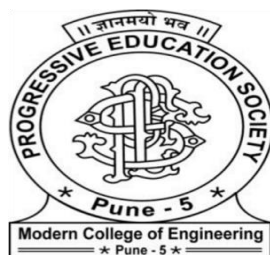


Modern College of Engineering, Pune-5

MCA Department



**Progressive Education Society's
Modern College of Engineering,
Shivajinagar,
Pune-05**

MCA DEPARTMENT

**E-CURRICULUM
BOOKLET
(2020Pattern)**

**SY – MCA (UNDER ENGINEERING)
SEMESTER III**



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Quality Policy of the Institute

We, PES Modern College of Engineering are committed to develop and foster cultured and promising professionals by imparting quality education in the field of Engineering and Management.





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Department Vision

“To develop Competent Technocrats in the field of Computer applications imbued with human values”

Departmental Mission

- To impart knowledge in the field of Computer applications with a focus on developing the required competencies.
- To improve technical skill of the students through practical and hands-on experience.
- To enhance the quality of the students by collaboration with Alumni and Industry.
- To make students socially responsible citizens.

Mission of the Institution

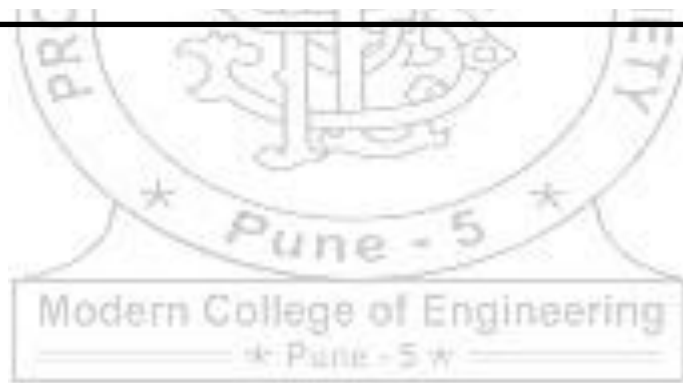
- To develop outstanding professionals with high ethical standards capable of creating and managing global enterprises
- To foster innovation and research by providing a stimulating learning environment
- To ensure equitable development of students of all ability levels and backgrounds
- To be responsive to changes in technology, socio-economic and environmental conditions
- To foster and maintain mutually beneficial partnerships with alumni and industry



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Program Educational Objectives

- PEO 1: The broad knowledge of computer applications for successful careers in industry.
- PEO 2: The habit of lifelong learning for career development in this dynamic and rapidly changing field.
- PEO 3: The ability to inculcate effective communication in the team through demonstration of good analytical, design, development and implementation skills.



program Outcomes :

After completing MCA degree student will be able to:

- PO1. Apply knowledge of mathematics, computer science appropriate for real world applications.
- PO2. Identify, formulate, analyze and solve complex computing problems using relevant domain disciplines.
- PO3. Design and evaluate solutions for complex computing problems that meet specified needs for real world applications.



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- PO4. Apply programming logic including design of algorithm, programs, analysis and interpretation of data to provide valid solutions
- PO5. Apply appropriate techniques and modern computing tools for development of real world applications.
- PO6. Understand and commit to professional ethics and cyber regulations, responsibilities, and norms of professional computing practices.
- PO7. Understand the need and develop the capacity to persistent learning for continual development as a computer professional.
- PO8. Participate as a member and leader in a team and stand out in multidisciplinary environments to demonstrate computing and management skills.
- PO9. Communicate effectively to comprehend and present effective technical Documentation.
- PO10. Apply the computing knowledge efficiently & effectively with concern for societal, environmental, and cultural aspects relevant to professional computing practices.
- PO11. To contribute effectively as an individual and as a member or leader in diverse teams and in multidisciplinary environments.
- PO12. To identify a timely opportunity and innovation with entire effort to function as an successful entrepreneur.



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3.	Web Technology	
4.	Cloud Computing	
5.	Elective II	
6.	Software Testing And Quality Assurance	
7.	Web Technology Laboratory	



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8.	Computer Laboratory	
9.	Data Science Laboratory	
10.	Project Based Learning II(Mini Project II)	
11.	Audit Course-3	
12.	Non Credit Cour-3 MOOOC-Course III Swayam/Spoken Tutorial /NPTEL	



Course Structure SY MCA SEM III



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Subject Code	Teaching Subject	Scheme Hrs/Week	Examination Scheme								Th	Pr
			Lect	Pract	Paper		Tw	Or	Pr	Marks		
					Int	Ex	Int	Ext	Ext			
410901	Data Science	3	-	30	70	-	-	-	100	3		
410902	Web Technologies	3	-	30	70	-	-	-	100	3		
410903	Cloud Computing	3	-	30	70	-	-	-	100	3		
410904	# Elective-II	3	-	30	70	-	-	-	100	3		
410905	Software Testing And Quality Assurance	3	-	30	70	-	-	-	100	3		
410906	Web Technologies Lab	-	2	-	-	50	-	-	50		02	
410907	## Computer Laboratory	-	4	-	-	25	-	50	75		02	



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410908	Data Science Laboratory	-	4	-	-	25		50	75		01
410909	Project Based Learning II(Mini Project II)	-	2	-	-	50		-	50		01
	Total	15	12	150	350	150	-	100	750		21
410910	* Audit Course-3										Grade
410911	** Non Credit Course 3:MOOC Course-III-Swayam/Spoken Tutorial/NPTEL Course										Grade

##**Computer Laboratory is software Testing Laboratory+ Elective II Laboratory**

***410910-Audit Course 3(AC3) Options:**

[410910A-AC3-I Foreign Language](#)

[410910B-AC3-II Professional Ethics and Etiquettes](#)

[410910C-AC3-III Mobile App Development](#)

Structure for Second Year MCA (Semester IV)

Course Code	Course	Teaching Scheme Hours/Week		Examination Scheme						Credit
		TH	PR	Int	Ext	T W	OR	PR	Total Marks	
410912	* Major Project	-	15	100	200	-	-	-	300	15
410913	Seminar on Major Project	-	2	50	-	-	-	-	50	1
	Total	-	17	150	200	-	-	-	350	16



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410914	** Audit Course-4									Grade
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***Major Project with Industrial Internship**

****410914-Audit Course 4(AC4) Options:**

[410914A -AC4-I:Entrepreneurship Development](#)

[410914B -AC4-II: Digital and Social Media Marketing](#)

#Elective II (410904) Course options

Course Code	Elective- II
410904 A	Big Data Analytics (Elective II)
410904 B	Machine Learning (Elective II)
410904 C	Object Oriented Analysis and Design (Elective II)
410904 D	Internet of Things (Elective II)
410904 E	Open Elective (Elective II)

****Non Credit MOOC Courses:** Non Credit course is compulsory. No grade points are associated with non-credit courses and are not accounted in the calculation of the performance indices SGPA & CGPA. Result of assessment will be PP or NP. Set of non-credit courses offered is provided. **Conduction and assessment of performance in said course is to be done at institute level.** The selection of 3 distinct non-credit MOOC courses, one per semester (Sem I, II & III) should be decided by respective institute. The list of non credit MOOC courses suggested is given below

Suggested MOOC Courses- Swayam /Spoken Tutorial/NPTEL

Sr. No.	Non Credit Course -1	Non Credit Course -2
1	C programming -8 weeks	Introduction To Soft Computing-8 weeks



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2	Enhancing soft skill and personality – 8 wks	RDBMS Postgres SQL -6 Weeks
3	Design and analysis of algorithms -8 weeks	Privacy and Security in Online Social Media -8 weeks
4	Linux (Spoken tutorial)	Employment Communication A Lab based course – 8 weeks
5	Soft Skill Development-8 weeks	PHP and MySQL (Spoken tutorial)
6	Speaking Effectively -8 weeks	Scilab (Spoken tutorial)

**** Institute may choose any one of suggested MOOC Course or decide any other MOOC course at Institute level.**

410901

Data Science



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Teaching Scheme, Credit, Examination Scheme

Teaching Scheme	Credit	Examination Scheme
TH: 03 Hours/Week	03	Internal: 30 Marks External : 70 Marks

- Prerequisite courses, if any: **Data Structures And Algorithms (310902)**
- Companion Course, if Any: **Data Science 410908**

Course Objectives:

- : To understand the need of Data Science and Big Data
- ❖ To learn about the Data Evolution and understanding the data.
- ❖ To learn Data Preprocessing Techniques and machine learning algorithms required for Data Science.
- ❖ To visualize data and use for communicating stories from data.
- ❖ To visualize data and use for communicating stories from data.

Upon completion of the subject, students will be able to:

Course Outcomes:



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On completion of the course, learner will be able to

CO1: Explain flow process for data science problems.

CO2: Elaborate data preprocessing and warehouse.

CO3: Utilize various classification techniques for commercially available datasets.

CO4: Implement association rule mining for commercially available datasets.

CO5: Apply standard clustering methods for commercially available datasets.

CO6: Compare appropriate data visualization method for effective visualization of

Course Contents

Unit I: Introduction to Data Science.

What is Data Science, Need of Data Science, Big data and Data Science, The current Scenario, Industry Perspective Types of Data: Structured vs. Unstructured Data, Quantitative vs. Categorical Data, Big Data vs. Little Data, Data science process, Role Data Scientist.

Unit II: Data Processing And Warehouse

What is Data Preprocessing, Need of Data Preprocessing, Data Preprocessing Techniques and Importance of Data Preprocessing.

What is Data Warehouse, Need of Data Warehouse, Components and Types of Data Warehouse, Data Warehouse Tools, Advantages and Disadvantages of Data Warehouse, Applications of Data warehouse

Unit III: Classification

Introduction, Classification requirements, Nearest Neighbor classifier, Naïve Bayes classifier, Decision tree, Forecasting Numeric data- Regression methods, Neural networks classifiers. Evaluating Model performance: Measuring performance for classification, Estimating future performance.

Unit IV: Association Rule



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Introduction to frequent pattern mining, Understanding association rules, Association properties, Apriori, FP-Growth, Eclat algorithm, performance evaluation of association rule mining.

Unit V: Clustering

Introduction to clustering, Types of Clustering: partitional, hierarchical, and density-based clustering Applications of clustering, clustering performance evaluation.

Unit VI: Data Visualization

Data visualisation: Introduction, Types of data visualisation, Benefits of Data Visualisation Data visualization Techniques, Types of Graphs: Bar Graph, Stacked Bar Chart, Pie Chart, Doughnut Chart, Line Chart, Area Chart, Treemap chart, Heatmap, Waterfall Chart, Scatter Plot, Histogram, Box plot.

References

Reference Books:

1. Bharti Motwani, “Data Analytics with R”, Wiley 2019.
2. Hadley Wickham, “R for Data Science: Import, Tidy, Transform, Visualize, and ModelData”, — First Edition, O'Reilly Media Publisher, ISBN: 9781491910399, 2017.
3. T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Springer, 2013.
4. Tom Mitchell, Machine Learning. McGraw-Hill, 1997.
5. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data. Cambridge University Press, 2012.
6. Carl Edward Rasmussen and Christopher K. I. Williams, Gaussian Processes for Machine Learning. MIT Press, 2005.
7. Daphne Koller and N. Friedman, Probabilistic Graphical Models: Principles and Techniques. MIT Press, 2009.
8. Christopher Bishop, Pattern Recognition and Machine Learning. Springer, 2007.
9. Laura Igual and Santi Segui, Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications, Springer; 1st ed. 2017 edition



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MOOC Courses: <web links>

1. <https://nptel.ac.in/courses/106/106/106106179/>

Text Books:

1. Jeffrey S.Saltz,Jeffre M. Stanton, “An Introduction to Data Science”, Sage Publications,2018
2. Seema Acharya ,”Data Analytics using R “ , Mc Graw Hill, 2018
3. Cathy O’Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O’Reilly.
4. Jiawei Han, Micheline Kamber, “Data mining: concepts and techniques”, Morgan Kaufmann Publisher, second edition.
5. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets.

Continuous Assessment details (Internal Evaluation Scheme)

Scheme	Open Book Test	MCQ Test	End Term Test
Marks	10	10	10
Unit*	I-II	III-IV	V-VI

[Note: - * indicates unit number may vary]



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Unit wise Question Bank

Unit I : Introduction to Data Science

1. What is Data Science? ...
2. Differentiate between Data Analytics and Data Science. ...
3. What do you understand about linear regression? ...
4. What do you understand by logistic regression? ...
5. What is a confusion matrix? ...
6. What do you understand about the true-positive rate and false-positive rate?

Unit II: Data Processing and warehouse

1. What are the 5 components of data warehouse?
2. What is data warehousing answer?
3. What are the 3 characteristics of data warehouse?
4. What is OLAP and OLTP?
5. What are the types of data warehouse?
6. Explain confidence intervals in detail.

Unit III: Classification

1. Describe the role of correctness in machine learning.
2. Illustrate the curse of dimensionality in detail.
3. Explain the goodness of fitting in multiple regression model.
4. Describe regularization in detail.
5. Explain the simple linear regression model in detail.
6. What is classification used for in data science?
7. What are the questions on data science?
8. What are the methods of classification?
9. What are classification techniques?
10. What is difference between classification and regression?

