SANJEEV AGRAWAL GLOBAL EDUCATIONAL (SAGE) UNIVERSITY, BHOPAL

Scheme

for

Master of Technology (Big Data and Cloud Computing)

School of Advanced Computing

SANJEEV AGRAWAL GLOBAL EDUCATIONAL (SAGE) UNIVERSITY, BHOPAL

Program Educational Objectives (PEOs)

PEO-1: Students shall have the ability to apply knowledge across the disciplines and in emerging areas of Big Data and Cloud Computing for higher studies, research, employability, product development and handle the realistic problems.

PEO-2: To understand industry careers involving innovation and programming solving using Big Data and Cloud Computing.

PEO-3: Students shall possess academic excellence with innovative insight, soft skills, managerial skills, leadership qualities, knowledge of contemporary issues and understand the need for lifelong learning for a successful professional career.

PEO-4: Students will have the ability to apply the gained knowledge to improve the society ensuring ethical and moral values.

PEO-5: Promote Design, Research, and implementation of products and services in the field of Artificial Intelligence through strong communication and entrepreneurial skills.

Program Outcomes (POs):

PO-1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO-2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO-3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO-4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO-5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO-6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO-7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO-8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO-9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO-10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO-11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO-12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Curriculum Components

Components	Credits
Program Core (08 Courses)	**28**
Program Electives (Discipline Specific Electives) (04 Courses)	**16**
Project Based Learning (PBL)/MOOCs (04 courses)	**12**
Project (02 Courses)	**28**
Total	**84**

First Semester																	
Course Code	**Course Title**	**Contact Hours Per Week**			**Credits**	**ESE Duration (Hours)**	**Theory**						**Practical**			**G T**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**Tot**	**CE**	**ESE**	**Tot**	
MA20M101	Advanced Mathematics	3	1	-	4	3	30	05	05	10	50	100	-	-	-	100
BC21M102	Cloud Architecture	3	1	-	4	3	30	05	05	10	50	100				100
BC21M103	Big Data Technologies and Framework	3	-	2	4	3	30	05	05	10	50	100	20	30	50	150
Table-1	DSE-I	3	-	2	4	3	30	05	05	10	50	100	20	30	50	150
Table-1	DSE-II	3	1	-	4	3	30	05	05	10	50	100	-	-	-	100
AI20M104	Software Lab-I	-	-	4	2	2	-				-	-	20	30	50	50
PB20M101	Project Based Learning-I	-	-	4	2	2	-				-	-	50^	50	100	100
		Total			**24**											**750**

L-Lecture, T-Tutorial, P-Practical, MSE- Mid Semester Exam, ASG- Assignment, TA- Teacher's Assessment, ATTD-Attendance, CE-Continuous Evaluation ,ESE- End Semester Exam, Tot-Total, GT-Grand Total, ^ - Two assessment by panel of Expert

Second Semester																
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Theory**						**Practical**			**G T**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**Tot**	**CE**	**ESE**	**Tot**	
BC21M201	Cloud Storage Infrastructure	3	1	-	4	3	30	05	05	10	50	100	-	-	-	100
BC21M202	Data Center Networking	2	1	2	4	3	30	05	05	10	50	100	20	30	50	150
BC21M203	Exploratory Data Analysis	3	-	2	4	3	30	05	05	10	50	100	20	30	50	150
Table-1	DSE-III	3	-	2	4	3	30	05	05	10	50	100	20	30	50	150
Table-1	DSE-IV	3	1	-	4	3	30	05	05	10	50	100	-	-	-	100
BC20M204	Cloud Computing Tools	-	-	4	2	2	-				-	-	20	30	50	50
PB20M201	Project Based Learning-II	-	-	4	2	2	-				-	-	50^	50	100	100
		Total			**24**											**800**

L-Lecture, T-Tutorial, P-Practical, MSE- Mid Semester Exam, ASG- Assignment, TA- Teacher's Assessment, ATTD-Attendance, CE-Continuous Evaluation ,ESE- End Semester Exam, Tot-Total, GT-Grand Total, ^ - Two assessment by panel of Expert

Third Semester																
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Theory**						**Practical**			**GT**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**Tot**	**CE**	**ESE**	**Tot**	
	MOOC-1	-	-	8	4	-	-	-	-	-	-	-	50	50	100	100
	MOOC-2	-	-	8	4	-	-	-	-	-	-	-	50	50	100	100
BC21M301	Dissertation Phase-I	-	-	24	12	2	-				-	-	150	150	300	300
		Total			**20**											**500**

L-Lecture, T-Tutorial, P-Practical, MSE- Mid Semester Exam, ASG- Assignment, TA- Teacher's Assessment, ATTD-Attendance, CE-Continuous Evaluation, ESE- End Semester Exam, Tot-Total, GT-Grand Total

Fourth Semester																	
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Theory**						**Practical**			**GT**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**Tot**	**CE**	**ESE**	**Tot**	
BC21M401	Dissertation Phase-II	-	-	32	16	-					-	-	200	200	400	400
		Total			**16**											**400**

L-Lecture, T-Tutorial, P-Practical, MSE- Mid Semester Exam, ASG- Assignment, TA- Teacher's Assessment, ATTD-Attendance, CE-Continuous Evaluation ,ESE- End Semester Exam, Tot-Total, GT-Grand Total

Distribution of credits across all components

SEM No.	Prog. Core	Discipline Specific Electives (DSE)	Project Based Learning (PBL)/ MOOCs	Project	Total Credit
I.	14	08	02	-	**24**
II.	14	08	02	-	**24**
III.	-	-	08	12	**20**
IV.	-	-	-	16	**16**
Total	**28**	**16**	**12**	**28**	**84**

Table-1
List of Discipline Specific Electives (DSE)

SN	Course Code	DSE-I
1.	**AI20M106**	Internet of Things
2.	**BC21M107**	Database Systems: Design and Implementation
3.	**BC21M108**	Operating System and Virtualization
SN	**Course Code**	**DSE-II**
1.	**AI20M109**	Data Mining and Warehousing
2.	**BC21M110**	Managing Virtual Environments
3.	**BC21M111**	Design and Development of Cloud Application
SN	**Course Code**	**DSE-III**
1.	**BC21M204**	Web Technologies
2.	**BC21M205**	Soft Computing
3.	**BC21M206**	Introduction to Intelligent System
SN	**Course Code**	**DSE-IV**
1.	**BC21M207**	Bio inspired Computation
2.	**BC21M208**	Cloud Security
3.	**BC21M209**	Analytics of Things

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Syllabus

for

M Tech (Big Data and Cloud Computing)

School of Advanced Computing

COURSE CODE	ADVANCED MATHEMATICS	Total Lecture:60 Theory:45 Tutorial:15
MA20M101		(LTP=3 –1–0=4)

Course Objectives:

- To introduce students to the theoretical distributions, sampling distributions and their applications
- To introduce the students to the solution of partial differential equation
- Demonstrate an understanding to the theory and applications of linear algebra
- To extend the concept of the computer algorithms related to dimensionality reduction and feature extraction.
- To introduce the concepts of Stochastic process and Markov process transition.

UNIT	CONTENTS	HOURS
I.	Probability, compound probability and discrete random variable. Binomial, Normal and Poisson's distributions, Sampling distribution, elementary concept of estimation and theory of hypothesis, recurred relations.	8
II.	Solution of Partial Differential Equation (PDE) by separation of variable method, numerical solution of PDE (Laplace, Poisson's, Parabola) using finite difference methods, Elementary properties of FT, DFT, WFT, Wavelet transform, Haas transform.	10
III.	Finite differences: forward, backward and central difference operators, polynomial interpolation: equally spaced and unequally spaced data; Numerical Differentiation, Numerical integration- Trapezoidal and Simpson1/3rd and 3/8th rules; Initial value problems - Taylor series method, Euler and modified Euler methods, Runge- Kutta methods.	10
IV.	Solution of Linear systems– Gaussian elimination method, LU factorization method, Cholesky's factorization method. Linear least-squares problems - Normal equations, QR method (or Gram Schmidt Ortho- normalization), Singular value decomposition (SVD) for linear least-squares problems, numerical rank determination via SVD, Principal Component Analysis.	10
V.	Stochastic process, Markov process transition probability transition probability matrix, just and higher order Markov process, Application of Eigen value problems in Markov Process, Markov chain. Queuing system, transient and steady state, traffic intensity, distribution queuing system, concepts of queuing models (M/M/1: Infinity/ Infinity/ FC FS), (M/M/1: N/ Infinity/ FC FS), (M/M/S: Infinity/ Infinity/ FC FS)	07

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Understand**[2] probability, sampling distribution and discrete random variable.
CO 2	**Interpret**[2] the terms and their applications of Solution of Partial Differential Equations
CO 3	**Relate**[2] the numerical methods and their use in obtaining approximate solutions to otherwise intractable linear/non-linear system of equations and differential equations.
CO 4	**Analyse**[4] the fundamental use of matrices in the computer algorithms related to dimensionality reduction and feature extraction.
CO 5	**Implement**[3] Stochastic process, Markov process transition probability transition probability matrix and Markov process.
Text Books	• Gupta S C , Kapoor V. K. (2014): **Fundamentals of Mathematical Statistics**, Delhi: Sultan Chand & Sons. • Jimmie Gilbert (2010): **Linear Algebra And Matrix Theory,** New Delhi Elsevier. • Grewal B S (2014): **Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB,** 10th Edition: Khanna Publishers.
Reference Books	• Rohatgi, V.K., Saleh, Md. Ehsanes A.K. (2009): **An introduction to probability and statistics,** 2nd Edition, New Delhi: Wiley India. • Trefethen L. N., David Bau (1997): **Numerical Linear Algebra,** Philadelphia SIAM.

