Fergusson College (Autonomous), Pune

NEP 2020 - Based Curriculum

For

M. Sc. II – Computer Science

With effect from July 2024

Program Outcomes (POs) of M.Sc. Computer Science	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the discipline that forms a part of a postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	**Social competence:** Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise and help reach conclusion in group settings.
PO4	**Research-related skills and Scientific temper:** Infer scientific literature, build sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	**Trans-disciplinary knowledge**: Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence**: Perform independently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics**: Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability**: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Program Specific Outcomes (PSOs) for M.Sc. Computer Science Program	
PSO1	**Academic competence**: Identify, formulate and solve real world computing system problems of various domains by understanding and applying the principles Of mathematics, computing techniques and business concepts.
PSO2	**Personal and Professional Competence**: Analyse, design, test, develop and maintain desktop, web, mobile and cross platform software applications using modern tools and technologies in economical and affordable way.
PSO3	**Research Competence:** Identify the potentiality to design experiments for complex problems, collect data, interpret data, develop, implement computer programs and use knowledge in various domains to identify research gaps and hence to provide solutions to new ideas and innovations.
PSO4	**Entrepreneurial and Social competence:** Analyse and understand the evolutionary changes in computing by inculcating employability and entrepreneur skills among the lifelong learners with moral values and ethics. Develop skills required for social interaction.

Semester	Paper Code	Paper Title	Credits
III	CSC601	Cryptography and Information Security	**4**
	CSC602	Soft Computing	**4**
	CSC603 **OR** CSC604	Cloud Computing Big Data Analytics	**4**
	CSC610	Research Project	**4**
	CSC620	Computer Science Practical V	**2**
	CSC621	Computer Science Practical VI	**2**
		Total Semester Credits	**20**
IV	CSC651 **OR** CSC652	Software Metrics and Project Management MOOCS	**4**
	CSC660	Research Project	**6**
	CSC670	Computer Science Practical VII	**2**
	CSC671	OJT/ Industrial Training	**8**
		Total Semester Credits	**20**
		Total PG-II Credits	**40**

Teaching and Evaluation (Only for FORMAL education courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	**15 / 30**	**1 / 2**	**25**	**10**	**15**
2	**30 / 60**	**2 / 4**	**50**	**20**	**30**
3	**45 / 90**	**3 / 6**	**75**	**30**	**45**
4	**60 / 120**	**4 / 8**	**100**	**40**	**60**

Eligibility: As per the rules and regulations of Savitribai Phule Pune University (SPPU)

S.Y. M.Sc. Computer Science Semester III		
CSC601	**(Core)Cryptography and Information Security**	**Number of Credits: 04**
	Course Outcomes (COs) **On completion of the course, the students will be able to:**	
CO1	Identify different ways of securing digital environment	
CO2	Explain the concepts related to Info-Sys-Security, Cryptography	
CO3	Solve the security problems by choosing appropriate cryptography algorithms.	
CO4	Analyse the requirements of computer security and choose the appropriate security technique such as cryptography, message digesting, authentication	
CO5	Evaluate the different types of attacks which are possible in a digital environment.	
CO6	Compile all the security techniques to build a secure digital environment	

Unit. No.	Title of Unit and Contents
I	**Security Overview** • The need for Security • Security Approaches • Principles of Security • Types of Attacks
II	**Cryptography: Concepts and Techniques** • Plain Text and Cipher Text • Substitution Techniques • Transposition Techniques • Symmetric and Asymmetric key cryptography
III	**Symmetric Key Cryptography** • Algorithm types and modes • Overview of symmetric key cryptography • DES (Data Encryption Standard), Double DES, Triple DES, IDEA (International Data Encryption Algorithm) • RC5, Blowfish, AES (Advanced Encryption Standard) • Diffie-Hellman key exchange
IV	**Asymmetric key Cryptography** • RSA algorithm • Symmetric and Asymmetric key cryptography • Digital Envelope
V	**Public Key Infrastructure** • Message Integrity Techniques-Message Digest MD5, SHA • Digital Signature • Digital Certificates • Public Key Cryptography Standard (PKCS)

