Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: M.Sc.

Revised Syllabus of M.Sc. Information Technology(Part-I)
Choice Based Credit & Grading System (60:40)
w.e.f. Academic Year 2020-2021

Sr. No.	Heading	Particulars
1	Title of Course	Information Technology
2	Eligibility for Admission	**a)** Student securing minimum 45% marks at the three years B.Sc. (IT) degree in Information Technology of University of Mumbai or any recognized university are eligible. OR 1. B.E. in IT with minimum 45% marks 2. B.E. in Electronics with minimum 45% marks 3. B.E. in Electronics and Telecomm minimum 45% marks. 4. B.E. in Computer with minimum 45% marks 5. B.Sc. in Computer Science with minimum 45% marks 6. B.Sc. Maths with minimum 45% marks 7. B.Sc. Physics with minimum 45% marks 8. B.Sc. Statistics with minimum 45% marks 9. B.C.A. with minimum 45% marks
3	Passing marks	40%
4	Ordinances/Regulations (if any)	-
5	No. of Semesters	Two
6	Level	P.G.
7	Pattern	Semester (60:40)
8	Status	Revised
9	To be implemented from Academic year	2020-2021

Preamble of the Syllabus:

The M.Sc. Information Technology programs are started with an aim to make the learners employable and impart industry oriented training.

The main objectives of the course are:

- To think analytically, creatively and critically in developing robust, extensible and highly maintainable technological solutions to simple and complex problems.
- To apply their knowledge and skills to be employed and excel in IT professional careers and/or to continue their education in IT and/or related post graduate programs.
- To be capable of managing complex IT projects with consideration of the human, financial and environmental factors.
- To work effectivelyas a part of a team to achieve a common stated goal.
- To adhere to the highest standards of ethics, including relevant industry and organizational codes of conduct.
- To communicate effectivelywith a range of audiences both technical and non-technical.
- To develop an aptitude to engage in continuing professional development.

Objectives of the Course:

The new syllabus is aimed to achieve the objectives. The syllabus spanning three years covers the industry relevant courses. The students will be ready for the jobs available in different fields like:

- Research in Computing
- Data Science
- Cloud Computing
- Soft Computing Techniques
- Research in Computing Practical
- Data Science Practical
- Cloud Computing Practical
- Soft Computing Techniques Practical
- Big Data Analytics
- Modern Networking
- Microservices Architecture
- Image Processing
- Big Data Analytics Practical
- Modern Networking Practical
- Microservices Architecture Practical
- Image Processing Practical

Course Outcome: By the end of the course, a student should develop the Ability:

- Learners are able to use and apply current technical concepts and practices in the core information technologies.
- Learners are able to apply knowledge of computing and mathematics appropriate to the discipline.
- Learners are able to analyze a problem, and identify and define the computing requirements appropriate to its solution.
- Learners are able to effectively integrate IT based solutions into the user environment.
- Learners are able to design, implement, and evaluate a computer based system, process, component, or program to meet desired needs.

Scheme of Examination

A) Internal Assessment: 40 % **40 Marks**

Sr. No.	Particular		Marks
01	One periodical class test / online examination to be conducted in the given semester		20 Marks
02	One case study/ project with presentation based on curriculum to be assessed by the teacher concerned		15 Marks
	Presentation	10 Marks	
	Written Document	05 Marks	
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities		05 Marks

Question Paper Pattern for Class Test

Question No.	Particular	Marks
Q-1	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q-2	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination: 60 % **60 Marks**

- Duration: The examination shall be of 2 hours duration.

Theory question paper pattern
1. There shall be five questions each of 12 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

➢ **Passing Standard**

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 Out of 60) separately, to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Choice Based Credit Grading and Semester System (CBCGS)
M. Sc. Information Technology Syllabus
To be implemented from the Academic year 2020-2021

SEMESTER I

Course Code	Course Nomenclature	Credits
PIT1RIC	Research in Computing	4
PIT1DSC	Data Science	4
PIT1CLC	Cloud Computing	4
PIT1SCT	Soft Computing Techniques	4
PIT1RCP	Research in Computing Practical	2
PIT1DSP	Data Science Practical	2
PIT1CCP	Cloud Computing Practical	2
PIT1SCP	Soft Computing Techniques Practical	2
Total		24

Choice Based Credit Grading and Semester System (CBCGS)
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SEMESTER II

Course Code	Course Nomenclature	Credits
PIT2BDA	Big Data Analytics	4
PIT2MNW	Modern Networking	4
PIT2MSA	Microservices Architecture	4
PIT2IGP	Image Processing	4
PIT2BDP	Big Data Analytics Practical	2
PIT2MNP	Modern Networking Practical	2
PIT2MAP	Microservices Architecture Practical	2
PIT2IPP	Image Processing Practical	2
Total		24

Semester I

Course Code PIT1RIC	**Research in Computing**

Objectives

- To be able to conduct business research with an understanding of all the latest theories.
- To develop the ability to explore research techniques used for solving any real world or innovate problem.

