3. Artificial Intelligence: A New Synthesis, Nilsson, Elsevier, ISBN 9788181471901
4. Introduction to Artificial Intelligence and Expert System, Dan Patterson, Prentice Hall of India
   Pvt. Ltd., New Delhi, 1997
5. Artificial Intelligence: A Modern Approach, Russel &Norvig, Pearson Education
6. Introduction to Machine Learning , Ethem Alpaydin, PHI

E-Resources:

- https://www.oracle.com/in/chatbots/what-is-a-chatbot/
- https://www.dataversity.net/case-study-predictive-analytics-and-data-science-keep-an-eye-on-the-weather/
- https://www.senseforth.ai/conversational-ai-case-studies/SBI-Cards/

SAVITRIBAI PHULE PUNE UNIVERSITY
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)
SEMESTER III
CA 602 MJ: Machine Learning

Teaching Scheme: Theory: 4 Hrs./Week	Credits 04	Examination Scheme: Continuous Evaluation: 30 Marks End-Semester : 70 Marks

Course Objectives:

- To understand the need for Machine learning
- To study and understand classification methods
- To understand the need for multi-class classifiers.
- To learn the working of clustering algorithms
- To learn fundamental neural network algorithms.

Course Outcomes:

- After successful completion of this course, learner will be able to:
- Identify the needs and challenges of machine learning for real time applications.
- Select and apply appropriately supervised machine learning algorithms for real time applications.
- Implement variants of multi-class classifier and measure its performance.
- Compare and contrast different clustering algorithms.
- Design a neural network for solving engineering problems.

Course Contents		
Unit I	**Introduction To Machine Learning**	**12 Hrs**
	Introduction to Machine Learning, Comparison of Machine learning with traditional programming, ML vs AI vs Data Science. Types of learning: Supervised, Unsupervised, and semi-supervised, reinforcement learning techniques, Models of Machine learning: Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models. Important Elements of Machine Learning- Data formats, Learnability, Statistical learning approaches	
Unit II	**Supervised Learning: Regression and Classification**	**12 Hrs**
	Linear regression, logistic regression, Evaluation Metrics: MAE, RMSE, R2 Classification: Naïve-based and Decision tree based classifier, K-nearest neighbor, Support vector machine.	
Unit III	**Supervised Learning: Ensembles and Multi-Class classification**	**12 Hrs**
	Ensemble Learning: Bagging, Boosting, Random Forest, Adaboost. Binary-vs-Multiclass Classification, Variants of Multiclass Classification: One-vs-One and One-vs-All Evaluation Metrics and Score: Accuracy, Precision, Recall, Fscore, Cross-validation	
Unit IV	**Unsupervised Learning**	**12 Hrs**
	K-Means, K-medoids, Hierarchical, and Density-based Clustering, Outlier analysis: introduction of isolation factor, local outlier factor. Evaluation metrics and score: elbow method, extrinsic and intrinsic methods	
Unit V	**Artificial Neural Networks**	**12 Hrs**

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

Reference Books:

1. Bishop, Christopher M., and Nasser M. Nasrabadi, "Pattern recognition and machine learning",Vol. 4. No. 4. New York: springer, 2006.
2. Ethem Alpaydin, " Introduction to Machine Learning", PHI 2nd Edition-2013
3. Shalev-Shwartz, Shai, and Shai Ben-David, "Understanding machine learning: From theory to algorithms", Cambridge university press, 2014.
4. Jiawei Han, Micheline Kamber, and Jian Pie, "Data Mining: Concepts and Techniques", Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807
5. Goodfellow I.,Bengio Y. and Courville, " A Deep Learning", MIT Press, 2016
6. Charu Agarwal, "Neural Networks and deep learning", A textbook

E-resources:

- Foundation of Machine Learning: https://cs.nyu.edu/~mohri/mlbook/
- Dive into Deep Learning: http://d2l.ai/
- A brief introduction to machine learning for Engineers: https://arxiv.org/pdf/1709.02840.pdf
- Introduction to Machine Learning : https://nptel.ac.in/courses/106105152
- Introduction to Machine Learning (IIT Madras): https://onlinecourses.nptel.ac.in/noc22_cs29/prevew
- Deep learning: https://nptel.ac

SAVITRIBAI PHULE PUNE UNIVERSITY
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)
SEMESTER III
CA 603 MJ: Software Engineering

Teaching Scheme: Theory: 2 Hrs./Week	Credits 02	Examination Scheme: Continuous Evaluation: 15 Marks End-Semester : 35 Marks

Course Objectives:

- To learn and understand the principles of Software Engineering
- To be acquainted with methods of capturing, specifying, visualizing and analyzing software requirements.
- To study agile software development methodology

Course Outcomes:

After successful completion of this course, learner will be able to:

- Compare and contrast various Software Engineering models
- Decide on appropriate process model for a developing a software project
- Classify software applications and Identify unique features of various domains
- Prepare System Requirement Specification (SRS) for the given problem
- Design and analyze Data Flow diagrams

