Thakur Educational Trust's (Regd.)
THAKUR COLLEGE OF SCIENCE & COMMERCE
AUTONOMOUS COLLEGE, PERMANENTLY AFFILIATED TO UNIVERSITY OF MUMBAI
NAAC Accredited Grade 'A' (3rd Cycle) & ISO 9001: 2015 (Certified)
Best College Award by University of Mumbai for the Year 2018-2019
tcsc
CELEBRATING 25 YEARS OF GLORY

Syllabus for M. Sc. (I.T.) Part 1

P.G. Program

Program: Master of Science

Course: Information Technology

(In accordance with N.E.P. Guidelines)

Semester I and II

(For Autonomous Status)

Choice Based Credit System (CBCS)

To be introduced with effect from

Academic Year 2023-2024

Syllabus for Approval

Sr. No.	Heading	Particulars
1.	Title of the Program	**M.Sc. (Information Technology) Part I**
2.	Eligibility for Admission	Ordinance no. O.5051 Circular no. UG/284 of 2007 dated 16th June 2007
3.	Passing Marks	40%
4.	Ordinances / Regulations (if any)	As applicable for all M.Sc. Courses
5.	No. of Years / Semesters	One year / Two semesters
6.	Level	P.G. / ~~U.G.~~/ ~~Diploma~~ / ~~Certificate~~ **(Strike out which is not applicable)**
7.	Pattern	~~Yearly~~ / Semester **(Strike out which is not applicable)**
8.	Status	~~Revised~~ / New /~~Amended~~ **(Strike out which is not applicable)**
9.	To be implemented from Academic Year	From Academic Year **2023-2024**

PREAMBLE

The B.Sc. Information Technology programme was started in 2001 with an aim to make the students 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 programmes.
- To be capable of managing complex IT projects with consideration of the human, financial and environmental factors.
- To work effectively as 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 effectively with a range of audiences both technical and non-technical.
- To develop an aptitude to engage in continuing professional development.

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:

- Software Development (Programming)
- Website Development
- Mobile app development
- Internet of Things
- Software Testing
- Networking
- Database Administration
- System Administration
- Cyber Law Consultant
- GIS (Geographic Information Systems)
- IT Service Desk
- Security
- Technical communication skills
- Green IT

And many others

BOS Members-Department of IT (2023-2024)

Sr. No.	Designation	Name	Particulars
1	Chairman	Dr. Santosh Kumar Singh	Head, Department of Information Technology, TCSC
2	V.C. Nominee	Dr. Rajendra Patil	Bunts Sangha's College Mumbai
3	Subject Expert from Bangalore University	Dr. Terence Johnson	Professor & HOD Department Information Technology AMC College of Engineering Bengaluru.
4	Subject Expert from Other College	Mr. Mandar Bhave	Asst. Professor, Department of Information Technology, D.G. Ruparel College
5	Member	Ms. Jyotsna Anmar	Asst. Professor, Department of Information Technology, TCSC
6	Member	Ms. Sherlyn Kevin	Asst. Professor, Department of Information Technology, TCSC
7	Member	Ms. Poonam Jain	Asst. Professor, Department of Information Technology, TCSC
8	Member	Mr. Mahesh Kudalkar	Asst. Professor, Department of Information Technology, TCSC
9	Member	Ms. Rimsy Dua	Asst. Professor, Department of Information Technology, TCSC
10	Member	Mr. Mithilesh Vishwakarma	Asst. Professor, Department of Information Technology, TCSC
11	Member	Ms. Sagarika Prakash	Asst. Professor, Department of Information Technology, TCSC
12	Member	Ms. Neenu Johnson	Asst. Professor, Department of Information Technology, TCSC
13	Member	Ms. Manpreet Hire	Asst. Professor, Department of Information Technology, TCSC
14	Member	Ms. Gurveen Kaur	Asst. Professor, Department of Information Technology, TCSC
15.	Member	Ms. Sana Khan	Asst. Professor, Department of Information Technology, TCSC
16.	Subject Expert	Mr. Omkar R. Singh	Head, Department of Data Science, TCSC

