Graphic Era Hill University B.Tech. in Computer Science and Engineering				
Semester IV				
COURSE MODULE				
COURSE				**Credits**
Code	**Title**	**NEP Component**	**AICTE Component**	
TCS408	**Programming in Java**	**DSC (PBL)**	**PCC**	**3**
TCS402	Finite Automata and Formal Languages	DSC	PCC	3
TCS403	Microprocessors	DSC	PCC	3
TCS409	**Design and Analysis of Algorithms**	**DSC (PBL)**	**PCC**	**3**
	Discipline Specific Elective-II	DSE	PEC	3
PCS408	Java Programming Lab	DSC	LC	1
PCS403	Microprocessors Lab	DSC	LC	1
PCS409	DAA Lab	DSC	LC	1
XCS401	Career Skills-II	AEC	AEC	2
PESE400	Practical for Employability Skill Enhancement	SEC	SEC	1
SCS401	MOOCS Seminar	VAC	VAC	1
GP401	General Proficiency	SEC	SEC	1
			Total	**23**

Mandatory Non-Graded Course				
HSS203	Indian Constitution	MNG	MC	2

DISCIPLINE SPECIFIC ELECTIVE-II

COURSE CODE	COURSE NAME
TCS451	**Virtualization and Cloud Computing**
TCS471	Statistical Data Analysis with R
TCS431	Microcontroller and Its Interfacing
TCS495	**Foundation of Cyber Security**
TCS421	**Fundamentals of Statistics and AI**
TCS433	*Blockchain and its Applications (Through Swayam)
TCS465	*Linear Algebra (Through Swayam)

Graphic Era Hill University B.Tech. in Computer Science and Engineering (AI and ML)				
Semester IV				
COURSE MODULE				
COURSE				**Credits**
Code	**Title**	**NEP Component**	**AICTE Component**	
TCS402	Finite Automata and Formal Languages	DSC	PCC	3
TCS403	Microprocessors	DSC	PCC	3
TCS409	**Design and Analysis of Algorithms**	**DSC (PBL)**	**PCC**	**3**
TCS464	**Deep Learning**	**DSC (PBL)**	**PCC**	**3**
	Discipline Specific Elective-II	DSE	PEC	3
PCS403	Microprocessors Lab	DSC	LC	1
PCS409	DAA Lab	DSC	LC	1
PCS464	Deep Learning Lab	DSC	LC	1
XCS401	Career Skills-II	AEC	AEC	2
PESE400	Practical for Employability Skill Enhancement	SEC	SEC	1
SCS401	MOOCS Seminar	VAC	VAC	1
GP401	General Proficiency	SEC	SEC	1
			Total	**23**

Mandatory Non-Graded Course				
HSS203	Indian Constitution	MNG	MC	2

DISCIPLINE SPECIFIC ELECTIVE-II

COURSE CODE	COURSE NAME
TCS445	Responsible and Explainable AI (AI Ethics, Bias and Explainability)
TCS408(E)	**Programming in Java**
TCS484	Biometric Securities
TCS451	Virtualization and Cloud Computing
TCS471	Statistical Data Analysis with R
TCS431	Microcontroller and Its Interfacing
TCS495	Foundation of Cyber Security
TCS433	Blockchain and its Applications (Through Swayam)
TCS465	Linear Algebra (Through Swayam)
TCS463	Discrete Mathematics (Through Swayam)

Graphic Era Hill University
B.Tech. in Computer Science and Engineering (AI and DS)

Semester IV

COURSE MODULE

COURSE				Credits
Code	**Title**	**NEP Component**	**AICTE Component**	
TCS408	**Programming in Java**	**DSC (PBL)**	**PCC**	**3**
TCS402	Finite Automata and Formal Languages	DSC	PCC	3
TCS403	Microprocessors	DSC	PCC	3
TCS409	**Design and Analysis of Algorithms**	**DSC (PBL)**	**PCC**	**3**
	Discipline Specific Elective-II	DSE	PEC	3
PCS408	Java Programming Lab	DSC	LC	1
PCS403	Microprocessors Lab	DSC	LC	1
PCS409	DAA Lab	DSC	LC	1
XCS401	Career Skills-II	AEC	AEC	2
PESE400	Practical for Employability Skill Enhancement	SEC	SEC	1
SCS401	MOOCS Seminar	VAC	VAC	1
GP401	General Proficiency	SEC	SEC	1
			Total	**23**

Mandatory Non-Graded Course				
HSS203	Indian Constitution	MNG	MC	2

DISCIPLINE SPECIFIC ELECTIVE-II

COURSE CODE	COURSE NAME
TCS462	**Introduction to Big Data**
TCS471	Statistical Data Analysis with R
TCS451	Virtualization and Cloud Computing
TCS431	Microcontroller and Its Interfacing
TCS433	*Blockchain and its Applications (Through Swayam)
TCS465	*Linear Algebra (Through Swayam)

Graphic Era Hill University
B.Tech. in Computer Science and Engineering (Cyber Security)