COURSE CODE	CLOUD ARCHITECTURE	Total Lecture : 60 Theory : 45 Tutorial : 15
BC21M102		(LTP=3 – 1 – 0 = 4)

Course Objectives:

- Analyze the components of cloud computing showing how business agility in an organization can be created.
- Evaluate the deployment of web services from cloud architecture.
- Critique the consistency of services deployed from a cloud architecture.
- Compare and contrast the economic benefits delivered by various cloud models based on application requirements, economic constraints and business requirements.
- Critically analyze case studies to derive the best practice model to apply when developing and deploying cloud based applications

UNIT	CONTENTS	HOURS
I	**CLOUD COMPUTING FUNDAMENTALS:** Cloud Computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public vs private clouds, role of virtualization in enabling the cloud; Business Agility: Benefits and challenges to Cloud architecture. Application availability, performance, security and disaster recovery; next generation Cloud Applications.	8
II	**CLOUD APPLICATIONS**: Technologies and the processes required when deploying web services; Deploying a web service from inside and outside a cloud architecture, advantages and disadvantages.	6
III	**MANAGEMENT OF CLOUD SERVICES:** Reliability, availability and security of services deployed from the cloud. Performance and scalability of services, tools and technologies used to manage cloud services deployment; Cloud Economics : Cloud Computing infrastructures available for implementing cloud based services. Economics of choosing a Cloud platform for an organization, based on application requirements, economic constraints and business needs (e.g Amazon, Microsoft and Google, Salesforce.com, Ubuntu and Redhat)	12
IV	**APPLICATION DEVELOPMENT:** Service creation environments to develop cloud based applications. Development environments for service development; Amazon, Azure, Google App.	10
V	**CLOUD IT MODEL:** Analysis of Case Studies when deciding to adopt cloud computing architecture. How to decide if the cloud is right for your requirements. Cloud based service, applications and development platform deployment so as to improve the total cost of ownership (TCO)	9

Course Outcome as per Bloom's Taxonomy	
At the end of the course the students will be able to:	
CO1	**Identify**[1] the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
CO2	**Explain**[3] the core issues of cloud computing such as security, privacy, and interoperability.
CO3	**Understand**[2] the fundamental of tools and technologies used to manage cloud services
CO4	**Understand**[2] the environment creation of Amazon, Azure, Google App.
CO5	**Explain**[3] the need of cloud architecture: when & how to use it.
Text Books	• Shroff Gautam (2010): **Enterprise Cloud Computing Technology Architecture Applications** ,1st edition, Cambridge: Cambridge University Press.
Reference Books	• Velte Toby, Velte Anthony, Elsenpeter Robert (2009): **Cloud Computing, A Practical Approach,** 1st edition, Emeryville: McGraw-Hill Osborne Media. • Chorafas Dimitris N. (2010): **Cloud Computing Strategies,** 1st edition, Boca Raton, Florida: CRC Press.

COURSE CODE	BIG DATA TECHNOLOGIES AND FRAMEWORK	Total Lecture : 60 Theory : 45 Practical : 15
BC21M103		(LTP=3 – 0 – 2 = 4)

Course Objectives:

- To have knowledge on accessing, storing and manipulating the huge data from different resources.
- To understand the working environment of Pig and Hive for processing the structured and unstructured data.
- To differentiate the RDBMS and Hive architectures and implement queries to process the data using sqoop.
- To have a knowledge on searching mechanisms using solr.

UNIT	CONTENTS	HOURS
I	Concepts, Needs and Challenges of big data. Types and source of big data. Components of Hadoop Eco System- Data Access and storage, Data Intelligence, Data Integration, Data Serialization, Monitoring, Indexing.	8
II	Apache Pig Introduction, Parallel processing using Pig, Pig Architecture, Grunt, Pig Data Model-scalar and complex types. Pig Latin- Input and output, Relational operators, User defined functions. Working with scripts. Apache Hive Fundamentals Introduction-Hive modules, Data types and file formats, Hive QL-Data Definition and Data Manipulation. Apache Hive Advanced Concepts 4hour Hive QL queries, Hive QL views- reduce query complexity. Hive scripts. Hive QL Indexes-create, show, drop. Aggregate functions. Bucketing vs Partitioning.	12
III	Relational database management in Hadoop: Bi directional data transfer between Hadoop and external database. Import data- Transfer an entire table, import subset data, use different file format. Incremental import import new data, incrementally import data, preserving the value	8
IV	Sqoop Export transfer data from Hadoop, update the data, update at the same time, export subset of columns. Hadoop ecosystem integration- import data to hive, using partitioned hive tables, replace special delimiters.	7
V	Introduction. Information retrieval search engine, categories of data, inverted index. Design- field attributes and types. Indexing- indexing tool. Indexing operations using csv documents. Searching data- parameters, default query	10
List of Experiments		
1	Implement a program using Pig latin operators and user defined functions Implement a program using operators and Pig latin scripts Program using Hive manipulation and data definition languages	
2	Implement a program using Hive queries with partitioning.	
3	Implement a program using Hive indexes. Implement a program using Hive views Implement a program using Hive external table by accessing the external file created by Pigor any other tool. Program using Hive scripts and aggregate functions	
4	Implement a program using Hive queries with bucketing and clustering. Implement a program	

	for data transfer between Hadoop and external database using sqoop.
5	Program to import data and incremental data in sqoop.
6	Program to preserve the value in sqoop Program to export data from Hadoop using sqoop Program to import data to hive and using partitioned hive tables
7	Program for inverted index using solr Program for indexing operations using csvfiles in solr. Program to search data using solr

Course Outcome as per Bloom's Taxonomy	
At the end of the course the students will be able to:	
CO1	**Illustrate** the usage of data on different Big data ecosystems.
CO2	**Demonstrate** the Pig architecture and evaluation of pig scripts.
CO3	**Describe** the Hive architecture and execute SQL queries on sample data sets.
CO4	**Understand**[2] the process of transferring data between different file systems and to execute operations using sqoop.
CO5	**Understand**[2] the concepts of indexing and use these concepts in solr search engine.
Text Books	• Gates Alan (2011): **Programming Pig Dataflow Scripting with Hadoop**, California: O'Reilly Media, Inc. • Rutherglen Jason, Wampler Dean, Caprialo Edward (2012): **Programming Hive,** California: O'Reilly Media, Inc. • Kathleen Ting, Jarek Jarcec Cecho (2013): **Apache Sqoop Cookbook**, California: O'Reilly Media, Inc.
Reference Books	• Shahi Dikshant, Solr Apache (2015): **A Practical approach to enterprise search**, New York: Apress. • Lam Chuck (2010): **Hadoop in Action**, Manning Publications • Andrea Gazzarini, Apache Solr (2015): **Essentials**, PACKT Publications.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-I	Total Lecture:60 Theory:45 Practical:15
AI20M106	INTERNET OF THING	(LTP= 3 – 0 – 2 = 4)

Course Objectives

- To Understand the Architectural Overview of IoT.
- To Understand the IoT Reference Architecture and Real World Design Constraints.
- To Understand the various IoT Protocols (Data link, Network, Transport, Session, Service)
- To understand security aspect in IoT.
- To design an IoT application.

UNIT	CONTENTS	HOURS
I.	Evolution of IoT: Review of computer communication concepts (OSI layers, components, packet communication, Networks, TCP-IP, subnetting,IPV4 addressing and challenges). IPV6 addressing. IoT architecture reference layer.	10
II.	Introduction to IoT components: Characteristics IoT sensor nodes, Edge computer, cloud and peripheral cloud, single board computers, open source hardwares, Examples of IoT infrastructure	10
III.	IoT protocols and softwares: MQTT, UDP, MQTT brokers, publish subscribe modes, HTTP, COAP,XMPP and gateway protocols, IoT Communication Pattern, IoT protocol Architecture, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BT, BLE,SIG,NFC, LORA,Lifi,Widi)	10
IV.	IoT security: Need for encryption, standard encryption protocol, light weight cryptography, Quadruple Trust Model for IoT-A – Threat Analysis and model for IoT-A, Cloud security. open source IoT platforms, cloud dashboards.	8
V.	IoT application and its Variants: Case studies: IoT for smart cities, health care, agriculture, smart meters.M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0,IoT standards.	7

List of Practical's

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.

9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.

10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.

11. To install MySQL database on Raspberry Pi and perform basic SQL queries.

12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.

13. Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.

14. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.

15. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Understand**[2] the definition and significance of the Internet of Things
CO 2	**Understand**[2] the architecture, operation, and business benefits of an IoT solution
CO 3	**Understand**[2] various layers and Examine the potential business opportunities that IoT can uncover
CO 4	**Interpret**[2] the relationship between IoT, cloud computing, and big data
CO 5	**Identify**[1] how IoT differs from traditional data collection systems
Text Books	• Holler Jan, Tsiatsis Vlasios, Mulligan Catherine, Avesand Stefan, Karnouskos Stamatis, Boyle David (2014): **From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence**, 1st Edition, Cambridge: Academic Press. • Madisetti Vijay, Bahga Arshdeep (2014): **Internet of Things(A Hands-on Approach) ,** 1st Edition, VPT. • Bernd Scholz-Reiter, Michahelles Florian: **Architecting the Internet of Things** , Springer.
Reference Books	• Minoli Daniel (2013): **Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications**, New Delhi: Wiley Publications. • Peter Waher (2015): **Learning Internet of Things** , Mumbai: PACKT publishing.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-I	Total Lecture:60 Theory:45 Practical:15
BC21M107	DATABASE SYSTEMS: DESIGN AND IMPLEMENTATION (LTP= 3 – 0 – 2 = 4)	

Course Objectives:

- To emphasize the underlying principles of Relational Database Management System.
- To model and design advanced data models to handle threat issues and counter measures.
- To implement and maintain the structured, semi-structured and unstructured data in an efficient database system using emerging trends.