Course Contents		
Unit I	**Introduction to Software Engineering**	**06 Hrs**
	Definition of Software, Characteristics of Software, Software Application Domains, Definition of Software Engineering, Need for software Engineering, Mc Call's Quality factors, The Software Process, Software Engineering Practice	
Unit II	**Software Development Life Cycle (SDLC)**	**06 Hrs**
	Introduction, Activities of SDLC, A Generic Process Model, Prescriptive Process models: Waterfall Model, Incremental Model, Prototyping Model, Spiral Model, 3.5 Concurrent Models, Types	
Unit III	**Requirement Engineering**	**06 Hrs**
	Introduction, Requirement Engineering Tasks, Establishing Groundwork for understanding of Software Requirement, Requirement Gathering, Feasibility study, Fact Finding Techniques	
Unit IV	**Analysis and Design Engineering**	**06 Hrs**
	Decision Tree and Decision Table, Data Flow Diagrams (DFD), Data Dictionary (DD), Elements of DD, Advantages of DD, Input and Output Design, Pseudocode, Introduction to Object-oriented analysis and Design	
Unit V	**Agile Development**	**06 Hrs**
	Agility, Agile Process, Principles, The Politics Of Agile Development, Human Factors, Extreme Programming(XP), Adaptive Software Development (ASD), Scrum, Dynamic System Development Model (DSDM)	

Reference Books:

1. Software Engineering : A Practitioner's Approach- Roger S. Pressman, McGraw hill International Editions 2010 (Seventh Edition)

2. Fundamentals of Software Engineering- Rajib Mall, PHI Publication, Fourth Edition

E-Resources:
- Software Engineering and Quality Assurance – Mrs Anuradha A. Puntambekar
- https://books.google.co.in/books?id=r203sZeGhhcC&printsec=frontcover&dq=Software+Engineering+ebook&hl=en&sa=X&ved=0ahUKEwi9wJr-l6LpAhU46nMBHeWQCQwQ6AEINDAB#v=onepage&q&f=false
- Software Engineering – Bharat Bhushan Agarawal and Sumit Prakash Tayal
- https://books.google.co.in/books?id=CDWRq0B9e5kC&printsec=frontcover&dq=Software+Engineering+ebook&hl=en&sa=X&ved=0ahUKEwi9wJr-l6LpAhU46nMBHeWQCQwQ6AEIVzAF#v=onepage&q&f=false
- Software Engineering – Jibitesh Mishtre and Ashok Mohanty
- https://books.google.co.in/books?id=YnGz2ghKF-gC&printsec=frontcover&dq=Software+Engineering+ebook&hl=en&sa=X&ved=0ahUKEwi9wJr-l6LpAhU46nMBHeWQCQwQ6AEIaTAH#v=onepage&q&f=false

SAVITRIBAI PHULE PUNE UNIVERSITY
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)
SEMESTER III
CA 604 MJP: Lab Course Based on CA 601 MJ

Teaching Scheme: Laboratory: 4 Hrs./Week	Credits 02	Examination Scheme: Continuous Evaluation: 15 Marks End-Semester : 35 Marks

Course Objectives

- To learn and apply various search strategies for AI
- To Formalize and implement constraints in search problems

Course Outcomes

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

- Apply informed search / uninformed search or heuristic approaches
- Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning
- Design and develop an interactive AI application

Guidelines for Instructor's Manual

The instructor shall frame at least 14 assignments. Instructor's manual consisting of University syllabus, list of assignments, conduction & Assessment guidelines is to be developed.

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of Certificate, table of contents, and handwritten write-up for each assignment. Write-up shall include Title, Problem Statement, software and Hardware requirements, Date of Completion.

Students shall submit softcopy of program codes with sample outputs of all performed assignments. Lab in-charge shall maintain softcopy of program codes submitted by students. For reference, one or two journals may be maintained with program prints.

Guidelines for Assessment

Continuous assessment of laboratory work is to be carried out based on overall performance of students. For each lab assignment, the instructor shall assign grade/marks based on parameters such as timely completion, understanding and neatness with appropriate weightage.

Suggested Laboratory Assignments

01	Implement depth first search algorithm
02	Implement Breadth first search algorithm
03	Use an undirected graph and develop a recursive algorithm for searching all the vertices of a graph
04	Implement A star Algorithm
05	Implement AO star Algorithm
06	Use Greedy Search algorithm to implement selection sort
07	Use Greedy Search algorithm to find single source shortest path
08	Use Greedy Search algorithm to obtain Minimum Spanning Tree
09	Develop an elementary Chabot for any suitable customer interaction application.
10	Develop an Expert system for a Hospital or any suitable application.

SAVITRIBAI PHULE PUNE UNIVERSITY
SAVITRIBAI PHULE PUNE UNIVERSITY   **SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)**   **SEMESTER III**   **CA 605 MJP: Lab Course Based on CA 602 MJ**

Teaching Scheme: **Laboratory: 4 Hrs./Week**	Credits **02**	Examination Scheme: **Continuous Evaluation: 15 Marks** **End-Semester : 35 Marks**

Course Objectives
- Develop in depth understanding for implementation of the regression models.
- Learn supervised and unsupervised machine learning algorithms.
- Study Artificial Neural Networks

Course Outcomes

After successful completion of the course, students will be able to
- Implement and evaluate linear regression and random forest regression models.
- Apply and evaluate classification and clustering techniques.