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School of Computational Science & Technology
M.Sc. Information Technology (Two) Years P.G. Program
Course and Credit Structure as per
School Specific Core Framework of NEP 2020
M.Sc. Information Technology

Year (2-year PG)	Level	Major		RM	OJT/FP	RP	Cumm. Credit	Degree
		Mandatory	Elective Any One					
I	6.0 SEM-I	1. Data Science (6) 2. Cloud Computing (6) 3. Image Processing (2)	Soft Computing Techniques (4) OR Remote Sensing (4)	Research in Computing (4)			22	PG Diploma
	6.0 SEM-II	1. Big Data Analytics (6) 2. Advance Image Processing (6) 3. Modern Networking (2)	Micro services Architecture (4) OR Advance Python Programming (4)		Internship / FP (04)		22	
II	6.5 SEM-III	1. Machine Learning (6) 2. Applied Artificial Intelligence (6) 3. Technical Writing and Entrepreneurship Development (2)	Robotic Process Automation (4) OR Data Analytics using Advance R Programming			Research Project (4)	22	**MSc-Information Technology**
	6.5 SEM-IV	1. Natural Language Processing (6) 2. Deep Learning (6)	Blockchain (4) OR Human Computer Interaction (4)			Research Project (6)	22	
Cumulative Credit		**54**	**16**	**04**	**04**	**10**	**88**	

SEMESTER 1

MAJOR SSC-I				
M. Sc (Information Technology)		**Semester 1**		
Course Name: Data Science		**Course Code:**		
Periods per week (1 Period is 60 minutes)		**4**		
Credits		**4**		
		Hours	**Marks**	
Evaluation System	**Theory Examination**			
	Internal			

Course 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.

SYLLABUS		
UNIT	**DETAILS**	**LECTURES**
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, Cross-Industry 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 Practical Business 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	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,	12

	Graphics, Pictures, Showing the Difference	

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
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

MAJOR SSC-I Practical				
B. Sc (Information Technology)		**Semester 1**		
Course Name: **Data Science Practical**		**Course Code:**		
Periods per week (1 Period is 60 minutes)		**4**		
Credits		**2**		
		Hours	**Marks**	
Evaluation System	**Theory Examination**			
	Internal			

Course Outcomes:
Learners will be able to -
Apply quantitative modeling and data analysis techniques to the solution of real-world business problems, communicate findings, and effectively present results using data visualization techniques.
Recognize and analyze ethical issues in business related to intellectual property, data security, integrity, and privacy.
Apply ethical practices in everyday business activities and make well-reasoned ethical business and data management decisions.
Demonstrate knowledge of statistical data analysis techniques utilized in business decision making.
Apply principles of Data Science to the analysis of business problems.

SR. NO.	DETAILS
1-10.	10 Practical based on above syllabus, covering entire syllabus

MAJOR SSC-II				
M. Sc (Information Technology)		**Semester 1**		
Course Name: Cloud Computing		**Course Code:**		
Periods per week (1 Period is 60 minutes)		**4**		
Credits		**4**		
		Hours	**Marks**	
Evaluation System	**Theory Examination**			
	Internal			

Course 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

SYLLABUS		
UNIT	**DETAILS**	**LECTURES**
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,	12

	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	
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 Consideration **Service Quality Metrics and SLAs:** Service Quality Metrics, SLA Guidelines	12

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
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	--	2012

MAJOR SSC-II Practical				
B. Sc (Information Technology)		**Semester 1**		
Course Name: **Cloud Computing Practical**		**Course Code:**		
Periods per week (1 Period is 60 minutes)		**4**		
Credits		**2**		
		Hours	**Marks**	
Evaluation System	**Theory Examination**			
	Internal			

Course Outcomes:
Learners will be able to -
Analyze the Cloud computing setup with its vulnerabilities and applications using different architectures.
Design different workflows according to requirements and apply map reduce programming model.
Apply and design suitable Virtualization concept, Cloud Resource Management and design scheduling algorithms.
Create combinatorial auctions for cloud resources and design scheduling algorithms for computing clouds
Assess cloud Storage systems and Cloud security, the risks involved, its impact and develop cloud application

