M.Sc. (OR & CA)

Master of Science

(Operations Research and Computer Applications)

Program Structure and Syllabus 2019-20 Admissions Onwards

(UNDER MAHATMA GANDHI UNIVERSITY PGCSS REGULATIONS 2019)

EXPERT COMMITTEE IN COMPUTER ENGINEERING AND APPLICATION

MAHATMA GANDHI UNIVERSITY

2019

EXPERT COMMITTEE IN COMPUTER ENGINEERING AND APPLICATION (PG)

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M.Sc. (OR & CA) Degree Program

(Mahatma Gandhi University Regulations PGCSS2019 from 2019-20 Academic Year)

1. Aim of the Program

Role of computers in decision making is inevitable. The application of scientific methods with the help of computers to improve the effectiveness of operations, decisions, and management leads to the introduction of a new discipline Operations Research and Computer Applications (OR & CA). Master of Science (OR & CA) is a program specifically designed to equip students with the capability of building intelligent systems for decision making by integrating the computing capability of computers and the scientific methods available in Operations Research.

2. Eligibility for Admissions

The admission to the M.Sc. (OR & CA) programme shall be as per the rules and regulations of the University. Students admitted under this programme are governed by the Regulations in force.

3. Medium of Instruction

The medium of instruction and examination shall be in English for all courses.

4. Duration of the Course

The duration of the programme shall be 4 semesters. The duration of each semester shall be 90 working days. Odd semesters from June to October and even semesters from December to April.

A student may be permitted to complete the programme, on valid reasons, within a period of 8 continuous semesters from the date of commencement of the first semester of the programme.

The programme shall include two types of courses, Core courses and Elective Courses.

There will be five core courses for the first three semesters. In the last semester there will be four elective courses. Elective courses are created in three separate groups with four courses each and students can select any one complete group as the set of electives. The selection of courses from different groups are not permissible. In addition to these four elective courses,

the last semester consists of one project and a comprehensive viva-voce. The viva-voce should cover questions from all courses in the programme.

5. Assessment

The evaluation scheme for each course shall contain two parts; (a) internal evaluation and (b) external evaluation. 25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weightage between internal and external is 1:3. Both internal and external evaluation of a student is carried out using a direct grading system based on a 7-point scale. For all courses in each semester and for the overall programme, letter grades and GPA/SGPA/CGPA are given on the following scale:

Range	Grade	Indicator
4.50 to 5.00	A+	Outstanding
4.00 to 4.49	A	Excellent
3.50 to 3.99	B+	Very good
3.00 to 3.49	B	Good(Average)
2.50 to 2.99	C+	Fair
2.00 to 2.49	C	Marginal
up to 1.99	D	Deficient(Fail)

No separate minimum is required for internal evaluation for a pass, but a minimum **C** grade is required for a pass in an external evaluation. However, a minimum **C grade** is required for pass in a course.

Internal evaluation: The internal evaluation shall be transparent system involving periodic test papers, assignments, and seminar. The weightage assigned to various components for internal evaluation is as follows.

	Component	Weightage
i)	Assignment	1
ii)	Seminar	2
iii)	Best two test papers	1 each (2)
	Total	5

For test papers all questions shall be set in such a way that the answers can be awarded grades A+, A, B, C, D, and E. The grade points assigned to these grades are as follows:

Grade	Grade point
A+	5
A	4
B	3
C	2
D	1
E	0

Maximum weight for internal evaluation is **5.** Therefore Maximum Weighted Grade Point (WGP) is **25**. Consider the following example scenario to calculate the overall grade of the course at the time of internal evaluation.

components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the course
Assignment	1	A	4	4	
Seminar	2	A+	5	10	**WGP/Total weight = 24/5 =4.8**
Test paper 1	1	A+	5	5	
Test paper 2	1	A+	5	5	
Total	**5**			**24**	**A+**

To evaluate the assignment, the components to be considered and the respective weights are as follows:

Components	Weight
Punctuality	1
Content preparation	2
Organization	1
Presenting results & Conclusion	1

For evaluating the seminar, the following components can be considered:

Components	Weights
Relevance of the topic selected	1
For content formulation	1
Presentation	2
Reference and citation	1

For evaluation of the project, components and weightage are as follows:

Components	Weightage
Relevance of the topic	1
Content formulation and proper organization of project	2
Project presentation & viva-voce	1
References and citations	1
Total	**5**

Maximum weight for internal evaluation of the project is 5. Therefore Maximum Weighted Grade Point (WGP) is 25. For the purpose of evaluation, consider the following example situation.

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the course
Relevance of the topic	1	B	3	3	**WGP/Total weight = 22 / 5 = 4.4**
Content formulation and proper organization of project	2	A+	5	10	
Project presentation & viva-voce	1	A+	5	5	
References and citations	1	A	4	4	
Total	5			22	A

For comprehensive viva-voce, components and weightage are as given below:

Components	Weightage
Course viva (all courses from first semester to fourth semester including elective courses)	5
Total	5

In the case of viva-voce, the maximum weight is 5. Therefore Maximum Weighted Grade Point (WGP) is 25. Since there is no different division in viva-voce, grades can be assigned and WGP can be calculated accordingly.

To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal grade. The course teacher and the faculty advisor shall maintain the academic record of each student registered for the course which shall be forwarded to the University through the college Principal and a copy should be kept in the college for at least two years for verification.

External evaluation: The external Examination in theory courses is to be conducted by the University with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. The external evaluation shall be done immediately after the examination preferably through Centralized Valuation.

Maximum weight for external evaluation is 30.Therefore Maximum Weighted Grade Point (WGP) is 150. Different types of questions shall be given different weights to quantify their range as follows:

Sl.No.	Type of Questions	Weight	Number of questions to be answered
1.	Short Answer type questions	1	8 out of 10
2	Short essay/ problem solving type questions	2	6 out of 8
3.	Long Essay type questions	5	2 out of 4

Overall grade of an answer paper of a course should be done as follows:

Type of Question	Qn. No's	Grade Awarded	Grade point	Weightage	Weighted Grade Point
Short Answer	1	A+	5	1	5
	2	-	-	-	-
	3	A	4	1	4
	4	C	2	1	2
	5	A	4	1	4
	6	A	4	1	4
	7	B	3	1	3
	8	A	4	1	4
	9	B	3	1	3
	10	-	-	-	
Short Essay	11	B	3	2	6
	12	A+	5	2	10
	13	A	4	2	8
	14	A+	5	2	10
	15	-	-	-	-
	16	-	-	-	-
	17	A	4	2	8
	18	B	3	2	6
Long Essay	20	A+	5	5	25
	21	-	-	-	-
	22	-	-	-	-
	23	B	3	5	15
			TOTAL	**30**	**117**
Calculation : **Overall Grade of the theory paper = Sum of Weighted Grade Points / sum of the weightage** **117/30 = 3.90 = Grade B+**					

For the external evaluation of the project, the components and weightage are as follows.

Components	Weightage
Relevance of the topic	2
Content formulation and proper organization of project	6
Project presentation & viva-voce	6
References and citations	1
Total	**15**

Maximum weight for external project evaluation is **15.** Therefore Maximum Weighted Grade Point (WGP) is 75. The following example scenario can be followed at the time of evaluating the external project.

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W*GP	Overall Grade of the course
Relevance of the topic	2	C	2	4	**WGP/Total weight = 55 / 15 = 3.67**
Content formulation and proper organization of the project	6	A+	5	30	
Project presentation & viva-voce	6	B	3	18	
References and citations	1	B	3	3	
Total	**15**			**55**	**B+**

For comprehensive viva-voce (External) maximum weight for external evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75. During viva, the examiner can ask questions by considering all the core and elective courses included in the entire programme. As per the performance of the student, a grade can be assigned and calculate the corresponding WGP and then assign the overall grade.

After completing the internal and external evaluation of a course, the calculation of Grade Point Average (GPA) of the course is calculated by the University. After completing each semester, the Semester Grade Point Average (SGPA) and after completing the programme, the Cumulative Grade Point Average (CGPA) is also done by the University.

6. The Program Structure

M.Sc. OPERATIONS RESEARCH AND COMPUTER APPLICATIONS
(M.Sc. OR & CA)

Semester I
CE020101	Statistical Inference
CE020102	Linear Programming and Simulation
CE020103	Decision Analysis
CE020104	Introduction to Operating Systems
CE020105	Java Programming

Semester II
CE020201	Non Linear Programming
CE020202	Queuing Theory and Statistical Forecasting
CE020203	Data Base Management Systems
CE020204	Linux administration
CE020205	Python

Semester III
CE020301	Replacement, Reliability and Network Models
CE020302	Inventory Theory and Dynamic Programming
CE020303	Software Engineering UML & Case Study
CE020304	Data analytics using Python
CE020305	Web Programming

Semester IV
CE020401	Advanced Reliability Theory
CE	Elective 1
CE	Elective 2
CE	Elective 3
CE020402	Project
CE020403	Viva – Voce

Group A
CE830401	Logistic Management
CE830402	Data Mining
CE830403	Big Data Analytics

Group B
CE840401	Quality Control and Assurance
CE840402	Cyber Security
CE840403	R-Programming

Group C
CE850401	Supply Chain Management
CE850402	Soft Computing
CE850403	Machine Learning

7. Scheme

Semester	Course Code	Course Name	Type of the Course	Teaching Hours Lect.	Credit	Total Credit
I	CE020101	Statistical Inference	Core	5	4	20
	CE020102	Linear Programming and Simulation	Core	5	4	
	CE020103	Decision Analysis	Core	5	4	
	CE020104	Introduction to Operating Systems	Core	5	4	
	CE020105	Java Programming	Core	5	4	
II	CE020201	Non Linear Programming	Core	5	4	20
	CE020202	Queuing Theory and Statistical Forecasting	Core	5	4	
	CE020203	Data Base Management Systems	Core	5	4	
	CE020204	Linux Administration	Core	5	4	
	CE020205	Python Programming	Core	5	4	
III	CE020301	Replacement, Reliability and Network Models	Core	5	4	20
	CE020302	Inventory Theory and Dynamic Programming	Core	5	4	
	CE020303	Software Engineering UML & Case Study	Core	5	4	
	CE020304	Data Analytics using Python	Core	5	4	
	CE020305	Web Programming	Core	5	4	
IV	CE020401	Advanced Reliability Theory	Core	7	4	20
	CE	Elective 1	Elective	6	4	
	CE	Elective 2	Elective	6	4	
	CE	Elective 3	Elective	6	4	
	CE020402	Project	Core		2	
	CE020403	Viva-Voce	Core		2	

8. First Semester Courses

CE020101	Statistical Inference
CE020102	Linear Programming and Simulation
CE020103	Decision Analysis
CE020104	Introduction to Operating Systems
CE020105	Java Programming

CE020101: Statistical Inference

Learning objectives:

1) Determine the probability that an observation will be above or below or between two points using standard normal distribution.

2) Significance of sample in learning the characteristics of population. Determine the probability that the sample mean or sample proportion will be above or below or between two points using standard normal distribution.

3) Define hypothesis testing and the test procedure to make conclusion about the parameter of the population.

4) Discuss the general idea of Analysis of Variance and its application in real life problems.

5) Comparison between parametric and non-parametric methods and characteristics of chi – square distribution.

Unit 1

Continuous Distributions: Uniform Continuous Distribution: Pdf, Probabilities as area, Expected value and Variance, Problems; Normal Distribution: Characteristics of Normal Distribution; Standard normal Distribution: Characteristics of Standard Normal Distribution, Finding Z for a given area, Normal approximation to Binomial, Normal approximation to Poisson; Exponential Distribution: Characteristics of the Exponential Distribution.

Unit 2

Sampling Distribution: Central Limit Theorem for Mean, Sample Size, Standard Error; Confidence Interval for a Mean (μ) with known σ and with unknown σ, Confidence Interval for a Proportion; Sample size determination for a mean and proportion. Confidence interval for the difference of two means and two proportions.

Unit 3

Testing of Hypothesis: Logic of Hypothesis testing, Hypothesis Formulation, Types of Errors, Relation between α and β; Testing Mean for known and unknown population variance; P-values, Z-test and t- test Two Sample Hypothesis Tests; Comparing Two Proportions, Comparing Two Means (Independent samples and Paired samples), Comparing Two variances: F Test.