Guidelines for Instructor's Manual

The instructor shall frame at least 14 assignments. Instructor's manual consisting of University syllabus, list of assignments, conduction & Assessment guidelines is to be developed.

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of Certificate, table of contents, and handwritten write-up for each assignment. Write-up shall include Title, Problem Statement, software and Hardware requirements, Date of Completion.

Students shall submit softcopy of program codes with sample outputs of all performed assignments. Lab in-charge shall maintain softcopy of program codes submitted by students. For reference, one or two journals may be maintained with program prints.

Guidelines for Assessment

Continuous assessment of laboratory work is to be carried out based on overall performance of students. For each lab assignment, the instructor shall assign grade/marks based on parameters such as timely completion, understanding and neatness with appropriate weightage.

Suggested Laboratory Assignments

Visit websites providing datasets for Machine learning from various domains such as Finance, Healthcare, Science etc and download. For example download datasets named "Australian Credits", "BUPA", "Ionosphere" etc. Study the datasets and prepare a descriptive table giving name of the dataset, URL from where it was downloaded, type of dataset (Synthetic/Real-world), No. of Attributes, no. of records, number of classes (if applicable) etc.

Download any open source software such as WEKA and install. Download in-built datasets and include their description in the table mentioned above. Carry out following assignments

01	Using any open source software such as WEKA and its datasets, perform classification using Naïve Bayes classifier, note accuracy
02	Using any open source software such as WEKA and its datasets, perform classification using C4.5 – the decision tree classifier
03	Using any open source software such as WEKA and its datasets, perform classification using Neural network classifier
04	Perform assignment 1 above using any available attribute selection algorithm in WEKA and note the accuracy and compare it with accuracy obtained in assignment 1 above

05	Perform assignment 2 above using any available attribute selection algorithm in WEKA and note the accuracy and compare it with accuracy obtained in assignment 2 above
06	Perform assignment 3 above using any available attribute selection algorithm in WEKA and note the accuracy and compare it with accuracy obtained in assignment 3 above
07	Perform assignment 1 above using any available instant selection algorithm in WEKA and note the accuracy and compare it with accuracy obtained in assignment 1 above
08	Perform assignment 2 above using any available attribute selection algorithm in WEKA and note the accuracy and compare it with accuracy obtained in assignment 2 above
09	Perform assignment 3 above using any available attribute selection algorithm in WEKA and note the accuracy and compare it with accuracy obtained in assignment 3 above
10	Perform assignment 2 above using both attribute and instance selection algorithm in WEKA and note the accuracy and compare it with accuracy obtained in assignments 2, 5 and 8 above
11	Using any open source software such as WEKA and its datasets, perform clustering using 'EM' algorithm
12	Implement K-Means clustering/ hierarchical clustering on sales_data_sample.csv dataset. Determine the number of clusters using the elbow method. Dataset link : https://www.kaggle.com/datasets/kyanyoga/sample-sales-data

SAVITRIBAI PHULE PUNE UNIVERSITY
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)
SEMESTER III
CA 610 MJ: Mobile Application Development

Teaching Scheme: Theory: 2 Hrs./Week	Credits 02	Examination Scheme: Continuous Evaluation: 15 Marks End-Semester : 35 Marks

Course Objectives
- To study the Android mobile application development platform
- To understand the essence of Android programming
- To learn Android mobile application development process

Course Outcomes

After successful completion of the course, students will be able to
- Describe architecture, components and lifecycle development of Android application development cycle
- Design simple Android applications
- Apply advanced Android features

Course Contents		
Unit I	**Introduction**	**06 Hrs**
	Introduction to Android - Overview and evolution of Android , Features of Android, Android architecture, Components of an Android Application, Manifest file, Android Activity Service Lifecycle	
Unit II	**User Interface**	**06 Hrs**
	Basic UI Designing (Form widgets, Text Fields, Layouts, [dip, dp, sip, sp] versus px), Intent, All components (Button, Slider, Image view, Toast), Event Handling, Adapters and Widgets, Menus	
Unit III	**Threads and Notifications**	**06 Hrs**
	Threads running on UI thread (runOnUiThread), Worker thread, Handlers & Runnable, Asyn Tasks, Broadcast Receivers, Services and notifications, Toast and Alarms	
Unit IV	**Advanced Android Programming**	**06 Hrs**
	Content Providers – SQLite Programming, JSON Parsing, Accessing Phone Service (Call, SMS, MMS), Location based services	
Unit V	**ReactJs**	**06 Hrs**
	React Introduction, Setup and Create Simple Hello World App, Understanding React Foundation or Structure, React ES6, React JSX, React Components, React Classes, React Props, React Events, React DevTools, Reat Data Flow, React Conditionals, React Lists, React Forms, React Router, React Hooks, Building a Simple To-Do List Application (Setup), Deploying React	

Reference Books:
1. Beginning Android Application Development, Wei-Meng Lee, Wiley
2. React Native in Action, nader dabit, Nickie Buckne, O'reilly Publications

SAVITRIBAI PHULE PUNE UNIVERSITY
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)
SEMESTER III
CA 611 MJP: Lab Course Based on CA 610 MJ

Teaching Scheme: Laboratory: 4 Hrs./Week	Credits 02	Examination Scheme: Continuous Evaluation: 15 Marks End-Semester : 35 Marks

Course Objectives
- To study the Android mobile application development platform
- To understand the essence of Android programming
- To learn Android mobile application development process

Course Outcomes
After successful completion of the course, students will be able to
- Design simple Android applications
- Apply advanced Android features

Guidelines for Instructor's Manual
The instructor shall frame at least 14 assignments. Instructor's manual consisting of University syllabus, list of assignments, conduction & Assessment guidelines is to be developed.