Semester IV

COURSE MODULE

COURSE				Credits
Code	**Title**	**NEP Component**	**AICTE Component**	
TCS408	**Programming in Java**	**DSC (PBL)**	**PCC**	**3**
TCS402	Finite Automata and Formal Languages	DSC	PCC	3
TCS403	Microprocessors	DSC	PCC	3
TCS409	**Design and Analysis of Algorithms**	**DSC (PBL)**	**PCC**	**3**
	Discipline Specific Elective-II	DSE	PEC	3
PCS408	Java Programming Lab	DSC	LC	1
PCS403	Microprocessors Lab	DSC	LC	1
PCS409	DAA Lab	DSC	LC	1
XCS401	Career Skills-II	AEC	AEC	2
PESE400	Practical for Employability Skill Enhancement	SEC	SEC	1
SCS401	MOOCS Seminar	VAC	VAC	1
GP401	General Proficiency	SEC	SEC	1
			Total	**23**

Mandatory Non-Graded Course				
HSS203	Indian Constitution	MNG	MC	2

DISCIPLINE SPECIFIC ELECTIVE-II

COURSE CODE	COURSE NAME
TCS495	**Foundation of Cyber Security**
TCS451	Virtualization and Cloud Computing
TCS471	Statistical Data Analysis with R
TCS431	Microcontroller and Its Interfacing
TCS421	Fundamentals of Statistics and AI
TCS465	*Linear Algebra (Through Swayam)

GRAPHIC ERA HILL UNIVERSITY

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS408** Course Title: **Programming in JAVA**
2. Contact Hours: **L:** 3 **T**: 0 **P**: 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **ESE** 50
5. Credits: 3
6. Semester: IV
7. Category of Course: DSC
8. Pre-requisite: Fundamental of Computer & Introduction to Programming (TCS 101), Programming for problem solving(TCS 201), Data Structures with C(TCS 302), Object Oriented Programming with C++ (TCS 307)
9. Course Outcome:

	After completion of the course the students will be able to**:** CO1 Explain the Java programming features and develop programs to demonstrate the same. CO2 Make use of object oriented concepts to develop applications CO3 Classify exceptions and demonstrate applications for file handling and multithreading. CO4 Analyze collection framework and develop applications using GUI CO5 Compare and utilize collection framework for programming application CO6 Design applications for event handling and accessing databases using Java features.

10. **Details of the Course:**

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction to Java :** Java version history**,** Importance and features of Java, Concepts of Java Virtual machine (JVM), Setting up a Java Development Environment. **Variables and Data Types:** Keywords, Constants, Variables and data types, operators and expressions, Control statements, Conditional statements, loops and iterations, **Introduction to Arrays**: Declaring, Initializing, Accessing and Modifying arrays	10
Unit - II	**Methods and their uses:** void method, void with parameters, Pass by Value vs Pass by reference, Recursive Methods, Understanding the Method Call stack **Object Oriented Programming in Java:** Inheritance, super classes, multilevel hierarchy, abstract and final classes, overloading and overriding **Packages and interfaces**: Packages, Defining Packages, Using Packages, import and static import, Access protection. **Interface:** Defining Interfaces, abstract methods declarations, implementing interfaces, extended interfaces, interface references.	10
Unit – III	**Exception handling:** Exception Types, Exception class, Runtime Exception Class, Error Class, Checked and unchecked Exceptions, Defining new exceptions; Handling: try, catch and finally; throw statement, throws clause. **Input/Output:** Basics, Byte and Character Streams, reading and writing from console and file. **Multithreaded programming:** Java thread model, synchronization, messaging, thread class, Runnable interface, inter thread communication, Producer/ consumer problems, Wait () and notify ().	9
Unit – IV	**Java Collection and Generic Framework:** Introduction to Collection and Generic Framework: Interfaces Iterator, List, Set, Array List, Linked List Hash Set and Array Deque classes **Java Swing**: Introduction to Swings, Swing applications, Swing Controls :	9

	Java FX: JavaFX basics, stage, scene, pane, JavaFX Layouts and Scene builder, Animations in JavaFX	
Unit – V	**Event Handling:** Event delegation model, classes, Event Listener Interfaces,Adapter classes. **Java Database Connectivity (JDBC):** The Concept of JDBC, JDBC drivers, Querying / Retrieving Data, Update, Delete Statements, and Inserting related records (To be used with MySQL or PostgreSQL)	8
	Total	**46**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Herbert Schildt	Java 2 The Complete Reference	9th Edition	McGraw Hill Education	2017
E. Balaguruswamy	Programming with Java- a Primer	6th Edition	McGraw Hill Education	2019

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Kathy Sierra, Bert Bates, Trisha Gee	Head First Java: A Brain-Friendly Guide	3rd Edition	O'Reilly Media, Inc.	2022
Cay S. Horstmann	Core Java, Volume I (Fundamentals) and Volume II	12th Edition	Addison-Wesley Professional	2021
Cay S. Horstmann	Core Java Volume II (Advanced Features)	12th Edition	Oracle Press	2021

GRAPHIC ERA HILL UNIVERSITY

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 402** Course Title: **Finite Automata and Formal Languages**
2. Contact Hours: **L:** **3** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **ESE** **50**
5. Credits: **3**
6. Semester: **IV**
7. Category of Course: **DSC**
8. Pre-requisite: Engineering Mathematics-I (TMA 101), Engineering Mathematics-II (TMA 201)

9. Course Outcome:	After completion of the course the students will be able to**:** CO1: Demonstrate the conversion of NFA into DFA, ϵ-NFA into DFA and Minimization of Finite Automata by using Myhill-Nerode Theorem CO2: Formulate DFA, RE and FA with output. CO3: Design CFG and check the language is not CFL. CO4: Design PDA and convert n-PDA into d-PDA. CO5: Design Turing machines for addition, subtraction, multiplication etc. CO6:Formulate finite machines; push down automata and Turing machines for automated functioning of devices.