Unit 4

Analysis Of Variance:

One factor ANOVA (Completely Randomized Model), Comparison of more than two Means, Test for Homogeneity of Variances. Characteristics of Chi square distribution. Test of hypothesis comparing an observed set of frequencies to an expected distribution. Chi square test for independence and goodness of fit.

Unit 5

SPSS FOR WINDOWS:-An over view SPSS windows processes, Creating and Editing a Data File, Managing Data, Base system Models; Frequencies, Cross tabulation and Chi Square Analysis. Descriptive Statistics, T – test procedure and One way ANOVA

Text Books

1. Applied Statistics in Business and Economics,McGraw hill.
2. Rohatgi V.K , An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.1998.
3. Darren George "SPSS for windows" 8TH ed,2000.

REFERENCES

1.Gupta S C , Kapur, V K, 'Fundamentals of Mathematical Statistics', Sultan Chand and Co,2014.
2.Erwin Miller ,John E.Freund, 'Probability and statistics for engineers' Prentice-Hall of India / Pearson , 7th Ed.
3.Hines, W.W, Montgomery, D.C, Goldman, D. M. and Borror, C.M, 'Probability and Statistics in Engineering'. 4/e. 2003, John Wiley & Sons,2003.
4.Trevor Hastie, Robert Tibishirani Jerome Friedman 'The Element of statistical learning' , Second Edition,Springer,2017.
5.Walpole, R. E., Myers, R. H., Myers S L & Keying Ye, 'Probability and Statistics for Engineers and Scientists'. 8 ed, Pearson Education,2007.

CE020102: LINEAR PROGRAMMING AND SIMULATION

Learning objectives:

1) A clear understanding of the concept of simplex and geometric interpretation using convex sets.

2) A concrete understanding of the basic concepts of Linear Programming Problem and analyze the foundation for the development of the general simplex algorithm.

3) To illustrate the use of LPP in the real applications and are formulated and solved using Solver. Economic interpretation of sensitivity analysis.

4) To determine the shipping schedule that minimizes the total shipping cost while satisfying supply and demand.

5) To understand the concept of computerized imitation of the random behavior of a system for the purpose of estimating its measures of performance.

Unit 1

Convex sets and associated theorems, Extreme points, Convex and concave functions, properties. Extreme points –Basic feasible solutions.

Unit 2

Linear Programming Problems: Formulation of LPP in product Mix, Work force Scheduling, Blending Models, Logistics Model, Financial Model, Marketing Model. Fundamental properties of solutions. Simplex Method - Two phase Method - Revised Simplex Method. Duality - Primal and Dual LPP problems – Properties - Dual Simplex Method .Integer programming problem

Unit 3

Spread Sheet Analysis of LPP using Solver.

Sensitivity analysis - Discrete changes in cost vector in requirement vector – Coefficient-

Matrix- problems solving using solver and economic interpretation of sensitivity analysis

Unit 4

Transportation Problem - Methods of generating Basic Feasible solution – Optimality - Modi method - Assignment Problem - Routing problems - Traveling Salesman problem Integer programming Problem - Gomory's method - Branch and bound Method.

Unit 5

Simulation - Nature and need for simulation - Monte Carlo method - generation of pseudo random numbers by mid-square method, congruence multiplier method – Manual simulation of a single server model- Spreadsheet based simulation of the single server model.

Text Books:

1. G. Hadley, Linear Programming,2002
2. Hamdy A Taha, 'Operations Research', 9th Ed., Mc Millan Publishing Company, 2010.
3. Data Analysis and Decision Making, Albright, Winston and Zappe (3rd Edition)

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 9th Edition 2011.
2. Kantiswaroop, PK Guptha, Manmohan,"Operation Research", 13th Ed, Sulthan Chand & Sons 2007.
3. Ronald L Rardin, 'Optimisation in Operation Research', 2nd Ed., 2016.
4. Mc Millan Claude Jr, 'Mathematical Programming', 2nd Ed. Wiley Series, 1979.
5. Gillet B G, 'Introduction to Operation Research: a computer oriented algorithmic approach', Mc Graw Hill Book Comp. 1976.

CE20103 - DECISION ANALYSIS

Learning Objectives:

1) Understand importance of decision making process in business.

2) Understand the concept of posterior probability using Bayesian analysis.

3) Make decisions under various decision making environments.

4) Determine the expected value of perfect information, expected opportunity loss and

expected monetary value associated with any decision.

Unit 1

Introduction to decision analysis, elements of decision problems, structuring decisions. Decision making under uncertainty-Optimism (Maximax or Minimin) Criterion, Pessimism (Maximin or Minimax) criterion. Decision making under Risk-Expected monetary value (EMV), Expected Opportunity Loss (EOL).

Unit 2

Posterior probabilities, Decision Making under Uncertainty/Risk, Bayesian Analysis, Utility

Theory, Application of Bayes Theorem, Bayes approach to inference and decision, loss function.

Unit 3

Steps of decision making process, types of decision making environments. Decision making under uncertainty. Decision tree analysis, Decision Trees and Influence Diagrams, decision making with utilities:-utility function utility curve, construction of utility curves.

Unit 4

Decision making under risk- Expected monetary value (EMV), expected Opportunity loss (EOL) Expected value of perfect information (EVPI).

Unit 5

Ideas of subjective probability, prior and posterior distributions, determination of prior distribution, natural conjugate priors, prior-posterior analysis for Bernoulli, Poisson and normal processes, improper priors, estimation and testing using improper prior in normal samples.

Text Books:

1. Raaiffe H and Schlaiffer R (2000) Applies Statistical Decision Theory, M.T.Press.
2. James O Begger Statistical Decision Theory and Bayesian Analysis, Springer Verlag.

References:

1. De Groot M.H optimal statistical Decisions, John wiley.
2. Raymond H. Myers (Author), Douglas C. Montgomery," Response Surface Methodology: Process and Product Optimization Using Designed Experiments (Wiley Series in Probability and Statistics)",2016.

CE020104: INTRODUCTION TO OPERATING SYSTEMS

OBJECTIVES

To introduce students to:

- Fundamental concepts of systems software and functions of operating systems as a resource manager
- Strategies for constrained resource allocation and process scheduling
- Memory and I/O Management techniques
- Salient features of popular operating systems

Unit 1

Introduction**:** Parts of Computer System- Hardware, Software, Data, Users, Different types of computers, Characteristics of computers, Input output Devices, Memory:RAM,ROM and cache ,secondary memory :Magnetic tape, floppy disk, hard disk, compact disk.

Unit 2

Introduction: What is an operating system, History of operating systems, Operating system concepts, System calls, Processes: Introduction to process, Inter process communication, IPC problems, Process Scheduling algorithms, and deadlock.

Unit 3

Input/output: Principles of I/O Hardware, Principles of I/O software, Deadlocks Block devices, RAM Disks, Clocks, Terminals, System calls, Managing I/O Devices, Disk Caches.

Unit 4

Memory Management: Basic Memory Management, swapping, internal and external fragmentation, paging, segmentation, Virtual memory, Page replacement algorithms

Unit 5

File Systems: Files, Directory, File systems implementation, Security, Protection Mechanisms, , Disk Data Structures, Internal representation of files, Buffer Cache.

Text Books

1. Andrew S. Tarenbaum and Albert Woodhll ,Operating systems, Design and Implementation,2006.
2. Silberschatz, Galvin, Gagne, "Operating System Concepts", 9th Ed, Wiley-India, 2012.

References

1. Andrew Tanenbaum "Introduction To Operating System",3rdedn . Pearson, 2006
2. Williams Stallings"Operating Systems: Internals And Design Principles" 5thedn. Pearson,2006

CE020105: JAVA PROGRAMMING

OBJECTIVES

- Let students install and work with JDK, also make them aware the use of java doc.
- Practice basic data types, operators and control structures in Java
- Practice basic handling of classes and objects in Java
- Introduce the following selected APIs: I/O, Strings, Threads, AWT, Applet, and Networking
- Idea to approach and use a new package

Unit 1

Object oriented programming-Encapsulation-Inheritance-Polymorphism-characteristics of java- program structure-identifiers-operators-variables-literals-data types-Arrays. Control Statements-selection statements-iterative statements-jump statements - Loops- while loop-do while loop- for loop.

Unit 2

Classes-declaration, object references-instantiation- method declaration-method calling, this operator- constructor- method overloading-constructor overloading-method overriding-inheritance-super class-dynamic method dispatch-final-static-abstract classes, String Handling.

Unit 3

Packages - creating packages-using packages-Interfaces-Exception Handling Techniques-try-catch-throw-throws-finally-Multithreading-creation of multithreaded program-Thread class-Runnable interface- thread priorities.

Unit 4

Applet Fundamentals -applet tag-applet life cycle-passing parameters to applets- working with graphics, Line-Rectangle-Oval, Arc- color setting-I/O Streams: DataInputStream-DataOutputStream-BufferedReader-BufferedWriter classes

Unit 5

Event Handling-Delegation Event Model-Event Classes-Sources of Events-Event Listeners-AWT: Frame Class-AWT Controls: Label-Button-Checkbox-List-Choice control-Text Field-Text Area- Lay out Managers.

JDBC.

Text Books

1) Java2 the Complete Reference Seventh Edition: Patrick Naughton. 2006.
2) Java: The Complete Reference by Herbert Schildt, 9th Ed, 2017.

References

1. Horstmann and Coronell ,"Core Java -, Volume 1 and 2" , 10 th Ed, Pearson, 2016.

2. The Java Programming Language, Ken Arnold, David Holmes, James Gosling, Prakash Goteti, 3rd Edition, Pearson.

9. Second Semester Coures

CE020201	Non Linear Programming
CE020202	Queuing Theory and Statistical Forecasting
CE020203	Data Base Management Systems
CE020204	Linux Administration
CE020205	Python Programming

CE20201: NON LINEAR PROGRAMMING

Learning objectives:

1) Solve optimization problem in nonlinear programming using mathematical tools.
2) To learn the distinction between the mathematical tools and the tools available in OR in solving nonlinear problems.

3) Provide a conceptual background of solving a particular class of a nonlinear programming known as unconstrained nonlinear programming.

4) Provide a conceptual background of solving a particular class of a nonlinear programming known as constrained nonlinear programming.

5) Provide some procedures to solve some of the complicated nonlinear programming such as quadratic programming using different methods.

Unit 1

Unimodal and Convex functions, Hessian Matrix, Positive definite and Negative definite matrices - One dimensional optimization - Newton's Method- Fibonacci Method- Golden Section Method - Quadratic Interpolation Method.

Unit 2

Multi-dimensional unconstrained optimization - Univariate Method - Neider and Meads Method, Conjugate Directions and Conjugate Gradient – Fletcher-Reeves Method – Davidson-Fletcher- Powell Method - Graphical solution method.

Unit 3

Multi-dimensional constrained optimization - Lagrange multiplier method - Kuhn-Tucker Conditions - Modified Hookes and Jeeves Method - Interior and Exterior Penalty Function Method.

Unit 4

Quadratic Programming – Wolfe's Method - Beales Method - Geometric Programming Polynomials - Calculus Method - Arithmetic Geometric Inequality Method.

Separable programming - Piecewise linear Approximation Method - Case studies in Nonlinear Programming.

Unit 5

Stochastic programming –sequential stochastic programming, non-sequential stochastic programming, chance constrained programming.

Text Books:

1. S.S. Rao, "Optimization: Theory and Applications" 2_{nd} Edition, WileyEastern,2013

2. Bazaara, Shetty and Sherali "Non-linear Programming: Theory and Algorithms", Wiley,1993.

References:

1. S.S. Rao, "Engineering Optimization: Theory and Practice" 2_{nd} Edition, WileyEastern,2013

CE020202 - QUEUING THEORY AND STATISTICAL FORECASTING

Learning objectives:

1) Distinguish between Poisson process and the exponential random variable and apply this knowledge to solve problems involving memoryless processes.
2) Understand various components of a queuing system and description of each of them.
3) Describe the concept of time series and its application in statistical forecasting.
4) Role of regression analysis in statistical forecasting.
5) Comparison between different forecasting techniques and select appropriate model in real life situations.

Unit 1

Structure if a queuing system. Transient state and study state. Pure birth process, probability distribution of inter arrival times (exponential process). , Pure death process. Probability distribution of service times.