Guidelines for Student Journal
The laboratory assignments are to be submitted by student in the form of journal. Journal consists of Certificate, table of contents, and handwritten write-up for each assignment. Write-up shall include Title, Problem Statement, software and Hardware requirements, Date of Completion.
Students shall submit softcopy of program codes with sample outputs of all performed assignments. Lab in-charge shall maintain softcopy of program codes submitted by students. For reference, one or two journals may be maintained with program prints.

Guidelines for Assessment
Continuous assessment of laboratory work is to be carried out based on overall performance of students. For each lab assignment, the instructor shall assign grade/marks based on parameters such as timely completion, understanding and neatness with appropriate weightage.

Suggested Laboratory Assignments

01	Create an Application for registration of users with required fields. Provide Menu items to add, delete and edit with adequate validations
02	Create sample application with login module. Verify Check username and password. On successful login, pass username to next screen and if login fails, prompt the user
03	Create Tables Project (pno, p_name, ptype, duration) and Employee (id, e_name, qualification, join-date), assume Project – employee has a many to many relationship. Using database perform following operation. 1) Add new record into table. 2) Accept a project name from user and display information of employees working on the project.
04	Create application to send and receive messages using SMS Manager.
05	Create application to send an email.
06	Create application with a login form. Validate the user and send an email.
07	Create application to search a specific location on Google Map
08	Create application to calculate distance between two locations on Google Map
09	Create application using JSON to provide Employee information

10	Create an application to capture and send a sales order for a pharma sales agent. Application should first sync using APIs - a) products with rates from server b) customers details. Login should find sales person id based on mobile number and allow him to input a sales order with multiple products. Order should be saved locally and updated on server if connection is available (or sync later with server).
11	Create and Deploy Application covering assignments 1, 2 and 3 above using ReactJs

SAVITRIBAI PHULE PUNE UNIVERSITY
SAVITRIBAI PHULE PUNE UNIVERSITY **SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)** **SEMESTER III** **CA 612 MJ: Software Testing**

Teaching Scheme: Theory: 2 Hrs./Week	Credits 02	Examination Scheme: Continuous Evaluation: 15 Marks End-Semester : 35 Marks

Course Objectives

- To study fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods
- To know various software testing issues and solutions in software unit test; integration, regression, and system testing
- To learn how to plan and design test cases and data, conduct tests, manage defects, and generate a test reports

Course Outcomes

- Distinguish between white box and black box testing
- Define Software testing life cycle
- Design test cases

Course Contents		
Unit I	**Introduction**	**06 Hrs**
	Introduction, Basics of Software Testing, Testing Principles, Goals, Testing Life Cycle, Phases of Testing, Defects, Defect Life Cycle, Defect Report, Test Plan(IEEE format), verification and validation	
Unit II	**White-box testing**	**06 Hrs**
	Introduction, Need of white box testing, Testing types, Test adequacy criteria, static testing by humans, Structural testing - logic coverage criteria, Basis path testing, Graph metrics, Loop Testing, Data flow testing, Mutation Testing, Design of test cases. Testing of Object oriented systems, Challenges in White box testing	
Unit III	**Black-box Testing**	**06 Hrs**
	Introduction, Need of black box testing, Black box testing Concept, Requirement Analysis, Test case design criteria, Testing Methods, requirement based testing, Positive & negative testing, Boundary value analysis, Equivalence Partitioning class, state based or graph based, cause effect graph based, error guessing, documentation testing & domain testing, design of test cases, Integration testing	
Unit IV	**System and Acceptance testing**	**06 Hrs**
	System testing, Functional system testing, Non-functional system testing Acceptance testing, Performance testing, Regression testing, Ad-hoc testing, Internationalization testing, Usability and Accessibility testing	
Unit V	**Test Management, Automation, metrics and measurements**	**06 Hrs**

Test Planning, Test Management, Test Process, Test Reporting	
What is test Automation?, Design and Architecture for Automation, Selecting testing tool	
What are test metrics and measurements? Types of metrics	

Reference Books:

1. Software testing Principle and Practices By Ramesh Desikan, Pearson Education, ISBN 81-7758-121-X 5.
2. Software Testing Principles and Tools By M.G. Limaye TMG Hill Publication, ISBN 13:978-0-07-013990-9 3.
3. Software Testing Principles and Practices By Naresh Chauhan, Oxford University Press, ISBN 0-19-806184-6 4.
4. Software Testing Concepts and Tools By Nageshwar Rao , Dreamtech ,ISBN 81-7722-712-2

