University of Mumbai

No. UG/ 106 of 2019-20

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, the Head of the University Department and Directors of the recognized Institutions in Science & Technology Faculty is invited to the syllabus uploaded by Academic Authority Unit which was accepted by the Academic Council at its meeting held on 27th February, 2013 **vide** item No. 4.133 relating to the revised syllabus as per (CBSGS) for M.Sc. Information Technology (Sem. I & II).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Information & Technology at its meeting held on 25th July, 2019 have been accepted by the Academic Council at its meeting held on 26th July, 2019 **vide** item No.4.76 and that in accordance therewith, the revised syllabus as per the (CBCS) for the M.Sc. (I. T.) (Part – I) (Sem.-I & II) has been brought into force with effect from the academic year 2019-20, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
11th September, 2019

(Dr. Ajay Deshmukh)
REGISTRAR

To

The Principals of the affiliated Colleges, the Head of the University Department and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.76/26/07/2019

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No. UG/ 106 -A of 2019-20 MUMBAI-400 032 11th September, 2019

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Information & Technology,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. Ajay Deshmukh)
REGISTRAR

Cover Page

AC 26/07/2019
Item No. 4.76

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	M.Sc in Information Technology Part I
2	Eligibility for Admission	B.Sc(IT), B.Sc(CS), B.E, BCA (Sem I & II) B.Sc(Phy), B.Sc(Maths), B.Sc(Stats) B.Sc(Electronics)
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	-
5	No. of Years / Semesters	Two Years - Four 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	~~New~~ / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	From Academic Year 2019-2020

Date: 25/7/19

Signature :

Name of BOS Chairperson / ~~Dean~~ : Dr. (Mrs.) R. Srivaramangai

rsrimangai@udct.mu.ac.in

Rajan
(for R. G. Deshmukh)
25/7/19

Academic Council: 26/07/2019

Item No: 4.76

UNIVERSITY OF MUMBAI

Syllabus for M.Sc. Part I (Semester I and II)

Programme: M.Sc.

Subject: Information Technology

(Choice Based Credit System with effect from the academic year 2019 – 2020)

Semester – I		
Course Code	**Course Title**	**Credits**
PSIT101	Research in Computing	4
PSIT102	Data Science	4
PSIT103	Cloud Computing	4
PSIT104	Soft Computing Techniques	4
PSIT1P1	Research in Computing Practical	2
PSIT1P2	Data Science Practical	2
PSIT1P3	Cloud Computing Practical	2
PSIT1P4	Soft Computing Techniques Practical	2
	Total Credits	**24**

Semester – II		
Course Code	**Course Title**	**Credits**
PSIT201	Big Data Analytics	4
PSIT202	Modern Networking	4
PSIT203	Microservices Architecture	4
PSIT204	Image Processing	4
PSIT2P1	Big Data Analytics Practical	2
PSIT2P2	Modern Networking Practical	2
PSIT2P3	Microservices Architecture Practical	2
PSIT2P4	Image Processing Practical	2
	Total Credits	**24**

Program Specific Outcomes

PSO1: Ability to apply the knowledge of Information Technology with recent trends aligned with research and industry.

PSO2: Ability to apply IT in the field of Computational Research, Soft Computing, Big Data Analytics, Data Science, Image Processing, Artificial Intelligence, Networking and Cloud Computing.

PSO3: Ability to provide socially acceptable technical solutions in the domains of Information Security, Machine Learning, Internet of Things and Embedded System, Infrastructure Services as specializations.

PSO4: Ability to apply the knowledge of Intellectual Property Rights, Cyber Laws and Cyber Forensics and various standards in interest of National Security and Integrity along with IT Industry.

PSO5: Ability to write effective project reports, research publications and content development and to work in multidisciplinary environment in the context of changing technologies.

SEMESTER I

M. Sc (Information Technology)		Semester – I	
Course Name: Research in Computing		**Course Code: PSIT101**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**4**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**60**
	Theory Internal	**--**	**40**

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.

Unit	Details	Lectures
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**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Business Research Methods	William G.Zikmund, B.J Babin, J.C. Carr,	Cengage	8e	2016

		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

M. Sc (Information Technology)		**Semester – I**	
Course Name: Research in Computing Practical		**Course Code: PSIT1P1**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**40**

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

Course Outcome	A learner will be able to: □ solve real world problems with scientific approach. □ develop analytical skills by applying scientific methods. □ recognize, understand and apply the language, theory and models of the field of business analytics □ foster an ability to critically analyze, synthesize and solve complex unstructured business problems □ understand and critically apply the concepts and methods of business analytics □ identify, model and solve decision problems in different settings □ interpret results/solutions and identify appropriate courses of action for a given managerial situation whether a problem or an opportunity □ create viable solutions to decision making problems

M. Sc (Information Technology)		Semester – I	
Course Name: Data Science		**Course Code: PSIT102**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**4**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**60**
	Theory Internal	**--**	**40**

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.

Pre requisites	Basic understanding of statistics

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, Graphics, Pictures, Showing the Difference	**12**

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

M. Sc (Information Technology)		**Semester – I**	
Course Name: Data Science Practical		**Course Code: PSIT1P2**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**40**

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

Course Outcome	• 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.
- Use data mining software to solve real-world problems.
- Employ cutting edge tools and technologies to analyze Big Data.
- Apply algorithms to build machine intelligence.
- Demonstrate use of team work, leadership skills, decision making and organization theory.

M. Sc (Information Technology)		Semester – I	
Course Name: Cloud Computing		**Course Code: PSIT103**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**4**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**60**
	Theory Internal	**--**	**40**

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.

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	**12**

	Sign-On (SSO), Cloud-Based Security Groups, Hardened Virtual Server Images	
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**

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

M. Sc (Information Technology)		Semester – I	
Course Name: Cloud Computing Practical		**Course Code: PSIT1P3**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**40**

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

Course Outcome	• 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 • Broadly educate to know the impact of engineering on legal and societal issues involved in addressing the security issues of cloud computing.

M. Sc (Information Technology)		Semester – I	
Course Name: Soft Computing Techniques		**Course Code: PSIT104**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**4**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**60**
	Theory Internal	**--**	**40**

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

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.	**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**

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

M. Sc (Information Technology)		**Semester – I**	
Course Name: Soft Computing Techniques Practical		**Course Code: PSIT1P4**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**40**

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

Course Outcome	• 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 • 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 • 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.

SEMESTER II

M. Sc (Information Technology)		Semester – II	
Course Name: BigData Analytics		**Course Code: PSIT201**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**4**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**60**
	Theory Internal	**--**	**40**

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,	**12**

	Advanced MapReduce. In-Memory Computing with Spark, Spark Basics, Interactive Spark with PySpark, Writing Spark Applications,	
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**

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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

M. Sc (Information Technology)		**Semester – II**	
Course Name: BigData Analytics Practical		**Course Code: PSIT2P1**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**40**

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

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.

M. Sc (Information Technology)		Semester – I	
Course Name: Modern Networking		**Course Code: PSIT202**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**4**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**60**
	Theory Internal	**--**	**40**

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.

Pre requisites	Fundamentals of Networking

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 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 Software-Defined 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 Software-	**12**

	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 InterfaceRouting, ITU-T Model, OpenDaylight OpenDaylight Architecture OpenDaylight Helium, REST REST Constraints 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,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,Software-Defined 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, 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 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	**12**
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	**12**

	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	

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

M. Sc (Information Technology)		**Semester – II**	
Course Name: Modern Networking Practical		**Course Code: PSIT2P2**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**40**

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

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

M. Sc (Information Technology)		Semester – I	
Course Name: Microservice Architecture		**Course Code: PSIT203**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**4**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**60**
	Theory Internal	**--**	**40**

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.	**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:**	**12**

	Microservices Ecosystems, Building the location Service, Enhancing Team Service.	
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, Building the Proximity Monitor. **Putting It All Together:** Identifying and Fixing Anti-Patterns, Continuing the Debate over Composite Microservices, The Future.	**12**

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

M. Sc (Information Technology)		Semester – II	
Course Name: Microservices Architecture Practical		**Course Code: PSIT2P3**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**40**

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

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

M. Sc (Information Technology)		Semester – II	
Course Name: Image Processing		**Course Code: PSIT204**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**4**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**60**
	Theory Internal	**--**	**40**

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.

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	**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 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	**12**
III	**Wavelet and Other Image Transforms:** Preliminaries, Matrix-based Transforms, Correlation, Basis Functions in the Time-Frequency Plane, Basis	**12**

	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,	
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**

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

M. Sc (Information Technology)		**Semester – II**	
Course Name: Image Processing Practical		**Course Code: PSIT2P4**	
Periods per week **1 Period is 60 minutes**	**Lectures**	**4**	
	Credits	**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**40**

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

Course Outcome	• Understand the relevant aspects of digital image representation and their practical implications. • Have the ability to design pointwise intensity transformations to meet stated specifications. • Understand 2-D convolution, the 2-D DFT, and have the abitilty to design systems using these concepts. • Have a command of basic image restoration techniques. • Understand the role of alternative color spaces, and the design requirements leading to choices of color space. • Appreciate the utility of wavelet decompositions and their role in image processing systems. • Have an understanding of the underlying mechanisms of image compression, and the ability to design systems using standard algorithms to meet design specifications.

Evaluation Scheme

Internal Evaluation (40 Marks)

The internal assessment marks shall be awarded as follows:

1. **30 marks (Any one of the following):**
    a. **Written Test or**
    b. **SWAYAM (Advanced Course) of minimum 20 hours and certification exam completed or**
    c. **NPTEL (Advanced Course) of minimum 20 hours and certification exam completed or**
    d. **Valid International Certifications (Prometric, Pearson, Certiport, Coursera, Udemy and the like)**
    e. **One certification marks shall be awarded one course only. For four courses, the students will have to complete four certifications.**
2. **10 marks**
   The marks given out of 40 for publishing the research paper should be divided into four course and should awarded out of 10 in each of the four course.

i. **Suggested format of Question paper of 30 marks for the written test.**

Q1.	**Attempt *any two* of the following:**	**16**
a.		
b.		
c.		
d.		
Q2.	**Attempt *any two* of the following:**	**14**
a.		
b.		
c.		
d.		

ii. **10 marks from every course coming to a total of 40 marks, shall be awarded on publishing of research paper in UGC approved Journal with plagiarism less than 10%. The marks can be awarded as per the impact factor of the journal, quality of the paper, importance of the contents published, social value.**

External Examination: (60 marks)

	All questions are compulsory	
Q1	**(Based on Unit 1) Attempt *any two* of the following:**	**12**
a.		
b.		
c.		
d.		
Q2	**(Based on Unit 2) Attempt *any two* of the following:**	**12**
Q3	**(Based on Unit 3) Attempt *any two* of the following:**	**12**
Q4	**(Based on Unit 4) Attempt *any two* of the following:**	**12**
Q5	**(Based on Unit 5) Attempt *any two* of the following:**	**12**

Practical Evaluation (50 marks)

A Certified copy journal is essential to appear for the practical examination.

1.	**Practical Question 1**	**20**
2.	**Practical Question 2**	**20**
3.	**Journal**	**5**
4.	**Viva Voce**	**5**

OR

1.	**Practical Question**	**40**
2.	**Journal**	**5**
3.	**Viva Voce**	**5**

University of Mumbai

No. UG/23 of 2020-21

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, the Head University Departments and Directors of the recognized Institutions in Science & Technology Faculty is invited to the syllabus uploaded Academic Authority Unit which was accepted by the Academic Council at its meeting held on 7th April, 2014 vide item No. 4.39 relating to the revised syllabus as per the (CBGS) of M.Sc. in Information Technology (Sem. III &IV).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Information Technology at its meeting held on 17th April, 2020 vide Item No.1 and subsequently made by the Board of Deans at its meeting held on 20th July, 2020 vide item No. 48 have been accepted by the Academic Council at its meeting held on 23rd July, 2020 vide item No. 4.100 and that in accordance therewith, the revised syllabus as per the (CBCS) of M.Sc. Part-II (Sem-III & IV) in Information Technology has been brought into force with effect from the academic year 2020-21 accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
(11th November, 2020
To

(Dr. Vinod Patil)
I/c REGISTRAR

The Principals of the affiliated Colleges, the Head University Departments and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.100/23/07/2020

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No. UG/23 -A of 2020-21 MUMBAI-400 032 11th November, 2020

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Information Technology,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. Vinod Patil)
I/c REGISTRAR

Copy to :-

1. **The Director of Board of Student Development.,**
2. **The Deputy Registrar (Eligibility and Migration Section)**
3. **The Director of Students Welfare,**
4. **The Executive Secretary to the to the Vice-Chancellor,**
5. **The Pro-Vice-Chancellor**
6. **The Registrar and**
7. **The Assistant Registrar, Administrative sub-centers, Ratnagiri, Thane & Kalyan, for information.**

1. **The Director of Board of Examinations and Evaluation**
2. **The Finance and Accounts Officers**
3. **Record Section**
4. **Publications Section**
5. **The Deputy Registrar, Enrolment, Eligibility and Migration Section**
6. **The Deputy Registrar (Accounts Section), Vidyanagari**
7. **The Deputy Registrar, Affiliation Section**
8. **The Professor-cum- Director, Institute of Distance and Open Learning Education,**
9. **The Director University Computer Center (IDE Building), Vidyanagari,**
10. **The Deputy Registrar (Special Cell),**
11. **The Deputy Registrar, (PRO)**
12. **The Deputy Registrar, Academic Authorities Unit (1 copies) and**
13. **The Assistant Registrar, Executive Authorities Unit**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **The Assistant Registrar Constituent Colleges Unit**
2. **BUCTU**
3. **The Deputy Accountant, Unit V**
4. **The In-charge Director, Centralize Computing Facility**
5. **The Receptionist**
6. **The Telephone Operator**
7. **The Secretary MUASA**
8. **The Superintendent, Post-Graduate Section**
9. **The Superintendent, Thesis Section**

for information.

AC_____

Item No:_____

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1.	Title of the Course	M.Sc. (Information Technology) Part II
2.	Eligibility for Admission (Lateral Entry) (Students who would like to have additional degrees)	Students who have completed MCA, M.Sc. Computer Science / Mathematics / Statistics / Physics / Electronics / Data Science, M.B.A. (I.T), M.C.M., M.Tech (20% extra seats to provided for these students) M.Sc IT from University of Mumbai (with previous syllabus under General IT) or other recognized Institutions who are willing to do specialized degree
3.	Passing Marks	40%
4.	Ordinances / Regulations (if, any)	Existing ordinances and regulations.
5.	Number of years / Semesters	Two years – Four Semesters
6.	Level	P.G. / U.G. /Diploma / Certificate (Strike out which is not applicable)
7.	Pattern	~~Yearly /~~ Semester, Choice Based (Strike out which is not applicable)
8.	Status	~~New /~~ Revised
9.	To be implemented from Academic year	From the Academic Year **2020 – 2021**

Date: April 17, 2020

Name of the BoS Chairperson ~~/ Dean~~:

Signature: _____

Dr. (Mrs.) R. Srivaramangai

(rsrimangai@udit.mu.ac.in)

Academic Council _____
Item No: _____

UNIVERSITY OF MUMBAI

Syllabus for M.Sc. I.T. Part II
Semester III and IV
Programme: M.Sc.
Subject: Information Technology
CHOICE BASED(REVISED)
with effect from the academic year
2020 – 2021

Artificial Intelligence Track
Image Processing Track
Cloud Computing Track
Security Track

SEMESTER - III					
	Course Title				
Course Code	Theory	Credits	Course Code	Practical	Credits
PSIT301	Technical Writing and Entrepreneurship Development	4	PSIT3P1	Project Documentation and Viva	2
Elective 1: Select Any one from the courses listed below along with corresponding practical course					
PSIT302a	Applied Artificial Intelligence	4	PSIT3P2a	Applied Artificial Intelligence Practical	2
PSIT302b	Computer Vision		PSIT3P2b	Computer Vision Practical	
PSIT302c	Cloud Application Development		PSIT3P2c	Cloud Application Development Practical	
PSIT302d	Security Breaches and Countermeasures		PSIT3P2d	Security Breaches and Countermeasures Practical	
Elective 2: Select Any one from the courses listed below along with corresponding practical course					
PSIT303a	Machine Learning	4	PSIT3P3a	Machine Learning Practical	2
PSIT303b	Biomedical Image Processing		PSIT3P3b	Biomedical Image Processing Practical	
PSIT303c	Cloud Management		PSIT3P3c	Cloud Management Practical	
PSIT303d	Malware Analysis		PSIT3P3d	Malware Analysis Practical	
Elective 3: Select Any one from the courses listed below along with corresponding practical course					
PSIT304a	Robotic Process Automation	4	PSIT3P4a	Robotic Process Automation Practical	2
PSIT304b	Virtual Reality and Augmented Reality		PSIT3P4b	Virtual Reality and Augmented Reality Practical	
PSIT304c	Data Center Technologies		PSIT3P4c	Data Center Technologies Practical	
PSIT304d	Offensive Security		PSIT3P4d	Offensive Security Practical	
	Total Theory Credits	**16**		Total Practical Credits	**8**
Total Credits for Semester III: 24					

SEMESTER - IV					
	Course Title				
Course Code	Theory	Credits	Course Code	Practical	Credits
PSIT401	Blockchain	4	PSIT4P1		2
Elective 1: Select Any one from the courses listed below along with corresponding practical course					
PSIT402a	Natural Language Processing	4	PSIT4P2a	Natural Language Processing Practical	2
PSIT402b	Digital Image Forensics		PSIT4P2b	Digital Image Forensics Practical	
PSIT402c	Advanced IoT		PSIT4P2c	Advanced IoT Practical	
PSIT402d	Cyber Forensics		PSIT4P2d	Cyber Forensics Practical	
Elective 2: Select Any one from the courses listed below along with corresponding practical course					
PSIT403a	Deep Learning	4	PSIT4P3a	Deep Learning Practical	2
PSIT403b	Remote Sensing		PSIT4P3b	Remote Sensing Practical	
PSIT403c	Server Virtualization on VMWare Platform		PSIT4P3c	Server Virtualization on VMWare Platform Practical	
PSIT403d	Security Operations Center		PSIT4P3d	Security Operations Center Practical	
Elective 3: Select Any one from the courses listed below. Project Implementation and Viva is compulsory					
PSIT404a	Human Computer Interaction	4	PSIT4P4	Project Implementation and Viva	2
PSIT404b	Advanced Applications of Image Processing				
PSIT404c	Storage as a Service				
PSIT404d	Information Security Auditing				
	Total Theory Credits	**16**		Total Practical Credits	**8**
Total Credits for Semester IV: 24					

If a student selects all 6 papers of Artificial Intelligence Track, he should be awarded the degree **M.Sc. (Information Technology), Artificial Intelligence Specialisation.**
If a student selects all 6 papers of Image Processing Track, he should be awarded the degree **M.Sc. (Information Technology), Image Processing Specialisation.**
If a student selects all 6 papers of Cloud Computing Track, he should be awarded the degree **M.Sc. (Information Technology), Cloud Computing Specialisation**
If a student selects all 6 papers of Artificial Security Track, he should be awarded the degree **M.Sc. (Information Technology), Security Specialisation**
All other students will be awarded M.Sc. (Information Technology) degree.

