GONDWANA UNIVERSITY
GADCHIROLI

NATIONAL EDUCATION POLICY(NEP) 2020

Syllabus
of

M.Sc. (Computer Science) – II

Semester III & IV

(Faculty of Science and Technology)

Gondwana University, Gadchiroli

NEP 2020 P.G. PROGRAMME SESSION 2024-25

Faculty of Science and Technology

Program Name - M.Sc. Sem-III (Computer Science)

Sr. No.	Course Category	Subject Name	Total Credit	Teaching Scheme (Hrs)			Examination Scheme									Total Marks
							Theory					Practical				
				Theory	Practical	Total Hrs.	UA	CA	Total Mark	Min. Passing	Duration of Exam (Hrs.)	UA	CA	Total Mark	Min. Passing	
1	Major	Software Testing and Quality Assurance	04	04	--	04	80	20	100	40	03	--	--	--	--	100
2		Artificial Intelligence and Robotics	04	04	--	04	80	20	100	40	03	--	--	--	--	100
3		Big Data Analytics	04	04	--	04	80	20	100	40	03	--	--	--	--	100
4		**Practical Based on Major Subject 1, 2, 3**	02	-	04	04	-	-	-	-	-	30	20	50	25	50
5	Major (Elective) Any one from elective basket	Natural Language Processing Machine Learning Internet of Things (IoT) High-Performance Computing Computer Vision	02	02	--	02	40	10	50	20	02	--	--	50	25	50
6		**Practical based on Elective Subject**	02	-	04	04	-	-	-	-	-	30	20	50	25	50
7		**Research Project**	04	--	08	08	--	--	--	--	--	60	40	100	50	100
Total			22	14	16	26	280	70	350	-	-	120	80	250	125	550

Gondwana University, Gadchiroli

NEP 2020 P.G. PROGRAMME SESSION 2024-25

Faculty of Science and Technology

Programme Name - M.Sc. Sem IV (Computer Science)

Sr. No.	Course Category	Subject Name	Total Credit	Teaching Scheme (Hrs)			Examination Scheme									Total Marks
							Theory					Practical				
				Theory	Practical	Total Hrs.	UA	CA	Total Mark	Min. Passing	Duration of Exam (Hrs.)	UA	CA	Total Mark	Min. Passing	
1	Major	Data Science	04	04	--	04	80	20	100	40	03	--	--	--	--	100
2		Advanced Web Development Using PHP	04	04	--	04	80	20	100	40	03	--	--	--	--	100
3		**Practical-I based on** Data Science	02	-	04	04	-	-	-	-	-	30	20	50	25	50
4		**Practical-II based on** Advanced Web Development Using PHP	02	-	04	04	-	-	-	-	-	30	20	50	25	50
5	**Major (Elective) Any one from Elective basket#**	Advanced Cryptography Embedded System Advanced Computer Networks R Programming Web Analytics	04	04	--	04	80	20	100	40	03	--	--	--	--	100
6		**Research Project**	06	--	12	12	--	--	--	--	--	90	60	150	75	150
Total			22	12	20	32	240	60	300	-	-	150	100	250	125	550

Student may perform practical to improve the knowledge of the subject (Annexure A).

- **CA** (College Assessment): It will be evaluated by Internal Examiner appointed by the college in consultation with the University. A process of College assessment is given in Refer Appendix A.
- **UA** (University Assessment): It will be evaluated by External Examiner appointed by the university.
- For Practical marks distribution, Refer Appendix B
- **For Paper Pattern,** refer Appendix C

- **Practical Lab:**

1) Not more than two students should be allowed to do practical on a single PC.

2) Wherever possible practical should be performed using Open-Source Software.

M.Sc. - I (Computer Science)

Semester – III

Syllabus

Note: For Details about assessment, practical examination, Paper Pattern, kindly refers Appendix

M.Sc. (Computer Science) - II (SEMESTER – III)

PAPER – I: SOFTWARE TESTING AND QUALITY ASSURANCE

Credit: 4 **Max. Marks: 80**

Program Learning Outcome:

1. Students will be able to trace the historical evolution of quality practices and evaluate their impact on contemporary software development.
2. Students will analyze program errors and determine the necessary conditions for achieving software reliability.
3. Learners will apply maturity models, including Capability Maturity Model (CMM) and Capability Maturity Model Integration (CMMI), to improve the test process within software development.

Unit – I:–Basic Concepts and Preliminaries

Quality Revolution, Software Quality, Role of Testing, Verification and Validation, Failure, Error, Fault, and Defect , Notion of Software Reliability, Objectives of Testing, What Is a Test Case?, Expected Outcome, Concept of Complete Testing, Central Issue in Testing, Testing Activities, Test Levels, Sources of Information for Test Case Selection, White-Box and Black-Box Testing, Test Planning and Design, Monitoring and Measuring Test Execution, Test Tools and Automation, Test Team Organization and Management

Unit – II: Theory of Program Testing

Basic Concepts in Testing Theory, **Theory of Goodenough and Gerhart** - Fundamental Concepts, Theory of Testing, Program Errors, Conditions for Reliability, Drawbacks of Theory, Theory of Weyuker and Ostrand, **Theory of Gourlay** - Few Definitions, Power of Test Methods, Adequacy of Testing, Limitations of Testing, **Testing Types -** Unit Testing, Control Flow Testing, Data Flow Testing, Domain Testing, System Integration Testing

Unit – III: System Test Categories

Taxonomy of System Tests, **Basic Tests** - Boot Tests, Upgrade/Downgrade Tests, Light Emitting Diode Tests, Diagnostic Tests, Command Line Interface Tests. **Functionality Tests** - Communication Systems Tests, Module Tests, Logging and Tracing Tests, Element Management Systems Tests, Management Information Base Tests, Graphical User Interface Tests, Security Tests, Feature Tests. **Robustness Tests** - Boundary Value Tests, Power Cycling Tests, On-Line Insertion and Removal Tests, High-Availability Tests, Degraded Node Tests. Interoperability Tests. Performance Tests, Scalability Tests, Stress Tests, Load and Stability Tests, Reliability Tests, Regression Tests, Documentation Tests, Regulatory Tests. **Functional Testing**, **Test Generation from FSM Models**, **System Test Design, System Test Planning and Automation**

Unit – IV: Software Quality

System Test Execution, Acceptance Testing, Software Reliability, Test Team Organization, **Software Quality**-Five Views of Software Quality, **McCall's Quality Factors and Criteria** - Quality Factors, Quality Criteria, Relationship Between Quality Factors and Criteria, Quality Metrics. **ISO 9126 Quality Characteristics**, **ISO 9000:2000 Software Quality Standard** - **ISO 9000:2000 Fundamentals**, **ISO 9001:2000 Requirements**,

Maturity Models - Basic Idea in Software Process, **Capability Maturity Model** - CMM Architecture, Five Levels of Maturity and Key Process Areas, Common Features of Key Practices, Application Of CMM, Capability Maturity Model Integration (CMMI), **Test Process Improvement**, **Testing Maturity Model**

Books:

1) "Foundations of Software Testing" by Dorothy Graham, Erik van Veenendaal, Isabel Evans, Rex Black, ISTQB Foundation, ISBN - 978-1844809899

2) "Systematic Software Testing" by Rick D. Craig, Stefan P. Jaskiel, ISBN - 978-1580537918

References:

1) SOFTWARE TESTING AND QUALITY ASSURANCE Theory and Practice, A JOHN WILEY & SONS, INC., PUBLICATION, ISBN - 978-0-471-78911-6

M.Sc. (Computer Science) - II (SEMESTER – III)

PAPER – II: ARTIFICIAL INTELLIGENCE AND ROBOTICS

Credit: 4 **Max. Marks: 80**

Program Learning Outcome:

1. To present a problem oriented in depth knowledge of Artificial Intelligence and Robotics.
2. To address the underlying concepts, methods and application of different Artificial Intelligence and Robotics
3. List and explain the basic elements of industrial robots analyze robot kinematics and its control methods.

Unit – I: Prolog Programming and AI

Prolog: Introduction to Turbo Prolog, Structure of Languages. Cut, Fail, Recursion, Lists and Complex Structure **Introduction to AI:** Definition of AI, AI Technique, Pattern Recognition, Level of The Model, Criteria for Success, Problems and Problems Spaces, Defining the Problem, Production System, Control Strategies, Heuristic, Problem Characteristics.

Unit – II: Problem Solving

Basic Problem-Solving Methods, State Space Search; Production Systems, Depth-First, Breadth-First Search, Heuristic Search - Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction End, Means-End Analysis.

Unit – III: Structural Representation and Natural Language Understanding

Structural Representation of Knowledge: Some Common Language Structures, Choosing Level of Representation, Finding the Right Structure, Declarative Representation.

Natural Language Understanding: Concept of Understanding, Keyword Matching, Syntactic and Symantic Analysis, Understanding Language Generation and Matching Translation, General Concept of Implementation of A.I. System, Introduction to Pattern Recognition, Translation.