SAVITRIBAI PHULE PUNE UNIVERSITY
SAVITRIBAI PHULE PUNE UNIVERSITY
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)
SEMESTER III
CA 613 MJP: Lab Course Based on CA 612 MJ

Teaching Scheme: **Laboratory: 4 Hrs./Week**	Credits **02**	Examination Scheme: **Continuous Evaluation: 15 Marks** **End-Semester : 35 Marks**

Course Objectives
- To understand white box testing
- To know black box testing
- To be familiar with automation tool

Course Outcomes

After successful completion of the course, students will be able to
- Perform white box testing activities
- Apply black box testing concepts
- Enlist features of a automation tool

Guidelines for Instructor's Manual

The instructor shall frame at least 14 assignments. Instructor's manual consisting of University syllabus, list of assignments, conduction & Assessment guidelines is to be developed.

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of Certificate, table of contents, and handwritten write-up for each assignment. Write-up shall include Title, Problem Statement, software and Hardware requirements, Date of Completion.
Students shall submit softcopy of program codes with sample outputs of all performed assignments. Lab in-charge shall maintain softcopy of program codes submitted by students. For reference, one or two journals may be maintained with program prints.

Guidelines for Assessment

Continuous assessment of laboratory work is to be carried out based on overall performance of students. For each lab assignment, the instructor shall assign grade/marks based on parameters such as timely completion, understanding and neatness with appropriate weightage.

Suggested Laboratory Assignments

01	To study and identify defects in a given data entry form
02	To improve user experience for a given sign-in page
03	Compute Code Coverage (Statement, Path, Condition & Function coverage) for given code
04	Compute Cyclomatic complexity for a given flow graph
05	Prepare a requirement traceability matrix for a given system
06	Prepare test execution data for the system specified in assignment 5 above
07	Prepare a set of positive and negative test cases for a given system
08	From the given problem, construct a decision table
09	Identify equivalence classes for a given problem statement
10	Develop a use case scenario for the specified system
11	Download, install and use any open source testing tool

SAVITRIBAI PHULE PUNE UNIVERSITY		
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)		
SEMESTER III		
CA 631 RP: Research Work - I		
Teaching Scheme: **Laboratory: 8 Hrs./Week**	**Credits** **04**	**Examination Scheme:** **Continuous Evaluation: 30 Marks** **End-Semester : 70 Marks**

Course Objectives

- To provide hands-on experience to research work

Course Outcomes

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

- Apply research methodology to carry out research in a chosen problem domain
- Design and develop a novel methodology / framework etc
- Conduct experiments and analyze results

Guidelines for carrying out Research work

Each student shall carry out the research work during semester III under the guidance of the appointed faculty Advisor/Mentor. Students shall work on a research problem and publish a paper / file a copyright / patent based on the work carried out. The student shall prepare and submit a report based on the work carried out consisting of – Face Page, certificate, Acknowledgement, Abstract, Table of Contents, List of Tables, List of Figures, Abbreviations, and separate Chapters dealing with Introduction, Literature Review, Design details of Proposed System, Experimental Results and analysis, and a chapter providing Conclusions and future scope. List of Publications, Copyright/patent, references and appendix shall also be included in the report.

Guidelines for Assessment

The work carried out shall be evaluated on a continuous basis by the assigned faculty advisor / mentor for 30 marks and panel of examiners appointed shall evaluate the work based on the report for 70 marks.

SEMESTER IV

SAVITRIBAI PHULE PUNE UNIVERSITY		
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)		
SEMESTER IV		
CA 651 MJ: Industrial Training		
Teaching Scheme: **Laboratory: 24 Hrs/Week**	**Credits** **12**	**Examination Scheme:** **Continuous Evaluation: 100 Marks** **End-Semester : 200 Marks**

Course Objectives

- To provide opportunities for students to get professional experience
- To learn and understand real life/industrial situations
- To get familiar with various tools and technologies used in industries and their applications.
- To nurture professional and societal ethics

Course Outcomes

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

- To demonstrate professional competence
- To apply knowledge gained through training to complete academic activities in a professional manner
- To choose appropriate technology and tools to solve given problem.
- To demonstrate abilities of a responsible professional and use ethical practices in day to day life.
- To analyze various career opportunities and decide carrier goals

Guidelines for Industry Training

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

Core objective is to expose students to the industry environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry. Industry training is intended to provide students with an opportunity to apply conceptual knowledge from academics to the realities of the field work/training.

Duration:

The student is expected to carry out online/offline industry training for minimum of 360 hrs during the winter vacation of 4-6 weeks (with at least 30hrs/week) and during semester IV

Identifying place/work for Industrial training

Student may choose to undergo Industry training at Industry/Govt. Organizations/NGO/MSME/Research Labs/Institutes. Students must get training proposals sanctioned from college authority well in advance. Internship work identification process should be initiated in the 3rd semester in coordination with training and placement cell/ industry institute cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their 3rd semester examinations.