Table of Contents

SEMESTER III

PSIT301: Technical Writing and Entrepreneurship Development

M. Sc (Information Technology)		**Semester – III**	
Course Name: Technical Writing and Entrepreneurship Development		**Course Code: PSIT301**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- This course aims to provide conceptual understanding of developing strong foundation in general writing, including research proposal and reports.
- It covers the technological developing skills for writing Article, Blog, E-Book, Commercial web Page design, Business Listing Press Release, E-Listing and Product Description.
- This course aims to provide conceptual understanding of innovation and entrepreneurship development.

Unit	Details	Lectures	Outcome
I	Introduction to Technical Communication: What Is Technical Communication? The Challenges of Producing Technical Communication, Characteristics of a Technical Document, Measures of Excellence in Technical Documents, Skills and Qualities Shared by Successful Workplace Communicators, How Communication Skills and Qualities Affect Your Career? **Understanding Ethical and Legal Considerations:** A Brief Introduction to Ethics, Your Ethical Obligations, Your Legal Obligations, The Role of Corporate Culture in Ethical and Legal Conduct, Understanding Ethical and Legal Issues Related to Social Media, Communicating Ethically Across Cultures, Principles for Ethical Communication **Writing Technical Documents:** Planning, Drafting, Revising, Editing, Proofreading **Writing Collaboratively:** Advantages and Disadvantages of Collaboration, Managing Projects, Conducting Meetings, Using Social Media and Other Electronic Tools in Collaboration, Importance of Word Press Website, Gender and Collaboration, Culture and Collaboration.	**12**	**CO1**
II	**Introduction to Content Writing:** Types of Content (Article, Blog, E-Books, Press Release, Newsletters Etc), Exploring Content Publication Channels. Distribution of your content across various channels. **Blog Creation:** Understand the psychology behind your web traffic,	**12**	**CO2**

	Creating killing landing pages which attract users, Using Landing Page Creators, Setting up Accelerated Mobile Pages, Identifying UI UX Experience of your website or blog. **Organizing Your Information:** Understanding Three Principles for Organizing Technical Information, Understanding Conventional Organizational Patterns, **Emphasizing Important Information:** Writing Clear, Informative Titles, Writing Clear, Informative Headings, Writing Clear Informative Lists, Writing Clear Informative Paragraphs.		
III	**Creating Graphics:** The Functions of Graphics, The Characteristics of an Effective Graphic, Understanding the Process of Creating Graphics, Using Color Effectively, Choosing the Appropriate Kind of Graphic, Creating Effective Graphics for Multicultural Readers. **Researching Your Subject:** Understanding the Differences Between Academic and Workplace Research, Understanding the Research Process, Conducting Secondary Research, Conducting Primary Research, **Research and Documentation:** Literature Reviews, Interviewing for Information, Documenting Sources, Copyright, Paraphrasing, Questionnaires. **Report Components:** Abstracts, Introductions, Tables of Contents, Executive Summaries, Feasibility Reports, Investigative Reports, Laboratory Reports, Test Reports, Trip Reports, Trouble Reports	**12**	**CO3**
IV	**Writing Proposals:** Understanding the Process of Writing Proposals, The Logistics of Proposals, The "Deliverables" of Proposals, Persuasion and Proposals, Writing a Proposal, The Structure of the Proposal. **Writing Informational Reports:** Understanding the Process of Writing Informational Reports, Writing Directives, Writing Field Reports, Writing Progress and Status Reports, Writing Incident Reports, Writing Meeting Minutes. **Writing Recommendation Reports:** Understanding the Role of Recommendation Reports, Using a Problem-Solving Model for Preparing Recommendation Reports, Writing Recommendation Reports. **Reviewing, Evaluating, and Testing Documents and Websites:** Understanding Reviewing, Evaluating, and Testing, Reviewing Documents and Websites, Conducting Usability Evaluations, Conducting Usability Tests, Using Internet tools to check writing Quality, Duplicate Content Detector, What is Plagiarism?, How to avoid writing plagiarism content? **Innovation management: an introduction:** The importance of innovation, Models of innovation, Innovation as a management process. **Market adoption and technology diffusion:** Time lag between innovation and useable product, Innovation and the market ,	**12**	**CO4**

	Innovation and market vision ,Analysing internet search data to help adoption and forecasting sales ,Innovative new products and consumption patterns, Crowd sourcing for new product ideas, Frugal innovation and ideas from everywhere, Innovation diffusion theories.		
V	**Managing innovation within firms:** Organisations and innovation, The dilemma of innovation management, Innovation dilemma in low technology sectors, Dynamic capabilities, Managing uncertainty, Managing innovation projects **Operations and process innovation:** Operations management, The nature of design and innovation in the context of operations, Process design, Process design and innovation **Managing intellectual property:** Intellectual property, Trade secrets, An introduction to patents, Trademarks, Brand names, Copyright **Management of research and development:** What is research and development?, R&D management and the industrial context, R&D investment and company success, Classifying R&D, R&D management and its link with business strategy, Strategic pressures on R&D, Which business to support and how?, Allocation of funds to R&D, Level of R&D expenditure **Managing R&D projects:** Successful technology management, The changing nature of R&D management, The acquisition of external technology, Effective R&D management, The link with the product innovation process, Evaluating R&D projects.	**12**	**CO5**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Technical Communication	Mike Markel	Bedford/St. Martin's	11	2014
2.	Innovation Management and New Product Development	Paul Trott	Pearson	06	2017
3.	Handbook of Technical Writing	Gerald J. Alred , Charles T. Brusaw , Walter E. Oliu	Bedford/St. Martin's	09	2008
4.	Technical Writing 101: A Real-World Guide to Planning and Writing Technical Content	Alan S. Pringle and Sarah S. O'Keefe	scriptorium	03	2009
5.	Innovation and Entrepreneurship	Peter Drucker	Harper Business	03	2009

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Develop technical documents that meet the requirements with standard guidelines. Understanding the essentials and hands-on learning about effective Website Development.
CO2: Write Better Quality Content Which Ranks faster at Search Engines. Build effective Social Media Pages.
CO3: Evaluate the essentials parameters of effective Social Media Pages.
CO4: Understand importance of innovation and entrepreneurship.
CO5: Analyze research and development projects.

PSIT3P1: Project Documentation and Viva

M. Sc (Information Technology)		**Semester – III**	
Course Name: Project Documentation and Viva		**Course Code: PSIT3P1**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	--

The learners are expected to develop a project beyond the undergraduate level. Normal web sites, web applications, mobile apps are not expected. Preferably, the project should be from the elective chosen by the learner at the post graduate level. In semester three. The learner is supposed to prepare the synopsis and documentation. The same project has to be implemented in Semester IV.
More details about the project is given is Appendix 1.

PSIT302a: Applied Artificial Intelligence

M. Sc (Information Technology)		**Semester – III**	
Course Name: Applied Artificial Intelligence		Course Code: PSIT302a	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To explore the applied branches of artificial intelligence
- To enable the learner to understand applications of artificial intelligence
- To enable the student to solve the problem aligned with derived branches of artificial intelligence.

Unit	*Details*	*Lectures*	*Outcome*
I	**Review of AI:** History, foundation and Applications **Expert System and Applications:** Phases in Building Expert System, Expert System Architecture, Expert System versus Traditional Systems, Rule based Expert Systems, Blackboard Systems, Truth Maintenance System, Application of Expert Systems, Shells and Tools	**12**	**CO1**
II	**Probability Theory:** joint probability, conditional probability, Bayes's theorem, probabilities in rules and facts of rule based system, cumulative probabilities, rule based system and Bayesian method **Fuzzy Sets and Fuzzy Logic:** Fuzzy Sets, Fuzzy set operations, Types of Member ship Functions, Multivalued Logic, Fuzzy Logic, Linguistic variables and Hedges, Fuzzy propositions, inference rules for fuzzy propositions, fuzzy systems, possibility theory and other enhancement to Logic	**12**	**CO2**
III	**Machine Learning Paradigms:** Machine Learning systems, supervised and un-supervised learning, inductive learning, deductive learning, clustering, support vector machines, cased based reasoning and learning. **Artificial Neural Networks:** Artificial Neural Networks, Single-Layer feedforward networks, multi-layer feed-forward networks, radial basis function networks, design issues of artificial neural networks and recurrent networks	**12**	**CO3**
IV	**Evolutionary Computation:** Soft computing, genetic algorithms, genetic programming concepts, evolutionary programming, swarm intelligence, ant colony paradigm, particle swarm optimization and applications of evolutionary algorithms. **Intelligent Agents:** Agents vs software programs, classification of agents, working of an agent, single agent and multiagent systems, performance evaluation, architecture,	**12**	**CO4**

	agent communication language, applications		
V	Advanced Knowledge Representation Techniques: Conceptual dependency theory, script structures, CYC theory, script structure, CYC theory, case grammars, semantic web. Natural Language Processing: Sentence Analysis phases, grammars and parsers, types of parsers, semantic analysis, universal networking language, dictionary	**12**	**CO5**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Artificial Intelligence	Saroj Kaushik	Cengage	1st	2019
2.	Artificial Intelligence: A Modern Approach	A. Russel, Peter Norvig		1st	
3.	Artificial Intelligence	Elaine Rich,Kevin Knight,Shivashankar B. Nair	Tata Mc-Grawhill	3rd	

M. Sc (Information Technology)		**Semester – III**	
Course Name: Artificial Intelligence Practical		**Course Code: PSIT3P2a**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	--

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completion of course the learner will:
CO1: be able to understand the fundamentals concepts of expert system and its applications.
CO2: be able to use probability and concept of fuzzy sets for solving AI based problems.
CO3: be able to understand the applications of Machine Learning. The learner can also apply fuzzy system for solving problems.
CO4: learner will be able to apply to understand the applications of genetic algorithms in different problems related to artificial intelligence.
CO5: A learner can use knowledge representation techniques in natural language processing.

PSIT302b: Computer Vision

M. Sc (Information Technology)		Semester – III	
Course Name: Computer Vision		**Course Code: PSIT302b**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To develop the student's understanding of the issues involved in trying to define and simulate perception.
- To familiarize the student with specific, well known computer vision methods, algorithms and results.
- To provide the student additional experience in the analysis and evaluation of complicated systems.
- To provide the student additional software development experience.
- To provide the student with paper and proposal writing experience.

Unit	Details	Lectures	Outcome
I	**Introduction:** What is computer vision?, A brief history, Image formation, Geometric primitives and transformations, Geometric primitives, D transformations, D transformations, D rotations, D to D projections, Lens distortions, Photometric image formation, Lighting, Reflectance and shading, Optics, The digital camera, Sampling and aliasing, Color ,Compression **Feature-based alignment**: D and D feature-based alignment, D alignment using least squares , Application: Panography , Iterative algorithms , Robust least squares and RANSAC , D alignment , Pose estimation , Linear algorithms, Iterative algorithms , Application: Augmented reality , Geometric intrinsic calibration, Calibration patterns, Vanishing points , Application: Single view metrology , Rotational motion ,Radial distortion	**12**	**CO1**
II	**Structure from motion :** Triangulation, Two-frame structure from motion , Projective (uncalibrated) reconstruction, Self-calibration , Application: View morphing , Factorization, Perspective and projective factorization , Application: Sparse D model extraction, Bundle adjustment, Exploiting sparsity , Application: Match move and augmented reality , Uncertainty and ambiguities , Application: Reconstruction from Internet photos , Constrained structure and motion , Line-based techniques , Plane-based techniques	**12**	**CO2**

	Dense motion estimation : Translational alignment , Hierarchical motion estimation, Fourier-based alignment , Incremental refinement , Parametric motion, Application: Video stabilization, Learned motion models , Spline-based motion, Application: Medical image registration, Optical flow, Multi-frame motion estimation ,Application: Video denoising , Application: De-interlacing , Layered motion, Application: Frame interpolation, Transparent layers and reflections		
III	**Image stitching :** Motion models, Planar perspective motion, Application: Whiteboard and document scanning , Rotational panoramas , Gap closing , Application: Video summarization and compression, Cylindrical and spherical coordinates, Global alignment, Bundle adjustment,Parallax removal , Recognizing panoramas, Direct vsfeature-based alignment, Compositing , Choosing a compositing surface, Pixel selection and weighting (de-ghosting) , Application: Photomontage,Blending **Computational photography :** Photometric calibration ,Radiometric response function ,Noise level estimation ,Vignetting ,Optical blur (spatial response) estimation ,High dynamic range imaging ,Tone mapping ,Application: Flash photograpy,Super-resolution and blur removal,Color image demosaicing ,Application: Colorization,Image matting and compositing ,Blue screen matting ,Natural image matting ,Optimization-based matting ,Smoke, shadow, and flash matting ,Video matting ,Texture analysis and synthesis ,Application: Hole filling and inpainting ,Application: Non-photorealistic rendering	**12**	**CO3**
IV	Stereo correspondence Epipolar geometry , Rectification ,Plane sweep , Sparse correspondence , D curves and profiles , Dense correspondence, Similarity measures , Local methods , Sub-pixel estimation and uncertainty , Application: Stereo-based head tracking , Global optimization , Dynamic programming , Segmentation-based techniques, Application: Z-keying and background replacement, Multi-view stereo, Volumetric and D surface reconstruction, Shape from silhouettes **3D reconstruction :** Shape from X , Shape from shading and photometric stereo, Shape from texture, Shape from focus , Active rangefinding , Range data merging , Application: Digital heritage , Surface representations , Surface interpolation, Surface simplification, Geometry images , Point-based representations, Volumetric representations , Implicit surfaces and level sets , Model-based reconstruction, Architecture, Heads and faces , Application: Facial	**12**	**CO4**

	animation , Whole body modeling and tracking ,Recovering texture maps and albedos , Estimating BRDFs ,Application: D photography		
V	**Image-based rendering :** View interpolation, View-dependent texture maps, Application: Photo Tourism , Layered depth images, Impostors, sprites, and layers, Light fields and Lumigraphs , Unstructured Lumigraph, Surface light fields, Application: Concentric mosaics, Environment mattes, Higher-dimensional light fields , The modeling to rendering continuum, Video-based rendering , Video-based animation, Video textures , Application: Animating pictures, D Video, Application: Video-based walkthroughs **Recognition :** Object detection, Face detection, Pedestrian detection, Face recognition, Eigenfaces, Active appearance and D shape models, Application: Personal photo collections, Instance recognition, Geometric alignment, Large databases, Application: Location recognition, Category recognition, Bag of words, Part-based models, Recognition with segmentation, Application: Intelligent photo editing, Context and scene understanding , Learning and large image collections, Application: Image search, Recognition databases and test sets	**12**	**CO5**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Computer Vision: Algorithms and Applications	Richard Szeliski	Springer	1st Edition	2010

M. Sc (Information Technology)		**Semester – III**	
Course Name: Computer Vision Practical		**Course Code: PSIT3P2b**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	--

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:
After completion of the course, a student should be able to:
CO1: Understand the basics of computer vision
CO2: Understand and analyse various structure form motion and various estimates of Dense Motion
CO3: Apply various motion models to images and understand computation photography techniques

CO4: Apply Epipolar geometry , Rectification and various other 3D correspondence and Stereo reconstruction techniques
CO5: Understand image-based rendering and reconstruction

PSIT302c: Cloud Application Development

M. Sc (Information Technology)		**Semester – III**	
Course Name: Cloud Application Development		**Course Code: PSIT302c**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To develop and deploy Microservices for cloud
- To understand Kubernetes and deploy applications on Azure Kubernetes Service
- To understand DevOps for Azure
- To follow the DevOps practices for software development
- To build APIs for Azure and AWS

Unit	Details	Lectures	Outcomes
I	**Implementing Microservices:** Client to microservices communication, Interservice communication, data considerations, security, monitoring, microservices hosting platform options. **Azure Service Fabric:** Introduction, core concepts, supported programming models, service fabric clusters, develop and deploy applications of service fabric. **Monitoring Azure Service Fabric Clusters:** Azure application, resource manager template, Adding Application Monitoring to a Stateless Service Using Application Insights, Cluster monitoring, Infrastructure monitoring.	**12**	**CO1**
II	**Azure Kubernetes Service (AKS):** Introduction to kubernetes and AKS, AKS development tools, Deploy applications on AKS. **Monitoring AKS:** Monitoring, Azure monitor and analytics, monitoring AKS clusters, native kubernetes dashboard, Prometheus and Grafana. **Securing Microservices:** Authentication in microservices, Implenting security using API gateway pattern, Creating application using Ocrlot and securing APIs with Azure AD. **Database Design for Microservices:** Data stores, monolithic approach, Microservices approach, harnessing cloud computing, dataase options on MS Azure, overcoming application development challenges. **Building Microservices on Azure Stack:** Azure stack, Offering IaaS, PaaS on-premises simplified, SaaS on Azure	**12**	**CO2**

	stack.		
III	.**NET DevOps for Azure:** DevOps introduction, Problem and solution. **Professional Grade DevOps Environment:** The state of DevOps, professional grade DevOps vision, DevOps architecture, tools for professional DevOps environment, DevOps centered application. **Tracking work:** Process template, Types of work items, Customizing the process, Working with the process. **Tracking code:** Number of repositories, Git repository, structure, branching pattern, Azure repos configuration, Git and Azure.	**12**	**CO3**
IV	**Building the code:** Structure of build, using builds with .NET core and Azure pipelines, **Validating the code:** Strategy for defect detection, Implementing defect detection. **Release candidate creation:** Designing release candidate architecture, Azure artifacts workflow for release candidates, **Deploying the release:** Designing deployment pipeline, Implementing deployment in Azure pipelines. **Operating and monitoring release:** Principles, Architectures for observability, Jumpstarting observability.	**12**	**CO4**
V	**Introduction to APIs:** Introduction, API economy, APIs in public sector. **API Strategy and Architecture:** API Strategy, API value chain, API architecture, **API** management. **API Development:** Considerations, Standards, kick-start API development, team orientation. **API Gateways:** API Gateways in public cloud, Azure API management, AWS API gateway. **API Security:** Request-based security, Authentication and authorization.	**12**	**CO5**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Building Microservices Applications on Microsoft Azure- Designing, Developing, Deploying, and Monitoring	Harsh Chawla Hemant Kathuria	Apress	--	2019
2.	.NET DevOps for Azure A Developer's Guide to DevOps Architecture the Right Way	Jeffrey Palermo	Apress	--	2019
3.	Practical API Architecture and Development with Azure and AWS - Design and Implementation of APIs for the Cloud	Thurupathan Vijayakumar	Apress	--	2018

M. Sc (Information Technology)		Semester – III	
Course Name: Cloud Application Development Practical		**Course Code: PSIT3P2c**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	--

List of Practical:
10 practical covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:
After completion of the course, a student should be able to:

CO01: Develop the Microservices for cloud and deploy them on Microsoft Azure.

CO02: Build and deploy services to Azure Kubernetes service.

CO03: Understand and build the DevOps way.

CO04: Thoroughly build the applications in the DevOps way.

CO05: Build the APIs for Microsoft Azure and AWS.

PSIT302d: Security Breaches and Countermeasures

M. Sc (Information Technology)		**Semester – III**	
Course Name: Security Breaches and Countermeasures		**Course Code: PSIT302d**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To get the insight of the security loopholes in every aspect of computing.
- To understand the threats and different types of attacks that can be launched on computing systems.
- To know the countermeasures that can be taken to prevent attacks on computing systems.
- To test the software against the attacks.