Unit 2

Classification of Queuing models – {M/M/1 : (∞/FCFS)} (unlimited queue, limited queuing space) – Unlimited Queue, {(M/M/1): (∞/SIRO)}, {(M/M/1): (N/FCFS)} Exponential service – Finite (or Limited) Queue. Multi-server Queuing Models-{M/M/s : (∞/FCFS)} Exponential service –Unlimited Queue, {(M/M/s): (N/FCFS)} (unlimited queue, limited queuing space). Multi-Phase Service Queuing models-{M/E_k/1 : (∞/FCFS)} Erlang service Time distribution with K-Phases.

Unit 3

Time series, components of time series, additive and multiplicative models, determination of trend, analysis seasonal fluctuations, test for trend and seasonality, Exponential and moving average smoothing. Forecasting a single time series, constant mean model - updating forecasts,

checking the adequacy of the model, locally, simple exponential smoothing-updating forecast, actual Implementation of simple exponential smoothing.

Unit 4

Regression model-linear and nonlinear models, prediction from regression model with known coefficients. Least Squares Estimates of Unknown coefficients. Estimation in the general linear regression model. General Principal of statistical model building- Model specification and estimation, diagnostic checking, lack of fit test.

Unit 5

Stochastic time series models: - Stochastic differential equation models-Autoregressive processes, partial Auto correlation, moving average processes, Autoregressive Moving Average (ARMA) processes. Nonstationary processes-Autoregressive Integrated Moving Average (ARIMA) models.

Text Books

1. Karlin, S and Taylor H. (1975) A first course in Stochastic processes,1981.
2. Ross Sheldon M. Stochastic Processes. J. Wiley, 1983.
3. Ross Sheldon M. Introduction to Probability Models. Academic Press,1989.
4. J. Medhi: Stochastic Process: Second Edition New age International,1994.

References:

1. Kantiswaroop, PK Guptha, Manmohan,"Operation Research", 13th Ed, Sulthan Chand & Sons 2007.
2. Ronald L Rardin, 'Optimisation in Operation Research', 2nd Ed., 2016.
3. Mc Millan Claude Jr, 'Mathematical Programming', 2nd Ed. Wiley Series, 1979.

CE020203 - DATABASE MANAGEMENT SYSTEMS (DBMS)

OBJECTIVES

- Be aware of basic concepts of data bases and data base management systems
- Be aware of concepts of relational data bases
- Know to normalize relational data bases
- Skilled in using relational algebra and relational calculus
- Develop skills to write database queries

Unit 1

Introduction: purpose of dB Systems. View of Data. Data Models. Database Language, Transaction Management, Storage Management, Database Admission, Database users.

E-R Model: Basic Concepts, Design Issues, Mapping Constraints, Keys, E-R Diagrams, Weak Entity Sets, Extended ER Features, Design of an E-R dB Schema, Reduction of E-R Schema to Tables.

Unit 2

Relational Model: Structure of Relational dB, Relational Algebra, Tuple Relational and domain Relational Calculus, Extended Relational- Algebra, Operation, Modification of the dB.

SQL: Basic Structure, Set Operations, Aggregate functions, Null Values, Nested Sub queries, Derived Relations, Views, Modification of the DB, Joined Relations, Data Definition Language.

Unit 3

Integrity Constraints, Domain Constraints, Referential Integrity, Assertion, Triggers, Functional Dependencies, Relational Db Design, Decomposition, Normalisation IN, 2N, 3N, Domain- key Normal Form.

Unit 4

Object oriented dB new dB Applications, Object Oriented Data Model, Object Oriented Languages- persistent Programming Language-Orient Relational dB

Nested Relations, Complex types & Object Orientation, Querying with Complex Types, Creation of Complex values & Objects, Comparison of Object- Oriented & Object- Relational dB.

Unit 5

Parallel dB, Introduction I/O Parallelism, Intraquery parallelism, Distributed dB, Distributed data storage, Network Transparency, Distributed Query processing, Distributed Transaction Model, Decision. Support System, Data Analysis, Data Mining, Data Warehousing, Multimedia dB

Text Books

1. Database System Concepts Author: Abraham Silberschatz, Henry F.Korth, S. Sudarshan.(Mc Grew Hill Publications).

References

1. Philip J. Pratt, Joseph J Adamski, 'Database Management Systems', Cengage Learning, 2009
2. RameezElmasri, Shamkant B. Navathe, 'Fundamentals of Database Systems', 5th Ed., Pearson Education, 2009
3. Arun K Majumdar, Pritimoy Bhattacharyya, 'Database Management Systems', TMH, 2009
4. ISRD group, 'Introduction to Database Management Systems', TMH, 2008.
5. Raghu Ramakrishnan, Johannes Gehrke 'Database Management Systems', McGraw Hill International Edition, 2003

CE020204– LINUX ADMINISTRATION

OBJECTIVES:

At the end of this course the learner is expected

1. To gain knowledge on the basic Linux commands.
2. To have clear understanding in open source software

Unit 1:

Linux introduction and file system - Basic Features, Advantages, Installing requirement, Basic Architecture of Unix/Linux system, Kernel, Shell - Linux File system - Boot block, Super block, Inode table, Data blocks, Linux standard directories. Commands for files and directories cd, ls, cp, rm, mkdir, rmdir, pwd, file, more, less, Creating and viewing files using cat, file comparisons, View files, disk related commands, checking disk free spaces.

Unit 2:

Essential Linux commands, Understanding shells, Processes in Linux, process fundamentals, connecting processes with pipes, redirecting input/output, Background processing, managing multiple processes, scheduling of processes. Batch commands, kill, ps, who, Printing commands, find, sort, touch, file, file processing commands - wc, cut, paste etc - mathematical commands - expr, factor etc. Creating and editing files with vi editor

Unit 3:

System administration - Common administrative tasks, identifying administrative files configuration and log files, Role of system administrator, Managing user accounts-adding & deleting users, changing permissions and ownerships, Creating and managing groups, modifying group attributes, Temporary disabling of users accounts, creating and mounting file system,

checking and monitoring system performance - file security & Permissions, becoming super user using su. Getting system information with uname, host name, disk partitions & sizes, users, kernel, installing and removing packages with rpm command

Unit 4:

Shell programming - Basics of shell programming, various types of shell available in Linux, comparisons between various shells, shell programming in bash Conditional and looping statements, case statement, parameter passing and arguments, Shell variables, system shell variables, shell keywords, Creating Shell programs for automating system tasks

Unit 5:

Simple filter commands pr, head, tail, cut, sort, uniq, tr - Filter using regular expression grep, egrep, sed Understanding various Servers DHCP, DNS, Squid, Apache, Telnet, FTP,Samba.

Text Books:

1. Red Hat Linux Bible by Cristopher Negus, Wiley Dreamtech India, 2004.
2. UNIX Shell Programming by Yeswant Kanethkar, BPB
3. Ganesh Sanjiv Naik **,** Learning Linux Shell Scripting: Leverage the power of shell scripts to solve real-world problems, 2nd Edition, Packt,2018.

References:

 1.Official Red Hat Linux Users guide by Redhat, Wiley Dreamtech India

 2.UNIX for programmers and users by Graham Glass & King Ables, Pearson Education

 3. Beginning Linux Programming by Neil Mathew & Richard Stones, Wiley Dreamtech India

 4. Muster J.C., Introduction to UNIX and LINUX, McGraw Hill, 2002.

 5. Quigley E., UNIX Shells by Example, Prentice Hall, 2001.

 6. O'Reilly, Learning the vi Editor, 6th Edition, 1998, Arnold Robbins, Linda Lamb

 7. O'Reilly, Learning the bash Shell, 2nd Edition, By Cameron Newham, Publisher: O'Reilly Media,
    Released: March 2005, 3rd edition

 8.W. Richard Stevens, "Advanced Programming in the UNIX environment" 2nd edition, Addition-Wesley, 2005

 9.Beginning Linux Programming by Neil Mathew & Richard Stones, Wiley Dreamtech India

CE020205: PYTHON PROGRAMMING

OBJECTIVES

- Understand the concepts of python programming

- To improve the programming skills of students by object oriented concepts
- Create new GUI based programming to solve industry standard problems.

- To extend programming to find solutions to real world problems using libraries

Unit 1

Introduction to Python - Features of Python - Identifiers - Reserved Keywords -Variables Comments in Python – Input, Output and Import Functions - Operators – Data Types and Operations – int, float, complex, Strings, List, Tuple, Set, Dictionary - Mutable and Immutable Objects – Data Type Conversion - Illustrative programs: selection sort, insertion sort, bubble sort.

Unit 2

Decision Making -conditional (if), alternative (if-else), if..elif..else -nested if – Loops -for,range() while, break, continue, pass; Functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum of an array of numbers, linear search, binary search, bubble sort, insertion sort, selection sort.

Unit 3

Built-in Modules - Creating Modules - Import statement - Locating modules - Namespaces and Scope - The dir() function - The reload function - Packages in Python Files and exception: text files, reading and writing files Renaming and Deleting files Exception handling exceptions, Exception with arguments, Raising an Exception - User defined Exceptions – Assertions in.

Unit 4

GUI Programming- Introduction – Tkinter Widgets – Label – Message Widget – Entry Widget – Text Widget – tk Message Box – Button Widget – Radio Button- Check Button – List box- Frames _ Top level Widgets – Menu Widget.

Unit 5

NumPy: Creating Arrays (array() and arange), reshape(), sum(), min() and max() methods, Item wise arithmetic operations. Pattern Matching Using Regular Expressions: Python Standard Library Module RE.Database Programming in Python with sqlite3: Creating Tables, Querying (Inserting

Tuples, Selecting Rows and Updating Tuples) Using Cursor to Iterate over Selected Tuples.Files: Opening and Closing a File, Opening Modes, Various Read and Write Methods.

Text Books

1)The Complete Reference Python - Martin C. Brown

References

1. Ljubomir Perkovic, "Introduction to Computing Using Python: An Application Development Focus", Wiley, 2012.
2. Charles Dierbach, "Introduction to Computer Science Using Python: A Computational Problem-Solving Focus", Wiley, 2013.

10. Third Semester Coures

CE020301	Replacement, Reliability and Network Models
CE020302	Inventory Theory and Dynamic Programming
CE020303	Software Engineering UML & Case Study
CE020304	Data Analytics using Python
CE020305	Web Programming

CE020301: REPLACEMENT, RELIABILITY AND NETWORK MODELS

Learning objectives:

1) Apply replacement policy for items whose efficiency deteriorates with time and for items that fail completely.
2) Realize the need to study replacement and maintenance analysis techniques.
3) Understand the importance of using PERT and CPM techniques for project management.
4) To know the main difference between PERT and CPM network techniques.
5) Construct network diagrams with single and three time estimates of activities of involved in a project.

Unit 1

Single Commodity Static flows - the basic maximum flow problem - Variations of the maximum flow problem - Flows in graphs with gains – Multi-commodity flows.

Unit 2

Network simplex method - Network approach to transportation problems - critical path method - Resource levelling - Time/cost trade off – Compression and decompression - PERT network - probabilistic aspect of PERT - practical problems - Formulation and solution. Project outline including timeline (Gantt chart)

Unit 3

Equipment replacement policies in deterministic and stochastic cases - replacement models for unbounded horizons and uncertain cost-replacement in anticipation of failure -group replacement policy.

Unit 4

Basic concepts - Failure density - Failure rate analysis-hazard functions - hazard models - Normal, Exponential, Poisson, Hyper - exponential, Erlang, gamma and Weibull distributions Reliability of systems - Series parallel, K-out-of-n-system- perfect and imperfect switches.

Unit 5

Evaluation and Reliability Predictions - Maintenance- preventive and corrective – Maintainability Equation – Availability - Maintainability trade-off - Reliability improvement and allocation.

Text Books:

1. Kennington. J and Helgason R,"Algorithms for Network Programming", 1$_{st}$Edition 1981, John Wiley.
2. Ford, L.R & Fulkerson, D.R, "Flows in Networks", Princeton University Press

CE020302- INVENTORY THEORY AND DYNAMIC PROGRAMMING

Learning Objective:

1) To understand the meaning of inventory control as well as various forms and functional role of inventory.
2) Calculate the economic order quantity for minimizing total inventory cost.
3) Use various selective inventory control techniques to classify inventory items into broad categories.