10.**Details of the Course:**

UNIT	**CONTENTS**	**Contact Hrs**
Unit – I	Introduction; Alphabets, Strings and Languages; Automata and Grammars, Deterministic finite Automata (DFA)-Formal Definition, Simplified notation: State transition graph, Transition table, Language of DFA, Nondeterministic finite Automata (NFA), NFA with epsilon transition, Language of NFA, Equivalence of NFA and	10

	DFA, Minimization of Finite Automata, Distinguishing one string from other, Myhill-Nerode Theorem	
Unit - II	Regular expression (RE), Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Kleen's Theorem, Regular expression to FA, DFA to Regular expression, Arden Theorem, Non Regular Languages, Pumping Lemma for regular Languages. Application of Pumping Lemma, Closure properties of Regular Languages, Decision properties of Regular Languages, FA with output: Moore and Mealy machine, Equivalence of Moore and Mealy Machine, Applications and Limitation of FA.	10
Unit – III	Context free grammar (CFG) and Context Free Languages (CFL): Definition, Examples, Derivation, Derivation trees, Ambiguity in Grammar, Inherent ambiguity, Ambiguous to Unambiguous CFG, Useless symbols, Simplification of CFGs, Normal forms for CFGs: CNF and GNF, Closure proper ties of CFLs, Decision Properties of CFLs: Emptiness, Finiteness and Membership, Pumping lemma for CFLs.	9
Unit – IV	Push Down Automata (PDA): Description and definition, Instantaneous Description, Language of PDA, Acceptance by Final state, Acceptance by empty stack, Deterministic PDA, Equivalence of PDA and CFG, CFG to PDA and PDA to CFG, Two stack PDA.	10
Unit – V	Turing machines (TM): Basic model, definition and representation, Instantaneous Description, Language acceptance by TM, Variants of Turing Machine, TM as Computer of Integer functions, Universal TM, Church's Thesis, Recursive and recursively enumerable languages, Halting problem, Introduction to Undecidability, Undecidable problems about TMs. Post correspondence problem (PCP), Modified PCP, Introduction to recursive function theory.	8
	Total	**47**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
J. Hopcroft, R. Motwani, and J. Ullman.	Introduction to Automata Theory, Languages, and Computation,	3rd Edition	Pearson Education India	2008
KLP Mishra and N. Chandrasekaran,	Theory of Computer Science: Automata, Languages and Computation	3rd Edition	Prentice Hall Of India	2007

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Michael Sipser	Introduction to the Theory of Computation	3rd Edition	PWS Publishing Company	2012
Peter Linz	Introduction to Formal Languages and Automata	6th Edition	Jones and Bartlett Publishers, Inc.	2016

GRAPHIC ERA HILL UNIVERSITY

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS403** Course Title: **Microprocessors**
2. Contact Hours: **L:** 3 **T**: 0 **P**: 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **ESE** 50
5. Credits: 3
6. Semester: IV
7. Category of Course: DSC
8. Pre-requisite: Basic Electronics Engineering(TEC 101 / TEC201), Fundamental of Computer & Introduction to Programming (TCS 101), TCS 301

9. Course Outcome:	After completion of the course the students will be able to**:** CO1 Identify of 8085 and 8086 microprocessors and memory segmentation CO2 Analysis of Instruction set of 8085and 8086. CO3 Implementation of different programs on 8085 and 8086 based microcomputer kit. CO4 Design the Interfacing of 8255 and 8085/8086. CO5 Design & develop Interfacing of microprocessor with Timing Devices1 CO6 Evaluate & Develop projects on embedded system using the foundation of microprocessor

10. **Details of the Course:**

UNIT	**CONTENTS**	**Contact Hrs**
Unit – I	Introduction to Microprocessors: Evolution of Microprocessors, Microcomputer , different type of buses, Example of an 8085 based System, Microprocessor Internal Architecture, Pin diagram and function of each pin, memory interfacing.	9