Unit	Details	Lectures	Outcome
I	**Introduction to Security Breaching**: Overview of Information Security, Threats and Attack vectors, Concepts of Hacking – Ethical and Unethical, Information Security Controls, Concepts of penetration Testing, Information Security Laws and Standards. **Evaluation Security of IT Organisation:** Concepts, Methodology, Tools, Countermeasures, Penetration Testing. **Network Scanning:** Concepts, Scanning beyond IDS and firewalls, Tools, Banner Grabbing, Scanning Techniques, Network Diagrams, penetration testing. **Enumeration:** Concepts, Different types of enumeration: Netbios, SNMP, LDAP, NTP, SMTP, DNS, other enumeration techniques, Countermeasures, Penetration Testing	**12**	**CO1**
II	**Analysis of Vulnerability:** Concepts, Assessment Solutions, Scoring Systems, Assessment Tools, Assessment Reports. **Breaching System Security:** Concepts, Cracking passwords, Escalating privileges, Executing Applications, Hiding files, covering tracks, penetration testing. **Threats due to malware:** Concepts, Malware Analysis, Trojan concepts, countermeasures, Virus and worm concepts, anti-malware software, penetration testing. **Network Sniffing:** Concepts, countermeasures, sniffing techniques, detection techniques, tools, penetration testing.	**12**	**CO2**

III	**Social Engineering:** Concepts, Impersonation on networking sites, Techniques, Identity theft, Insider threats, countermeasures, Pen testing. **Denial of Service and Distributed Denial of service:** Concepts, techniques, botnets, attack tools, countermeasures, protection tools, penetration testing. **Hijacking an active session:** Concepts, tools, application level session hijacking, countermeasures, network level session hijacking, penetration testing. **Evasion of IDS, Firewalls and Honeypots:** Introduction and concepts, detecting honeypots, evading IDS, IDS and Firewall evasion countermeasures, evading firewalls, penetration testing.	**12**	**CO3**
IV	**Compromising Web Servers:** Concepts, attacks, attack methodology, attack tools, countermeasures, patch management, web server security tools, penetration testing. **Compromising Web Applications:** Concepts**,** threats, methods, tools, countermeasures, testing tools, penetration testing. **Performing SQL Injection:** Concepts, types, methodology, tools, techniques, countermeasures. **Compromising Wireless Networks:** Concepts, wireless encryption, threats, methodology, tools, compromising Bluetooth, countermeasures, wireless security tools, penetration testing.	**12**	**CO4**
V	**Compromising Mobile Platforms:** Attack vectors, Compromising Android OS, Compromising iOS, Mobile spyware, Mobile Device Management, Mobile security, penetration testing. **Compromising IoT:** Concepts, attacks, compromising methodology, tools, countermeasures, penetration testing. **Cloud Security:** Concepts, Security, threats, attacks, tools, penetration testing. **Cryptography:** Concepts, email encryption, algorithms, disk encryption, tools, cryptanalysis, Public key infrastructure, countermeasures.	**12**	**CO5**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	CEHv10, Certified Ethical Hacker Study Guide	Ric Messier	Sybex - Wiley	-	2019
2.	All in One, Certified Ethical Hacker	Matt Walker	Tata McGraw Hill	-	2012
3.	CEH V10: EC-Council Certified Ethical Hacker Complete Training Guide	I.P. Specialist	IPSPECIALIST	-	2018

M. Sc (Information Technology)		Semester – III	
Course Name: Security Breaches and Countermeasures Practical		**Course Code: PSIT3P3d**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcome:
CO1: The student should be able to identify the different security breaches that can occur. The student should be able to evaluate the security of an organization and identify the loopholes. The student should be able to perform enumeration and network scanning.

CO2: The student should be able to identify the vulnerability in the systems, breach the security of the system, identify the threats due to malware and sniff the network. The student should be able to do the penetration testing to check the vulnerability of the system towards malware and network sniffing.

CO3: The student should be able to perform social engineering and educate people to be careful from attacks due to social engineering, understand and launch DoS and DDoS attacks, hijack and active session and evade IDS and Firewalls. This should help the students to make the organization understand the threats in their systems and build robust systems.

CO4: The student should be able to identify the vulnerabilities in the Web Servers, Web Applications, perform SQL injection and get into the wireless networks. The student should be able to help the organization aware about these vulnerabilities in their systems.

CO5: The student should be able to identify the vulnerabilities in the newer technologies like mobiles, IoT and cloud computing. The student should be able to use different methods of cryptography.

PSIT303a: Machine Learning

M. Sc (Information Technology)		**Semester – III**	
Course Name: Machine Learning		**Course Code: PSIT303a**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- Understanding Human learning aspects.
- Understanding primitives in learning process by computer.
- Understanding nature of problems solved with Machine Learning

Unit	Details	Lectures	Outcome
I	**Introduction:** Machine learning, Examples of Machine Learning Problems, Structure of Learning, learning versus Designing, Training versus Testing, Characteristics of Machine learning tasks, Predictive and descriptive tasks, Machine learning Models: Geometric Models, Logical Models, Probabilistic Models. Features: Feature types, Feature Construction and Transformation, Feature Selection.	**12**	**CO1**
II	**Classification and Regression: Classification:** Binary Classification- Assessing Classification performance, Class probability Estimation Assessing class probability Estimates, Multiclass Classification. **Regression**: Assessing performance of Regression- Error measures, Overfitting- Catalysts for Overfitting, Case study of Polynomial Regression. **Theory of Generalization:** Effective number of hypothesis, Bounding the Growth function, VC Dimensions, Regularization theory.	**12**	**CO2**
III	**Linear Models:** Least Squares method, Multivariate Linear Regression, Regularized Regression, Using Least Square regression for Classification. Perceptron, Support Vector Machines, Soft Margin SVM, Obtaining probabilities from Linear classifiers, Kernel methods for non-Linearity.	**12**	**CO2 CO3**
IV	**Logic Based and Algebraic Model: Distance Based Models:** Neighbours and Examples, Nearest Neighbours Classification, Distance based clustering-K means Algorithm, Hierarchical clustering, **Rule Based Models:** Rule learning for subgroup discovery, Association rule mining. **Tree Based Models:** Decision Trees, Ranking and Probability estimation Trees, Regression trees, Clustering Trees.	**12**	**CO2 CO3 CO4**

V	Probabilistic Model: Normal Distribution and Its Geometric Interpretations, Naïve Bayes Classifier, Discriminative learning with Maximum likelihood, Probabilistic Models with Hidden variables: Estimation-Maximization Methods, Gaussian Mixtures, and Compression based Models. **Trends In Machine Learning :** Model and Symbols-Bagging and Boosting, Multitask learning, Online learning and Sequence Prediction, Data Streams and Active Learning, Deep Learning, Reinforcement Learning.	**12**	**CO5**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Machine Learning: The Art and Science of Algorithms that Make Sense of Data	Peter Flach	Cambridge University Press		2012
2.	Introduction to Statistical Machine Learning with Applications in R	Hastie, Tibshirani, Friedman	Springer	2nd	2012
3.	Introduction to Machine Learning	Ethem Alpaydin	PHI	2nd	2013

M. Sc (Information Technology)		**Semester – III**	
Course Name: Machine Learning Practical		**Course Code: PSIT3P3a**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:
After completion of the course, a student should be able to:
CO1: Understand the key issues in Machine Learning and its associated applications in intelligent business and scientific computing.
CO2: Acquire the knowledge about classification and regression techniques where a learner will be able to explore his skill to generate data base knowledge using the prescribed techniques.
CO3: Understand and implement the techniques for extracting the knowledge using machine learning methods.
CO4: Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
CO5: Understand the statistical approach related to machine learning. He will also Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

PSIT303b: Biomedical Image Processing

M. Sc (Information Technology)		**Semester – III**	
Course Name: Biomedical Image Processing		**Course Code: PSIT303b**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To design intelligent systems that can analyze biomedical images.
- To understand different scientific approaches in biomedical image processing.
- To understand the structure of biomedical images and how to correlate it with different biological data.
- To design systems to identify different physical conditions on the basis of biomedical data.

Unit	Details	Lectures	Outcome
I	**Introduction:** Biosignals, Biosignal Measurement Systems, Transducers, Amplifier/Detector, Analog Signal Processing and Filters, ADC Conversion, Data Banks **Bio signal Measurements, Noise, and Analysis:** Biosignals, Noise, Signal Analysis: Data Functions and Transforms **Spectral Analysis: Classical Methods :** Fourier Series Analysis, Power Spectrum, Spectral Averaging: Welch's Method **Noise Reduction and Digital Filters :** Noise Reduction, Noise Reduction through Ensemble Averaging, Z-Transform, Finite Impulse Response Filters, Infinite Impulse Response Filters	**12**	**CO1**
II	**Modern Spectral Analysis: The Search for Narrowband Signals:** Parametric Methods, Nonparametric Analysis: Eigen analysis Frequency Estimation **Time Frequency Analysis:** Basic Approaches, The Short-Term Fourier Transform: The Spectrogram, The Wigner Ville Distribution: A Special Case of Cohen's Class, Cohen's Class Distributions **Wavelet Analysis:** Continuous Wavelet Transform, Discrete Wavelet Transform, Feature Detection: Wavelet Packets **Optimal and Adaptive Filters:** Optimal Signal Processing: Wiener Filters, Adaptive Signal Processing, Phase-Sensitive Detection	**12**	**CO2**

III	Multivariate Analyses: Principal Component Analysis and Independent Component Analysis : Linear Transformations, Principal Component Analysis, Independent Component Analysis **Chaos and Nonlinear Dynamics :** Nonlinear Systems, Phase Space, Estimating the Embedding Parameters, Quantifying Trajectories in Phase Space: The Lyapunov Exponent, Nonlinear Analysis: The Correlation Dimension, Tests for Nonlinearity: Surrogate Data Analysis **Nonlinearity Detection: Information-Based Methods :** Information and Regularity, Mutual Information Function, Spectral Entropy, Phase-Space-Based Entropy Methods, Detrended Fluctuation Analysis	**12**	**CO3**
IV	**Image Processing: Filters, Transformations, and Registration :** Two-Dimensional Fourier Transform, Linear Filtering, Spatial Transformations, Image Registration **Image Segmentation :** Pixel-Based Methods, Continuity-Based Methods, Multi thresholding Morphological Operations, Edge-Based Segmentation **Image Acquisition and Reconstruction :** Imaging Modalities, CT, PET, and SPECT, Magnetic Resonance Imaging, Functional MRI	**12**	**CO4**
V	**Classification I: Linear Discriminant Analysis and Support Vector Machines :** Linear Discriminators, Evaluating Classifier Performance, Higher Dimensions: Kernel Machines Support Vector Machines, Machine Capacity: Overfitting or "Less Is More", Extending the Number of Variables and Classes, Cluster Analysis **Classification II: Adaptive Neural Nets :** Training the McCullough Pitts Neuron, The Gradient Decent Method or Delta Rule, Two-Layer Nets: Back Projection, Three-Layer Nets, Training Strategies, Multiple Classifications, Multiple Input Variables	**12**	**CO5**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Biosignal and Medical Image Processing	John L. Semmlow, Benjamin Griffel	CRC Press	3rd	2014
2.	Biomedical Signal and Image Processing	Kayvan Najarian Robert Splinter	CRC Press	2nd	2012
3.	Introduction to Biomedical Imaging	Andrew Webb	Wiley-Interscience		2003

M. Sc (Information Technology)		Semester – III	
Course Name: Biomedical Image Processing Practical		**Course Code: PSIT3P3b**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Understand basics of Bio signals and various classical techniques of bio signal processing.

CO2: Understand various modern spectral analysis techniques.

CO3: Understand and apply various multivariate analysis techniques on bio signals.

CO4: Understand and apply various transformations filters to images, and different techniques for image acquisition and construction.

CO5: Understand the AI perspective in biological image processing using SVM and Neural Networks.

PSIT303c: Cloud Management

M. Sc (Information Technology)		Semester – III	
Course Name: Cloud Management		**Course Code: PSIT303c**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To Understand the Fundamental Ideas Behind Cloud Computing, The Evolution Of The Paradigm, Its Applicability; Benefits, As Well As Current And Future Challenges;
- The Basic ideas And Principles In Data Center Design; Cloud Management Techniques And Cloud Software Deployment Considerations;
- Different CPU, Memory And I/O Virtualization Techniques That Serve In Offering Software, Computation
- And Storage Services On The Cloud; Software Defined Networks (SDN) And Software Defined Storage (SDS);
- Cloud Storage Technologies And Relevant Distributed File Systems, Nosql Databases And Object Storage;
- The Variety Of Programming Models And Develop Working Experience In Several Of Them.

Unit	Details	Lectures	Outcome
I	What is VMM? What's new in VMM Get Started Release notes - VMM Turn telemetry data on/off Deploy a VMM cloud Create a VMM cloud Manage a VMM cloud Deploy a guarded host fabric Deploy guarded hosts Configure fallback HGS settings Deploy a shielded VHDX and VM template Deploy a shielded VM Deploy a shielded Linux VM Deploy and manage a software defined network (SDN) infrastructure Deploy an SDN network controller Deploy an SDN SLB Deploy an SDN RAS gateway Deploy SDN using PowerShell Set up a VM network in SDN Encrypt VM networks in SDN Allow and block VM traffic with SDN port ACLs Control SDN virtual network bandwidth with QoS Load balance network traffic Set up NAT for traffic forwarding in an SDN Route traffic across networks in the SDN infrastructure Configure SDN guest clusters Update the NC server certificate Set up SDN SLB VIPs Back up and restore the SDN infrastructure Remove an SDN from VMM Manage SDN resources in	**12**	**CO1**

	the VMM fabric Deploy and manage Storage Spaces Direct Set up a hyper-converged Storage Spaces Direct cluster Set up a disaggregated Storage Spaces Direct cluster Manage Storage Spaces Direct clusters Assign storage QoS policies for Clusters How To Plan System requirements – VMM Plan VMM installation Plan a VMM high availability deployment Identify VMM ports and protocols Plan the VMM compute fabric Plan the VMM networking fabric Identify supported storage arrays Upgrade and install Upgrade VMM Install VMM Install the VMM console Enable enhanced console session Deploy VMM for high availability Deploy a highly available VMM management server Deploy a highly available SQL Server database for VMM Deploy a highly available VMM library Set up TLS 1.2 Deploy update rollups Back up and restore VMM Manage the VMM library Library overview Add file-based resources to the VMM library Add profiles to the VMM library Add VM templates to the VMM library Add service templates to the VMM library Manage VMM library resources Manage virtualization servers Manage VMM host groups Add existing Hyper-V hosts and clusters to the fabric Add a Nano server as a Hyper-V host or cluster Run a script on host Create a cluster from standalone Hyper-V hosts Provision a Hyper-V host or cluster from bare-metal Create a guest Hyper-V cluster from a service template Set up networking for Hyper-V hosts and clusters Set up storage for Hyper-V hosts and clusters Manage MPIO for Hyper-V hosts and clusters Manage Hyper-V extended port ACLs Manage Hyper-V clusters Update Hyper-V hosts and clusters Run a rolling upgrade of Hyper-V clusters Service Hyper-V hosts for maintenance Manage VMware servers Manage management servers Manage infrastructure servers Manage update servers Manage networking Network fabric overview Set up logical networks Set up logical networks in UR1 Set up VM networks Set up IP address pools Add a network gateway Set up port profiles Set up logical switches Set up MAC address pools Integrate NLB with service templates Set up an IPAM server Manage storage Set up storage fabric Set up storage classifications Add storage devices Allocate storage to host groups Set up a Microsoft iSCSI Target Server Set up a Virtual Fibre Channel Set up file storage Set up Storage Replica in VMM		

II	Service Manager What's new in Service Manager Get started Evaluation and activation of Service Manager Service Manager components Supported configurations System requirements - Service Manager Release notes - Service Manager Enable service log on Manage telemetry settings How to Plan Planning for Service Manager Plan for deployment Service Manager editions Recommended deployment topologies Operations Manager considerations Service Manager databases Port assignments Prepare for deployment Service Manager performance Plan for performance and scalability Plan for hardware performance Deploy Deploy Service Manager Deployment scenarios Install on a single computer Install on two computers Install on four computers Set up remote SQL Server Reporting Services Use SQL Server AlwaysOn availability groups for failover Create and deploy server images Install on VMs Configure PowerShell Register with the data warehouse to enable reporting Deploy additional management servers Deployment considerations with a disjointed namespace Learn about the new Self Service portal Deploy the Self-Service portal Set up load balancing Back up the encryption key Index non-English knowledge articles Troubleshoot deployment issues Deploy from a command line Move databases Upgrade Upgrade Service Manager Upgrade the self-service portal to Service Manager 2016 Upgrade SQL Server Reporting Services Set up a lab environment for upgrade Prepare the production environment Prepare the lab environment Run an upgrade Complete tasks after upgrade Troubleshoot upgrade issues Administer Use management packs to add functionality Use connectors to import data Import data from Active Directory Domain Services Import data and alerts from Operations Manager Import data from Configuration Manager Import runbooks from Orchestrator Import data from VMM Use a CSV file to import data Optionally disable ECL logging for faster connector synchronization Configuration items Configure incident management Configure service level management Configure workflows Configure change and activity management Configure release management Configure	**12**	**CO2**

	Desired Configuration Management to generate incidents Configure notifications Use the service catalog to offer services Use groups, queues, and lists in Service Manager Use runbooks to automate procedures User interface customization Manage user roles Manage Run As accounts Manage knowledge articles Configure and use Service Manager cmdlets Manage the data warehouse Register source systems to the data warehouse Troubleshoot computer problems with tasks Configure your preference for sharing diagnostic and usage data Operate Search for information Manage incidents and problems Manage changes and activities Manage service requests Manage release records Data warehouse reporting and analytics Use and manage standard reports		
III	What is Configuration Manager? Microsoft Endpoint Configuration Manager FAQ What happened to SCCM? Introduction Find help for Configuration Manager How to use the docs How to use the console Accessibility features Software Center user guide Fundamentals Configuration Manager fundamentals Sites and hierarchies About upgrade, update, and install Manage devices Client management Security Role-based administration Configuration Manager and Windows as a Service Plan and design Get ready for Configuration Manager Product changes Features and capabilities Security and privacy for Configuration Manager Security and privacy overview Plan for security Security best practices and privacy information Privacy statement - Configuration Manager Cmdlet Library Additional privacy information Configure security Cryptographic controls technical reference Enable TLS About enabling TLS Enable TLS on clients Enable TLS on site servers and remote site systems Common issues when enabling TLS 1Migrate data between hierarchies Migration overview Plan for migration Planning for migration Prerequisites for migration Checklists for migration Determine whether to migrate data Planning the source hierarchy Planning migration jobs Planning client migration Planning for content deployment Planning to migrate objects Planning to monitor migration Planning to complete migration Configure source hierarchies and	**12**	**CO3**

	source sites Operations for migrating Security and privacy for migration Deploy servers and roles Deploy servers and roles Install infrastructure Get installation media Before you run setup Setup reference Setup downloader Prerequisite checker Prerequisite checks Installing sites Prepare to install sites overview Prepare to install sites Prerequisites for installing sites Use the setup wizard Use a command-line Command-line overview Command-line options Install consoles Upgrade an evaluation install Upgrade to Configuration Manager Scenarios to streamline your installation Configure sites and hierarchies Configure sites and hierarchies overview Add site system roles Add site system roles overview Install site system roles Install cloud-based distribution points About the service connection point Configuration options for site system roles Database replicas for management points Site components Publish site data Manage content and content infrastructure Content infrastructure overview Install and configure distribution points Deploy and manage content Monitor content Microsoft Connected Cache Troubleshoot Microsoft Connected Cache Run discovery Discovery methods overview About discovery methods Select discovery methods Configure discovery methods Site boundaries and boundary groups Site boundaries and boundary groups overview Boundaries Boundary groups Procedures for boundary groups High availability High availability options Site server high availability Flowchart - Passive site server setup Flowchart - Promote site server (planned) Flowchart - Promote site server (unplanned) Prepare to use SQL Server Always On Configure SQL Server Always On Use a SQL Server cluster Custom locations for database files Configure role-based administration		
IV	What's new in Orchestrator Automate with runbooks Get started Install Orchestrator Work with runbooks in the Orchestrator console Example runbook: Creating a runbook to monitor a folder Release notes – Orchestrator Turn on/off telemetry How To Plan Database sizing and performance Feature performance considerations System requirements – Orchestrator Design a runbook Deploy Upgrade Orchestrator Deploy runbooks Configure Orchestrator database connections Migrate Orchestrator between environments Change the Orchestrator database Manage Runbooks	**12**	**CO4**