VI	**Internet Security Protocols** • SSL, TLS, SHTTP, TSP • Electronic Money • SET, 3-D Secure Protocol • Email Security
VII	**User Authentication and Kerberos** • Use of Cryptography for authentication • Passwords, Certificate-based Authentication • Key Management – Kerberos
VIII	**Case Study** • Application Security • Network Security • Software Security • Operating system security • Database security • Device Security (IOT, mobile security) • Practical Cryptography

References:

1. Andrew Tanenbaum, Computer Networks Fourth Edition
2. Atul Kahate, Cryptography and Network Security Second Edition
3. Charles P. Pfleeger, Shari Lawrence Pfleeger, Security in Computing 5th edition, Prentice Hall
4. Wenbo Mao, Modern Cryptography: Theory and Practice, Prentice Hall.
5. William Stallings, Cryptography And Network Security Principles And Practice, Fourth or Fifth Edition, Pearson
6. William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall.

S.Y. M.Sc. Computer Science Semester III		
CSC602	**(Core) Soft Computing**	**Number of Credits: 04**
	Course Outcomes (COs) **On completion of the course, the students will be able to:**	
CO1	Describe the importance of different soft computing techniques.	
CO2	Discuss the mathematical base of soft computing techniques and its application in real life problems.	
CO3	Implement soft computing techniques like fuzzy logic and neural network to solve the problems.	
CO4	Differentiate between hard and soft computing techniques and illustrate different soft computing techniques.	
CO5	Compare and contrast various algorithms under fuzzy logic and neural networks	
CO6	Combine the knowledge of all soft computing techniques to solve real life problems.	

Unit. No.	Title of Unit and Contents
I	**Introduction to Soft Computing:** 1.1 Neural Networks: Definition, Advantages, Applications, Scope 1.2 Fuzzy logic: Definition, Applications 1.3 Genetic Algorithms: Definition, Applications.
II	**Fuzzy Sets and Relations:** 2.1 Brief Review of Conventional Set Theory, Introduction to Fuzzy Sets, Properties of Fuzzy Sets 2.2 Operations on Fuzzy Sets, Crisp Relation, Fuzzy Relation, Cartesian Product and Composition 2.3 Tolerance and equivalence relation, Fuzzy Tolerance and equivalence relation, 2.4 Value assignments, Other Forms of the Composition.
III	**Membership Functions, Russification and Defuzzification:** 3.1 Features of the Membership Function, Various Forms 3.2 Fuzzification, Defuzzification to Crisp Sets, λ-Cuts for Fuzzy Relations, 3.3 Defuzzification to Scalars, Membership value Assignment-Intuition, Inference.

IV	**Fuzzy Classification, Logic and Fuzzy Systems:** 4.1 Classical Logic, Fuzzy Logic 4.2 Approximate Reasoning, Natural Language 4.3 Linguistic Hedges, Fuzzy (Rule-Based) Systems 4.4 Fuzzy Classification
V	**Fuzzy Arithmetic and the Extension Principle** 5.1 Extension Principle, Crisp Functions, Mapping, and Relations 5.2 Functions of Fuzzy Sets – Extension Principle 5.3 Fuzzy Transform (Mapping) 5.4 Fuzzy Arithmetic 5.5 Interval Analysis in Arithmetic 5.6 Approximate Methods of Extension
VI	**Neural Network** 6.1 Fundamental Concept: Artificial Neural Network, Biological Neural Network 6.2 Comparison Between Biological Neuron and Artificial Neuron (Brain vs. Computer) 6.3 Advantages of Neural Networks 6.4 Application Scope of Neural Networks. 6.5 **Artificial Neurons, Neural Networks and Architectures**: Neuron Abstraction, Neuron Signal Functions, 6.6 Mathematical Preliminaries, Architectures: Feed forward and Feedback, Salient Properties of Neural Networks 6.7 **Geometry of Binary Threshold Neurons and Their Networks**: Pattern Recognition and Data Classification, Convex Sets, 6.8 Convex Hulls and Linear Separability, Space of Boolean Functions, Binary Neurons are Pattern Dichotomizers, Non-linearly Separable Problems 6.9 Capacity of a Simple Threshold Logic Neuron, Multilayer Networks. 6.10 **Learning and Memory:** An Introduction, Long Term Memory, The Behavioural Approach to Learning, The Molecular Problem of Memory, Learning Algorithms, Error Correction and Gradient Descent Rules, Learning Objective for TLNs, Pattern Space and Weight Space.