UNIT	CONTENTS	HOURS
I	Relational Model Database System Architecture–EER Modeling-Indexing–Normalization–Query processing and optimization – Transaction Processing	8
II	Parallel Databases Architecture, Data partitioning strategy, Interquery and Intraquery Parallelism –Parallel Query Optimization. Distributed Databases Features – Distributed Database Architecture –Fragmentation –Replication-Distributed Query Processing – Distributed Transactions Processing	10
III	Spatial databases-Type of spatial data–Indexing in spatial databases, Mobile Databases– Transaction Model in MDS	10
IV	Semi Structured databases – XML –Schema-DTD- XPath- XQuery, Semantic Web –RDF–RDFS	8
V	Introduction to Database Security Issues–Security Models–Different Threats to databases– Counter measures to deal with these problems. Emerging Technologies Cloud databases – Streaming Databases - Graph Databases-New SQL	9
	LIST OF EXPERIMENTS	
1	Model any given scenario into ER/EER Model using any tool ERD Plus, ER Win, Oracle SQL developer)	
2	Creating applications with RDBMS Table creation with constraints, alter schema, insert values, aggregate functions, simple and complex queries with joins PLSQL-PROCEDURES, CURSORS, FUNCTIONS, TRIGGERS	
3	Partition a given database based on the type of query and compares the execution speed of the query with/without parallelism.	
4	Create an XML document and validate it against an XML Schema/DTD. Use XQuery to query and view the contents of the database.	
5	Consider an application in which the results of football games are to be represented in XML,DTD and Xquery. For each game, we want to be able to represent the two teams involved ,which one was playing at home, which players scored goals(some of which may have been penalties)and the time when each was scored, and which players were shown yellow or red cards. You might use some attributes. You can check your solutions with the online demo of the Zorba XQueryengine4.	
6	To implement parallel join and parallel sort algorithms to get marks from different colleges of the university and publish10 ranks for each discipline.	

7	Create a distributed database scenario, insert values, fragment the database and query the database.
8	Consider a schema that contains the following table with the key underlined: Employee (Eno, Ename, Desg, Dno). Assume that we horizontally fragment the table as follows: Employee1(Eno; Ename; Desg;Dno), where 1¡= Dno ¡=10 Employee2(Eno;Ename; Desg; Dno), where 11 ¡= Dno ¡=20 Employee3 (Eno;Ename; Desg;Dno),where21¡=Dno¡=30In addition, assume we have 4 sites that contain the following fragments:Site1hasEmployee1Site2hasEmployee2Site3has Employee2andEmployee3Site4hasEmployee1Implementatleast5suitablequerieson Employeefragments.Addrelationsto the database as per your requirements.
9	Download a spatial dataset based on any specific theme (containing layer information) from Quantum GIS and import it into Postgres SQL(PostGIS) and Query and view the database.
10	To investigation of some spatial analysis techniques using Toxic Release Inventory (www.epa.gov/triexplorer/) data for Massachusetts from the Environmental Protection Agency (EPA),which indicate the magnitude of the releases of toxic core chemicals into land, water and air ata site in the state. Note that these TRI locations were geo coded from a list of addresses provided by the EPA
11	Use sample datasets from health care domain, Visualize and interpret the results
12	Import the Hubway data intoNeo4jandconfigureNeo4j.Then, answer the following questions using the Cypher Query Language: a) List top 10 stations with most outbound trips (Show station name and number of trips) b) List top 10 stations with most inbound trips (Show station name and number of trips) c) List top 5 routes with most trips (Show starting station name, ending station name and number of trips) (4) List the hour number (for example 13 means 1pm -2pm) and number of trips which start from the station" B.U.Central" d)List the hour number(forexample13means1pm-2pm)and number of trips which end at the station "B.U. Central"

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	**Design** and implement database depending on the business requirements and considering various design issues.
CO2	**Categorize** and design the structured, semi-structured and unstructured databases.
CO3	**Review** cloud, streaming and graph databases.
CO4	**Understand**[2] the requirements of data and transaction management in mobile and spatial database and differentiate those with RDBMS.
CO5	**Characterize** the database threats and its counter measures.
Text Books	• Silberschatz Avi, Korth Hank, Sudarshan S (2010): **Database System Concepts** ,6th Edition, Noida: McGraw Hill. • Elmasri Ramez Navathe B (2014): **Fundamentals of database systems** , 7th edition, United States: Addison Wesley.
Reference Books	• Singh S.K. (2011): **Database Systems: Concepts, Design Applications** , 2nd edition, Delhi: Pearson education. • Fawcett Joe, Ayers Danny, Quin Liam R. E. (2012): **Beginning XML**, 5th

	Edition, New Delhi: Wiley India Private Limited. • Connolly Thomas M., Begg Carolyn (2015): **Database Systems: A Practical Approach to Design, Implementation, and Management** , 6th edition, New Delhi: Pearson India.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-I	Total Lecture:60 Theory:45 Practical:15
BC21M108	OPERATING SYSTEMS AND VIRTUALIZATION (LTP= 3 – 0 – 2 = 4)	

Course Objectives:

- To introduce Virtualization, operating systems fundamental concepts and its technologies.
- To provides skills to write programs that interact with operating system components such as processes, thread, memory during concurrent execution.
- To provide the skills and knowledge necessary to implement, provisioning and administer server and desktop virtualization.

UNIT	CONTENTS	HOURS
I	History of OS - Computer system architecture a layered view with interfaces, Glenford Myer, Monolithic Linux Hybrid Windows 10 kernels Layered architecture of operating system and core functionalists. PROCESS Introduction, Process Operations, States, Context switching, Data Structures (Process Control Block (PCB), Process Scheduling: Multi-Level Feedback Queue, Multi-processor Scheduling, Deadlocks and its detection.	10
II	MEMORY Introduction, Address Spaces, Memory API, Address Translation, Paging - Faster Translations (TLB), Smaller Tables. Virtual Memory System in x86.	10
III	CONCURRENCY Introduction, Thread Models, Thread API, Building Evaluating a Lock, Test And Set, Classical problems handling using semaphore, Monitors, Persistence - File Organization: The i-node, Crash Consistency file security.	10
IV	VIRTUAL MACHINES Process and System VMs Taxonomy of VMs.TYPES OF VIRTUALIZATION Hardware Emulation, Full Virtualization with binary translation, Hardware assisted, Operating System Virtualization, OS assisted /Para virtualization.	8
V	HYPERVISOR Type 1, Type 2, Paravirtualization, Server Virtualization, Desktop Virtualization, Overview VM portability - Clones, Templates, Snapshots, OVF, Hot and Cold Cloning Protecting Increasing Availability, Light Weight Virtual machine: Container / Docker.	7

List of Experiment	
1	Study of Basic Linux Commands.
2	Shell Programming (I/O, Decision making, Looping, Multi-level branching).
3	Crating child process using fork() system call, Orphan and Zombie process creation.
4	Simulation of CPU scheduling algorithms (FCFS, SJF, Priority and Round Robin).
5	Simulation of Bankers algorithm to check weather given system is in safe state or not. Also check whether addition resource requested can be granted immediately.
6	Parallel Thread management using pthread library. Implement a data parallelism using multi-threading.

7	Dynamic memory allocation algorithms - first-fit, best-fit, worst-fit algorithms.
8	Page Replacement Algorithms FIFO, LRU and Optimal.
9	Virtualization Setup: Type-1, Type-2 Hypervisor.
10	Implementation of OS / Server Virtualization.
Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO1	**Understand**[2] operating system layers and kernel architectures.
CO2	**Design**[6] various techniques for process management.
CO3	**Construct**[6] various address translation mechanism.
CO4	**Perform**[4] process threading and synchronization.
CO5	**Classify**[4] the light-weight virtual machines with dockers and containers.
Text Books	• Silberschatz, Abraham, Gagne Greg, Galvin Peter B. (2018): **Operating system concepts** , 10th Edition, New Delhi: Wiley Publishers. • Portnoy Matthew (2016): **Virtualization Essentials**, 2nd Edition, New Jersey: John Wiley Sons Inc.
Reference Books	• Anderson Thomas, Dahlin Michael (2014): **Operating Systems: Principles and Practice** , 2nd Edition, Recursive Books. • Stallings William (2015): **Operating Systems: Internals and Design Principles** , 8th Edition, Pearson. • Smith, Nair (2005): **Virtual Machines Versatile Platforms for Systems and Processes** , 1st Edition, Morgan Kaufmann Publishers.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-II	Total Lecture : 60 Theory : 45 Tutorial : 15
AI20M109	DATA MINING AND WAREHOUSING	(LTP= 3 – 1 –0 = 4)

Course Objectives:

- Understand the components, architecture and other important tools of data warehousing.
- To understand data pre-processing and data visualization techniques
- To study algorithms for finding hidden and interesting patterns in data
- To understand and apply various classification and clustering techniques using tools.
- To understand types of association rules & algorithms.

UNIT	CONTENTS	HOURS
I.	Introduction to DWH : Data warehouse (DWH): Need, Definition, Advantages of DWH, OLTP Vs DWH, 3-tier Architecture, DWH Design Process, ETL Process, DWH Back-end Tools and Utilities, Metadata Repository, Models of DWH: Enterprise Warehouse, Data Mart, Virtual Warehouse, Comparison.	10
II.	Dimensional Modeling: Dimensional Model Vs ER Model, DWH Schemas: Star, Snowflake, Fact Constellation, their Comparison, Techniques to Handle Changing Dimensions, Aggregation, Families of Fact Tables, Fact Less Fact Tables; Data Warehouse Indexing: Factors used to select an Indexing Technique, Properties of a Good Indexing Technique for DWH, Indexing Techniques: Projection Index, Bitmap Index (Pure and Encoded), Join Index and their Comparison.	10
III.	Data Mining and Functionalities: Need of Data Mining, Knowledge Discovery in Database (KDD), Architecture of Data Mining System, Data Mining on Different kind of Data, Data Mining Functionalities; Data Preprocessing: Need, Cleaning, Integration, Transformation, Reduction, Discretization, Concept Hierarchy Generation.	8
IV.	Cluster Analysis: Categories of Clustering methods, Partitioning methods: k-Means, kMedoids; Prediction: Numerical Prediction, Linear, Non-Linear Regression; Outlier Analysis: Applications, Techniques.	7
V.	Classification: Decision Tree Classifier, Rule Based Classification, Bayesian Classification, Neural Network Classification: Back Propagation Algorithm, Lazy Learner: kNN Classifier, Case-Based Reasoning, Other: Fuzzy Set Approach, Classifier Accuracy Measures, Techniques for Evaluating Classifier Accuracy; Frequent Itemset Mining: Interesting Item Set Mining: Market Basket Analysis, APriori Algorithm, Generating Association Rules, Types of Association Rules, Correlation Analysis. Data Mining on different Databases: Multimedia Data Mining, Web Mining, Text Mining, Spatial Data Mining, Mining on Social Networks, Multi-relational Data Mining.	10