	Design and build runbooks Create and test a sample runbook Control runbook activities Monitor activities Runbook properties Track runbooks Install TLS Install and enable TLS 1.2 Manage Orchestrator Servers Runbook permissions Back up Orchestrator Bench mark Optimize performance of .Net activities Configure runbook throttling Recover a database Recover web components Add an integration pack View Orchestrator data with PowerPivot Change Orchestrator user groups Common activity properties Computer groups Standard Activities Orchestrator standard activities Alphabetical list of Standard Activities Ports and protocols of Standard Activities System Run Program Run .NET Script End Process Start/Stop Service Restart System Save Event Log Query WMI Run SSH Command Get SNMP Variable Monitor SNMP Trap Send SNMP Trap Set SNMP Variable Scheduling Monitor Date/Time Check Schedule Monitoring Monitor Event Log Monitor Service Get Service Status Monitor Process Get Process Status Monitor Computer/IP Get Computer/IP Status Monitor Disk Space Get Disk Space Status Monitor Internet Application Get Internet Application Status Monitor WMI File Management Compress File Copy File Create Folder Decompress File Delete File Delete Folder Get File Status Monitor File Monitor Folder Move File Move Folder PGP Decrypt File PGP Encrypt File Print File Rename File Email Send Email Notification Send Event Log Message Send Syslog Message Send Platform Event Utilities Apply XSLT Query XML Map Published Data Compare Values Write Web Pages Read Text Log Write to Database Query Database Monitor Counter Get Counter Value Modify Counter Invoke Web Services Format Date/Time Generate Random Text Map Network Path Disconnect Network Path Get Dial-up Status Connect/Disconnect Dial-up Text File Management Append Line Delete Line Find Text Get Lines Insert Line Read Line Search and Replace Text Runbook Control Invoke Runbook Initialize Data Junction Return Data Orchestrator Integration Toolkit Overview of Orchestrator Integration Toolkit Installation Command Line Activity Wizard Integration Pack Wizard Integration Packs Active Directory Active Directory activities Add Computer To Group		

	Add Group To Group Add User To Group Create Computer Create Group Create User Delete Computer Delete Group Delete User Disable Computer Disable User Enable Computer Enable User Get Computer Get Group Get Organizational Unit Get User Move Computer Move Group Move User Remove Computer From Group Remove Group From Group Remove User From Group Rename Group Rename User Reset User Password Unlock User Update Computer Update Group Update User		
V	Data Protection Manager How does DPM work? What can DPM back up? DPM-compatible tape libraries Get Started DPM build versions DPM release notes What's new in DPM What DPM supports How To Plan Your DPM Environment Get ready to deploy DPM servers Prepare your environment for DPM Prepare data storage Identify compatible tape libraries Identify data sources you want to protect Install or Upgrade DPM Install DPM Upgrade your DPM installation Add Modern Backup storage Deduplicate DPM storage Deploy DPM Deploy the DPM protection agent Deploy protection groups Configure firewall settings Offline backup Using own disk Protect Workloads Back up Hyper-V virtual machines Back up Exchange with DPM Back up SharePoint with DPM Back up SQL Server with DPM Back up client computers with DPM Back up file data with DPM Back up system state and bare metal Back up and restore VMware servers Back up and restore VMM servers Prepare to back up a generic data source Prepare machines in workgroups and untrusted domains for backup Back up the DPM server Monitor and Manage Monitor DPM Set up DPM logging Generate DPM reports Use SCOM to manage and monitor DPM servers Improve replication performance Use central console to manage DPM servers	**12**	**CO5**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Microsoft SCVMM 2019	Whitepaper	Microsoft		2019
2.	Microsoft Endpoint Manager 2019	Whitepaper	Microsoft		2019
3.	Microsoft SCO 2019	Whitepaper	Microsoft		2019
4.	Microsoft SCOM 2019	Whitepaper	Microsoft		2019
5.	Microsoft SCSM 2019	Whitepaper	Microsoft		2019
6.	Microsoft DPM 2019	Whitepaper	Microsoft		2019
7.	Introducing Microsoft	Mitch Tulloch with	Microsoft		2012

	System Center 2012	Symon Perriman and the System Center Team	Press		

M. Sc (Information Technology)		**Semester – III**	
Course Name: Cloud Management Practical		**Course Code: PSIT3P3c**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:
After completion of the course, a student should be able to:

CO1: Understand the concepts of VMM, SDN, NAS , HyperV etc.
CO2: Understand and demonstrate the use of Service manager with various deployments that can be performed using it.
CO3: Understand SCCM and Demonstrate the use of Configuration Manager
CO4: Understand automation with runbooks and demonstrate the use of Windows Orchestrator
CO5: Understand and demonstrate the use of Data Protection Manager

PSIT303d: Malware Analysis

M. Sc (Information Technology)		**Semester – III**	
Course Name: Malware Analysis		**Course Code: PSIT303d**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- Possess the skills necessary to carry out independent analysis of modern malware samples using both static and dynamic analysis techniques.
- Have an intimate understanding of executable formats, Windows internals and API, and analysis techniques.
- Extract investigative leads from host and network-based indicators associated with a malicious program.
- Apply techniques and concepts to unpack, extract, decrypt, or bypass new anti-analysis techniques in future malware samples.
- Achieve proficiency with industry standard tools including IDA Pro, OllyDbg, WinDBG, PE Explorer, ProcMon etc.

Unit	Details	Lectures	Outcome
I	**Malware Analysis:** Introduction, Techniques, Types of malware, General rules for Malware Analysis. **Basic Static Techniques:** Antivirus Scanning, Hashing, Finding Strings, Packed and Obfuscated Malware, Portable Executable Malware, Portable executable File Format, Linked Libraries and Functions, Static Analysis, The PE file headers and sections. **Malware Analysis in Virtual Machines:** Structure of VM, Creating and using Malware Analysis machine, Risks of using VMware for malware analysis, Record/Replay. **Basic Dynamic Analysis:** Sandboxes, Running Malware, Monitoring with process monitor, Viewing processes with process explorer, Comparing registry snapshots with regshot, Faking a network, Packet sniffing with Wireshark, Using INetSim, Basic Dynamic Tools. x86 Disassembly	**12**	**CO1**
II	**IDA PRO:** Loading an executable, IDA Pro Interface, Using cross references, Analysing functions, Using graphing options, Enhancing disassembly, Extending IDA with plug-ins. **Recognising C Code constructs in assembly:** Global	**12**	**CO2**

	v/s local variables, Disassembling arithmetic operations, recognizing if statements, recognizing loops, function call conventions, Analysing switch statements, Disassembling arrays, Identifying structs, Analysing linked list traversal. **Analysing Malicious Windows Programs:** The windows API, The Windows Registry, Networking APIs, Understanding running malware. Kernel v/s user mode, Native API. **Advanced Dynamic Analysis – Debugging:** Source-level v/s Assembly-level debugging, kernel v/s user mode debugging, Using a debugger, Exceptions, Modifying execution with a debugger, modifying program execution.		
III	**Advanced Dynamic Analysis – OLLYDBG:** Loading Malware, The Ollydbg Interface, Memory Map, Viewing threads and Stacks, Executing code, Breakpoints, Loading DLLs, Tracing, Exception handling, Patching, Analysing shell code, Assistance features, Plug-ins, Scriptable debugging. **Kernel Debugging with WINDBG:** Drivers and kernel code, Using WinDbg, Microsoft Symbols, kernel debugging and using it, Rootkits, Loading drivers, kernel issues with windows. **Malware Functionality – Malware Behavior:** Downloaders and launchers, Backdoors, Credential stealers, Persistence mechanisms, Privilege escalation, covering the tracks. **Covert Malware Launching:** Launchers, Process injection, Process replacement, Hook injection, detours, APC injection.	**12**	**CO3**
IV	**Data Encoding:** Goal of Analysing algorithms, Simple ciphers, Common cryptographic algorithms, Custom encoding, decoding. **Malware – focused network signatures:** Network countermeasures**,** Safely investigating attacker online, Content-Based Network Countermeasures, Combining Dynamic and Static Analysis Techniques, Understanding the Attacker's Perspective**.** **Anti-disassembly:** Concepts, Defeating disassembly algorithms, anti-disassembly techniques, Obscuring flow control, Thwarting stack-frame analysis. **Anti-debugging:** Windows debugger detection, debugger behavior, Interfering with debugger functionality, Debugger vulnerabilities.	**12**	**CO4**
V	**Anti-virtual machine techniques:** VMWare artifacts, Vulnerable functions, Tweaking settings, Escaping the virtual machine. **Packers and unpacking:** Packer anatomy, Identifying Packed Programs, Unpacking options, Automated Unpacking, Manual Unpacking, Common packers, Analysing without unpacking, Packed DLLs,	**12**	**CO5**

	Shellcode Analysis: Loading shellcode for analysis, Position-independent Code, Identifying Execution Location, Manual Symbol Resolution, Shellcode encoding, NOP Sleds, Finding Shellcode. **C++ Analysis:** OOP, Virtual and Non-virtual functions, Creating and destroying objects. **64-bit Malware:** Why 64-bit malware? Differences in x64 architecture, Windows 32-bit on Windows 64-bit, 64-bit hints at malware functionality.		

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Practical Malware Analysis – The Hands-On Guide to Dissecting Malicious Software	Michael Sikorski, Andrew Honig	No Scratch Press	-	2013
2.	Mastering Malware Analysis	Alexey Kleymenov, Amr Thabet	Packt Publishing	-	2019
3.	Windows Malware Analysis Essentials	Victor Marak	Packt Publishing		2015

M. Sc (Information Technology)		**Semester – III**	
Course Name: Malware Analysis Practical		**Course Code: PSIT3P3d**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:
After completion of the course, a student should be able to:
CO1: Understand various introductory techniques of malware analysis and creating the testing environment
CO2: Perform advanced dynamic analysis and recognize constructs in assembly code.
CO3: Perform Reverse Engineering using OLLYDBG and WINDBG and study the behaviours and functions of malware
CO4: Understand data encoding, various techniques for anti-disassembly and anti-debugging
CO5: Understand various anti virtual machine techniques and perform shellcode analysis of various languages along with x64 architecture.

PSIT304a: Robotic Process Automation

M. Sc (Information Technology)		Semester – III	
Course Name: Robotic Process Automation		**Course Code: PSIT304a**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To make the students aware about the automation today in the industry.
- To make the students aware about the tools used for automation.
- To help the students automate a complete process

Unit	Details	Lectures	Outcome
I	**Robotic Process Automation:** Scope and techniques of automation, About UiPath **Record and Play:** UiPath stack, Downloading and installing UiPath Studio, Learning UiPath Studio, Task recorder, Step-by-step examples using the recorder.	**12**	**CO1**
II	**Sequence, Flowchart, and Control Flow:** Sequencing the workflow, Activities, Control flow, various types of loops, and decision making, Step-by-step example using Sequence and Flowchart, Step-by-step example using Sequence and Control flow **Data Manipulation:** Variables and scope, Collections, Arguments – Purpose and use, Data table usage with examples, Clipboard management, File operation with step-by-step example, CSV/Excel to data table and vice versa (with a step-by-step example)	**12**	**CO2**
III	**Taking Control of the Controls :** Finding and attaching windows, Finding the control, Techniques for waiting for a control, Act on controls – mouse and keyboard activities, Working with UiExplorer, Handling events, Revisit recorder, Screen Scraping, When to use OCR, Types of OCR available, How to use OCR, Avoiding typical failure points **Tame that Application with Plugins and Extensions:** Terminal plugin, SAP automation, Java plugin, Citrix automation, Mail plugin, PDF plugin, Web integration,	**12**	**CO3**

	Excel and Word plugins, Credential management, Extensions – Java, Chrome, Firefox, and Silverlight		
IV	**Handling User Events and Assistant Bots:** What are assistant bots?, Monitoring system event triggers, Hotkey trigger, Mouse trigger, System trigger ,Monitoring image and element triggers, An example of monitoring email, Example of monitoring a copying event and blocking it, Launching an assistant bot on a keyboard event **Exception Handling, Debugging, and Logging:** Exception handling, Common exceptions and ways to handle them, Logging and taking screenshots, Debugging techniques, Collecting crash dumps, Error reporting	**12**	**CO4**
V	**Managing and Maintaining the Code:** Project organization, Nesting workflows, Reusability of workflows, Commenting techniques, State Machine, When to use Flowcharts, State Machines, or Sequences, Using config files and examples of a config file, Integrating a TFS server **Deploying and Maintaining the Bot:** Publishing using publish utility, Overview of Orchestration Server, Using Orchestration Server to control bots, Using Orchestration Server to deploy bots, License management, Publishing and managing updates	**12**	**CO5**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Learning Robotic Process Automation	Alok Mani Tripathi	Packt	1st	2018
2.	Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation	Srikanth Merianda	Createspace Independent Publishing	1st	2018
3.	The Simple Implementation Guide to Robotic Process Automation (Rpa): How to Best Implement Rpa in an Organization	Kelly Wibbenmeyer	iUniverse	1st	2018

M. Sc (Information Technology)		**Semester – III**	
Course Name: Robotic Process Automation		**Course Code: PSIT3P4a**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50

	Internal	**--**	**-**

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completing the course, a learner will be able to:

CO1: Understand the mechanism of business process and can provide the solution in an optimize way.

CO2: Understand the features use for interacting with database plugins.

CO3: Use the plug-ins and other controls used for process automation.

CO4: Use and handle the different events, debugging and managing the errors.

CO5: Test and deploy the automated process.

PSIT304b: Virtual Reality and Augmented Reality

M. Sc (Information Technology)		**Semester – III**	
Course Name: Virtual Reality and Augmented Reality		**Course Code: PSIT304b**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To learn background of VR including a brief history of VR, different forms of VR and related technologies, and broad overview of some of the most important concepts
- To provide background in perception to educate VR creators on concepts and theories of how we perceive and interact with the world around us
- To make learner aware of high-level concepts for designing/building assets and how subtle design choices can influence user behavior
- To learn about art for VR and AR should be optimized for spatial displays with spatially aware input devices to interact with digital objects in true 3D
- Walkthrough of VRTK, an open source project meant to spur on cross-platform development

Unit	Details	Lectures	Outcome
I	Introduction: What Is Virtual Reality, A History of VR, An Overview of Various Realities, Immersion, Presence, and Reality Trade-Offs, The Basics: Design Guidelines, Objective and Subjective Reality, Perceptual Models and Processes, Perceptual Modalities	**12**	**CO1**
II	Perception of Space and Time, Perceptual Stability, Attention, and Action, Perception: Design Guidelines, Adverse Health Effects, Motion Sickness, Eye Strain, Seizures, and Aftereffects, Hardware Challenges, Latency, Measuring Sickness, Reducing Adverse Effects, Adverse Health Effects: Design Guidelines	**12**	**CO2**
III	Content Creation, Concepts of Content Creation, Environmental Design, Affecting Behavior, Transitioning to VR Content Creation, Content Creation: Design Guidelines, Interaction, Human-Centered Interaction, VR Interaction Concepts, Input Devices, Interaction Patterns and Techniques, Interaction: Design Guidelines	**12**	**CO3**

IV	Design and Art Across Digital Realities, Designing for Our Senses, Virtual Reality for Art, 3D Art Optimization, Computer Vision That Makes Augmented Reality Possible Works, Virtual Reality and Augmented Reality: Cross-Platform Theory	**12**	**CO4**
V	Virtual Reality Toolkit: Open Source Framework for the Community, Data and Machine Learning Visualization Design and Development in Spatial Computing, Character AI and Behaviors, The Virtual and Augmented Reality Health Technology Ecosystem	**12**	**CO5**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	The VR Book, Human Centered Design for Virtual Reality	Jason Jerald	ACM Books	1st	2016
2.	Creating Augmented and Virtual Realities	Erin Pangilinan, Steve Lukas, Vasanth Mohan	O'Reilly	1st	2019
3.	Virtual reality with VRTK4	Rakesh Baruah	APress	1st	2020

M. Sc (Information Technology)		**Semester – III**	
Course Name: Virtual Reality and Augmented Reality Practical		**Course Code: PSIT3P4b**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Apply the concepts of VR and AR in real life.
CO2: Reduce the greatest risk to VR.
CO3: Design the way users interact within the scenes they find themselves in.
CO4: be exposed to VR, AR and today's resources
CO5: Effectively use open source VR software.

PSIT304c: Data Centre Technologies

M. Sc (Information Technology)		Semester – III	
Course Name: Data Centre Technologies		**Course Code: PSIT304c**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- Identify important requirements to design and support a data center.
- Determine a data center environment's requirement including systems and network architecture as well as services.
- Evaluate options for server farms, network designs, high availability, load balancing, data center services, and trends that might affect data center designs.
- Assess threats, vulnerabilities and common attacks, and network security devices available to protect data centers.
- Design a data center infrastructure integrating features that address security, performance, and availability.
- Measure data center traffic patterns and performance metrics.