Student can undergo training in the form of the following but not limited to:

- Industry / Government Organization
- Working for consultancy/ research project
- Contribution in Incubation/ Innovation/ Entrepreneurship Cell / startups cells of institute
- In-house product development, intercollegiate, inter department research internship under research group, micro/small/medium enterprises/online internship,
- Research internship under professors from reputed Institutes/Research organizations,
- NGOs
- Participate in open source development.

Diary/Workbook:

Students must maintain daily Diary/ Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documentation. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any.
Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record duly signed and stamped by the industry/organization where the training was carried out

The student shall prepare and submit a report based on the work carried out consisting of –

- Title/Cover Page
- Training completion certificate
- Details of place of training- Company background-organization and activities/Scope and object of the study / Supervisor details
- Index/Table of Contents
- Introduction
- Title/Problem statement/objectives
- Motivation/Scope and rationale of the work carried out
- Methodological details
- Results / Analysis /inferences and conclusion
- Suggestions / Recommendations for improvement to industry, if any
- Attendance Record
- Acknowledgement
- List of references (Library books, magazines and other sources)

Guidelines for Assessment

The work carried out shall be evaluated on a continuous basis by the assigned faculty advisor / mentor for 100 marks and panel of examiners appointed shall evaluate the work based on the report for 200 marks.

SAVITRIBAI PHULE PUNE UNIVERSITY		
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)		
SEMESTER IV		
CA 660 MJ: Management Information System		
Teaching Scheme: Theory: 2 Hrs./Week	Credits 02	Examination Scheme: Continuous Evaluation: 15 Marks End-Semester : 35 Marks

Course Objectives

- To learn fundamentals of Information Systems.
- To know methodology and applications of MIS
- To understand how Information System supports in decision making and knowledge management.
- To be familiar with various technologies of MIS

Course Outcomes

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

- Define need, objectives and architecture of MIS and its role in business planning
- Enlist activities for development of MIS
- Demonstrate understanding of DSS and Knowledge Management
- Describe applications and various technologies of MIS

Course Contents		
Unit I	**Introduction to Information Systems**	**06 Hrs**
	Need and objectives of Information systems. Components and resources of information systems, Types of information systems: Operations support systems and Management support systems. Management Information Systems (MIS): Definition, role and impact of MIS, Functions of the managers: planning, organizing, staffing, coordinating and directing, MIS as a support to the management Management of Business: Concept of Corporate Planning, Essentiality of strategic planning, development of business strategies, types of strategies, MIS for strategic Business Planning	
Unit II	**MIS Development and BPR**	**06 Hrs**
	Development of Long range plans of the MIS, Determining Information Requirements, Development and implementation of MIS, Managing Information Quality, MIS – Development process model Business Process Re-engineering (BPR) – Introduction, Business Process, Process and Value Stream model of the organization, MIS and BPR	
Unit III	**Decision Support Systems and Knowledge Management**	**06 Hrs**
	Decision Support Systems (DSS): Concept and philosophy, Characteristics, Components of DSS, tools, Using Decision Support systems: What-if, sensitivity, Goal-seeking analysis and Optimization analysis, GDSS, DSS application in E-enterprise Knowledge Management systems, Knowledge-based expert system, MIS and	

	benefits of DSS	
Unit IV	**Applications of MIS**	**06 Hrs**
	Applications in Manufacturing Sector: HR Management, Marketing Management, Finance Management, Materials Management and Marketing Management Applications in services: Banking, Insurance, Airline, Hotel, Hospital, Education	
Unit V	**Infotech Infrastructure**	**06 Hrs**
	Technology for MIS – Data, Transaction, Application and Information processing. Database and client-server architecture, MIS and RDBMS Data Warehouse (DW) – Data in DW, Architecture and design of DW, Organization, Management implementation of DW, Business Intelligence, DW and MIS E-Business – Introduction, models, security issues, Electronic payment systems, Web enabled Business Management, MIS in Web environment	

Reference Books:

1. Jawadekar W., "Management Information Systems", 6th Edition, Tata McGraw-Hill Publishing
2. KC Laudon, JP Loudon, "MIS Managing digital firm", Person Education
3. O'Brien James , "Management Information Systems" , 7th Edition, Tata McGravv-Hill
4. Arpita Gopal, Chandrani Singh, "E-world Emerging trends in Information Technology", Excel Books

SAVITRIBAI PHULE PUNE UNIVERSITY
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)
SEMESTER IV
CA 661 MJ: Digital Marketing

Teaching Scheme: Theory: 2 Hrs./Week	Credits 02	Examination Scheme: Continuous Evaluation: 15 Marks End-Semester : 35 Marks

Course Objectives

- To study the need of Digital marketing
- To understand the role of Social media in marketing
- To learn SEO and Digital Analytics

Course Outcomes

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

- Define the core concepts of digital marketing
- Describe the process of creating and running digital media based campaigns
- Identify and utilize various tools such as social media, SEO and analytics