Expected Learning Outcomes:

The learner will be able to:

1) Solve real world problems with scientific approach.
2) Develop analytical skills by applying scientific methods.
3) Recognize, understand and apply the language, theory and models of the field of business Analytics.
4) Foster an ability to critically analyze, synthesize and solve complex unstructured business problems
5) Understand and critically apply the concepts and methods of business analytic

I	**Introduction:** Role of Business Research, Information Systems and Knowledge Management, Theory Building, Organization ethics and Issues	**12**
II	**Beginning Stages of Research Process:** Problem definition, Qualitative research tools, Secondary data research	**12**
III	**Research Methods and Data Collection:** Survey research, communicating with respondents, Observation methods, Experimental research	**12**
IV	**Measurement Concepts, Sampling and Field work:** Levels of Scale measurement, attitude measurement, questionnaire design, sampling designs and procedures, determination of sample size	**12**
V	**Data Analysis and Presentation:** Editing and Coding, Basic Data Analysis, Univariate Statistical Analysis and Bivariate Statistical analysis and differences between two variables. Multivariate Statistical Analysis.	**12**

Course Code	**Practical List**
PIT1RCP	10 Practical based on above syllabus, covering entire syllabus
1	1A) Write a program for obtaining descriptive statistics of data. 1B) Import data from different data sources (from Excel,csv, mysql,sql server, oracle to R/Python/Excel)
2	2A) Design a survey form for a given case study, collect the primary data and analyze it 2B) Perform suitable analysis of given secondary data
3	3A) Perform testing of hypothesis using one sample t-test. 3B) Perform testing of hypothesis using two sample t-test. 3C) Perform testing of hypothesis using paired t-test
4	4A) Perform testing of hypothesis using chi-squared goodness-of-fit test. 4B) Perform testing of hypothesis using chi-squared Test of Independence
5	5A) Perform testing of hypothesis using Z-test
6	6A) Perform testing of hypothesis using one-way ANOVA. 6B) Perform testing of hypothesis using two-way ANOVA. 6C) Perform testing of hypothesis using multivariate ANOVA (MANOVA).
7	7A) Perform the Random sampling for the given data and analyze it.

	7B) Perform the Stratified sampling for the given data and analyze it.
8	8A) Compute different types of correlation.
9	9A) Perform linear regression for prediction. 9B) Perform polynomial regression for prediction.
10	10A) Perform multiple linear regression. 10B) Perform Logistic regression.

Reference Books:

1. Business Research Methods William G.Zikmund, B.J Babin, J.C. Carr, Cengage 8e 2016 6 Atanu Adhikari, M.Griffin
2. Business Analytics Albright Winston Cengage 5e 2015
3. Research Methods for Business Students Fifth Edition Mark Saunders 2011
4. Multivariate Data Analysis Hair Pearson 7e 2014

Course Code PIT1DSC	**Data Science**	

Objectives:

- Develop in depth understanding of the key technologies in data science and business analytics: data mining, machine learning, visualization techniques, predictive modeling, and statistics.
- Practice problem analysis and decision-making. Gain practical, hands-on experience with statistics programming languages and big data tools through coursework and applied research experiences.

Expected Learning Outcomes

The learners will be able to

1) Recognize and analyze ethical issues in business related to intellectual property, data security, integrity, and privacy.
2) Apply ethical practices in everyday business activities and make wellreasoned ethical business and data management decisions.
3) Demonstrate knowledge of statistical data analysis techniques utilized in business decision making.
4) Apply principles of Data Science to the analysis of business problems.
5) Demonstrate use of team work, leadership skills, decision making and organization theory

I	**Data Science Technology Stack**: Rapid Information Factory Ecosystem, Data Science Storage Tools, Data Lake, Data Vault, Data Warehouse Bus Matrix, Data Science Processing Tools ,Spark, Mesos, Akka , Cassandra, Kafka, Elastic Search, R ,Scala, Python, MQTT, The Future **Layered Framework:** Definition of Data Science Framework, CrossIndustry Standard Process for Data Mining (CRISP-DM), Homogeneous Ontology for Recursive Uniform Schema, The Top Layers of a Layered Framework, Layered Framework for High-Level Data Science and Engineering **Business Layer:** Business Layer, Engineering a PracticalBusiness Layer **Utility Layer**: Basic Utility Design, Engineering a Practical Utility Layer	**12**
II	**Three Management Layers**: Operational Management Layer, Processing-Stream Definition and Management, Audit, Balance, and Control Layer, Balance, Control, Yoke Solution, Cause-and-Effect, Analysis System, Functional Layer, Data Science Process **Retrieve Superstep :** Data Lakes, Data Swamps, Training the Trainer Model, Understanding the Business Dynamics of the Data Lake, Actionable Business Knowledge from Data Lakes, Engineering a Practical Retrieve Superstep, Connecting to Other Data Sources.	**12**
III	**Assess Superstep:** Assess Superstep, Errors, Analysis of Data, Practical Actions, Engineering a Practical Assess Superstep, 1	**12**
IV	**Process Superstep :** Data Vault, Time-Person-Object-Location-Event Data Vault, Data Science Process, Data Science, **Transform Superstep :** Transform Superstep, Building a Data Warehouse, Transforming with Data Science, Hypothesis Testing, Overfitting and Underfitting, Precision-Recall, Cross-Validation Test	**12**

V	**Transform Superstep:** Univariate Analysis, Bivariate Analysis, Multivariate Analysis, Linear Regression, Logistic Regression, Clustering Techniques, ANOVA, Principal Component Analysis (PCA), Decision Trees, Support Vector Machines, Networks, Clusters, and Grids, Data Mining, Pattern Recognition, Machine Learning, Bagging Data,Random Forests, Computer Vision (CV) , Natural Language Processing (NLP), Neural Networks, TensorFlow. **Organize and Report Supersteps :** Organize Superstep, Report Superstep, Graphics, Pictures, Showing the Difference	**12**

Course Code	**Practical List**
PIT1DSP	10 Practical based on above syllabus, covering entire syllabus
1	Creating Data Model using Cassandra.
2	Conversion from different formats to HOURS format
3	Utilities and Auditing
4	Retrieving Data
5	Assessing Data
6	Processing Data
7	Transforming Data
8	Organising Data
9	Generating Reports
10	Data Visualisation with Power BI

Reference Books:

1. Practical Data Science Andreas François Vermeulen APress 2018

2. Principles of Data Science Sinan Ozdemir PACKT 2016

3. Data Science from Scratch Joel Grus O'Reilly 2015

4. Data Science from Scratch first Principle in python Joel Grus Shroff Publishers 2017

5. Experimental Design in Data science with Least Resources N C Das Shroff Publishers 2018

Course Code PIT1CLC	**Cloud Computing**

Objectives:

- To learn how to use Cloud Services.
- To implement Virtualization.
- To implement Task Scheduling algorithms.
- Apply Map-Reduce concept to applications.
- To build Private Cloud.
- Broadly educate to know the impact of engineering on legal and societal issues involved.