Unit	Details	Lectures	Outcome
I	Virtualization History and Definitions Data Center Essential Definitions Data Center Evolution Operational Areas and Data Center Architecture The Origins of Data Center Virtualization Virtual Memory Mainframe Virtualization Hot Standby Router Protocol Defining Virtualization Data Center Virtualization Timeline Classifying Virtualization Technologies A Virtualization Taxonomy Virtualization Scalability Technology Areas Classification Examples Summary Data Center Network Evolution Ethernet Protocol: Then and Now Ethernet Media Coaxial Cable Twisted-Pair Optical Fiber Direct-Attach Twinaxial Cables Ethernet Data Rate Timeline Data Center Network Topologies Data Center Network Layers Design Factors for Data	**12**	**CO1**

	Center Networks Physical Network Layout Considerations The ANSI/TIA-942 Standard Network Virtualization Benefits Network Logical Partitioning Network Simplification and Traffic Load Balancing Management Consolidation and Cabling Optimization Network Extension The Humble Beginnings of Network Virtualization Network Partitioning Concepts from the Bridging World Defining VLANs VLAN Trunks Two Common Misconceptions About VLANs Misconception Number 1: A VLAN Must Be Associated to an IP Subnet Misconception Number 2: Layer 3 VLANs Spanning Tree Protocol and VLANs Spanning Tree Protocol at Work Port States Spanning Tree Protocol Enhancements Spanning Tree Instances Private VLANs VLAN Specifics Native VLAN Reserved VLANs IDs Resource Sharing Control and Management Plane Concepts from the Routing World Overlapping Addresses in a Data Center Defining and Configuring VRFs VRFs and Routing Protocols VRFs and the Management Plane VRF-Awareness VRF Resource Allocation Control		
II	An Army of One: ACE Virtual Contexts Application Networking Services The Use of Load Balancers Load-Balancing Concepts Layer 4 Switching Versus Layer 7 Switching Connection Management Address Translation and Load Balancing Server NAT Dual NAT Port Redirection Transparent Mode Other Load-Balancing Applications Firewall Load Balancing Reverse Proxy Load Balancing Offloading Servers SSL Offload TCP Offload HTTP Compression Load Balancer Proliferation in the Data Center Load Balancer Performance Security Policies Suboptimal Traffic Application Environment Independency ACE Virtual Contexts Application Control Engine Physical Connections Connecting an ACE Appliance Connecting an ACE Module Creating and Allocating Resources to Virtual Contexts Integrating ACE Virtual Contexts to the Data Center Network Routed Design Bridged Design One-Armed Design Managing and Configuring ACE Virtual Contexts Allowing Management Traffic to a Virtual Context Allowing Load Balancing Traffic Through a Virtual	**12**	**CO2**

	Context Controlling Management Access to Virtual Contexts ACE Virtual Context Additional Characteristics Sharing VLANs Among Contexts Virtual Context Fault Tolerance Instant Switches: Virtual Device Contexts Extending Device Virtualization Why Use VDCs? VDCs in Detail Creating and Configuring VDCs VDC Names and CLI Prompts Virtualization Nesting Allocating Resources to VDCs Using Resource Templates Managing VDCs VDC Operations Processes Failures and VDCs VDC Out-of-Band Management Role-Based Access Control and VDCs Global Resources Fooling Spanning Tree Spanning Tree Protocol and Link Utilization Link Aggregation Server Connectivity and NIC Teaming Cross-Switch PortChannels Virtual PortChannels Virtual PortChannel Definitions Configuring Virtual PortChannels Step 1: Defining the Domain Step 2: Establishing Peer Keepalive Connectivity Step 3: Creating the Peer Link Step 4: Creating the Virtual PortChannel Spanning Tree Protocol and Virtual Port Channels Peer Link Failure and Orphan Ports First-Hop Routing Protocols and Virtual Port Channels Layer 2 Multipathing and vPC+ FabricPath Data Plane FabricPath Control Plane FabricPath and Spanning Tree Protocol Virtual PortChannel Plus Virtualized Chassis with Fabric Extenders Server Access Models Understanding Fabric Extenders Fabric Extender Options Connecting a Fabric Extender to a Parent Switch Fabric Extended Interfaces and Spanning Tree Protocol Fabric Interfaces Redundancy Fabric Extender Topologies Straight-Through Topologies Dual-Homed Topologies		
III	Virtualized Chassis with Fabric Extenders Server Access Models Understanding Fabric Extenders Fabric Extender Options Connecting a Fabric Extender to a Parent Switch Fabric Extended Interfaces and Spanning Tree Protocol Fabric Interfaces Redundancy Fabric Extender Topologies Straight-Through Topologies Dual-Homed Topologies Use Case: Mixed Access Data Center A Tale of Two Data Centers A Brief History of Distributed Data Centers The Cold Age (Mid-1970s to 1980s) The Hot Age (1990s to Mid-2000s) The Active-Active Age (Mid-2000s to	**12**	**CO3**

	Today) The Case for Layer 2 Extensions Challenges of Layer 2 Extensions Ethernet Extensions over Optical Connections Virtual PortChannels FabricPath Ethernet Extensions over MPLS MPLS Basic Concepts Ethernet over MPLS Virtual Private LAN Service Ethernet Extensions over IP MPLS over GRE Overlay Transport Virtualization OTV Terminology OTV Basic Configuration OTV Loop Avoidance and Multihoming Migration to OTV OTV Site Designs VLAN Identifiers and Layer 2 Extensions Internal Routing in Connected Data Centers Use Case: Active-Active Greenfield Data Centers Summary Storage Evolution Data Center Storage Devices Hard Disk Drives Disk Arrays Tape Drives and Libraries Accessing Data in Rest Block-Based Access *Small Computer Systems Interface Mainframe Storage Access* Advanced Technology Attachment File Access Network File System Common Internet File System Record Access Storage Virtualization Virtualizing Storage Devices Virtualizing LUNs Virtualizing File Systems Virtualizing SANs		
IV	Server Evolution Server Architectures Mainframes RISC Servers x86 Servers x86 Hardware Evolution CPU Evolution Memory Evolution Expansion Bus Evolution Physical Format Evolution Introducing x86 Server Virtualization Virtualization Unleashed Unified Computing Changing Personalities Server Provisioning Challenges Server Domain Operations Infrastructure Domain Operations Unified Computing and Service Profiles Building Service Profiles Identifying a Service Profile Storage Definitions Network Definitions Virtual Interface Placement Server Boot Order Maintenance Policy Server Assignment Operational Policies Configuration External IPMI Management Configuration Management IP Address *Additional Policies* Associating a Service Profile to a Server Installing an Operating System Verifying Stateless Computing Using Policies BIOS Setting Policies Firmware Policies Industrializing Server Provisioning	**12**	**CO4**

	Cloning Pools Service Profile Templates Server Pools Use Case: Seasonal Workloads		
V	Moving Targets Virtual Network Services Definitions Virtual Network Services Data Path vPath-Enabled Virtual Network Services Cisco Virtual Security Gateway: Compute Virtual Firewall Installing Virtual Security Gateway Creating Security Policies, Sending Data Traffic to VSG Virtual Machine Attributes and Virtual Zones Application Acceleration, WAN Acceleration and Online Migration Routing in the Virtual World Site Selection and Server Virtualization Route Health Injection Global Server Load Balancing Location/ID Separation Protocol Use Case: Virtual Data Center The Virtual Data Center and Cloud Computing The Virtual Data Center Automation and Standardization What Is Cloud Computing? Cloud Implementation Example Journey to the Cloud Networking in the Clouds Software-Defined Networks Open Stack Network Overlays	**12**	**CO5**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Data Center Virtualization Fundamentals	Gustavo Alessandro Andrade Santana	Cisco Press	1st	2014

M. Sc (Information Technology)		**Semester – III**	
Course Name: Data Centre Technologies Practical		**Course Code: PSIT3P4c**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Understand basic concepts in Virtualization.
CO2: Understand concepts of Load Balancing and Aggregation /virtual switching

CO3: Understand Data center Migration and Fabric Building
CO4: Understand various Changes in Server Architecture
CO5: Understand the concepts of Cloud computing and how to move towards a cloud computing technology.

PSIT304d: Offensive Security

M. Sc (Information Technology)		**Semester – III**	
Course Name: Offensive Security		**Course Code: PSIT304d**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- Understanding of security requirements within an organization
- How to inspect, protect assets from technical and managerial perspectives
- To Learn various offensive strategies to penetrate the organizations security.
- To learn various tools that aid in offensive security testing.

Unit	Details	Lectures	Outcome
I	Fault Tolerance and Resilience in Cloud Computing Environments, Securing Web Applications, Services, and Servers, Wireless Network Security, Wireless Sensor Network Security: The Internet of Things, Security for the Internet of Things, Cellular Network Security	**12**	**CO1**
II	Social Engineering Deceptions and Defenses, What Is Vulnerability Assessment, Risk Management, Insider Threat, Disaster Recovery, Security Policies and Plans Development	**12**	**CO2**
III	Introduction to Metasploit and Supporting Tools The importance of penetration testing Vulnerability assessment versus penetration testing The need for a penetration testing framework Introduction to Metasploit When to use Metasploit? Making Metasploit effective and powerful using supplementary tools Nessus NMAP w3af Armitage Setting up Your Environment Using the Kali Linux virtual machine - the easiest way Installing Metasploit on Windows Installing Metasploit on Linux Setting up exploitable targets in a virtual	**12**	**CO3**

	environment Metasploit Components and Environment Configuration Anatomy and structure of Metasploit Metasploit components Auxiliaries Exploits Encoders Payloads Post, Playing around with msfconsole Variables in Metasploit Updating the Metasploit Framework 55		
IV	Information Gathering with Metasploit Information gathering and enumeration Transmission Control Protocol User Datagram Protocol File Transfer Protocol Server Message Block Hypertext Transfer Protocol Simple Mail Transfer Protocol Secure Shell Domain Name System Remote Desktop Protocol Password sniffing Advanced search with shodan Vulnerability Hunting with Metasploit Managing the database Work spaces Importing scans Backing up the database **NMAP** NMAP scanning approach **Nessus** Scanning using Nessus from msfconsole Vulnerability detection with Metasploit auxiliaries Auto exploitation with db_autopwn **Post exploitation** What is meterpreter? Searching for content Screen capture Keystroke logging Dumping the hashes and cracking with JTR Shell command Privilege escalation Client-side Attacks with Metasploit Need of client-side attacks What are client-side attacks? What is a Shellcode? What is a reverse shell? What is a bind shell? What is an encoder? **The msfvenom utility** Generating a payload with msfvenom Social Engineering with Metasploit Generating malicious PDF Creating infectious media drives	**12**	**CO4**
V	Approaching a Penetration Test Using Metasploit Organizing a penetration test Preinteractions Intelligence gathering/reconnaissance phase Predicting the test grounds Modeling threats Vulnerability analysis Exploitation and post-exploitation Reporting Mounting the environment Setting up Kali Linux in virtual environment	**12**	**CO5**

	The fundamentals of Metasploit Conducting a penetration test with Metasploit Recalling the basics of Metasploit Benefits of penetration testing using Metasploit Open source Support for testing large networks and easy naming conventions Smart payload generation and switching mechanism Cleaner exits The GUI environment Penetration testing an unknown network Assumptions Gathering intelligence Using databases in Metasploit Modeling threats Vulnerability analysis of VSFTPD backdoor The attack procedure The procedure of exploiting the vulnerability Exploitation and post exploitation Vulnerability analysis of PHP-CGI query string parameter vulnerability Exploitation and post exploitation Vulnerability analysis of HFS Exploitation and post exploitation Maintaining access Clearing tracks Revising the approach Reinventing Metasploit Ruby – the heart of Metasploit Creating your first Ruby program Interacting with the Ruby shell Defining methods in the shell Variables and data types in Ruby Working with strings Concatenating strings The substring function The split function Numbers and conversions in Ruby Conversions in Ruby Ranges in Ruby Arrays in Ruby Methods in Ruby Decision-making operators Loops in Ruby Regular expressions Wrapping up with Ruby basics **Developing custom modules** Building a module in a nutshell The architecture of the Metasploit framework Understanding the file structure The libraries layout Understanding the existing modules The format of a Metasploit module Disassembling existing HTTP server scanner module Libraries and the function Writing out a custom FTP scanner module Libraries and the function Using msftidy Writing out a custom SSH authentication brute forcer Rephrasing the equation Writing a drive disabler post exploitation module Writing a credential harvester post exploitation module **Breakthrough meterpreter scripting**		

	Essentials of meterpreter scripting Pivoting the target network Setting up persistent access API calls and mixins Fabricating custom meterpreter scripts Working with RailGun Interactive Ruby shell basics Understanding RailGun and its scripting Manipulating Windows API calls Fabricating sophisticated RailGun scripts The Exploit Formulation Process The absolute basics of exploitation The basics The architecture System organization basics Registers Exploiting stack-based buffer overflows with Metasploit Crashing the vulnerable application Building the exploit base Calculating the offset Using the pattern_create tool Using the pattern_offset tool Finding the JMP ESP address Using Immunity Debugger to find executable modules Using msfbinscan Stuffing the space Relevance of NOPs Determining bad characters Determining space limitations Writing the Metasploit exploit module Exploiting SEH-based buffer overflows with Metasploit Building the exploit base Calculating the offset Using pattern_create tool Using pattern_offset tool *Table of Contents* Finding the POP/POP/RET address The Mona script Using msfbinscan Writing the Metasploit SEH exploit module Using NASM shell for writing assembly instructions **Bypassing DEP in Metasploit modules** Using msfrop to find ROP gadgets Using Mona to create ROP chains Writing the Metasploit exploit module for DEP bypass		

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Computer and Information Security Handbook	John R. Vacca	Morgan Kaufmann Publisher	3rd	2017
2.	Metasploit Revealed: Secrets of the Expert Pentester	Sagar Rahalkar	Packt Publishing		2017

M. Sc (Information Technology)	**Semester – III**
Course Name: Offensive Security Practical	**Course Code: PSIT3P4d**
Periods per week (1 Period is 60 minutes)	4
Credits	2

		Hours	Marks
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completion of the course, a student should be able to:
CO1: Understand basic security issues in cloud, IoT etc.
CO2: Understand different security techniques and policies
CO3: Use Vulnerability assessment and exploitation tool
CO4: Analyze the network perform reconnaissance and enumerate the target to detect vulnerabilities
CO5: Perform offensive tests using Metasploit on various application, generating payloads etc.

SEMESTER IV

PSIT401: Blockchain

M. Sc (Information Technology)		Semester – IV	
Course Name: Blockchain		**Course Code: PSIT401**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To provide conceptual understanding of the function of Blockchain as a method of securing distributed ledgers, how consensus on their contents is achieved, and the new applications that they enable.
- To cover the technological underpinnings of blockchain operations as distributed data structures and decision-making systems, their functionality and different architecture types.
- To provide a critical evaluation of existing "smart contract" capabilities and platforms, and examine their future directions, opportunities, risks and challenges.

Unit	Details	Lectures	Outcome
I	**Blockchain:** Introduction, History, Centralised versus Decentralised systems, Layers of blockchain, Importance of blockchain, Blockchain uses and use cases. **Working of Blockchain:** Blockchain foundation, Cryptography, Game Theory, Computer Science Engineering, Properties of blockchain solutions, blockchain transactions, distributed consensus mechanisms, Blockchain mechanisms, Scaling blockchain **Working of Bitcoin:** Money, Bitcoin, Bitcoin blockchain, bitcoin network, bitcoin scripts, Full Nodes and SVPs, Bitcoin wallets.	**12**	**CO1**
II	**Ethereum:** three parts of blockchain, Ether as currency and commodity, Building trustless systems, Smart contracts, Ethereum Virtual Machine, The Mist	**12**	**CO2**

	browser, Wallets as a Computing Metaphor, The Bank Teller Metaphor, Breaking with Banking History, How Encryption Leads to Trust, System Requirements, Using Parity with Geth, Anonymity in Cryptocurrency, Central Bank Network, Virtual Machines, EVM Applications, State Machines, Guts of the EVM, Blocks, Mining's Place in the State Transition Function, Renting Time on the EVM, Gas, Working with Gas, Accounts, Transactions, and Messages, Transactions and Messages, Estimating Gas Fees for Operations, Opcodes in the EVM. **Solidity Programming:** Introduction, Global Banking Made Real, Complementary Currency, Programming the EVM, Design Rationale, Importance of Formal Proofs, Automated Proofs, Testing, Formatting Solidity Files, Reading Code, Statements and Expressions in Solidity, Value Types, Global Special Variables, Units, and Functions,		
III	**Hyperledger:** Overview, Fabric, composer, installing hyperledger fabric and composer, deploying, running the network, error troubleshooting. **Smart Contracts and Tokens:** EVM as Back End, Assets Backed by Anything, Cryptocurrency Is a Measure of Time, Function of Collectibles in Human Systems, Platforms for High-Value Digital Collectibles, Tokens as Category of Smart Contract, Creating a Token, Deploying the Contract, Playing with Contracts.	**12**	**CO3**
IV	**Mining Ether:** Why? Ether's Source, Defining Mining, Difficulty, Self-Regulation, and the Race for Profit, How Proof of Work Helps Regulate Block Time, DAG and Nonce, Faster Blocks, Stale Blocks, Difficulties, Ancestry of Blocks and Transactions, Ethereum and Bitcoin, Forking, Mining, Geth on Windows, Executing Commands in the EVM via the Geth Console, Launching Geth with Flags, Mining on the Testnet, GPU Mining Rigs, Mining on a Pool with Multiple GPUs. **Cryptoecnomics:** Introduction, Usefulness of cryptoeconomics, Speed of blocks, Ether Issuance scheme, Common Attack Scenarios.	**12**	**CO4**
V	**Blockchain Application Development:** Decentralized Applications, Blockchain Application Development, Interacting with the Bitcoin Blockchain, Interacting Programmatically with Ethereum—Sending Transactions, Creating a Smart Contract, Executing Smart Contract Functions, Public vs. Private Blockchains, Decentralized Application Architecture, **Building an Ethereum DApp:** The DApp, Setting Up a Private Ethereum Network, Creating the Smart Contract, Deploying the Smart Contract, Client	**12**	**CO5**

	Application, **DApp deployment:** Seven Ways to Think About Smart Contracts, Dapp Contract Data Models, EVM back-end and front-end communication, JSON-RPC, Web 3, JavaScript API, Using Meteor with the EVM, Executing Contracts in the Console, Recommendations for Prototyping, Third-Party Deployment Libraries, **Creating Private Chains.**		

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Beginning Blockchain A Beginner's Guide to Building Blockchain Solutions	Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda	Apress		2018
2.	Introducing Ethereum and Solidity	Chris Dannen	Apress		2017
3.	The Blockchain Developer	Elad Elrom	Apress		2019
4.	Mastering Ethereum	Andreas M. Antonopoulos Dr. Gavin Wood	O'Reilly	First	2018
5.	Blockchain Enabled Applications	Vikram Dhillon David Metcalf Max Hooper	Apress		2017

M. Sc (Information Technology)		**Semester – III**	
Course Name: Blockchain		**Course Code: PSIT**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:
After completion of the course, a student should be able to:

CO1: The students would understand the structure of a blockchain and why/when it is better than a simple distributed database.

CO2: Analyze the incentive structure in a blockchain based system and critically assess its functions, benefits and vulnerabilities

CO3: Evaluate the setting where a blockchain based structure may be applied, its potential and its limitations

CO4: Understand what constitutes a "smart" contract, what are its legal implications and what it can and cannot do, now and in the near future

CO5: Develop blockchain DApps.

PSIT402a: Natural Language Processing

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Natural Language Processing		**Course Code: PSIT402a**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- The prime objective of this course is to introduce the students to the field of Language Computing and its applications ranging from classical era to modern context.
- To provide understanding of various NLP tasks and NLP abstractions such as Morphological analysis, POS tagging, concept of syntactic parsing, semantic analysis etc.
- To provide knowledge of different approaches/algorithms for carrying out NLP tasks.
- To highlight the concepts of Language grammar and grammar representation in Computational Linguistics.