Course Contents		
Unit I	**Introduction to Digital Marketing (DM)**	**06 Hrs**
	Introduction, Traditional Vs DM, Internet Users, DM Landscape, DM Strategy, DM Plan, Ethical and Legal framework of DM Display Advertising: Introduction, concept, Digital Metrics, Types of Ads, Display Plan, Targeting in DM , Geographic and Language Targeting, Ad Server, Ad Exchange	
Unit II	**Search Engine Advertising**	**06 Hrs**
	Why pay for Search Advertising?, Ad placement and Ad Ranks, creating campaign, Google Ad account, Enhancing Campaign, Performance reports, E-Commerce Vs Google Ads Introduction to Mobile Marketing – Models, Toolkits and Features	
Unit III	**Social Media Marketing**	**06 Hrs**
	Introduction, Listen, Goal Setting, Strategy, Implementation, Measurement, Improvement, TikTok, Social Entertainment, Gamification Facebook Marketing – Organic and Paid marketing, Insights, Facebook stories, 3D Posts, Managers – Ad, Pixel, pages and Business Linked-in Marketing – Strategy, Sales lead Generation and Analytics Introduction to DM using Twitter, Instagram and Pinterest	
Unit IV	**Search Engine Optimization (SEO)**	**06 Hrs**
	Concept, Phases, Website Audit, Optimization (On and Off page), the Google Search Engine, SEO – UX and UI	
Unit V	**Digital Analytics**	**06 Hrs**
	Data Collection, Key Metrics, Outcome and Experience Analysis, Creating Executive dashboards, Affiliate Marketing, Introduction attribution models	

| | Video Marketing (VM) – VM Using Youtube and Twitter, Types of VM, Video Analytics | |

Reference Books:
1. Digital Marketing, Seema Gupta, 2nd Edition, Mc-GrawHill
2. Digital Marketing, Vanadana Ahuja, 2nd Edition, Oxford University Press
3. Digital Marketing for Dummies, Ryan Deiss, Russ Henneberry, Dummies
4. Traffic Secrets, Russell Brunson, Google Books

SAVITRIBAI PHULE PUNE UNIVERSITY
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)
SEMESTER IV
CA 662 MJ: ERP

Teaching Scheme: Theory: 2 Hrs./Week	Credits 02	Examination Scheme: Continuous Evaluation: 15 Marks End-Semester : 35 Marks

Course Objectives

- To learn Basics of ERP, CRM and SCM
- To study ERP Selection process
- To understand various aspects of ERP Project Management

Course Outcomes

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

- Enumerate architecture, components and various modules of ERP
- Apply ERP vendor selection process
- Describe ERP Project management

Course Contents		
Unit I	**Introduction**	**06 Hrs**
	Defining ERP, Functional Modules, Common Myths, Evolution of ERP, characteristics of ERP, Process Integration with ERP, Benefits of ERP, Technology behind ERP, Implementation costs, Justifying Investments ERP Market and Vendors, SaaS, IaaS, PaaS, Cloud ERP Extended ERP services – SCM, CRM, PLM, GIS Related Technologies – Data Warehousing, Mining, OLAP, Business Intelligence (BI), Business Analytics (BA)	
Unit II	**ERP Planning**	**06 Hrs**
	Planning for ERP – Understanding organizational requirements, Project scope and broad implementation approach, determining resources, top management and organizational commitment, matching business processes with ERP, ERP Package evaluation and selection, creating Budget, ERP deployment models, preparing organization for implementation	
Unit III	**ERP Implementation**	**06 Hrs**
	Designs of ERP systems, Implementation approaches, Risks/failure factors, Mitigating Implementation risks – Critical success factors, ERP implementation life cycle, Data migration, organization of ERP Implementation team, performance measurement, Management and complexity of Large-scale ERP Projects, User Training, Evaluating ERP projects, Case study of ERP implementation	
Unit IV	**ERP: Going Live and Post Management**	**06 Hrs**
	Preparing to Go Live, strategies for migration to new ERP systems, performance measurement surprises, Managing ERP after Go Live, Maintenance of ERP system	

Unit V		06 Hrs
	ERP and E-business – E-business supply chain integration, ERP/E-business integration, Bringing ERP to the entire enterprise, Service-Oriented Architecture, Enterprise Application Integration (EAI), Application Service Provider model for ERP Implementation	

Reference Books:

1. Enterprise Resource Planning, Ashim Raj Singla, Cengage Learning publishers
2. Enterprise Resource Planning, Alexis Leon, 3rd Ed, McGraw Hill education
3. ERP In Practice (ERP strategies for steering organizational competence and competitive advantage), Jagan Nathan Vaman, McGraw Hill
4. ERP Systems for Manufacturing Supply Chains: Applications, Configuration, and Performance, Odd Jøran Sagegg, Erlend Alfnes, CRC Press

SAVITRIBAI PHULE PUNE UNIVERSITY SECOND YEAR M. Sc. (COMPUTER APPLICATIONS) SEMESTER IV CA 663 MJ: Information Security		
Teaching Scheme: Theory: 2 Hrs./Week	Credits 02	Examination Scheme: Continuous Evaluation: 15 Marks End-Semester : 35 Marks

Course Objectives

- To understand the fundamental principles and concepts in Information Security
- To acquire the knowledge of cryptography
- To learn standard algorithms and protocols employed to provide confidentiality, integrity and authenticity
- To acquire the knowledge of security protocol deployed in web security
- To study Information Security tools