Unit IV_: Association Rule

1. What is association rule in machine learning?



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2. What is meant by association in data mining
3. What is association rule with example?
4. Why is the association rule especially important in big data analysis?
5. What is Association in machine learning with example?
6. Is Association supervised or unsupervised?
7. What is the application of association rule?
8. What is association analysis?
9. What is strong association rule?
10. Is Netflix recommendation supervised or unsupervised?
11. Is associative learning unsupervised learning?
12. What is Step 5 in machine learning?

Unit V_: Clustering

1. What is clustering and its types?
2. What is the purpose of data clustering?
3. What is clustering and its example?
4. What are the 3 types of cluster?
5. What is benefits of clustering data?
6. What are major clustering methods?
7. What are the few methods of clustering?
8. What is a real life example of clustering?

Unit VI_:Data Visualization

1. What are the different types of data visualization in data science?
2. What is data visualization and examples?
3. What are data Visualisation techniques?
4. What are the benefits of data visualization?
5. Which is the best visualization tool?
6. hat are two uses of data visualization?

MOOC Courses: <web links>

1. <https://nptel.ac.in/courses/106/106/106106179/>

Continuous Assessment details (Internal Evaluation Scheme)



Progressive Education Society's
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MCA Department

Scheme	Open Book Test	Mid Term Exam	MCQ Test
Marks	10	10	10
Unit*	I - II	III-IV	V - VI



Teaching Scheme, Credit, Examination Scheme

Teaching Scheme	Credit	Examination Scheme
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TH : 03 Hours / Week	03	In_Sem: 30 Marks End_Sem : 70 Marks
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Prerequisites (Conceptual knowledge to understand the course contents)

- ❖ NIL



Course Objectives

Course Objectives:

- ❖ To learn the fundamentals of web essentials and markup languages
- ❖ To use the Client side technologies in web development
- ❖ To use the Server side technologies in web development
- ❖ To understand the web services and frameworks

Course Outcome

Upon completion of the subject, students will be able to:

Course Outcomes:

On completion of the course, learner will be able to

- CO1:** Design web-based application using client-side Technology.
- CO2:** Develop the structure of web sites using XML components.



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CO3: Analyze current client-side web technologies: JavaScript in detail.

CO4: Apply recent client-side web technologies: Angular JS in detail.

CO5: Apply the server side technologies for web development

CO6: Create the effective web applications for business functionalities using ASP.NET

Course Contents

Unit I: Introduction to Scripting Language

Introduction to Web Technology, internet and www, Web Servers, Website planning and design issues, HTML: structure of html document, HTML elements: headings, paragraphs, line break, colors & fonts, links, frames, lists, tables, images and forms, Difference between HTML and HTML5. CSS:

Introduction to Style Sheet, Inserting CSS in an HTML page, CSS selectors. **Algorithms:** Problem Solving, Introduction to Algorithms, Characteristics of algorithms, Algorithm design tools: Pseudo code and flowchart, Analysis of Algorithms, Complexity of algorithms- Space complexity, Time complexity, Asymptotic notation- Big-O, Theta and Omega, standard measures of efficiency. Algorithmic Strategies- Introduction to algorithm design strategies- Divide and Conquer, and Greedy strategy.

Unit II: Scripting Language II

XML: Introduction to XML, Features and applications of XML, XML key component, XML DTD, XML Schema, elements, attributes, XML Namespaces, Transforming XML into XSLT. Concept of linked organization, singly linked list, doubly linked list, circular linked list and operations on above data structure. Application of linked list for Representation and manipulations of polynomials

Unit III : Client –Side Technology-I JavaScript

JavaScript: Overview of JavaScript (need/why JavaScript, applications, advantages, limitations), using JS in an HTML (Embedded, External), variables/ Data types, Control Structures: if..else, switch case, Loop Controls: for, while, for..in ,Functions and Dialog Boxes, page redirect, cookies, events .



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JS objects: JavaScript-Object Properties, Methods, JavaScript-Number Properties, Methods, JavaScriptString Properties, Methods, JavaScript-Array Properties, Methods, JavaScript-Math Properties, Methods, JavaScript-Date Properties, and Methods.

Unit IV: Client-Side Technology II

AngularJS: Overview (what? why? Applications? advantages? limitations?), General Features, Core Features, parts of AngularJS, AngularJS environment setup, MVC architecture, simple application execution in AngularJS, How AngularJS Integrates with HTML: AngularJS directives, AngularJS:

Unit V: Server-Side Technology-I PHP

PHP variables and operators, taking an user inputs and generating outputs, Formatting String, library function for string manipulation. A rray fundamentals, Single-Dimensional Arrays, Multidi mensional Arrays, Associative arrays, library functions for array manipulation, Dates and Times funct ion, Userdefined functions, Object oriented programming using PHP, File Handing in PHP, cookie and session.

Unit VI : Server-Side Technology-II ASP.NET

Introduction to ASP.NET: (what? why? Applications? advantages? limitations?), Components of ASP.NET, ASP.NET life cycle, ASP.NET page creation, Event Handling, ASP.NET: Server side objects and control, ASP.NET with Databases, ASP.NET : creating a web services.

References

Reference Books :

1. CSS - Definitive Guide. By Eric Meyer, Oreilly Publication
2. 2 .Robin Nixon, "Learning PHP, Mysql and Javascript with JQuery,CSS&HTML5", O'REILLY, ISBN: 13:978-93-5213-015-3
3. Sandeep Panda, "Angular JS: Novice To Ninja", SPD, First Edition 2014, ISBN-13: 978- 0992279455

Text Books:



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1. Complete reference HTML, TMH, 4th Ed.
2. Web Technologies - 2nd Edition, Tata McHill by Achut Godbole
3. HTML, DHTML, JavaScript, Perl & CGI Ivan Bayross, BPB Pub, 3rd Ed.
4. “Angular: Up and Running”, by Shyam Seshadri, O’REILLY Publication, SBN101491999837 Edition: 1st
5. Ralph Moseley & M. T. Savaliya, “Developing Web Applications”, Wileypublications, ISBN 13 : 9788126538676
6. ASP.NET Core 5 And Angular Fourth Edition”, Author: Valerio De Sanctis, Published on 29Jan-2021, ISBN : 9781800562219, Publisher : Packt Publishing

e-Books/online tutorials:

1. www.w3schools.com
2. <https://www.tutorialspoint.com/angularjs/index.htm>
<https://www.tutorialspoint.com/javascript/index.htm>

Continuous Assessment details (Internal Evaluation Scheme)

Scheme	Open Book Test	Mid Term Exam	MCQ Test
Marks	10	10	10



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Unit*	I - II	III-IV	V - VI
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[Note: - * indicates unit number may vary]

Unit wise Question Bank

UNIT I – Scripting Language-I

1. What is the difference between the JavaScript and Java?
2. Mention the benefits of using JavaScript code in HTML Document?
3. What is the need for client side scripting?
4. Justify- “JavaScript is an event-driven scripting language”
13. What are the advantages and disadvantages of indirectly embedding the JavaScript?
14. Mention the Primitive data types used in JavaScript.
15. Comment on the statement. “Each object of a class has its own instance of static member variable.”
17. What is the use of typeof operator in JavaScript? Give Example.
18. What do you mean by implicit type conversion? Give example.
19. Develop a JavaScript page to demonstrate an If condition by which the time on your browser is less than 10; you will get a “good Morning” greeting.

UNIT II – Scripting Language -II

1. What is a markup language? ...
2. What is XML? ...
3. What are the features of XML? ...
4. What are the differences between HTML and XML? ...
5. Which tag is used to find the version of XML and the syntax? ...
6. What is XML DOM Document? ...
7. What is XPath? ...
8. What is an attribute?



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UNIT III Client-side Technology

1. Which technology is related to the client-side working?
2. What are the different client-side technologies?
3. What technology language is used in client-side and server-side?
4. In which software is used for client-side scripting?
5. What feature enables Spa feature in AngularJS?
6. What does the \$dirty flag indicates in Angular *?
7. How many rootScope can AngularJS application have?
8. What is the difference between \$scope and \$rootScope?

UNIT IV Client –side Technology-II

1. What are examples of client-side technologies?
2. What technology language is used in client-side and server-side?
3. Which language is mainly used for client-side?
4. What benefits does a client-side program bring?
5. What benefits does a client-side program bring?
6. What is difference between client-side and server-side?
7. What is difference between client-side and server-side validation?

UNIT V Server-side Technology

- 1) What is PHP? ...
- 2) What is PEAR in PHP? ...
- 3) Who is known as the father of PHP? ...
- 4) What was the old name of PHP? ...
- 5) Explain the difference b/w static and dynamic websites? ...
- 6) What is the name of scripting engine in PHP? ...
- 7) Explain the difference between PHP4 and PHP5.

UNIT VI –Server-side Technology ASP



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1. What is ASP.NET?
2. What is ASP.NET?
3. What is the difference between the ASP and ASP.NET?
4. What is IIS?
5. What is the usage of IIS?
6. What is a multilingual website?

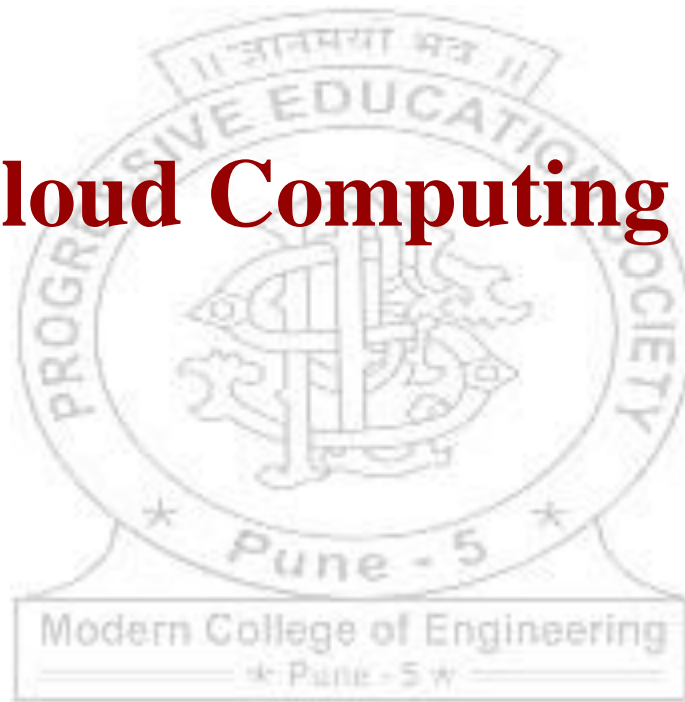




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410903

Cloud Computing



Teaching Scheme, Credit, Examination Scheme

Teaching Scheme	Credit	Examination Scheme
TH: 03 Hours/Week	03	In_Sem: 30 Marks End_Sem : 70 Marks

Prerequisites (Conceptual knowledge to understand the course contents)

- ❖ Prerequisite courses, if any: Computer Network (301913)



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Course Objectives

Course Objectives:

- ❖ To study fundamental concepts of cloud computing
- ❖ To learn various data storage methods on cloud
- ❖ To understand the implementation of Virtualization in Cloud Computing
- ❖ To learn the application and security on cloud computing
- ❖ To understand the advanced technologies in cloud computing

Course Outcome:

On completion of the course, learner will be able to

CO1: Understand the different Cloud Computing environment

CO2: Use appropriate data storage technique on Cloud

CO3: Analyze virtualization technology

CO4: Develop and deploy applications on Cloud

CO5: Apply security in cloud applications

CO6: Use advance techniques in Cloud Computing

Course Contents

Unit I: Basics of Cloud Computing

Introduction, Cloud Characteristics, Cloud computing architecture, Advantages and Disadvantages of Cloud Computing. Grids, Utility Computing, client-server model, P-



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to-P Computing, Cloud computing Service delivery model, Cloud Types – Private, Public and Hybrid, Cloud API.

Unit II: Cloud Computing Services

Layers in cloud architecture, Software as a Service (SaaS), features of SaaS and benefits, Platform as a Service (PaaS), features of PaaS and benefits, Infrastructure as a Service (IaaS), features of IaaS and benefits, DBaaS (Database as a service), Comparison of various cloud computing providers/Softwares

Unit III: Virtualization

Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Types of Hypervisors, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data-Center Automation. Common Standards: The Open Cloud

Consortium, Open Virtualization Format, Standards for Application Developers: Browsers (Ajax), Data (XML, JSON), Solution Stacks (LAMP and LAPP), Syndication (Atom, Atom Publishing Protocol, and RSS), Standards for Security.

Unit IV: Resource Management And Applications of Cloud

Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources. Applications: Moving application to cloud, Microsoft Cloud Services, Google Cloud Applications, and Amazon Cloud Services, Cloud Applications (Social Networking, E-mail, Office Services and Google Apps.

Unit V: Cloud Security

Cloud Security Mechanisms: Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single Sign-On (SSO), Hardened Virtual Server Images.

Cloud Issues: Stability, Partner Quality, Longevity, Business Continuity, Service-Level Agreements, Agreeing on the Service of Clouds, Solving Problems, Quality of Service, Regulatory Issues and Accountability.