Unit - II	Programming with 8085: Instruction set, programming model of 8085, addressing modes, assembly language programming, Timing and control, peripheral I/O, memory mapped I/O, 8085 Interrupts, Stack and subroutines, Machine & Instruction cycle of 8085.	10
Unit – III	16 Bit Processor: 16-bit Microprocessors (8086): Architecture, pin diagram, Physical address, segmentation, memory organization, Bus cycle, Addressing modes, Instruction set ,Assembly Language Programming of 8086, comparison of 8086 & 8088	8
Unit – IV	Interfacing (Data Transfer) with Microprocessor: Data Transfer Schemes: Introduction, handshaking signals, Types of transmission, 8255 (PPI), Serial Data transfer (USART 8251), memory interfacing, 8257 (DMA), programmable interrupt Controller (8259).	9
Unit – V	Interfacing of Microprocessor with Timing Devices: Programmable Interval Timer/ Counter (8253/8254): Introduction, modes, Interfacing of 8253, applications, Need of ADC & DAC, resolution, Introduction to DAC & ADC, ADC & DAC Interfacing (0808, 0809).	9
	Total	**45**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Ramesh Gaonkar	Microprocessor Architecture, Programming, and Applications with the 8085	6th	Penram International Publication (India) Pvt. Ltd	2013
A. K. Ray & K. M. Bhurchandi	Advanced Microprocessors and peripherals	3rd	Tata McGraw Hill	2012

Muhammad Ali Mazidi, Janice Gillispie Mazidi,	8051 Microcontroller & Embedded System,	2nd	Pearson / PHI publication	2007

Reference Books:

Authors Name	**Title**	**Edition**	**Publisher, Country**	**Year**
Douglas V. Hall,	Microprocessors and Interfacing,	3rd	Tata McGraw Hill	2012
Barry B. Brey,	The Intel Microprocessors Architecture Programming and interfacing,	8th	Pearson	2012

GRAPHIC ERA HILL UNIVERSITY

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS451** Course Title: **Virtualization and Cloud Computing**
2. Contact Hours: **L:** 3 **T**: 1 **P**: 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **ESE** 50
5. Credits: 3
6. Semester: IV
7. Category of Course: DSE
8. Pre-requisite: Fundamental of Computer & Introduction to Programming(TCS 101), Fundamental of Cloud Computing and Bigdata(TCS351)

9. Course Outcome:	After completion of the course the students will be able to**:** CO1 Discuss the different paradigms of cloud computing. CO2 Contrast parallel and distributed computing. CO3 Identify the concept of virtualization technique. CO4 Apply virtualization technique in cloud computing platform. CO5 Describe the architectures of cloud computing. CO6 Demonstrate the Use case of the virtualization and cloud computing services.

10. **Details of the Course:**

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction to Cloud Computing** Why Cloud Computing (CC)? Different Perspectives on CC, Different Stakeholders in CC, Total cost of ownership (TCO) of on-premises IT, Cloud Computing Taxonomy, Characteristics of cloud computing, Characteristics of cloud computing as per NIST, Cloud Definitions. Cloud Computing at a Glance, The Vision of Cloud Computing, Cloud Computing Reference Model, Challenges Ahead, Historical Developments, Distributed Systems, Virtualization, Web 2.0, Service-Oriented Computing, Utility-Oriented Computing, Building Cloud Computing Environments, Application Development, Infrastructure and System Development, Computing Platforms	9

	and Technologies, Amazon Web Services (AWS), Google AppEngine, Microsoft Azure, Hadoop, Force.com and Salesforce.com	
Unit - II	**Virtualization** Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Execution Virtualization, Types of hardware virtualization: Full virtualization - partial virtualization - para virtualization Desktop virtualization: Software virtualization – Memory virtualization - Storage virtualization – Data Virtualization – Network virtualization, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples, Xen: Para virtualization, VMware: Full Virtualization, Microsoft Hyper-V.	9
Unit – III	**Virtual Machines** Virtual machines basics, Process virtual machines: Memory architecture emulation, Instruction emulation, Operating system emulation, Dynamic binary optimization, High level VN architecture, System virtual machines: Resource virtualization (Processors, Memory, Input/Output), Case Study of Intel VT-x	8
Unit – IV	**Parallel and Distributed Computing** Eras of Computing, Parallel vs. Distributed Computing, Elements of Parallel Computing, What is Parallel Processing?, Hardware Architectures for Parallel Processing, Approaches to Parallel Programming, Levels of Parallelism, Laws of Caution, Elements of Distributed Computing, General Concepts and Definitions, Components of a Distributed System, Architectural Styles for Distributed Computing, Models for Inter-Process Communication, Technologies for Distributed Computing, Remote Procedure Call, Distributed Object Frameworks, Service Oriented Computing	8
Unit – V	**Cloud Computing Architecture** Fundamental Cloud Architectures - Workload Distribution Architecture - Resource Pooling Architecture - Dynamic Scalability Architecture – Elastic Resource Capacity Architecture -Service Load Balancing Architecture – Cloud Bursting Architecture - Elastic Disk Provisioning Architecture – Redundant Storage Architecture. Cloud Computing Reference Architecture (CCRA): Introduction, benefits of CCRA, Migrating into a Cloud: Introduction, Challenges while migrating to Cloud, Broad approaches to migrating into the cloud, Seven-step model of migration into a cloud, Migration Risks and Mitigation.	9