	6.11 Linear Separability, Hebb Network, Perceptron Network, α-Least Mean Square learning
VII	**Genetic Algorithms** 7.1 A gentle introduction to Genetic Algorithms. 7.2 Robustness of traditional Optimization and Search Methods, 7.3 The goals of optimization, how are Genetic Algorithms different from Traditional Methods? 7.4 A simple Genetic Algorithm.

Books:

1. Deepa & Shivanandan, "Introduction to Soft Computing", Wiley Publication, 2011
2. Timothy Ross, "Fuzzy Logic with Engineering Applications", 3rd Edition, Wiley Publication, 2010
3. Satish Kumar, "Neural Networks", Tata McGraw Hill, 2004
4. David Goldberg, "Genetic Algorithms in Search Optimization and Machine Learning", Pearson Education, 1989

Web References:

1. https://www.tutorialspoint.com/artificial intelligence
2. https://onlinelibrary.wiley.com
3. http://neuralnetworksanddeeplearning.com
4. http://www.myreaders.info/html/soft_computing.html

S.Y. M.Sc. Computer Science Semester III		
CSC603	**(Elective) Cloud Computing**	**Number of Credits: 04**
	Course Outcomes (COs) **On completion of the course, the students will be able to:**	
CO1	Describe various Cloud computing platforms and models.	
CO2	Explain different cloud architectures and Operating systems related functions.	
CO3	Implement various virtualization concepts and apply them to understand types of hypervisors used in cloud computing.	
CO4	Classify different levels and challenges of security under cloud security architecture.	
CO5	Compare and contrast different types of service models under cloud platforms.	
CO6	Integrate various challenges and issues in cloud computing with respect to security and quality of services.	

Unit. No.	Title of Unit and Contents
I	**Introduction to Cloud Computing** 1.1 Cloud Computing definition, 1.2 Cloud service Models and Types 1.3 Benefits and limitations of Cloud 1.4 Cloud computing vs. Cluster computing vs. Grid Computing 1.5 Cloud Computing and SOA
II	**Virtualization** 2.1 Virtualization Basics 2.2 Benefits of Virtualization 2.3 Understanding Hypervisors
III	**Infrastructure as a Service (IaaS)** 3.1 Introduction to IaaS 3.2 Introduction to virtualization 3.3 Different approaches to virtualization 3.4 Data storage in cloud computing 3.5 Examples of clouds
IV	**Platform as a Service (PaaS)** 4.1 Evolution of computing paradigms and related components 4.2 Introduction to PaaS-What is PaaS 4.3 Service Oriented Architecture (SOA)

V	**Software as a Service(SaaS)** 5.1 Introduction to SaaS 5.2 Web services 5.3 Case Study on SaaS
VI	**Cloud Security** 6.1 Cloud Security Fundamentals 6.2 Privacy and Security in Cloud 6.3 Cloud Security Architecture 6.4 Identity Management and Access control 6.5 Cloud Computing security challenges
VII	**Issues in Cloud Computing** 7.1 Issues in Inter cloud computing 7.2 Quality of services in cloud Computing 7.3 Data Migration in Cloud 7.4 Streaming in Cloud
VII	**Programming, Environments and Applications** 8.1 Features of Cloud and Grid Platforms 8.2 Programming Support of Google App Engine 8.3 Programming on Amazon AWS and Microsoft Azure, 8.4 Emerging Cloud Software Environments, 8.5 Applications: Moving application to cloud, Microsoft Cloud Services, Google Cloud Applications, Amazon Cloud Services, and Cloud Applications.