SR. NO.	**DETAILS**
1-10.	10 Practical based on above syllabus, covering entire syllabus

MAJOR SSC-III			
M. Sc (Information Technology)		**Semester 1**	
Course Name: Image Processing		**Course Code:**	
Periods per week (1 Period is 60 minutes)		**2**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**		
	Internal		

Course Objectives:
Learners will be able to -
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 segmentation and representation techniques.
Interpret Image compression standards.

SYLLABUS		
Unit	**Details**	**Lectures**
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	**6**
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 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	**6**
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	**6**

	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,	
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	**6**
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)	**6**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Digital Image Processing	Gonzalez and Woods	Pearson/Prentice Hall	Fourth	2018
2.	Fundamentals of Digital Image Processing	A K. Jain	PHI		
3.	The Image Processing Handbook	J. C. Russ	CRC	Fifth	2010

GENERIC ELECTIVE: Opt for any ONE out of the following TWO

Generic Elective			
M. Sc (Information Technology)		**Semester 1**	
Course Name: Soft Computing Techniques		**Course Code:**	
Periods per week (1 Period is 60 minutes)		**3**	
Credits		**3**	
		Hours	**Marks**
Evaluation System	**Theory Examination**		
	Internal		

Course 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

Pre requisites	Basic concepts of Artificial Intelligence. Knowledge of Algorithms

SYLLABUS		
UNIT	**DETAILS**	**LECTURES**
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	9
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, Auto associative memory network, hetero-associative memory network, bi-directional associative memory, Hopfield networks, iterative auto-associative memory networks, temporal associative memory networks.	9
III	Unsupervised Learning Networks: Fixed weight competitive nets, Kohonen self-organizing feature maps, learning vectors quantization, counter propagation 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.	9
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.	9

	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.	
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.	9

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Artificial Intelligence and Soft Computing	Anandita Das Battacharya	SPD	3rd	2018
2.	Principles of Soft computing	S. N. Sivanandam S. N. Deepa	Wiley	3rd	2019
3.	Neuro-Fuzzy and Soft Computing	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	McGraw-Hill		1997
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

Generic Elective Practical			
B. Sc (Information Technology)		**Semester 1**	
Course Name: **Soft Computing Practical**		**Course Code:**	
Periods per week (1 Period is 60 minutes)		**2**	
Credits		**1**	
		Hours	**Marks**
Evaluation System	**Theory Examination**		
	Internal		

Course Outcomes: Learners will be able to -
Identify and describe soft computing techniques and their roles in building intelligent machines
Recognize the feasibility of applying a soft computing methodology for a particular problem
Effectively use existing software tools to solve real problems using a soft computing approach
Evaluate and compare solutions by various soft computing approaches for a given problem
Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
Apply genetic algorithms to combinatorial optimization problems
Apply neural networks for classification and regression problems

SR. NO.	DETAILS
1-10.	10 Practical based on above syllabus, covering entire syllabus

Generic Elective				
M. Sc (Information Technology)		**Semester 1**		
Course Name: Remote Sensing		**Course Code:**		
Periods per week (1 Period is 60 minutes)		**3**		
Credits		**3**		
		Hours	**Marks**	
Evaluation System	**Theory Examination**			
	Internal			

Course Objectives:
Attain a foundational knowledge and comprehension of the physical, computational, and perceptual basis for remote sensing.
Gain familiarity with a variety of physical, biological, and human geographic applications of remote sensing.
Gain basic experience in the hands-on application of remote sensing data through visual interpretation and digital image processing exercises.
Analyze and synthesize understanding by identifying and developing research and application proposal using remote sensing.