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Construct**[6] an end-to-end data warehousing solution.
CO 2	**Evaluate**[5] various data processing algorithms in their applicability to different problems.
CO 3	**Display**[4] the process of converting data into a user defined format required for particular analysis.
CO 4	**Utilize**[2] statistical tools in deriving insights from data.
CO 5	**Describe**[1] various techniques for clustering and classification. Apply various techniques to solve real-world data analysis problems
Text Books	• Kimball, Reeves, Ross, With Thornth, Wiley John (2002): **The Data Warehouse Lifecycle Toolkit**. • Han Jiawei, Kamber Micheline, Kaufman Morgan, **Data Mining: Concepts and Techniques** , 2nd Edition.
Reference Books	• Mallach Efrem G (2009): **Decision Support and Data Warehouse Systems**, Noida: Tata McGraw Hill. • Berry M , Linoff G, Wiley John (2008): **Mastering Data Mining: The art and science of customer relationship management** , 1st Edition, New Delhi: Wiley India Pvt. Ltd.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-II	Total Lecture: 60 Theory : 45 Tutorial : 15
BC21M110	MANAGING VIRTUAL ENVIRONMENTS (LTP= 3 – 1– 0 = 4)	

Course Objectives:

- Discuss and evaluate the management of complex virtual environments.
- Critically analyze key performance factors in virtualized systems.
- Identify and formulate judgments for management requirements relating to the configuration and performance of virtual environments.
- Identify and analyze the principal issues in troubleshooting virtual environments.
- Performance evaluations and critical evaluations of a small scale virtual environment developed in the lab.

UNIT	CONTENTS	HOURS
I	PERFORMANCE MANAGEMENT IN A VIRTUAL ENVIRONMENT: Management techniques, methodology and key performance metrics used to identifying CPU, memory, network, virtual machine and application performance bottlenecks in a virtualized environment. 13 SRM-M.Tech Cloud Computing 2015 – 16	10
II	CONFIGURATION AND CHANGE MANAGEMENT: Configuration and change management goals and guidelines, tools and technologies in virtualized environments.	10
III	SECURE VIRTUAL NETWORKING: Configuration and change management goals and guidelines, tools and technologies in virtualized environments; Virtual network security architecture, network segmentation and traffic isolation to secure a virtual network configuration.	8
IV	PROTECTING THE MANAGEMENT ENVIRONMENT: Server authentication, authorization, and accounting, SSL certificates, server hardening; Protecting the host system: security architecture, controlling access to storage, hardening hosts, Hardening virtual machines; Virtual machine security architecture, security parameters; Protecting the host and virtual machine systems using server authentication, authorization, and accounting techniques.	7
V	TROUBLESHOOTING VIRTUAL ENVIRONMENTS: Interpreting host, network, storage, cluster and virtual machine log files. Network troubleshooting, traffic sniffing, storage access problems, iSCSI authentication and digests. Virtual machine migration, cluster errors with shares, pools, and limits; Command line interfaces and syntax, interpreting host, network, storage, cluster, virtual machine log files and network traces.	10

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	**Understand**[2] the management technique & methodology for virtual environment
CO2	**Explain**[3] goals & guidelines of change management
CO3	**Understand**[2] the virtual network architecture & it's security issues
CO4	**Explain**[3] the security parameter of how to protect host & virtual machine
CO5	**Identify**[1] and analyze the principal issues in troubleshooting virtual environments.
Text Books	• Cafaro Massimo, Aloisio Giovanni (2011): **Grids, Clouds and Virtualization** Springer; [ISBN: 978-0857290489]. • Wolf Chris and M. Halter Erick (2005): **Virtualization,** A press; 1 edition [ISBN: 978- 1590594957]. • Somani Gaurav (2010): **Scheduling and Isolation in Virtualization**, VDM Verlag Dr. Müller [ISBN: 978-3639295139], Muller Publishers, Germany, Sept..
Reference Books	• Boursas Latifa , Carlson Mark, Hommel Wolfgang, Sibilla Michelle, Wold Kes (2008): **Systems and Virtualization Management: Standards and New Technologies,** [ISBN: 978-3540887072]. • Haletky Edward L (2007): **VMware ESX Server in the enterprise,** 1 edition, Prentice Hall;. • Haletky Edward (2011): **VMware ESX and ESXi in the Enterprise - Planning Deployment of Virtualization Servers,** 2 edition , Prentice Hall.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-II	Total Lecture : 60 Theory : 45 Tutorial : 15
BC21M111	DESIGN & DEVELOPMENT OF CLOUD APPLICATIONS (LTP= 3 – 0 – 2 = 4)	

Course Objectives:

- Design and develop elegant and flexible cloud software solutions.
- Evaluate the security issues related to the development of cloud applications.
- Manage and deploy a cloud based application.
- Research and critique a topic related to Software development in the cloud.
- Analyze a real world problem and develop a cloud based software solution.

UNIT	CONTENTS	HOURS
I	DESIGNING CLOUD BASED APPLICATIONS: Role of business analyst, requirements gathering, UML, use of state diagrams, wire frame prototypes, use of design tools such as Balsamiq. Selecting front end technologies and standards, Impact of growth in mobile computing on functional design and technology decisions.	10
II	CLOUD APPLICATION DEVELOPMENT: Technical architecture considerations – concurrency, speed and unpredictable loads. Agile development, team composition (including roles/responsibilities), working with changing requirements and aggressive schedules. Understanding Model View Controller (MVC). Advanced understanding of views", location, and the presentation layer: Advanced Ajax and JQuery. Presenting to different browsers and devices. Localization and internationalization; Understanding client location and device type. Mobile application development – Android, iOS, WP, RIM, Symbian.	10
III	STORING OBJECTS IN THE CLOUD: Session management. Advanced database techniques using MySQL and SQL Server, blob storage, table storage. Working with Third Party APIs: Overview of interconnectivity in cloud ecosystems. Working with Twitter API, Flickr API, Google Maps API. Advanced use of JSON and REST.	8
IV	CLOUD APPLICATIONS AND SECURITY ISSUES: Understanding cloud based security issues and threats (SQL query injections, common hacking efforts), SSL, encrypted query strings, using encryption in the database. Authentication and identity. Use of oAuth. OpenID; Understanding QA and Support: Common support issues with cloud apps: user names and passwords, automated emails and spam, browser variants and configurations.	7
V	USE CASES: Design, develop and deploy an advanced cloud app using framework and platform of choice to demonstrate an understanding of database, presentation and logic. Application should demonstrate integration with third party API, sensitivity to geography of user (language, currency, time and date format), authentication of user, security, and awareness of client device/browser. Case Studies: Salesforce, Basecamp, Xero.com, Dropbox.	10

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO1	**Understand**[2] the requirement to develop cloud application.
CO2	**Explain**[3] the mobile development process.
CO3	**Understand**[2] the storing process in the cloud.
CO4	**Explain**[3] the security issues of cloud.
CO5	**Understand**[2] the designing process cloud app.
Text Books	• Webber Jim, Parastatidis Savas, Robinson Ian (2010): **REST in Practice**,1st edition,California: O'Reilly Media. • Pace Eugenio, Betts Dominic, Densmore Scott, Dunn Ryan, Narumoto Masashi, Woloski Matias (2010): **Developing Applications for the Cloud on the Microsoft Windows Azure Platform,** 1st edition, Microsoft Press. • Wellman Dan (2009): **jQuery UI 1.6,** Mumbai: PACKT Publishing.
Reference Books	• Lubbers Peter, Albers Brian, Salem Frank, Smith Ric (2010): **Pro HTML5 Programming:** Apress. • Babin Lee (2006): **Beginning Ajax with PHP,** 1st edition: Apress. • York Richard (2009): **Beginning JavaScript and CSS development with jQuery** New Jersey: John Wiley & Sons, Inc. • Benson Edward (2008): **The art of Rails**: Wiley Pub, Indianapolis.

COURSE CODE	PROJECT BASED LEARNING-I	TOTAL LECTURE:30 PRACTICAL:30
PB20M101		**(LTP=0-0-4=2)**
Learning Objectives:	• Integrating the knowledge and skills of various courses on the basis of multidisciplinary projects • Develop the skill of critical thinking and evaluation. • To develop 21st century success skills such as critical thinking, problem solving, communication, collaboration and creativity/innovation among the students. • To enhance deep understanding of academic, personal and social development in students. • Employ the specialized vocabularies and methodologies.	
Course Outcomes		
At the end of the course the students will be able to:		
Course Outcomes:	• **Apply**[3]a sound knowledge/skills to select and develop their topicand project respectively. • **Develop**[6] plans and allocate roles with clear lines of responsibilityand accountability. • **Design**[6] solutions to complex problems following a systematicapproach like problem identification, formulation and solution. • **Collaborate**[6] with professionals and the community at large inwritten and in oral forms. • **Correlate**[4]the knowledge, skills and attitudes of a professional.	
General Guidelines:	• PBL will be an integral part of UG/PG Programs at different levels. • Each semester offering PBL will provide a separate Course Code, twocredits will be allotted to it. • Faculty will be assigned as mentor to a group of 30 students minimum byHoS. • Faculty mentor will have 4 hours/week to conduct PBL for assigned students. • Student will select a topic of their choice from syllabus of any course offered in respective semester (in-lines with sustainable development goals). • Student may work as a team maximum 3 or minimum 2 members for single topic. • For MSE, student's performance will be assessed by panel of three experts either from other department/school, or from samedepartment/school based on chosen topic. This will be comprised of apresentation by student followed by viva-voce. It will be evaluated for 30 marks. • 20 marks would be allotted for continuous performance assessment by concerned guide/mentor. For ESE, student will need to submit a project report in prescribed format,duly signed by concerned guide/mentor and head of the school. The report should be comprised of following components: 1. Introduction	

	2. Review of literature 3. Methodology 4. Result and Discussion 5. Conclusion and Project Outcomes 6. References • Student will need to submit three copies for 1. Concerned School 2.Central Library 3. Self • The integrity of the report should be maintained by student. Any malpractice will not be entertained. • Writing Ethics to be followed by student, a limit of 10 % plagiarism ispermissible. Plagiarism report is to be attached along with the report. • Project could be a case study/ analytical work /field work/ experimentalwork/ programming or as per the suitability of the program.