4) To learn how to control inventory costs and applications of Dynamic programming.

5) Make distinction between linear programming and dynamic programming approaches for solving a problem.

6) Understand various dynamic programming models and their applications in solving a decision-problem.

Pre-requisite: Knowledge of Calculus

Unit 1

Inventory control - Different variables involved. Single item deterministic- Economic lot size models with uniform rate, finite & infinite production rates, with or without shortage- Multiitem models with one constant.

Unit 2

Deterministic models with price-breaks- AII units discount model and incremental discount model. Probabilistic single period profit maximization models with uniform demand, instantaneous demand, with or without setup cost.

Unit 3

Dynamic inventory models, Multi-echelon problems. Integrated approach to production inventory and to maintenance problems. Feedback control in inventory management.

Unit 4

Probabilistic Inventory Control Models. Single period EOQ model for uncertain Demand. Instantaneous demand with Shortages (Discrete and continues Replenishment)

Unit 5

Dynamic programming - Bellman's principle of optimality, characteristics of a dynamic programming problem. Solutions of simple classical problems with single constraint.

Solution to Linear Programming problem and Integer Programming problem using Dynamic programming approach.

Applications of dynamic programming-The shortest path through a network, production planning, inventory problems, investment planning, cargo loading and Knapsack problems.

Text Books:

1. Starr and Miller, "Inventory control Theory and Practice", 1st Edition, 1985, PHI

2. Robert E. Larson and John L.Casti, "Principles of Dynamic Programming", Vol-I and II, 1st edition, 1982,

References:

1. Kantiswaroop, PK Guptha, Manmohan,"Operation Research", 13th Ed, Sulthan Chand & Sons 2007.
2. Ronald L Rardin, 'Optimisation in Operation Research', 2nd Ed., 2016.

CE020303: SOFTWARE ENGINEERING, UML & CASE STUDY

OBJECTIVES

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

- Understand the importance of basic processes in software Development life cycle.

- Understand the various activities incorporate with different models and know their Significance.

- Familiarize the requirements in engineering and systematic approach in classical Software design and development techniques.

- Familiarize with various software testing techniques and tools.

Unit 1

Computer – based System Engineering, Emergent System Properties, System & Other environment, System Modelling, The System Engineering process, System Procurement, Software Process, Software Process Models, Process iteration, Software Specification, Software Design & implementation, Software Validation, Evolution & Automated Process Support, Project Management, Management Activities, Project Planning, Project Scheduling, and Risk Management.

Unit 2

Software Requirement Functional & Non-functional requirement, User requirement, System requirement, Software requirement document. Requirements engineering process. Feasibility Studies, Requirement elicitation & Analysis, Requirement Validation & Management System Models, Context Models, Behavioural Models, Data Models, Object

Unit 3

Architectural Design: System Structuring, Control Models, Modular Decomposition, Domain-specific architectures, Object & Object Classes, An object oriented design process, Design evolution.

Verification & Validation: Verification & Validation Planning, S/W inspections, Automated Static Analysis, Defect testing, Integration testing, Object-Oriented testing, Testing workbenches, Reliability Validation.

Unit 4

Management: Limits of thinking, Group working, Cheering & Keeping people, People Capability Maturity Model, Productivity, Estimation techniques, Algorithmic cost modelling, Project duration & Staffing, Quality assurance & Standard Quality Planning, Quality Control, Process & Product Quality, Process analysis & Modelling.

Unit 5

UML: UML Views, Static View, Use Case view, Interaction View, State Machine View, Activity View, Physical View, Model Management View, Extensibility Construction, Connections among views.

Text Books:

1.   Software Engineering 6th Edition Author: Ian Sommeaville (Pearson Education)
2.   The UML Reference Manual. Author: Ivar Jacobson Grady Booch (Addision Wesley)

References

1. Fundamentals of Software Engineering fourth edition by Rajib Mall, Prentice-Hall of India Pvt.Ltd; 2014
2. Software Engineering 10th Edition by Ian Sommerville, Pearson, 2016

CE020304: DATA ANALYTICS USING PYTHON

OBJECTIVES

- To learn the basics of the python programming environment.
- The course will introduce data manipulation and cleaning techniques using python data science library.
- By the end of this course, students will be able to take tabular data, clean it, manipulate it, and run basic inferential statistical analyses.

Unit 1

Basics of python for Data Analysis- Python Libraries and data structures- ,NumPy , pandas , matplotlib ,IPython , SciPy - Installation and Setup

IPython- Basics, Using the Command History, Interacting with the Operating System, Software Development Tools

Unit 2

NumPy Basics: Arrays and Vectorized Computation - The NumPy ndarray: A Multidimensional Array Object, Universal Functions: Fast Element-wise Array Functions , Data Processing Using Arrays, File Input and Output with Arrays, Linear Algebra ,Random Number Generation

Pandas -Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics, Handling Missing Data, Hierarchical Indexing

Unit 3

Data Loading, Storage, and File Formats -Reading and Writing Data in Text Format, Binary Data Formats, Interacting with HTML and Web APIs , Interacting with Databases

Data Wrangling: Clean, Transform, Merge, Reshape , Combining and Merging Data Sets, Reshaping and Pivoting, Data Transformation, String Manipulation

Unit 4

Plotting and Visualization - A Brief matplotlib API Primer- Figures and Subplots ,Colors, Markers, and Line Styles , Ticks, Labels, and Legends , Annotations and Drawing on a Subplot , Saving Plots to File , matplotlib Configuration- Plotting Functions in pandas , Line Plots, Bar Plots, Histograms and Density Plots , Scatter Plots - Python Visualization Tool Ecosystem

Unit 5

Data Aggregation and Group Operations- GroupBy Mechanics, Data Aggregation, Group-wise Operations and Transformations, Pivot Tables and Cross-Tabulation

Time Series Basics- Date Ranges, Frequencies, and Shifting- Time Zone Handling- Periods and Period Arithmetic- Resampling and Frequency Conversion-Time Series Plotting

Financial and Economic Data Applications - Data Munging

References:

1. Python for Data Analysis, by Wes McKinney, 2nd edition
2. Python Data Analysis, by Armando Fandango, 2nd edition
3. Hands-On Data Analysis with NumPy and pandas: Implement Python packages from data Manipulation to processing Paperback, by Curtis Miller

CE020305: WEB PROGRAMMING

OBJECTIVES

- To impart basic skills in moderately complex use of the following tools/ script/ languages:
- To choose the appropriate web tools/languages for creating state-of-the art web sites
- To expose students to current trends and styles in web design and applications

Unit 1

HTML, Basic HTML, Document Body Text, Hyperlink, Adding more formatting, LISTS- Using Color & images- Tables, Multimedia objects, Frames, forms- MARQUEE.

DHTML, Cascading ,style sheets, Introduction using styles, Working simple examples, Defining your own styles, Properties & values in styles , Style sheets.

Unit 2

Java script , Introduction to Java script , Basics Variables , String manipulation , Mathematical Functions , Operations , Arrays , Functions , Objects in Java script- regular expressions , Built- in objects , Data validation

Unit 3

Introduction to Mysql: features and advantages -data types –operators-DDL-DCL-DML commands –types and levels of privileges-creation of tables-adding data-displaying contents-update-deletion-manipulating tables-aggregate functions-sub queries-procedures-trigger views.

Unit 4

Introduction to PHP- Advantages –features-PHP syntax-variables-PHP tags and styles -data types, variables, operators-type casting- array operators-control structures-arrays-sorting arrays-file functions-string functions-functions in PHP.

Unit 5

Object Oriented Concepts in PHP – classes, objects, inheritance, overloading and overriding – interfaces-exception handling techniques.

<u>Textbooks</u>

1. HTML Black Book, Steven Holzner, Dreamtech Publishers

2. PHP and MySQL web development –Luke Willing and Laura Thomson Pearson Education

<u>References</u>

1. Deitel and Deitel and Nieto, "Internet and World Wide Web – How to Program", Prentice Hall, 5th Edition, 2011.

2. Herbert Schildt, "Java-The Complete Reference", Eighth Edition, Mc Graw Hill Professional, 2011.

3. Jeffrey C and Jackson, "Web Technologies A Computer Science Perspective", Pearson Education, 2011.

4. Gopalan N.P. and Akilandeswari J., "Web Technology", Prentice Hall of India, 2011.

5. Paul Dietel and Harvey Deitel, "Java How to Program", , 8th Edition Prentice Hall of India.

6. Mahesh P. Matha, "Core Java A Comprehensive Study", Prentice Hall of India, 2011.

7. Uttam K.Roy, "Web Technologies", Oxford University Press, 2011.

11. Fourth Semester Courses.

CE020401	Advanced Reliability Theory
CE	Elective -1
CE	Elective - 2
CE	Elective - 3
CE020402	Project
CE020403	Viva-Voce

CE020401: ADVANCED RELIABILITY THEORY

Unit 1

Reliability concepts and measures, components and systems, coherent systems, reliability of coherent systems, series and parallel systems, K out of N system and its reliability, bounds on system reliability.

Unit 2

Life distributions, survival function, hazard function, residual life time, survival fonction of residual life time, mean residual life function, one-one correspondence of these fuctions, common life distributions, exponential, weibull, gamma, makeham, pareto, releigh, lognormal, proportional hasard models and their characteristics.

Unit 3

Notion of aging, IFR, IFRA, DMRC, NBU, NBUE classes and their rules, exponential distribution and its aging property, aging properties of common life distributions, classes under formation of coherent structures, convolutions and mixtures of these cases.

Unit 4

Test for exponentiability against positive aging based time on test- statistics, Hollender Proschan statistics, Deshpande (IFRA) statistics, unbiasedness and symptotic to a symptotic relative efficiency.

Unit 5

Type –1, Type-11 and random censuring schemes, likelihood functions based on these sampling schemes. Estimation and testing based on these schemes for various parametric models. Kaplan-Myres estimates of the distribution function.

  Textbooks:

1. Barlow and proschan, Statistical theory of reliability and life testing, 1981.

2. **David A. Freedman,Statistical Models: Theory and Practice , 2009**

3. Lawles: Statistical models and methods for lift time data.

4. Sinha, S.K: Reliability and life testing

5. Zachs: Introduction to reliability analysis, probability models and statistical methods.

References:

1. Michael A. Proschan , **K. K. Gordon Lan**, **Janet Turk Wittes** Statistical Monitoring of Clinical Trials: A Unified Approach (Statistics for Biology and Health), 12 Feb 2010.

Electives – Group A	CE830401 - Logistic Management
	CE830402 - Data Mining
	CE830403 - Big Data Analytics
Electives – Group B	CE840401 - Quality Control and Assurance
	CE840402 - Cyber Security
	CE840403 - R-Programming
Electives – Group C	CE850401 - Supply Chain Management
	CE850402 - Soft Computing
	CE850403 - Machine Learning

CE830401: LOGISTICS MANAGEMENT

Unit 1

Logistics - Definition – concepts- activities - functions. Transportation - warehousing, order processing, information handling and procurement. Materials management functions and control, inventory - Management in logistics system, inventory decision-making, MRP, MRP in systems, multi-echelons.

Unit 2

Distribution Management, Outbound logistics, Facility location, Classical location problems, Strategic planning models for location analysis, location models, multi objective analysis of location models, Overview Of Vehicle Routing Problems, Integrated Models Of Location And Routing, direct shipment, warehousing, cross-docking; push vs. pull systems.

Unit 3

Transportation decisions (mode, selection, fleet size), market channel structure. Logistics Customer Service, Modelling logistics systems, Simulation of logistic systems, cost effective distribution strategies, Value of information in logistics, E- logistics, risk-pooling effect, International and global issues in logistics, Integrated functional activities in logistics, Role of government in international logistics, Principal characteristics of logistics in various countries and regions.