Unit – IV: Robot Basics

Robot-Basic concepts, Need, Law, History, Anatomy, specifications. Robot configurations-cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot. **ROBOT ELEMENTS** - End Effectors-Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types. **ROBOT APPLICATIONS** - Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, Disaster management. Applications, Micro and Nanorobots, Future Applications

Books:

1) Rich, Knight, Nair, "Artificial Intelligence", TMH, 3rd Ed., ISBN 9780070087705
2) Dan W Patterson "Introduction to Artificial Intelligence and Expert Systems", PHI Publication, ISBN-8120307771
3) NJ Nilsson, "Principles of AI", Narosa Pub. House, 1990, ISBN-8185198292
4) Fu. K. S, Gonzalez.R.C & Lee. C.S.G, "Robotics control, sensing, vision and intelligence", Tata-McGraw Hill Pub. Co., 2008

References:

1) Peter Jackson, "Introduction to Expert Systems", AWP, MA, 1992, ISBN: 0079097855
2) R.J. Schalkoff, "Artificial Intelligence - An Engineering Approach", TMH, 1992, ISBN: 0070550840 Burnham and Hall, "Prolog Programming and Application", A. R. Hall, ISBN:04702026.

M.Sc. (Computer Science) - II (SEMESTER – III)
PAPER – III: BIG DATA ANALYTICS

Credit: 4 **Max. Marks: 80**

Program Learning Outcome:

1. Students will gain a comprehensive understanding of Big Data concepts, technologies, and analytics fundamentals, enabling effective data collection, preprocessing, and exploration.
2. Students will expertise in the Hadoop ecosystem, including its architecture, data movement processes, and advanced features like Hive, HBase, and Pig, along with the ability to design and monitor applications using Zookeeper.

Unit I: Data Fundamentals and Preparation for Analytics

Big Data and Analytics: Introduction to Big Data, Big Data Characteristics, Types of Bigdata, Traditional Versus Big Data Approach, Technologies Available for Big Data, Infrastructure for Big Data, Use of Data Analytics, Big Data Challenges. Data Collection, **Sampling and Preprocessing:** Types of Data Sources Sampling, Types of Data Elements, Visual Data Exploration and Exploratory Statistical Analysis, Missing Values, Outlier Detection and Treatment, Standardizing Data, Categorization, Weights of Evidence Coding, Variable Selection, Segmentation

Unit II: Analytics Techniques

Predictive Analytics: Target Definition, Linear Regression, Logistic Regression, Decision Trees, Neural Networks, Support Vector Machines, Ensemble Methods, Multiclass Classification Techniques, Evaluating Predictive Models **Descriptive Analytics:** Association Rules, Sequence Rules, Segmentation **Survival Analysis:** Survival Analysis Measurements, Kaplan Meier Analysis, Parametric Survival Analysis, Proportional Hazards Regression, Extensions of Survival Analysis Models, Evaluating Survival Analysis Models.

Unit III: Hadoop Ecosystem Exploration

Introduction to Hadoop and Hadoop Architecture: Big Data – Apache Hadoop & Hadoop Ecosystem, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce -, Data Serialization, **HDFS, HIVE AND HIVEQL, HBASE:** HDFS-Overview, Installation and Shell, Java API; Hive Architecture and Installation, Comparison with Traditional Database, HiveQL Querying Data, Sorting And Aggregating, Map Reduce Scripts, Joins & Sub queries, HBase concepts, Advanced Usage, Schema Design, Advance Indexing, PIG, Zookeeper , how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper

Unit IV: Graph Data Magic with Spark, MongoDB, and Neo4j

Apache Spark, MongoDB and Neo4j: Introduction to Data Analysis with Spark, Downloading Spark and Getting Started, Programming with RDD, Spark SQL, Spark Streaming. Introduction to MongoDB key features, Core Server tools, MongoDB through the JavaScript's Shell, Creating and Querying through Indexes, Document-Oriented, principles of schema design, constructing queries on Databases, collections and Documents, MongoDB Query Language, Graph **Analytics and Data Visualization:** Apache Spark GraphX: Property Graph, Graph Operator, SubGraph, Triplet, Neo4j: Modeling data with Neo4j, Cypher Query Language: General clauses, Read and Write clauses. Big Data Visualization with D3.js, Kibana and Grafana.

Book:

1. Bart Baesens, Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Wiley, 2014

References:

1. Xyz Dirk Deroos et al., Hadoop for Dummies, Dreamtech Press, 2014.
2. Chuck Lam, Hadoop in Action, December, 2010.
3. Leskovec, Rajaraman, Ullman, Mining of Massive Datasets, Cambridge University Press.
4. I.H. Witten and E. Frank, Data Mining: Practical Machine learning tools and techniques.

M.Sc. (Computer Science) - II (SEMESTER – III)

Practical Based on Major Subject I, II & III

Credit: 2 **Max. Marks: 50**

Practical on Subject 1 (Software Testing and Quality Assurance)

1. Understand the Automation Testing Approach (Theory Concept)
2. Using Selenium IDE, write a test suite containing minimum 2 test cases.
3. Conduct a test suite for any two websites.
4. Write and test a program to provide total number of objects present/available on the page
5. Study of any testing tool (e.g. Winrunner)
6. Study of any web testing tool (e.g. Selenium)
7. Study of any bug tracking tool (e.g. Bugzilla,bugbit)
8. Study of any test management tool (e.g. TestDirector)
9. Study of any open source-testing tool (e.g. TestLink)

Practical on Subject 2 (Artificial Intelligence and Robotics)

1. Write a Program in Prolog to find the Maximum and Minimum.
2. Write a prolog program that will help us find the equivalent resistance of a resistive circuit
3. Write a Program to verifies whether a line segment is horizontal, vertical or oblique
4. Write a Program to find Relations in Prolog such family relationship.
5. Write a Program in Prolog to use various Comparison and Arithmetic Operators in Prolog.
6. Demonstrate the CUT Predicate in Prolog.
7. Write a Program in Prolog to insert an element into a list.
8. Demonstrate Towers of Hanoi Problem in Prolog.
9. Write a Program in Prolog to insert the element in Linked List.
10. Demonstrate the Monkey and Banana Problem in Prolog.

Practical on Subject 3 (Big Data Analytics)

1. Install, configure and run python, NumPy and Pandas.
2. Install, configure and run Hadoop and HDFS.
3. Visualize data using basic plotting techniques in Python.
4. Implement NoSQL Database Operations: CRUD operations, Arrays using MongoDB.
5. Implement Functions: Count – Sort – Limit – Skip – Aggregate using MongoDB.
6. Implement word count / frequency programs using MapReduce.
7. Implement a MapReduce program that processes a dataset.
8. Implement clustering techniques using SPARK.
9. Implement an application that stores big data in MongoDB / Pig using Hadoop / R

M.Sc. (Computer Science) - II (SEMESTER – III)
Major Elective
PAPER –V- Elective – I – NATURAL LANGUAGE PROCESSING

Credit: 2 **Max. Marks: 40**

Program Learning Outcome:

3. Students should be able to perform semantic analysis of text, including sentiment analysis, entity recognition, and topic modeling
4. Students should be able to apply NLP techniques to real-world problems, such as chatbots, language translation, information extraction, and text summarization styles using JavaScript and CSS also will understand how to script forms.

Unit – I: Introduction to Natural Language Processing

Understanding natural language processing, basic applications, advanced applications. Advantages of togetherness - NLP and Python, Environment setup for NLTK, the power of human language, the impact of natural language processing (NLP) on society, NLP tasks that machines can do, self-improvement of NLP technology. **Language Processing and Python:** Computing with Language, a Closer Look at Python, Simple Statistics, Back to Python: Making Decisions and Taking Control, Automatic Natural Language Understanding

Unit – II: N-Grams (Tokens)

N-Grams, Evaluating Language Models, Generalization and Zeros, Smoothing, Kneser-Ney Smoothing, Huge Language Models and Stupid Backoff, Advanced: Perplexity's Relation to Entropy. **Accessing Text Corpora and Lexical Resources**: Accessing Text Corpora, Conditional Frequency Distributions, More Python: Reusing Code, Lexical Resources, WordNet. Naive Bayes Classifiers.

Unit – III: Logistic Regression

Classification: the sigmoid, Learning in Logistic Regression, the cross-entropy loss function, Gradient Descent Regularization, Multinomial logistic regression, interpreting models, advanced: Deriving the Gradient Equation. **Vector Semantics and Embedding:** Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector, Pointwise Mutual Information (PMI), Applications of the tf-idf or PPMI vector models, Word2vec.