SANJEEV AGRAWAL GLOBAL EDUCATIONAL (SAGE) UNIVERSITY, BHOPAL

M Tech (Big Data and Cloud Computing)

II Semester

School of Advanced Computing

COURSE CODE	CLOUD STORAGE INFRASTRUCTURES	Total Lecture:60 Theory:45 Tutorial:15
BC21M201		(LTP=3-1-0=4)

Course Objectives:

- Critically appraise the opportunities and challenges of information management in complex business environments
- Evaluate information storage management design in a cloud environment and how it relates to the business objectives of an organization
- Analyze the role technology plays in the design of a storage solution in a cloud architecture
- Investigate how a global storage solution can be optimized so that it can be delivered successfully from the cloud
- Analyze how best to provide reliable access to information both locally CLOUD STORAGE INFRASTRUCTURES and remotely using storage technologies

UNIT	CONTENTS	HOURS
I	VIRTUALIZED DATA CENTER ARCHITECTURE: Cloud infrastructures; public, private, hybrid. Service provider interfaces; Saas, Paas, Iaas. VDC environments; concept, planning and design, business continuity and disaster recovery principles. Managing VDC and cloud environments and infrastructures.	8
II	INFORMATION STORAGE SECURITY & DESIGN: Storage strategy and governance; security and regulations. Designing secure solutions; the considerations and implementations involved. Securing storage in virtualized and cloud environments. Monitoring and management; security auditing and SIEM.	10
III	STORAGE NETWORK DESIGN: Architecture of storage, analysis and planning. Storage network design considerations; NAS and FC SANs, hybrid storage networking technologies (iSCSI, FCIP, FCoE), design for storage virtualization in cloud computing, host system design considerations.	9
IV	OPTIMIZATION OF CLOUD STORAGE: Global storage management locations, scalability, operational efficiency. Global storage distribution; terabytes to petabytes and greater. Policy based information management; metadata attitudes; file systems or object storage.	8
V	INFORMATION AVAILABILITY DESIGN: Designing backup/recovery solutions to guarantee data availability in a virtualized environment. Design a replication solution, local remote and advanced. Investigate Replication in NAS and SAN environments. Data archiving solutions; analyzing compliance and archiving design considerations.	10

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	**Compare**[4] the advantages and disadvantages of various cloud computing Platforms
CO2	**Analyze**[4] the performance of Cloud Computing.

CO3	**Analyse**[4] the components of a virtualised data centre and appraise the role of storage in it.
CO4	**Evaluate**[5]the management and optimisation of a cloud based storage solution.
CO5	**Analyze**[6] the performance of Data archiving solutions.
Text Books	• Schulz Greg (2011): **Cloud and Virtual Data Storage Networking,** Boca Raton: Auerbach Publications. • Poniatowski Marty (2009): **Foundations of Green IT,** 1st edition, New Jersey: Prentice Hall. • EMC (2012): **Information Storage and Management Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments**, 2nd edition, New Jersey: Wiley.
Reference Books	• Herminghaus Volker, Scriba Albrecht (2009): **Storage Management in Data Centers**, Springer edition. • Schmidt Klaus (2006): **High Availability and Disaster Recovery**, Springer edition.

COURSE CODE	DATA CENTER NETWORKING	Total Lecture:60 Theory:30 Tutorial:15 Practical: 15
BC21M202		(LTP=2-1-1=4)

Course Objectives:

- Critically discuss data centre networking technologies and protocols.
- Evaluate key concepts in modern Layer 2 & Layer 3 data centre networks.
- Research a topic related to networking technologies in modern data centers.
- Design, build and configure complex routed and switched networks.
- Justify the implementation of networking solutions in a virtualized environment.

UNIT	CONTENTS	HOURS
I	EVOLUTION OF DATA CENTRE DESIGN: Design for flexibility, scalability, environmental control, electrical power, flooring, fire protection, security, network infrastructure. Energy use and greenhouse gas emissions. Requirements for modern data centers, high availability and Service Orientated Infrastructures (SOI). Modern data centre use case studies.	6
II	DATA CENTRE ARCHITECTURES: Network connectivity optimization evolution: Top of rack (TOR), end of rack (EOR), scale up vs scale up, solutions that reduce power and cabling. Data Centre standards; TIA/EIA-942. Structured cabling standards, fibre and copper cabling characteristics, cable management, bandwidth requirements, I/O connectivity.	6
III	SERVER ARCHITECTURES: Stand-alone, blades, stateless, clustering, scaling, optimization, virtualization. Limitation of traditional server deployments; modern solutions. Applications; database, finance etc. Redundant Layer 2 and Layer 3 designs. Case studies.	5
IV	LAYER 2 NETWORKS: Ethernet; IEEE 802.3ba; 40 Gbps and 100 Gbps Ethernet. IEEE 802.1D Spanning Tree Protocol (STP), RSTP, PVST, MSTP. TRILL (Transparent Interconnection of Lots of Links), RBridges, IEEE 802.1Qbg Edge Virtual Bridging, 802.1Qbh Bridge Port Extension. Fibre Channel over Ethernet (FCoE) vs Internet Small Computer System Interface (iSCSI). Data Center Bridging (DCB); priority-based flow control, congestion notification, enhanced transmission selection, Data Center Bridging Exchange (DCBX). Layer 2 Multicasting; Case studies.	7
V	LAYER 3 AND BEYOND: Cloud Computing 2015 – 16 Layer 3 Data Centre technologies, network virtualization. Protocols; IPv4, IPv6, MPLS, OSPF, IS-IS, BGP. OTV, VPLS layer 2 extension protocols. Locator Identifier Separation Protocol (LISP). Layer 3 Multicasting. Data centre application services. Data centre networking use case studies and the enabling technologies and protocols in the modern data centre.	6

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	**Identify**[1] and describe the functions to build data center networking for switch network.
CO2	**Discuss**[1] different types of logical and physical components of a storage infrastructure.

CO3	**Understand**[2] the importance of Fibre Channel protocols and how to communicate with each other**.**
CO4	**Identify**[1] **and analyzes**[4] the common threats in each domain.
CO5	**Understanding**[2] of networking protocols
Text Books	• Gai Silvano, DeSanti Claudio (2009): **I/O Consolidation in the Data Center,** 1st edition, Indianapolis: Cisco Press. • Corbin Kevin, Fuller Ron, Jansen David (2010): **NX-OS and Cisco Nexus Switching: Next-Generation Data Center Architecture** 1st edition, Indianapolis: Cisco Press. • Gai Silvano, Salli Tommi, Andersson Roge(2010): **Cisco Unified Computing System,**1st edition, Indianapolis: Cisco Press**.**
Reference Books	• Nash Darukhanawalla, Patrice Bellagamba (2009): **Interconnecting Data Centers Using VPLS,**1st edition, Indianapolis: Cisco Press. • Kembel Robert W., Cummings Roger (1998): **The Fibre Channel Consultant,** 3rd edition, Northwest Learning Associates, inc. • Kembal Robert W (2009): **Fiber Channel Switched Fabric**: Northwest Learning Associates, inc. • Hufferd John L (2003): **ISCSI,** Boston: Addison-Wesley.

COURSE CODE	EXPLORATORY DATA ANALYSIS	Total Lecture:60 Theory:45 Practical: 15
BC21M203		(LTP=3-0-1=4)

Course Objectives:

- This course introduces the methods for data preparation and data understanding.
- It covers essential exploratory techniques for understanding multivariate data by summarizing it through statistical methods and graphical methods.
- Supports to summarize the insurers use of predictive analytics, data science and Data Visualization.

UNIT	CONTENTS	HOURS
I	INTRODUCTION TO EXPLORATORY DATA ANALYSIS: Module content: Data Analytics lifecycle, Exploratory Data Analysis (EDA) Definition, Motivation, Steps in data exploration, The basic data types Data Type Portability	8
II	PREPROCESSING-TRADITIONAL METHODS AND MAXIMUM LIKELIHOOD ESTIMATION: Module content: Introduction to Missing data, Traditional methods for dealing with missing data, Maximum Likelihood Estimation – Basics, Missing data handling, Improving the accuracy of analysis. Preprocessing Bayesian Estimation, Introduction to Bayesian Estimation ,Multiple Imputation-Imputation Phase, Analysis and Pooling Phase, Practical Issues in Multiple Imputation, Models for Missing Notation Random Data	11
III	DATA SUMMARIZATION & VISUALIZATION: Module content: Statistical data elaboration, 1-D Statistical data analysis, 2-D Statistical data Analysis, ND Statistical data analysis, Outlier Analysis Module content: Introduction, Extreme Value Analysis, Clustering based, Distance Based and Density Based outlier analysis, Outlier Detection in Categorical Data	9
IV	FEATURE SUBSET SELECTION: Module content: Feature selection algorithms: filter methods, wrapper methods and embedded methods, Forward selection backward elimination, Relief, greedy selection, genetic algorithms for features election	9
V	DIMENSIONALITY REDUCTION: Module content: Introduction, Principal Component Analysis(PCA), Kernel PCA, Canonical Correlation Analysis, Factor Analysis, Multi dimensional scaling, Correspondence Analysis.	8
	Practical's on Data Analysis and Visualization	

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	**Explain**[2] the way to handle missing data in the real world data sets by choosing appropriate methods.
CO2	**Identify**[1] the outliers if any in the data set.
CO3	**Choose**[3] appropriate feature selection and dimensionality reduction

CO4	**Visualize**[5]the data using basic graphs and plots
CO5	**Summarize**[5] the data using basic statistics.
Text Books	• Jambu Michael (1990): **Exploratory and multivariate data analysis,** Cambridge : Academic Press Inc. • Aggarwal Charu C (2015): **Data Classification Algorithms and Applications,** Boca Raton: CRC press.
Reference Books	• Aggarwal Charu C (2015): **Data Mining The Text book**: Springer. • Enders Craig K (2010): **Applied Missing Data Analysis**, New York City: Guilford Press. • Koch Inge (2014): **Analysis of Multivariate and High dimensional data**, Cambridge University Press.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-III	Total Lecture:60 Theory:45 Practical: 15
BC21M204	**WEB TECHNOLOGIES**	**(LTP=3-0-1=4)**

Course Objectives:

- To comprehend the advanced concepts of web programming and internet
- To perceive how to use techniques, skills and apply algorithmic principles while analyzing their appropriateness
- To apprehend one or more of the tools to develop interactive, client-side, server-side Executable web applications using advanced technologies and evaluate its effectiveness.