Unit VI: Future Of Cloud Computing

How the Cloud Will Change Operating Systems, Location-Aware Applications, Intelligent Fabrics, Paints, and More, The Future of Cloud TV, Future of Cloud-Based



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Smart Devices, Faster Time to Market for Software Applications, Home-Based Cloud Computing, Mobile Cloud, Autonomic Cloud

Engine, Multimedia Cloud, Energy Aware Cloud Computing, Jungle Computing. Docker at a Glance: Process Simplification, Broad Support and Adoption, Architecture, Getting the Most from Docker, The Docker Workflow.

References

Reference Books:

1. Dr. Kumar Saurabh, "Cloud Computing", Wiley Publication, ISBN10: 8126536039
2. Buyya, "Mastering Cloud Computing", Tata McGraw Hill, ISBN-13: 978-1-25-902995-0,
3. Barrie Sosinsky, "Cloud Computing", Wiley India, ISBN: 978-0-470-90356-8
4. Kailash Jayaswal, "Cloud computing", Black Book, Dreamtech Press
5. Thomas Erl, Zaigham Mahmood and Ricardo Puttini, "Cloud Computing: Concepts, Technology and Architecture", Pearson, 1st Edition, ISBN :978 9332535923, 9332535922 6. Tim Mather, Subra K, Shahid L., Cloud Security and Privacy, O'Reilly, ISBN-13 978-81-8404-
▪ 815-5.

Text Books:

1. Jack J. Dongarra, Kai Hwang, Geoffrey C. Fox, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Elsevier, ISBN :9789381269237, 9381269238, 1st Edition.
2. Thomas Erl, Zaigham Mahmood and Ricardo Puttini, Cloud Computing: Concepts, Technology & Architecture, Pearson, ISBN :978 9332535923, 9332535922.
3. Gautam Shrof, "ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications Cambridge University Press ISBN: 978051177847

Web Links

1. <http://www.fo.com/web>

2. https://in.top10quest.com/web/search_now

E books links

1. <https://www.javatpoint.com/cloud-computing-tutorial>

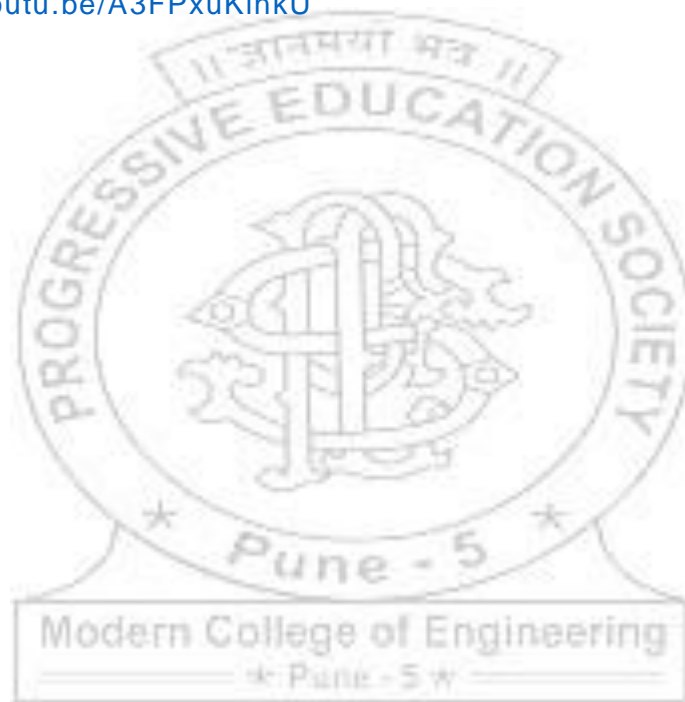


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2. <https://study.com/academy/lesson/what-is-cloud-computing-definition-advantages...>
[What is Cloud Computing? - Definition, Advantages ... - Study.com](#)
3. <https://www.researchgate.net/publication/324587212>

Video Lectures (IIT/ NPTEL/ any other) Links

1. <https://youtu.be/NzZXz3fJf6o>
2. <https://youtu.be/A3FPxuKlnkU>

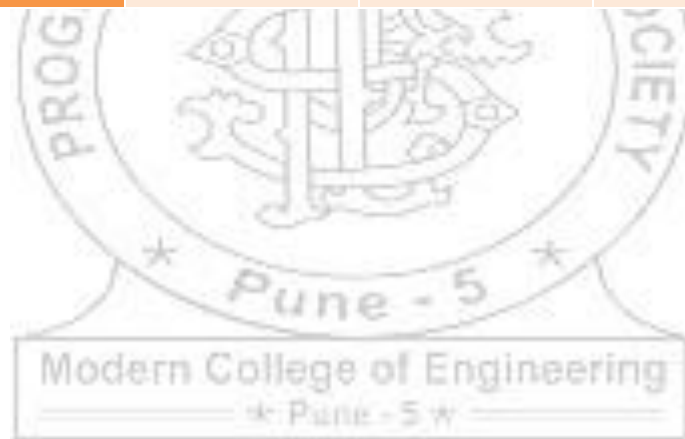


continuous Assessment details (Internal Evaluation Scheme)



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Scheme	Open Book	MCQ Test-I	MCQ Test-II
	Test		
Marks	10	10	10
Unit*	I & II	III	IV



Unit wise Question Bank

Unit I Basics of Cloud Computing

1. What are the innovative characteristics of cloud computing?
2. Which are the technologies on which cloud computing relies?
3. Define cloud computing and identify its core features?



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4. What are the major advantages of cloud computing?
5. Describe the vision introduced by cloud computing?

Unit II Services of cloud Computing

1. Explain the cloud ecosystem.
2. What are the disadvantages of virtualization?
3. What does infrastructure-as-a-service refer to?
4. Give the names of some popular software-as-a-service solutions?
5. 10. Give some examples of public cloud?
6. 11. What is Google App Engine?
7. 12. Which is the most common scenario for a private cloud.
8. 13. What are the types of applications that can benefit from cloud computing?
9. 14. What are the most important advantages of cloud technologies for social

Unit III Virtualization

1. What is Windows Azure?
2. 16. Describe Amazon EC2 and its basic features?
3. 17. Discuss the use of hypervisor in cloud computing.
4. 18. Discuss the objective of cloud information security.
5. 19. Describe cloud computing services.
6. 20. Distinguish between authentication and authorization.
7. 21. What are the fundamental principles of cloud security design?
8. 22. Discuss the security challenges in cloud computing.

Unit IV Resource Management And Applications of Cloud

1. Give overview of applications of cloud computing?
2. 11. What fundamental advantages does cloud computing technology bring to scientific applications?
3. 12. Describe how cloud computing technologies can be applied to support remote ECG monitoring?
4. 13. Describe some examples of CRM and ERP implementation based on cloud computing technologies.
5. 14. Describe the major features of the Aneka Application Model.
6. 15. What is AWS? What types of services does it provide?
7. 16. Describe the architecture of Windows Azure.
8. 17. What are basic requirements of a secure cloud software?

Unit V Cloud Security

1. 18. What are the different approaches to cloud software requirement engineering?



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2. 19.Explain the cloud security policy implementation.
3. 20.Explain Virtual LAN (VLAN) and Virtual SAN. Give their benefits.
4. 21.Explain the concept of Map reduce.
5. 22.Discuss the cloud federation stack.

Unit VI Future of Cloud Computing


1. What are the future trends of cloud computing?
2. How cloud computing will affect the future of computing?
3. Why is the future of computing in the cloud?
4. What is cloud computing replacing?

410904 A

Elective II-Big Data Analysis



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Savitribai Phule Pune University, Pune		
		 Home
Teaching Scheme: TH: 03 Hours/Week	410904A: Elective: II- Big Data Analytics	Second year of MCA (2020 Course)
Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: Internal: 30 Marks External : 70 Marks

Prerequisites (Database Management System (310912))

Companion Course, if any: Data Science(410901),Computer Lab (410907)

Course Objectives:

- ❖ To provide an overview of current industry of big data analytics.
- ❖ To gain knowledge of different the tools required to analyse big data like Hadoop, NoSql MapReduce.
- ❖ To study the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
- ❖ To acquire skills to solve complex real world problems related to decision support.

Course Outcome

Course Outcome:



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On completion of the course, learner will be able to

CO1: Understand big data analytics concepts

CO2: Solve big data problems using Hadoop

CO3: Apply different Supervised learning and Unsupervised Learning algorithms

CO4: Understand different data visualization techniques.

CO5: Understand Hadoop Architecture

CO6: Solve Complex real world problems in various applications like recommender systems, social media applications, etc..

Course Contents

Unit I : Introduction to Big Data

Big Data: Definition of Big Data, Characteristics of Data and Big Data, Evolution of Big Data, Challenges with Big Data.

Big Data Analytics: Introduction to big data analytics, Classification of Analytics, Big Data Technologies.

Data Analytics Life Cycle: Need of Data analytic lifecycle, Data analytic lifecycle: Discovery, Data Preparation, Model Planning, Model Building, various phases of Communicating Results, Operationalization

Unit II : Supervised and Unsupervised Learning

Supervised Learning: Structure of Regression Model, Linear Regression, Logistics Regression, Time series analysis, Support Vector Machine.

Association Rule: Structure of Association Rule, Apriori Algorithm, evaluation of candidate rules **Clustering:** Clustering Methods, Partition Methods, Hierarchical Methods.

Unit III : Recommendations and Mining Social Network Graphs

A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.

Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities.



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Unit IV: Big Data Visualization

Introduction to Data visualization, Challenges to Big data visualization, Conventional datavisualization tools, Techniques for visual data representations, Types of data visualization, Visualizing Big Data, Tools used in data visualization, Analytical techniques used in Big data Visualization.

Unit V: Introduction to Hadoop

Big Data – Apache Hadoop & Hadoop Eco System – Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization.

Management: The SCM repository, SCM process, Version Control and Change Control, SCM tools- GitHub or others, Configuration management for Web Apps. Maintenance & Reengineering: Software Maintenance, Reengineering, Business Process Reengineering

Unit VI: Hadoop Architecture

Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands , Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration – HDFS Administering – Monitoring & Maintenance.

References

Reference Books

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packet Publishing 2013.
2. Tom Plunkett, Brian Macdonald et al, “Oracle Big Data Handbook”, Oracle Press, 2014.
3. Jy Liebowitz, “Big Data and Business analytics”, CRC press, 2013.
4. Business Intelligence – Data Mining and Optimization for Decision Making – Carlo Vercellis – Wiley Publications.
5. Big Data & Analytics – Seema Acharya & Subhashini Chellappan – Wiley Publications
1. Big Data (Black Book) – DT Editorial Services – Dreamtech Press.
2. Data Mining: Concepts and Techniques Second Edition – Jiawei Han and Micheline Kamber – Morgan Kaufman Publisher
3. Alex Holmes “Hadoop in Practice”, Manning Press, Dreamtech Press
4. Ashutosh Nandeshwar , “Tableau Data Visualization Codebook”, Packt Publishing, ISBN 9781-84968-978-6



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Text Books:

1. David Dietrich, Barry Hiller, “Data Science & Big Data Analytics”, EMC education services, Wiley publications, 2012.
2. Chris Eaton, Dirk deeroos et al., “Understanding Big data ”, McGraw Hill, 2012.
Anand Rajaraman and Jeff Ullman “Mining of Massive Datasets”, Cambridge University Press 4. Tom White, “HADOOP: The definitive Guide” , O Reilly 2012

MOOC Courses: <web links>

1. <https://nptel.ac.in/courses/106/107/106107220/>
<https://nptel.ac.in/courses/106/104/106104189/>

E books links

1. <http://www.bigdatauniversity.com/>
2. <http://index-of.co.uk/Big-Data-Technologies/Hadoop%20in%20Practice%202nd%20Edition%20%7BPRG%7D.pdf>
<http://myweb.sabanciuniv.edu/rdehkharghani/files/2016/02/The-Morgan-Kaufmann-Series-inData-Management-Systems-Jiawei-Han-Micheline-Kamber-Jian-Pei-Data-Mining.-Conceptsand-Techniques-3rd-Edition-Morgan-Kaufmann-2011.pdf>

Video Lectures (IIT/ NPTEL/ any other) Links

1. MOOC Courses: <web links>
2. 1. <https://www.classcentral.com/course/swayam-software-engineering-14293>
3. NPTEL Courses: <web links>
4. 1. <https://www.nptelvideos.in/2012/11/software-engineering.html>

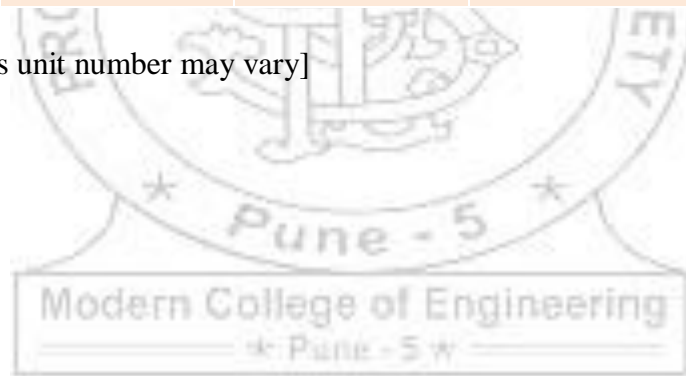
Continuous Assessment details (Internal Evaluation Scheme)



Progressive Education Society's
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MCA Department

Scheme	Open Book Test	MCQ-1	MCQ -2	Final Total
Marks	10	10	10	30
Unit*	I-II	III-IV	V-VI	

[Note: - * indicates unit number may vary]



Unit wise Question Bank

UNIT I - Introduction to Big Data Analytics: Question bank

1. What is Big Data ? Explain Characteristics of Big Data.?
2. Draw HDFS Architecture. Explain any two commands of HDFS from the following commands with syntax at least one example of each. Copy From Local, setrep, checksum?
3. What is big data analytics? Explain four 'V's of Big data.?