Unit – IV: Corpus and Dataset

Corpus, need of corpus, corpus analysis, types of data attributes, Categorical or qualitative data attributes, Numeric or quantitative data attributes, different file formats for corpora, accessing free corpora, preparing a dataset for NLP applications, selecting data, Preprocessing the dataset, Formatting, Cleaning, Sampling, transforming data, Web scraping. **Preprocessing:** Handling corpus-raw text, getting raw text, Lowercase conversion, Sentence tokenization, Challenges of sentence tokenization, Stemming for raw text, Challenges of stemming for raw text, Lemmatization of raw text, Challenges of lemmatization of raw text, Word tokenization, Challenges for word tokenization, Word lemmatization, Challenges for word lemmatization

Books:

1. Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", O'Reilly, ISBN: 978-0-596-51649-9
2. Lane, Howard and Hapke, "Natural Language Processing in Action", Manning Publications ISBN: 978-1617294631
3. Daniel Jurafsky, James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing", Pearson, ISBN: 978-0135041963

References:

1. Goutam Chakraborty, "Text Mining and Analysis: Practical Methods, Examples, and Case Studies Using SAS ", SAS Institute, ISBN: 978-1629597135

M.Sc. (Computer Science) - II (SEMESTER – III)
Major Elective
PAPER – V - Elective – II – MACHINE LEARNING

Credit: 2 **Max. Marks: 40**

Program Learning Outcome:

1. Recognize the characteristics of Machine Learning techniques that enable to solve real world problems
2. Recognize the characteristics of machine learning strategies
3. Apply various supervised learning methods to appropriate problems
4. Identify and integrate more than one technique to enhance the performance of learning

Unit – I: Introduction to Machine Learning:

Introduction, Components of Learning, Learning Models, Geometric Models, Probabilistic Models, Logic Models, Grouping and Grading, designing a Learning System, Types of Learning, Supervised, Unsupervised, Reinforcement, Perspectives and Issues, Version Spaces, PAC Learning, VC Dimension.

Unit – II: Supervised and Unsupervised Learning:

Decision Trees: ID3, Classification and Regression Trees, **Regression:** Linear Regression, Multiple Linear Regression, Logistic Regression, **Neural Networks:** Introduction, Perception, Multilayer Perception, **Support Vector Machines:** Linear and Non-Linear, Kernel Functions, K Nearest Neighbors.

Introduction to clustering, K-means clustering, K-Mode Clustering.

Unit – III: Ensemble and Probabilistic Learning:

Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees,

Boosting: AdaBoost, Stacking.

Gaussian mixture models - The Expectation-Maximization (EM) Algorithm, Information Criteria, **Nearest neighbor methods** - Nearest Neighbor Smoothing, Efficient Distance Computations: the KD-Tree, Distance Measures.

Unit – IV: Reinforcement Learning and Evaluating Hypotheses:

Introduction, Learning Task, Q Learning, Non-deterministic Rewards and actions, temporal-difference learning, Relationship to Dynamic Programming, Active reinforcement learning, Generalization in reinforcement learning.

Motivation, **Basics of Sampling Theory**: Error Estimation and Estimating Binomial Proportions, The Binomial Distribution, Estimators, Bias, and Variance

Genetic Algorithms: Motivation, Genetic Algorithms: Representing Hypotheses, Genetic Operator, Fitness Function and Selection, An Illustrative Example, Hypothesis Space Search, Genetic Programming, **Models of Evolution and Learning:** Lamarkian Evolution, Baldwin Effect, Parallelizing Genetic Algorithms.

Books:

1. Ethem Alpaydin," Introduction to Machine Learning", MIT Press, Prentice Hall of India
2. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar" Foundations of Machine Learning", MIT PRESS
3. Tom Mitchell, "Machine Learning", McGraw Hill.

References:

1. Charu C.Aggarwal, "Data Classification Algorithms and Applications", CRC Press.
2. Charu C. Aggarwal, "DATA CLUSTERING Algorithms and Applications", CRC Press.
3. Kevin P. Murphy **"Machine Learning: A Probabilistic Perspective"**, The MIT Press.
4. Jiawei Han and Micheline Kambers and JianPei, **"Data Mining Concepts and Techniques"**, Morgan Kaufman Publications

M.Sc. (Computer Science) - II (SEMESTER – III)
Major Elective
PAPER – V - Elective – III - INTERNET OF THINGS (IoT)

Credit: 2 **Max. Marks: 40**

Program Learning Outcome:

1. Students will learn how IoT works and after learning this syllabus they will start building the ideas into reality.
2. Students will familiar with IoT Hardware like Sensors, Actuator and Cloud Computing.

Unit - I: Introduction to Internet of Things (IoT)

Historical perspective of Internet and IoT, Definition and concept of IoT, Meaning of Things in IoT, Objectives and Principle, Necessity of IoT, Characteristics, Applications, Advantages and Disadvantages, Challenges, Using IoT with Python, Categories, IoT Layers, IoT System Architecture, working of IoT System, Databases, Security and Privacy issues, Significance and Scope of IoT in future trends, IoT Devices, Integrating other technologies with IoT

Unit - II: IoT Development Boards: Microprocessor and Microcontroller/Embedded Kits

IoT Development boards: purpose and its features, types of IoT board categories, Selection of right IoT Development Board for project. **Open Source Boards:** Arduino UNO, BeagleBoard, DragonBoard, ESP32, HummingBoard, Odroid, Particle Boron, Raspberry Pi, Banana Pi, Tessel, Jetson Nano, UDOO. **Open Source Tools and Platforms:** Curl, Platform IO, NodeRed. **Commercials Tools and Platforms:** Mendix, Predix, Fogwing, MuleSoft

Unit - III: Protocols and IoT Hardware: Sensors and Actuators

Role of Protocol, Sensor and Actuator **IoT-Oriented Communication Protocols:** WiFi, Bluetooth, Zigbee, AMQP, MQTT, XMPP, REST, CoAP, OPC-UA, LoRaWAN, WebSocket, Cellular: GSM, PRS, EDGE 2, UMTS/HSPA-3G, LTA 4G **Sensors:** Analog sensors, Digital sensors, Signal conditioning sensors **Actuators:** switches, motors, Human attention actuators **Interfacing sensors and actuators:** connecting external hardware components to IoT Development Boards

Unit - IV: Cloud Computing and Data analytics

Basics of Cloud, need of Cloud in IoT, Benefits of Cloud for IoT project, AWS IoT, PTC Thingworx, Azure IoT Hub, Google Cloud IoT, Oracle IoT Cloud, SiemensMind Sphere, Kaa, IBBM Watson IoT, Cisco Cloud, AllibabaCloud, ARM Pelion, CloudPlugs IoT, RightTech IoT Cloud, EMQ X Cloud, SAP IoT **Project Building with data analytics:** Interfacing and Installing the Arduino IDE, Raspberry Pi, ESP8266, NodeMCU, solderless Breadboard, Programming Arudino **Project:** Blinking of LED with pause of few seconds, Creating a blinking of five LED wave, Real time temperature monitoring system with data analytics using any IoT cloud and python or any suitable language

Books:

1. Vilas Kisanrao Tembhurne, Dr. A. K. Damodaram, Vijay Dattatray Chaduhari, Sandip Khantwal, "Internet of Things (IoT) in 5G Mobile Technologies", Alpha International Publication (AIP), ISBN: 978-93-95978-63-7.
2. Anand Tamboli "Build Your Own IoT Platform: Develop a Fully Flexible and Scalable Internet of Things" A press Publication, ISBN: 9781484275177

References:

1. Jamil Yusuf Khan "Internet of Things (IoT): Systems and Applications" Jenny Standford Publication, ISBN: 9814800295

M.Sc. (Computer Science) - II (SEMESTER – III)
Major Elective
PAPER – IV - Elective – IV – HIGH-PERFORMANCE COMPUTING

Credit: 2 **Max. Marks: 40**

Program Learning Outcome:

1. It covers parallel programming models, GPU parallelism with CUDA, optimization techniques and trends in high performance computing.
2. The students will learn the Optimization Techniques.
3. The concept of GPU Parallelism will be well understood.

Unit - I: **Parallel Programming**

Introduction to Parallel Computing, Evolution of Parallel Computers, Motivating Parallelism, Parallel Architecture, **Parallel programming Models**: Implicit models, Semi-Implicit model, Explicit model, Thinking in Parallel, Scope of parallel computing, Dichotomy of parallel computing, Communication model of parallel platforms, Parallel Algorithm Design.

Unit - II: Introduction to GPU Parallelism with Cuda

Introduction to GPU architecture, History of GPU, Early GPU, Understanding GPU parallelism, CPU vs GPU Architectural Differences, The Birth of GPGPU, Nvidia – ATI Technologies and Intel, CUDA architecture, Application of CUDA, Introduction to CUDA C.

Unit - III: Optimization Techniques and best practice for parallel codes

Data prefetching, Communication and computations overlapping and increasing computation efficiency, Data Granularity, Data types and Accuracy, Data organization and arrangement, Checkpointing

Unit - IV: Contemporary to High Performance Computing

High Performance Computing, Terascale to Petascale: The past 15 years in HPC, Performance: Gordon Bell Prize, HPC challenge, Green500, SHOC, Trends: Architecture, Software, Clouds and Grids in HPC, Introduction to Computational Modelling: The modelling process.

Books:

1. High Performance Computing: A chapter Sampler by CRC Press – Taylor & Francis

References:

1. High Performance Computing, by Thomas Sterling, Maciej Brodowicz, Matthew Anderson, Morgan Kaufmann Publication ISBN: 9780124202153.

M.Sc. (Computer Science) - II (SEMESTER – III)
Major Elective
PAPER – V - Elective – V - COMPUTER VISION

Credit: 2 **Max. Marks: 40**

Program Learning Outcome:

1. To understand basic knowledge, theories and methods in image processing and computer vision.
2. To implement basic and some advanced image processing techniques in OpenCV.
3. To apply 2D and 3D image alignment and image reconstruction techniques.
4. To design and develop innovative image processing and computer vision applications.