Expected Learning Outcomes:

The learners will be able to

1) Analyze the Cloud computing setup with its vulnerabilities and applications using different architectures.
2) Design different workflows according to requirements and apply map reduce programming model.
3) Apply and design suitable Virtualization concept, Cloud Resource Management and design scheduling algorithms.
4) Create combinatorial auctions for cloud resources and design scheduling algorithms for computing clouds
5) Assess cloud Storage systems and Cloud security, the risks involved, its impact and develop cloud application

I	**Introduction to Cloud Computing:** Introduction, Historical developments,Building Cloud Computing Environments, **Principles of Parallel and Distributed Computing:** Eras of Computing, Parallel v/s distributed computing, Elements of Parallel Computing, Elements of distributed computing, Technologies for distributed computing. **Virtualization:** Introduction, Characteristics of virtualized environments, Taxonomy of virtualization techniques, Virtualization and cloud computing, Pros and cons of virtualization, Technology examples. Logical Network Perimeter, Virtual Server, Cloud Storage Device, Cloud usage monitor, Resource replication, Ready-made environment.	**12**
II	**Cloud Computing Architecture:** Introduction, Fundamental concepts and models, Roles and boundaries, Cloud Characteristics, Cloud Delivery models, Cloud Deployment models, Economics of the cloud, Open challenges. **Fundamental Cloud Security:** Basics, Threat agents, Cloud security threats, additional considerations. **Industrial Platforms and New Developments:** Amazon Web Services, Google App Engine, Microsoft Azure.	**12**
III	**Specialized Cloud Mechanisms**: Automated Scaling listener, Load Balancer, SLA monitor, Pay-per-use monitor, Audit monitor, fail over system, Hypervisor, Resource Centre, Multidevice broker, State Management Database. **Cloud Management Mechanisms:** Remote administration system, Resource Management System, SLA Management System, Billing Management System, **Cloud Security Mechanisms:** Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single Sign-On (SSO), Cloud-Based Security Groups, Hardened Virtual Server Images	**12**

IV	**Fundamental Cloud Architectures:** Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture. **Advanced Cloud Architectures:** Hypervisor Clustering Architecture, Load Balanced Virtual Server Instances Architecture, Non-Disruptive Service Relocation Architecture, Zero Downtime Architecture, Cloud Balancing Architecture, Resource Reservation Architecture, Dynamic Failure Detection and Recovery Architecture, Bare-Metal Provisioning Architecture, Rapid Provisioning Architecture, Storage Workload Management Architecture	**12**
V	**Cloud Delivery Model Considerations:** Cloud Delivery Models: The Cloud Provider Perspective, Cloud Delivery Models: The Cloud Consumer Perspective, **Cost Metrics and Pricing Models:** Business Cost Metrics, Cloud Usage Cost Metrics, Cost Management Considerations, **Service Quality Metrics and SLAs:** Service Quality Metrics, SLA Guidelines	**12**

Course Code	**Practical List**
PIT1CCP	10 Practical based on above syllabus, covering entire syllabus
1	Write a program for implementing Client Server communication model using TCP. A) A client server based program using TCP to find if the number entered is prime. B) A client server TCP based chatting application
2	Write a program for implementing Client Server communication model using UDP. A) A client server based program using UDP to find if the number entered is even or odd. B) A client server based program using UDP to find the factorial of the entered number C) A program to implement simple calculator operations like addition, subtraction, multiplication and division. D) A program that finds the square, square root, cube and cube root of the entered number.
3	A multicast Socket example.
4	Write a program to show the object communication using RMI. A) A RMI based application program to display current date and time. B) A RMI based application program that converts digits to words, e.g. 123 will be converted to one two three.
5	Show the implementation of web services.
6	Implement Xen virtualization and manage with Xen Center
7	Implement virtualization using VMWare ESXi Server and managing with vCenter
8	Implement Windows Hyper V virtualization
9	Develop application for Microsoft Azure.
10	Develop application for Google App Engine

Reference Books:

1) Mastering Cloud Computing Foundations and Applications Programming Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi Elsevier - 2013
2) Cloud Computing Concepts, Technology & Architecture Thomas Erl, Zaigham Mahmood, and Ricardo Puttini Prentice Hall - 2013
3) Distributed and Cloud Computing, From Parallel Processing to the Internet of Things Kai Hwang, Jack Dongarra, Geoffrey Fox MK Publishers -- 2012VMware and Microsoft Platform in the Virtual Data center, 2006,Auerbach.

Course Code PIT1SCT	Soft Computing Techniques

Objectives

- Soft computing concepts like fuzzy logic, neural networks and genetic algorithm, where Artificial Intelligence is mother branch of all.
- All these techniques will be more effective to solve the problem efficiently

Expected Learning Outcomes:

The learners will be able to

1) Identify and describe soft computing techniques and their roles in building intelligent machines.
2) Recognize the feasibility of applying a soft computing methodology for a particular problem
3) Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
4) Apply genetic algorithms to combinatorial optimization problems
5) Evaluate and compare solutions by various soft computing approaches for a given problem.