Unit 4

Logistics in different industries: Third party, and fourth party logistics, Airline Schedule Planning, Railway Networks, Postal services, the maritime industries, health

Text Books

1. Martin Christopher, "Logistics and Supply Chain Management", Prentice Hall, 1998.
2. David. Bloomberg, Stephen LeMay, Joe Hanna, "Logistics", Prentice Hall 2000

References:

1. Chopra,Kalra "Supply Chain Management", 6Ed, Pearson, 2016.

2. Dr.S.Ramachandran,S.Kumaran,Mr.Ishanka Saikia Mr.V.Anandaraj , "Supply Chain and Logistics Management", 2018.

CE830402: DATA MINING

OBJECTIVES

- Design and implement systems for data mining
- Evaluate the performance of different data-mining algorithms
- Propose data-mining solutions for different applications

Unit 1

Introduction: Data mining, Relational Databases, Data Warehouses, Data Mining Functionalities, Mining Frequent Patterns, Associations, and Correlations, Classification and Prediction, Cluster Analysis, Classification of Data Mining systems, Major issues in Data Mining, Data Warehouse

and OLAP Technology for Data Mining, Multidimensional Data Model, From Tables and Spreadsheets to Data Cubes, Stars, Snowflakes and Fact Constellations, Schemas for Multidimensional Databases, Examples for Defining Star, Snowflake and Fact Constellation Schemas, Data Warehouse Architecture, Steps for the Design and Construction of Data Warehouses, A Three-Tier Data Warehouse Architecture, From Data Warehousing to Data Mining, Data Warehouse Usage, From On-Line Analytical Processing to On-Line Analytical Mining.

Unit 2

Data Preprocessing: Needs of Preprocessing the Data, Data Cleaning, Missing Values, Noisy Data, Data Cleaning as a Process, Data Integration and Transformation, Data Integration, Data Transformation, Data Reduction, Attribute Subset Selection, Dimensionality Reduction, Numerosity Reduction, Discretization and Concept Hierarchy Generation, Binning, Histogram Analysis, Segmentation By Natural Partitioning.

Unit 3

Mining Frequent Patterns, Associations, and correlations: Basic Concepts, Efficient and Scalable Frequent Itemset Mining Methods, The Apriori Algorithm: Finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, From Association Mining to Correlation Analysis, Strong Rules Are Not Necessarily Interesting: An Example, From Association Analysis to Correlation Analysis, Constraint-Based Association Mining, Metarule-Guided Mining of Association Rules, Constraint Pushing: Mining Guided by Rule Constraints.

Unit 4

Classification and Prediction: Issues Regarding Classification and Prediction, Preparing the Data for Classification and Prediction, Comparing Classification and Prediction Methods Classification by Decision Tree Induction, Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Bayesian Classification, Bayes' Theorem, Naïve Bayesian Classification, Rule-based Classification, Using IF-THEN Rules for Classification, Rule Extraction from a Decision, Rule Induction Using a Sequential Covering Algorithm, Classification by Back propagation, A Multilayer Feed-Forward Neural Network, Defining a Network Topology, Backpropagation, Inside the Black Box: Backpropagation and Interpretability, Prediction, Linear Regression,

Nonlinear Regression, Classifier Accuracy and Error Measures, Classifier Accuracy Measures, Predictor Error Measures.

Unit 5

Cluster Analysis: Introduction, Types of Data in Cluster Analysis, Interval-Scaled Variables, Binary Variables, Categorical, Ordinal, and Ratio-Scaled Variables, Vector Objects, A Categorization of Major Clustering Methods, Partitioning Methods, Classical Partitioning Methods: k-Means and k-Medoids, Hierarchical Methods, Agglomerative and Divisive Hierarchical Clustering, ROCK: A Hierarchical Clustering Algorithm for Categorical Attributes, Density-Based Methods, DBSCAN: A Density- 33 Based Clustering Method Based on Connected Regions with Sufficiently High Density, OPTICS: Ordering Points to Identify the Clustering Structure, Outlier Analysis, Statistical Distribution-Based Outlier Detection, Distance-Based Outlier Detection.

Textbook:

1. Data Mining – Concepts and Techniques - JIAWEI HAN & MICHELINE KAMBER, ELSEVIER, 2nd Edition.

References:

2. Data Mining Techniques – ARUN K PUJARI, University Press

3. Building the DataWarehouse- W. H. Inmon, Wiley Dreamtech India Pvt. Ltd.

4. Data Warehousing in the Real World – SAM ANAHORY & DENNIS MURRAY. Pearson Edn Asia.

5. Data Warehousing Fundamentals – PAULRAJ PONNAIAH WILEY STUDENT EDITION

6. Data Mining Introductory and advanced topics –MARGARET H DUNHAM, PEARSON EDUCATION.

7. Ian H. Witten, Eibe Frank, "Data Mining - Practical Machine Learning Tools and Techniques", Morgan Kaufmann Publishers, Third Edition, 2011.

8. Soman, Divakar and Ajay, "Data Mining – Theory and Practice", PHI, 2006.

9. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, "Introduction to Data Mining", *Pearson* Addison Wesley, 2006.

10. Arun K Pujari, "Data Mining Techniques", Universities Press, 2001.

11. Margaret H Dunham, "Data Mining: Introductory and Advanced Topics", Pearson Education India, 2006.

CE830403: BIG DATA ANALYTICS

OBJECTIVES:

- Explore the open source software for distributed storage and processing of large data sets.

- Achieving massive scalability in processing the large data sets.

- Scheduling workflows and achieve high performance in distributed environment.

Unit 1

Introduction – distributed file system – Big Data and its importance, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce.

Unit 2

Big Data and Hadoop: Hadoop Ecosystem- Core Components - Hadoop Distributions -Developing Enterprise Applications. HDFS: Architecture - Using HDFS Files - Hadoop Specific File Types - HDFS Federation and High Availability. HBase: HBase Architecture - HBase Schema Design - New HBase Features

Unit 3

MapReduce- Processing data with MapReduce: Execution pipeline - Runtime Coordination and Task Management in MapReduce - Designing MapReduce implementations: Using MapReduce as a framework for parallel processing - Face Recognition Example - Simple Data Processing with MapReduce - Inverted Indexes Example - Building joins with MapReduce - Road Enrichment Example - Link Elevation Example - Common MapReduce Design Gotchas.

Unit 4

Hive-Features –Hive in the hadoop ecosysytem – Datatypes and file formats –primitive and collection datatypes – HiveQL – Databases in Hive – Creating tables –Partitioned, Managed Tables – Dropping Tables- Alter table. Pig - Installing and Running Pig: Execution Types- Running Pig Programs- Grunt- Comparison with Databases.

Unit 5

Oozie- Components - Oozie Workflow - Oozie Coordinator - Oozie Bundle - Oozie Job Execution Model- Accessing Oozie - Oozie SLA - Scheduling workflows using Ooziecoordinator: Oozie Coordinator System--Oozie coordinator components and variables. Spark-Spark Architecture-Spark Streaming-Streaming Operator-Spark SQL-Resilient Distribution Dataset (RDD).

Textbook

1. Authored by DT Editorial Services, "Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization WileyIndia, 2016.

2. Mike Frampton, "Mastering Apache Spark", Packt Publishing, 2015

REFERENCES:

1. Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich, PROFESSIONAL Hadoop® Solutions, Wrox,2013.

2. Tom White, Hadoop: The Definitive Guide, O'Reilly Media 3rd Edition,May6, 2012.

3. Jason Rutherglen, Dean Wampler, Edward Capriolo, Programming Hive, O'Reilly,2012.

4. Snehalatha, Scheduling Workflows using Oozie Coordinator, DeveloperIQ Magazine, August 28, http://developeriq.in/articles/2013/aug/28/scheduling-workflows-using-oozie-coordinator.

5. Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, Learning Spark, O'Reilly, February 2015.https://spark.apache.org/docs/latest/programming-guide.html.

6. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.

7. Chris Eaton, Dirk deroos et al. , "Understanding Big data ", McGraw Hill, 2012.

CE840401: QUALITY CONTROL AND ASSURANCE

Unit 1

Introduction to Quality Control- meaning of Quality and its improvement – Statistical methods for Quality improvement – Total Quality Management – corporate structure in an organization and role of quality, Japanese approach of TQM basic philosophy and fundamental models of TQM.

Unit 2

Statistical process control, theory of control charts, Shewhart control chart for variables-$\bar{X}$,R,s charts, attribute control charts- p, np, c, u charts, modified control chart.

Unit 3

Fundamentals of experimental design– factorial experiments for process design and improvement - fractional factorial experiments for process design and improvement. The Acceptance Sampling Problem- Single Sampling plans for attributes- double, multiple and sequential sampling- AOQL plans.

Unit 4

Introduction: Overview of Six Sigma -Value of Six Sigma Recognize why organizations use six sigma.Six Sigma—Define Process Mapping Develop and review process maps, flowcharts.

Unit 5

Introduction to Modern Quality Management system, Historical Development of quality standards, ISO 9001:2000 Quality Management systems. Standards, Documentation, implementation of ISO 9000:2000, Quality management systems.

Text Books:
1. Montgomery, Douglas C. "Introduction to Statistical Quality Control", 3rd edition, 1996, John Wiley.
2. Juran J.M. and Gryna F.M. "Juran's Quality Control Handbook", 4th edition, 1988, McGraw Hill.

References:

1. Sarv Singh Soin , Total Quality Control Essentials: Key Elements, Methodologies and Managing for Success Hardcover,1992.

2. Periyasamy Aravin Prince, Apparel Quality Control, 2014.

CE840402: CYBER SECURITY

OBJECTIVES:
- To familiarize various types of cyber-attacks and cyber-crimes.
- To give an overview of the cyber laws
- To study the defensive techniques against these attacks

Expected outcome: The students will be able to understand cyber-attacks, types of cybercrimes, cyber laws and also how to protect them self and ultimately the entire Internet community from such attacks

Unit 1

Introduction to information systems, Types of information Systems, Development of Information Systems, Introduction to information security, Need for Information security, Threats to Information Systems, Information Assurance, Cyber Security, and Security Risk Analysis.

Unit 2

Application security (Database, E-mail and Internet), Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall and VPNs, Intrusion Detection and Prevention Systems, Access Control. Security Threats -Viruses, Worms, Trojan Horse, Bombs, Trapdoors, Spoofs, E-mail viruses, Macro viruses, Malicious Software, Network and Denial of Services Attack, Security Threats to E-Commerce- Electronic Payment System, e-Cash, Credit/Debit Cards. Digital Signature, public Key Cryptography.

Unit 3

Developing Secure Information Systems, Application Development Security, Information Security Governance & Risk Management, and Security Architecture & Design Security Issues in Hardware, Data Storage & Downloadable Devices, Physical Security of IT Assets, Access Control, CCTV and intrusion Detection Systems, Backup Security Measures.

Unit 4

Security Policies, Why Policies should be developed, WWW policies, Email Security policies, Policy Review Process-Corporate policies-Sample Security Policies, Publishing and Notification Requirement of the Policies. Information Security Standards-ISO, IT Act, Copyright Act, Patent Law, IPR. Cyber Laws in India; IT Act 2000 Provisions, Intellectual Property Law: Copy Right Law, Software License, Semiconductor Law and Patent Law.

Unit 5

Network Concepts, Threats to Network Communications, Wireless Network Security, Denial of Service, Distributed Denial-of-Service, Strategic Defences: Security Countermeasures, Cryptography in Network Security, Network Management

Textbook:

1. Charles P. Pfleeger, Shari Lawerance Pfleeger, "Analysing Computer Security ", Pearson Education India. 2007.

References :

1. Michael E. Whitman, 'Information Security: incident response and disaster recovery', Cengage Learning, 2009

2. Wm. Arthur Conklin, Gregory B. White, Chuck Cotheren, Dwayne Williams, Roger Lavis, 'Principles of Computer Security-Security + and Beyond', Dreamtech Press,

3. V.K. Pachghare, "Cryptography and information Security", PHI Learning Private Limited, Delhi India.

4. Dr. Surya Prakash Tripathi, Ritendra Goyal, Praveen kumar Shukla ,"Introduction to Information Security and Cyber Law" Willey Dreamtech Press.

5. Schou, Shoemaker, "Information Assurance for the Enterprise", Tata McGraw Hill.

6. CHANDER, HARISH," Cyber Laws And It Protection", PHI Learning Private Limited, Delhi ,India.

CE840403: R PROGRAMMING

OBJECTIVES

- Master the use of the R interactive environment
- Expand R by installing R packages
- Explore and understand how to use the R documentation
- Read Structured Data into R from various sources
- Understand the different data types in R
- Understand the different data structures in R

Unit 1

Introduction, How to run R, R Sessions and Functions, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes.