Unit-I: Computer Vision and Images

Computer Vision: Introduction to Computer Vision, brief History of Computer Vision,

Images: Types of images (analog, digital, grey scale, multispectral), Operations on Images (Changing pixels in small neighborhoods, enhancing an entire image, combining multiple images), Problems in Digital Images (geometric distortion, scattering, blooming, CCD variations, clipping or wrap-around, chromatic distortion, quantization effects),

Unit-II: Image Formation

Geometric primitives and transformations: 2D Transformations, 3D Transformations, 3D Rotations.

Photometric image formation: Lighting, Reflectance and shading, optics.

The digital camera: Sampling and aliasing, Color, Compression.

Unit-III: Image Processing

Point operators: Pixel transforms, Color transforms, Compositing and matting, Histogram equalization, Tonal adjustment

Filtering: Linear filtering (Separable filtering, Band-pass and steerable filters)

Non-linear filtering (Median filtering, Bilateral filtering, Guided image filtering,), Binary image processing, application of image processing.

Unit-IV: Deep Learning

Supervised learning: Nearest neighbors, Bayesian classification, Logistic regression, Support vector machines, Decision trees and forests

Unsupervised learning: Clustering, K-means and Gaussians mixture models, Manifold learning, Semi-supervised learning.

Deep neural networks: Weights and layers, Activation functions, Regularization and normalization, Dataset augmentation, Dropout, Batch normalization.

Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer- Texts in Computer Science, Second Edition, 2022.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, Second Edition, 2015.
3. Computer Vision and Techniques, Complete Python Approach
4. Dr. Pavithra G, Prof. Sandeep Srivastava, Prof. Dr. S.Kalarani, Dr. Saravana Balaji B, Mr. Sulaima Lebbe Abdul Haleem ISBN-978-1-68509-224-5

References:

1. Computer Vision, Linda Shapiro, University of Washington.

M.Sc. (Computer Science) - II (SEMESTER – III)

Practical Based on Major Elective Subject I, II, III, IV & V

Credit: 2 **Max. Marks: 50**

Practical on Elective Subject 1 (Natural Language Processing)

1. Write a program in Python to collect text data using Twitter APIs.
2. Write a program in Python to extract text from PDF file and store it for further analysis.
3. Write a program in Python to read JavaScript Object Notation (JSON) file.
4. Write a program in Python to read parse/read HTML pages.
5. Write a program in Python for Standardizing the Text
6. Write a program in Python for Tokenizing the Text
7. Write a program in Python for Stemming the Text
8. Write a program in Python for Lemmatizing the Text
9. Write a program in Python to replace an emoji with a relevant, meaningful word.
10. Write a program in Python to remove emoticons.
11. Write a program in Python to replace emoticons with relevant, meaningful words.
12. Write a program in Python to generate the n-grams for a given sentence.
13. Write a program in Python to convert text to features using TF-IDF.
14. Write a program in Python to convert text to a feature using a count vectorizer.
15. Write a program in Python to understand and generate a hash vectorizer.
16. Write a program in Python to find the similarity between two texts.
17. Write a program in Python to tag the parts of speech in a sentence.
18. Write a program in Python to do a sentiment analysis.
19. Write a program in Python to understand disambiguating word sense.
20. Write a program in Python to understand and generate a co-occurrence matrix.

Practical on Elective Subject 2 (Machine Learning)

1. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
2. Assuming a set of documents that need to be classified, use the naïve Bayesian algorithm.
3. Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
4. Write a program to implement k-Nearest Neighbor algorithm to classify the iris. print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
5. Write a program to implement Logistic Regression algorithm to classify the housing price data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
6. Write a program to implement and compare SVM, KNN and Logistic regression algorithm to classify the iPhone purchase records data set. Print both correct and wrong predictions. Java/ Python ML library classes can be used for this problem.

Practical on Elective Subject 3 (Internet of Things (IoT))

(Use any IoT Development Board and Python or any suitable language)

1. Project based on LED blinking means automatically turn on and off of LED with pause of few second.
2. Project based on creating LED blinking wave means automatically turn on and off a series of LED lights for better visual effects.
3. Project based on controlled LED by pushbutton means LED is ON or OFF by pushing switch.
4. Project based on Light Dimmer means creating a dimmer switch by adding a potentiometer to control the brightness of LED.
5. Project based on Temperature Monitoring System means sensor can be used to read the temperature, and readings can be displayed on the display device.
6. Project based on Motor Speed Control means control the speed of a fan according to weather outside.
7. Project based on Weather Reporting System means a system in which use sensors to measure the temperature, humidity and rain besides that send this information anywhere.
8. Project based on Liquid Level Monitoring System means a system in which alerting when a liquid tank is full. Building smart system that can fill a tank with liquid without overflowing.
9. Project based on LED Light Lamp means building own IoT based Light Lamp by using an app from your phone remotely control the light intensity and change the color to soothe your eyes. It should support multiple colors.

10. Project based on Soil Moisture Detection means incase forgetting to water your plants, automate the watering process with python. Soil moisture sensors can be used to detect the moisture in the soil and you can then water the plants according to the soil moisture.
11. Project based on Fire Detection System means fire spreads at a quick rate and it is necessary to take action as soon as possible, building a fire detection systemthat will alert the owner of the building, home, etc and will also report directly to the fire department so that immediate action can be taken.
12. Project based on Air Pollution Monitoring System means monitoring the different particles present in air like led, carbon dioxide, sulphor dioxide, toxic gases, etc that are responsible for air pollution. So the system can monitor and store all the data on the web servers to check the pollution statistics remotely.
13. Project based on Surveillance Camera means building your own surveillance camaras using raspberry Pi and Camera. This can be used to monitor the baby or childrens room and you can also monitor the home from your smartphones with just a few taps.
14. Project based on Health Monitoring System means using several small sensors located around the body to continuously measure the statistics of the body by calculating ECG, EEG. Blood pressure, tempertature, etc. This information can be sent and stored on the cloud.
15. Project based on Home Automation System means automate most of the appliances like fan lights, tv, door, music system, etc. One can send signals from smartphone and control all the devices remotely.
16. Project based on Facial Recognition Door Unlock means to make a door locking system that will only open when the authorized person tries to open the door. You need implement a facial recognition system in Python and then if the person exists in the database then give the entry inside the door.

Practical on Elective Subject 4 (High Performance Computing)

1. Write a program in CUDA C to perform a vector addition in parallel.
2. Write a program in CUDA C to perform matrix multiplication in parallel.
3. Write a program in CUDA C to perform a simple element-wise multiplication of two arrays in parallel.
4. Write a program in CUDA C to perform the image flipper: IMFLIPG.CU
5. Write a program in CUDA C to launch the GPU kernels.
6. Write a program in CUDA C to perform a simple reduction operation (finding the sum of all elements in an array) in parallel.
7. Write a program in CUDA C to perform parallel sorting of an array using the Thrust library.
8. Write a program in CUDA C to perform parallel histogram calculation.
9. Write a program in CUDA C to perform parallel prefix sum (also known as scan) operation.
10. Write a program in CUDA C to perform parallel image processing, specifically grayscale conversion.

Practical on Elective Subject 5 (Computer Vision)

1. Program for image formation using 2D Transformation.
2. Program for image formation using 3D transformation.
3. Program for reflectance or shading shape in computer vision.
4. Program to generate a multicolor benzene with nth cyclic rotations.
5. Program to generate a shape of star.
6. Program to process an image using m x n pixel transformation. (where m and n are Number of rows and columns respectively).
7. Program to generate the colored rectangle using color transforms of point operators.
8. Program to animate the background colour to any new colour.
9. Program to animate an object (any shape) to move from one end to another.
10. Animated Program for activation function to generate a line/ curve on a pictorial graph.
11. write a program to generate same shape with different co-ordinates based on the number you enter in a uniform pattern.
12. write a program on Unsupervised learning Pattern Matching with Regular Expressions.
13. Write a program on Regularization Parentheses for Grouping and Capturing with Regex (regular expression).
14. Create a Simple Two Player Game using Turtle in Python.

M.Sc. (Computer Science) - II (SEMESTER – III)

RESEARCH PROJECT

Credit: 4 **Max. Marks: 100**

Course Outcomes:

1. Identify different elements and processes of the system and Represent various stages of software development.
2. Illustrate structured analysis development strategy.
3. Analyze system through development strategy.
4. Evaluate the requirement engineering tasks and Devise a computerized solution for the proposed problem definition.

Instruction

A. A student may individually or in group must select one case studies related to computer domain subject. Research Project should be done in groups (**Maximum 2 students)**. However, each student must be given responsibility for a distinct module and care should be taken to monitor the progress of an individual student.

B. The Project Work should be done using the tools covered in **M.Sc. (Computer Science)**

C. The Project Work should be of such a nature that it could prove useful or be relevant from the System-oriented/Application/commercial/management angle.

D. The project work will carry 100 marks.

E. The external viva-voce examination for Research Project would be held as per the Examination Time Table of the second year of study, by a panel of one external and one internal examiner. They will jointly evaluate the work on the date of examination and assign the marks based on performance.

And submit the report at the end in the following format. Proofread the report carefully to ensure clarity, coherence, and correctness of language and presentation.