I	Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, Fuzzy Computing, Neural Computing, Genetic Algorithms, Associative Memory, Adaptive Resonance Theory, Classification, Clustering, Bayesian Networks, Probabilistic reasoning, applications of soft computing.	**12**
II	Artificial Neural Network: Fundamental concept, Evolution of Neural Networks, Basic Models, McCulloh-Pitts Neuron, Linear Separability, Hebb Network. Supervised Learning Network: Perceptron Networks, Adaptive Linear Neuron, Multiple Adaptive Linear Neurons, Backpropagation Network, Radial Basis Function, Time Delay Network, Functional Link Networks, Tree Neural Network. Associative Memory Networks: Training algorithm for pattern Association, Autoassociative memory network, hetroassociative memory network, bi-directional associative memory, Hopfield networks, iterative autoassociative memory networks, temporal associative memory networks.	**12**
III	UnSupervised Learning Networks: Fixed weight competitive nets, Kohonen self- organizing feature maps, learning vectors quantization, counter propogation networks, adaptive resonance theory networks. Special Networks: Simulated annealing, Boltzman machine, Gaussian Machine, Cauchy Machine, Probabilistic neural net, cascade correlation network, cognition network, neo-cognition network, cellular neural network, optical neural network Third Generation Neural Networks: Spiking Neural networks, convolutional neural networks, deep learning neural networks, extreme learning machine model.	**12**

IV	Introduction to Fuzzy Logic, Classical Sets and Fuzzy sets: Classical sets, Fuzzy sets. Classical Relations and Fuzzy Relations: Cartesian Product of relation, classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets. Membership Function: features of the membership functions, fuzzification, methods of membership value assignments. Defuzzification: Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations, Defuzzification methods. Fuzzy Arithmetic and Fuzzy measures: fuzzy arithmetic, fuzzy measures, measures of fuzziness, fuzzy integrals.	**12**
V	Fuzzy Rule base and Approximate reasoning: Fuzzy proportion, formation of rules, decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference systems, Fuzzy logic control systems, control system design, architecture and operation of FLC system, FLC system models and applications of FLC System. Genetic Algorithm: Biological Background, Traditional optimization and search techniques, genetic algorithm and search space, genetic algorithm vs. traditional algorithms, basic terminologies, simple genetic algorithm, general genetic algorithm, operators in genetic algorithm, stopping condition for genetic algorithm flow, constraints in genetic algorithm, problem solving using genetic algorithm, the schema theorem, classification of genetic algorithm, Holland classifier systems, genetic programming, advantages and limitations and applications of genetic algorithm. Differential Evolution Algorithm, Hybrid soft computing techniques – neuro – fuzzy hybrid, genetic neuro-hybrid systems, genetic fuzzy hybrid and fuzzy genetic hybrid systems.	**12**

Course Code	**Practical List**
PIT1SCP	10 Practical based on above syllabus, covering entire syllabus
1	1A) Design a simple linear neural network model. 1B) Calculate the output of neural net using both binaryand bipolar sigmoidal function.
2	2A) Generate AND/NOT function using McCulloch-Pitts neural net. 2B) Generate XOR function using McCulloch-Pittsneural net.
3	3A) Write a program to implement Hebb's rule. 3B) Write a program to implement of delta rule.
4	4A) Write a program for Back Propagation Algorithm. 4B) Write a program for error Backpropagationalgorithm.
5	5A) Write a program for Hopfield Network. 5B) Write a program for Radial Basis function.
6	6A) Kohonen Self organizing map. 6B) Adaptive resonance theory
7	7A) Write a program for Linear separation. 7B) Write a program for Hopfield network model for associative memory.
8	8A) Membership and Identity Operators | in, not in. 8B) Membership and Identity Operators is, is not.
9	9A) Find ratios using fuzzy logic. 9B) Solve Tipping problem using fuzzy logic
10	10A) Implementation of Simple genetic algorithm. 10B) Create two classes: City and Fitness using Geneticalgorithm.

Reference Books:

1. Artificial Intelligence and Soft Computing Anandita Battacharya Das SPD 3rd 2018
2. Principles of Soft computing S.N.Sivanandam S.N.Deepa Wiley 3 rd 2019
3. Neuro-Fuzzy Computing and Soft J.S.R.Jang, C.T.Sun and E.Mizutani Prentice Hall of India 2004
4. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications S.Rajasekaran, G. A. Vijayalakshami Prentice Hall of India 2004
5. Fuzzy Logic with Engineering Applications Timothy J.Ross McGrawHill 1997 15
6. Genetic Algorithms: Search, Optimization and Machine Learning Davis E.Goldberg Addison Wesley 1989
7. Introduction to AI and Expert System Dan W. Patterson Prentice Hall of India 2009

Semester II

Course Code PIT2BDA	**Big Data Analytics**

Objectives:

- To provide an overview of an exciting growing field of big data analytics.
- To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
- To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
- To enable students to have skills that will help them to solve complex realworld problems in for decision support.

Expected Learning Outcomes:
The learners will be able to

1) Understand the key issues in big data management and its associated applications in intelligent business and scientific computing.
2) Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.
3) Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4) Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

I	Introduction to Big Data Characteristics of Data, and Big Data Evolution of Big Data, Definition of Big Data, Challenges with big data, Why Big data? Data Warehouse environment, Traditional Business Intelligence versus Big Data. State of Practice in Analytics, Key roles for New Big Data Ecosystems, Examples of big Data Analytics. Big Data Analytics: Introduction to big data analytics, Classification of Analytics, Challenges of Big Data, Importance of Big Data, Big Data Technologies, Data Science, Responsibilities, Soft state eventual consistency. Data Analytics Life Cycle	12
II	Analytical Theory and Methods Clustering and Associated Algorithms, Association Rules, Apriori Algorithm, Candidate Rules, Applications of Association Rules, Validation and Testing, Diagnostics, Regression, Linear Regression, Logistic Regression, Additional Regression Models.	12
III	Analytical Theory and Methods Classification, Decision Trees, Naïve Bayes, Diagnostics of Classifiers, Additional Classification Methods, Time Series Analysis, Box Jenkins methodology, ARIMA Model, Additional methods. Text Analysis, Steps, Text Analysis Example, Collecting Raw Text, Representing Text, Term Frequency-Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments	12