	Total	**43**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi	Mastering Cloud Computing	1st Edition	McGraw Hill Education	2017
Jim Smith , Ravi Nair	Virtual Machines: Versatile Platforms for Systems and Processes	1st Edition	Morgan Kaufmann	2005
Pachghare V. K.	Cloud Computing	1st Edition	PHI Learning Pvt Ltd	2016

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Barrie Sosinsky	Cloud Computing Bible	1st Edition	Wiley	2011

GRAPHIC ERA HILL UNIVERSITY

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS471** Course Title: **Statistical Data Analysis with R**
2. Contact Hours: **L:** 3 **T**: 1 **P**: 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **ESE** 50
5. Credits: 3
6. Semester: IV
7. Category of Course: DSE
8. Pre-requisite: Engineering Mathematics-I (TMA101), Programming for problem solving(TCS 201), Fundamental of Cloud Computing and Bigdata(TCS351)

9. Course Outcome:	After completion of the course the students will be able to:
	CO1 Understand the concepts of statistics
	CO2 Apply the probability distribution techniques in different applications.
	CO3 Understand the needs of data pre-processing
	CO4 Implement the manipulation and processing of data in R
	CO5 Apply the concepts of functions in R
	CO6 Understand the use of R in data Analytics

10. **Details of the Course:**

UNIT	CONTENTS	Contact Hrs
Unit – I	**Statistics:** Introduction to Statistics- Descriptive Statistics, Summary Statistics Basic probability theory, Statistical Concepts (uni-variate and bi-variate sampling, distributions, re-sampling, statistical Inference, prediction error),	9
Unit - II	**Probability Distribution:** Introduction to Probability**,** Probability Distribution (Continuous and discrete- Normal, Bernoulli, Binomial, Negative Binomial, Geometric and Poisson distribution) , Bayes' Theorem, Central Limit theorem, Data	10

	Exploration & preparation, Concepts of Correlation, Regression, Covariance, Outliers.	
Unit – III	**Introduction to R and Data Pre-processing:** Introduction & Installation of R, R Basics, Finding Help, Code Editors for R, Command Packages, Manipulating and Processing Data in R, Reading and Getting Data into R, Exporting Data from R	10
Unit – IV	**Objects and Data Types**: Data Objects-Data Types & Data Structure. Viewing Named Objects, Structure of Data Items, Manipulating and Processing Data in R (Creating, Accessing, Sorting data frames, Extracting, Combining, Merging, reshaping data frames), Control Structures	8
Unit – V	**Functions:** Functions in R (numeric, character, statistical), working with objects, Viewing Objects within Objects, Constructing Data Objects, Building R Packages, Running and Manipulating Packages, Non parametric Tests- ANOVA, chi-Square, t-Test, U-Test, Introduction to Graphical Analysis, Using Plots(Box Plots, Scatter plot, Pie Charts, Bar charts, Line Chart), Plotting variables, Designing Special Plots, Simple Liner Regression, Multiple Regression	9
	Total	**46**

Text Books:

Authors Name	**Title**	**Edition**	**Publisher, Country**	**Year**
Mark Gardener	Beginning R: The Statistical Programming Language	1st Edition	Wiley	2013
Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani	An Introduction to Statistical Learning: with	2nd Edition	Springer	2021

	Applications in R			

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
N Das	Statistical Methods (Combined edition volume 1 & 2) Paperback – 1 July 2017	1st Edition	McGraw Hill Education	2017

GRAPHIC ERA HILL UNIVERSITY

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 495** Course Title: **Foundation of Cyber Security**
2. Contact Hours: **L:** **4** **T**: **0** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0**
4. Relative Weight: **CIE** **25** **MSE** **25** **ESE** **50**
5. Credits: **3**
6. Semester: **IV**
7. Category of Course: **DSE**
8. Pre-requisite: Introduction to Cryptography (TCS392)

9. Course Outcome:	After completion of the course the students will be able to**:** CO1 Explain different cyber threats and attacks CO2 Know the working of various cyber-attacks and cyber security protocols CO3 Analyse the different cyber security protocols. CO4 Use scripting language to implement security protocols. CO5 Apply security techniques to secure web applications CO6 Develop cyber security protocols.

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to Cyber Security What is Cyber security, why we need Cyber security, The Zero Trust Model, Overview of ethical hacking. Protect Against - Unauthorized Modification, Unauthorized Deletion and Unauthorized Access. Three pillars of Cyber Security - Confidentiality, Availability and Integrity. Steps to fix a crime - Identify Cyber Threats, Analyse and Evaluate Threat, Treatment. Type of Hackers - White Hat, Great Hat, Black Hat. Penetration Testing and its Phases - Reconnaissance, Scanning, Gaining Access, Maintaining Access, Covering Tracks.	9
2	**Unit 2**: Linux Basics and Scripting for Ethical Hacking	10