SYLLABUS		
UNIT	**DETAILS**	**LECTURES**
I	Remote Sensing: Basic Principles Introduction, Electromagnetic Radiation and Its Properties, Terminology, Nature of Electromagnetic Radiation, The Electromagnetic Spectrum, Sources of Electromagnetic Radiation, Interactions with the Earth's Atmosphere, Interaction with Earth-Surface Materials, Spectral Reflectance of Earth Surface Materials Remote Sensing Platforms and Sensors Introduction, Characteristics of Imaging Remote Sensing Instruments, Spatial Resolution, Spectral Resolution, Radiometric Resolution, Optical, Near-infrared and Thermal Imaging Sensors, Along-Track Scanning Radiometer (ATSR), Advanced Very High Resolution Radiometer (AVHRR) and NPOESS VIIRS, MODIS, Ocean Observing Instruments, IRS LISS, Landsat Instruments, SPOT Sensors, Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), High-Resolution Commercial and Small Satellite Systems, Microwave Imaging Sensors, European Space Agency Synthetic Aperture Spaceborne Radars, Radarsat, TerraSAR-X and COSMO/Skymed, ALOS PALSAR	9
II	Hardware and Software Aspects of Digital Image Processing Introduction, Properties of Digital Remote Sensing Data, Digital Data, Data Formats, System Processing, Numerical Analysis and Software Accuracy, Some Remarks on Statistics, Preprocessing of Remotely-Sensed Data Introduction, Cosmetic Operations, Missing Scan Lines, Destriping Methods, Geometric Correction and Registration, Orbital Geometry Model, Transformation Based on Ground Control Points, Resampling Procedures, Image Registration, Other Geometric Correction Methods, Atmospheric Correction, Background, Image-Based Methods, Radiative Transfer Models, Empirical Line Method, Illumination and View Angle Effects, Sensor Calibration, Terrain Effects	9
III	Image Enhancement Techniques Introduction, Human Visual System, Contrast Enhancement, Linear Contrast Stretch, Histogram Equalization, Gaussian Stretch, Pseudocolour Enhancement, Density Slicing,	9

	Pseudocolour Transform, Image Transforms Introduction, Arithmetic Operations, Image Addition, Image Subtraction, Image Multiplication, Image Division and Vegetation Indices, Empirically Based Image Transforms, Perpendicular Vegetation Index, Tasselled Cap (Kauth–Thomas) Transformation, Principal Components Analysis, Standard Principal Components Analysis, Noise-Adjusted PCA, Decorrelation Stretch, Hue-Saturation-Intensity (HSI) Transform, The Discrete Fourier Transform, Two- Dimensional Fourier Transform, Applications of the Fourier Transform, The Discrete Wavelet Transform, The One-Dimensional Discrete Wavelet Transform, The Two-Dimensional Discrete Wavelet Transform, Change Detection, Introduction, NDVI Difference Image, PCA, Canonical Correlation Change Analysis, Image Fusion, HSI Algorithm, PCA, Gram-Schmidt Orthogonalization, Wavelet-Based Methods, Evaluation – Subjective Methods, Evaluation – Objective Methods	
IV	Filtering Techniques Spatial Domain Low-Pass (Smoothing) Filters, Moving Average Filter, Median Filter, Adaptive Filters, Spatial Domain High-Pass (Sharpening) Filters, Image Subtraction Method, Derivative-Based Methods, Spatial Domain Edge Detectors, Frequency Domain Filters Classification : Geometrical Basis of Classification, Unsupervised Classification, The k-Means Algorithm, ISODATA, A Modified k-Means Algorithm, Supervised Classification, Training Samples, Statistical Classifiers, Neural Classifiers, Subpixel Classification Techniques, The Linear Mixture Model, Spectral Angle Mapping, ICA, Fuzzy Classifiers, More Advanced Approaches to Image Classification, Support Vector Machines, Decision Trees, Other Methods of Classification, Incorporation of Non-spectral Features, Texture, Use of External Data, Contextual Information, Feature Selection, Classification Accuracy Advanced Topics Introduction, SAR Interferometry, Basic Principles, Interferometric Processing, Problems in SAR Interferometry, Applications of SAR Interferometry, Imaging Spectroscopy, Processing Imaging Spectroscopy Data, Lidar, Lidar Details, Lidar Applications	9
V	Environmental Geographical Information Systems: A Remote Sensing Perspective, Definitions, The Synergy between Remote Sensing and GIS, Data Models, Data Structures and File Formats, Spatial Data Models, Data Structures, File Formats, Raster to Vector and Vector to Raster Conversion, Geodata Processing, Buffering, Overlay, Locational Analysis, Slope and Aspect, Proximity Analysis, Contiguity and Connectivity, Spatial Analysis, Point Patterns and Interpolation. Relating Field and Remotely-Sensed Measurements: Statistical Analysis, Exploratory Data Analysis and Data Mining, Environmental Modelling, Visualization, Multicriteria Decision Analysis of Groundwater Recharge Zones, Data Characteristics, Multicriteria Decision Analysis, Evaluation, Assessing Flash Flood Hazards by Classifying Wadi Deposits in Arid Environments, Water Resources in Arid Lands, Case Study from the Sinai Peninsula, Egypt, Optical and Microwave Data Fusion, Classification of Wadi Deposits, Correlation of Classification Results with Geology and Terrain Data, Remote Sensing and GIS in Archaeological Studies, Introduction, Homul (Guatemala) Case Study, Aksum (Ethiopia) Case Study	9