IV	Data Product, Building Data Products at Scale with Hadoop Data Science Pipeline and Hadoop Ecosystem, Operating System for Big Data, Concepts, Hadoop Architecture, Working with Distributed file system, Working with Distributed Computation, Framework for Python and Hadoop Streaming, Hadoop Streaming, MapReduce with Python, Advanced MapReduce. In-Memory Computing with Spark, Spark Basics, Interactive Spark with PySpark, Writing Spark Applications,	12
V	Distributed Analysis and Patterns,Computing with Keys, Design Patterns, Last-Mile Analytics, Data Mining and Warehousing, Structured Data Queries with Hive, HBase, Data Ingestion, Importing Relational data with Sqoop, Injesting stream data with flume. Analytics with higher level APIs, Pig, Spark's higher level APIs..	12

Course Code	**Practical List**
PIT2BDP	10 Practical based on above syllabus, covering entire syllabus
1	Install, configure and run Hadoop and HDFS ad explore HDFS
2	Implement word count / frequency programs using MapReduce
3	Implement an MapReduce program that processes a weather dataset
4	Implement an application that stores big data in Hbase / MongoDB and manipulate it using R / Python
5	Implement the program in practical 4 using Pig
6	Configure the Hive and implement the application in Hive.
7	Write a program to illustrate the working of Jaql.
8	Implement the following:
A	Implement Decision tree classification techniques
B	Implement SVM classification techniques
9	Solve the following:
A	REGRESSION MODEL Import a data from web storage. Name the dataset and now do Logistic Regression to find out relation between variables that are affecting the admission of a student in an institute based on his or her GRE score, GPA obtained and rank of the student. Also check the model is fit or not. require (foreign), require(MASS).
B	MULTIPLE REGRESSION MODEL Apply multiple regressions, if data have a continuous independent variable. Apply on above dataset.
10	Solve the Following:
A	CLASSIFICATION MODEL a. Install relevant package for classification. b. Choose classifier for classification problem. c. Evaluate the performance of classifier.
B	CLUSTERING MODEL a. Clustering algorithms for unsupervised classification. b. Plot the cluster data using R visualizations.

Reference Books:

1. Big Data and Analytics: Subhashini Chellappan Seema Acharya, Wiley, First
2. Data Analytics with Hadoop An Introduction for Data Scientists: Benjamin Bengfort and Jenny Kim, O'Reilly, 2016
3. Big Data and Hadoop: V.K Jain, Khanna Publishing, First, 2018

Course Code PIT2MNW	Modern Networking

Objectives

- To understand the state-of-the-art in network protocols, architectures and applications.
- Analyse existing network protocols and networks.
- Develop new protocols in networking
- To understand how networking research is done
- To investigate novel ideas in the area of Networking via term-long research projects.

Expected Learning Outcomes:
The learners will be able to

1) Demonstrate in-depth knowledge in the area of Computer Networking.
2) To demonstrate scholarship of knowledge through performing in a group to identify, formulate and solve a problem related to Computer Networks
3) Prepare a technical document for the identified Networking System Conducting experiments to analyze the identified research work in building Computer Networks

I	Modern Networking Elements of Modern Networking The Networking Ecosystem ,Example Network Architectures,Global Network Architecture,A Typical Network Hierarchy Ethernet Applications of Ethernet Standards Ethernet Data Rates Wi-Fi Applications of Wi-Fi,Standards Wi-Fi Data Rates 4G/5G Cellular First Generation Second Generation, Third Generation Fourth Generation Fifth Generation, Cloud Computing Cloud Computing Concepts The Benefits of Cloud Computing Cloud Networking Cloud Storage, Internet of Things Things on the Internet of Things, Evolution Layers of the Internet of Things, Network Convergence Unified Communications, Requirements and Technology Types of Network and Internet Traffic,Elastic Traffic,Inelastic Traffic, Real-Time Traffic Characteristics Demand: Big Data, Cloud Computing, and Mobile TrafficBig Data Cloud Computing,,Mobile Traffic, Requirements: QoS and QoE,,Quality of Service,Quality of Experience, Routing Characteristics, Packet Forwarding, Congestion Control ,Effects of Congestion,Congestion Control Techniques, SDN and NFV SoftwareDefined Networking,Network Functions Virtualization Modern Networking Elements	**12**
II	Software-Defined Networks SDN: Background and Motivation, Evolving Network Requirements Demand Is Increasing,Supply Is IncreasingTraffic Patterns Are More ComplexTraditional Network Architectures are Inadequate, The SDN Approach Requirements SDN Architecture Characteristics of Software12 20 Defined Networking,	**12**