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4. 4. Briefly discuss applications of bigdata.
5. What is Map Reduce? Explain working of various phases of Map Reduce with appropriate example and diagrams Big Data in Healthcare, Transportation & Medicine.

UNIT II – Supervised and Unsupervised Learning: Question bank

1. What are the advantages of Hadoop?
2. Explain Hadoop Architecture and its Components with proper diagram
3. What is Hadoop Ecosystem? Discuss various components of Hadoop Ecosystem.
4. Explain core architecture of Hadoop with suitable block diagram. Discuss role of each component in detail.
5. What is data serialization? With proper examples discuss and differentiate structured, unstructured and semi-structured data.
6. Make a note on how type of data affects data serialization.
7. List various configuration files used in Hadoop Installation. What is use of mapred-site.xml?
8. What is Name node & Data node in Hadoop Architecture.
9. What is supervised and Unsupervised Learning?
10. What is Clustering? Explain Clustering Methods, Partitioned Methods?
11. What is Association Rule? Explain Apriori and Candidate rule ?
12. Explain types of Regressions?

UNIT III – Hadoop

1. Discuss role of Data node and Name node in HDFS
2. Difference between HDFS and Hbase
3. Compare Row oriented and Column Oriented database structure
4. Explain the concept of Blocks and Heartbeat Message in HDFS Architecture. What are the benefits of block transfer?
5. Explain what is MapReduce in Hadoop?
6. Explain XML Files used in Hadoop?
7. Draw the HDFS Architecture? Give Advantages of file distribution System

UNIT IV – Big Data Visualization: Question Bank

1. What do you mean by big data visualization, give example?
2. Explain the types of visualization? Explain the challenges of visualization?
3. Describe the techniques and types of the visualization of big data?
4. Explain the tools and analytics used in visualizing the big data?
5. Write a case study on wordcount program of Hadoop?



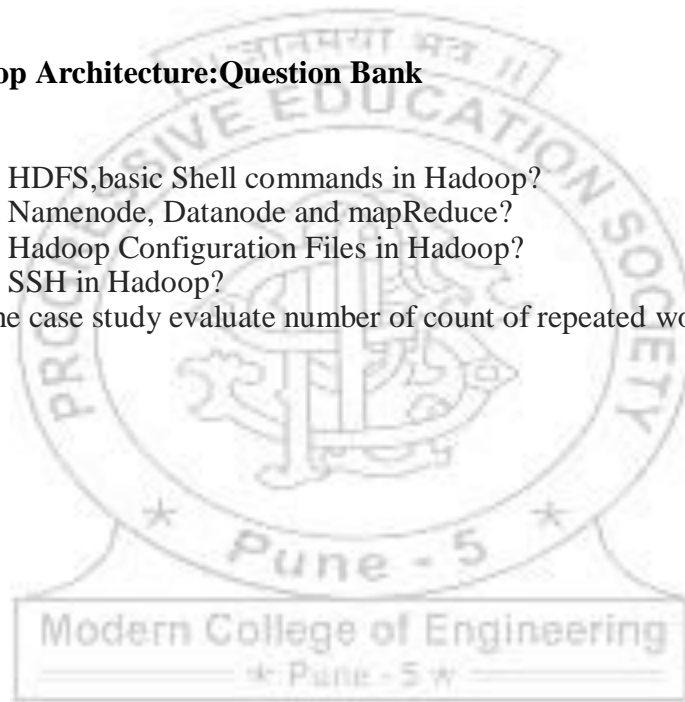
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UNIT V – Introduction to Hadoop:Question Bank

1. Draw the architecture of Hadoop,also explain its advantages?
2. Explain Input and Output in Hadoop?
3. What is mapReduce explain with Example?
4. Explain data visualization techniques?
5. What is data serialization explain with example?

UNIT VI – Hadoop Architecture:Question Bank

1. Explain HDFS,basic Shell commands in Hadoop?
2. Explain Namenode, Datanode and mapReduce?
3. Explain Hadoop Configuration Files in Hadoop?
4. Explain SSH in Hadoop?
5. Write the case study evaluate number of count of repeated words in file?




410904 B



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Elective II-Machine Learning



	Savitribai Phule Pune University, Pune	 Home
Teaching Scheme: TH: 03 Hours/Week	41090B: Elective: II- Machine Learning	Second year of MCA (2020 Course)



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MCA Department

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: Internal: 30 Marks External : 70 Marks
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Prerequisite courses, if any: Discrete Mathematics and Statistics (310901)

Companion Course, if any : Data Science (410901)

Course Objectives:

- ❖ To study fundamentals of machine learning
- ❖ To acquaint with various machine learning algorithms
- ❖ To become aware of various logic based and algebraic models in machine learning
- ❖ To study trends in machine learning

Course Outcomes:

On completion of the course, learner will be able to

CO1: Understand basic concepts of Machine Learning.

CO2: Understand classification concepts.

CO3: Apply different regression and generalization techniques.

CO4: Apply various logic Based and algebraic algorithms for real world applications.

CO5: Use probabilistic models for machine learning

CO6: Understand trends In Machine Learning

Unit I: Introduction To Machine Learning

Introduction: What is Machine Learning, Examples of Machine Learning applications, Training versus Testing, Positive and Negative Class, Cross-validation. Types of Learning: Supervised, Unsupervised and Semi-Supervised Learning. Dimensionality Reduction: Introduction to Dimensionality Reduction, Subset Selection, Introduction to Principal Component Analysis.

Unit II: Classification

Binary and Multiclass Classification: Assessing Classification Performance, Handling more than two classes, Multiclass Classification-One vs One, One vs Rest Linear Models: Perceptron, Support Vector Machines (SVM), Soft Margin SVM, Kernel methods for non-linearity



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Unit III: Regression And Generalization

Regression: Assessing performance of Regression – Error measures, Overfitting and Underfitting,
Catalysts for Overfitting, VC Dimensions Linear Models: Least Square method, Univariate Regression,
Multivariate Linear Regression, Regularized Regression - Ridge Regression and Lasso
Theory of
Generalization: Bias and Variance Dilemma, Training and Testing Curves Case Study of Polynomial Curve Fitting.

Unit IV: Logic Based And Algebraic Models

Distance Based Models: Neighbors and Examples, Nearest Neighbor Classification,
Distance based clustering algorithms - K-means and K-medoids, Hierarchical clustering.
Rule Based Models: Rule learning for subgroup discovery , Association rules mining –
Apriori Algorithm, Confidence and Support parameters. Tree Based Models: Decision
Trees, Minority Class, Impurity Measures – Gini Index and Entropy, Best Split

Unit V: Probabilistic Models

Conditional Probability, Joint Probability, Probability Density Function, Normal Distribution and its
Geometric Interpretation, Naïve Bayes Classifier, Discriminative Learning with Maximum Likelihood.
Probabilistic Models with Hidden variables: Expectation-Maximization methods, Gaussian Mixtures

Unit VI: Trends In Machine Learning

Ensemble Learning: Combining Multiple Models, Bagging, Randomization, Boosting,
Stacking Reinforcement Learning: Exploration, Exploitation, Rewards, Penalties Deep
Learning: The Neuron,



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Expressing Linear Perceptron as Neurons, Feed Forward Neural Networks, Linear Neurons and their Limitations, Sigmoid, Tanh and ReLU Neurons

Learning Resource

Text Books:

1. Ethem Alpaydin: Introduction to Machine Learning, PHI 2nd Edition-2013.
2. Peter Flach: Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press, Edition 2012.

Reference Books:

1. C. M. Bishop: Pattern Recognition and Machine Learning, Springer 1st Edition-2013.
2. Ian H Witten, Eibe Frank, Mark A Hall: Data Mining, Practical Machine Learning Tools and Techniques, Elsevier, 3rd Edition.
3. Parag Kulkarni: Reinforcement Learning and Systemic Machine Learning for Decision Making, IEEE Press, Reprint 2015.
4. Nikhil Buduma: Fundamentals of Deep Learning, O'Reilly Media, June 2017.
5. Hastie, Tibshirani, Friedman: Introduction to Statistical Machine Learning with Applications in R, Springer, 2nd Edition 2012.
6. Kevin P Murphy: Machine Learning – A Probabilistic Perspective, MIT Press, August 2012.

MOOC Courses: <web links>

1. <https://www.coursera.org/learn/machine-learning>

Unit 1: Introduction to machine Learning: Question Bank

1. Define machine learning and explain the natural language processing.
2. What do you mean by supervised and unsupervised machine learning algorithms?
3. Explain how machine learning works for the following unsupervised machine learning applications: a. Item Categorization b. Customer Segmentation c. Automatic labeling d. Similarity detection
4. Explain the concept of adaptive learning?
5. Explain data formats for supervised learning problem with example?
6. What is Principal Component Analysis (PCA)? When it is used?

Unit II: Classification

1. What do you mean by linear regression? Which applications are best modeled by linear regression?



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2. Write short note on 1. ROC Curve 2. Bernoulli Naïve Bayes 3. Kernel PCA.
3. Explain Higher dimensional linear regression with suitable example?
4. Elaborate Naïve Bayes Classifier working with example?
5. Explain the nonlinear SVM with example.
6. Explain Kernel based Classification in detail.
7. Explain in detail the Ridge regression and the Lasso regression.
8. What do you mean by linearly separable data and non-linearly separable data?
9. Discuss in brief the dictionary learning.
10. Explain isotonic regression and write the applications in brief.

Unit III: Regression And Generalization

1. How do you know if a regression is overfitting or underfitting?
2. Is overfitting or underfitting acceptable which is better to be accepted in developing a model?
3. What is underfitting and overfitting what are their effects on the performance of a machine learning model suggest some ways to address overfitting?
4. What are the conditions for overfitting and underfitting?
5. What is ridge regression and lasso regression?
6. Is ridge regression and lasso regression linear regression?
7. What type of regression is lasso?
8. What is lasso regression used for?

Unit IV: Logic Based And Algebraic Models

1. What is K-means algorithm with example?
2. What does K in K nearest neighbors classification mean?
3. What is the difference between K-means clustering algorithm and the K nearest neighbors KNN classification?
4. Which distance algorithm is used in K-means clustering?
5. What are the types of hierarchical clustering methods?
6. What are the two techniques for hierarchical clustering?
7. What is the difference between PCA and hierarchical clustering?



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Unit V: Probabilistic Models

1. What is joint and conditional probability with example?
2. How do you calculate joint probability from conditional?
3. What is the difference between joint probability and conditional probability?
4. What is normal distribution and its geometric interpretation?
5. What is the probability density function of a normal distribution?
6. What are the 4 characteristics of a normal distribution?
How do you interpret probability density function?

Unit VI: **Trends In Machine Learning**


1. What is ensemble learning technique?
2. What is ensemble learning give an example?
3. Which are the three types of ensemble learning?
4. How is stacking different from bagging and boosting?
5. What are bagging and boosting?
6. What is bagging and boosting in random forest?
7. When to use boosting vs bagging?

410904 C

Elective II-Internet of Things



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MCA Department

Savitribai Phule Pune University, Pune		
Teaching Scheme: TH: 03 Hours/Week	410904C: Elective: II- Internet of Things	 Home
Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: Internal: 30 Marks External : 70 Marks

Prerequisite courses, if any: Computer Network (310913)

Course Objectives:

- ❖ To understand fundamentals of IoT system including essence, basic design strategy and process modelling.
- ❖ To apply the concept of Internet of Things in the real-world scenario.
- ❖ To understand fundamentals of privacy and its breach in IoT.
- ❖ To develop comprehensive approach towards building small low cost IoT system.

Course Outcomes:

On completion of the course, learner will be able to

CO1: Understand general concepts of Internet of Things (IoT)

CO2: Analyze various M2M and IoT architectures

CO3: Implement an architectural design for IoT for specified requirement



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CO4: Analyze applications of IoT in real time scenario

CO5: Analyze the challenges of IoT architectures.

CO6: Recognize various devices, sensors and applications

Unit I: Introduction to Embedded System and Internet of Things

Embedded Systems: Application Domain and Characteristic of Embedded System, Real time systems and Real time scheduling, IoT Definition, Characteristics. IoT Functional Blocks, Physical design of IoT, Logical design of IoT, Communication models & APIs Introduction to IoT: Sensing, Actuation, Networking basics, Communication Protocols, Sensor Networks.

Unit II:IoT & M2M

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Unit III:IoT Architectures

IoT Architecture -State of the Art – Introduction, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Unit IV: IoT Protocols

Protocol Standardization for IoT, Efforts, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards, Protocols – IEEE 802.15.4, BACNet Protocol, Modbus, KNX, Zigbee Architecture, Network layer, APS layer.