Types of Project

The Applications Areas of the project - Financial/Marketing/Database Management System/ Relational Database Management System/E-Commerce /Internet/ Manufacturing/ web Designing/Hardware and Software interaction-based etc.

Project Proposal (Synopsis)

The project proposal should be prepared in consultation with the guide.

The project Synopsis proposal should clearly state the objectives and environment of the proposed project to be undertaken. It should have full details in the following form:

1. Title Page.
2. Certificate Page.
3. Declaration Page.
4. Acknowledgment Page.
5. Introduction and Objectives and Hypothesis of the Project
6. Project Category (DBMS/RDBMS/OOPS/Web Designing/Internet etc.)
7. Tools/Platform, Languages to be used
8. A complete Structure of the program:
    i. Analysis.
    ii. Numbers of Modules.
    iii. Data Structures or Tables

iv. Process Logic.
v. Types of Report Generation.

9. Scope of future Application.
10. Bibliography

Distribution of Mark of Project based on following				
Module	**Maximum Marks**		**Min. Marks for Passing**	
	CA	**UA**	**CA**	**UA**
a) Synopsis relevance with that of final work	10	15	5	7.5
b) Project Work	10	15	5	7.5
c) Project Report	10	15	5	7.5
d) Presentation of Project Work	10	15	5	7.5
Total	**40**	**60**	**20**	**30**

M.Sc. (C/S) - II

(SEMESTER–IV)

M.Sc. (Computer Science) - II (SEMESTER – IV)

PAPER - I: DATA SCIENCE

Credit: 4 **Max Marks:80**

Program Learning Outcome:

1. Understand the key difference between various areas of data science.
2. Understand the fundamental concepts of tool and techniques available in data science.
3. Understand the fundamental algorithms available in Artificial Intelligence.
4. Understand the key algorithms available in data mining and machine learning

Unit-I:

Introduction to Data Science (15 L) Foundation of Data science, Evolution of Data Science – Data Science Roles – Stages in a Data Science Project – Applications of Data Science in various fields – Data Security Issues. Area and Scope of Data Science, Steps of Data Science Process: Data collection, Pre- processing, Data Collection Strategies – Data Pre-Processing Overview – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization. Training and testing. Use cases in various domain such Image, Natural Language, Audio and Video.

Unit-II:

Introduction to Artificial Intelligence: Introduction Artificial Intelligence, The Foundations of AI, AI Technique, Production system characteristics, Production systems: 8-puzzle problem. Searching: Uniformed search strategies – Breadth first search, depth first search.

Unit-III:

Searching Algorithms and Learning: Local Search Algorithms: Generate and Test, Hill climbing, simulated annealing search, Constraint satisfaction problems, Greedy best first search, A* search, AO* search. Self-Learning: Propositional logic - syntax & semantics Game Playing: Overview, Minimax algorithm, Alpha-Beta pruning, Additional Refinements. Model Development Simple and Multiple Regression – Model Evaluation using Visualization – Residual Plot – Distribution Plot – Polynomial Regression and Pipelines – Measures for In-sample Evaluation – Prediction and Decision Making

Unit-IV:

Introduction to Data Mining and Machine Learning: Introduction to Data Mining and Machine Learning, Supervised, Unsupervised and Reinforcement learning. Prediction vs Classification v/s Clustering. Association Rule Mining, classification and regression techniques, clustering, Scalability and data management issues in data mining algorithms, measures of interestingness.

Books:

1. Rachel Schutt, Cathy O'Neil, "Doing Data Science: Straight Talk from the Frontline" by Schroff/O'Reilly, 2013.
2. S. Russell and P. Norvig, Artificial Intelligence a Modern Approach, 2nd Edition. Pearson Education, 2007.
3. John W. Foreman, "Data Smart: Using data Science to Transform Information into Insight" by John Wiley &Sons, 2013.
4. Ian Ayres, "Super Crunchers: Why Thinking-by-Numbers Is the New Way to Be Smart" Ist Edition by Bantam,2007.
5. Eric Seigel, "Predictive Analytics: The Power to Predict who Will Click, Buy, Lie, or Die", 1st Edition, by Wiley,2013.

References:

1. Jure Leskovek, Anand Rajaraman, Jeffrey Ullman, Mining of Massive Datasets. v2.1, Cambridge University Press.
2. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly.

M.Sc. (Computer Science) - II (SEMESTER – IV)

PAPER - II: ADVANCED WEB DEVELOPMENT USING PHP

Credit: 4 **Max Marks:80**

Program Learning Outcome:

1. Gain Knowledge of Installing and configuring Web Server for server-side development.
2. Design and develop interactive websites.
3. Understand the concept of administration and security.

Unit-I: Introduction to Core PHP

Introduction to PHP, Why PHP, Hardware & Software Requirements, Advantages of PHP Why PHP is better alternative, PHP Syntax, Data Types, Variables, Operators, Conditional Statements, Loops; Super Globals, String Manipulation, Working with Array, PHP functions, Working with Forms.

Unit-II: MySQL Database

MySQL Database - What is Database, Database Models, Tables, Records and Files, SQL Language, MySQL Command-Line. Working with PHP MyAdmin – Working with PHP MyAdmin, Creating Web Databases, Database Engines, and Data types in MySQL, Creating Fields Unique Key; Insert, Update, View & Delete Records, Drop Database/Tables, and Primary/Foreign Keys.

Unit-III: Advanced PHP Programming

Cookies – What is Cookie, Cookie Syntax, How to Create, Store, Retrieve and Delete Cookie. PHP File Upload – Create an Upload-File Form, Upload Script and Save Uploaded file, putting restrictions on uploads. PHP File Handling – Opening and Closing of a File, Check End-of-file, Reading a File – Line by Line and Character by Character. Session – What is Session? Creating, Storing and Destroying Sessions. Classes & Object – OO Concepts, Define Class, Class Attributes, An Object, Creating an Object, Object Properties & Methods, Object constructors and destructors, Static Method, Class Inheritance, Abstract Class, Implement Inheritance.

Unit-IV: PHP MYSQL Administration & Security

Advanced MySQL Administration– Understanding privilege system, making database secure. Authentication with PHP and MySQL: Identifying visitors. Controlling access. Basic authentication. Apache authentication. Custom authentication.

Books:

1.Larry Ullman, "PHP 6 and MYSQL 5 for Dynamic Web Sites: Visual Quick Pro Guide", Peachpit Press, ISBN- 978-0321525994.
2.Luke Welling, Laura Thomson, "PHP and MYSQL Web Development", ISBN 978-0-672-32916-6.
3.Larry Ullman, "Effortless E-Commerce with PHP and MySQL", New Riders, ISBN 978-0321656223.
4.Janet Valade, "PHP MySQL for Dummies", Goels Computer Hut Publication, ISBN: 9788126535118.

References:

Steven Holzner, "PHP: The Complete Reference", McGraw Hill Osborne, ISBN- 978-0071508544.
Sandy Carter, "Web Database Applications with Php and Mysql", Shroff Publication 2nd Edition 2004, ISBN-9788173669057.

M.Sc. (Computer Science) - II (SEMESTER – IV)

Practical I

Credit: 2 **Max. Marks: 50**

Practical on DATA SCIENCE

1. Practical of Data collection, Data curation and management for Unstructured data (NoSQL).
2. Practical of Data collection, Data curation and management for Large-scale Data system (such as MongoDB).
3. Practical of Principal Component Analysis.
4. Practical of Clustering.
5. Practical of Time series forecasting.
6. Practical of Simple/Multiple Linear Regression.
7. Practical of Logistics Regression.
8. Practical of Hypothesis testing.
9. Practical of Analysis of Variance.
10. Practical of Decision Tree.

M.Sc. (Computer Science) - II (SEMESTER – IV)

Practical - II

Credit: 2 **Max. Marks: 50**

Practical on ADVANCED WEB DEVELOPMENT USING PHP

1. Write a PHP program to display the todays' date and current time.
2. Write a PHP program to calculate sum of given number.
3. Write a PHP program to display the Fibonacci series.
4. Write PHP program to display current day using switch case.
5. Write a PHP program to prepare student Mark sheet using Switch statement.
6. Write a PHP program to demonstrate the use of array.
7. Write a PHP program to display the use of associative array.
8. Write a PHP program to display the use of multidimensional array.
9. Write a PHP program to generate the multiplication of matrix.
10. Write a PHP program for reading the content of file.
11. Write PHP program to copy the content of a file.
12. Write PHP program to append a file
13. Write a PHP Program for Create, Delete, and Copying file from PHP Script.
14. Write a PHP Program to Recursive Traversals of Directory.
15. Write PHP program to test for functions' existence.
16. Write a program to build a simple HTML form.
17. Write a program to build an HTML form including multiple checkboxes.
18. Write a program to Add an Array Variable to a Session Variable.
19. Write a PHP program to send Mail from PHP Script.
20. Write a PHP program to read the employee detail using form component.
21. Write a PHP program to create a table in MySQL database.
22. Write a PHP program to insert a record into a table in MySQL.
23. Write a PHP program to select a record from a table in MySQL database.