Unit 2

R Programming Structures, Control Statements, Loops, – Looping Over Nonvector Sets,- If-Else, Arithmetic and Boolean Operators and values, Default Values for Argument, Return Values, Deciding Whether to explicitly call return- Returning Complex Objects, Functions are Objective, No Pointers in R, Recursion, A Quick sort Implementation-Extended Extended Example: A Binary Search Tree.

Unit 3

Doing Math and Simulation in R, Math Function, Extended Example Calculating Probability-Cumulative Sums and Products-Minima and Maxima- Calculus, Functions Fir Statistical Distribution, Sorting, Linear Algebra Operation on Vectors and Matrices, Extended Example: Vector cross Product- Extended Example: Finding Stationary Distribution of Markov Chains, Set Operation, Input /output, Accessing the Keyboard and Monitor, Reading and writer Files

Unit 4

Graphics, Creating Graphs, The Workhorse of R Base Graphics, the plot() Function – Customizing Graphs, Saving Graphs to Files.

Unit 5

Probability Distributions, Normal Distribution- Binomial Distribution- Poisson Distributions Other Distribution, Basic Statistics, Correlation and Covariance, T-Tests,-ANOVA.

Textbooks:

1. The Art of R Programming, Norman Matloff, Cengage Learning,2011.

2. R for Everyone, Lander, Pearson,2018.

References:

1. Siegel, S, Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill International, Auckland,1956

2. R Cookbook, PaulTeetor, Oreilly.2011.

CE850401: SUPPLY CHAIN MANAGEMENT

Unit 1

Fundamentals of Supply Chain Management, Supply chain networks, integrated supply chain planning, and Decision phases in s supply chain, Supply chain models and modelling systems.

Unit 2

Supply chain planning: Strategic, operational and tactical, Supply chain strategies, Supply chain drivers and obstacles, Strategic Alliances and Outsourcing, purchasing aspects of supply chain.

Unit 3

Supply chain performance measurement: The balanced score card approach, Performance Metrics. Planning demand and supply, Demand forecasting in supply chain, aggregate planning in supply chain, Predictable variability. Supply Chain Inventory Management.

Unit 4

Inventory theory models: Economic Order Quantity Models, Reorder Point Models and Multi-echelon Inventory Systems, Relevant deterministic and stochastic inventory models and Vendor

managed inventory models. Role of transportation in a supply chain: direct shipment, warehousing, cross-docking; push vs. pull systems; transportation decisions (mode selection, fleet size), market channel structure, vehicle routing problem. Decisions in a supply chain, Mathematical Foundations of distribution management, Supply chain facility layout and capacity planning.

Unit 5

Strategic Cost Management in Supply Chain. The financial impacts, Volume leveraging and cross docking, global logistics and material positioning, global supplier development, target pricing, cost management enablers, Measuring service levels in supply chains, Customer Satisfaction

Text Books

1. David Simchi-Levi, Philip Kaminsky, and Edith Simchi-Levi, "Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies", 2$_{nd}$ Edition, McGraw-Hill, 2003.
2. Christopher, M. "Logistics and Supply Chain Management: Strategies for Reducing Costs and Improving Services". London: Financial Times/Pitman.

References:

1. David Simchi-Levi., Philip Kaminsky , Edith Simchi-Levi   Managing the Supply Chain: The Definitive Guide for the Business Professional, 2004.

2. David Simchi-Levi, Operations Rules – Delivering Customer Value through Flexible Operations (The MIT Press) , 2013.

CE850402: SOFT COMPUTING

OBJECTIVES

- Gain basic understanding of intelligent systems.
- Introduce students to the concepts of fuzzy systems, artificial neural networks, genetic algorithms, support vector machines, swarm intelligence.
- Foster the abilities in designing and implementing intelligent solutions for real-world and engineering problems.
- Learn the working principles of expert systems.

Unit 1

Introduction to Soft Computing Artificial neural networks - biological neurons, Basic models of artificial neural networks – Connections, Learning, Activation Functions, McCulloch and Pitts Neuron, Hebb network.

Unit 2

Artificial Neural Networks: Introduction, Artificial Neurons, Perceptron, Multilayer Perceptron, Back Propagation Algorithm, Competitive Networks, Recurrent Networks, ANFIS, ART Networks

Unit 3

Fuzzy systems: Fuzzy Sets, Membership Functions, Linguistic Variables, Operations on Fuzzy Sets, Fuzzy Relations, Fuzzy Logic, Fuzzy Reasoning, GMP and GMT, Fuzzy Inference Systems-Defuzzification methods, Fuzzy Controllers-Mamdani and Larsen Models

Unit 4

Genetic Algorithms: Introduction, theoretical foundation of genetic algorithm, Multi-objective Genetic Algorithms. Support vector classification–linearly separable and nonlinearly separable – support vector regression -Use of Linear and Polynomial Kernels

Unit 5

Swarm intelligent systems: Introduction, ant colony systems, types of ant colony systems, working of ant colony systems, particle swarm optimization. Expert Systems: Introduction, stages in the development of an expert system

Textbook:

1. Samir Roy, Udit Chakraborty, Introduction to Soft Computing Neuro- Fuzzy Genetic Algorithms, Pearson, 2013.
2. N.P. Padhy, Artificial Intelligence and Intelligent systems, Oxford Press, New Delhi, 2005.
3. Gareth James,Daniela Witlen,Trevor Hastie,Robert Tibshirani, An Introduction to statistical learning with Applications in R,Springer,NewYork, 2013.

References:

1. Hung T. Nguyen,Elbert A. Walker,A First Course in Fuzzy Logic,2nd Edn,CRC Press, 1999.

2. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw Hill, 1997.

3. K. Vinoth Kumar, Fundamentals of Soft Computing, S.K Kataria & Sons, 2nd Edn, 2012.

4. Sushil Kumar Singh, Soft Computing (Neural Networks, Fuzzy Logic and Genetic Algorithms), Galgotia, 2012.

5. Satish Kumar, Neural Networks, A Classroom Approach, MC Graw Hill Education pvt ltd., second edition, 2012.

6. Simon O Hayken, Neural Networks: A Comprehensive Foundation (International Edition), Mac Millan Publishing Company, 1994.

7. Yegnanarayana B, Artificial Neural Networks, PHI,2009.

8. David E. Goldberg, Genetic algorithms in search, optimization & Machine Learning, PearsonEducation, 2005.

9. Jang J.S.R., Sun C.T. and Mizutani E, Neuro-Fuzzy and Soft computing, Pearson Education 2003.

CE850403: MACHINE LEARNING

Objectives:
- Develop a general understanding of what is machine learning and its applications in real life situations
- Understand a wide variety of learning models.
- Understand how to evaluate models generated from data.
- Develop basic ideas to generate models using SVM, HMM, etc.
- Develop a general understanding of unsupervised learning models.

Unit 1

Introduction to Machine Learning, Examples of Machine Learning applications - Learning associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning. Supervised learning- Input representation, Hypothesis class, Version space, Vapnik-Chervonenkis (VC) Dimension.

Unit 2

Classification- Cross validation and re-sampling methods- K- fold cross validation, Boot strapping, Measuring classifier performance- Precision, recall, ROC curves. Bayes Theorem, Bayesian classifier, Maximum Likelihood estimation, Density functions, Regression.

Unit 3

Decision Trees- Entropy, Information Gain, Tree construction, ID3, Issues in Decision Tree learning- Avoiding Over-fitting, Reduced Error Pruning, The problem of Missing Attributes, Gain Ratio, Classification by Regression (CART), Neural Networks- The Perceptron, Activation Functions, Training Feed Forward Network by Back Propagation.

Unit 4

Kernel Machines- Support Vector Machine- Optimal Separating hyper plane, Soft-margin hyperplane, Kernel trick, Kernel functions. Discrete Markov Processes, Hidden Markov models, three basic problems of HMMs- Evaluation problem, finding state sequence, learning model parameters. Combining multiple learners, Ways to achieve diversity, Model combination schemes, Voting, Bagging, Boosting.

Unit 5

Unsupervised Learning-Clustering Methods-K-means, Expectation-Maximization Algorithm, Hierarchical Clustering Methods, Density based clustering.

Textbook:

Ethem Alpaydın, Introduction to Machine Learning (Adaptive Computation and Machine Learning), MIT Press, 2004.

References:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. Margaret H. Dunham. Data Mining: introductory and Advanced Topics, Pearson, 2006
3. Mitchell. T, Machine Learning, McGraw Hill.
4. Ryszard S. Michalski, Jaime G. Carbonell, and Tom M. Mitchell, Machine Learning: An Artificial Intelligence Approach, Tioga Publishing Company.

12. Model Question Papers

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019
First Semester
CE020101-Statistical Inference
(2019 Admission on wards)

Time: Three Hour   **Maximum Weight: 30**
Part A
Short answer type Questions not exceeding One Page
Answer any **Eight** *Questions.*
Each Questions Carries a weight of 1.

1. Find the cumulant generating function of exponential distribution and hence find the first three moments.

2. Give the expression for the even ordered central moment of a normal distribution.

3. State Lindberg-Levy form of CLT. What is its use?

4. Define confidence interval. What are different methods of constructing confidence intervals?

5. How different levels of confidence and sample size affect the width of the confidence interval.

6. What are the principle steps involved in Statistical Test?

7. Explain Z-test and T-test.

8. What does a chi-square test of independence tell us?

9. Explain test for Homogenity of variance.

10. How can you compare two data files in SPSS

                                                                            (8×1 = 8 Weights)

Part B

Short essay /problem solving type Questions not exceeding Two Page

Answer any **Six** *Questions.*

Each Questions Carries a weight of 2.

11. Define uniform distribution. If X has a uniform distribution over [0, 1], find the

    Distribution of $Y = -2 \log X$.

12. A sample of 25 people was collected. The mean deviation in the population is 1. Calculate 95% C.I for the mean.

13. We observed 28 sucesses in 70 independent Bernoulli trials. Compute a 90% confidence interval for the population propotion p.

14. The life time of a certain brand of an electric bulb may be considered as a random variable with mean 1200 hours and S.D=250 hrs.Find the probability using CLT that the average lifetime of 60 bulbs exceeds 1400 hours.

15. Explain the following terms:

       (i) Errors of first and second kind.

       (ii)The best critical region.

       (iii) Power function of the test.

       (iv) Level of significance.

       (v) Simple and Composite hypothesis.

16. For a chi-square distribution with n d.f. establish the following recurrence relation Between the moments: $\mu_{r+1} = 2r\,(\mu_r + n\,\mu_{r-1})$, $r \geq 1$.

17. How can you plot ANOVA cell means in SPSS? How can you do ANOVA contrasts in SPSS.

18. How do you test a group of variables in SPSS regression.

$(6\times2 = 12 \text{ Weights})$

Part C

Long essay type questions.

*Answer any **Two** Questions.*

Each Questions Carries a weight of 5.

19. Derive the odd and even order moments about mean of the normal distribution. Disscuss the importance of Normal distribution.

20. A researcher belives that the average cost of college textbooks is $ 180. She samples 30 Textbooks and calculates the mean of the sample , to be $205.

  a. Does this value warrent the conclusion that the average cost of textbooks is greater than $ 180.

  b. What could cause this difference .

21. State and prove the reproductive property of chi-square distribution. For large n, show that Chi-square distribution approximately distributed with parameters n and $\sqrt{2n}$.

22. Suppose that, over the years, forecasters have determined. The mean high temperature

in a particular city during the month of February to be 34^0 and that this year, the high temperature for each of the 28 days of the month are as follows. Use this data for the following questions.

Date	high temperature	Date	high temperature	Date	high temperature
1	28	12	18	23	28
2	27	13	20	24	26
3	32	14	24	25	30
4	31	15	29	26	31
5	36	16	36	27	35
6	28	17	35	28	39
7	25	18	39		
8	21	19	38		
9	17	20	42		
10	17	21	20		
11	19	22	31		

(1) What type of t-test compares the mean of this data to the mean of 34^0 , representing the mean over time.

(2) Input data into SPSS and perform the appropriate t-test . what is the value of t.

(3) What is the p-value.

(4) Write a short summery of the results based upon α=0.05, making reference to p.