	Bash, Linux commands, man page, adding and deleting, users and adding them to sudo group, switching users, creating, copying, moving and removing file, Writing and appending text to a file, file permissions, working with editors, grep, cut command, starting and stopping services Introduction to Bash scripting - Basics of Bash or Shell scripting, conditional statements, loops, manipulating files Introduction to Python - Basics of Python, conditional statements, loops, list, tuple, dictionary, functions.	
3	**Unit 3:** Networking Basics for Ethical Hacking Virtualization - Installing and configuring virtual machine, Network address translation, differences of IPv4 and IPv6, IP Address, Mac Address, TCP 3-way handshake, netcat - The Swiss Army Knife of TCP/IP Connections, use netcat to Listen on a port, pushing a command shell back to listener, transfer files, ICMP and Ping command, use of Wireshark tool.	9
4	**Unit 4:** Basics of Web and Web Security The client-server model for the web, various web threats and attacks, web cross site scripting (XSS) attack and use of scripting languages, phishing attacks, spear phishing, SQL injection attack, use of web penetration testing tools.	9
5	**Unit 5:** Introduction to Cyber Threats and System Hacking Cyber threats - malware, password attacks, distributed denial-of-service (DDos), ransomware attack, eavesdropping attack (man in the middle attack), birthday attack, IP and mac address spoofing, anonymous browsing and use of tor browser.	10
	Total	**47**

Text Books:

Authors Name	**Title**	**Edition**	**Publisher, Country**	**Year**
Anne Kohnke, Dan Shoemaker, Ken E. Sigler	The Complete Guide to Cybersecurity Risks and Controls (Internal Audit and IT Audit)	1st edition	Taylor & Francis Ltd	2022

Georgia Weidman	Penetration Testing: A Hands-On Introduction to Hacking	1st Edition	No Starch Press, USA	2014
Nina Godbole and Sunit Belapure	Cyber security : understanding cyber crimes, computer forensics and legal perspectives	1st Edition	Wiley, India	2011

Reference Books:

Authors Name	**Title**	**Edition**	**Publisher, Country**	**Year**
OccupyTheWeb	Linux Basics for Hackers: Getting Started with Networking, Scripting, and Security in Kali	Illustrated Edition	No Starch Press, USA	2018

GRAPHIC ERA HILL UNIVERSITY

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS421** Course Title: **Fundamental of Statistics and AI**
2. Contact Hours: **L:** 3 **T**: 0 **P**: 0
3. Examination Duration (Hrs): **Theory** 4 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **ESE** 50
5. Credits: 3
6. Semester: 4
7. Category of Course: DSE
8. Pre-requisite: Engineering Mathematics-I (TMA101), Engineering Mathematics-II (TMA201), Python Programming for Computing (TCS341)

9. Course Outcome:	After completion of the course the students will be able to**:** CO1 Demonstrate knowledge of statistical and exploratory data analysis data analysis techniques utilized in decision making. CO2 Apply principles of Data Science to the analysis of business problems. CO3 To use Machine Learning Algorithms to solve real-world problems. CO4 To provide data science solution to business problems and visualization. CO5 To learn the basic concepts and techniques of AI and machine learning CO6 To explore the various mechanism of Knowledge and Reasoning used for building expert system

10. **Details of the Course:**

S. No.	Contents	Contact Hours
1	**Unit 1:** **Introduction to AI** Definition, Problem, State space representation. Intelligent Systems: Categorization of Intelligent System, Components of AI Program,	10

	Foundations of AI, Applications of AI, Current trends in AI, Intelligent Agents: Anatomy, structure, Types	
2	**Unit 2:** **Problem solving** Solving problem by Searching: Problem Solving Agent, Formulating Problems. Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search. Local Search Algorithms and Optimization Problems: Hill climbing search Simulated annealing, Local beam search.	9
3	**Unit 3:** **An Introduction to Data Science, Data Processing and Visualization** Definition, working, benefits and uses of Data Science, Data science vs. Business Intelligence, The data science process, Role of a Data Scientist. Data Processing and Visualization**:** **Data** Formatting, Exploratory Data Analysis, Filtering, and hierarchical indexing using Pandas. Data Visualization: Basic Visualization Tools, Specialized Visualization Tools, Seaborn Creating and Plotting Maps.	9
4	**Unit 4:** **Statistical Data Analysis & Inference** Populations and samples, Statistical modelling, probability distributions, fittings a model, Statistical methods for evaluation, Exploratory Data Analysis, Getting started with R, Manipulating and Processing data in R, working with function in R, working with descriptive Statistics, Working with graph plot in R.	9

5	**Unit 5:** **Statistical Applications** Basic Statistical operations, Linear Regression Analysis, Logistic and Exponential Regression, Time Series Analysis, Probability Distribution, ANOVA, Correlation and Covariance.	8
	Total	**45**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Tom M. Mitchell	Machine Learning	1st Edition	McGraw Hill Education	2017
K.G. Srinivasa, G.M. Siddesh, Chetan Shetty, Sowmya B.J.	Statistical Programming in R	1st Edition	Oxford University Press	2017

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year

GRAPHIC ERA HILL UNIVERSITY

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS464** Course Title: **Deep Learning**
2. Contact Hours: **L:** 3 **T**: 0 **P**: 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **ESE** 50
5. Credits: 3
6. Semester: IV
7. Category of Course: DSC
8. Pre-requisite: Fundamentals of Artificial Intelligence and Machine Learning (TCS364), Python Programming (TCS346)