	SDN- and NFV-Related Standards StandardsDeveloping Organizations Industry Consortia Open Development Initiatives, SDN Data Plane and OpenFlow SDN Data Plane, Data Plane Functions Data Plane Protocols OpenFlow Logical Network Device Flow Table Structure Flow Table Pipeline, The Use of Multiple Tables Group Table OpenFlow Protocol, SDN Control Plane SDN Control Plane Architecture Control Plane Functions, Southbound Interface Northbound InterfaceRouting, ITU-T Model, OpenDaylight OpenDaylight Architecture OpenDaylight Helium, REST REST Constraints Example REST API, Cooperation and Coordination Among Controllers, Centralized Versus Distributed Controllers, HighAvailability Clusters Federated SDN Networks, Border Gateway Protocol Routing and QoS Between Domains, Using BGP for QoS Management IETF SDNi OpenDaylight SNDi SDN Application Plane SDN Application Plane Architecture Northbound Interface Network Services Abstraction Layer Network Applications, User Interface, Network Services Abstraction Layer Abstractions in SDN, Frenetic Traffic Engineering PolicyCop Measurement and Monitoring Security OpenDaylight DDoS Application Data Center Networking, Big Data over SDN Cloud Networking over SDN Mobility and Wireless Information-Centric Networking CCNx, Use of an Abstraction Layer	
III	Virtualization, Network Functions Virtualization: Concepts and Architecture, Background and Motivation for NFV, Virtual Machines The Virtual Machine Monitor, Architectural Approaches Container Virtualization, NFV Concepts Simple Example of the Use of NFV, NFV Principles High-Level NFV Framework, NFV Benefits and Requirements NFV Benefits, NFV Requirements, NFV Reference Architecture NFV Management and Orchestration, Reference Points Implementation, NFV Functionality, NFV Infrastructure,Container Interface,Deployment of NFVI Containers,Logical Structure of NFVI Domains,ComputeDomain, Hypervisor Domain,Infrastructure Network Domain, Virtualized Network Functions, VNF Interfaces,VNFC to VNFC Communication,VNF Scaling, NFV Management and Orchestration, Virtualized Infrastructure Manager,Virtual Network Function Manager,NFV Orchestrator, Repositories, Element Management, OSS/BSS, NFV Use Cases Architectural Use Cases, Service-Oriented Use Cases, SDN and NFV Network Virtualization, Virtual LANs ,The Use of Virtual LANs,Defining VLANs, Communicating VLAN Membership,IEEE 802.1Q VLAN Standard, Nested VLANs, OpenFlow VLAN Support, Virtual Private Networks, IPsec VPNs,MPLS VPNs, Network Virtualization, Simplified Example, Network Virtualization Architecture, Benefits of Network Virtualization, OpenDaylight's Virtual Tenant Network, Software-Defined Infrastructure,SoftwareDefined Storage, SDI Architecture	**12**
IV	Defining and Supporting User Needs, Quality of Service, Background, QoS Architectural Framework, Data Plane, Control Plane, Management Plane, Integrated Services Architecture, ISA Approach ISA Components, ISA Services, Queuing Discipline, Differentiated Services, Services, DiffServ Field, DiffServ Configuration and Operation, Per-Hop Behavior, Default Forwarding PHB, ServiceLevel Agreements, IP Performance Metrics, OpenFlow QoS Support, Queue Structures, Meters, QoE: User Quality of Experience, Why QoE?,Online Video Content Delivery, Service Failures Due to Inadequate QoE Considerations QoE-Related Standardization Projects, Definition of Quality of Experience, Definition of Quality, Definition of Experience Quality Formation Process, Definition of Quality of Experience, QoE Strategies in Practice, The QoE/QoS Layered Model Summarizing and Merging the ,QoE/QoS Layers, Factors Influencing QoE, Measurements of QoE, Subjective Assessment, Objective Assessment, End-User Device Analytics, Summarizing the QoE Measurement Methods, Applications of QoE Network Design Implications of QoS and QoE Classification of QoE/ QoS Mapping Models, Black-Box Media-Based QoS/QoE Mapping Models, GlassBox Parameter-Based	**12**

	QoS/QoE Mapping Models,Gray-Box QoS/QoE Mapping Models, Tips for QoS/QoE Mapping Model Selection,IPOriented Parameter-Based QoS/QoE Mapping Models,Network Layer QoE/QoS Mapping Models for Video Services, Application Layer QoE/QoS Mapping Models for Video Services Actionable QoE over IP-Based Networks, The System-Oriented Actionable QoE Solution, The Service-Oriented Actionable QoE Solution, QoE Versus QoS Service Monitoring, QoS Monitoring Solutions, QoE Monitoring Solutions, QoE-Based Network and Service Management, QoE-Based Management of VoIP Calls, QoE-Based Host-Centric Vertical Handover, QoE-Based Network-Centric Vertical Handover	
V	Modern Network Architecture: Clouds and Fog, Cloud Computing, Basic Concepts, Cloud Services, Software as a Service, Platform as a Service, Infrastructure as a Service, Other Cloud Services, XaaS, Cloud Deployment Models, Public Cloud Private Cloud Community Cloud, Hybrid Cloud, Cloud Architecture, NIST Cloud Computing Reference Architecture,ITU-T Cloud Computing Reference Architecture, SDN and NFV, Service Provider Perspective Private Cloud Perspective, ITU-T Cloud Computing Functional Reference Architecture, The Internet of Things: Components The IoT Era Begins, The Scope of the Internet of Things Components of IoT-Enabled Things, Sensors, Actuators, Microcontrollers, Transceivers, RFID, The Internet of Things: Architecture and Implementation, IoT Architecture,ITU-T IoT Reference Model, IoT World Forum Reference Model, IoT Implementation, IoTivity, Cisco IoT System, ioBridge, Security Security Requirements, SDN Security Threats to SDN, SoftwareDefined Security, NFV Security, Attack Surfaces, ETSI Security Perspective, Security Techniques, Cloud Security, Security Issues and Concerns, Cloud Security Risks and Countermeasures, DataProtection in the Cloud, Cloud Securityas a Service, Addressing Cloud Computer Security Concerns, IoT Security, The Patching Vulnerability, IoT Security and Privacy Requirements Defined by ITU-TAn IoT Security Framework, Conclusion	**12**