Books:

1. Dr. Kumar Saurabh, “Cloud Computing”, Wiley Publication, 2012
2. Gautam Shroff, Enterprise Cloud Computing, Cambridge publication, 2010
3. Ronald Krutz and Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley-India, 2010
4. Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper, Cloud Computing for Dummies, Wiley India Edition, 2010

Web References:

1. https://aws.amazon.com/what-is-cloud-computing/
2. https://www.tutorialspoint.com/cloud_computing/index.htm

S.Y. M.Sc. Computer Science Semester III		
CSC604	**(Elective) Big Data Analytics**	**Number of Credits: 04**
	Course Outcomes (COs) **On completion of the course, the students will be able to:**	
CO1	Identify the usage of data storage that are unstructured.	
CO2	Explain the concepts related to Big data analysis	
CO3	Learn the technologies that supports big data.	
CO4	Analyse the various methods that supports big data analytics.	
CO5	Learn various report generation techniques.	
CO6	Apply the concepts and create application.	

Unit. No.	Title of Unit and Contents
I	**Introduction to Big Data** **1.1** Types of Digital Data-Characteristics of Data – Evolution of Big Data – Definition of Big Data **1.2** Challenges with Big Data – 3Vs of Big Data – Non Definitional traits of Big Data **1.3** Business Intelligence vs. Big Data – Data warehouse and Hadoop environment – Coexistence.
II	**Classification of analytics** **2.1** Brief concept of Data Analytics **2.2** Terminologies in Big Data – CAP Theorem – BASE Concept. NoSQL: **2.3** Types of Databases – Advantages – NewSQL – SQL vs. NOSQL vs NewSQL.
III	**Hadoop** **3.1** Features **3.2** Advantages – Versions – Overview of Hadoop Eco systems **3.3** Hadoop distributions – Hadoop vs. SQL – RDBMS vs. Hadoop – Hadoop Components – Architecture – HDFS **3.4** Map Reduce: Mapper – Reducer – Combiner– Partitioner Searching – Sorting – Compression. **3.5** Hadoop 2 (YARN): Architecture – Interacting with Hadoop Eco systems.
IV	**No SQL databases** **4.1** Introduction of Mongo DB **4.2** Features – Data types – Mongo DB Query language **4.3** CRUD operations – Arrays – Functions: Count – Sort **4.4** Limit – Skip – Aggregate – Map Reduce. Cursors **4.5** Indexes – Mongo Import – Mongo Export.

VI	**Hadoop Eco systems** **5.1** Hive – **5.2** Architecture – data type – File format. **5.3** Features – Anatomy – Pig on Hadoop – Pig Philosophy – Pig Latin overview – Data types – Running pig – Execution modes of Pig **5.4** HDFS commands – Relational operators – Eval Functions – Complex data type – Piggy Bank – User defined Functions
VII	**Parameter substitution** **6.1** Diagnostic operator. Jasper Report: **6.2** Introduction – Connecting to Mongo DB – Connecting to Cassandra **6.3** Introduction to Machine learning: Linear Regression – Clustering **6.4** Collaborative filtering – Association rule mining – Decision tree.

References:

1. Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley Publication, 2015.
2. Judith Hurwitz, Alan Nugent, Dr. Fern Halper, Marcia Kaufman, "Big Data for Dummies", John Wiley & Sons, Inc., 2013.
3. Tom White, "Hadoop: The Definitive Guide", O'Reilly Publications, 2011.
4. Kyle Banker, "Mongo DB in Action", Manning Publications Company, 2012.
5. Russell Bradberry, Eric Blow, "Practical Cassandra A developers Approach", Pearson Education, 2014.