9. **Course Outcome:**	After completion of the course, the students will be able to**:** CO1: Define the fundamental concepts of artificial neural networks and differentiate between perceptrons and deep neural networks. CO2: Describe the architecture and functionalities of Convolutional Neural Networks (CNNs) for image processing tasks. CO3: Implement basic neural network architectures using popular deep learning libraries. CO4: Analyze the impact of different activation functions on the performance of neural networks. CO5: Choose suitable deep learning architectures (CNNs, RNNs) based on the specific problem and data characteristics. CO6: Design and implement a deep learning model (e.g., CNN or LSTM) to solve a simple engineering-related problem

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours

1	**UNIT 1: Introduction to Neural Networks and Deep Neural Networks** Basics of neural networks, Perceptrons and activation functions, Architecture of a simple neural network Multi-layer perceptrons (MLP), Forward propagation and backpropagation, Loss functions and optimization algorithms	10
2	**UNIT 2: Convolutional Neural Networks (CNNs)** Understanding convolutions and pooling, Architecture of CNNs, Applications in image recognition and processing	10
3	**UNIT 3: Recurrent Neural Networks (RNNs) and LSTMs** Basics of RNNs, Problems with RNNs (vanishing and exploding gradients), Long Short-Term Memory (LSTM) networks	10
4	**UNIT 4: Advanced Topics in Deep Learning** Autoencoders, Generative Adversarial Networks (GANs), Transfer learning and fine-tuning	10
5	**UNIT 5: Practical Applications of Deep Learning** Natural Language Processing (NLP), Autonomous vehicles, Medical image analysis	8
	Total	**48**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
John D. Kelleher	Deep Learning	1st Edition	MIT Press, USA	2019
Francois Chollet	Deep Learning with Python	2nd Edition	Manning Publications Co., USA	2024
Amlan Chakrabarti Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra	Deep Learning	1st Edition	Pearson, India	2021

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Maxime Chevalier-Boisvert, Julien Rougerie, and Fabian-Robert Picard	Recurrent Neural Networks for Beginners	1st Edition	Packt Publishing Ltd, UK	2021
Aurélien Géron	Hands-On Machine Learning with	2nd Edition	O'Reilly Media, Inc., USA	2024

	Scikit-Learn, Keras & TensorFlow			

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SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 462** Course Title: **Introduction to Big Data**
2. Contact Hours: **L:** 3 **T:** 1 **P:** 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **ESE** 50
5. Credits: 3
6. Semester: IV
7. Category of Course: DSE
8. Pre-requisite: (**TCS-342) Introduction to Statistical Data Science, TCS-302 Data structures with C**

9. **Course Outcome:**	After completion of the course, the students will be able to**:** CO1: Outline the theory of big data, and explain challenges of big data CO2: Understand the types of Big data and its characteristics CO3: Compare Business Intelligence Vs Big Data CO4: Get the idea of NoSQL databases, different types of NoSQL/NewSQL datastores CO5: Discuss various types of Big Data analytics CO6: Elaborate a Big Data management architecture

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Big Data and its Challenges** Defining Big Data, Characteristics of Big Data, Evolution of Big Data, Traditional Business Intelligence vs Big Data, The Evolution of Data Management, Understanding the Waves of Managing Data, creating manageable data structures, Web and content management, Managing big data. Building a Successful Big Data Management Architecture, beginning with capture, organize, integrate, analyze, and act, Setting the architectural foundation, Performance matters, Traditional and advanced analytics.	**9**
2	**Unit 2:** **Big Data Types and its Sources** Defining Structured Data Exploring sources of big structured data, Understanding the role of relational databases in big data Defining Unstructured Data, exploring sources of unstructured data, Understanding the role of a CMS in big data management. Looking at Real-Time and Non Real-Time Requirements, Putting Big Data Together, managing different data types, integrating data types into a big data environment.	**8**
3	**Unit 3:** **Technology Foundations of Big Data** Exploring the Big Data Stack: - Layer 0: Redundant Physical Infrastructure - Physical redundant networks, Managing hardware: Storage and servers, Infrastructure operations - Layer 1: Security Infrastructure, Interfaces and Feeds to and from Applications and the Internet- Layer 2: Operational Databases. Layer 3: Organizing Data Services and Tools. Layer 4: Analytical Data Warehouses, Big Data Analytics, Big Data Applications.	**9**

4	**Unit 4:** **Introduction to NoSQL and NewSQL** Introduction to NoSQL, Uses, Features and Types, Need, Advantages, Disadvantages and Application of NoSQL, Overview of NewSQL. RDBMSs Are Important in a Big Data Environment. PostgreSQL relational database. Nonrelational Databases. Key-Value Pair Databases - Riak keyvalue database. Document Databases MongoDB, CouchDB . Columnar Databases, HBase columnar database. Graph Databases- Neo4J graph database.	**8**
5	**Unit 5:** **Big Data Analytics** Basic analytics, Advanced analytics, Operationalized analytics, Monetizing analytics. Modifying Business Intelligence Products to Handle Big Data, Studying Big Data Analytics Examples, Terminologies used in Big Data environment.	**8**
	Total	**42**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Judith Hurwitz, Alan Nugent , Fern Halper , Marcia Kaufman	Big Data for Dummies	1st	Wiley, United States	2013
Subhashini Chellappan Seema Acharya	Big Data and Analytics	2nd	Wiley, United States	2019
DT Editorial Services	Big Data	1st	Dreamtech Press, New Dehli	2016