M.Sc. (Computer Science) - II (SEMESTER – IV)
Major Elective
PAPER – V- Elective – I - ADVANCED CRYPTOGRAPHY

Credit: 4 **Max. Marks: 80**

Program Learning Outcome:

1. Analyze and design classical encryption techniques and block ciphers.
2. Understand and analyze data encryption standard.
3. Understand and analyze public-key cryptography, RSA and other public-key cryptosystems such as Diffie-Hellman Key Exchange, Elgamal Cryptosystem, etc.
4. Understand key management and distribution schemes and design User Authentication

Unit-I: Introduction and Encryption Techniques

Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, Fundamental security design principles, Attack surfaces and Attack Trees, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography, Traditional Block Cipher structure, Data Encryption Standard (DES), Strength of DES, Differential and Linear Cryptanalysis, Block cipher Design Principles, Groups, Rings and Fields, Modular Arithmetic, Euclidean Algorithm and Polynomial Arithmetic.

Unit-II: Advanced Encryption Standard

Finite Field Arithmetic, AES Structure, AES Transformation Functions, AES Key Expansion, AES Implementation, Multiple Encryption and Triple DES, Electronic Codebook, Cipher Block Chaining Mode, Counter Mode, XTS-AES mode for Block-Oriented Storage Devices, Format-Preserving Encryption, Principles of Pseudorandom Number Generation, Pseudorandom Number Generation using a Block Cipher, Stream Ciphers, RAC, True Random Number Generators.

Unit-III: Symmetric and Asymmetric Ciphers

Symmetric Cipher Model, Multiple Encryption and Triple DES, Block Cipher Modes of Operation, Stream Ciphers and RC4, Principles of Public-Key Cryptosystems, The RSA Algorithm, Diffie-Hellman Key Exchange, Elgamal Cryptographic System, Elliptic Curve Arithmetic, Elliptic Curve Cryptography, Pseudorandom Number Generation Based on an Asymmetric Cipher.

Unit-IV: Cryptographic Data Integrity Algorithms and User Authentication

Applications of Cryptographic Hash Functions, Requirements and Security, Hash Functions Based on Cipher Block Chaining, Secure Hash Algorithm, Requirement for Message Authentication Codes (MACs), Security of MACs. Authenticated Encryption: CCM and GCM, Digital Signature, Elgamal & Schnorr Digital Signature Scheme, NIST Digital Signature Algorithm, Elliptic Curve Digital Signature Algorithm, RSA-PSS Digital Signature Algorithm, Remote User-Authentication Principles, Remote User-Authentication Using Symmetric and Asymmetric Encryption, Kerberos.

Books:

1. William Stallings, *"Cryptography and Network Security Principles and Practices"*, Seventh Edition, Pearson Education Limited, Print ISBN 10:1-292-15858-1, Print ISBN 13: 978-1-292-15858-7
2. Lawrence C. Washington, Elliptic Curves. *Number Theory and Cryptography*, Chapman and Hall, CRC Press 2003.

References:

1. William Stallings, *"Cryptography and Network Security Principles and Practices"*, Fourth Edition, Prentice Hall, Print ISBN-10: 0-13-187316-4, Print ISBN-13: 978-0-13-187316-2
2. Fred Piper & Sean Murphy, "Cryptography: A Very Short Introduction", Oxford, ISBN-13: 978-0192803153
3. Arto Salomaaa, "Public-Key Cryptography", Second Edition, Springer, 1996, ISBN 3-540-61356-0.

M.Sc. (Computer Science) - II (SEMESTER – IV)
Major Elective
PAPER – V- Elective – II - EMBEDDED SYSTEM

Credit: 4 **Max. Marks: 80**

Program Learning Outcome:

1. To Define an Embedded System and understand the Embedded system design flow.
2. To understand Embedded Hardware building blocks and various Embedded Processor architecture models.
3. To understand the device driver concepts and able to design various device drivers.
4. To know the importance of testing an embedded system.
5. To understand the use of various ECAD tools in the design of the embedded systems

Unit – I:-Introduction to Embedded System

An Embedded System-Definition, Examples, Current Technologies, Integration in system Design, Embedded system design flow, hardware design concepts, software development, processor in an embedded system and other hardware units, introduction to processor based embedded system design concepts.

UNIT – II: Embedded Hardware

Embedded hardware building blocks, Embedded Processors – ISA architecture models, Internal processor design, processor performance, Board Memory – ROM, RAM, Auxiliary Memory, Memory Management of External Memory, Board Memory and performance. Embedded board Input / output – Serial versus Parallel I/O, interfacing the I/O components, I/O components and performance, Board buses – Bus arbitration and timing, Integrating the Bus with other board components, Bus performance.

UNIT – III: Embedded Software

Device drivers, Device Drivers for interrupt-Handling, Memory device drivers, On-board bus device drivers, Board I/O drivers, Explanation about above drivers with suitable examples. Embedded operating systems – Multitasking and process Management, Memory Management, I/O and file system management, OS standards example – POSIX, OS performance guidelines, Board support packages, Middleware and Application Software – Middle ware, Middleware examples, Application layer software examples.

UNIT – IV:-Embedded System Design, Development, Implementation and Testing

Embedded system design and development lifecycle model, creating an embedded system architecture, introduction to embedded software development process and tools- Host and Target machines, linking and locating software, Getting embedded software into the target system, issues in Hardware-Software design and co-design. Implementing the design-The main software utility tool, CAD and the hardware, Translation tools, Debugging tools, testing on host machine, simulators, Laboratory tools, System Boot-Up.

Books:

1) "Introduction to Embedded Systems a Cyber-Physical Systems Approach Second Edition" by Edward Ashford Lee and Sanjit Arunkumar Seshia"
2) Embedded System Design: "Embedded Systems Foundations of Cyber-Physical Systems, and the Internet of Things" Fourth Edition by Peter Marwedel.

References:

1) Philip Koopman "Better Embedded System Software" ISBN: 0984449000/978-0984449002.
2) Daniel D. Gajski, Samar Abdi, Andreas Gerstlauer, Gunar Schirner, "Embedded System Design: Modeling, Synthesis and Verification".

M.Sc. (Computer Science) - II (SEMESTER – IV)
Major Elective
PAPER – V- Elective – III - ADVANCED COMPUTER NETWORK

Credit: 4 **Max. Marks: 80**

Program Learning Outcome:

1) Useful to proceed with industrial requirements.
2) Understand the challenges, design goals and architecture of Computer Networks.
3) Understand the channel encoding and modulation mechanism.
4) Describe the communication, energy efficiency, computing, storage and transmission.

Unit – 1: Computer Network

Components of Computer Network – NIC (National Interface Card), Hub, Switches, Modem, Routers, Cables and Connectors, **Computer Network Architecture** – Peer to peer Network and Client/Server Network, Protocol Layer and their services, **Network Applications** – Web, HTTP, HTTPs, FTP, DNS and Electronic Mail, Features of Computer Network, Multiplexing and Demultiplexing, **Transmission modes** – Simplex mode, Half Duplex mode, Full Duplex mode, **Digital encoding** – Digital to Digital conversion, Analog to Digital conversion, Digital to Analog conversion, Analog to Analog conversion, **Routing algorithm** – Adaptive routing algorithm and Non adaptive routing algorithm, Distance vector algorithm

Unit – 2: Virtualization Techniques

Basics of Virtualization, Need of Virtualization, **Types of Virtualizations** – Network Virtualization, Sever and Machine Virtualization, Storage Virtualization, Application Virtualization, Client and Desktop Virtualization, **Network Hypervisor** – Native of Bare Metal Hypervisor and Hosted Hypervisor, **Overview of Hardware Virtualization** – Virtualization of CPU, Memory Virtualization, I/O Virtualization, Controller software and Host protocol, Transport Virtualization

Unit – 3: Network Security

Introduction, **Aspects of Network Security**- Privacy, Message Integrity, Authentication, Non Repudiation, **Types of Network security devices-** Active devices, Passive devices, Preventative devices**,** The OSI Security Architecture, Security Attacks, Security Services, Security Mechanism, **IP Security:** IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, **Web Security:** Web Security Overview, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction.

Unit -4: Wireless Sensor Technology

Overview of Wireless Sensor Network, Need and Application of Sensor Networks, Types of Wireless Sensor Networks**,** Characteristics and Challenges of Wireless Sensor Network, **Network Architecture** - Sensor Network Scenarios, Design Principle, Physical and Transceiver Design consideration, Optimization goals and Figures of merits and Gateway concepts, **Medium Access Control (MAC)** - Wireless MAC protocols, characteristics of MAC protocols in Sensor Network, Contention-Free MAC Protocols, Contention-Based MAC Protocols, and Hybrid MAC Protocols, **Network Layer** - Routing Metrics, Flooding and Gossiping, Data Centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing, **Sensor Network Platform and Tools**- Sensor Node Hardware – Berkeley Motes, Sensor Network Programming Challenges, Node level software platforms, Node level Simulators.

Books:

1. Tanenbaum AS, Wetherall DJ. Computer Networks. Fifth edition, Pearson Education, Inc. 2011.
2. Dr Dayanand Ambawade, Dr Deven Shah. Advanced Computer Network, Wiley India Pvt. Limited
3. Network Virtualization, Victor Moreno, Kumar Reddy, Cisco Press (2006).

References:

1. Chayapathi R, Hassan SF, Shah P. Network Functions Virtualization (NFV) with a Touch of SDN: Netw Fun Vir (NFV ePub_1. Addison-Wesley Professional; 2016 Nov 14.