UNIT	CONTENTS	HOURS
I	HTML5, CSS3, XML, JavaScript and JQuery Internet Application –Web architecture – HTML5 – Geolocation - HTML5 API - HTML- CSS3 - Client side and Server Side Programming - Extensible Markup Language - Document structure, navigation and transformation – XHTML - Javascript -DOM methods -JSON-Jquery - JQuery UI - Document ready function - JQuery templates	**10**
II	Web Applications and services: Application Frameworks-MVC (Model-View-Controller) framework- Laravel framework - Angular JS – Single Page Applications-Responsive Web Design	**8**
III	Web Communication Processes and Technologies HTTP- Request/Response Model- HTTP Methods- AJAX-Implementing AJAX Frameworks - AJAX with JSON - Implementing Security and Accessibility in AJAX Applications - Secure AJAX Applications	**8**
IV	Web ServersNode.js- Node Package Manager –REPL(Read-Evaluate-Print-Loop)Terminal, Node.js. Webserver - Callbacks -Events- Express framework-Cookies-Sessions-Scaling - Creating a simple server, Rendering HTML, Rendering JSON Data	**9**
V	Storage MongoDB-Manipulating and Accessing MongoDB Documents from Node.js Web toolkits - Backend Web frameworks Backend Web frameworks: Node and Express, Django, Ruby on Rails Frontend Web Frameworks Angular, React, Vue.js, Ember.js, Meteor - Meteor JS framework	**9**
	List of Experiments : 1. Create a user registration webpage for an event using HTML elements like form, image with appropriate CSS. 2. Develop a dynamic web page with validation using JavaScript and handle the events. 3. Design a shopping cart application using Laravel framework. 4. Create a MongoDB collection of "Research articles" with required details. 5. Design an application in node.js for student management. 6. Create an application using Meteor JS framework.	

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	**Understand**[1] advanced web Technologies concepts and write a well formed XML document

	and manipulate the Document Object Model to fetch and display information using jQuery.
CO2	**Develop**[6] build practical, real world web applications using AJAX.
CO3	**Generate**[6] dynamic page content using Node.js, use JSON to pass AJAX updates between Client and Server**.**
CO4	**Create**[6] application using Node.js with popular NOSQL database, MongoDB**.**
CO5	Efficiently **create**[6] mobile and desktop apps using Frontend Web framework.
Text Books	• Dayley Brad (2017): **Node.js, MongoDB, and AngularJS Web Development,** 2nd edition, Boston: Addison Wesley. • Duckett Jon (2014): **JavaScript and JQuery**: **Interactive Front-End Web Development**, New Jersey: Wiley. • Zammetti, Frank (2020): **Modern Full-Stack Development**, New York City: Apress.
Reference Books	• Duckett Jon (2014): **HTML and CSS: Design and Build Websites**, New Jersey: John Wiley & Sons, Inc. • Holdener Anthony T (2008): **Ajax: The Definitive Guide,** California: O'Reilly Media. • Stauffer Matt (2019): **Laravel: Up and Running**, 2nd Edition, California: O'Reilly Media. • Hartl, Michael (2015): **Ruby on Rails Tutorial: Learn Web Development with Rails**, Boston: Addison- Wesley Professional. • Elman, Julia, Lavin Mark (2014): **Lightweight Django: Using REST, WebSockets, and Backbone**, California: O'Reilly Media, Inc. • Seshadri, Shyam, Green Brad (2014): **AngularJS: Up and Running: Enhanced Productivity with Structured Web Apps**, California: O'Reilly Media, Inc.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-III	Total Lecture:60 Theory:45 Practical: 15
BC21M205	**SOFT COMPUTING**	**(LTP=3-0-1=4)**

Course Objectives:

The objective of this course is to introduce methods for handling imprecise and uncertain data using Rough sets, Neuro Fuzzy Systems and foster their abilities in designing and implementing optimal solutions for real-world and engineering problems using derivative free optimization techniques.

UNIT	CONTENTS	HOURS
I	Introduction to Soft Computing: Soft Computing Overview – Uncertainty in data, Hard vs Soft Computing	**8**
II	Neural Networks: Introduction, RBF Networks, Self-Organizing Map, Boltzmann Machines, Convolutional Neural Networks	**8**
III	Fuzzy Systems: Fuzzy Sets, Fuzzy Relations, and Membership functions, Properties of Membership functions, Fuzzification and Defuzzification. Fuzzy logic: Fuzzy Rule based systems, Fuzzy Decision making, Fuzzy Classification, Fuzzy CMeans Clustering.	**9**
IV	Rough Sets – Definition, Upper and Lower Approximations, Boundary Region, Decision Tables and Decision Algorithms. Properties of Rough Sets. Rough K-means clustering.	**9**
V	Optimization Techniques: Introduction, Genetic Algorithm, Memetic Algorithms, Particle Swarm Optimization, Ant Colony Optimization, Frog-Leaping. Hybrid Systems: GA Based Back Propagation Networks, Fuzzy Back Propagation Networks, Evolutionary Ensembles	**10**

List of Experiments :

1. Develop Fuzzy Decision-Making for Job Assignment Problem.
2. Implement TSP using Optimization Techniques.
3. Develop a suitable method for Health Care Application using Neuro- Fuzzy systems.
4. Develop a suitable method for Face Recognition System.
5. Layout Optimization using Genetic Algorithms.
6. Fault Diagnosis using rough set theory.
7. Software safety analysis using roughsets A Neuro-fuzzy Approach to Bad Debt Recovery in Healthcare.

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	Have a general **understanding**[2] of soft computing methodologies, to deal with imprecise and uncertaindata
CO2	**Develop**[6] computational neural network models for some simple biologicalsystems;
CO3	**Develop**[6]fuzzy models for engineering systems, particularly for controlsystems;
CO4	**Apply**[3]derivative free optimization methods to solve real world problems
CO5	**Demonstrate**[2] some applications of computational intelligence
Text Books	• S.N. Sivanandham and S.N. Deepa (2011): **Principles of Soft Computing,** 2nd Edition, New Delhi: Wiley Publications. • Andries P. Engelbrecht (2007): **Computational Intelligence: An Introduction**, New Jersey: John Wiley & Sons.
Reference Books	• Fausett Laurene V (1993): **Fundamentals of Neural Networks: Architectures, Algorithms And Applications,** London: Pearson. • Haykin Simon (2008): **Neural Networks and Learning Machines**, New Jersey: Prentice Hall. • Ross Timothy J (2010): **Fuzzy Logic with Engineering Applications** , 3rd Edition, New Jersey: Wiley.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-III	Total Lecture:60 Theory:45 Practical: 15
BC21M206	**INTRODUCTION TO INTELLIGENT SYSTEM**	**(LTP=3-0-2=4)**

Course Objectives:

- To introduce the basic intelligent system concepts.
- To describe and learn various algorithms in the neural networks for optimizing real world problems
- To learn fuzzy logic and its implementation methods.

UNIT	CONTENTS	HOURS
I	INTRODUCTION AND BASIC CONCEPTS: Introduction- Humans and Computers , the structure of the brain ,Learning in machines and the differences. The basic neuron- Introduction Modeling the single neuron, learning in simple neurons. The perception: a vectorial perspective, the perception learning rule, Proof of perceptron, Limitations of perceptrons.	**10**
II	MULTILAYER NETWORKS: The multi layer perceptron: Introduction Altering the perception model. The new model, the new learning rule Multi layer perception algorithm, XOR problem. Multi layer feed forward networks, error back propagation training algorithm Problems with back propagation, Boltzman training, Combined back propagation Cauchy training.	**8**
III	RESONANT NETWORKS AND APPLICATIONS: Hop-field networks ,Recurrent and bi- directional associative memories, Problems on BAM, Counter propagation network.Problems on counter propagation network ,Artificial Resonance Theory (ART) Application of neural network: Hand written digit recognition Application of neural network: character recognition, Traveling sales man problem, a neuro-controller.	**8**
IV	FUZZY SET THEORY:Introduction to fuzzy set theory, Fuzzy set vs Crisp set Problems on fuzzy set and crisp sets, Properties of fuzzy sets , Operations on fuzzy set, Fuzzy compliments, Fuzzy intersection, Fuzzy union ,Fuzzy relations.	**9**
V	FUZZY LOGIC AND SYSTEMS: Fuzzy Logic: Classical logic, multi valued logic, Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges and their inferences Fuzzy systems: fuzzy controllers, Fuzzy systems and neural networks, Fuzzy automata, Fuzzy dynamic system.	**9**

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	Gain deep **understanding**^{2} of the basic artificial intelligence techniques.
CO2	Apply their knowledge to **design**^{6} solutions to different problems
CO3	Have the ability to **design**^{6} and **develop**^{6} an intelligent system for a selected application.
CO4	**Describe**^{2} and **apply**^{3} various techniques for logic programming and machine learning.
CO5	**Implement**^{6} standard AI algorithms.
Text Books	• Klir G.J., Yuan Bo (2009): **Fuzzy Sets and Fuzzy Logic Theory and Applications**, Delhi: Prentice Hall of India. • Ross Timothy S (2011): **Fuzzy Logic with engineering applications**, New Delhi: Weily India Pvt. Ltd. • Kosko B (2009): **Neural Networks and Fuzzy Systems: A dynamical system approach to machine intelligence**, New Delhi: Prentice Hall of India.
Reference	• Beale R, Jackson T (1990): **Neural Computing, An Introduction**: Adam Hilger.