S.Y. M.Sc. Computer Science Semester III		
CSC610	**(Core) Research Project**	**Number of Credits: 04**
	Course Outcomes (COs) **On completion of the course, the students will be able to:**	
CO1	To enable the students to undertake research projects that are relevant and important.	
CO2	To apply pre-learnt concepts to design research problem with the help of literature survey.	
CO3	To enable students to do sufficient groundwork in terms of preparing the outline of a research plan which includes grants, infrastructural requirements and procurement of resources.	
CO4	To allow students the opportunity to develop a thorough research proposal. UGC guidelines to be followed for writing the research proposal.	
CO5	To encourage research culture which includes exploring collaborative project ideas.	
CO6	To give students the opportunity to present their proposal before funding agencies and if possible, procure funding for the project	

Introduction

The NEP 2020 has emphasized on the inclusion of research and development in Higher Education Institutions. As colleges are an integral part of knowledge impartment and creation NEP 2020 has introduced the research component to quite a substantial degree at postgraduate level. The multidisciplinary, transdisciplinary and translational research culture is expected to be introduced at postgraduate level. Such research projects undertaken will obviously enhance the research productivity, collaboration at national and international level in various industries, government as well as community based organisations and agencies.

S.Y. M.Sc. Computer Science Semester III		
CSC620	**(Core) Computer Science Practical V**	**Number of Credits: 02**
	Course Outcomes (COs) **On completion of the course, the students will be able to:**	
CO1	Identify the methods for implementing cryptography and soft computing techniques.	
CO2	Design security techniques to provide authenticity.	
CO3	Explore technologies support Soft computing and cryptography.	
CO4	Analyse tools and methods that support soft computing and cryptography	
CO5	Learn Concepts related to application of security and soft computing techniques	
CO6	Apply concepts to create security and soft computing applications	

Unit. No.	Title of Unit and Contents
I	Accept input from the user and encrypt the same using following Substitution Cipher Technique ● Ceaser Cipher ● Modified Ceaser Cipher ● Playfair Ceaser
II	Accept input from the user and encrypt the same using following Transposition Cipher Technique ● Rail Fence Technique ● Columnar Technique
III	Implement Diffie-Hellman Key Exchange Algorithm
IV	Accept username and password from the user. Implement Asymmetric Key Cryptography Algorithm – RSA to encrypt password. (Use Python RSA package) **Output should show –** Password – XYZ Encrypted password - &^% Decrypted password – XYZ *Python is given for a reference; student can use any programming language
V	Accept input form the user – ● Using simple-crypt / cryptocode python module perform encryption/decryption on the entered text. ● Using python hashlib module calculate the message digest of the input – MD5 and SHA ● Perform base64encoding and base64decoding using python – use base64 module

	*Python is given for a reference; student can use any programming language to implement these security mechanism
VI	Write a program to implement Fuzzy Operations Union, Intersection, Complement, Algebraic sum, Algebraic product, Cartesian product.
VII	Write a program to implement Max-Min Composition and Max-Product Composition
VIII	Write a program to implement De Morgan's law
IX	Write a program to implement Perceptron Learning Rule
X	Write a program to implement Feed Forward Network

S.Y. M.Sc. Computer Science Semester III		
CSC621	**(Core) Computer Science Practical VI**	**Number of Credits: 02**
	Course Outcomes (COs) **On completion of the course, the students will be able to:**	
CO1	To understand the principles and paradigm of Cloud Computing	
CO2	To appreciate the role of Virtualization Technologies	
CO3	Ability to design and deploy Cloud Infrastructure	
CO4	Understand cloud security issues and solutions	
CO5	Analyze the performance of Cloud Computing.	
CO6	Understand the importance of virtualization in distributed computing and how this has enabled the development of Cloud Computing	

Unit. No.	Title of Unit and Contents
I	Working and Implementation of Infrastructure as a service.
II	Working and Implementation of Software as a service.
III	Working and Implementation of Platform as a service.
IV	Practical Implementation of Storage as a Service.
V	Working of Google drive to make spreadsheet and notes
VI	Execute the step for demonstration and implementation of cloud on single sign on..
VII	Practical Implementation of cloud security.
VIII	Installing and Developing Application Using Google App Engine.
IX	Case Study
X	Case Study

S.Y. M.Sc. Computer Science Semester III		
CSC621	**(Core) Computer Science Practical VI**	**Number of Credits: 02**
	Course Outcomes (COs) **On completion of the course, the students will be able to:**	
CO1	To understand the principles and paradigm of Big data analytics	
CO2	Analyse the architecture of big data analytics.	
CO3	To learn the programming concept of big data	
CO4	To execute Hadoop architecture	
CO5	To integrate Programming concept of No SQL and Big data.	
CO6	Case study Applications.	