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Computer Processing of Remotely-Sensed Images: An Introduction	Paul M. Mather, Magaly Koch	Wiley-Blackwell	4th	2011
2.	Remote Sensing for Geoscientists Image Analysis and Integration	Gary L. Prost	CRC Press	3rd	2014
3.	Remote Sensing: Models and Methods for Image Processing	Robert A. Schowengerdt	Elsevier	3rd	2007

Generic Elective Practical			
B. Sc (Information Technology)		**Semester 1**	
Course Name: **Remote Sensing Practical**		**Course Code:**	
Periods per week (1 Period is 60 minutes)		**2**	
Credits		**1**	
		Hours	**Marks**
Evaluation System	**Theory Examination**		
	Internal		

SR. NO.	DETAILS
1-10.	10 Practical based on above syllabus, covering entire syllabus

RM				
M. Sc (Information Technology)		**Semester 1**		
Course Name: Research in Computing		**Course Code:**		
Periods per week (1 Period is 60 minutes)		**3**		
Credits		**3**		
		Hours	**Marks**	
Evaluation System	**Theory Examination**			
	Internal			

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.

Pre requisites	Basic knowledge of statistical methods. Analytical and logical thinking.

Syllabus		
Unit	**Details**	**Lectures**
I	**Introduction:** Role of Business Research, Information Systems and Knowledge Management, Theory Building, Organization ethics and Issues	**9**
II	**Beginning Stages of Research Process:** Problem definition, Qualitative research tools, Secondary data research	**9**
III	**Research Methods and Data Collection:** Survey research, communicating with respondents, Observation methods, Experimental research	**9**
IV	**Measurement Concepts, Sampling and Field work:** Levels of Scale measurement, attitude measurement, questionnaire design, sampling designs and procedures, determination of sample size	**9**
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.	**9**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Business Research Methods	William G.Zikmund, B.J Babin, J.C. Carr, Atanu Adhikari, M.Griffin	Cengage	8e	2016
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

RM Practical				
M. Sc (Information Technology)			**Semester 1**	
Course Name: Research in Computing Practical			**Course Code:**	
Periods per week (1 Period is 60 minutes)			**2**	
Credits			**1**	
			Hours	**Marks**
Evaluation System	**Theory Examination**			
	Internal			

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.

SR. NO.	DETAILS
1-10.	10 Practical based on above syllabus, covering entire syllabus

SEMESTER 2

MAJOR SSC-I				
M. Sc (Information Technology)			**Semester 2**	
Course Name: Big Data Analytics			**Course Code:**	
Periods per week (1 Period is 60 minutes)			**4**	
Credits			**4**	
			Hours	**Marks**
Evaluation System	**Theory Examination**			
	Internal			

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 real-world problems in for decision support.