Books	• Rao V.B, Rao H.V. (2003): **C++, Neural Networks and Fuzzy Logic**, Delhi: BPB Publications. • Kendal Simon, Creen, Malcolm (2007): **An Introduction to Knowledge Engineering**: Springer-Verlag Limited.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-IV	Total Lecture:60 Theory:45 Tutorial: 15
BC21M207	**BIO-INSPIRED COMPUTING**	**(LTP=3-1-0=4)**

Course Objectives:

- To understand the fundamentals of evolutionary theory and cellular automata.
- To learn the artificial neural systems and swarm optimization for feature selection.
- To learn the genetic algorithm and hybridization with mimetic algorithms.

UNIT	CONTENTS	HOURS
I	INTRODUCTION TO EVOLUTIONARY ALGORITHM: Evolutionary algorithm, components of evolutionary algorithm representation (definition of individuals), Evaluation function (Fitness function), Population, parent selection Mechanism, Variation Operators, Survivor Selection Mechanism (Replacement), Initialization, Termination Condition, evolutionary algorithm case study Cellular systems, cellular automata, modeling with cellular systems, other cellular systems, computation with cellular systems, artificial life: analysis and synthesis of cellular systems.	**10**
II	NEURAL SYSTEMS: Biological nervous systems, artificial neural networks, neuron models, architecture, signal encoding ,synaptic plasticity, unsupervised learning, supervised learning, reinforcement learning, evolution of neural networks, hybrid neural systems, case study.	**8**
III	DEVELOPMENTAL AND IMMUNE: Rewriting system, synthesis of developmental system, evolutionary rewriting systems, evolutionary developmental programs, biological immune systems, lessons for artificial immune systems, algorithms and applications, shape space, negative selection algorithm, clonal selection algorithm.	**8**
IV	BEHAVIORAL SYSTEMS: Behavior is cognitive science, behavior in AI, behavior based robotics, biological inspiration for robots, robots as biological models, robot learning, evolution of behavioral systems, learning in behavioral systems, co-evolution of body and control, towards self-reproduction, simulation and reality. GENETIC ALGORITHMS Representation of Individuals, Mutation, Recombination, Population Models, Parent Selection, Survivor Selection, Example Application: Solving a Job Shop Scheduling	**9**
V	Introduction to Local Search, Lamarckianism and the Baldwin Effect, Structure of a Memetic Algorithm, Heuristic or Intelligent Initialization, Hybridization within Variation Operators: Intelligent Crossover and Mutation, Local Search Acting on the output from Variation Operators ,Hybridization During the Genotype to Phenotype Mapping, Design Issues for Memetic Algorithms. Biological self-organization, Particle Swarm Optimization (PSO), ant colony optimization. (ACO).	**9**

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	**Understand**[1] basic concepts of evolutionary algorithm
CO2	**Understand**[1] the basic features of neural and immune systems and able to build the neural model**.**
CO3	**Explain**[2] how complex and functional high-level phenomena can emerge from low-level interactions**.**
CO4	**Explain**[2] the computational processes derived from neural models.

CO5	**Implement**[6] simple bio-inspired algorithms like genetic and Particle Swarm Optimization.
Text Books	• Floreano D., Mattiussi, C. (2008): **Bio-Inspired Artificial Intelligence**, Cambridge: MIT Press. • Song Tao, Zheng Pan, Mou Ling Dennis Wong, Wang Xun (2019): **Bio-Inspired Computing Models and Algorithm**s: World scientific. • Neumann F., Witt C (2010): **Bioinspired Computation in combinatorial optimization:Algorithms and their computational complexity**, Springer.
Reference Books	• Goldberg D. E. (1989): **Genetic algorithms in search, optimization, and machine learning** , Boston: Addison- Wesley. • Haykin Simon O (2008): **Neural Networks and Learning Machines**, 3rd Edition, New Jersey: Prentice Hall. • Dorigo M., Stutzle T (2004): **Ant Colony Optimization:** A Bradford Book. • Ebelhart R. C. (2001): **Swarm Intelligence ,** Morgan Kaufmann. • Xin-She Yang, Zhihua Cui Renbin Xiao Amir Hossein Gandomi Mehmet Karamanoglu (2013): **Swarm Intelligence and Bio-Inspired Computation**, 1st Edition, Elsevier.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-IV	Total Lecture:60 Theory:45 Tutorial: 15
BC21M208	CLOUD SECURITY	(LTP=3-1-0=4)

Course Objectives:

The course on cloud security introduces the basic concepts of security systems and cryptographic protocols, which are widely used in the design of cloud security. The issues related multi tenancy operation, virtualized infrastructure security and methods to improve virtualization security are also dealt with in this course

UNIT	CONTENTS	HOURS
I	SECURITY CONCEPTS Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defence in depth, least privilege, how these concepts apply in the cloud, what these concepts mean and their importance in PaaS, IaaS and SaaS. e.g. User authentication in the cloud; Cryptographic Systems- Symmetric cryptography, stream ciphers, block ciphers, modes of operation, public-key cryptography, hashing, digital signatures, public-key infrastructures, key management, X.509 certificates, OpenSSL	10
II	MULTI-TENANCY ISSUES Isolation of users/VMs from each other. How the cloud provider can provide this; Virtualization System Security Issues- e.g. ESX and ESXi Security, ESX file system security, storage considerations, backup and recovery; Virtualization SystemVulnerabilities- Management console vulnerabilities, management server vulnerabilities, administrative VM vulnerabilities, guest VM vulnerabilities, hypervisor vulnerabilities, hypervisor escape vulnerabilities, configuration issues, malware (botnets etc).	09
III	VIRTUALIZATION SYSTEM-SPECIFIC ATTACKS Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyperjacking.	07
IV	TECHNOLOGIES FOR VIRTUALIZATION-BASED SECURITY ENHANCEMENT IBM security virtual server protection, virtualization-based sandboxing; Storage Security- HIDPS, log management, Data Loss Prevention. Location of the Perimeter.	09
V	LEGAL AND COMPLIANCE ISSUES Responsibility, ownership of data, right to penetration test, local law where data is held, examination of modern Security Standards (eg PCIDSS), how standards deal with cloud services and virtualization, compliance for the cloud provider vs. compliance for the customer.	10

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	**Articulate**[4] the differences between deployment models (public, private, hybrid, and community) versus service models (infrastructure-, platform-, and software-as-a-service) of cloud computing.
CO2	**Describe**[2] cloud security architectures from the perspectives of: providers, brokers, carriers, and auditors.
CO3	**Describe**[2] a methodology for orchestrating a cloud ecosystem.

CO4	**Understand**[2] how cloud computing changes the traditional enterprise security considerations compared to on-premise.
CO5	**Understand**[2] how identity management considerations are different in the cloud, compared to on-premise and how shared security responsibilities change in each service model.
Text Books	• Mather Tim, Kumaraswamy Subra, Latif Shahed (2009): **Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance**,1st edition, California: O'Reilly Media. • Krutz Ronald L., Vines Russell Dean (2010): **Cloud Security**: New Jersey: Wiley Publishing, Inc. • Rittinghouse John, Ransome James (2009): **Cloud Computing,** Boca Raton: CRC Press. • Winkler (Vic) J.R. (2011): **Securing the Cloud**: Syngress**.** • Cloud Security Alliance (2009): **Security Guidance for Critical Areas of Focus in Cloud Computing.**
Reference Books	• Vmware (2011): **VMware Security Hardening Guide**, White Paper. • Timothy Grance, Jansen Wayne; NIST (2011): **Guidelines on Security and Privacy in Public Cloud Computing** . • Evelyn Brown NIST (2011): **Guide to Security for Full Virtualization Technologies**. • Peter Mell, Timothy Grance NIST (2011): **The NIST Definition of Cloud Computing**. • William Hau, Rudolph Araujo et al **How Virtualization Affects PCI DSS.** • www.foundstone.com. • Wang Chenxi: **Compliance with Clouds: Caveat Emptor** , www.forrester.com/2010.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-IV	Total Lecture:60 Theory:45 Tutorial: 15
BC21M209	**ANALYTICS OF THINGS**	**(LTP=3-1-0=4)**

Course Objectives:

To introduce the technology that enables IoT, application of IoT, cloud support for IoT and access data using mobile computing devices. This will serve as foundation for the cyber physical systems, Internet of services leading to Industry 4.0 changes.

UNIT	CONTENTS	HOURS
I	Introduction to IoT: Algorithm design techniques: Divide and Conquer, Brute force, Greedy, Dynamic Programming. Time complexity (asymptotic notation, recurrence relations)	**8**
II	IOT Hardware platforms: Overview of IoT supported Hardware Platforms: Raspberry pi, Arduino, Intel Galileo	**8**
III	Communication in IOT: Interface protocol, Serial, SPI, I2C, 6LoWPAN, 802.11wifi, 802.15 Bluetooth, 802.15.4 Zigbee, RTLS, GPS, CoAp – Constrained application protocol, RPL – routing protocol for lossy networks.	**9**
IV	IOT Software development: Linux, Networking configurations in Linux, Accessing Hardware & Device Files interactions, Python packages: JSON, XML, HTTPLib, URLLib, SMTPLib, XMPP, Contiki OS	**8**
V	IoT Physical Servers & Cloud Offerings 6hours Introduction to Cloud Storage Models & Communication APIs, Cloud of things, Xively Cloud for IOT, PHP & MySQL for data processing, WAMP, Designing a RESTful Web API, MQTT, Amazon Web Services for IoT Case Studies illustrating IoT Design 5hours Smart Home, Smart Parking, weather reporting and monitoring	**12**

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO1	**Identify**[1] the technologies that enables IoT.
CO2	**Use**[3] Hardware and software required to design and build IoT
CO3	**Develop**[6] programs for interfacing with sensors and actuators and other IoT devices
CO4	**Set up**[6] the servers to upload IoT data to cloud for further analysis
CO5	**Understand**[2] the different commands of PHP.
Text Books	• Bahga Arshdeep, Madisetti, Vijay (2015): **Internet of Things: A hands-on Approach** University Press. • McEwen Adrian , Cassimally, Hakim (2014): **Designing the Internet of Things**: New Jersey: Wiley.
Reference Books	• Bessis Nik, Dobre Ciprian (2014): **Big Data and Internet of Things: A Roadmap for Smart Environments:** Springer. • Maik Schmidt (2011): **Arduino: A Quick-Start Guide:** The Pragmatic Bookshelf. • Slama Dirk, Puhlmann Frank, Morrish Jim, Bhatnagar Rishi M (2015): **Enterprise IoT: Strategies and Best Practices for Connected Products and Services,** California :O'Reilly Media. • Zhou Honbo(2012): **The Internet of Things in the Cloud: A Middleware Perspective,** Boca Raton: CRC Press. • Anderson Quinton (2013): **Storm Real-time Processing Cookbook,** Mumbai : PACKT Publishers. • Dundar Onur (2015): **Home Automation with Intel Galileo**: Mumbai: PACKT Publishing.