Unit	Details	Lectures	Outcome
I	Introduction to NLP, brief history, NLP applications: Speech to Text(STT), Text to Speech(TTS), Story Understanding, NL Generation, QA system, Machine Translation, Text Summarization, Text classification, Sentiment Analysis, Grammar/Spell Checkers etc., challenges/Open Problems, NLP abstraction levels, Natural Language (NL) Characteristics and NL computing approaches/techniques and steps, NL tasks: Segmentation, Chunking, tagging, NER, Parsing, Word Sense Disambiguation, NL Generation, Web 2.0 Applications : Sentiment Analysis; Text Entailment; Cross Lingual Information Retrieval (CLIR).	**12**	**CO1**
II	Text Processing Challenges, Overview of Language Scripts and their representation on Machines using	**12**	**CO2**

	Character Sets, Language, Corpus and Application Dependence issues, Segmentation: word level(Tokenization), Sentence level. Regular Expression and Automata Morphology, Types, Survey of English and Indian Languages Morphology, Morphological parsing FSA and FST, Porter stemmer, Rule based and Paradigm based Morphology, Human Morphological Processing, Machine Learning approaches.		
III	Word Classes ad Part-of-Speech tagging(POS), survey of POS tagsets, Rule based approaches (ENGTOWL), Stochastic approaches(Probabilistic, N-gram and HMM), TBL morphology, unknown word handling, evaluation metrics: Precision/Recall/F-measure, error analysis.	**12**	**CO3**
IV	NL parsing basics, approaches: TopDown, BottomUp, Overview of Grammar Formalisms: constituency and dependency school, Grammar notations CFG, LFG, PCFG, LTAG, Feature- Unification, overview of English CFG, Indian Language Parsing in Paninian Karaka Theory, CFG parsing using Earley's and CYK algorithms, Probabilistic parsing, Dependency Parsing: Covington algorithm, MALT parser, MST parser.	**12**	**CO4**
V	Concepts and issues in NL, Theories and approaches for Semantic Analysis, Meaning Representation, word similarity, Lexical Semantics, word senses and relationships, WordNet (English and IndoWordnet), Word Sense Disambiguation: Lesk Algorithm Walker's algorithm, Coreferences Resolution:Anaphora, Cataphora.	**12**	**CO5**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Handbook of Natural Language Processing	Indurkhya, N., & Damerau, F. J.	CRC Press Taylor and Francis Group	2nd	2010
2.	Speech and Language Processing	Martin, J. H., & Jurafsky, D.	Pearson Education India	2nd	2013
3.	Foundations of Statistical Natural Language Processing	Manning, Christopher and Heinrich, Schutze	MIT Press	1st	1997
4.	Natural Language Processing With Python	Steven Bird, Edward Loper	O'Reilly Media	2nd	2016
5.	Video Links				

	1. http://www.nptelvideos.in/2012/11/natural-language-processing.html

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Natural Language Processing Practical		**Course Code: PSIT4P2a**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Students will get idea about know-hows, issues and challenge in Natural Language Processing and NLP applications and their relevance in the classical and modern context.

CO2: Student will get understanding of Computational techniques and approaches for solving NLP problems and develop modules for NLP tasks and tools such as Morph Analyzer, POS tagger, Chunker, Parser, WSD tool etc.

CO3: Students will also be introduced to various grammar formalisms, which they can apply in different fields of study.

CO4: Students can take up project work or work in R&D firms working in NLP and its allied areas.

CO5: Student will be able to understand applications in different sectors

PSIT402b: Digital Image Forensics

M. Sc (Information Technology)		Semester – IV	
Course Name: Digital Image Forensics		**Course Code: PSIT402b**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To understand describe the origin of computer forensics and the relationship between law enforcement and industry.
- Describe electronic evidence and the computing investigation process.
- Extracting Digital Evidence from Images and establishing them in court of Law.
- Enhancing images for investigation and various techniques to enhance images.
- Interpret and present Evidences in Court of Law.

Unit	Details	Lectures	Outcome
I	History of Forensic Digital Enhancement, Establishing Integrity of Digital Images for Court,	**12**	**CO1**
II	Digital Still and Video Cameras, Color Modes and Channel Blending to Extract Detail	**12**	**CO2**
III	Multiple Image Techniques, Fast Fourier Transform (FFT) – Background Pattern Removal.	**12**	**CO3**
IV	Contrast Adjustment Techniques, Advanced Processing Techniques, Comparison and Measurement	**12**	**CO4**
V	The Approach – Developing Enhancement Strategies for Images Intended for Analysis, Digital Imaging in the Courts, Interpreting and Presenting Evidence	**12**	**CO5**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Forensic Digital Image	Brian Dalrymple, Jill	CRC		2018

	Processing: Optimization of Impression Evidence	Smith	Press		
2.	Forensic Uses of Digital Imaging	John C. Russ, Jens Rindel, P. Lord	Taylor & Francis Group	2nd	2016

M. Sc (Information Technology)		**Semester – III**	
Course Name: Digital Image Forensics Practical		**Course Code: PSIT4P2b**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Understand the basics of image forensics and techniques to establish their integrity

CO2: Understand different techniques for extracting detail from images.

CO3: Understand and apply various advanced techniques in image processing and to compare and measure various parameters associated with them

CO4: Apply various enhancement strategies for digital images

CO5: Prepare the evidence to be acceptable in the court of law.

PSIT402c: Advanced IoT

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Advanced IoT		**Course Code: PSIT402c**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To understand the latest developments in IoT
- To build smart IoT applications
- To leverage the applications of IoT in different technologies
- To build own IoT platform

Unit	Details	Lectures	Outcome
I	The Artificial Intelligence 2.0, IoT and Azure IoT Suite, Creating Smart IoT Application	**12**	**CO1**
II	Cognitive APIs, Consuming Microsoft Cognitive APIs, Building Smarter Application using Cognitive APIs.	**12**	**CO2**
III	Implementing Blockchain as a service, Capturing, Analysing and Visualizing real-time data, Making prediction with machine learning.	**12**	**CO3**
IV	IoT and Microservices, Service Fabric, Build your own IoT platform: Introduction, Building blocks for IoT solution, Essentials for building your own platform, Platform requirements, building the platform by initializing cloud instance, installing basic software stacks, securing instance and software, installing node.js and Node-RED, Message broker.	**12**	**CO4**
V	Building Critical components, configuring message broker, creating REST interface, Rule engine and authentication, documentation and testing, Introspection on what we build and deliverables.	**12**	**CO5**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	IoT, AI, and Blockchain for .NET- Building a Next-Generation Application from the Ground Up	Nishith Pathak Anurag Bhandari	Apress	--	2018
2.	Microservices, IoT and Azure	Bob Familiar	Apress	--	2015
3.	Build your own IoT Platform	Anand Tamboli	Apress	--	2019
4.	Internet of Things Architectures, Protocols and Standards	Simone Cirani Gianluigi Ferrari Marco Picone Luca Veltri	Wiley	1	2019

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Advanced IoT Practical		**Course Code: PSIT4P2c**	
Periods per week (1 Period is 60 minutes)		**4**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**50**
	Internal	**--**	**-**

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Build smart IoT applications on Azure.

CO2: Use Microsoft cognitive APIs to build IoT applications.

CO3: Implement Blockchain in IoT.

CO4: Install and use microservices in IoT.

CO5: Build own IoT platform and use it in a customised way.

PSIT402d: Cyber Forensics

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Cyber Forensics		**Course Code: PSIT402d**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- Explain laws relevant to computer forensics
- Seize digital evidence from pc systems
- Recover data to be used as evidence
- Analyse data and reconstruct events
- Explain how data may be concealed or hidden

Unit	Details	Lectures	Outcome
I	Computer Forensics: The present Scenario, The Investigation Process, Computers – Searching and Seizing, Electronic Evidence, Procedures to be followed by the first responder.	**12**	**CO1**
II	Setting up a lab for Computer Forensics, Hard Disks and File Systems, Forensics on Windows Machine, Acquire and Duplicate Data	**12**	**CO2**
III	Recovery of deleted files and partitions, Using Access Data FTK and Encase for forensics Investigation, Forensic analysis of Steganography and Image files, Cracking Application passwords.	**12**	**CO3**
IV	Capturing logs and correlating to the events, Network Forensics – Investigating logs and Network traffic, Investigating Wireless and Web Attacks.	**12**	**CO4**
V	Email Tracking and Email Crime investigation. Mobile Forensics, Reports of Investigation, Become an expert witness.	**12**	**CO5**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	EC-Council CHFIv10 Study Guide	--	EC-Council	--	2018
2.	The official CHFI Exam 312-49 study Guide	Dave Kleiman	SYNGRESS	--	2007
3.	Digital Forensics and Incident Response	Gerard Johansen	Packt Publishing	--	2020
4.	Practical Cyber Forensics	Niranjan Reddy	Apress	--	2019

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Cyber Forensics Practical		**Course Code: PSIT4P2d**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Investigate the cyber forensics with standard operating procedures.

CO2: Recover the data from the hard disk with legal procedure.

CO3: To recover and analyse the data using forensics tool

CO4: Acquire the knowledge of network analysis and use it for analysing the internet attacks.

CO5: Able to investigate internet frauds done through various gadgets like mobile, laptops, tablets and become a forensic investigator.

PSIT403a: Deep Learning

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Deep Learning		**Course Code: PSIT403a**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- To present the mathematical, statistical and computational challenges of building neural networks
- To study the concepts of deep learning
- To enable the students to know deep learning techniques to support real-time applications

Unit	Details	Lectures	Outcome
I	**Applied Math and Machine Learning Basics:** Linear Algebra: Scalars, Vectors, Matrices and Tensors , Multiplying Matrices and Vectors , Identity and Inverse Matrices, Linear Dependence and Span , norms, special matrices and vectors, eigen decompositions. **Numerical Computation:** Overflow and under flow, poor conditioning, Gradient Based Optimization, Constraint optimization.	**12**	**CO1**
II	**Deep Networks:** Deep feedforward network , regularization for deep learning , Optimization for Training deep models	**12**	**CO2**
III	Convolutional Networks, Sequence Modelling, Applications	**12**	**CO3**
IV	Deep Learning Research: Linear Factor Models, Autoencoders, representation learning	**12**	**CO4**
V	Approximate Inference, Deep Generative Models	**12**	**CO5**

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

1.	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courvile	An MIT Press book	1st	2016
2.	Fundamentals of Deep Learning	Nikhil Buduma	O'Reilly	1st	2017
3.	Deep Learning: Methods and Applications	Deng & Yu	Now Publishers	1st	2013
4.	Deep Learning CookBook	Douwe Osinga	O'Reilly	1st	2017

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Deep Learning Practical		**Course Code: PSIT4P3a**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:
After completion of the course, a student should be able to:
CO1: Describes basics of mathematical foundation that will help the learner to understand the concepts of Deep Learning.
CO2: Understand and describe model of deep learning
CO3: Design and implement various deep supervised learning architectures for text & image data.
CO4: Design and implement various deep learning models and architectures.
CO5: Apply various deep learning techniques to design efficient algorithms for real-world applications.

PSIT403b: Remote Sensing

M. Sc (Information Technology)		Semester – IV	
Course Name: Remote Sensing Practical		**Course Code: PSIT403b**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

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 a research and application proposal using remote sensing.

Unit	Details	Lectures	Outcome
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,	**12**	**CO1**

	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		
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	**12**	**CO2**
III	Image Enhancement Techniques Introduction, Human Visual System, Contrast Enhancement, Linear Contrast Stretch, Histogram Equalization, Gaussian Stretch, Pseudocolour Enhancement, Density Slicing, 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	**12**	**CO3**
IV	Filtering Techniques	**12**	**CO4**

	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		
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	**12**	**CO5**

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
4.	Introductory Digital Image Processing: A Remote Sensing Perspective	John R. Jensen	Pearson		2015

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Remote Sensing Practical		**Course Code: PSIT4P3b**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop.

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Understand the basics of remote sensing and its various applications

CO2: Understand the Hardware and Software aspects of Digital Image Processing and demonstrate various techniques in pre-processing data

CO3: Demonstrate various image enhancement and transformation techniques.
CO4: Understand and Demonstrate various filtering, classification techniques along with advanced functionalities.

CO5: Perform comparison of Field and Remotely sensed measurements using various techniques.

PSIT403c: Server Virtualization on VMWare Platform

M. Sc (Information Technology)		Semester – IV	
Course Name: Server Virtualization on VMWare Platform		**Course Code: PSIT403c**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- Identify the need for Server Virtualization
- Describe the components and features of vSphere 6.7 and ESXi
- Describe how VMware's products help solve business and technical challenges with regard to Server Virtualization

Unit	Details	Lectures	Outcome
I	**Introducing VMware vSphere 6.7:** Exploring VMware vSphere 6.7, Examining the Products in the vSphere Suite, Examining the Features in VMware vSphere, Licensing VMware vSphere, Why Choose vSphere? **Planning and Installing VMware ESXi:** VMware ESXi Architecture, Understanding the ESXi Hypervisor, Examining the ESXi Components, Planning a VMware vSphere Deployment, Choosing a Server Platform, Determining a Storage Architecture, Integrating with the Network Infrastructure, Deploying VMware ESXi, Installing VMware ESXi Interactively, Performing an Unattended Installation of VMware ESXi, Deploying VMware ESXi with vSphere Auto Deploy, Performing Post-installation Configuration, Reconfiguring the Management Network, Using the vSphere Host Client, Configuring Time Synchronization, Configuring Name Resolution, **Installing and Configuring vCenter Server:**	**12**	**CO1**

	Introducing vCenter Server, Centralizing User Authentication Using vCenter Single Sign-On, Understanding the Platform Services Controller, Using the vSphere Web Client for Administration, Providing an Extensible Framework, Choosing the Version of vCenter Server, Planning and Designing a vCenter Server Deployment, Sizing Hardware for vCenter Server, Planning for vCenter Server Availability, Running vCenter Server and Its Components as VMs, Installing vCenter Server and Its Components, Installing vCenter Server in an Enhanced Linked Mode Group, Exploring vCenter Server, The vSphere Web Client Home Screen, Using the Navigator, Creating and Managing a vCenter Server Inventory, Understanding Inventory Views and Objects, Creating and Adding Inventory Objects, Exploring vCenter Server's Management Features, Understanding Basic Host Management, Examining Basic Host Configuration, Using Scheduled Tasks, Using the Events and Events Consoles in vCenter Server, Working with Host Profiles, Tags and Custom Attributes, Managing vCenter Server Settings, General vCenter Server Settings, Licensing, Message of the Day, Advanced Settings, Auto Deploy, vCenter HA, Key Management Servers, Storage Providers, vSphere Web Client Administration, Roles, Licensing, vCenter Solutions Manager, System Configuration, VMware Appliance Management Administration, Summary, Monitor, Access, Networking, Time, Services, Update, Administration, Syslog, Backup.		
II	vSphere Update Manager and the vCenter Support Tools: vSphere Update Manager, vSphere Update Manager and the vCenter Server Appliance, Installing the Update Manager Download Service, The vSphere Update Manager Plug-in Contents, Reconfiguring the VUM or UMDS, Installation with the Update Manager Utility, Upgrading VUM from a Previous Version, Configuring vSphere Update Manager, Creating Baselines Routine Updates, Attaching and Detaching Baselines or Baseline Groups, Performing a Scan, Staging Patches, Remediating Hosts, Upgrading VMware Tools, Upgrading Host Extensions, Upgrading Hosts with vSphere Update Manager, Importing an ESXi Image and Creating the Host Upgrade Baseline, Upgrading a Host, Upgrading VM Hardware, Performing an Orchestrated Upgrade, Investigating Alternative Update Options, Using vSphere Update Manager PowerCLI, Upgrading and Patching without vSphere Update Manager, vSphere	**12**	**CO2**

	Auto Deploy, Deploying Hosts with Auto Deploy, vCenter Support Tools, ESXi Dump Collector, Other vCenter Support Tools. **Creating and Configuring a vSphere Network:** Putting Together a vSphere Network, Working with vSphere Standard Switches, Comparing Virtual Switches and Physical Switches, Understanding Ports and Port Groups, Understanding Uplinks, Configuring the Management Network, Configuring VMkernel Networking, Enabling Enhanced Multicast Functions, Configuring TCP/IP Stacks, Configuring Virtual Machine Networking, Configuring VLANs, Configuring NIC Teaming, Using and Configuring Traffic Shaping, Bringing It All Together, Working with vSphere Distributed Switches, Creating a vSphere Distributed Switch, Removing an ESXi Host from a Distributed Switch, Removing a Distributed Switch, Managing Distributed Switches, Working with Distributed Port Groups, Managing VMkernel Adapters, Using NetFlow on vSphere Distributed Switches, Enabling Switch Discovery Protocols, Enabling Enhanced Multicast Functions, Setting Up Private VLANs, Configuring LACP, Configuring Virtual Switch Security, Understanding and Using Promiscuous Mode, Allowing MAC Address Changes and Forged Transmits.		
III	**Creating and Configuring Storage Devices:** Reviewing the Importance of Storage Design, Examining Shared Storage Fundamentals, Comparing Local Storage with Shared Storage, Defining Common Storage Array Architectures, Explaining RAID, Understanding vSAN, Understanding Midrange and External Enterprise Storage Array Design, Choosing a Storage Protocol, Making Basic Storage Choices, Implementing vSphere Storage Fundamentals, Reviewing Core vSphere Storage Concepts, Understanding Virtual Volumes, SCs vs LUNs, Storage Policies, Virtual Volumes, Working with VMFS Datastores, Working with Raw Device Mappings, Working with NFS Datastores, Working with vSAN, Working with Virtual Machine–Level Storage, Configuration, Leveraging SAN and NAS Best Practices **Ensuring High Availability and Business Continuity:** Understanding the Layers of High Availability, Clustering VMs, Introducing Network Load Balancing Clustering, Introducing Windows Server Failover Clustering, Implementing vSphere High Availability, Understanding vSphere High Availability Clusters. Understanding vSphere High Availability's Core Components, Enabling vSphere HA, Configuring	**12**	**CO3**

	vSphere High Availability, Configuring vSphere HA Groups, Rules, Overrides, and Orchestrated VM Restart, Managing vSphere High Availability, Introducing vSphere SMP Fault Tolerance, Using vSphere SMP Fault Tolerance with vSphere High Availability, Examining vSphere Fault Tolerance, Use Cases, Planning for Business Continuity, Providing Data Protection, Recovering from Disasters, Using vSphere Replication. **Securing VMware vSphere:** Overview of vSphere Security, Securing ESXi Hosts, Working with ESXi Authentication, Controlling Access to ESXi Hosts, Keeping ESXi Hosts Patched, Managing ESXi Host Permissions, Configuring ESXi Host Logging, Securing the ESXi Boot Process, Reviewing Other ESXi Security Recommendations, Securing vCenter Server, Managing vSphere Certificates, Working with Certificate Stores, Getting Started with Certificate Management, Authenticating Users with Single Sign-On, Understanding the vpxuser Account, Managing vCenter Server Permissions, Configuring vCenter Server Appliance Logging, Securing Virtual Machines, Configuring a Key Management Server for VM and VSAN Encryption, Virtual Trusted Platform Module, Configuring Network Security Policies, Keeping VMs Patched.		
IV	**Creating and Managing Virtual Machines:** Understanding Virtual Machines, Examining Virtual Machines from the Inside, Examining Virtual Machines from the Outside, Creating a Virtual Machine, Choosing Values for Your New Virtual Machine, Sizing Virtual Machines, Naming Virtual Machines, Sizing Virtual Machine Hard Disks, Virtual Machine Graphics, Installing a Guest Operating System, Working with Installation Media, Using the Installation Media, Working in the Virtual Machine Console, Installing VMware Tools, Installing VMware Tools in Windows, Installing VMware Tools in Linux, Managing Virtual Machines, Adding or Registering Existing VMs, Changing VM Power States, Removing VMs, Deleting VMs, Modifying Virtual Machines, Changing Virtual Machine Hardware, Using Virtual Machine Snapshots. **Using Templates and vApps:** Cloning VMs, Creating a Customization Specification, Cloning a Virtual Machine, Introducing vSphere Instant Cloning, Creating Templates and Deploying Virtual Machines, Cloning a Virtual Machine to a Template, Deploying a Virtual Machine from a Template, Using OVF Templates, Deploying a VM from an OVF Template, Exporting a VM as an OVF Template, Examining OVF	**12**	**CO4**