Unit	Details	Lectures
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**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
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

MAJOR SSC-I Practical			
M. Sc (Information Technology)		**Semester 2**	
Course Name: Big Data Analytics Practical		**Course Code:**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**		

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

Practical No	Details
1 - 10	10 Practical based on above syllabus, covering entire syllabus

MAJOR SSC-II				
M. Sc (Information Technology)		**Semester 2**		
Course Name: Advanced Image Processing		**Course Code:**		
Periods per week (1 Period is 60 minutes)		**4**		
Credits		**4**		
		Hours	**Marks**	
Evaluation System	**Theory Examination**			
	Internal			

SYLLABUS		
Unit	**Details**	**Lectures**
I	Enhancement in Frequency domain Introduction, 2-D Discrete Fourier Transform, Properties of Fourier transform, Basic filtering in the frequency domain, Smoothing and Sharpening filters, FFT algorithm. Discrete cosine transform (DCT), KL (PCT) transform, HAAR, Basics of wavelets. Remote Sensing Introduction (Passive and Active sensing), Electromagnetic remote sensing process, Physics of radiant energy, Energy source and its characteristics, Atmospheric interactions with electromagnetic radiation, Energy interaction with Earth's surface materials.	**12**
II	Microwave Remote Sensing Introduction, The Radar principle, Factors affecting microwave measurements, Radar wavebands, Side looking airborne (SLAR) systems, Synthetic Aperture Radar (SAR), Polarimetric SAR (PolSAR), Interaction between microwaves and Earth's surface, Interpreting SAR images, Geometric characteristics. Remotes Sensing Platforms and Sensors Introduction, Satellite system parameters, Spatial Resolution, Spectral Resolution, Radiometric Resolution, Temporal resolution, Imaging sensor systems (thermal, multispectral and microwave imaging), Earth resources satellites, Meteorological satellites, Satellites carrying microwave sensors, OCEASAT-1, IKONOS, Latest trends in remote sensing platforms and sensors (weather, land observation and marine satellites).	**12**
III	Image Analysis Introduction, Visual interpretation, Elements of visual interpretation, Digital processing, Pre-processing, Enhancement, Transformations, Classification, Integration, Classification accuracy assessment. Applications Introduction, Agriculture, Forestry, Geology, Hydrology, Sea Ice, Land cover, Mapping, Oceans and Costal.	**12**
IV	Medical Image Processing Various modalities of medical imaging, Breast cancer imaging, Mammographic imaging, Ultrasound imaging, Magnetic resonance imaging (MRI), Breast thermograph imaging, Problems with medical images. Image enhancement, Spatial domain methods, Frequency domain methods, other modalities of medical imaging, Radiography, Positron emission tomography (PET), Computed tomography angiography (CTA), Echocardiogram.	**12**
V	**Feature Extraction and Statistical Measurement** Selection of features, Shape related features, Shape representation,	**12**

	Bounding box, Shape matrix, Moments of region and shape, Co-occurrence matrix, Principal feature analysis (PFA), Fourier descriptors, Snake boundary detection, Snake algorithm, Texture analysis, Texture features, Feature extraction using discrete Fourier transform, wavelet transform, Gabor filters for texture analysis, Breast tissue detection, Analysis of tissue structure.	

Books and References:			
Title	**Author/s**	**Edition**	**Publisher**
Text Book of Remote Sensing and Geographical Information Systems	M. Anji Reddy	4th Edition	BS publication
Remote Sensing and Image Interpretation	Lillesand, T.M. and Kiefer, R.W.	6th edition.	John Wiley and Sons Inc.
Medical Image Processing Concepts and Applications	Sinha, G.R., Patel, Bhagwati Charan		PHI
Digital Image Processing	Gonzalez and Woods	3rd Edition	Pearson
Digital Image Processing and Analysis	Bhabatosh Chanda,Dwijesh Dutta Majumder	2nd Edition	PHI

MAJOR SSC-II Practical			
M. Sc (Information Technology)		**Semester 2**	
Course Name: Advanced Image Processing Practical		**Course Code:**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**		