<div align="right">(2×5 = 10 Weights)</div>

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019
First Semester
CE020102-Linear Programming and Simulation

(2019 Admission on wards)

Time: Three Hour   **Maximum Weight: 30**

<div align="center">

Part A

Short answer type Questions not exceeding One Page

Answer any **Eight** *Questions.*

Each Questions Carries a weight of 1.

</div>

1. Define slack and surplus variables in LPP.

2. Define a convex function and prove that a positive linear combination of convex functions is again convex.

3. Explain the terms   (i) Objective function   (ii) Decision variables.

4. Establish the difference between : (i) Feasible solution (ii) Basic feasible solution
   (iii) Degenerate basic feasible solutions.

5. Write the role of pivot element in simplex table.

6. How do you recognize optimality in the simplex table?

7. Define primal problem and dual problem.

8. Give the mathematical formulation of an assignment.

9. What is integer linear programming?

10. What are the elements of a simulation model? What are the advantages of using Simulation?

$$(8\times1 = 8 \text{ Weights})$$

Part B

Short essay /problem solving type Questions not exceeding Two Page

Answer any **Six** *Questions.*

Each Questions Carries a weight of 2.

11. A firm manufactures headache pills in two sizes A and B. Size A contains 2 grains Of aspirin, 5 grains of bicarbonate and 1 grain of codeine. Size B contain 1 grain of aspirin, 8 grains of bicarbonate and 6 grains of codeine. It is found by users that it   requires at least 12 grains of aspirin, 74 grains of bicarbonate and 24 grains of codeine for providing immediate effect. It is required to determine the least of   number of pills a patient should take to get immediate relief. Formulate the problem as a standard LPP.

12. Use the graphical method to solve the following LPP following LP problem:

   Maximize $Z = 4x_1 + 3x_2$

   Subject to $2x_1 + x_2 \leq 1000$

   $X_1 + X_2 \leq 800$

   $X_1 \leq 400$ and $X_2 \leq 700$

   X_1 and $X_2 \geq 0$.

13. Use simplex method to solve :

   Maximize $Z = 3x_1 + 2x_2$

Subject to $\quad x_1 + x_2 \leq 4$

$\qquad X_1 - X_2 \leq 2$

$\qquad X_1$ and $X_2 \geq 0$.

14. Solve the following assignment problem:

	1	2	3	4
A	30	27	31	39
B	28	18	28	37
C	33	17	29	41
D	27	18	30	43
E	40	20	27	36

15. Prove that the dual of the dual of a given primal is again primal.

16. Write a short note on salesman problem

17. Prove that the set of all feasible solutions of a linear programming problems forms a Convex set.

18. Write a short note on variable transformation method.

$(6 \times 2 = 12$ Weights$)$

Part C

*Long essay type questions.Answer any **Tow** Questions.*

Each Questions Carries a weight of 5.

19. Solve the following mixed –integer programming using Gomory's cutting plane method

$\qquad$ Maximize $\quad Z = x_1 + x_2$

$\qquad X_2 \leq 2$; X_1 and $X_2 \geq 0$.

$\qquad$ And x_1 is an integer.

20. Explain the two Phase method to solve a linear programming problem.

21. Discuss one method of finding solution to a Transportation problem.

22. Write an algorithm to generate random numbers using mid-square method. Give examples.

QP Code
Reg. No. ………………..
Name …………………...

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019
First Semester
CE020103 – Non Linear Programming
(2019 Admission on wards)
Time: Three Hour   **Maximum Weight: 30**

Part A
Short answer type Questions not exceeding One Page
Answer any **Eight** *Questions.*
Each Questions Carries a weight of 1.

1. Explain Hessian Matrix.

2. Explain Newton's method of optimization

3. State Fibonacci method.

4. Define Geometric Programming Problem.

5. Define positive and negative matrix.

6. Write the general form of separable programming.

7. Define local and global maxima.

8. Describe conjugate direction.

9. How will you identify whether a function is concave or convex? Give example.

10. Describe Powell method.

(8×1 = 8 Weights)

Part B

Short essay /problem solving type Questions not exceeding Two Page

Answer any **Six** *Questions.*

Each Questions Carries a weight of 2.

11. Prove that any local minimum of a convex function is a global minimum.

12. Summarise the procedure of univariate method.

13. Minimise $X_1^3 - 6X_1^2 + 11X_1 + X_3$ Subject to $X_1^2 + X_2^2 - X_3^2 \leq 0$

$$4 - X_1^2 - X_2^2 - X_3^2 \leq 0$$

$$X_1 \geq 0, X_i \geq 0 \ i=1, 2, 3$$

Using Lagrange Multiplier method.

14. Explain Wolf's method with example.

15. What are the procedures in separable programming?

16. Explain Markovian process

17. Determine X_1, X_2 so as to

Maximize $Z = 12X_1 + 21X_2 + 2X_1X_2 - 2X_1^2 - 2X_2^2$

Subject to

$X_2 \leq 8$

$X_1 + X_2 \leq 10$

And $X_1, X_2 \geq 0$

18. Explain Newton's method of optimization.

$(6 \times 2 = 12 \text{ Weights})$

Part C

Long essay type questions.

*Answer any **Tow** Questions.*

Each Questions Carries a weight of 5.

19. Develop Kuhn Tucker condition for:

Minimize $Z = X_1^2 + 5X_1^2 + 10 X_3^2 - 4X_1X_2 + 6X_1X_3 - 12X_2X_3 - 2X_1 + 10X_2 + 5X_3$

Subject to the constraints $X_1 + 2X_2 + X_3 \geq 4$ and all the variables non-negative.

20. Describe two types of penalty method.

21. Solve the unimodal function $f(x) = X^2 - 2.6X + 2$, $-2 \leq X \leq 3$ Using Fibonacci method.

22. (a) Explain piecewise linear approximation of a non –linear function.

(b) Describe case study in non –linear programming.

$(2 \times 5 = 10 \text{ Weights})$

QP Code

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019
Second Semester
CE020202-Queuing Theory and Statistical Forecasting
(2019 Admission on wards)

Time: Three Hour   **Maximum Weight: 30**

Part A

Short answer type Questions not exceeding One Page

Answer any **Eight** *Questions.*

Each Questions Carries a weight of 1

1. Distinguish between ARMA and ARIMA models.

2. Describe various components of the Queuing system.

3. Distinguish between Queuing Cost and Level of service.

4. Explain the term Erlang service.

5. What are the techniques used in smoothing time series.

6. Explain the terms Exponential and moving average smoothing

7. Discuss the relevance of variate difference method in time series analysis data.

8. Distinguish Additive and multiplicative models.

9. How we predict unknown coefficients from Regression model.

10. Define the term Partial Auto correlation.

(8×1 = 8 Weights)

Part B

Short essay /problem solving type Questions not exceeding Two Page
Answer any **Six** *Questions.*

Each Questions Carries a weight of 2.

11. What are the two mathematical model employed for time series analysis? Which one of the two models is considered to be more useful and why?

12. Distinguish between Poisson process and the exponential random variable.

13. Describe the properties of least square estimates.

14. Explain Autoregressive Moving Average (ARMA) process.

15. Derive the probability distribution of inter arrival times (Exponential process).

16. Write a note on actual implementation of simple exponential smoothing.

17. What is the role of regression analysis in Statistical forecasting?

18. Explain in detail about the Multi-server queuing models.

<div align="right">(6×2 = 12 Weights)</div>

Part C

Long essay type questions.

*Answer any **Tow** Questions.*

19. Find the differential equation of pure death process. If the process starts with i individuals, find the mean and variance of the number N(t) present at time t.

20. Describe the concept of time series and its application in statistical forecasting. Explain the classification of forecast methods.

21. Explain in detail the General principle of Statistical Model building – model specification and estimation.

22. Which are various Stochastic Time series models? Explain.

<div align="right">(2×5 = 10 Weights)</div>

QP Code   Reg. No. ………………..

Name …………………...

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019

Third Semester

CE020301– Replacement, Reliability and Network Models

(2019 Admission on wards)

Time: Three Hour   Maximum Weight: 30

Part A

Short answer type Questions not exceeding One Page

*Answer any **Eight** Questions.*

Each Questions Carries a weight of 1.

1. What is meant by critical path? Why should we know which activities are critical?

2. What is Maximum flow problem?

3. What is project crashing?

4. What is individual replacement policy?

5. What is optimal project duration?

6. Write short note on k-out–of-n System.

7. What is meant by multi-commodity flow?

8. How can we represent a network transportation problem?

9. What do you meant by replacement?

10. What are Hazard function?

Part B

Short essay /problem solving type Questions not exceeding Two Page

Answer any **Six** *Questions.*

Each Questions Carries a weight of 2.

11. A project schedule has the following characteristics:

Activity : 1-2 1-3 2-4 3-4 3-5 4-9 5-6 5-7 6-8 7-8 8-10 9-10

  Time : 4   1   1   1   6   5   4   8   1   2   5   7

 (i) Construct network diagram.

 (ii) EST, LST, EFT, and LFT of activities.

 (iii)   Total float for each activity.

 (iv)Critical path and its duration.

12. Briefly explain replacement of item which deteriorates with time when money value is counted.

13. Explain Ford-Fulkerson algorithm for maximum flow problem.

14. Write note on multi-commodity flows over time.

15. Explain group replacement policy.

16. A machine with constant failure rate λ will survive a period of 100 hours without failure, with Probability 0.50.

  (i)   Determine the failure rate λ.

  (ii)   Find the probability that the machine will survive 500 hours without failure.

  (iii)   Determine the probability that the machine will fail within 1000hours, when

      You know that the machine was functioning at 500 hours.

17. Explain various phases of application of PERT.

18. A feet owner finds from his past records that the costs per year of running a vehicle whose Purchase price is rs.50,000 are as under:
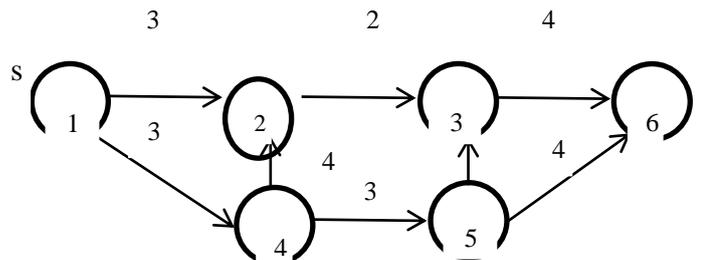
Part C

*Long essay type questions. Answer any **Tow** Questions.*

Each Questions Carries a weight of 5.

19. Determine the maximum flow between nodes from source to sink in the networks:

20. What are the application areas of k-out –of –n-systems? Also give a specific example.

21. Explain various steps in PERT/CPM techniques.

22. Define simulation model. Distinguish between deterministic and stochastic simulation models.

$(2\times5 = 10$ Weights$)$

QP Code   Reg. No. ………………..

                                                                             Name …………………...

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019

Third Semester

CE020302-Inventory Theory and Dynamic Programming

(2019 Admission on wards)

Time: Three Hour   Maximum Weight: 30

Part A

Short answer type Questions not exceeding One Page

*Answer any **Eight** Questions.*

Each Questions Carries a weight of 1.

1. What are the three basic costs associated with inventories?

2. Describe briefly the EOQ concept?

3. Explain: (a) Recorder point; (b) Lead time; (c) Safety stock.

4. Define the terms setup cost, hold cost and shortage cost as applied to an inventory problem.

5. What are essential characteristics of dynamic programming problems?

6. How is inventory control useful to a businessman?

7. Differentiate between deterministic and stochastic inventory models.

8. Briefly explain inventory policies.

9. Define shock models and wear models.

10. Define: (a) Stage; (b) State ;(c) State variable; and (d) Decision variable.

<div align="right">(8×1 = 8 Weights)</div>

Part B

Short essay /problem solving type Questions not exceeding Two Page

Answer any **Six** *Questions.Each Questions Carries a weight of 2.*

11. Explain the problem of EOQ with Warehouse Capacity constraint.

12. Write note on economic production quality model when replenishment is gradual.

13. Explain the concept of dynamic programming and the relation between dynamic and linear programming approach.

14. Explain the single period model with instantaneous demand.

15. A retailer estimates her fixed cost for placing an order at Rs.1, 000. Presently she orders in optimal quantities of 400 units. She has, however, heard of the benefits of just-in-time purchasing – a principle that advocates purchasing goods in smaller lots
As a means of keeping inventory down. If she wishes to order in lots no larger than 50, what should be her fixed ordering costs?