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Michele Chambers, Michael	Big Data, Big Analytics: Emerging	1st	Wiley, United States	2013

Minelli , Ambiga Dhiraj	Business Intelligence and Analytic Trends for Today's Businesses			

GRAPHIC ERA Hill UNIVERSITY, DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS409** Course Title: **Design and Analysis of Algorithms**
2. Contact Hours: **L:** 3 **T**: 0 **P**: 0
3. Examination Duration (Hrs): **Theory** 3 **Practical** 0
4. Relative Weight: **CIE** 25 **MSE** 25 **ESE** 50
5. Credits: 3
6. Semester: IV
7. Category of Course: DSC
8. Pre-requisite: Fundamental of Computer & Introduction to Programming (TCS101), Programming for problem solving (TCS201), Data Structures with C (TCS302)

9. Course Outcome:	After completion of the course the students will be able to**:** CO1 Discuss various asymptotic notations to analyse time and space complexity of algorithms CO2 Analyse the various paradigms for designing efficient algorithms using concepts of design and conquer, greedy and dynamic programming techniques CO3 Provide solutions to complex problems using the concept of back tracking and branch and bound techniques. CO4 Apply algorithm design techniques to predict the complexity of certain NP complete problems. CO5 Implement Dijkstra's, Bellman-ford, Prims, Kruskal's algorithms to solve the real world problems like traveling salesman problem, job sequencing, packet routing. CO6 Apply pattern matching algorithms like Rabin Karp Algorithm, Brute-force techniques etc., to find a particular pattern.

10. **Details of the Course:**

UNIT	CONTENTS	Contact Hrs

Unit – I	**Asymptotic Notations and Searching Algorithms** **Introduction to Algorithms -** What is an Algorithm, Rate of growth, Commonly used rate of growths, Types of analysis, Asymptotic Notations, Solving Recurrence relations using Master Method, Iteration, Recursion Tree, and Substitution Method **Searching -** Linear search (sorted and unsorted), Iterative and recursive binary search, Exponential search, Tower of Hanoi and solving its recursion, Fibonacci and solving its recursion	8
Unit - II	**Sorting Algorithms** **Sorting -** Bubble sort, Insertion sort, selection sort, quick sort, randomized quick sort, merge sort, Heap sort, counting sort, External sorting, Radix sort , bucket sort. **Divide sorting algorithms into following types -** online sort, stable sort, in place sort, Comparison of sorting algorithms on the basis of number of swaps, by number of comparisons, recursive or iterative nature, time and space complexity **Backtracking:** N-Queens Problem, Hamiltonian Path, Graph Coloring, Subset Sum	10
Unit – III	**Graph Algorithms** Representation of Graphs, Breadth-first search (BFS), depth-first search (DFS), topological sort, Difference between BFS and DFS **Data structures for disjoint sets -** Finding cycle in a graph, Finding strongly connected components **Minimum spanning trees -** Kruskal and Prim algorithms (Greedy Algorithms) **Single source shortest paths -** Dijkstra (Greedy Approach) and Bellman ford (Dynamic Programming)	12

	algorithms, Working on -ve edge & cycle, difference & similarity. **All pair shortest paths -** The Floyd Warshall algorithm	
Unit – IV	**Algorithm Design Techniques - Greedy and Dynamic Programming** **Greedy algorithms** –Optimal substructure property, Activity selection problem, Job sequencing problem, Huffman codes, fractional knapsack problem **Dynamic Programming -** Overlapping substructure property, Optimal substructure property, Tabulation vs Memorization, Fibonacci numbers, 0/1 Knapsack problem, Longest common subsequence, Matrix chain multiplication, Longest increasing subsequence.	10
Unit – V	**Hashing, String Matching and NP-Completeness** **Hashing -** Introduction to Hashing, Hash function, Collision and collision handling, - Chaining, Open addressing (longest probing, quadratic probing, double hashing) **String Matching -** Naive string-matching algorithm, The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm **NP-Completeness** - Importance of NP-completeness, P, NP, NP Complete and NP hard problems, Polynomial time and polynomial time verification, The subset-sum problem, The traveling salesman problem	10
	Total	**50**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year

Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, and Clifford Stein	Introduction to Algorithms	4th Edition	MIT Press	2022

Reference Books:

Authors Name	**Title**	**Edition**	**Publisher, Country**	**Year**
Donald Knuth	Art of Computer Programming, The: Volume 1: Fundamental Algorithms (ART OF COMPUTER PROGRAMMING)	3rd Edition	Addison-Wesley	1998
Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran:"	Fundamentals of Computer Algorithms	2nd Edition	Universities press	2007
Anany Levitin	Introduction to the Design & Analysis of Algorithms	2nd Edition	Pearson Education	2008