Unit. No.	Title of Unit and Contents
I	Working and Implementation of Big data subsets.
II	Working and Implementation of Hadoop architecture.
III	Working and Implementation of No SQL and Big data.
IV	Practical Implementation of Big data analytics.
V	Working with various architecture level of big data analytics.
VI	Practical implementation of CRUD operations.
VII	Practical Implementation of big data analytics application.
VIII	Implementation of the structure of big data analytics.
IX	Case Study
X	Case Study

S.Y. M.Sc. Computer Science Semester IV		
CSC-651	**(Core) Software Metrics and Project Management**	**Number of Credits: 04**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	To ensure successful medium and large scale software projects.	
CO2	To Examines Requirements Elicitation, Project Management, Verification & Validation and Management of Large Software Engineering Projects	
CO3	To learn to select and apply project management techniques for process modelling, planning, estimation, process metrics and risk management.	
CO4	To perform software verification and validation using inspections, design and execution of system test cases	
CO5	Learn various cost management techniques.	
CO6	Apply the concepts in various case studies.	

Unit. No.	Title of Unit and Contents
I	**Introduction to Project Management** 1.1 What is a Project? 1.2 What is Project management? 1.3 Project phases and project life cycle 1.4 Organizational structure Qualities of Project Manager WBS
II	**Project Management Components** 2.1 Project Integration Management 2.2 Project plan development and execution 2.3 Change controls 2.4 CCB Configuration management
III	**Scope Management** 3.1 Strategic planning 3.2 Scope planning, definition 3.3 Verification and control
IV	**Time management** 4.1 Activity planning 4.2 Schedule development and control 4.3 GANTT Chart

V	**Cost Management** 5.1 Cost estimation and Control 5.2 COCOMO model 5.3 BASIC COCOMO NUMERICALS
VI	**Quality Management** 6.1 Quality planning and assurance 6.2 Human Resource Management • Organizational planning • Staff acquisition 6.3 Communication Management • Information distribution • Reporting 6.4 Risk Management • Risk identification • Quantification and control
VII	**Software Metrics** 7.1 The scope of software metrics 7.2 Size- oriented metrics 7.3 Function oriented 7.4 Software metrics data collection 7.5 Analyzing software data
VIII	**Software Reliability** 8.1 Measurement and prediction 8.2 Resource measurement 8.3 Productivity, teams and tools 8.4 Planning a measurement program 8.5 What is metrics plan? 8.6 Developing goals, questions and metrics 8.7 Where and When: Mapping measures to activities 8.8 How: Measurement tools 8.9 Who: Measurers , analyst, tools revision plans
IX	**Quality Standards** 9.1 CMM levels 9.2 KPA's 9.3 PSP/TSP

References:

1. Software Engineering Roger Pressman McGraw-Hill
2. Software Metrics for Project Management and process improvement Robert B. Grady Prentice hill

S.Y. M.Sc. Computer Science Semester IV		
CSC660	**(Core) Research Project**	**Number of Credits: 06**
	Course Outcomes (COs) **On completion of the course, the students will be able to:**	
CO1	Carry out a substantial research-based project	
CO2	Capacity development to analyze data and process research findings	
CO3	Use research findings to advance education theory and practice.	
CO4	Focus on quality review of the research papers and may be published in peer reviewed journals or may be presented in conferences / seminars. The research project outcome can be considered for evaluation based on following criteria.	
CO5	Compile and communicate the findings/conclusions / results obtained in the science community through various means of communication.	
CO6	Enable students to put together a research paper that can be published or presented at conferences.	

Introduction

The research project proposal needs to be implemented by following the given timeline. Under the NEP, students are expected to get industry ready by the time they pass out of their Masters' degree course. There is also an emphasis on research so that every student is expected to carry out independent research project as a part of their Post Graduate program. The emphasis is on research that is socially applicable, and carried out with scientific rigor. One benchmark of good quality research is publication of the project either in International or National level scientific journals or the presentation of students' research work at International, National or State level conferences. With this broad objective, the following has been proposed for student research projects at Masters Level.