Course Code	**Practical List**
PIT2MNP	10 Practical based on above syllabus, covering entire syllabus
1	Configure IP SLA Tracking and Path Control Topology
2	Using the AS_PATH Attribute
3	Configuring IBGP and EBGP Sessions, Local Preference, and MED
4	Secure the Management Plane
5	Configure and Verify Path Control Using PBR
6	IP Service Level Agreements and Remote SPAN in a Campus Environment
7	Inter-VLAN Routing
8	Simulating MPLS environment
9	Simulating VRF
10	Simulating SDN with • OpenDaylight SDN Controller with the Mininet Network Emulator • OFNet SDN network emulator
11	Simulating OpenFlow Using MININET

Reference Books:

1. Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud William Stallings AddisonWesley
2. Network Functions Virtualization (NFV) with a Touch of SDN Rajendra Chayapathi Syed Farrukh Hassan AddisonWesley

Course Code PIT2MSA	**Microservice Architecture**

Objectives

- Gain a thorough understanding of the philosophy and architecture of Web applications using ASP.NET Core MVC;
- Gain a practical understanding of.NET Core;
- Acquire a working knowledge of Web application development using ASP.NET Core MVC 6 and Visual Studio Persist data with XML Serialization and ADO.NET with SQL Server Create HTTP services using ASP.NET Core Web API;
- Deploy ASP.NET Core MVC applications to the Windows Azure cloud.

Expected Learning Outcomes:
The learners will be able to

1) Develop web applications using Model View Control. Create MVC Models and write code that implements business logic within Model methods, properties, and events.
2) Create Views in an MVC application that display and edit data and interact with Models and Controllers..
3) Gaining a thorough understanding of the philosophy and architecture of .NET
4) Core Understanding packages, met packages and frameworks
5) Acquiring a working knowledge of the .NET programming model

I	Microservices: Understanding Microservices, Adopting Microservices, The Microservices Way. Microservices Value Proposition: Deriving Business Value, defining a Goal-Oriented, Layered Approach, Applying the Goal-Oriented, Layered Approach. Designing Microservice Systems: The Systems Approach to Microservices, A Microservices Design Process, Establishing a Foundation: Goals and Principles, Platforms, Culture.	**12**
II	Service Design: Microservice Boundaries, API design for Microservices, Data and Microservices, Distributed Transactions and Sagas, Asynchronous Message-Passing and Microservices, dealing with Dependencies, System Design and Operations: Independent Deployability, More Servers, Docker and Microservices, Role of Service Discovery, Need for an API Gateway, Monitoring and Alerting. Adopting Microservices in Practice: Solution Architecture Guidance, Organizational Guidance, Culture Guidance, Tools and Process Guidance, Services Guidance.	**12**
III	Building Microservices with ASP.NET Core: Introduction, Installing .NET Core, Building a Console App, Building ASP.NET Core App. Delivering Continuously: Introduction to Docker, Continuous integration with Wercker, Continuous Integration with Circle CI, Deploying to Dicker Hub. Building Microservice with ASP.NET Core: Microservice, Team Service, API First Development, Test First Controller, Creating a CI pipeline, Integration Testing, Running the team service Docker Image. Backing Services: Microservices Ecosystems, Building the location Service, Enhancing Team Service.	**12**
IV	Creating Data Service: Choosing a Data Store, Building a Postgres Repository, Databases are Backing Services, Integration Testing Real Repositories, Exercise the Data Service.Event Sourcing and CQRS: Event Sourcing, CQRS pattern, Event Sourcing and CQRS, Running the samples. Building an ASP.NET Core Web Application: ASP.NET Core Basics, Building Cloud-Native Web Applications. Service Discovery: Cloud Native Factors, Netflix Eureka, Discovering and Advertising ASP.NET Core Services. DNS and Platform Supported Discovery.	**12**
V	Configuring Microservice Ecosystems: Using Environment Variables with Docker, Using Spring Cloud Config Server, Configuring Microservices with etcd, Securing Applications and Microservices: Security in the Cloud, Securing ASP.NET Core Web Apps, Securing ASP.NET Core Microservices. Building Real-Time Apps and Services: Real-Time Applications Defined, Websockets in the Cloud, Using a Cloud Messaging Provider,	**12**

	Building the Proximity Monitor. Putting It All Together: Identifying and Fixing Anti-Patterns, Continuing the Debate over Composite Microservices, The Future.	

Course Code	**Practical List**
PIT2MAP	10 Practical based on above syllabus, covering entire syllabus
1	Building APT.NET Core MVC Application
2	Building ASP.NET Core REST API.
3	Working with Docker, Docker Commands, Docker Images and Containers.
4	Installing software packages on Docker, Working with Docker Volumes and Networks.
5	Working with Docker Swarm.
6	Working with Circle CI for continuous integration.
7	Creating Microservice with ASP.NET Core.
8	Working with Kubernetes.
9	Creating Backing Service with ASP.NET Core.
10	Building real-time Microservice with ASP.NET Core.

Reference Books:

1) Building Microservices with ASP.NET Core ,Kevin Hoffman ,O'Reilly
2) Building Microservices: Designing Fine-Grained Systems, Sam Newman ,O'Reilly
3) Production-ready Microservices, Susan J. Fowler, O'Reilly

Course Code PIT2IGP	**Image Processing**

Objectives:

- Review the fundamental concepts of a digital image processing system.
- Analyze images in the frequency domain using various transforms.
- Evaluate the techniques for image enhancement and image restoration.
- Categorize various compression techniques.
- Interpret Image compression standards. Interpret image segmentation and representation techniques.

Expected Learning Outcomes:
The learners will be able to

1) Understand the relevant aspects of digital image representation and their practical implications.
2) Have the ability to design pointwise intensity transformations to meet stated specifications.
3) Understand 2-D convolution, the 2-D DFT, and have the abitilty to design systems using these concepts.
4) Have a command of basic image restoration techniques.
5) Understand the role of alternative color spaces, and the design requirements leading to choices of color space.