16. What are the costs associated with inventory? Distinguish between deterministic and Stochastic models.

17. Write a short note on (s, S) inventory model.

18. A manufacturer has to supply his customers 600 units of his products per year. The Shortages are not allowed and the inventory carrying cost amounts to Rs.6 per unit Per year. The set up cost per run is Rs. 80. Find:

   (a) The EOQ.

   (b) The minimum average yearly cost.

   (c) The optimum run size.

<div align="right">(6×2 = 12 Weights)</div>

Part C
Long essay type questions. Answer any ***Tow*** *Questions.*

Each Questions Carries a weight of 5.

19. Describe a multi-item deterministic demand inventory model by taking a constraint on the maximum number of orders placed per year into consideration. State the procedure

to find the optimal policy.

20. What is the application of dynamic programming? Explain.

21. The demand for a purchased item is 1,000 units / month, and shortages are allowed. If
    If the unit cost is Rs. 1.50 per unit, the cost of making one purchase is Rs. 600, the olding cost
    for one unit is Rs. 2 per year, and the cost of one shortage is Rs. 10 per
    year, determine:

    (a) The optimal purchase quality.

    (b) The number of orders per year.

    (c) The optimum total yearly cost.

22. Explain cargo loading and knapsack problems.

$(2 \times 5 = 10 \text{ Weights})$

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019
Fourth Semester
CE840401-Quality Control and Assurance
(2019 Admission on wards)

Time: Three Hour   **Maximum Weight: 30**
Part A
Short answer type Questions not exceeding One Page

Answer any **Eight** *Questions.*

Each Questions Carries a weight of 1.

1. Distinguish between assignable causes and chance causes.

2. What are the benefits of Total Quality Management?

3. What is the role of np-chart in statistical process control?

4. Define process capability.

5. Explain operating characteristic function of the control chart.

6. Distinguish between single sampling and double sampling plan.

7. Explain the terms (i) AQL (ii) ATI.

8. Explain fractional experiment.

9. What is Taguchi's principal contribution to Statistics?

10. Explain the benefits of ISO 9000.

Part B

Short essay /problem solving type Questions not exceeding Two Page

Answer any **Six** *Questions.*

Each Questions Carries a weight of 2.

11. Explain the meaning and significance of Statistical Process Control.

12. Give the principle of TQM? What is its use?

13. Explain the R- chart and S-charts. What purposes do they serve?

14. Explain the np- chart and p charts .How is it prepared?

15. Derive OC and ATI curves for double sampling for attributes.

16. Illustrate sequential sampling plans. Derive OC and ASN function.

17. Explain CRD.

18. Briefly discuss the steps for implementing ISO 9000 quality system. How can this system be used to improve quality performance?

(6×2 = 12 Weights)

Part C

Long essay type questions. Answer any **Tow** *Questions.*

Each Questions Carries a weight of 5.

19. (a) Explain Causes of variation in quality and describe the OC for control chart.

    (b) Derive OC curve for single sampling plan.

20. What is acceptance sampling plan? Discuss multiple acceptance sampling Plan.

21. Discuss control charts for conformities and non-conformities.

22. Write short notes on:

    (a) Principles of experimentation.

    (b) LSD.

(2×5 = 10 Weights)

QP Code   Reg. No. ………………..
                                               Name …………………...

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019
Fourth Semester
CE830402- Advanced Game Theory
(2019 Admission on wards)
Time: Three Hour   Maximum Weight: 30
Part A
Short answer type Questions not exceeding One Page
Answer any **Eight** *Questions.*
Each Questions Carries a weight of 1.

1. Define rectangular games with example.
2. Write the definition of the game in extensive form.
3. Define mixed strategy of the player.
4. What is saddle point? Examine the saddle point of the pay –off matrix $\begin{bmatrix} 1 & 3 \\ -2 & 10 \end{bmatrix}$
5. Define s- equivalent in n-person game.
6. Explain the terms extensive form and normal form a game.
7. Show that the values of a game is unique.
8. Define "subgame".
9. Explain the mapping method of separable games.
10. In the case of zero- sum two person game show that a saddle point is also an equilibrium point.

(8×1 = 8 Weights)

Part B

Short essay /problem solving type Questions not exceeding Two Page

Answer any **Six** *Questions.*

Each Questions Carries a weight of 2.

11. State and prove min-max theorem for rectangular games.
12. Explain in detail about the rectangular games with saddle point.
13. Show that every convex set is connected. Give an example of a connected set which is   not Convex.
14. Explain in detail about the properties of optimal strategies.
15. Write the general definition of finite games.
16. Define the separable game. Explain the method of solving a rectangular game as a separable

game.

17. Find the value of the game whose matrix is $\begin{bmatrix} 0 & 2 & 0 \\ 0 & 0 & 2 \\ 2 & 0 & 0 \end{bmatrix}$.

18. Solve the separable game whose pay –off function is

   $M(x, y) = (x - y)^2$.

<div align="right">(6×2 = 12 Weights)</div>

Part C

*Long essay type questions. Answer any **Tow** Questions.*

Each Questions Carries a weight of 5.

19. State and prove the fundamental theorem for a rectangular game.

20. Solve the separable game whose pay-off function is

   $M(x, y) = \cos 4\pi x \cos 4\pi + x + y$.

21. Explain the mapping method to find the solution of a rectangular game with an example.

22. Solve the following game using the method of approximating:

   $$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 0 & 1 \\ 2 & 3 & 0 \end{bmatrix}$$

<div align="right">(2×5 = 10 Weights)</div>

QP Code   Reg. No. ………………..

                                                         Name …………………...

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019

First Semester

CE020104– Introduction to Operating System

(2019 Admission on wards)

Time: Three Hour   Maximum Weight: 30

Part A

Short answer type Questions not exceeding One Page

*Answer any **Eight** Questions.*

Each Questions Carries a weight of 1.

1. What is fragmentation? What are the two type of fragmentation?

2. Explain working of paging.

3. Explain the conditions for the occurrence of deadlocks.

4. Explain in detail demand paging.

5. Explain critical section problem and its conditions.

6. What are the functions of Operating Systems? Explain.

7. Explain file systems implementation.

8. Write a short note on

    a) Cache b) ROM

    C) RAM d) Floppy Disk

9. What is swapping in memory management?

10. What is a disk cache?

                                                            (8×1 = 8 Weights)

Part B

Short essay /problem solving type Questions not exceeding Two Page

*Answer any **Six** Questions.*

Each Questions Carries a weight of 2.

11. Explain the structure of a file system

12. Explain the different type of System Call

13. Explain the different deadlock avoidance algorithm.

14. Explain process scheduling algorithm.

15. Explain type of Operating system

16. With a neat diagram, explain the layers of I/O system

17. Discuss the mechanism of mapping logical address to physical address with neat diagram

18. What is process? Explain the role of Process Control Block in a typical OS

                                          (6×2 = 12 Weights)

Part C

Long essay type questions.

*Answer any **Two** Questions.*

Each Questions Carries a weight of 5.

19. Explain in detail the different page replacement algorithms

20. What is critical section? Explain with suitable example?

21. Briefly explain File systems

22. Write a note on

a) Inter process communications?

b) Free space management in files

(2×5 = 10 Weights)

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019
Second Semester

CE020204 - LINUX ADMINISTRATION
(2019Admission onwards)

Time: Three Hours   Maximum Weight:30

Part A
Short Answer Type Questions not exceeding one page
Answer any eight questions.
Each question carries a weight of1.

1. Write short notes on DNS.

2. What are filters? Give an example.

3. List any four file commands in Linux.

4. What are configuration files?

5. What is the use of chmod command?

6. What is the purpose of $HOME directory?

7. How can you create groups in Linux?

8. What is Telnet?

9. What is the use of tail and head?

10. How will you find the 99th line of a file using only tail and head command?

(8*1=8 Weights)

Part B

Short Essay type Questions not exceeding two pages.

Answer any six questions.

Each question carries a weight of 2.

11. What are the different types of commonly used shells on a typical Linux system?

12. Differentiate between super block and boot block.

13. What is the difference between UNIX and Linux Operating System?

14. What is the advantage in using command line argument in shell scripting?

15. What are the text editors? Explain the features of vi editor.

16. How do you get system information in Linux?

17. Explain the common administrative task in Linux.

18. Explain the usage of expr and factor commands.

(6×2 = 12 Weights)

Part C

*(Long Essay Type Questions) Answer any **two** questions.*

Each question carries a weight of 5.

19. (a) Discuss the looping statements used in shell programming with example.

   (b) Write a shell program to find the sum of digits of a number.

20. Explain the basic architecture of Unix/Linux system. What are its advantages?

21. Briefly explain how the packages are installed and removed in Linux.

22. Briefly explain about user and group creation and its management.

(2×5 = 10 Weights)

QP Code   Reg. No. ………………..
                                                    Name …………………...

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019
Third Semester
CE020305–WEB PROGRAMMING
(2019 Admission onwards)
Time: Three Hours   **Maximum Weight: 30**

Part A
Short Answer Type Questions not exceeding one page
*Answer any **eight** questions.*
Each question carries a weight of 1.

1. What are the difference between HTML and DHTML?

2. What is the structure of a webpage?

3. List any five aggregate functions in MYSQL.

4. How to implement the HTML links??

5. Explain pair and unpaired tag in HTML?

6. What is style sheet?

7. How to declare an array in PHP?

8. What PHP stands for?

9. List any five built-in objects in JavaScript?

10. Explain <marquee> tag in HTML?

<div align="right">(8×1 = 8 Weights)</div>

Part B

Short Essay type Questions not exceeding two pages.

*Answer any **six** questions.*

Each question carries a weight of 2.

11. How we can define a constraint validation in JavaScript?

12. Mention about disadvantages of frames?

13. Write a JavaScript to calculate the area of triangle?

14. Compare and contrast User defined functions and built-in objects in PHP?

15. Discuss various data types available in PHP.

16. Distinguish between DDL, DCL and DML commands?

17. Differentiate function overloading and function overriding.

18. What is interface?

<div align="right">(6×2 = 12 Weights)</div>

Part C

*(Long Essay Type Questions) Answer any **two** questions.*

Each question carries a weight of 5.

19. Write a note on

    a)MYSQL

    b)Trigger

20. Discuss in detail about HTML List and Forms?

21. Explain various data types in PHP.

22. Briefly explain OOPS concepts in PHP with example.

QP Code   Reg. No. ………………..
                                                             Name …………………...

M. Sc. Operations Research and Computer Applications Degree (C.S.S) Examination, 2019

Fourth Semester

Elective–CE840403 - R Programming

(2019 Admission on wards)

Time: Three Hour   Maximum Weight: 30

Part A
Short answer type Questions not exceeding One Page
*Answer any **Eight** Questions.*
Each Questions Carries a weight of 1.

1. What is a list?

2. What is the use of legend function?

3. Describe any three data types in R?

4. Write simple structure of a R program?

5. What is a vector?

6. Define normal distribution

7. What is the use of pair() function?

8. What is survival analysis?

9. Describe 3 math functions in R?

10. Mention any two application of t-distribution?

                                                             (8×1 = 8 Weights)

Part B

Short essay /problem solving type Questions not exceeding Two Page

*Answer any **Six** Questions.*

Each Questions Carries a weight of 2.

11. Explain different data structures in R

12. Implement binary search tree with R

13. Write R program to plot the function f(x)=sin(x) in the interval(-3,3) in the steps of 0.1 the point character of the plot is to be triangle joined with the lines

14. Explain R function for differentiation and integration with example?

15. Write about all summary commands in R?

16. Write a note about creating graphics in R?

17. What are linear algebra operations in vectors and matrices?

18. Write an R function to find simple covariance

(6×2 = 12 Weights)

Part C

*Long essay type questions. Answer any **Two** Questions.*

Each Questions Carries a weight of 5.

19. Explain probability distributions in R?

20. Explain R programming structure and control structures

21. Explain the concept returning complex object, with an example program?

22. What are
    a) variable?
    b) Data types
    c) Math functions

Write R code to generate first N terms of a Fibonacci series

(2×5 = 10 Weights)