	Templates, Using Content Libraries, Content Library Data and Storage, Content Library Synchronization, Creating and Publishing a Content Library, Subscribing to a Content Library, Operating Content Libraries, Working with vApps, Creating a vApp, Editing a vApp, Changing a vApp's Power State, Cloning a vApp, Importing Machines from Other Environments, **Managing Resource Allocation:** Reviewing Virtual Machine, Resource Allocation, Working with Virtual Machine Memory, Understanding ESXi Advanced Memory Technologies, Controlling Memory Allocation, Managing Virtual Machine CPU Utilization, Default CPU Allocation, Setting CPU Affinity, Using CPU Reservations, Using CPU Limits, Using CPU Shares, Summarizing How Reservations, Limits, and Shares Work with CPUs, Using Resource Pools, Configuring Resource Pools, Understanding Resource Allocation with Resource Pools, Regulating Network I/O Utilization, Controlling Storage I/O Utilization, Enabling Storage I/O Control, Configuring Storage Resource Settings for a Virtual Machine, Using Flash Storage.		
V	**Balancing Resource Utilization:** Comparing Utilization with Allocation, Exploring vMotion, Examining vMotion Requirements, Performing a vMotion Migration Within a Cluster, Ensuring vMotion Compatibility, Using Per-Virtual-Machine CPU Masking, Using Enhanced vMotion Compatibility, Using Storage vMotion, Combining vMotion with Storage vMotion, Cross-vCenter vMotion, Examining Cross-vCenter vMotion Requirements, Performing a Cross-vCenter Motion, Exploring vSphere Distributed Resource Scheduler, Understanding Manual Automation Behavior, Reviewing Partially Automated Behavior, Examining Fully Automated Behavior, Working with Distributed Resource Scheduler Rules, Working with Storage DRS, Creating and Working with Datastore Clusters , Configuring Storage DRS. **Monitoring VMware vSphere Performance:** Overview of Performance Monitoring, Using Alarms Understanding Alarm Scopes, Creating Alarms, Managing Alarms, Working with Performance Charts, Overview Layout, Advanced Layout, Working with *esxtop*, Monitoring CPU Usage, Monitoring Memory Usage, Monitoring Network Usage, Monitoring Disk Usage. **Automating VMware vSphere:** Why Use Automation? vSphere Automation Automating with PowerCLI, PowerShell and PowerCLI, What's New in	**12**	**CO5**

	PowerCLI, Installing and Configuring PowerCLI on Windows, Installing and Configuring PowerCLI on macOS, Installing and Configuring PowerCLI on Linux, Additional PowerCLI Capabilities Getting Started with PowerCLI, Building PowerCLI Scripts, PowerCLI Advanced Capabilities, Additional Resources.		

Books and References:					
Sr No	Title	Author/s	Publisher	Edition	Year
1.	Mastering VMware vSphere 67	Nick Marshall, Mike Brown, G Blair Fritz, Ryan Johnson	Sybex, Wiley	--	2019
2.	Mastering VMware vSphere 67	Martin Gavanda, Andrea Mauro, Paolo Valsecchi, Karel Novak	Packt	--	2019

M Sc (Information Technology)		**Semester – IV**	
Course Name: Server Virtualization on VMWare Platform Practical		**Course Code: PSIT4P3c**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

List of Practical:
10 practicals covering the entire syllabus must be performed The detailed list of practical will be circulated later in the official workshop

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Understand VMWare VSphere 67, Install ESXi and Configure VSphere Centre

CO2: Demonstrate the use of VSphere Update Manager and Create a VSphere Network

CO3: Understand VSphere Security, Create and configure storage devices and Perform configurations to ensure business continuity

CO4: Demonstrate Resource allocation, Creating and managing virtual machine and the use of templates

CO5: Understand automation of vSphere and manage resource allocation

PSIT403d: Security Operations Centre

M. Sc (Information Technology)		Semester – IV	
Course Name: Security Operations Centre		**Course Code: PSIT403d**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- The SOC (Security Operations Centre) allows an organization to enforce and test its security policies, processes, procedures and activities through one central platform that monitors and evaluates the effectiveness of the individual elements and the overall security system of the organization.
- This will also allow the learners to configure various use cases and detect various attacks across the network and report them in real time and also take appropriate actions.
- This course will cover the design, deployment and operation of the SOC.
- Once this course is completed, students will have the skills to perform your SOC responsibilities effectively.

Unit	Details	Lectures	Outcome
I	**Introduction to Security Operations Management** Foundation Topics Introduction to Identity and Access Management Phases of the Identity and Access Lifecycle Registration and Identity Validation Privileges Provisioning Access Review Access Revocation Password Management Password Creation	**12**	**CO1**

	Password Storage and Transmission Password Reset Password Synchronization Directory Management Single Sign-On Kerberos Federated SSO Security Assertion Markup Language OAuth OpenID Connect Security Events and Logs Management Logs Collection, Analysis, and Disposal Syslog Security Information and Event Manager Assets Management Assets Inventory Assets Ownership Assets Acceptable Use and Return Policies Assets Classification Assets Labeling Assets and Information Handling Media Management Introduction to Enterprise Mobility Management Mobile Device Management Configuration and Change Management Configuration Management Change Management Vulnerability Management Vulnerability Identification Finding Information about a Vulnerability Vulnerability Scan Penetration Assessment Product Vulnerability Management Vulnerability Analysis and Prioritization Vulnerability Remediation Patch Management References and Additional Readings **Fundamentals of Cryptography and Public Key Infrastructure** (PKI) Cryptography Ciphers and Keys Ciphers Keys Block and Stream Ciphers Symmetric and Asymmetric Algorithms Symmetric Algorithms Asymmetric Algorithms Hashes Hashed Message Authentication Code Digital Signatures Digital Signatures in Action Key Management Next-Generation Encryption Protocols IPsec and SSL IPsec SSL Fundamentals of PKI Public and Private Key Pairs RSA Algorithm, the Keys, and Digital Certificates Certificate Authorities Root and Identity Certificates Root Certificate Identity Certificate X.500 and X.509v3 Certificates Authenticating and Enrolling with the CA Public Key Cryptography Standards Simple Certificate Enrollment Protocol Revoking Digital Certificates Using Digital Certificates PKI Topologies Single Root CA Hierarchical CA with Subordinate CAs Cross-certifying CAs Exam Preparation Tasks Review All Key Topics Complete Tables and Lists from Memory **Introduction to Virtual Private Networks (VPNs)**		

	What Are VPNs? Site-to-site vs. Remote-Access VPNs An Overview of IPsec IKEv1 Phase 1 IKEv1 Phase 2 IKEv2 SSL VPNs SSL VPN Design Considerations User Connectivity VPN Device Feature Set Infrastructure Planning Implementation Scope		
II	**Windows-Based Analysis** Process and Threads Memory Allocation Windows Registration Windows Management Instrumentation Handles Services Windows Event Logs Exam Preparation Tasks **Linux- and Mac OS X–Based Analysis** Processes Forks Permissions Symlinks Daemons UNIX-Based Syslog Apache Access Logs **Endpoint Security Technologies** Antimalware and Antivirus Software Host-Based Firewalls and Host-Based Intrusion Prevention Application-Level Whitelisting and Blacklisting System-Based Sandboxing	**12**	**CO2**
III	**Threat Analysis** What Is the CIA Triad: Confidentiality, Integrity, and Availability? Confidentiality Integrity Availability Threat Modeling Defining and Analyzing the Attack Vector Understanding the Attack Complexity Privileges and User Interaction The Attack Scope Exam Preparation Tasks **Forensics** Introduction to Cybersecurity Forensics The Role of Attribution in a Cybersecurity Investigation The Use of Digital Evidence Defining Digital Forensic Evidence Understanding Best, Corroborating, and Indirect or Circumstantial Evidence Collecting Evidence from Endpoints and Servers Collecting Evidence from Mobile Devices Collecting Evidence from Network Infrastructure Devices Chain of Custody Fundamentals of Microsoft Windows Forensics Processes, Threads, and Services Memory Management Windows Registry The Windows File System Master Boot Record (MBR) The Master File Table (MFT) Data Area and Free Space FAT NTFS MFT Timestamps, MACE, and Alternate Data Streams EFI Fundamentals of Linux Forensics Linux Processes Ext4 Journaling Linux MBR and Swap File System	**12**	**CO3**

	Exam Preparation Tasks **Fundamentals of Intrusion Analysis** Common Artifact Elements and Sources of Security Events False Positives, False Negatives, True Positives, and True Negatives Understanding Regular Expressions Protocols, Protocol Headers, and Intrusion Analysis Using Packet Captures for Intrusion Analysis Mapping Security Event Types to Source Technologies		
IV	**Introduction to Incident Response and the Incident Handling Process** **Introduction to Incident Response** What Are Events and Incidents? The Incident Response Plan The Incident Response Process The Preparation Phase The Detection and Analysis Phase Containment, Eradication, and Recovery Post-Incident Activity (Postmortem) Information Sharing and Coordination Incident Response Team Structure The Vocabulary for Event Recording and Incident Sharing (VERIS) **Incident Response Teams** Computer Security Incident Response Teams (CSIRTs) Product Security Incident Response Teams (PSIRTs) Security Vulnerabilities and Their Severity Vulnerability Chaining Role in Fixing Prioritization Fixing Theoretical Vulnerabilities Internally Versus Externally Found Vulnerabilities National CSIRTs and Computer Emergency Response Teams (CERTs) Coordination Centers Incident Response Providers and Managed Security Service Providers (MSSPs) **Compliance Frameworks** Payment Card Industry Data Security Standard (PCI DSS) PCI DSS Data Health Insurance Portability and Accountability Act (HIPAA) HIPAA Security Rule HIPAA Safeguards Administrative Safeguards Physical Safeguards Technical Safeguards Sarbanes-Oxley (SOX) Section 302 Section 404 Section 409 SOX Auditing Internal Controls **Network and Host Profiling** Network Profiling Throughput Measuring Throughput Used Ports Session Duration Critical Asset Address Space Host Profiling Listening Ports Logged-in Users/Service Accounts Running Processes Applications	**12**	**CO4**
V	**The Art of Data and Event Analysis** Normalizing Data Interpreting Common Data Values into a Universal Format Using the 5-Tuple Correlation to Respond to Security Incidents Retrospective Analysis and Identifying Malicious Files Identifying a	**12**	**CO5**

	Malicious File Mapping Threat Intelligence with DNS and Other Artifacts Deterministic Versus Probabilistic Analysis **Intrusion Event Categories** Diamond Model of Intrusion Cyber Kill Chain Model Reconnaissance Weaponization Delivery Exploitation Installation Command and Control Action and Objectives **Types of Attacks and Vulnerabilities** Types of Attacks Reconnaissance Attacks Social Engineering Privilege Escalation Attacks Backdoors Code Execution Man-in-the Middle Attacks Denial-of-Service Attacks Direct DDoS Botnets Participating in DDoS Attacks Reflected DDoS Attacks Attack Methods for Data Exfiltration ARP Cache Poisoning Spoofing Attacks Route Manipulation Attacks Password Attacks Wireless Attacks Types of Vulnerabilities **Security Evasion Techniques** Key Encryption and Tunneling Concepts Resource Exhaustion Traffic Fragmentation Protocol-Level Misinterpretation Traffic Timing, Substitution, and Insertion Pivoting		

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	CCNA Cyber Ops SECOPS 210-255 Official Cert Guide	Omar Santos, Joseph Muniz	CISCO	1st	2017
2.	CCNA Cyber Ops SECFND 210-250 Official Cert Guide	Omar Santos, Joseph Muniz	CISCO	1st	2017
3.	CCNA Cyber security Operations Companion Guide		CISCO	1st	2018

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Security Operations Centre Practical		**Course Code: PSIT4P3d**	
Periods per week (1 Period is 60 minutes)		**4**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2**	**50**
	Internal	**--**	**-**

List of Practical:
10 practicals covering the entire syllabus must be performed. The detailed list of

practical will be circulated later in the official workshop.

Course Outcomes:

After completion of the course, a student should be able to:
CO1: Understanding basics of SOC, Cryptography and managing and deploying VPNs.

CO2: Analyse Windows and Linux based logs along with logs generated by endpoints.

CO3: Understand and analyze various forms of intrusions, threats and perform forensic analysis on them.

CO4: Understand the incident response process and handle incidents by adhering to compliance policies and standards set by the organization.

CO5: Understand the various types of attacks and vulnerabilities, categorize events and perform incident analysis.

PSIT404a: Human Computer Interaction

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Human Computer Interaction		**Course Code: PSIT404a**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- Understand the important aspects of implementation of human-computer interfaces.
- Identify the various tools and techniques for interface analysis, design, and evaluation.
- Identify the impact of usable interfaces in the acceptance and performance utilization of information systems

Unit	Details	Lectures	Outcome
I	**The Interaction:** Models of interaction, Design Focus, Frameworks and HCI, Ergonomics, Interaction styles, Elements of the WIMP interface,Interactivity **Paradigms:** Introduction, Paradigms for interaction **Interaction design basics:** What is design?, The process of design, User focus, Cultural probes, Navigation design, the big button trap, Modes, Screen design and layout, Alignment and layout matters, Checking screen colors, Iteration and prototyping **HCI in the software process**: The software life cycle, Usability engineering , Iterative design and prototyping, Prototyping in practice, Design rationale	**12**	**CO1**
II	**Design**: Principles to support usability, Standards, Guidelines, Golden rules and heuristics, HCI patterns	**12**	**CO2**

	Implementation support: Elements of windowing systems, Programming the application, Going with the grain, Using toolkits, User interface management systems **Evaluation techniques:** What is evaluation?, Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, Choosing an evaluation method		
III	**Universal design:** Universal design principles, Multi-modal interaction, Designing websites for screen readers, Choosing the right kind of speech, Designing for diversity **User support:** Requirements of user support, Approaches to user support, Adaptive help systems, Designing user support systems **Cognitive models:** Goal and task hierarchies, Linguistic models, The challenge of display-based systems, Physical and device models, Cognitive architectures	**12**	**CO3**
IV	**Socio-organizational issues and stakeholder requirements:** Organizational issues, Capturing requirements **Communication and collaboration models:** Face-to-face communication, Conversation, Text-based communication, Group working **Task analysis:** Differences between task analysis and other techniques, Task decomposition, Knowledge-based analysis, Entity–relationship-based techniques, Sources of information and data collection, Uses of task analysis	**12**	**CO4**
V	**Dialog notations and design:** What is dialog?, Dialog design notations, Diagrammatic notations, Textual dialog notations, Dialog semantics, Dialog analysis and design **Models of the system:** Standard formalisms, Interaction models, Continuous behavior **Modeling rich interaction:** Status–event analysis, Rich contexts, Low intention and sensor-based interaction	**12**	**CO5**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Human Computer Interaction	Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale	Pearson Education	3rd	
2.	Designing the User Interface	Shneiderman B., Plaisant C., Cohen M., Jacobs S.	Pearson	5th	2013

Course Outcomes:

After completion of the course, a student should be able to:

CO1: have a clear understanding of HCI principles that influence a system's interface design, before writing any code.
CO2: understand the evaluation techniques used for any of the proposed system.
CO3: understand the cognitive models and its design.
CO4: able to understand how to manage the system resources and do the task analysis.
CO5: able to design and implement a complete system.

PSIT404b: Advanced IoT

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Advanced IoT		**Course Code: PSIT404b**	
Periods per week (1 Period is 60 minutes)		**4**	
Credits		**4**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**60**
	Internal	**--**	**40**

Course Objectives:

- To understand the applications on image processing in different disciplines.
- To apply the concepts to new areas of research in Image processing.

Unit	Details	Lectures	Outcome
I	Fuzzy Approaches and Analysis in Image Processing, Text information extraction from images, Image and Video steganography based on DCT and wavelet transform.	**12**	**CO1**
II	Zernike-Moments-Based Shape Descriptors for Pattern Recognition and Classification Applications, An Image De-Noising Method Based on Intensity Histogram Equalization Technique for Image Enhancement, A New Image Encryption Method Based on Improved Cipher Block Chaining with Optimization Technique	**12**	**CO2**
III	A Technique to Approximate Digital Planar Curve with Polygon, Shape Determination of Aspired Foreign Body on Pediatric Radiography Images Using Rule-Based Approach, Evaluation of Image Detection and Description Algorithms for Application in Monocular	**12**	**CO3**

	SLAM, Diophantine Equations for Enhanced Security in Watermarking Scheme for Image Authentication		
IV	Design, Construction, and Programming of a Mobile Robot Controlled by Artificial Vision, Review and Applications of Multimodal Biometrics for Secured Systems, Background Subtraction and Object Tracking via Key Frame-Based Rotational Symmetry Dynamic Texture, A Novel Approach of Human Tracking Mechanism in Wireless Camera Networks	**12**	**CO4**
V	Digital Image Steganography: Survey, Analysis, and Application, Vegetation Index: Ideas, Methods, Influences, and Trends, Expert System through GIS-Based Cloud	**12**	**CO5**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Advanced Image Processing Techniques and Applications	N. Suresh Kumar, Arun Kumar Sangaiah, M. Arun, S. Anand	IGI global	--	2017

Course Outcomes:

After completion of the course, a student should be able to:

CO01: Understand the advanced applications of Image processing.

CO02: Understand the application of image processing pattern recognition, encryption and image enhancement.

CO03: Understand and apply the image processing techniques in identification of foreign body using radiography, watermarking techniques.

CO04: Apply the image processing techniques to robot vision, biometrics, human tracking using wireless camera.

CO05: Apply image processing in steganography, expert systems through GIS based cloud.

PSIT404c: Storage as a Service

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Storage as a Service		**Course Code: PSIT404c**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- Understand the need for Storage Area Network and Data protection to satisfy the information explosion requirements.
- Study storage technologies: SAN, NAS, IP storage etc., which will bridge the gap between the emerging trends in industry and academics.
- To get an insight of Storage area network architecture, protocols and its infrastructure.
- To study and discuss the applications of SAN to fulfill the needs of the storage management in the heterogeneous environment.
- Study and understand the management of Storage Networks
- To understand different techniques of managing store.