Objectives:

1. To facilitate substantial data collection for the proposed research work
2. To carry out research following ethical aspects of research activities.
3. To compile and communicate the findings/conclusions / results obtained in the science community through various means of communication.
4. To enable students to put together a research paper that can be published or presented at conferences.

S.Y. M.Sc. Computer Science Semester IV		
CSC670	**(Core) Computer Science Practical VII**	**Number of Credits: 02**
Course Outcome (CO) On completion of the course, the students will be able to:		
CO1	Know about the essential packages which are essential to solve machine learning problems and perform data manipulation and analysis before machine learning is applied.	
CO2	Learn classification and regression problems	
CO3	Use python models for data cleaning and processing.	
CO4	Compare performance of models	
CO5	Know about the performance metrics for evaluation of a Machine Learning Model	
CO6	Build machine learning models for regression and classification problems for solving real life problems.	

Unit. No.	Title of Unit and Contents
I	Basic python programs using list, tuples, dictionaries.
II	Functions, Module Basics, Module Files as Namespaces, Import Model, Reloading Modules.
III	NumPy Library, Numpy functions, Numpy Indexing, Broadcasting, Storage of images in Numpy, reading csv files in Numpy, Analysis
IV	Visualization using matplotlib and Seaborn.
V	Pandas Library, working with dataframes and Series, loading csv, manipulating dataframes, Applying custom functions on dataframes, Aggregation functions, Filtering Data, Analysis.
VI	Data Preparation, Feature Selection and Engineering.
VII	Training Data, Testing Data, Scikit Learn library, Predictive Machine Learning Algorithms - Regression , classification & clustering,
VIII	Case Study

S.Y. M.Sc. Computer Science Semester IV		
CSC671	**(Core) OJT/ Industrial Training**	**Number of Credits: 08**
Course Outcome (CO) On completion of the course, the students will be able to:		
CO1	Describe the various skills, attitude and knowledge to understand the professionalism in the IT industry.	
CO2	Discuss the working culture of the Industry in view to maintain quality Standards	
CO3	Implement the confidence, presentation skills and logical thinking in developing the system	
CO4	Differentiate between the academics and professional work culture in timely delivery of projects.	
CO5	Compare and contrast the professional development of the programs and project.	
CO6	Combine the techniques to enhance oneself as a thorough software professional.	

Introduction

On-the-job training (OJT)/Industrial Training Internship is one of the most influential and well-established ways of teaching students the skills and knowledge needed to work in a professional environment. OJT/ Industrial Training often can facilitate a smooth transition from university to the industry/ market. As a result, several organizations give OJT/ Industrial Training to students before appointing them to full-time job positions. The newly introduced course structure in the NEP2020 envisages imparting strong knowledge, skills to improve the job potential of the students by providing experiential learning opportunities, values, and a research oriented vibrant higher education ecosystem for sustainable development. With these perspectives, in the NEP 2020 guidelines, OJT/ Industrial Training / Field work is made mandatory in the curriculum of all post graduate programmes.

Internships includes working with government or private organizations, higher education institutions, universities, research and development, labs/research organizations/non-government organisations, enterprises, centres involved in research, innovativeness and entrepreneurship, business organizations, local industry, artists, craftspeople, and similar other entities for providing opportunities to students for active engagement in on-site experiential learning.

It helps students get direct experience in using tools, software, techniques, equipment used, gain experience in data collection from the relevant field, conducting surveys etc. in a live environment and experience the work culture.

During OJT/ Industrial Training program, students work under the supervision of experienced professionals and are given tasks and responsibilities that are relevant to their field of study. They are also given feedback and guidance on their performance, which allows them to improve their skills and knowledge. OJT/Internship programs can vary in length, depending on the industry and the requirements of the program. Successful completion of the OJT/ Industrial Training can improve the employment potential of the

students or can also get an opportunity to continue their work as a research project in subsequent semesters. Internships can be mutually beneficial for the intern as well as the internship providing organization. The internship offering organizations provide training with an objective to create a pipeline of great future employees.