Unit V: IoT Privacy, Security and Governance

Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-DataPlatforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities.



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Unit VI: Applications of IoT & Case Studies

Home automation, Industry applications, Surveillance applications, IoT applications for industry: Future Factory Concepts, Other IoT application (Adhar Card, Health Services, Smart Parking Systems, Smart City)

Text Books:

1. Arshdeep Bahga, Vijay Madiseti, "Internet of Things – A hands-on approach", Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515
2. Michael Miller "The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World", 1st Edition, Pearson Publication 2015
3. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012. ISBN : 9781439892992

Reference Books:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012, ISBN:978-1-119-99435-0
3. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", Wiley, 2014, ISBN: 978-1-118-43063-7

e-Books: <web links>

1. <https://www.leverage.com/iot-ebook/introduction>

MOOC Courses: <web links>

1. <https://nptel.ac.in/courses/106/105/106105166/>
2. <https://www.coursera.org/specializations/uiuc-iot>

Question Bank

Unit I: Introduction to Embedded System and Internet of Things



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1. What is an embedded system? What are the components of embedded system?
2. What are the applications of an embedded system?
3. What are the main components of an embedded system?
4. Define embedded microcontroller.
5. What are the various classifications of embedded systems?
6. What are the two essential units of a processor on an embedded system?
7. Classify the processors in embedded system?

Unit II:IoT & M2M

1. How is M2M related to IoT?
2. What is IoT and M2M explain with example?
3. What is M2M and difference between M2M and IoT?
4. What is M2M how it is different from IoT?

What is IoT explain its architecture in detail with diagram?

5. What are the three architectural domain functionalities in M2M architecture?
6. What are the 4 stages of IoT architecture?

Unit III:IoT Architectures

1. What is an IoT reference model?
2. What are different layers of IoT reference model?
3. What does functional view of IoT reference architecture describe?
4. How many views are there present in IoT reference architecture?
5. What are the FCs in virtual entity FG in the functional view for the IoT reference architecture?
6. What is the functional model of IoT?
7. What is deployment and operational view of reference architecture?
8. What is a deployment architectural view?
9. How many views are there present in IoT reference architecture?



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10. What are the 4 stages of IoT architecture?

Unit IV: IoT Protocols

- 1) What are some protocol standardization efforts taken for IoT?
- 2) What is IoT protocol standardization?
- 3) What is the importance of protocol standardization in IoT?
- 4) What is protocol standardization?
- 5) What is M2M and WSN protocols?
- 6) What are Scada protocols? Which protocol is used in RFID?
- 7) What are the issues related to lack of standardization in IoT?
- 8) What are different efforts that have been taken for IoT protocol standardization?
- 9) What is the necessity for protocol standardization in IoT?
- 10) What are the two types of network access used in IEEE 802.15.4 networks?
- 11) What is IEEE 802.15.4 protocol how it is related to IoT?
- 12) Which layer allows communication between ZigBee and non ZigBee devices?

Unit V: IoT Privacy, Security and Governance

1. What are the various privacy and security issues in IoT?
2. Why privacy and security is important in IoT?
3. What are FP7 projects?
4. What is the 7th Framework Programme? What does FP7 stand for?
5. What is H2020 project?
6. What is data aggregation for IoT in smart cities?
7. What is smartie approach in IoT?
8. How IoT is used in smart city?
9. Which communication technologies and standards for IoT is used in smart city development?


Unit VI: Applications of IoT & Case Studies

- 1) What is IoT applications in real life?
- 2) What are surveillance applications in IoT?
- 3) What is future factory concept in IoT?
- 4) What is the application of IoT in manufacturing industries?



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- 5) What are key IoT applications in the industry?
- 6) How IoT helps in future industry development?
- 7) How does smart parking system work?
- 8) How do you build Smart parking?



410904E
Elective: II- OPEN
ELCTIVE

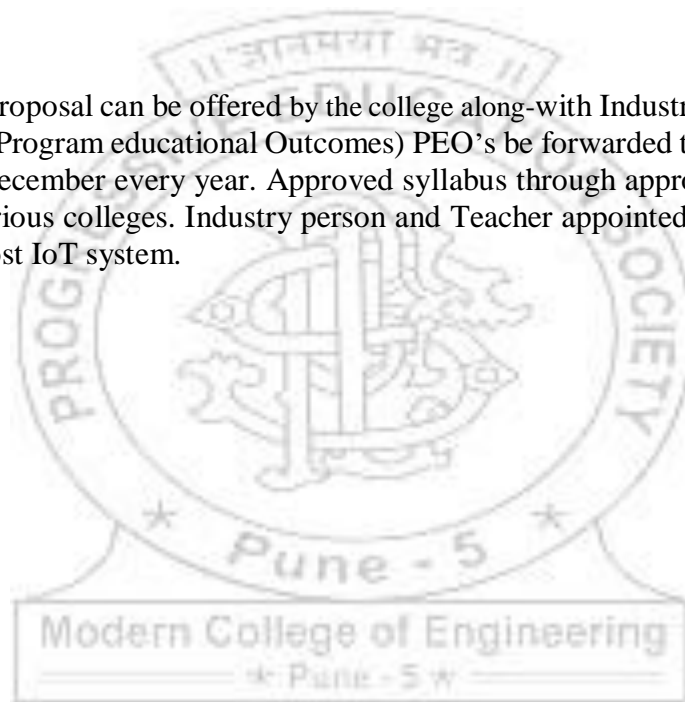
	Savitribai Phule Pune University, Pune	 Home
Teaching Scheme: TH: 03 Hours/Week	410904C: Elective: II- Open Elective	Second year of MCA (2020 Course)




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MCA Department

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: Internal: 30 Marks External : 70 Marks
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Open elective proposal can be offered by the college along-with Industry partner. A proposal with syllabus, (Program educational Outcomes) PEO's be forwarded to the Chairman BOS, before June / December every year. Approved syllabus through appropriate procedure can be taught in various colleges. Industry person and Teacher appointed together conduct the course. ll low cost IoT system.



	Savitribai Phule Pune University, Pune	 Home
Teaching Scheme: TH: 03 Hours/Week	410904C: Elective: II- Elective: II- Object Oriented Analysis	Second year of MCA (2020 Course)



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	and Design Open Elective	
Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: Internal: 30 Marks External : 70 Marks

Prerequisite courses, if any: Software Engineering & Project Management (310904)
Companion Course, if any: Computer Lab (410907)

Course Objectives:

- To transform requirement document to appropriate design. □
 - To study static and dynamic modelling
 - To understand Object Oriented Analysis and Design Concepts.
 - To acquaint with different software architectures.
- To understand use of design pattern in the applications

Course Outcomes:

On completion of the course, learner will be able to

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

CO2: Apply static modeling design to applications.

CO3: Understand application of UML in different systems

CO4: Apply dynamic modeling design to applications.

CO5: Evaluate software architectures

CO6: Understand various software design patterns



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Unit I :Introduction

Introduction to software design, design methods-procedural / structural and object oriented , Requirement Vs Analysis Vs. Architecture Vs. Design Vs. Development 4+1 Architecture, case study of transferring requirement to design, Unified Process, COMET use case based software life cycle, Introduction to UML -Basic building blocks, Reusability, Use case modelling, Use case template Case study – Transferring requirements into design using advanced tool.

Unit II :Static Modelling

Analysis Vs. Design, Class diagram- Analysis - Object & classes finding analysis & Design- design classes, refining analysis relationships, Relationship among classes: Associations, Dependencies, Generalizations, Aggregation. Adornments on Association: association names, association classes , qualified association, n-ary associations, ternary and reflexive association. Dependency relationship among classes, notations. Object diagram.

Unit III:Component, Deployment and Package

Component diagram- Interfaces & components, deployment diagram, Package diagram, Applications of UML in embedded systems, web applications, commercial applications.

Unit IV:Dynamic Modeling

Interaction & Interaction overview diagram, sequence diagram, Timing diagram, Communication diagram, Advanced state machine diagram, Activity diagram.

Unit V :Architecture Design

Introduction to Architectural design, overview of software architecture, Object oriented software architecture, Client server Architecture, Service oriented Architecture, and Component based Architecture, Real time software Architecture.

Unit VI:Design Patterns

Introduction to Creational design pattern – singleton, Factory, Structural design pattern- Proxy design pattern, Adapter design pattern, Behavioral – Iterator design pattern, Observer design pattern.



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Learning Resources:

Text Books:

1. Jim Arlow, Ilan Neustadt, —UML 2 and the unified process –practical object-oriented analysis and design|| Addison Wesley, Second edition, ISBN978-0201770605
2. Hassan Gomaa, —Software Modeling and Design- UML, Use cases, Patterns and Software Architectures|| Cambridge University Press, 2011, ISBN978-0-521-76414-8

Reference Books:

3. Eric J. Braude, —Software Design: from Programming to Architecture|| J. Wiley, 2004, ISBN 978-0- 471-20459-6
4. Garby Booch, James Rumbaugh, Ivar Jacobson, —The unified modeling language user guide ,Pearson Education, Second edition, 2008, ISBN0-321-24562-8

e-Books: <web links>

1. <http://bedford-computing.co.uk/learning/wp-content/uploads/2015/10/UML-Distrilled-3nd.pdf>
2. <https://edutechlearners.com/download/books/OOSE/OOAD.pdf>

MOOC Courses: <web links>

1. Object Oriented analysis and Design by By Prof. Partha Pratim Das, Prof. Ansuman Banerjee, Prof. Kausik Datta | IIT Kharagpur

410905



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Software Testing and Quality Assurance



Teaching Scheme, Credit, Examination Scheme

Teaching Scheme

Credit

Examination Scheme



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TH: 03 Hours/Week	03	In_Sem: 30 Marks End_Sem : 70 Marks
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Prerequisites

Software Engineering & Project Management (310904) Not Applicable

- **Companion Course**

Not Applicable

Course Objectives:

- ❖ To know the importance of software testing and quality assurance
- ❖ To study white box and black box testing techniques
- ❖ To get acquainted with various testing types
- ❖ To study tools used for automation testing

Course Outcomes:

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

- CO1:** Illustrate different approaches of quality management, assurance, and quality standard to software system
- CO2:** Create test plan, test cases and defect repository using case study.
- CO3:** Apply the concept of white box and black box testing techniques □
- CO4:** Analyze various testing types
- CO5:** To analyze recent automation tools for software testing.
- CO6:** Apply software testing automation concepts using Selenium

Course Contents



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Unit 1: Fundamentals of Software Quality Assurance

FUNDAMENTALS OF SOFTWARE QUALITY:

Definition of Quality, QA, QC, SQA, SQA basics, Components of the Software Quality Assurance System, software quality in business context, planning for software quality assurance, product quality and process quality, software process models, 7 QC Tools and Modern Tools.

QUALITY ASSURANCE MODELS:

Models for Quality Assurance, ISO-9000 series, CMM, CMMI, Test Maturity Models, SPICE, Malcolm Baldrige Model- P-CMM

SOFTWARE QUALITY ASSURANCE TRENDS:

Software Process- PSP and TSP, OO Methodology, Clean-room software engineering, Defect Injection and prevention, Internal Auditing and Assessments, Inspections & Walkthroughs, Case Tools and their effect on Software Quality.

TESTING SOFTWARE SYSTEM SECURITY:

Six-Sigma, TQM - Complexity Metrics and Models, Quality Management Metrics, Availability Metrics, Defect Removal Effectiveness, FMEA, Quality Function Deployment, Taguchi Quality Loss

Unit 2: Essentials of Software Testing

SOFTWARE TESTING BASICS:

Definition & Objectives of testing, testing life cycle, Software testing principles, The tester's role in a software development organization

TEST PLAN AND TEST CASES:

Preparation, Management and execution of Test Plan, Definition, Test Case Designing of Test Cases, prepared Test report.

DEFECT MANAGEMENT:

Origins of defects, Defect classes, The defect repository and test design, Defect examples, Developer / Tester support for developing a defect repository.

Unit 3: Software Testing Techniques

WHITE-BOX TESTING METHODOLOGIES:



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Static testing: by humans, using static analysis tools, Structural Testing: unit/code functional testing,

Code coverage Testing, Code Complexity testing, Mutation Testing

BLACK-BOX TESTING METHODOLOGIES:

Requirement based testing, Positive and negative testing, Boundary Value analysis, Equivalence Partitioning, State based or Graph-based Testing, Compatibility Testing, User Documentation Testing,

Domain Testing

Unit 4: Testing Strategies

Integration testing, System and Acceptance testing, Scenario testing, Performance Testing, Regression testing, Ad hoc Testing, Usability and Accessibility Testing, GUI testing, Validation testing, Specification-based testing, Testing Object Oriented Software, Testing Web Based Applications,

Database Testing

Unit 5: Software Test Automation

INTRODUCTION TO AUTOMATION TESTING:

Software Test Automation, Skills needed for Automation, Scope of Automation, Design and Architecture for Automation, Requirements for a Test Tool, Challenges in Automation Tracking the Bug, Debugging, Difference between manual testing and automated testing, **UI**

Automation Tools :

Cypress, Testcafe, Protractor, Case studies of automation testing

Unit 6: Selenium Tool

Introduction of Selenium, Brief History of The Selenium Project, Selenium's Tool Suite, Selenium IDE, Selenium RC, Selenium WebDriver, Selenium Grid, Test Design Considerations

Text Books:

1. Srinivasan Desikan, Gopalswamy Ramesh, Software Testing: Principles and Practices Pearson.
2. Daniel Galin, Software Quality Assurance: From Theory to Implementation, Pearson Addison Wesley.