M.Sc. (Computer Science) - II (SEMESTER – IV)
Major Elective
PAPER – V- Elective – IV - R PROGRAMMING

Credit: 4 **Max. Marks: 80**

Program Learning Outcome:

1) Students will acquire proficiency in fundamental numeric operations, vector manipulation, matrix algebra, handling non-numeric data types, and basic plotting, enabling them to perform essential data manipulations and analyses in R.
2) Students will adeptly apply essential R programming concepts and acquire foundational skills in elementary statistics, data visualization, and probability.
3) Students will effectively apply R to grasp concepts related to sampling distributions, hypothesis testing, analysis of variance, and various regression techniques, enhancing their practical statistical modeling and inference skills.
4) Students will excel in advanced R plot customization, understand the nuances of the Grammar of Graphics, and gain expertise in defining colors, plotting in higher dimensions, and creating interactive 3D visualizations.

Unit-I: **Foundations of R Mathematics and Data Structures**

Overview of R and its application, **Numeric, Arithmetic, Assignment, And Vectors:** R for Basic Math, Arithmetic, Logarithms and Exponentials, E-Notation, Assigning Objects, Vectors, creating a Vector, Sequences, Repetition, Sorting, and Lengths, Subsetting and Element Extraction, Vector-Oriented Behavior**,** **Matrices and Arrays:** Defining a Matrix, subsetting, Matrix operation and Algebra, Multidimensional array, **Non-Numeric Values:** Logical values, character, factors, List and Data frame. Special values, classes and coercion. Basic Plotting, **Reading and Writing Files:** R-Ready Data Sets, reading in external data files, Writing out data files and plot.

Unit-II: Programming Essentials and Statistical Foundations

Programming: Calling Functions, conditions and Loops, Writing Functions, Exceptions, Timings, and Visibility. **Statistics and Probability:** Elementary Statistics, Basic Data Visualization, Probability, Common Probability Distributions

Unit-III: Statistical Inference and Regression Analysis in R

Sampling Distributions and Confidence, Hypothesis Testing, Analysis of Variance, Simple Linear Regression, Multiple Linear Regression, Linear Model Selection and Diagnostics.

Unit-IV: Advance Graphics

Advanced Plot Customization, Going Further with the Grammar of Graphics, Defining Colors and Plotting in Higher Dimensions, Interactive 3D Plots.

Books:

1. The Book of R: A First Course in Programming and Statistics, by Tilman M. Davies

References:

1. R in Action, Data Analysis and Graphics with R, Robert I. Kabacoff, Manning Publication.
2. THE ART OF R PROGRAMMING, by Norman Matloff, No Starch Press, ISBN-10: 1-59327-384-3

M.Sc. (Computer Science) - II (SEMESTER – IV)
Major Elective
PAPER – IV- Elective – V - WEB ANALYTICS

Credit: 4 **Max. Marks: 80**

Program Learning Outcome:

1. Understand or grasp the significance and implications of web analytics in the context of digital marketing.
2. Study diverse web analytics platforms for a comprehensive study, examining their features, functionalities, and applications in digital marketing.
3. Utilize web analytics tools and metrics to extract business intelligence from customer purchasing patterns, demographics, and emerging trends

Unit-I: Navigating the Digital Landscape - Web Analytics Foundations

Introduction to Web Analytics: Definition, process, and key terms. Building block terms: Visit characterization, content characterization, conversion metrics. Categories: Offsite web, Onsite web. Web analytics platform, its evolution, need for web analytics, advantages, and limitations.

Unit-II: Data Symphony - Mastering Web Analytics Techniques

Data Collection Techniques: Clickstream Data: Web logs, web beacons, JavaScript tags, packet sniffing. Outcomes Data: E-commerce, lead generation, brand/advocacy, and support. Research Data: Mindset, organizational structure, timing. Competitive Data: Panel-Based Measurement, ISP-Based Measurement, Search Engine Data.

Unit-III: Beyond Numbers - Crafting Narratives in Web Analytics

Qualitative Analysis in Web Analytics: Heuristic Evaluations: Conducting and Benefits. Site Visits: Conducting and Benefits. Surveys: Website surveys, post-visit surveys, creating and running surveys, and their benefits.

Web Analytic Fundamentals: Capturing data: Web logs or JavaScript tags, Separate data serving and data capture. Type and size of data, Innovation, Integration, Selecting optimal web analytic tool. Understanding clickstream data quality, identifying unique page definition, Using cookies, Link coding issues. Web Metrics: Common metrics - Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, new visits.

Unit-IV: Insights Unleashed - Advanced Web Analytics Strategies

Optimization Strategies and Advanced Analytics: Optimization (e-commerce, non-e-commerce sites): Improving bounce rates, Optimizing AdWords campaigns. Real-time reports, Audience reports, Traffic source reports, Custom campaigns, Content reports. Google Analytics: Introduction, KPI characteristics, Need for KPI, Perspective of KPI, Uses of KPI.

Emerging Trends and Tools in Web Analytics: Web analytics 1.0, Limitations of web analytics 1.0. Introduction to analytic 2.0, Competitive intelligence analysis: CI data sources, Toolbar data, Panel data, ISP data, Search engine data, Hybrid data. Website traffic analysis: Comparing long-term traffic trends, Analyzing competitive site overlap and opportunities. Google Analytics: Brief introduction and working, AdWords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic. Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

Books:

1. Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc.
2. Kaushik A., Web Analytics 2.0 The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc.
3. Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons

References:

1. Web Analytics: An Hour a Day by Avinash Kaushik ,2007, Publisher(s): Sybex, ISBN: 9780470130650

M.Sc. (Computer Science) - II (SEMESTER – IV)

RESEARCH PROJECT

Credit: 06 **Max. Marks: 150**

Instruction:

- Project should be based on Proposed Synopsis submitted in the semester III

Project Report

In General, project report must consist of following. Depending upon the kind of project one may alter the following sequence in consultation with guide.

1. Title Page.
2. Certificate Page.
3. Declaration Page.
4. Acknowledgment Page.
5. Index or Content Page.
6. Documentation.
    - i. Introduction/Objectives.
    - ii. Preliminary System Analysis.
        - Identification of Need.
        - Preliminary Investigation.
        - Feasibility Study.
        - Need of New System.
        - Flaws in Present System.
    - iii. Project Category.
    - iv. Software Requirement Specification.
    - v. Detailed System Analysis.
        - No. of Modules with title of module.
        - Data Structures and Tables if any used in project.
        - Entity-Relationship Diagram if any used in project.
    - vi. System Design.
        - Source Code.
        - Input Screen & Output Screen.
    - vii. Validation Checks.
7. Implementation, Evaluation and Maintenance.
8. Security Measures taken.
9. Future Scope of the project.
10. Bibliography

Appendix

- Survey Questionnaire if any

Distribution of Mark of Project based on following				
Module	**Maximum Marks**		**Min. Marks for Passing**	
	CA	**UA**	**CA**	**UA**
a) Synopsis relevance with that of final work	15	10	7.5	5
b) Project Work	15	30	7.5	15
c) Project Report	15	20	7.5	10
d) Presentation of Project Work	15	30	7.5	15
Total	**60**	**90**	**30**	**45**

Annexure A

Note: Student may perform the practical based on major elective subject opted in semester IV.

Practical Major Elective I (ADVANCED CRYPTOGRAPHY)

1. Write a C/C^{++}program to encrypt and decrypt the given string
2. Write a C/C^{++}program to encrypt and decrypt the string using RSA algorithm.
3. Write a C/C^{++}program for encoding given alphanumeric value otherwise an error message generates.
4. Write a C/C^{++}program for decoding given alphanumeric value massage otherwise an error message generates.
5. Write a C/C^{++}program for GCD of two numbers using Euclidean Algorithm
6. Write a C/C^{++}program to implement RSA algorithm Naive Approach.
7. Write a C/C^{++}program for RSA asymmetric cryptographic algorithm
8. Write a C/C^{++}program which will ask the user to enter two prime numbers and then encrypt and decrypt a message using the RSA algorithm.
9. Write a C/C^{++}program to generate a random or pseudo-random number without any external source.
10. Write a C/C^{++}program to generate a random 10-digit number without using a rand () function.
11. Write a C/C^{++}program to encrypt given string using! and @ symbols, alternatively
12. Write a C/C^{++}program to calculates the key for two persons using Diffie-Hellman key exchange algorithm
13. Write a C/C^{++}program for implementation of the ElGamal encryption algorithm. The program expects an input file, plain.txt, which contains the plain text, and generates an output file, results.txt, which contains our decrypted text. The program also generates two intermediary files – cipher1.txt and cipher2.txt.
14. Write a C/C^{++}program to demonstrate Elliptic Curve Arithmetic
15. Write a C/C^{++}program to implement Elliptic Curve Cryptography
16. Write a C/C^{++}program to demonstrate Cryptographic Hash Functions
17. Write a C/C^{++}program to demonstrate the mechanism of the Hash Functions for division method
18. Write a C/C^{++}program to demonstrate Secure Hash Algorithm
19. Write a C/C^{++}program for implement hashed message authentication checksum (HMAC)
20. 20.Write a C/C^{++}program for Verifying a digital signature with your Cryptographic Coprocessor
21. Write a C/C^{++}program to create a digital signature with an RSA private key and verify that signature against the RSA public key exported as an x509 cert.
22. Write a C/C^{++}program for demonstrate Schnorr Digital Signature