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I	Introduction: Digital Image Processing, Origins of Digital Image Processing, Applications and Examples of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Digital Image Fundamentals: Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationships Between Pixels, Basic Mathematical Tools Used in Digital Image Processing, Intensity Transformations and Spatial Filtering: Basics, Basic Intensity Transformation Functions, Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing (Lowpass) Spatial Filters, Sharpening (Highpass) Spatial Filters, Highpass, Bandreject, and Bandpass Filters from Lowpass Filters, Combining Spatial Enhancement Methods, Using Fuzzy Techniques for Intensity Transformations and Spatial Filtering	12
II	Filtering in the Frequency Domain: Background, Preliminary Concepts, Sampling and the Fourier Transform of Sampled Functions, The Discrete Fourier Transform of One Variable, Extensions to Functions of Two Variables, Properties of the 2-D DFT and IDFT, Basics of Filtering in the Frequency Domain, Image Smoothing Using Lowpass	12

	Frequency Domain Filters, Image Sharpening Using Highpass Filters, Selective Filtering, Fast Fourier Transform Image Restoration and Reconstruction: A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only ---- Spatial Filtering, Periodic Noise Reduction Using Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering, Geometric Mean Filter, Image Reconstruction from Projections	

III	Wavelet and Other Image Transforms: Preliminaries, Matrix-based Transforms, Correlation, Basis Functions in the Time-Frequency Plane, Basis Images, Fourier-Related Transforms, Walsh-Hadamard Transforms, Slant Transform, Haar Transform, Wavelet Transforms Color Image Processing: Color Fundamentals, Color Models, Pseudocolor Image Processing, Full-Color Image Processing, Color Transformations, Color Image Smoothing and Sharpening, Using Color in Image Segmentation, Noise in Color Images, Color Image Compression. Image Compression and Watermarking: Fundamentals, Huffman Coding, Golomb Coding, Arithmetic Coding, LZW Coding, Run-length Coding, Symbol-based Coding, 8 Bit-plane Coding, Block Transform Coding, Predictive Coding, Wavelet Coding, Digital Image Watermarking,	12
IV	Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transform, Morphological Algorithms, Morphological Reconstruction¸ Morphological Operations on Binary Images, Grayscale Morphology Image Segmentation I: Edge Detection, Thresholding, and Region Detection: Fundamentals, Thresholding, Segmentation by Region Growing and by Region Splitting and Merging, Region Segmentation Using Clustering and Superpixels, Region Segmentation Using Graph Cuts, Segmentation Using Morphological Watersheds, Use of Motion in Segmentation	12
V	Image Segmentation II: Active Contours: Snakes and Level Sets: Background, Image Segmentation Using Snakes, Segmentation Using Level Sets. Feature Extraction: Background, Boundary Preprocessing, Boundary Feature Descriptors, Region Feature Descriptors, Principal Components as Feature Descriptors, Whole-Image Features, Scale-Invariant Feature Transform (SIFT)	12

Course Code	Practical List
PIT2IPP	10 Practical based on above syllabus, covering entire syllabus
1 a	Program to calculate number of samples required for an image.
b	Program to study the effects of reducing the spatial resolution of a digital image.
c	Program to study the effects of varying the number of intensity levels in a digital image
d	Program to perform image averaging (image addition) for noise reduction.
e	Program to compare images using subtraction for enhancing the difference between images.
f	Image Registration
2	Intensity transformation and Spatial Filtering
	IMAGE ENHANCEMENT
a	Basic Intensity Transformation functions i. Program to perform Image negation ii. Program to perform threshold on an image. iii. Program to perform Log transformation iv. Power-law transformations v. Piecewise linear transformations a. Contrast Stretching b. Gray-level slicing with and without background. c. Bit-plane slicing
b	Program to plot the histogram of an image and categorise 2. Program to apply histogram equalization.
c	Write a program to perform convolution and correlation.
d	Write a program to apply smoothing and sharpening filters on grayscale and color images a) Low Pass b) High Pass Note: Use all kernels mentioned in the reference book
3	Filtering in Frequency Domain

	a) Program to apply Discrete Fourier Transform on an image b) Program to apply Low pass and High pass filters in frequency domain c) Program to apply Laplacian filter in frequency domain d) Note: All other filters can be applied, studied and compared with filters in spatial domain. e) Program for high frequency emphasis filtering, high boost and homomorphic filtering.
4	Image Denoising i. Program to denoise using spatial mean, median and adaptive mean filtering ii. ii. Program for Image deblurring using inverse, Weiner filters
5	Color Image Processing i. Program to read a color image and segment into RGB planes , histogram of color image ii. Program for converting from one color model to another model iii. Program to apply false colouring(pseudo) on a gray scale image
6	Fourier Related Transforms Program to compute Discrete Cosine Transforms, Walsh -Hadamard Transforms, Haar Transform , Wavelet
7	Image compression Program to apply compression and decompression algorithm on an image (Arithmetic, Huffman and LZW coding techniques.
8	Morphological Image Processing i. Program to apply erosion, dilation, opening, closing ii. Program for detecting boundary of an image iii. Program to apply Hit-or-Miss transform iv. Program to apply morphological gradient on an image v. Program to apply Top-Hat/Bottom-hat Transformations
9	Image Segmentation i. Program for Edge detection using a. Sobel, Prewitt, Marr-Hildreth and Canny ii. Illustrate Watershed segmentation algorithm iii. Any more to be included(to be consulted)
10	Feature Extraction i. Apply Principal components for image description ii. Apply Harris-Stephens corner detector algorithm

Reference Books:

1) Digital Image Processing, Gonzalez and Woods, Pearson/Prentice Hall

2) Fundamentals of Digital Image Processing, A K. Jain, PHI

3) The Image Processing Handbook, J. C. Russ, CRC