Practical No	Details
1 - 10	10 Practical based on above syllabus, covering entire syllabus

MAJOR SSC-III				
M. Sc (Information Technology)		**Semester 2**		
Course Name: Modern Networking		**Course Code:**		
Periods per week (1 Period is 60 minutes)		**2**		
Credits		**2**		
		Hours	**Marks**	
Evaluation System	**Theory Examination**			
	Internal			

Objectives	To understand the state-of-the-art in network protocols, architectures and applications. Analyze 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

SYLLABUS		
Unit	**Details**	**Lectures**
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 Traffic Big 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 Software-Defined Networking, Network Functions Virtualization Modern Networking Elements	**6**
II	Software-Defined Networks SDN: Background and Motivation, Evolving Network Requirements Demand Is Increasing, Supply Is Increasing Traffic Patterns Are More Complex Traditional Network Architectures are Inadequate, The SDN Approach Requirements SDN Architecture Characteristics of Software-Defined Networking, SDN- and NFV-Related Standards Standards-Developing 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 Interface Routing, ITU-T Model, OpenDaylight OpenDaylight Architecture OpenDaylight Helium, REST REST Constraints	**6**

	Example REST API, Cooperation and Coordination Among Controllers, Centralized Versus Distributed Controllers, High-Availability 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, Compute Domain, 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, Software-Defined Storage, SDI Architecture	**6**
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, Service Level 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, Glass-Box Parameter-Based QoS/QoE Mapping Models,Gray-Box QoS/QoE Mapping Models, Tips for QoS/QoE Mapping	**6**

	Model Selection,IP-Oriented 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, Software-Defined Security, NFV Security, Attack Surfaces, ETSI Security Perspective, Security Techniques, Cloud Security, Security Issues and Concerns, Cloud Security Risks and Countermeasures, Data Protection in the Cloud, Cloud Security as 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	**6**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud	William Stallings	Addison-Wesley Professional		October 2015
2.	SDN and NFV Simplified A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization	Jim Doherty	Pearson Education, Inc		
3.	Network Functions Virtualization (NFV) with a Touch of SDN	Rajendra Chayapathi Syed Farrukh Hassan	Addison-Wesley		
4.	CCIE and CCDE Evolving Technologies Study Guide	Brad dgeworth, Jason Gooley, Ramiro Garza Rios	Pearson Education, Inc		2019

GENERIC ELECTIVE: Opt for any ONE out of the following TWO

Generic Elective				
M. Sc (Information Technology)		**Semester 1**		
Course Name: Microservices Architecture		**Course Code:**		
Periods per week (1 Period is 60 minutes)		**3**		
Credits		**3**		
		Hours	**Marks**	
Evaluation System	**Theory Examination**			
	Internal			

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.

Unit	Details	Lectures
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.	**9**
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.	**9**
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.	**9**
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.	**9**

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, Building the Proximity Monitor. Putting It All Together: Identifying and Fixing Anti-Patterns, Continuing the Debate over Composite Microservices, The Future.	**9**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Microservice Architecture: *Aligning Principles, Practices, and Culture*	Irakli Nadareishvili, Ronnie Mitra, Matt McLarty, and Mike Amundsen	O'Reilly	First	2016
2.	Building Microservices with ASP.NET Core	Kevin Hoffman	O'Reilly	First	2017
3.	Building Microservices: Designing Fine-Grained Systems	Sam Newman	O'Reilly	First	
4.	Production-ready Microservices	Susan J. Fowler	O'Reilly		2016

Generic Elective Practical				
B. Sc (Information Technology)			**Semester 1**	
Course Name: **Microservices Architecture Practical**			**Course Code:**	
Periods per week (1 Period is 60 minutes)			**2**	
Credits			**1**	
			Hours	**Marks**
Evaluation System	**Theory Examination**			
	Internal			