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3. Tamres L, “Introducing Software Testing”, Pearson Education, 2007. 4. Mathur A.P, “Fundamentals of Software Testing”, Pearson Education, 2008.
4. Software Quality Assurance – From Theory to Implementation, Daniel Galin, Pearson

Reference Books:

1. Software Testing and Quality Assurance – Theory and Practice, Kshirasagar Naik, Priyadashi Tripathy, Wiley India, 2010
2. Rajani & Oak, “Software Testing: Methodology, Tools and Processes” Tata McGraw-Hill, 2007
3. Software Automation Testing Tools for Beginners, Rahul Shende, Shroff Publishers and Distributors, 2012
4. Software Testing Techniques Boris Beizer, dreamTech pub, 2nd Edition

E-Books: <web links>

1. Selenium 1.0 Testing Tool beginners guide by David Burns, ISBN: 1849510261, ISBN 13: 9781849510264
2. Burnstein, “Practical Software Testing”, Springer International Edition, ISBN 81-8128-089-X

MOOC Courses: <web links>

1. <https://www.my-mooc.com/en/mooc/software-testing-fundamentals/>
2. <https://nptel.ac.in/courses/106/105/106105150/>
https://onlinecourses.nptel.ac.in/noc19_cs71/preview

Continuous Assessment details (Internal Evaluation Scheme)

Scheme	Open Book	MCQ-1	MCQ -2	Final Total
	Test			



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Marks	10	10	10	30
Unit*	I-II	III-IV	V-VI	

[Note: - * indicates unit number may vary]

Unit wise Question Bank

Unit 1: Fundamentals of Software Quality Assurance

1. Define software errors.
2. Define software faults
3. Define software failures.
4. List out the various causes of software errors.
5. Define Software Quality.
6. Define software Engineering.
7. Define quality control.
8. Show the relationship between failure, fault and error.
9. Define correctness.
10. Define portability

Unit 2: Essentials of Software Testing

1. What are the three categories belonging to McCall's factor model?
2. Relate Quality assurance with Quality control. Justify your answer that QA is not QC.
3. Define Software Quality Assurance.
4. What are the three categories belonging to Product Transition Software Quality Factors?
5. Outline the different components of SQA Architecture.



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6. Find the two contract review stages.
7. Label all the components in SQA architecture.
8. Show the process of object oriented model in flow chart format.
9. What are the main issues in the project development plan?
10. Extend the objectives of quality factors based on quality category

Unit 3: Software Testing Techniques

- 1) Explain the three categories belonging to McCall's factor model with examples.
- 2) Classify the McCall's factor model and extend its components.
- 3) Classify SQA system components and explain at least two major components in detail.
- 4) Explain in detail about five views of software quality and objectives of SQA.
- 5) Explain in detail about pre project quality components.
- 6) Explain in detail about SQA Architecture.
- 7) Extend the SQA system.
- 8) Outline the major components of SQA and explain in detail.
- 9) Demonstrate SQA activities in software development and software maintenance.
- 10) Illustrate McCall's factor model with an example.

Unit 4: Software Testing Strategies

1. What is the role of a software tester in a software development organization?
2. Differentiate between testing and debugging
3. List the members of the critical groups in a testing process.
4. List out the Software testing axioms.
5. Define the term Testing.

Unit 5: Software Test Automation



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1. What is automation testing?
2. What are the types of automation testing?
3. What's the difference between manual testing and automated testing?
4. When is a good time to automate a test?
5. When will you avoid automated testing?
6. How do you choose a tool/framework for automated testing?
7. What are the different parts of a test automation framework?
8. What is a test environment?

Unit 6: Selenium Tool

1. Why should Selenium be selected as a test tool?
2. What is Selenium? What are the different Selenium components?
3. What are the testing types that can be supported by Selenium?
4. What are the limitations of Selenium?
5. What is the difference between Selenium IDE, Selenium RC, and WebDriver?

Text Books:

5. Srinivasan Desikan, Gopaldaswamy Ramesh, Software Testing: Principles and Practices Pearson.
6. Daniel Galin, Software Quality Assurance: From Theory to Implementation, Pearson Addison Wesley.
7. Tamres L, "Introducing Software Testing", Pearson Education, 2007. 4. Mathur A.P, "Fundamentals of Software Testing", Pearson Education, 2008.
8. Software Quality Assurance – From Theory to Implementation, Daniel Galin, Pearson

Reference Books:

5. Software Testing and Quality Assurance – Theory and Practice, Kshirasagar Naik, Priyadashi Tripathy, Wiley India, 2010
6. Rajani & Oak, "Software Testing: Methodology, Tools and Processes" Tata McGraw-Hill, 2007
7. Software Automation Testing Tools for Beginners, Rahul Shende, Shroff Publishers and Distributors, 2012
8. Software Testing Techniques Boris Beizer, dreamTech pub, 2nd Edition

E-Books: <web links>



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3. 1.Selenium 1.0 Testing Tool beginners guide by David Burns, ISBN: 1849510261, ISBN 13: 9781849510264
4. Burnstein, "Practical Software Testing", Springer International Edition, ISBN 81-8128-089-X

MOOC Courses: <web links>

3. <https://www.my-mooc.com/en/mooc/software-testing-fundamentals/>
4. <https://nptel.ac.in/courses/106/105/106105150/>
https://onlinecourses.nptel.ac.in/noc19_cs71/preview





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**410906
Web Technology
Laboratory**

Teaching Scheme, Credit, Examination Scheme



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Teaching Scheme	Credit	Examination Scheme
PR : 02 Hours / Week	02	TW : 25 Marks PR : 50 Marks

Prerequisites (Conceptual knowledge to understand the course contents)

- ❖ NIL

Course Objectives:

- ❖ To study the representation, implementation of basic data structures
- ❖ To study various linear & non liner data structures
- ❖ To implement applications of Data Structure in solving real life problems To study various searching & sorting algorithms
- ❖ To implement various searching & sorting techniques.

Course Outcomes

Upon completion of the subject, students will be able to:

- ❖ Implement elementary data structures such as Arrays
- ❖ Implement representation & application of Linked List
- ❖ Demonstrate practical knowledge on the applications of stacks, queues
- ❖ Implement nonlinear data structure trees to solve mathematical problems.
- ❖ Implement representations & the applications of graphs.
- ❖ Implement different searching and sorting algorithms.

Suggested List of Laboratory Assignments

Part A: Software Testing and Quality Assurance



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MCA Department

1. Prepare test plan for an identified Mobile Application
2. Design test cases for any E-Commerce website
3. Manual Testing a) Write black box test cases for an application using Test Director tool. b) Perform white box testing – Cyclomatic complexity, data flow testing, control flow testing
4. Automated Testing Perform Black Box testing using automated testing tool on an application. Testing Points to be covered – data driven wizard, parameterization, exception handling
5. Defect Tracking : a. Log the test results in Test Director b. Prepare a Defect Tracking Report / Bug Report using MS-Excel or Defect Tracking Tool like BugZilla

- Part B: Elective- II A. Big Data Analytics
B. Machine Learning
C. Object Oriented Analysis and Design
D. Internet of Things
E. Open Elective

Suggested List for Big Data Analytics(Elective-II:410904 A)

1. To draw and explain Hadoop Architecture and Ecosystem with the help of a case study using WordCount example. To define and install Hadoop.
2. To implement the following file management tasks in Hadoop System (HDFS): Adding files and directories, Retrieving files, Deleting files
3. To run a basic Word Count MapReduce program to understand MapReduce Paradigm: To count words in a given file, To view the output file, and To calculate execution time.
4. To study and implement basic functions and commands in R Programming.
5. To build WordCloud, a text mining method using R for easy to understand and visualization than a table data.

Suggested List for Machine Learning (Elective-II:410904 B)



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1. Generate a proper 2-D data set of N points. Split the data set into Training Data set and Test Data set.
2. Download the open source software like WEKA or R or rJava. Document the distinct features and functionality of the software platform.
3. Implement Naïve Bayes Classifier and K-Nearest Neighbor Classifier on Data set of your choice. Test and Compare for Accuracy and Precision.
4. Implement K-Means Clustering and Hierarchical clustering on the proper data set of your choice. Compare their Convergence
5. Design and implement SVM for classification with the proper data set of your choice. Comment on Design and Implementation for Linearly non separable Dataset.

Suggested List for Object Oriented Analysis and Design(Elective-II:410904 C)

1. Construct UML Class Diagram and Object Diagram for Online Transaction Management System(e-shopping)
2. Design UML Sequence and Activity Diagram using UML FOR Order processing Management System
3. Draw UML Activity and Sequence Diagram for Event Management System (arranging seminar /workshop/conference sports/ cultural / annual social gathering etc)
4. Design UML Use case and Object Diagram for Feedback Management System
5. Construct UML State Machine Diagram for Placement Agency Management System

Suggested List for Internet of Things (Elective-II:410904 D)

1. Study of Raspberry-Pi, Beagle board, Arduino and other micro controller (History & Elevation)
2. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with temperature sensor. Write an application to read the environment temperature. If temperature crosses a threshold value, the application indicated user using LEDSs
3. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with IR sensor. Write an application to detect obstacle and notify user using LEDs.
4. Write an application using Raspberry-Pi /Beagle board to control the operation of stepper motor
5. Write a server application to be deployed on Raspberry-Pi /Beagle board. Write client applications to get services from the server application.

Suggested List for Open Elective (Elective-II:410904 E)

1. Lab Incharge will be set list of assignments based on Open Elective Syllabus



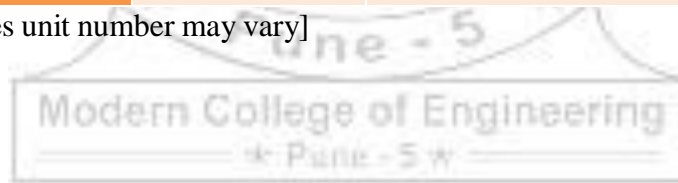
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Unit wise Question Bank (Practical Assignments)

Continuous Assessment details (Internal Evaluation Scheme)

Scheme	Viva - 1	Viva -2	Journal
Marks	10	10	5
Unit*	I – II -III	IV - V - VI	I - VI

[Note: - * indicates unit number may vary]





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410907 Computer Laboratory

(Software Testing Laboratory + Elective II Laboratory)

Learning Scheme	Credit	Examination Scheme
TH: 04 Hours/Week	02	TW : 25 Marks PR : 50 Marks

Prerequisite courses, if any: Software Engineering & Project Management (310904)

Companion Course, if any :

- ❖ Software Testing And Quality Assurance (410905),
- ❖ Big Data Analytics (410904 A),
- ❖ Machine Learning (410904 B),
- ❖ Object Oriented Analysis and Design (410904 C),
- ❖ Internet of Things(410904 D),
- ❖ Open Elective (410904 E).

Course Objectives:

- ❖ Introduce basic concepts of software testing and get aware of white box and block box testing techniques □
- ❖ To learn the importance of software quality and assurance software systems development. □
- ❖ Know in details automation testing and tools used for automation testing. □
- ❖ To acquire skills to solve complex real world problems related to decision support.

Course Outcomes:

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

CO1: Implement white box and block box testing techniques for any software systems



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CO2: Create Test plan and test cases using case studies.

CO3: Apply automation testing using tools

CO4: Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.

CO5: Design and develop machine learning model for a real time applications

CO6: Implement an architectural design for IoT for specified requirement

CO7: Interpret the importance of Computational Intelligence for solving the different problems

Guidelines for instructor's Manual

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

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory-Concept in brief, algorithm, flowchart, test cases, conclusion/analysis. Program codes with sample output of all performed assignments are to be submitted as softcopy. A conscious effort and little contribution towards Green IT and environment awareness, attaching Printed papers as part of write-ups and program listing to journal may be avoided. Use of DVD Containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Assessment

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



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Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of software testing concept and tools, proper indentation and comments. Use of open source software is to be encouraged.

Set of Suggested Assignment List
Part A: Software Testing and Quality Assurance
1. Prepare test plan for an identified Mobile Application
2. Design test cases for any E-Commerce website
3. Manual Testing a) Write black box test cases for an application using Test Director tool. b) Perform white box testing – Cyclomatic complexity, data flow testing, control flow testing
4. Automated Testing Perform Black Box testing using automated testing tool on an application. Testing Points to be covered – data driven wizard, parameterization, exception handling
5. Defect Tracking : a. Log the test results in Test Director b. Prepare a Defect Tracking Report / Bug Report using MS-Excel or Defect Tracking Tool like BugZilla
Part B: Elective- II
A. Big Data Analytics
B. Machine Learning
C. Object Oriented Analysis and Design
D. Internet of Things
E. Open Elective
Suggested List for Big Data Analytics(Elective-II:410904 A)
1. To draw and explain Hadoop Architecture and Ecosystem with the help of a case study using WorkCount example. To define and install Hadoop.
2. To implement the following file management tasks in Hadoop System (HDFS): Adding files and directories, Retrieving files, Deleting files
3. To run a basic Word Count MapReduce program to understand MapReduce Paradigm: To count words in a given file, To view the output file, and To calculate execution time.
4. To study and implement basic functions and commands in R Programming.