Unit	Details	Lectures	Outcome
I	Introduction to Information Storage Information Storage Data Types of Data Big Data Information Storage Evolution of Storage Architecture Data Center Infrastructure Core Elements of a Data Center Key Characteristics of a Data Center Managing a Data Center Virtualization and Cloud Computing Data Center Environment Application Database Management System (DBMS) Host (Compute) Operating System	**12**	**CO1**

	Memory Virtualization Device Driver 20 Volume Manager File System Compute Virtualization Connectivity Physical Components of Connectivity Interface Protocols IDE/ATA and Serial ATA 28 SCSI and Serial SCSI Fiber Channel Internet Protocol (IP) Storage Disk Drive Components Platter Spindle Read/Write Head Actuator Arm Assembly Drive Controller Board Physical Disk Structure Zoned Bit Recording Logical Block Addressing Disk Drive Performance Disk Service Time Seek Time Rotational Latency Data Transfer Rate Disk I/O Controller Utilization Host Access to Data Direct-Attached Storage DAS Benefit and Limitations Storage Design Based on Application Requirements and Disk Performance Disk Native Command Queuing Introduction to Flash Drives Components and Architecture of Flash Drives Features of Enterprise Flash Drives Concept in Practice: VMware ESXi Data Protection: RAID RAID Implementation Methods Software RAID Hardware RAID Array Components RAID Techniques Striping Mirroring Parity RAID Levels RAID 0 RAID 1 Nested RAID RAID 3 RAID 4 RAID 5 RAID 6 RAID Impact on Disk Performance Application IOPS and RAID Configurations RAID Comparison Hot Spares		
II	**Intelligent Storage Systems** Components of an Intelligent Storage System Front End Cache Structure of Cache Read Operation with Cache Write Operation with Cache Implementation Cache Management Cache Data Protection Back End Physical Disk Storage Provisioning Traditional Storage Provisioning LUN Expansion: MetaLUN Virtual Storage Provisioning 82 Comparison between Virtual and Traditional Storage Provisioning Use Cases for Thin and Traditional LUNs LUN Masking Types of Intelligent Storage Systems High-End Storage Systems Midrange Storage Systems **Fiber Channel Storage Area Networks** Fiber Channel: Overview The SAN and Its Evolution Components of FC SAN Node Ports Cables and Connectors Contents Interconnect Devices SAN Management Software FC Connectivity Point-to-Point Fiber Channel Arbitrated Loop Fiber Channel Switched Fabric FC-SW Transmission Switched Fabric Ports Fiber Channel Architecture Fiber Channel Protocol Stack	**12**	**CO2**

	FC-4 Layer FC-2 Layer FC-1 Layer FC-0 Layer Fiber Channel Addressing World Wide Names FC Frame 110. Structure and Organization of FC Data Flow Control BB_Credit EE_Credit Classes of Service Fabric Services Switched Fabric Login Types Zoning Types of Zoning FC SAN Topologies Mesh Topology Core-Edge Fabric Benefits and Limitations of Core-Edge Fabric Virtualization in SAN Block-level Storage Virtualization Virtual SAN (VSAN) **IP SAN and FCoE** iSCSI Components of iSCSI iSCSI Host Connectivity iSCSI Topologies Native iSCSI Connectivity Bridged iSCSI Connectivity Combining FC and Native iSCSI Connectivity iSCSI Protocol Stack iSCSI PDU 6 iSCSI Discovery iSCSI Names iSCSI Session iSCSI Command Sequencing FCIP FCIP Protocol Stack FCIP Topology FCIP Performance and Security FCoE I/O Consolidation Using FCoE Components of an FCoE Network Converged Network Adapter Cables FCoE Switches FCoE Frame Structure FCoE Frame Mapping FCoE Enabling Technologies Priority-Based Flow Control (PFC) Enhanced Transmission Selection (ETS Congestion Notification (CN) Data Center Bridging Exchange Protocol (DCBX) 1		
III	**Network-Attached Storage** General-Purpose Servers versus NAS Devices Benefits of NAS File Systems and Network File Sharing Accessing a File System Network File Sharing Components of NAS NAS I/O Operation NAS Implementations Unifi ed NAS Unifi ed NAS Connectivity 164 Gateway NAS Gateway NAS Connectivity Scale-Out NAS Scale-Out NAS Connectivity NAS File-Sharing Protocols NFS CIFS Factors Affecting NAS Performance File-Level Virtualization Object-Based and Unified Storage Object-Based Storage Devices Object-Based Storage Architecture Components of OSD Object Storage and Retrieval in OSD Benefits of Object-Based Storage Common Use Cases for Object-Based Storage Content-Addressed Storage CAS Use Cases Healthcare Solution: Storing Patient Studies Finance Solution: Storing Financial Records Unified Storage Components of Unifi ed Storage Data Access from Unified Storage	**12**	**CO3**

	Introduction to Business Continuity Information Availability Causes of Information Unavailability Consequences of Downtime Measuring Information Availability BC Terminology BC Planning Life Cycle Failure Analysis Single Point of Failure Resolving Single Points of Failure Multipathing Software Business Impact Analysis BC Technology Solutions I/O Operation without PowerPath I/O Operation with PowerPath Automatic Path Failover Path Failure without PowerPath Path Failover with PowerPath: Active-Active Array Path Failover with PowerPath: Active-Passive Array Backup and Archive Backup Purpose Disaster Recovery Operational Recovery Archival Backup Considerations Backup Granularity Recovery Considerations Backup Methods 6 Backup Architecture Backup and Restore Operations Backup Topologies Backup in NAS Environments Server-Based and Serverless Backup NDMP-Based Backup Backup Targets Backup to Tape Physical Tape Library Limitations of Tape 2 Backup to Disk Backup to Virtual Tape Virtual Tape Library Data Deduplication for Backup Data Deduplication Methods Data Deduplication Implementation Source-Based Data Deduplication Target-Based Data Deduplication Backup in Virtualized Environments Data Archive Archiving Solution Architecture Use Case: E-mail Archiving Use Case: File Archiving		
IV	Local Replication Replication Terminology Uses of Local Replicas Replica Consistency Consistency of a Replicated File System Consistency of a Replicated Database Local Replication Technologies Host-Based Local Replication LVM-Based Replication Advantages of LVM-Based Replication Limitations of LVM-Based Replication File System Snapshot Storage Array-Based Local Replication Full-Volume Mirroring Pointer-Based, Full-Volume Replication Pointer-Based Virtual Replication Network-Based Local Replication Continuous Data Protection CDP Local Replication Operation Tracking Changes to Source and Replica Restore and Restart Considerations Creating Multiple Replicas Local Replication in a Virtualized Environment Remote	**12**	**CO4**

	Replication Modes of Remote Replication Remote Replication Technologies Host-Based Remote Replication LVM-Based Remote Replication Host-Based Log Shipping Storage Array-Based Remote Replication Synchronous Replication Mode Asynchronous Replication Mode Disk-Buffered Replication Mode Network-Based Remote Replication CDP Remote Replication Three-Site Replication Three-Site Replication — Cascade/Multihop Synchronous + Asynchronous Synchronous + Disk Buffered Three-Site Replication — Triangle/Multitarget Data Migration Solutions Remote Replication and Migration in aVirtualized Environment Cloud Computing Cloud Enabling Technologies Characteristics of Cloud Computing Benefits of Cloud Computing Cloud Service Models Infrastructure-as-a-Service Platform-as-a-Service Software-as-a-Service Cloud Deployment Models Public Cloud Private Cloud Community Cloud Hybrid Cloud Cloud Computing Infrastructure Physical Infrastructure Virtual Infrastructure Applications and Platform Software Cloud Management and Service Creation Tools Cloud Challenges Challenges for Consumers Challenges for Providers Cloud Adoption Considerations		
V	Securing the Storage Infrastructure Information Security Framework Risk Triad Assets Threats Vulnerability Storage Security Domains Securing the Application Access Domain Controlling User Access to Data Protecting the Storage Infrastructure 341 Data Encryption Securing the Management Access Domain Controlling Administrative Access Protecting the Management Infrastructure Securing Backup, Replication, and Archive Security Implementations in Storage Networking FC SAN FC SAN Security Architecture Basic SAN Security Mechanisms LUN Masking and Zoning Securing Switch Ports Switch-Wide and Fabric-Wide Access Control Logical Partitioning of a Fabric: Virtual SAN NAS NAS File Sharing: Windows ACLs NAS File Sharing: UNIX Permissions NAS File Sharing: Authentication and Authorization Kerberos Network-Layer Firewalls IP SAN Securing Storage Infrastructure in Virtualized and Cloud Environments Security Concerns Security Measures Security at the Compute Level	**12**	**CO5**

	Security at the Network Level Security at the Storage Level Concepts in Practice: RSA and VMware Security Products RSA Secure ID RSA Identity and Access Management RSA Data Protection Manager VMware vShield Managing the Storage Infrastructure Monitoring the Storage Infrastructure Monitoring Parameters Components Monitored Hosts Storage Network Storage Monitoring Examples Accessibility Monitoring Capacity Monitoring Performance Monitoring Security Monitoring Alerts Storage Infrastructure Management Activities Availability Management Capacity Management Performance Management Security Management Reporting Storage Infrastructure Management in a Virtualized Environment Storage Management Examples Storage Allocation to a New Server/Host File System Space Management Chargeback Report Storage Infrastructure Management Challenges Developing an Ideal Solution 384Storage Management Initiative Enterprise Management Platform Information Lifecycle Management Storage Tiering Intra-Array Storage Tiering Inter-Array Storage Tiering		

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Information Storage and Management: Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments	EMC	John Wiley & Sons	2nd	2012

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Understand different techniques of storage and RAID Technologies
CO2: Understand different intelligent storage technologies. Also, understand the benefits of Fibre Channel Storage Networks along with iSCSI.
CO3: Understand the architecture of NAS and deployment along with Object based and unified storage technologies. Also, the learner will be able to configure the storage devices to maintain highest level of availability
CO4: Understand Replication and Migration techniques and implement them.
CO5: Understand Different techniques for managing and securing storage infrastructure.

PSIT404d: Information Security Auditing

M. Sc (Information Technology)		Semester – IV	
Course Name: Information Security Auditing		**Course Code: PSIT404d**	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	**Marks**
Evaluation System	**Theory Examination**	2½	60
	Internal	--	40

Course Objectives:

- Understand various information security policies in place.
- Assess an organization based on the needs and suggest the requisite information security policies to be deployed.
- Audit the organization across relevant policies and assist the organization in implementing such policies along with suggesting improvements.

Unit	Details	Lectures	Outcome
I	Secrets of a Successful Auditor Understanding the Demand for IS Audits Understanding Policies, Standards, Guidelines, and Procedures Understanding Professional Ethics Understanding the Purpose of an Audit Differentiating between Auditor and Auditee Roles Implementing Audit Standards Auditor Is an Executive Position Understanding the Corporate Organizational Structure Governance Strategy Planning for Organizational Control Overview of Tactical Management Planning and Performance Overview of Business Process Reengineering Operations Management Summary Audit Process	**12**	**CO1**

	Understanding the Audit Program Establishing and Approving an Audit Charter Preplanning Specific Audits Performing an Audit Risk Assessment Determining Whether an Audit Is Possible Performing the Audit Gathering Audit Evidence Conducting Audit Evidence Testing Generating Audit Findings Report Findings Conducting Follow-up (Closing Meeting)		
II	Information Systems Acquisition and Development Project Governance and Management Business Case and Feasibility Analysis System Development Methodologies Control Identification and Design Testing Methodologies Configuration and Release Management System Migration, Infrastructure Deployment and Data Conversion Post-implementation Review	**12**	**CO2**
III	Information Systems Operations Introduction Common Technology Components IT Asset Management Job Scheduling and Production Process Automation System Interfaces End-user Computing Data Governance Systems Performance Management Problem and Incident Management Change, Configuration, Release and IT Service Level Management Database Management Business Resilience Business Impact Analysis Data Backup, Storage and Restoration Business Continuity Plan Disaster Recovery Plans	**12**	**CO3**
IV	Information Systems Life Cycle Governance in Software Development Management of Software Quality Overview of the Executive Steering Committee Change Management Management of the Software Project Overview of the System Development Life Cycle Overview of Data Architecture Decision Support Systems Program Architecture Centralization vs. Decentralization Electronic Commerce System Implementation and Operations Understanding the Nature of IT Services Performing IT Operations Management Performing Capacity Management	**12**	**CO4**

	Using Administrative Protection Performing Problem Management Monitoring the Status of Controls Implementing Physical Protection		
V	Protecting Information Assets Understanding the Threat Using Technical Protection Business Continuity and Disaster Recovery Debunking the Myths Understanding the Five Conflicting Disciplines Called Business Continuity Defining Disaster Recovery Defining the Purpose of Business Continuity Uniting Other Plans with Business Continuity Understanding the Five Phases of a Business Continuity Program Understanding the Auditor Interests in BC/DR Plans	**12**	**CO5**

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	CISA®: Certified Information Systems Auditor	David Cannon	SYBEX	Fourth Edition	2016
2.	CISA Review Manual 27th Edition		ISACA		2019
3.	CISA Certified Information Systems Auditor All-in-One Exam Guide, Fourth Edition,		O'Reilly	4th Edition	2019

Course Outcomes:

After completion of the course, a student should be able to:

CO1: Understand various information security policies and process flow, Ethics of an Information security Auditor.

CO2: Understand various information systems in an organization, their criticality and various governance and management policies associated with them.

CO3: Critically analyse various operational strategies like asset management, data governance etc. and suggest requisite changes as per organizations requirements with improvements.

CO4: Understand the information flow across the organization and identify the weak spots, and also suggest improvements to strengthen them.

CO5: Come up with strong strategies to protect information assets and come up with an efficient business continuity plan, disaster recovery strategy etc.

PSIT4P4: Project Implementation and Viva

M. Sc (Information Technology)		**Semester – IV**	
Course Name: Project Implementation and Viva		**Course Code: PSIT4P4**	
Periods per week (1 Period is 60 minutes)		4	
Credits		2	
		Hours	**Marks**
Evaluation System	**Practical Examination**	2	50
	Internal	--	-

The project dissertation and Viva Voce details are given in Appendix 1.

Evaluation Scheme

Internal Evaluation (40 Marks)

The internal assessment marks shall be awarded as follows:

1. **30 marks (Any one of the following):**
    a. **Written Test or**
    b. **SWAYAM (Advanced Course) of minimum 20 hours and certification exam completed or**
    c. **NPTEL (Advanced Course) of minimum 20 hours and certification exam completed or**
    d. **Valid International Certifications (Prometric, Pearson, Certiport, Coursera, Udemy and the like)**
    e. **One certification marks shall be awarded one course only. For four courses, the students will have to complete four certifications.**
2. **10 marks**
   The marks given out of 40 (30 in Semester 4) for publishing the research paper should be divided into four course and should awarded out of 10 in each of the four course.

i. Suggested format of Question paper of 30 marks for the written test.

Q1.	**Attempt *any two* of the following:**	**16**
a.		
b.		
c.		
d.		
Q2.	**Attempt *any two* of the following:**	**14**
a.		
b.		
c.		
d.		

ii. 10 marks from every course coming to a total of 40 marks, shall be awarded on publishing of research paper in UGC approved / Other Journal with plagiarism

less than 10%. The marks can be awarded as per the impact factor of the journal, quality of the paper, importance of the contents published, social value.

External Examination: (60 marks)

	All questions are compulsory	
Q1	**(Based on Unit 1) Attempt *any two* of the following:**	**12**
a.		
b.		
c.		
d.		
Q2	**(Based on Unit 2) Attempt *any two* of the following:**	**12**
Q3	**(Based on Unit 3) Attempt *any two* of the following:**	**12**
Q4	**(Based on Unit 4) Attempt *any two* of the following:**	**12**
Q5	**(Based on Unit 5) Attempt *any two* of the following:**	**12**

Practical Evaluation (50 marks)

A Certified copy of hard-bound journal is essential to appear for the practical examination.

1.	**Practical Question 1**	**20**
2.	**Practical Question 2**	**20**
3.	**Journal**	**5**
4.	**Viva Voce**	**5**

OR

1.	**Practical Question**	**40**
2.	**Journal**	**5**
3.	**Viva Voce**	**5**

Project Documentation and Viva Voce Evaluation

The documentation should be checked for plagiarism and as per UGC guidelines, should be less than 10%.

1.	**Documentation Report (Chapter 1 to 4)**	**20**
2.	**Innovation in the topic**	**10**
3.	**Documentation/Topic presentation and viva voce**	**20**

Project Implementation and Viva Voce Evaluation

1.	**Documentation Report (Chapter 5 to last)**	**20**
2.	**Implementation**	**10**
3.	**Relevance of the topic**	**10**
4.	**Viva Voce**	**10**

Appendix – 1

Project Documentation and Viva-voce (Semester III) and Project Implementation and Viva-Voce (Semester IV)

Goals of the course Project Documentation and Viva-Voce

The student should:

- be able to apply relevant knowledge and abilities, within the main field of study, to a given problem
- within given constraints, even with limited information, independently analyse and discuss complex inquiries/problems and handle larger problems on the advanced level within the main field of study
- reflect on, evaluate and critically review one's own and others' scientific results
- be able to document and present one's own work with strict requirements on structure, format, and language usage
- be able to identify one's need for further knowledge and continuously develop one's own knowledge

To start the project:

- Start thinking early in the programme about suitable projects.
- Read the instructions for the project.
- Attend and listen to other student´s final oral presentations.
- Look at the finished reports.
- Talk to senior master students.
- Attend possible information events (workshops / seminars / conferences etc.) about the related topics.

Application and approval:

- Read all the detailed information about project.
- Finalise finding a place and supervisor.
- Check with the coordinator about subject/project, place and supervisor.
- Write the project proposal and plan along with the supervisor.
- Fill out the application together with the supervisor.
- Hand over the complete application, proposal and plan to the coordinator.
- Get an acknowledgement and approval from the coordinator to start the project.

During the project:

- Search, gather and read information and literature about the theory.

- Document well the practical work and your results.
- Take part in seminars and the running follow-ups/supervision.
- Think early on about disposition and writing of the final report.
- Discuss your thoughts with the supervisor and others.
- Read the SOP and the rest you need again.
- Plan for and do the mid-term reporting to the coordinator/examiner.
- Do a mid-term report also at the work-place (can be a requirement in some work-places).
- Write the first draft of the final report and rewrite it based on feedback from the supervisor and possibly others.
- Plan for the final presentation of the report.

Finishing the project:
- Finish the report and obtain an OK from the supervisor.
- Ask the supervisor to send the certificate and feedback form to the coordinator.
- Attend the pre-final oral presentation arranged by the Coordinator.
- Rewrite the final report again based on feedback from the opponents and possibly others.
- Prepare a title page and a popular science summary for your report.
- Send the completed final report to the coordinator (via plagiarism software)
- Rewrite the report based on possible feedback from the coordinator.
- Appear for the final exam.

Project Proposal/research plan
- The student should spend the first 1-2 weeks writing a 1-2 pages project plan containing:
  - Short background of the project
  - Aims of the project
  - Short description of methods that will be used
  - Estimated time schedule for the project
- The research plan should be handed in to the supervisor and the coordinator.
- Writing the project plan will help you plan your project work and get you started in finding information and understanding of methods needed to perform the project.

Project Documentation
The documentation should contain:
- Introduction - that should contain a technical and social (when possible) motivation of the project topic.
- Description of the problems/topics.
- Status of the research/knowledge in the field and literature review.
- Description of the methodology/approach. (The actual structure of the chapters here depends on the topic of the documentation.)
- Results - must always contain analyses of results and associated uncertainties.
- Conclusions and proposals for the future work.
- Appendices (when needed).
- Bibliography - references and links.

For the master's documentation, the chapters cannot be dictated, they may vary according to the type of project. However, in Semester III Project Documentation and Viva Voce must contain at least 4 chapters (Introduction, Review of Literature, Methodology / Approach, Proposed Design / UI design, etc. depending on the type of project.) The Semester III report should be spiral bound.

In Semester IV, the remaining Chapters should be included (which should include Experiments performed, Results and discussion, Conclusions and proposals for future work, Appendices) and Bibliography - references and links. Semester IV report should include all the chapters and should be hardbound.