Practical Major Elective II (EMBEDED SYSTEM)

1. Write a simple program to print “Hello World”
2. Write a simple program to show a delay.
3. Write a loop application to copy values from P1 to P2.
4. Write a C program for counting the no. of times that a switch is pressed & released.
5. Write a simple program to create a portable hardware delay.
6. Write a C program to test loop time outs.
7. Write a C program to test hardware-based timeouts loops.
8. Illustrate the use of port header file (PORT M) using an interface consisting of a keyword and Liquid crystal display.
9. Develop a simple EOS showing traffic light sequencing.
10. Write a program to display elapsed time over RS-232 Link.
11. Write a program to drive SEOS Using Timer 0.
12. Develop software for milk pasteurization system.
13. Develop & implement a program for intruder alarm system

Practical Major Elective III (ADVANCED COMPUTER NETWORKS)

1. 1.Configuring and testing a NIC in a computer network.
2. Setting up and testing a hub in a network.
3. Configuring and testing a switch in a network.
4. Configuring and testing a modem in a network.
5. Setting up and testing a router in a network.
6. Testing and troubleshooting different types of cables and connectors.
7. Implementing and testing a peer-to-peer network architecture.
8. Implementing and testing a client/server network architecture.
9. Configuring and testing network applications – Web, HTTP, FTP, DNS, and Email.
10. Configuring and testing multiplexing and demultiplexing in a network.
11. Testing and comparing the transmission modes – simplex, half-duplex, and full-duplex.
12. Implementing and testing digital encoding techniques in a network.
13. Implementing and testing routing algorithms – adaptive and non-adaptive routing.
14. Setting up and testing virtualization techniques – network virtualization, server virtualization, and storage virtualization.
15. Configuring and testing network security measures – privacy, message integrity, authentication, and non-repudiation.
16. Implementing and testing IP security measures in a network.
17. Setting up and testing wireless sensor networks.
18. Configuring and testing different MAC protocols in a wireless sensor network.
19. Implementing and testing different routing metrics and algorithms in a wireless sensor network.
20. Programming and testing sensor nodes using available platforms and simulators.

Practical Major Elective IV (R PROGRAMMING)

1. Download and install R and R Studio.
2. Write a R program to get details of object in memory.
3. Write a R program to get sequence of numbers from 20-50 and find mean of numbers from 20-60 and find sum of numbers from 51-91.
4. Write a R program to create a simple bar plot of five subject's marks.
5. Write a R program to get the unique element of a given string and unique numbers of vectors.
6. Write a R program to multiple two vectors of integer type and length 3.
7. Write a R program to find sum, mean and product of a vector ignore element like NA, or NaN.
8. Write a R program to create three vectors a, b, c with 3 integers. Combine the three vector to become a 3*3 matrix where each column represents a vector. Print the content of the matrix.
9. Write a R program to create 5*4 matrix, 3*3 matrix with labels and fill the matrix by rows and 2*2 matrix with labels and fill the matrix by columns.
10. Write a R program to create a matrix from a list of given vectors.
11. Write a R program to concatenate two given matrices of same column but different rows.
12. Write a R program to list containing a vector, a matrix and a list and give names to the elements in the list.
13. Write a R program to create a list containing a vector, a matrix and a list and give names to the elements in the list. Access the first and second element of the list.
14. Write a R program to create a list containing a vector, a matrix and a list and remove the second element.
15. Write a R program to select second element of a given nested list.
16. Write a R program to merge two given lists into one list.
17. Write a R program to create an empty data frame.
18. Write a R program to create a data frame from four given vectors.
19. Write a R program to create a data frame using two given vectors and display the duplicated elements and unique rows of the said data frame.
20. Write a R program to save the information of data frame in a file and display the information of the file.
21. Write a R program to combine three arrays so that the first row of the first array is followed by the first row of the second array and then first row of the third array.
22. Write a R program to create a two dimensional 5*3 array of sequence of even integers greater than 50.
23. Write a R program to create an ordered factor from data consisting of names of month.
24. Write a R program to concatenate two given factors in a single factor.

Practical Major Elective V (WEB ANALYTICS)

1. Setting up a web analytics platform and explaining its need and advantages.
2. Collecting clickstream data using web logs and web beacons in a website.
3. Implementing JavaScript tags in a website for data collection.
4. Conducting heuristic evaluations to improve website usability.
5. Conducting site visits and surveys to understand user behavior.
6. Capturing clickstream data using cookies and identifying unique page definitions.
7. Analyzing web metrics like hits, page views, visits, bounce rate, etc.
8. Creating custom campaigns and analyzing audience and traffic source reports.
9. Optimizing e-commerce and non-e-commerce sites to improve bounce rates.
10. Using real-time reports to track website performance.
11. Analyzing competitive site overlap and opportunities using web traffic analysis.
12. Setting up and analyzing data from Google Analytics.
13. Understanding KPI characteristics and the need for KPIs in web analytics.
14. Implementing AdWords campaigns and benchmarking in Google Analytics.
15. Analyzing different categories of website traffic, like organic and paid.
16. Using Google website optimizer to improve website performance.
17. Analyzing toolbar, panel, and search engine data for competitive intelligence analysis.
18. Implementing hybrid data analysis in web analytics.
19. Understanding and overcoming the limitations of web analytics 1.0.
20. Addressing privacy concerns related to web analytics.

Appendix A

Internal Assessment

1. The internal assessment marks shall be awarded by the concerned approved teacher by the university.
2. The internal assessment marks shall be sent to the University after the Assessment in the prescribed format and direction by university.
3. General guidelines for Internal Assessment are:
   a) The internal assessment marks assigned to each theory paper on the basics of the performance in any two assignments (each of 10 marks) as described below selected by the concerned teacher.
      1. Class Test / Model Examination
      2. Certification from IIT Spoken Tutorial / Swayam / NPTEL / PARAKH etc.
      3. Online Test
      4. Theory Assignments
      5. Programming Assignments
      6. Study tour / Industrial visits /Field Work
      7. Group discussions
      8. Participation in Conference/ Webinar / Seminar /Poster Competition/ Presentation
      9. Publishing Research Paper / Review Paper
      10. Participation in Departmental Activities / Avishkar
      11. Participation in Seminar/Workshop/Competition/Course organized by the university / other college/ Associations.
   b) There shall be no separate/extra allotment of workload to the concerned teacher related to the above assignments. He/ She shall conduct the internal assessment activity during the regular teaching days/periods as a part of the regular teaching activity.
   c) The concerned teacher/department/college shall have to keep a record of all the above activities until six months after the declaration of the results of that semester.
   d) At the beginning of each semester, every teacher/department/college shall inform his / her students unambiguously of the method he/she proposes to adopt and the scheme of marking for internal assessment. (Prescribed in the syllabus of respective Subjects)

Appendix B

Practical Marks Distribution

Practical Assessment:

Time: Minimum 2 Hours 30 Min. for conducting the practical examination subject to the condition of the availability of computers and printers at the center.

Marks Distribution: A practical mark will be allocated by the Internal & External Examiner jointly as per the following format

Sr. No.	Particulars	Marks in %	Time
a.	Writing, Execution, and Printout of Program-I	20	1 Hour
b.	Writing Program/Case Studies-II	10	30 Min
c.	Practical Record	10	
d.	Viva Voce	10	

Note: In a day examiner can conduct a maximum of two Practical Examinations of different classes/courses but not of the same class/course having 40 admission in a practical.

Appendix C

Paper Pattern of the Question Paper

General rules and regulations regarding the pattern of question papers for semester-end examinations are as follows:

1. Each paper will comprise four units.
2. The maximum marks for each theory paper will be 80.
3. The question paper will consist of five questions, each worth 16 marks.
4. First, four questions will be based on the four units, with internal choice.
5. The fifth question will be compulsory, covering topics from each of the four units with equal weightage, and there will be no internal choice.

M.Sc. (Computer Science) (NEP Pattern)

Year : [I/II] **Semester : [I/II/III/IV]**

Paper Code: **Paper : Name of Paper**

Time: 3 Hours] **[Max. Marks: 80/40**

Note 1) All questions are compulsory and carry equal marks.
2) Draw a Neat and Labeled diagram and use supporting data wherever necessary.
3) Avoid vague answers and write specific points/answers related questions.

Q1 EITHER (From Unit 1)	
a)	8/4
b)	8/4
OR	
c)	8/4
d)	8/4
Q2 EITHER (From Unit 2)	
a)	8/4
b)	8/4
OR	
c)	8/4
d)	8/4
Q3 EITHER (From Unit 3)	
a)	8/4
b)	8/4
OR	
c)	8/4
d)	8/4
Q4 EITHER (From Unit 4)	
a)	8/4
b)	8/4
OR	
c)	8/4
d)	8/4
Q5 Attempt all the questions.	
a) (From Unit 1)	4/2
b) (From Unit 2)	4/2
c) (From Unit 3)	4/2
d) (From Unit 4)	4/2