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5. To build WordCloud, a text mining method using R for easy to understand and visualization than a table data.

Suggested List for Machine Learning (Elective-II:410904 B)

1. Generate a proper 2-D data set of N points. Split the data set into Training Data set and Test Data set.

2 . Download the open source software like WEKA or R or rJava. Document the distinct features and functionality of the software platform.

3. Implement Naïve Bayes Classifier and K-Nearest Neighbor Classifier on Data set of your choice. Test and Compare for Accuracy and Precision.

5. Implement K-Means Clustering and Hierarchical clustering on the proper data set of your choice. Compare their Convergence

5. Design and implement SVM for classification with the proper data set of your choice. Comment on Design and Implementation for Linearly non separable Dataset.

Suggested List for Object Oriented Analysis and Design(Elective-II:410904 C)

1. Construct UML Class Diagram and Object Diagram for Online Transaction Management System(e-shopping)

2. Design UML Sequence and Activity Diagram using UML FOR Order processing Management System

3. Draw UML Activity and Sequence Diagram for Event Management System (arranging seminar /workshop/conference sports/ cultural / annual social gathering etc)

4. Design UML Use case and Object Diagram for Feedback Management System

5. Construct UML State Machine Diagram for Placement Agency Management System

Suggested List for Internet of Things (Elective-II:410904 D)

1. Study of Raspberry-Pi, Beagle board, Arduino and other micro controller (History & Elevation)

2. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with temperature sensor. Write an application to read the environment temperature. If temperature crosses a threshold value, the application indicated user using LEDSs

3. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with IR sensor. Write an application to detect obstacle and notify user using LEDs.

4. Write an application using Raspberry-Pi /Beagle board to control the operation of stepper motor

5. Write a server application to be deployed on Raspberry-Pi /Beagle board. Write client applications to get services from the server application.

Suggested List for Open Elective (Elective-II:410904 E)

1. Lab Incharge will be set list of assignments based on Open Elective Syllabus



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410908

Data Science Laboratory

Teaching Scheme, Credit, Examination Scheme

Teaching Scheme	Credit	Examination Scheme
TH: 04 Hours/Week	02	TW : 25 Marks PR : 50 Marks

Prerequisites (Conceptual knowledge to understand the course contents)

NULL

Companion Course, if any :Data Science (410901)

Course Objectives: To learn basics about Data Analytics Tool for Data Science

Course Outcome

On the completion of the Course learners will be able to:

CO1: Describe framework of any Data Analytics Tool

CO2: Write basic applications using the fundamentals of any Data Analytics Tool.

CO3: Apply Modeling techniques using any Data Analytics

Tool.

CO4: Implement Mining techniques using any Data Analytics

Tool



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CO5: Employ data analysis using graphs.

CO6: Implement Data Visualization

Suggested list of assignments

1. Installation and study of any one Data Analytics Tool Frame work.
2. Design and develop at least 10 problem statements which demonstrate the use of data structure, functions, Importing / Exporting Data in any data analytics tool.
3. Design and develop at least 5 problem statements which demonstrate the use of Control Structures of any data analytics tool.
4. Implement any 2 Classification techniques using any data analytics tool.
5. Implement any 2 Clustering techniques using any data analytics tool.
6. Implement any 2 Association Rule Mining techniques using any data analytics tool.
7. Visualize all the statistical measures (mean, mode, median, range, inter quartile range, etc.) using Histograms, Boxplots, scatter plots, etc.
8. Design and Develop real-time Data Science Application (e.g. Image Recognition/ Intelligent
9. Assistant/ Recommendation System/ Fake News Detection/ Emotion Recognition/ Chatbot/ Other)





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Continuous Assessment details (Internal Evaluation Scheme)

Scheme	Journal	Viva 1	Viva 2	Total
Marks	05	10	10	25



410909: Project Based Learning –II
(Mini Project- II)



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Teaching Scheme, Credit, Examination Scheme

Teaching Scheme	Credit	Examination Scheme
PR: 02 Hours/Week	01	Term Work: 50 Marks

Prerequisites (Conceptual knowledge to understand the course contents)

- ❖ Data Structures and Algorithms Laboratory (310906),
- ❖ OOP Laboratory (310907),
- ❖ Python Programming Laboratory (310908),
- ❖ Business Communication Lab (310909)

Companion Course, if any

Computer Laboratory (410907), Data Science Laboratory (410908)

Course Objectives:

- ❖ To develop critical thinking and problem solving ability by exploring and proposing solutions to realistic /social Problems.
- ❖ To understand software/system development life cycle
- ❖ To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism
- ❖ To develop an ecosystem that promotes entrepreneurship and research culture among the students

Course Outcome:

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

CO1: Identify the real life problem from societal need point of view



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CO2: Choose and compare alternative approaches to select most feasible one

CO3: Analyze and synthesize the identified problem from technological perspective

CO4: Design the reliable and scalable solution to meet challenges

CO5: Inculcate the habit of lifelong learning.

CO6: Design and develop technical documentation

Course Execution details

Preamble: Projectbased learning is an instructional approach designed to give students the opportunity to develop knowledge and skills through engaging projects set around challenges and problems they may face in the real world. PBL is more than just projects. With PBL students "investigate and respond to an authentic, engaging, and complex problem, or challenge" with deep and sustained attention. PBL is "learning by doing." The truth is, many in education are recognizing we live in a modern world sustained and advanced through the successful completion of projects. In short, If students are prepared for success in life, we need to prepare them for a project-based world. It is a style of active learning and inquirybased learning. (Reference: Wikipedia). Project based learning will also redefine the role of teacher as mentor in learning process. Along with communicating knowledge to students, often in a lecture setting, the teacher will also act as an initiator and facilitator in the collaborative process of knowledge transfer and development. The PBL model focuses the student on a big openended question, challenge, or problem to research and respond to and/or solve. It Brings what students should academically know, understand, and be able to do and requires students to present their problems, research process, methods, and results. Project based learning (PBL) requires regular mentoring by faculty throughout the semester for successful completion of the idea/project tasks selected by the students per batch. For the faculty involved in PBL, teaching workload of 2 Hrs/week/batch needs to be considered. The Batch should be divided into subgroups of 4 to 5 students. Idea implementation /Real life problem/Complex assignments / activities projects. under project based learning is to be carried throughout semester and Credit for PBL has to be awarded on the basis of internal continuous assessment and evaluation at the end of semester

1.Formulation of Team and Topic Finalization: Students should form a group of 3 to 4 members Staff and Students should discuss the relevant problem statement.(Prefer real world



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problems having some social impact and application) Each team should be allocated a guide. Students should submit Synopsis(should contain Flowchart, Usage of the logic, algorithm, functions and suitable data structure for implementing the solution)

2.Development Select any suitable programming platform (Open source, window, web, mobile applications or any other suitable) Prefer open source technologies for development. Students can select any programming language they have learnt or in which they are competent.

3.Design and Documentation SDLC has to be followed for design and development Prepare Analysis Specification Document, Input Specification and Design Specification Documents(use Data Design, DFD, Flowcharts, UML diagrams, Data Dictionary, ER dig etc.) Follow SDD, SRS Provide Test Specifications (test cases, test results, test methodology etc.) Report Generations if needed.

4.Report and Presentation Students should present the working model of the project to the guide and panel of the college. They should prepare a report comprising the above mentioned terminologies. Submit Hard copy/Soft copy of the report which should contain certificate signed by guide , HOD and principal (prefer soft copy)

Selection of Project/Problem:

The problem-based project oriented model for learning is recommended. The model begins with the identifying of a problem, often growing out of a question or “wondering”. This formulated problem then stands as the starting point for learning. Students design and analyze the problem/project within an articulated interdisciplinary or subject frame. A problem can be theoretical, practical, social, technical, symbolic, cultural, and/or scientific and grows out of students’ wondering within different disciplines and professional environments. A chosen problem has to be exemplary. The problem may involve an interdisciplinary approach in both the analysis and solving phases. By exemplarity, a problem needs to refer back to a particular practical, scientific, social and/or technical domain. The problem should stand as one specific example or manifestation of more general learning outcomes related to knowledge and/or modes of inquiry. There are no commonly shared criteria for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content, and structure of the activity.

- A few hands-on activities that may or may not be multidisciplinary.
- Use of technology in meaningful ways to help them investigate, collaborate, analyse, synthesize, and present their learning.
- Activities may include- Solving real life problem, investigation, /study and Writing reports of in depth study, field work



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Assessment: The institution/head/mentor is committed to assessing and evaluating both student performance and program effectiveness. Progress of PBL is monitored regularly on weekly basis. Weekly review of the work is necessary. During process of monitoring and continuous assessment and evaluation of the individual and the team performance is to be measured. PBL is monitored and continuous assessment is done by supervisor /mentor and authorities. Students must maintain an institutional culture of authentic collaboration, self-motivation, peer learning and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and Students must actively participate in assessment and evaluation processes. Group may demonstrate their knowledge and skills by developing a public product and/or report and/or presentation.

1. Individual assessment for each student (Understanding individual capacity, role and involvement in the project)
2. Group assessment (roles defined, distribution of work, intra-team communication and togetherness) . Documentation and presentation Evaluation and Continuous Assessment: It is recommended that all activities should to be recorded regularly, regular assessment of work need to be done and proper documents need to be maintained at college end by both students as well as mentor (PBL work book). Continuous Assessment Sheet (CAS) is to be maintained by all mentors/department and institutes.

Recommended parameters for assessment/evaluation and weightage:

3. Idea Inception and Awareness /Consideration of -Environment/ Social /Ethics/ Safety measures/Legal aspects (10%)
4. Outcomes of PBL/ Problem Solving Skills/ Solution provided/ Final product (Individual assessment and team assessment) (40%)
5. Documentation (Gathering requirements, design and modeling, implementation/execution, use of technology and final report, other documents) (15%)
6. Demonstration (Presentation, User Interface, Usability) (20%)
7. Contest Participation/ publication (15%) PBL workbook will serve the purpose and facilitate the job of students, mentor and project coordinator. It will reflect accountability, punctuality, technical writing ability and work flow of the work undertaken. Note: While planning for the assessment, choose a valid method based on your context. It should be able to understand by both the students as well as the faculty. The student group must follow the principles of Software Engineering (Scoping out the problem, the solution implementation and related documentation). Researching the problem and outlining various approaches is key here and should be emphasized by the tutor and the mentor. Aspects of design thinking (from



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the point of view of the person facing the problem) are very important. Students should not jump into the technology aspects first. The team can follow the principles of Agile Software Development. The weekly meetings could be used as a Scrum meeting. The tutor and mentor should actively help the students to scope the work and the approach. They must validate the technology choices. If the implementation code is well documented, the project can be continued by subsequent batch – which will help solve a bigger problem

Note: While planning for the assessment, choose a valid method based on your context. It should be able to understand by both the students as well as the faculty. The student group must follow the principles of Software Engineering (Scoping out the problem, the solution implementation and related documentation). Researching the problem and outlining various approaches is key here and should be emphasized by the tutor and the mentor. Aspects of design thinking (from the point of view of the person facing the problem) are very important. Students should not jump into the technology aspects first. The team can follow the principles of Agile Software Development. The weekly meetings could be used as a Scrum meeting. The tutor and mentor should actively help the students to scope the work and the approach. They must validate the technology choices. If the implementation code is well documented, the project can be continued by subsequent batch – which will help solve a bigger problem.

Student's Role in PBL

Prepare students for PBL before starting the sessions. Students must have ability to initiate the task/idea .they should not be mere imitators. They must learn to think. Students working in PBL must be responsible for their own learning. Throughout the PBL process, students have to define and analyze the problem, generate learning issues and apply what they have learned to solve the problem and act for them and be free. Students must quickly learn how to manage their own learning, Instead of passively receiving instruction. Students in PBL are actively constructing their knowledge and understanding of the situation in groups. Students in PBL are expected to work in groups. They have to develop interpersonal and group process skills, such as effective listening or coping creatively with conflicts. Inquiry Skills

Students in PBL are expected to develop critical thinking abilities by constantly relating: What they read to do? What they want to do with that information? They need to analyze information presented within the context of finding answers. Modeling is required so that the students can observe and build a conceptual model of the required processes. Formative and summative questions for evaluation: How effective is? How strong is the evidence for? How clear is? What are the justifications for thinking? Why is the method chosen? What is the evidence given to justify the solution? Information Literacy Information literacy is an integral part of self- directed learning Information literacy involves the ability to: Know when there is a need for information Identify the information needed to solve a given problem or issue Be able to locate the needed information Use the information to solve the given problem effectively. Skills required by students in information literacy include:



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How to prepare the search , How to carry out the research, Sorting and assessing of information in general

Collaborative learning It is an educational approach to teaching and learning that involves groups of students working together to solve a problem or complete a project In collaborative learning, learners have the opportunity to talk with peers, exchange diverse beliefs present and defend ideas, as well as questioning other ideas

Interpersonal Skills Interpersonal skills relating to group process are essential for effective problem solving and learning. It is important that students are made aware of these interpersonal skills.