Course Outcomes

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

- Identify cyber security threats and apply formal procedures to defend the attacks
- Apply appropriate cryptographic techniques
- Analyze web security solutions
- Identify and Evaluate Information Security threats and vulnerabilities in Information systems
- Demonstrate the use of standards and cyber laws to enhance Information Security

	Course Contents	
Unit I	**Introduction to Information Security**	**06 Hrs**
	Foundations of Security, Computer Security Concepts, The OSI Security Architecture, Security attacks, Security services, Security mechanism, A Model for Network Security Introduction to Tools: Clam AV antivirus engine, Anti Phishing, Anti Spyware	
Unit II	**Cryptography**	**06 Hrs**
	Number theory: Prime number, Fermat and Euler theorems , Testing for primality, Chinese reminder theorem, discrete logarithm, Public Key Cryptography and RSA, Key Management, Diffie- Hellman key exchange, El Gamal algorithm, Elliptic Curve Cryptography, introduction to crypt tool	
Unit III	**Data Integrity Algorithms And Web Security**	**06 Hrs**
	Cryptographic Hash Functions: Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Requirements and Security, Hash Functions Based on Cipher Block Chaining, Secure Hash Algorithm (SHA), SHA-3, MD4, MD5. **Message Authentication Codes**: Message Authentication Requirements, Message Authentication Functions, Requirements for Message Authentication Codes, Security of MACs. **Digital Signatures**: Digital Signatures, Schemes, Digital Signature	

	standard, PKI X.509 Certificate. Web Security issues, HTTPS, SSH, Email security: PGP, S/MIME, IP Security : IPSec, Introduction to Tools: Open SSL, Hash Calculator Tool : MD5, SHA1, SHA256, SHA 512	
Unit IV	**Network and System Security**	**06 Hrs**
	The OSI Security architecture, Access Control, Flooding attacks, DOS, Distributed DOS attacks Intrusion detection, Host based and network based Honeypot, Firewall and Intrusion prevention system, Need of firewall, Firewall characteristics and access policy, Types of Firewall, DMZ networks, **Intrusion prevention system:** Host based, Network based, Hybrid. Virtual Private Network (VPN) Operating system Security, Application Security, Security maintenance, Multilevel Security, Multilevel Security for role based access control, Concepts of trusted system, Trusted computing. Introduction to Tools: Wireshark, Windows Firewall, Snort, Linux iptables, Linux SELinux	
Unit V	**Cyber Security and Tools**	**06 Hrs**
	Introduction, Cybercrime and Information Security, Classification of Cybercrimes, The legal perspectives-Indian perspective, Global perspective, Categories of Cybercrime, Social Engineering, Cyber stalking, Proxy servers and Anonymizers, Phishing, Password Cracking, Key-loggers and Spywares, The Indian IT Act-Challenges, Amendments, Challenges to Indian Law and Cybercrime Scenario in India, Indian IT Act. Introduction to network security scanners: Nmap, Metasploit	

Reference Books:

1. William Stallings, "Cryptography and Network Security Principals and Practice", Seventh edition, Pearson
2. William Stallings, Lawrie Brown, "Computer Security Principles and Practice", 3rd_Edition, Pearson
3. Nina Godbole, Sumit Belapure, "Cyber Security", Wiley
4. Atul Kahate, "Cryptography and Network Security", 3e, McGraw Hill Education

SAVITRIBAI PHULE PUNE UNIVERSITY		
SECOND YEAR M. Sc. (COMPUTER APPLICATIONS)		
SEMESTER IV		
CA 681 RP: Research Work - II		
Teaching Scheme: **Laboratory: 12 Hrs./Week**	**Credits** **06**	**Examination Scheme:** **Continuous Evaluation: 50 Marks** **End-Semester : 100 Marks**

Course Objectives

- To get first-hand experience to apply research methodology

Course Outcomes

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

- Apply research methodology to carry out research in a chosen problem domain
- Design and develop a novel methodology / framework etc
- Conduct experiments and analyze results

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Guidelines for carry out Research Work

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Each student shall carry out the research work during semester IV in an online/offline manner while working on "CA 651 MJP - Industrial Training" in industry/organization/institute under the guidance of the appointed faculty Advisor/Mentor by the respective Institute. Preferably this work may be an extension of research work carried out by a student as a part of Research Work – I in Semester III. Students shall work on a research problem and publish a paper / file a copyright / patent based on the work carried out. The student shall prepare and submit a report based on the work carried out consisting of – Face Page, certificate, Acknowledgement, Abstract, Table of Contents, List of Tables, List of Figures, Abbreviations, and separate Chapters dealing with Introduction, Literature Review, Design details of Proposed System, Experimental Results and analysis, and a chapter providing Conclusions and future scope. List of Publications, Copyright/patent, references and appendix shall also be included in the report.

<div align="center">

Guidelines for Assessment

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The work carried out shall be evaluated on a continuous basis by the assigned faculty advisor / mentor for 50 marks and panel of examiners appointed shall evaluate the work based on the report for 100 marks.