Course Outcome	Develop web applications using Model View Control. Create MVC Models and write code that implements business logic within Model methods, properties, and events. Create Views in an MVC application that display and edit data and interact with Models and Controllers. Boost your hire ability through innovative and independent learning. Gaining a thorough understanding of the philosophy and architecture of .NET Core Understanding packages, metapackages and frameworks Acquiring a working knowledge of the .NET programming model Implementing multi-threading effectively in .NET applications

SR. NO.	DETAILS
1-10.	10 Practical based on above syllabus, covering entire syllabus

Generic Elective				
M. Sc (Information Technology)			**Semester 1**	
Course Name: Advance Python Programming			**Course Code:**	
Periods per week (1 Period is 60 minutes)			**2**	
Credits			**3**	
			Hours	**Marks**
Evaluation System	**Theory Examination**			
	Internal			

Objectives	This course aims to provide conceptual understanding of advanced features of Python.
	This course aims to provide the basic understanding of project development using Python.

SYLLABUS		
UNIT	**DETAILS**	**LECTURES**
I	Sets in Python: What is a set?, Creating and initializing a set, List vs Set, Creating an empty set, Adding values in set, Removing values from set, Iterating through a set, Set membership test, Methods of set, Union operation, Intersect operation, Difference operation, Symmetric operation. FrozenSet in Python: Usage, Difference between Set and FrozenSet, Operations and methods of frozen set. Python Lambda Functions: Introduction, Need and Usage of lambda function, Passing arguments to lambda function, Using lambda function with filter, map, reduce.	9
II	NumPY Library: Introduction, Setup and use numpy module, Ndarray Object, Data types, Array Attributes, Creating NumPy arrays, Creating array from existing data and from numerical values, Indexing and slicing, Iterating over array, Broadcasting of arrays, Array manipulation, 12 Mathematical functions, String functions, Arithmetic functions, Statistical Functions, Sort, Search and Count operations using Numpy. File I/O with Numpy. SciPY library: Introduction, Setup and use scipy module, SciPy sub-packages: Constants package, FFT package, Interpolate package, Linalg package, NdImage package, Special package	9
III	Matplotlib Library: Introduction, Setup and use Matplotlib module, 2D visualization using library, create bar graph, create histogram, create scatter plot, create area plot, create pie chart. Seaborn Library: Introduction, Difference between Matplotlib and Seaborn library, relplot functions, categorical plots, multi-plot grids, using color palettes.	9
IV	Pandas Library: Different Data Structures in Pandas, Creating series using various datasets, Creating data frame using various datasets, Creating panel in different ways, Basic operations on different data structure, Summarizing data and Descriptive statistics, Iteration of data structures, Sort operations, Windows functions, Aggregation, Handling Missing Data, Group By, Merging Data.	9
V	Socket Programming: Introduction to Sockets, Client, Servers. Socket Module, Creating a simple client- server application using socket programming. Sending Email in Python: Introduction of SMTP, Configure sender & receiver, Sending simple email, Sending HTML text in email, Adding attachments in email.	9

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Core Python Programming	R. Nageswara Rao	Dreamtech	2 nd	2018
2.	Python for Data Analysis	Wes McKinney	O'Reilly	2 nd	2018
3.	Python Crash Course	Eric Matthes	William Pollock	2 nd	2019
4.	Let Us Python	Yashavant Kanetkar Aditya Kanetkar	BPB	1 st	2019
5.	Python for Data Science for Dummies	John Paul Mueller	O'Reilly	2 nd	2019
6.	Programming Python	Mark Lutz	O'Reilly	3 rd	2018
7.	Learning Python Network Programming	Dr. M.O. Faruque Sarkar	O'Reilly	1 st	2015

Generic Elective Practical				
B. Sc (Information Technology)			**Semester 1**	
Course Name: **Advance Python Programming Practical**			**Course Code:**	
Periods per week (1 Period is 60 minutes)			**2**	
Credits			**1**	
			Hours	**Marks**
Evaluation System	**Theory Examination**			
	Internal			

Course Outcome	Understand importance of advanced features of Python

SR. NO.	DETAILS
1-10.	10 Practical based on above syllabus, covering entire syllabus