Consensual decision making skills, Dialogue and discussion skills, Team maintenance skills

Conflict management skills and Team leadership skills. Students who have these skills have a better opportunity to learn than students who do not have these skills and **Time Management Resources** Students need to have the ability to evaluate the resources used Students have to evaluate the source of the resources used by asking the following questions: How current is it?, Is there any reason to suspect bias in the source? How credible and accurate is it?

Meta-cognitive Skills Students need to reflect on the processes they are using during the learning process, Compare one strategy with another, and evaluate the effectiveness of the strategy used **Reflection Skills** Reflection helps students refine and strengthen their high-level thinking skills and abilities through self-assessment. Reflection gives students opportunities to think about how they answered a question, made a decision, or solved a problem. What strategies were successful or unsuccessful? , What issues need to be remembered for next time? , What could or should be done differently in the future?

Learning Resources:

Text Books:

- 1.A new model of problem based learning. By Terry Barrett. All Ireland Society for higher education (AISHE). ISBN:978-0-9935254-6-9; 2017
- 2.Problem Based Learning. By Mahnazmoallem, woei hung and Nada Dabbagh, Wiley Publishers. 2019.
- 3.Stem Project based learning and integrated science, Technology, Engineering and mathematics Approach By Robert Capraro, Mary Margaret Capraro



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References

Reference Books:

1. De Graff E, Kolmos A, red: Management of change: Implementation of problem-based and project-based learning in engineering. Rotterdam: Sense Publishers. 2007. 2. Gopalan, "Project management core text book",

2. Indian Edition James Shore and Shane Warden, "The Art of Agile Development"

MOOC Courses: <web links>

1. https://onlinecourses.nptel.ac.in/noc19_mg30/preview

Savitribai Phule Pune University, Pune
Second year of MCA (2020 Course)

**410910A:AC3 – I: Foreign
Language(Japanese Module 3)**

About Course: With changing times, the competitiveness has gotten into the nerves and Being the Best'at all times is only the proof of it. Nonetheless, being the best differs significantly from

Communicating the best. The best can merely be communicated whilst using the best suitable Language! Foreign languages like Japanese is the new trend of 21st century. Not only youngsters but even the professionals seek value in it. It is the engineer's companion in current times with an assertion of a thriving future. Metro cities like Pune has indisputably grown to become a major center of Japanese Education in India while increasing the precedence for



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Japanese connoisseurs. Japanese certainly serves a great platform to unlock a notoriously tough market & find a booming career. While the companies prefer candidates having the knowledge of the language, it can additionally help connect better with the native people thus prospering in their professional journey. Learning Japanese gives an extra edge to the resume since the recruiters consciously make note of the fact it requires real perseverance and self-discipline to tackle one of the most complex languages. It would be easy for all time to quit the impossible; however it takes immense courage to reiterate the desired outcomes, recognize that improvement is an ongoing process and ultimately soldier on it. The need of an hour is to introduce Japanese language with utmost professionalism to create awareness about the bright prospects and to enhance the proficiency and commitment. It will then prove to be the ultimate path to the quest for professional excellence!

Course Objectives:

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

Course Outcomes:

On completion of the course, student will be able to

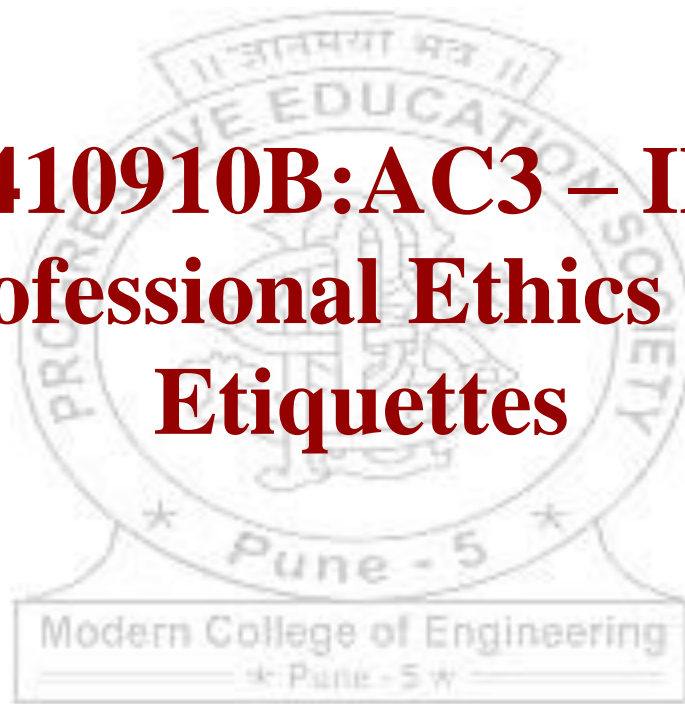
- CO1:** Apply language to communicate confidently and clearly in the Japanese language
- CO2:** Understand and use Japanese script to read and write
- CO3:** Apply knowledge for next advance level reading, writing and listening skills
- CO4:** Develop interest to pursue further study, work and leisure





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410910B:AC3 – II:
Professional Ethics and
Etiquettes





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Pre-requisite Course: Basic writing Skills including grammar and mechanics

Course Objectives:

- To make aware about types of ethical challenges and dilemmas confronting members of a range of professions
- To understand various ethical dilemmas
- To identify and describe relevant theoretical concepts related to professional ethics in engineering
- To understand the basic perception of profession, professional ethics, various moral issues uses of ethical theories

To describe workplace and interview etiquettes

Course Outcomes:

On completion of the course, learner will be able to

CO1: Describe the major elements of ethical theory.

CO2: Analyze and present results of complex ethics cases.

CO3: Develop basic life skills or etiquettes in order to succeed in corporate culture.

CO4: Acquire effective writing skills for drafting academic, business and technical documents

CO5: Demonstrate the understanding of professionalism in terms of workplace behaviors and relationships

CO6: Develop professional attitude

Course Contents

Unit I : Introduction to the concept of ethics and ethical behaviour

What are Ethics? Value Systems, A Brief History of Ethics, Ethics: Definitions, Key Concepts , Ethics Alarms Importance of Ethical Conduct in Business , Code of Ethics Professional Ethics

Unit II:Ethical Dilemmas, Sources and Their Resolutions

What is an Ethical Dilemma, Sources of Ethical Behavior, Code of Personal Ethics for Employees, How to Resolve an Ethical Problem, How to Resolve Ethical Dilemmas.

Unit III:Fundamental of Communication

Introduction to Theory of Communication, Methods of Communication, Barriers to Communication, Communication at the Workplace



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Unit IV: Professional Correspondence

Seven Cs of Business Correspondence- Completeness, Conciseness, Consideration, Concreteness, Clarity, Courtesy, Correctness. Parts of a Formal Letter and Formats, Email writing

Unit V: Workplace Etiquette

Personal Appearance - Formal Dressing, Casual Dressing, Accessories for Men & Women, Footwear, General Appearance, What To Wear for Different Occasions. Using the Right Tone of Voice, Managing your volume in Business Settings, Sounding Confident. Dealing with Body Odour, Etiquette for Personal Contact- Introductions, Getting the names right, Handshakes, Facial Expressions, Eye Contact, Hand gestures & Posture, Etiquette in and around the Office- Conversations at Work, Dealing with Colleagues

Unit VI: Interview Etiquette

What employers are looking for , Types of interviews , Top interview tips - preparing for an interview ,

Recommended interview attire , Interview checklist, Preparing for a telephonic interview, Frequently

Asked Questions (FAQs) during interview , Common reasons for applicant rejection

Reference Books:

1. Sanjay Kumar & Pushp Lata (2018). Communication Skills with CD. New Delhi: Oxford University Press.
2. Hemphill, P.D., McCormick, D. W., & Hemphill, R. D. (2001). Business Communication with writing improvement exercises. Upper Saddle River, NJ: Prentice Hall.
3. Locker, Kitty O. Kaczmarek, Stephen Kyo. (2019). Business Communication: Building Critical Skills. Place of publication not identified: Mcgraw-hill.

Nancy Mitchell, Etiquette Rules: A Field Guide to Modern Manners, Wellfleet Press



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410910C

Audit Course-1
310910A-AC3-III Mobile
App Development

Course Objectives:

- ❖ To understand and get familiar with different techniques and technologies of developing apps for mobile devices

Course Outcome:

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

CO1: Install and configure Android application development tools.

CO2: Design and develop User Interfaces for the Android platform.

CO3: Understanding enterprise scale requirements of mobile applications.

CO4: Demonstrate their ability to develop software with reasonable complexity on mobile platform.

CO5: Demonstrate their ability to deploy software to mobile devices

CO6: Apply development tools, techniques, programming languages and libraries required for Mobile app development



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Course Contents :

1. The Android Platform: Introduction to the Android platform and the Android Studio IDE, Android components, Activities, activity navigation
2. User Interface Design: Intents, Activity lifecycle, UI Design: Widgets and Layouts, UI Events,
Event Listeners
3. Graphics Support in Android: Drawables, Basics of Material Design, 2D graphics: Canvas/Drawing using a view
Multimedia in Android: Audio playback and MediaPlayer, SoundPool

Learning Resources:

Text Books:

1. Wei-Meng Lee, "Beginning Android Application Development", 1st Ed, Wiley Publishing.
2. J. F. DiMarzio, "Android: A Programmer's Guide", McGraw Hill Education (India) Private Limited. 1st Edition.

Reference Books:

1. Responsive Web Design with Html5 and Css3 by Ben Frain, second Edition
2. Lean Mobile App Development by Mike van Drongelen, Adam Dennis Richard Garabedian Alberto Gonzalez Aravind Krishnaswamy
3. Practical Android: 14 Complete Projects on Advanced Techniques and Approaches by Mark Wickham
Head First Android Development: A Brain-Friendly Guide 2nd Edition

e-Books: <web links>

1. <https://freecomputerbooks.com/mobileAndroidProgrammingBooks.html>

MOOC Courses: <web links>

1. https://onlinecourses.nptel.ac.in/noc20_cs52/preview



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410911:
NCC3: MOOC
Course-III-
Swayam/Spoken
Tutorial /NPTEL

This course aims to create an excellent opportunity for students to acquire the necessary skill set for employability through massive online courses where the rare expertise of world famous experts from academics and industry are available.

MOOCs (Massive Open Online Courses) provide affordable and flexible way to learn new skills.

MOOCs are courses delivered online and accessible to all for free.

Massive because enrollments are unlimited and can run into hundreds of thousands.

Open because anyone can enroll — that is, there is no admission process.

Online because they are delivered via the internet.

Course because their goal is to teach a specific subject.

MOOCs typically comprise video lessons, readings, assessments, and discussion forums.

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy.

NPTEL- National Programme on Technology Enhanced Learning is a project of MHRD initiated by seven Indian Institutes of Technology (Bombay, Delhi, Kanpur, Kharagpur, Madras, Guwahati and Roorkee) along with the Indian Institute of Science, Bangalore in 2003, to provide quality education to anyone interested in learning from the IITs. The main goal was to create web and video courses in all major



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branches of engineering and physical sciences at the undergraduate and postgraduate levels and management courses at the postgraduate level.

Spoken Tutorial is an initiative of national mission on education through ICT, MHRD, Govt. of India to promote IT literacy through Open Source Software. It is a multi-award winning educational content portal. Here one can learn various Free and Open Source Software all by oneself. Anybody with a computer and a desire for learning can learn from any place, at any time and in any language of their choice.

MOOCs course provider like, SWYAM, NPTEL, EDX, Coursera, Udemy, Udacity or similar ones can

About Course and Grade

Non Credit course is compulsory. No grade points are associated with non-credit courses and are not accounted in the calculation of the performance indices SGPA & CGPA. Result of assessment will be PP or NP. Set of non-credit courses offered is provided. Conduction and assessment of performance in said course is to be done at institute level. PP and NP Grade - The student registered and completed non credit MOOC course shall be awarded the grade PP after satisfactory completion of credit course and shall be included in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory internal assessment and shall be included in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory internal assessment performance and secured a passing grade in that course. Student who is unable to complete MOOC course will be awarded as NP grade.

Guidelines for conduction

Students have to enrol themselves for any one course which will be on going and complete the assignments. Grades will be given on the basis of submitted assignments and marks obtained. If student wants to earn a verified certificate, he/she will have to fill the online exam registration form and take the proctored exam conducted by NPTEL/Spoken Tutorial in person at any of the designated exam centres



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Suggested List of Courses (Any One)

1. Human Computer Interactions- 8 week
2. Embedded System Design with ARM - 8 weeks
3. Introduction to Blockchain Technology and Applications - 8 weeks
4. User –centric Computing for Human –Computer Interaction - 8 weeks
5. Introduction to Operations Research - 8 weeks
6. Data Mining - 8 weeks

Institute may choose any one of suggested MOOC Course or decide any other MOOC course
(not opted earlier) at Institute level.

Learning Resources:

1. Swayam- <https://swayam.gov.in/>
2. NPTEL- <https://onlinecourses.nptel.ac.in/>
3. Spoken Tutorial - <https://spoken-tutorial.org/tutorial-search>
4. Mooc- <http://mooc.org/>
5. Edx - <https://www.edx.org/>
6. Coursera- <https://www.coursera.org/>