COURSE CODE	PROJECT BASED LEARNING-II	TOTAL LECTURE:30 PRACTICAL:30
PB20M201		**(LTP=0-0-4=2)**
Learning Objectives:	• Integrating the knowledge and skills of various courses on the basis of multidisciplinary projects • Develop the skill of critical thinking and evaluation. • To develop 21st century success skills such as critical thinking, problem solving, communication, collaboration and creativity/innovation among the students. • To enhance deep understanding of academic, personal and social development in students. • Employ the specialized vocabularies and methodologies.	
Course Outcomes		
At the end of the course the students will be able to:		
Course Outcomes:	• **Apply**[3]a sound knowledge/skills to select and develop their topicand project respectively. • **Develop**[6] plans and allocate roles with clear lines of responsibilityand accountability. • **Design**[6] solutions to complex problems following a systematicapproach like problem identification, formulation and solution. • **Collaborate**[6] with professionals and the community at large inwritten and in oral forms. • **Correlate**[4]the knowledge, skills and attitudes of a professional.	
General Guidelines:	• PBL will be an integral part of UG/PG Programs at different levels. • Each semester offering PBL will provide a separate Course Code, twocredits will be allotted to it. • Faculty will be assigned as mentor to a group of 30 students minimum byHoS. • Faculty mentor will have 4 hours/week to conduct PBL for assigned students. • Student will select a topic of their choice from syllabus of any course offered in respective semester (in-lines with sustainable development goals). • Student may work as a team maximum 3 or minimum 2 members for single topic. • For MSE, student's performance will be assessed by panel of three experts either from other department/school, or from same department/school based on chosen topic. This will be comprised of a presentation by student followed by viva-voce. It will be evaluated for 30 marks. • 20 marks would be allotted for continuous performance assessment by concerned guide/mentor. For ESE, student will need to submit a project report in prescribed format,duly signed by concerned guide/mentor and head of the school. The report should be comprised of following components: 1. Introduction 2. Review of literature 3. Methodology 4. Result and Discussion	

	5. Conclusion and Project Outcomes 6. References • Student will need to submit three copies for 1. Concerned School 2.Central Library 3. Self • The integrity of the report should be maintained by student. Any malpractice will not be entertained. • Writing Ethics to be followed by student, a limit of 10 % plagiarism ispermissible. Plagiarism report is to be attached along with the report. • Project could be a case study/ analytical work /field work/ experimentalwork/ programming or as per the suitability of the program.

COURSE CODE	MOOC-1/ MOOC-2	Total Lecture: Practical:60
		(LTP=0-0-8=4)
Learning Objective:	• Integrating the knowledge and skills of various courses available in online mode. • Develop the skills of critical thinking and evaluation. • To make students to learn themselves by choosing the course as per there area of interest.	
	CONTENTS	**HOURS**
General Guidelines:	• This course creates an excellent opportunity for students to acquire the necessary skill set for research, employability through massive open online courses (MOOCs) where the rare expertise of world famous experts from academics and industry are available. • The basket for MOOCs will be a dynamic one, as courses keep on updating with time. • In this semester 8 credits will have to be acquired with online courses (MOOCs). Students will have to complete 2 MOOC's of their choice in the third semester (Out of which 01 should be Cloud Certification. • The MOOC-1 and MOOC-2 each carries internal marks of 50, which will be attained after he/she gets the MOOC certificate for which he/she got himself/herself enrolled. For end sem evaluation a Viva-Voce examination shall be conducted and it will carrie 50 marks. • Selection of MOOCs should be approved by the department.	60

GUIDELINES FOR M. TECH. DISSERTATION/ THESIS

Phase-1

- Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Dissertation Review Committee (DRC).
- A Dissertation Review Committee shall be constituted with the Head of the Department as Chairperson, Dissertation Supervisor and one senior faculty member of the Department offering the M. Tech. programme.
- Candidate has to present in Dissertation Work Review I, in consultation with his Dissertation Supervisor, the title, objective and plan of action of his dissertation work to the Dissertation Work Review Committee (DRC) for approval within four weeks from the commencement of Second year First Semester. The Dissertation Work Review I carries internal marks of 100. Evaluation should be done by the DRC for 50 marks and the Supervisor will evaluate the review for the other 50 marks. Only after obtaining the approval of the DRC can the student initiate the Dissertation work.
- If a candidate wishes to change his/her supervisor or topic of the dissertation, he/she can do so with the approval of the DRC. However, the DRC shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of dissertation proposal. If yes, his/her date of registration for the dissertation work starts from the date of change of Supervisor or topic as the case may be.
- A candidate shall submit his dissertation progress report in two stages at least with a gap of three months between them.
- The work on the dissertation shall be initiated at the beginning of the II year and the duration of the dissertation is two semesters. A candidate is permitted to submit thesis only after successful completion of all theory and practical courses with the approval of DRC not earlier than 40 weeks from the date of approval of the dissertation work. For the approval of DRC the candidate shall submit the draft copy of thesis to the Head of the Department and make an oral presentation before the DRC.
- The Dissertation Work Review II in II Year III Sem. carries internal marks of 100. Evaluation should be done by the DRC for 50 marks and the Supervisor will evaluate the work for the other 50 marks. The Supervisor and DRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain and progress of the Dissertation Work. A candidate has to secure a minimum of 70% of marks to be declared successful in Dissertation Work Review II. If he fails to obtain the minimum required marks, he has to reappear for Dissertation Work Review-II as and when conducted.
- One paper in third semester has to be published in any one journal of UGC care, SCOPUS or SCI.
- After successful completion of Dissertation Work Review II, it will be further adjudicated by an external examiner selected by the University. For this, the Principal of the College/School/Institute shall submit name of examiners from among the list of experts in the relevant specialization as submitted by the supervisor concerned and Head of the Department. It will carries external marks of 200.

Phase-2

- The Dissertation Work Review III in II Year IV Sem. carries 250 internal marks. Evaluation should be done by the DRC for 125 marks and the Supervisor will evaluate it for the other 125 marks. The DRC will examine the overall progress of the Dissertation Work and decide whether or not the Dissertation is eligible for final submission. A candidate has to secure a minimum of 70% of marks to be declared successful in Dissertation Work Review III. If he fails to obtain the required minimum marks, he has to reappear for Dissertation Work Review III as and when conducted. For Dissertation Evaluation (Viva Voce) in II Year II Sem. there are external marks of 250 and it is evaluated by the external examiner. The candidate has to secure a minimum of 50% marks in Dissertation Evaluation (VivaVoce) examination.
- One paper in fourth semester has to be published in any one journal of UGC care, SCOPUS or SCI.
- Dissertation Work Reviews II and III shall be conducted in phase I (Regular) and Phase II (Supplementary). Phase II will be conducted only for unsuccessful students in Phase I. The unsuccessful students in Dissertation Work Review II (Phase II) shall reappear for it at the time of Dissertation Work Review III (Phase I). These students shall reappear for Dissertation Work Review III in the next academic year at the time of Dissertation Work Review II only after completion of Dissertation Work Review II, and then Dissertation Work Review III follows. The unsuccessful students in Dissertation Work Review III (Phase II) shall reappear for Dissertation Work Review III in the next academic year only at the time of Dissertation Work Review II (Phase I).
- After approval from the DRC, a soft copy of the thesis should be submitted for ANTIPLAGIARISM check and the plagiarism report should be submitted to the University and be included in the final thesis. The Thesis will be accepted for submission, if the similarity index is less than 30%. If the similarity index has more than the required percentage, the student is advised to modify accordingly and re-submit the soft copy of the thesis after one month. The maximum number of re-submissions of thesis after plagiarism check is limited to TWO. The candidate has to register for the Dissertation work and work for two semesters. After three attempts, the admission is liable to be cancelled. The college authorities are advised to make plagiarism check of every soft copy of theses before submissions.
- Three copies of the Dissertation thesis certified by the supervisor shall be submitted to the College/School/Institute, after submission of a 2 research paper related to the dissertation work in a UGC care, SCOPUS or SCI journal. A copy of the submitted research paper shall be attached to thesis.
- The thesis shall be adjudicated by an external examiner selected by the University. For this, the Principal of the College/School/Institute shall submit a panel of three examiners from among the list of experts in the relevant specialization as submitted by the supervisor concerned and Head of the Department.
- If the report of the external examiner is unsatisfactory, the candidate shall revise and resubmit the Thesis. If the report of the examiner is unsatisfactory again, the thesis shall be summarily rejected. Subsequent actions for such dissertations may be considered, only on the specific

recommendations of the external examiner and /or Dissertation work Review Committee. No further correspondence in this matter will be entertained, if there is no specific recommendation for resubmission.

- If the report of the examiner is satisfactory, the Head of the Department shall coordinate and make arrangements for the conduct of Dissertation Viva- Voce examination. The Dissertation VivaVoce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who adjudicated the Thesis, with an external marks of 250. The candidate has to secure a minimum of 50% of marks in Dissertation Evaluation (Viva-Voce) examination.
- If he fails to fulfill the requirements as specified in previous point he will reappear for the Viva-Voce examination only after three months. In the reappeared examination also, if he fails to fulfill the requirements, he will not be eligible for the award of the degree, unless he is asked to revise and resubmit his dissertation work by the board within a specified time period (within four years from the date of commencement of his first year first semester).
- The Dissertation Viva-Voce External examination marks must be submitted to the University on the day of the examination.